VOLUME 2 NUMBER 1

MAY, 1916

THE MINERAL RESOURCES OF OREGON

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The Oregon Bureau of Mines and Geology

See Oregon First

Capitalize Oregon Scenery

Waterfall in Cascade Range
Photo by Weister

Some Little-Known Scenic Pleasure Places in the Cascade Range in Oregon

By IRA A. WILLIAMS

114 Pages 66 Illustrations

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CONTAINING

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ANNOUNCEMENT

With this issue we present the first number of Volume 2 of The Mineral Resources of Oregon. This is the first issue since December, 1914, and the first to be completed for publication giving results of field work during the past season. It is a preliminary paper involving the general geology of the Cascade Range and is to be followed by detailed reports upon the various other economic resources of the Range. Reports on other sections of the state will also be published later in the year as a result of field work during the summers of 1915-1916.

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VOLUME 2 NUMBER 1

MAY, 1916

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of all her Minerals

PUBLISHED MONTHLY AT CORVALLIS BY

THE OREGON BUREAU OF MINES AND GEOLOGY

H. M. PARKS, Director

SOME LITTLE-KNOWN SCENIC PLEASURE PLACES IN THE CASCADE RANGE IN OREGON

By IRA A. WILLIAMS

As a reader of this issue of the Mineral Resources of Oregon, do you know that Oregon possesses in her scenery an only slightly developed asset that can be made equal in economic importance to some of her principal industries? To bring Oregon into her own in this respect is requiring perseverance on the part of her inhabitants, and the expenditure of both money and energy, just as are these required for the opening of her paying mines, the establishment of her prosperous farming communities, the initiation of her large lumbering and fishing enterprises. Oregon today is thoroughly alive to this responsibility, however, and realizes the opportuneness of the present time to enter upon a campaign of active and substantial development of her scenic resources. The following article will interest you.

"SEE OREGON FIRST"

THERE seems to be a natural inclination on the part of many people who live in this western country to consider that the much used slogan "See America First" is not necessarily intended to apply to them; at least not in so forceful a degree as to those who live in lands where mountains and forests and canyons are not ever present features of their surroundings. We in Oregon quite generally realize that there is an abundance of scenic attractions at our very doors which therefore may be enjoyed at our convenience. As a result of this general impression that at home Oregon scenery is plentiful and always easy of access, many of us not only do not take our outings within our own state but deliberately plan vacation trips at greater expense and measurably less ultimate pleasure and satisfaction, if the truth were known, into neighboring states and other distant regions.

The scenic resources of the state are thus in the minds of many reduced to the commonplace, while, as a matter of poignant fact, the scenery to be found in the mountains of Oregon is equaled in magnificence by few and surpassed by no other equally accessible region on the entire continent. The varied opportunity this state affords for the exercise of the out-of-door spirit, whether on the part of the prospector, of the hunter, the fisherman, the naturalist or the climber of mountains, is unexcelled anywhere.

To substantiate this fact one needs call to mind the familiar names of but a few of Oregon's prime attractions: the great Columbia river gorge with its matchless waterfalls and towering cliffs; Crater lake, unique, colossal, world-famed; superb Mt. Hood; the noted limestone caves of Josephine county. Less famous, because less known, are Oregon's Matterhorn, Mt. Jefferson, the Three Sisters peaks and their glaciers, glacier-scored Diamond Peak, Mt. Thielsen, in appearance the Mount Pelee of the Cascades, Mt. McLoughlin; and Eagle Cap in the Wallowa mountains. Then there are the scores of lesser peaks and craters from which cubic miles of fresh lavas have issued; profound canyons innumerable, plunging cataracts and literally myriads of beautiful lakes and winding rivers.

The Nation's scenic watchword

The timeliness of "See America First" as most excellent advice for all wide-awake Americans must be admitted without reserve. For the people of Oregon, however, those who have leisure, men in all busy occupations of life, those whose duty it is to attract travel to the state and to explain its advantages as a place to live; for every live resident of this big state of ours, the national cry should be paraphrased into "*See Oregon First*". "See Oregon First" can be made the watchword of every Oregon person. It can be made made so if, when freedom permits, Oregonians will practice as well as pronounce this kind of allegiance to their home state. To bring this about the idea must, in some way, be made to sink deeply into the conscience and heart of every loyal citizen.

Glittering phrases and spectacular expressions when put in print are usually thought of as the ammunition of the habitual booster, and it is well known that their use is not always strictly confined to the presentation of the truth. On the other hand, there is no more fruitful method of advertising a meritorious article than by the adoption of a "trade-mark," a word, a set of words, caricature or design, that by continued use comes to stand for something that intelligent people may depend upon. Such a mark of merit uniformly admits its bearer everywhere, whether it be attached to a household article, farm implement, an organization, to a state or other commonwealth. Its mere use or mention is an introduction to something that is worthy and substantial. In just this way has the Portland Rose Festival become known the country over. "For you a rose in Portland grows" is accepted as literal truth because this great pageant has year after year justified itself and proved to thousands the right of that city to be heralded as the city of roses.

Oregon's scenic trade-mark

In the same manner has Oregon, a state filled with so bewildering a variety of scenic attractions, won the right to urge upon its own inhabitants and to emblazon to the world so commonplace, yet trenchant, a bit of advice as "*See Oregon First.*" The applicability of this slogan is based upon a resource of which Oregon posesses a preeminent amount. No one who has ever heeded this advice, whether citizen of Oregon or visitor from other state or land, has conscientiously said that it is in the slightest degree inappropriate. In fact, it is the devoted followers of "*See Oregon First*" that are the most active agents in broadcasting that happy idea to the world. The thought is one that should be kept before the minds of our children in the schools. It should be impressed upon the consciences of business and professional men and by all heralded far and wide as the recreational motto of a great state. In this way those at a distance should be told and invited to share the joys that are ours. 'If to our own *State* we be true it follows as the night the day, we can not be false to anyone.'

Financial value of Oregon scenery

Sordid figures may sound scarcely in place amongst visions of beautiful scenery. But even numbers may be made to contribute a delicate even if practical touch to the problem. There is in Oregon but one national park, that which encloses as the major attraction, Mt. Mazama in which is Crater Lake. Statistics of the past two years for Crater Lake National Park show that in 1914, 7,096 persons were admitted, and in 1915, 11,371 persons, the last an increase of more than 60 per cent over the admission for the preceding year. In 1914, 1,107 automobiles entered the park and in 1915, 2,015, an increase of over 80 per cent. Of the automobiles admitted, a considerable proportion are known to have come from outside of Oregon, many from states beyond the Rockies. We may confidently accept these numbers as indicating the growing appreciation of the scenic value of this one of Oregon's natural features by those who live in Oregon and those who pass through it.

We may further ponder the figures. In round numbers 11,000 persons entered the Park in 1915. The probable shortest stay of the average visitor is one day. It is apparent that the majority of visitors entered the park in automobiles. If we assume that on the average each person expended the cost of one day's stay while in the park, including personal expenses and supplies, the account may stand something like this: 11,000 persons at a minimum of $3.00 per day—$33,000. 2000 automobiles at, say $2.00 per day—$4,000, making a total of at least $37,000 expended within the park by one-day visitors the past season. This amount is interest at 10 per cent on $370,000. In 1914, 7,000 persons visited the park. Estimating on a similar basis, a minimum of $23,500 was spent by visitors in the park that year, which is 10 per cent in value of two-thirds of the former amount. The reasonable assumption is that the increased attendance is an indication of the recognition by the people of the state and country of the worth of this one of Oregon's scenic attractions. Crater Lake is being recognized because it is accessible. Its economic valuation thus raised during last year at least 57 per cent. With the improvements now being made and the general awakening of American people to home attractions, there is every reason to anticipate a continued swelling of the tourist traffic for each of several seasons to come. Each of these years its value will rise in similar proportion. It is easy arithmetic to determine at such a rate just how soon Crater Lake, but one of Oregon's attractions, will be creating an income of millions per year instead of thousands, besides bringing many people to Oregon that might otherwise never come.

The above figures take no account of extras indulged in by nearly every one, photographs, postcards, boat rental at the lake, etc., nor the cost of reaching and leaving the park, items all properly creditable to this particular one of Oregon's scenic spots. Many of these persons have traveled hundreds of miles from their homes both within and without the state for the sole purpose of seeing Crater Lake, the cost of such travel swelling in like amount the value of this feature as an economic resource.

Yet a few further figures for comparison will be instructive. In 1915, 51,820 people visited Yellowstone National Park, an increase of more than 150 per cent over the record for the preceding year. 34,814 people entered Mt. Rainier National Park in our sister state in 1915. There too, the attendance jumped over 140 per cent from that of 1914. As far back as 1913 concessionaires' receipts for the year in Yellowstone park amounted to over one million dollars. The difference in admissions to these two well known pleasure places is due less to their particular scenic features than to the accommodations for reaching and sojourning in them. These parks have been improved and persistently advertised throughout the years in a multitude of ways and thus brought to the attention of the world.

Capitalize Oregon scenery

The foregoing data are presented only to emphatically suggest what may be the financial possibilities to Oregon from her scenery. We have no way of even estimating in concrete form the value of her many other scenic spots. We know that thousands of sightseers already yearly travel the Columbia River Highway, as they do also the McKenzie road across the crest of the Cascade range. Hundreds of persons annually flock to our hot and mineral springs. A much lower number reach the less accessible, though no less magnificient, other pleasure places, of which there are many throughout the principal mountain ranges of Oregon. Were it possible to appraise the value of Oregon's scenic resources and to express that value in dollars and cents, even those meager small portions that are now generally known to the sightseeing public, it is not overstating the case to say that we would obtain a figure that would, without question, compare very favorably with the valuation of some of her other much better developed industries. Some day in the future it may be possible to do this and the gratifying thing about the matter is, there is enough for everybody. The state's resources in scenery are not consumed or rendered sterile by use as are her soils, depleted as are the forests, or become exhausted as do mines. All may enjoy scenery, the same scenery, throughout time. The more use made of it, the greater its value and the more substantial a source of income to the state does it become. *Oregon's scenery, and her pleasure places, constitute just as truly one of her principal undeveloped economic assets* as do her mines, her vast timber resources, even her agriculture, the extent of each of which is only beginning to be realized. *Capitalize Oregon Scenery.*

SCENIC FEATURES OF OREGON

THE State of Oregon is one of large size and small population. Being a state of giant forests and great mountain ranges it is to be expected that many parts of it would remain practically unknown for many years after settlement began. Today there are sections in each of the principal mountain ranges whose character is known only to the forest ranger and the hunter, the prospector and the occasional mountain climber. Some of these little explored regions possess attractions that, were they located so as to be easily reached, would class them high among the scenic features of the continent. Yearly more is being learned of these places, more publicity is being given to them, and with the rapid development of the various fundamental resources of the state they too will be gradually opened up, their beauties described and rendered available for our enjoyment and pleasure. That they will constitute important sources of added financial income to the state need not again be stated.

During the summer of 1915 the Oregon Bureau of Mines and Geology despatched a party into the Cascade range to make a reconnaissance trip along the crest of the range. Prior to this time some of the main geologic features of the range have been known in a general way, but theretofore no careful inspection of it had been made with a view to determining the source and character of the lavas that have issued along its crest, or their relation to the present peaks and less conspicious craters so plentifully scattered throughout its whole extent from north to south across the state. A further and chief purpose in all geologic work is the study of mineral deposits and the discovery or determination of the likelihood of the occurrence of bodies of ores of economic value.

Much prospecting and some mining has been done at various places in the Cascade range but, so far, such work has been carried on more or less haphazard and without the assistance that a thorough knowledge of the geologic conditions there would supply. This knowledge is now being acquired by the Oregon Bureau of Mines and Geology and the results of field work in those particular regions will be published from time to time during the coming years for the use of miners and prospectors.

Geology of scenery

Inasmuch as Oregon scenery is not surpassed in excellence anywhere, and since it cannot fail to become from the economic standpoint one of the state's great resources, considerable attention has been directed toward acquiring an understanding of the combination of conditions which produce features that are called scenic. Obviously scenery depends in all cases most largely, often entirely, upon the working of geologic processes. Forests adorn and grass and flowers decorate the earth features of hill or mountain, rock ridge, glacial meadow or sloping canyon wall. But these are mere veneer, the embroidery, as it were, that give the final beauty touch or setting to forms already built through volcanic agencies, the plowing action of the glaciers, the erosion of powerful rivers. Add to these uncounted lakes, bedeck the peaks with snowfield and glacier, place roaring rivers in each of a bewilderingly intricate meshwork of canyons and the geologic picture is complete. Thus the problem of scenery becomes one first of geology, then and secondly of *economic* geology for the reason that people come long distances and pay freely to enjoy it and through it revenue is yielded to the state.

Localities to be visited

It is proposed in this paper to call attention to some of the less known localities along the crest of the Cascade range that, though distant, have been found to possess an abundant scenic interest. Two particular localities stand out vividly in the writer's mind as exercising strong appeal to any one who has a love for the primitive in nature, the gigantic and the beautiful. These are Jefferson Park at the north foot of Mt. Jefferson, and the Three Sisters region, the position of which is indicated by the names of the peaks themselves. The two places are shown on the accompanying map which is a portion of an enlarged photograph of the large scale relief map of Oregon. The main wagon roads and principal trails are indicated on this map. Practically all of the area covered by it is within the national domain. This fact is one that assures proper protection and use of whatever valuable resources may exist there. Within the area of the map is included a portion of the Oregon National Forest at the north and from north to south parts of the Santiam, Deschutes, Cascade, Umpqua, and Crater National forests. The Warm Springs Indian Reservation lies north of the Deschutes forest and extends to the Cascade divide.

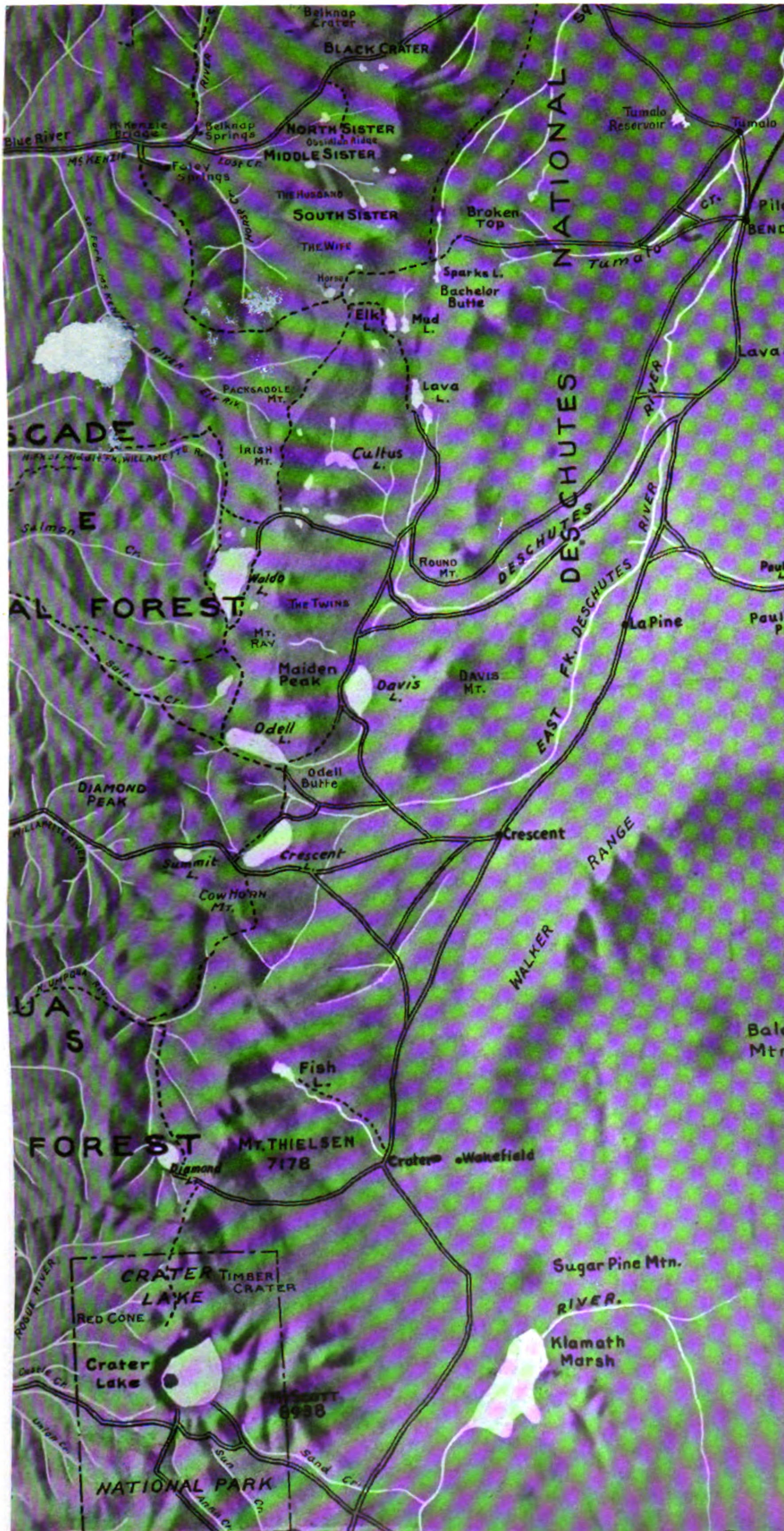
If one were to contemplate a visit to this region of rugged mountains, which, as the map shows, covers only the crest or summit portion of the Cascade range, he would first familiarize himself with whatever roads and trails there might be by which he could reach any particular locality. This information is to be obtained from maps, the most serviceable being those made by the United States Forest Service. Should one be so disposed that an extended trip into various parts of this interesting section could be undertaken, requiring a month or more of time, it would be necessary to ascertain not only the routes by which the different places of interest could be reached, but the plans for the trip must be so laid that replenishment of supplies will be possible at occasional points as needed. The geography of the entire region must from this standpoint be carefully studied and a working acquaintance gained with distances as well as places, also with the character of the trails and of the country to be traversed. Such preliminary knowledge not only contributes to the enjoyment of every mile of the journey, but is quite essential to its success.

JEFFERSON PARK TRIP

A VISIT to Jefferson Park is to be the object of our first excursion. As already pointed out, Jefferson Park is located at the north foot of Mt. Jefferson, which by the map is seen to be about 50 miles almost due south from Mt. Hood. Mt. Jefferson is barely more than 70 miles essentially due south from the town of Wyeth, a point on the railroad at the Columbia river, the north boundary of Oregon. An east-west line through Mt. Jefferson would pass about two miles north of the city of Albany, 65 miles to the west in the Willamette valley, while the town of Madras, beyond the Deschutes river in central Oregon, would be about an equal distance to the south of it and a little short of 35 miles away. Jefferson Park was formerly known as and still called by some Hanging Valley. Inasmuch as the latter term is commonly used with a somewhat different meaning, and since "park" is most happily applicable to this beauty spot of the Cascades, it is urged that the name Jefferson Park be permanently adopted.

The nearest road from which it is possible to reach the park terminates at present at Clackamas lake ranger station 30 miles up the summit to the north. From the west a wagon road is built up the north Santiam river to beyond Mill City 30 miles west and a little north of the park, and a branch of the Southern Pacific extends to


COLUMBIA RIVER
HOOD RIVER
Cascade Locks
Wyeth
THE DALLES
Mosier Cr.
Mill Cr.
Fivemile Cr.
Eightmile Cr.
MT. HOOD R.R.
Dee
Parkdale
Wahtum
Indian Mt.
Table Mt.
Larch Mt.
O.W.R.&N.
Bull Run
Bull Run L.
Lost L.
BULL RUN RIVER
SANDY RIVER
HOOD RIVER
Mt. HOOD 11,225
SALMON RIVER
OREGON NATIONAL FOREST
Gov't Camp
Frog L.
Clear L.
CLACKAMAS
ROARING RIVER
WHITE RIVER
Badger Cr.
Threemile Cr.
Barlow Cr.
Clackamas Lake
Mt. WILSON
OAK GROVE FORK
Austin Hot Springs
Baty Butte
Bagsby Hot Sprgs.
North Pinhead
Warm Springs Meadow
Lemiti L.
WARM SPRINGS RIVER
Beaver Cr.
Mill Cr.
WARM SPRINGS INDIAN RESERVATION
Olallie Butte
Olallie L.
BATTLE AX MT.
Elk L.
BREITENBUSH HOT SPGS RIVER
Breitenbush L.
Shitike Cr.
Warm Spring
Detroit
Jefferson Park
Whitewater Cr.
Mt. JEFFERSON 10,523
Bald Peter
N. Fork SANTIAM RIVER
BRUNO MT.
BACHELOR MT.
COFFIN MT.
Pamelia L.
Quartzville
SANTIAM NATIONAL FOREST
Marion L.
Jefferson Cr.
Metolius RIVER
Green Ridge
DESCHUTES
THREE FINGERED JACK
SANTIAM ROAD
Lava L.
Clear L.
Big L.
BLACK BUTTE
Mt. WASHINGTON
Sisters
Belknap Crater
Squaw Cr.


Belknap Crater
BLACK CRATER
NATIONAL
Tumalo Reservoir
Tumalo
Blue River
McKenzie Bridge
Belknap Springs
NORTH SISTER
Obsidian Ridge
MIDDLE SISTER
McKENZIE
Foley Springs
Lost Cr.
THE HUSBAND
SOUTH SISTER
Broken Top
BEND
THE WIFE
Tumalo
Sparks L.
Bachelor Butte
Elk L.
Mud L.
Lava L.
RIVER
Lava L.
PACKSADDLE MT.
SCADE
DESCHUTES
IRISH MT.
Cultus L.
E
Salmon Cr.
ROUND MT.
DESCHUTES
RIVER
Waldo L.
AL FOREST
THE TWINS
DESCHUTES
MT. RAY
EAST FK. DESCHUTES
La Pine
Maiden Peak
Davis L.
DAVIS MT.
Odell L.
Salt Cr.
Odell Butte
DIAMOND PEAK
Crescent
RANGE
Summit L.
Crescent L.
COW HORN MT.
WALKER
UMPQUA
UA
S
Bald Mtn
Fish L.
FOREST
MT. THIELSEN 7178
Crater
Wakefield
Diamond L.
Sugar Pine Mtn.
CRATER LAKE
TIMBER CRATER
RIVER
RED CONE
Klamath Marsh
Crater Lake
ROGUE RIVER
SCOTT 8938
Sand Cr.
NATIONAL PARK

Detroit and Hoover, the former a direct distance of 18 miles straight west of Jefferson Park. Better than 20 miles directly down the summit to the south the Santiam road passes across the range. At present, however, the park is inaccessible by trail from this direction, as it is also from the southeast, on account of Mt. Jefferson itself to encircle the west base of which necessitates a detour of many miles. Thus the only way that it can now be reached is by trail from the railroad at Detroit, and along the summit from the north, the last several miles of the latter course being along the rocky, treeless divide where occasional signs of an ancient Indian trail are all but obliterated by slides of loose rock and the shifting boundaries of the snowfields.

It may be well to remind the reader at this point, however, that even if the trip is long and some of it made less pleasant by poor trails or none at all, the effort necessary to make it will most certainly be fully repaid to every hardy one who loves the wild and the beautiful in nature, both of which are here to be enjoyed in exhilarating measure.

Government camp

He who proposes to enter Jefferson Park from the north by a trip along the summit of the Cascades will first land at Government Camp at the south base of Mt. Hood by horse or auto stage, after a trip from the west over the Barlow toll road. This road connects western with eastern Oregon and is the first crossing south of the Columbia River Highway. Up the west slope of the range it follows for many miles the canyon of the Sandy river and, approaching the summit, that of the Little Zigzag. After crossing the top of the range, down which it follows nearly to Clear lake, this road passes by easy grades out upon a great basalt plateau into which the Deschutes river has carved its gorge, often thousands of feet in depth. The old Barlow road followed down the canyon of White river. The present road, known as the Oak Grove road, now starts down the slope along the ridge between Clear and Frog lake creeks. Wapinitia, about 2,000 feet in altitude, is the town nearest to the summit on the east side and here connection is made with the main automobile road leading both north and south into all parts of eastern Oregon.

Side trip to Mt. Hood

While at Government Camp a trip up the slope of Mt. Hood is a most instructive and profitable one. A wagon road runs to Camp Blossom some 3 miles distant and about 2500 feet higher than Government Camp whose altitude is 3,880 feet above the sea. Camp Blossom is the point at the timber line where climbers spend the night and from which an early morning start is made for the top of Mt. Hood. In protected places at this elevation snow remains the year round and above the trees an unobstructed view to the east, south, and west may be obtained. Beyond the timber-line the slope of the mountain, except for occasional jutting ledges of hard rock, is a mixture of loose sliding

Mt. Hood from the south side near Camp Blossom. At the right is Steel Cliff. Crater Rock, an outcropping volcanic plug, shows through the snowy expanse high up toward the summit. Snowfield of the Zigzag at the left and of the White river glacier below Steel Cliff at the right.

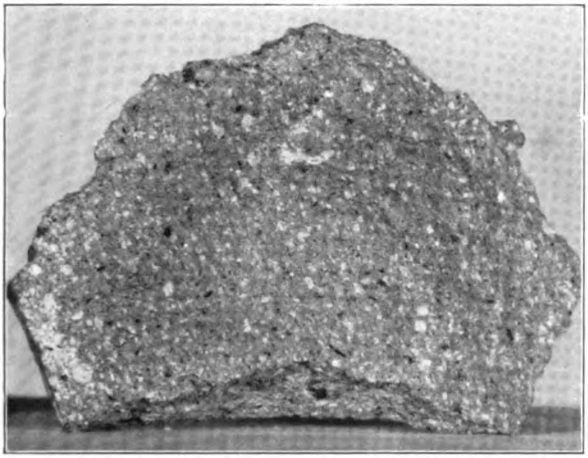
pieces of andesitic lava, volcanic ash and scoria. Into this the streams are deeply carving on all sides sharp V-shaped canons and the glaciers are gouging it out above and constantly moving large quantities of loosened material downwards within the reach of the ever greedy streams. The glaciers themselves furnish by their melting an unfailing supply of water. One naturally casts longing glances toward the summit where Steel Cliff, Crater Rock, and the snow-tipped northern rim of the old crater itself yet nearly a vertical mile above appear to be urgently beckoning. But our back is turned to the allurement of their call and we gaze southward toward Mt. Jefferson and Jefferson Park which, though 50 miles away, nevertheless exert a spell not possible of resistance.

The rugged Cascade range

Down the range toward the south Mt. Jefferson preeminently dominates the view. At our right in a westerly and southwesterly direction there is spread out a great expanse of most rugged mountainous country. Myriads of peaks there are and deeply riven canons. The distinct sky-line, which to the west is perhaps 25 miles away, as does also the intervening space, presents an interrupted though closely packed series of mountain tops and it is no illusion of the atmosphere that the more distant ones are fully as high as those that are nearer by. Many of these, a notable number of them, have flattened tops, and the tops of those that are highest are conspicuously even, as though all were portions of a former more or less flat lying plateau. Indeed, from our view point we may in imagination picture an originally fairly level stretch of country leading from the very base of Mt. Hood, where we now stand, west and southwestward for many miles and nearly to the present Willamette valley front of the Cascade range. Into this region of even surface we see the streams begin their work, cutting constantly headwards and extending their branches, gashing away slowly yet relentlessly throughout the hundreds of thousands of years, carving and undermining and carrying away the materials of this plain.

Sooner or later portions of the old surface would be destroyed, flat-topped divides would be reduced to sharp ridges and these ridges slowly melt and crumble and wear away. In the progress of this process of land carving, or erosion as the geologists call it, this land area would present varying features depending upon the stage in its wearing down at which it is observed. If our present observations and inferences are correct, it would seem that we are now looking upon this vast stretch of Cascade mountainous area at a time when its erosion, though pretty well advanced, is still being actively prosecuted by the many streams that flow from it and too while there yet remain many peaks with flattened tops to indicate the character of the surface of which they are now but widely separated parts. Many of the present

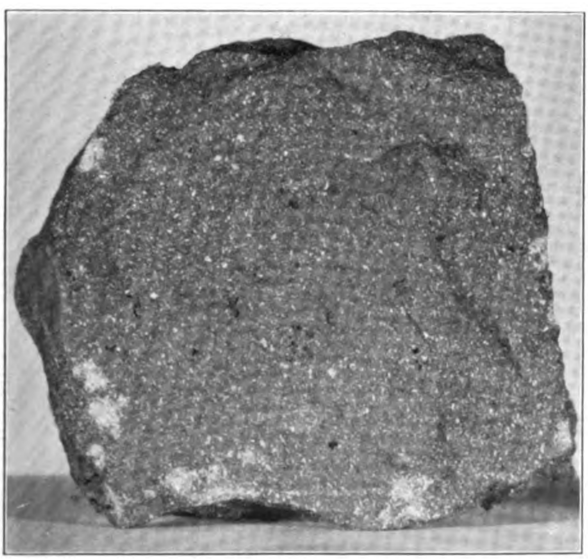
Two-thirds natural size



Magnified thin section

Porphyritic hypersthene andesite. This is the prevailing type of volcanic rock of which most of the higher parts of the Cascade mountains in Oregon are made. All of the principal peaks of the range (former craters) gave out chiefly this variety of lava. In the thin section the large white angular crystals of feldspar and occasional brown ones of hypersthene are seen to be set in a matrix of much smaller crystals, and the latter are in turn caught and held in a glassy residuum from which they were formed. At least two generations of crystals are thus clearly shown: the larger, called phenocrysts, began to grow early, possibly deep within the earth before the rock was erupted as a liquid lava; while the smaller crystals took shape during the brief time allowed them while the molten lava cooled and finally solidified.

Two-thirds natural size



Magnified thin section

Hypersthene andesite. The texture of the andesites varies from rather coarse-grained and porphyritic to fine-grained or dense, and sometimes vitreous or glassy. A "porphyritic" texture is one in which distinct crystals of one or more minerals appear in a background or matrix of finer grain or of actual glass. In this and the preceding view the white specks are mostly angular crystals of plagioclase feldspar, while the much fewer dark spots are a variety of pyroxene called hypersthene. The texture of the rock is further brought out in the accompanying photograph of the thin section, in which elongated crystals with sometimes ragged, sometimes angular outlines are seen to be set in a groundmass of glass. A larger "phenocryst" is seen near the top of the section.

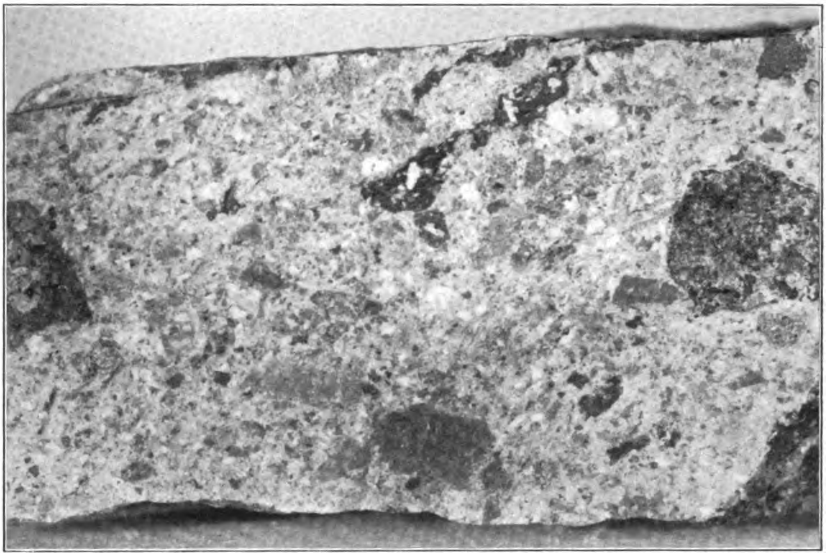
peaks of conspicuous sharpness within the field of view are no doubt but remnants of once flat-topped eminences, could we have seen them in ages gone by, that have been, as it were, worn to a point, or edge, by just such vigorous stream action as we see going on today.

Nor do we need to depend alone for our conclusions upon deductions made from the present distant point of view. When we examine at close range many of the prominent peaks in the part of the Cascade range that stretches west of its summit for sometimes 30 miles or more, and extends from the Columbia river 150 miles south to the Calapooyas, it is found that, as has been inferred from our distant view, the high peaks are often but miniature table lands or sharp rock-bound ridges or giant pinnacles, deeply separated from their neighbors by precipitous canons that are now occupied by the very streams whose incessant industry has modeled them into their present forms. And the rocks of which the different mountains are made resemble each other so closely as to leave little question of their having originally been portions of the same connected or closely related beds.

Rocks of Cascade range

As we still ponder the view before us, we try to conceive of the way in which the parent plain may have been brought into existence from which this part of the Cascade range grew, and above the general level of which now rise all of the more recent and many higher peaks so plentifully arrayed along its summit. The rocks comprising this former old plain are almost entirely volcanic. This means that it was built up by the accumulation of materials produced by the eruptions of volcanoes. It is found that the upper parts of this plain, and, therefore, of the isolated portions of it that today stand as flat-topped ridges or peaks, consist of a series of beds of hard rock that flowed out one layer after another as liquid lava and solidified as they came to rest and cooled. These hard top layers are prevailingly of a light to dark gray colored dense rock called andesite and they attain a thickness in places of a thousand feet or more. They are sometimes interbedded with less solid layers of rough and often rusty red or brown scoriaceous character, and rest nearly everywhere upon thick beds of tuff, hundreds of feet of which may be seen in the walls of the canyons of every river of any size in the entire region. The tuffs too are of volcanic origin. They are made up generally of coarse and fine angular or rounded pebbles or blocks which have usually been rather strongly cemented together into a firm rock by a filling of fine particles of ash, or of volcanic mud or in many cases of liquid lava, that has caught up these rock fragments and carried them along or has flowed into the open spaces among them and solidified, binding the entire mass together much the same as does the cement in a mixture of ordinary concrete.

Volcanic conglomerate. The bouldery nature of this type of rock is conspicuous. Filling in among the larger, more or less rounded boulders is a mixture of volcanic rock fragments of all dimensions from the size of pebbles to that of the finest ash. The heterogeneity, both in size and character, of the mixture of pieces of which the rock is composed leaves no question that they have been tumbled in together in a most promiscuous manner. When rock materials are deposited by water they are usually separated, or sorted and classified to a greater or less extent, into successive layers of sand, and silt, and gravel, etc.; the particles in each layer possessing a noticeable uniformity of size. In the volcanic conglomerate shown, this sorted arrangement of materials is absent. We are thus brought to the conclusion that water had little to do with its accumulation. Much evidence goes to show that great quantities of this kind of rock in the Cascade mountains of Oregon were formed by the down-hill movement of volcanic rock fragments, and an intermingling of them in some such manner as we see today about the lower slopes of more recent craters that by explosive eruptions have produced much of clinker, cinder and ash. Quantities of fine ash and dust were projected into the air and gently settled over wide stretches of country, the smaller pieces creeping into and occupying the interstices among the larger, until the whole became compacted into a bed of rock. Such we know was the process, and slow and gentle must it oftentimes have been, for in places now we find the trunks of trees, usually in part petrified, still standing upright, as though mercilessly smothered by the quiet rise of slowly accumulating sediments about their base.



Volcanic flow-breccia. Natural size. It is apparent that this rock is made by the cementing together of sub-angular to round pieces. Where the pieces are prevailingly round, as are gravel pebbles and boulders, the term "conglomerate" is used. These chunks of rock which, as may be seen, are of all sizes, are all of volcanic varieties. Close study by means of the microscope proves that the cementing substance which has bound them into a solid rock is itself also volcanic lava. We thus seem to have here a case of percolation of a liquid molten lava into the openings among the pieces of an open-textured bed of gravel or talus, the cooling and solidification of the lava tying them firmly together; as it were, a natural concrete. Doubtless in many instances the flowing lava picked up and carried along for miles rock fragments from its path, incorporating them into its mass to become a constituent part of the resulting rock strata, great thicknesses of which we observe today in many places in the Cascade range.

Naturally we inquire as to the source of these volcanic products that have been responsible for so much of the bulk of this great mountain range. As yet we do not know for certain, nor do we know much as to the position with reference to the sea level of the old surface over which these many hundreds, often thousands, of feet of volcanic rocks were spread. Doubtless some came out quietly and in large volume through fissures or breaks in the earlier rock layers that extended to sources of supply below. We are certain by the character of the rocks that large quantities were erupted violently from craters not unlike our Mts. Hood and Jefferson of today. But whether from these same mountains or others the location of which we now know, is a question yet unsolved. True it must be that the lavas came from some source at a higher level than the area over which they spread. Since we now find them occupying positions on the tops of many peaks so high that they could not have reached there from any of the present known sources of lava, and since the rivers have been able to dissect these beds, cutting downward through them two, at times three thousand feet, we are forced to conclude either that these rocks came from vents that were originally at higher altitudes still, or, as seems more reasonable, that the country which they covered was at that time at a lower level and has since been bodily uplifted, no doubt with extreme slowness, to its present position. It is highly probable that part of the vast body of these rocks that we are now able to study was first deposited in or flowed down the sloping bottom of an area of ocean water, coming to rest in great or shallow depths, then later elevated to become land surface.

It seems to be one of the tragedies of nature the pitiless attack that flowing streams wage against all land surfaces from the time they first emerge above the level of the ocean. We thrill to watch the process, though generations of men are as but moments in its slow and measured enactment. Here in the maze of peak and canyon before us, we see the net result so far of this everwaging battle between the forces that have lifted and those that are tearing down. The forces of elevation operate intermittently while those that wear down and carry away are ever active. It is to the never ceasing work of the main rivers and their tributaries in this part of the Cascade range

Ready for the trail. Three pack and two saddle horses comprise a satisfactory outfit for three persons. If supplies are well chosen, in quantity and character, two weeks' rations for both horses and men and sufficient camp equipment for comfortably and pleasurably "roughing it" can be carried on three animals. This photograph was taken at Warm Springs meadow on the Cascade summit. The tree of conical outline at the right is one of the firs, several varieties of which grow at this altitude.

that we may attribute the chief conspicuous features. That this is not true for most of the summit portion of the range we may guess by a glance in that direction and shall have demonstrated to us as we pass southward along its crest toward Jefferson Park.

THE CASCADE SUMMIT

GOVERNMENT Camp is the last point from which supplies can be obtained, though outfitting for the trip must already have been done at some place lower down to the east or west before entering the higher parts of the range. From Government Camp the road may be followed nearly south by Summit House and Frog lake to Clear lake, or the trail may be taken from Summit House down Mud creek and across Salmon river by Jack Pot and Dry meadows and Crater lake, a rough, more roundabout way to the same destination. Clear lake is about 12 miles from Government Camp, a short but ample distance for the first day's pack. It is an irregular shaped lake in part grown up with tules and surrounded by marsh. Though stocked with trout, it is not an ideal camping place in mid-summer as the only convenient water supply seems to be a poor spring near the east end of the lake.

Between Clear and Clackamas lakes, a distance by auto road of about ten miles, the divide is crossed. Clear lake drains eastward to the Deschutes, while Clackamas lake is the source of Clackamas river, one of the chief tributaries of the Willamette. Clackamas lake is the site of a Forest Ranger station and here the wagon road ends. From this place it is a short day's trip by trail to Warm Springs meadow and, if one is not hurried, yet another to Olallie meadow.

Character of Cascade summit

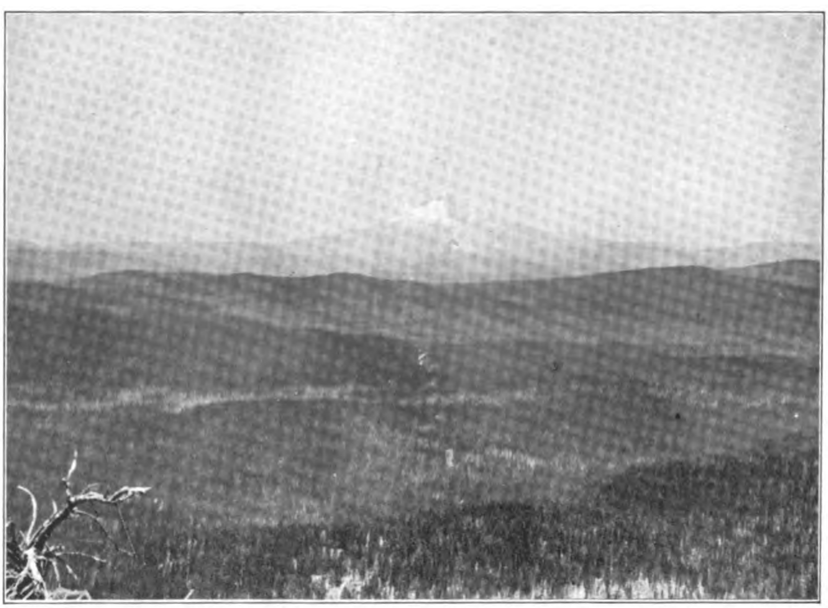
Thus far the country has been comparatively even and one rides for hours in the dense forest with scarcely a single glimpse of bare rock or opportunity to satisfy the longing for an unobstructed view of his surroundings. Occasional open places are named meadows since they are covered with grass, and are swampy or frequently surround ponds or lakes of varying size. There are many of these, and they appear to bear a direct genetic relation to the time when all of the higher parts of the range were covered with the perennial snow and ice of the glacial period. The presence of the small glaciers on Mt. Hood has been noted. There is evidence of their former extension for some distance south along the range crest. But it seems likely that while the general mildness of the topography is primarily due to the outpouring of liquid lavas, the lakes, ponds and marshy spots may have largely resulted from the accumulation of earthy materials so as to clog or obstruct drainage ways during the melting of the ice, whether or not the glaciers actually rested upon this part of the range. In any event, it is very apparent that the period of time during which the streams have had to work, many of which have cut enormously deep canons but a few miles west of the summit, has not been sufficient for them to extend their head branches to the very top of the range. Complete drainage and obliteration is the ultimate fate of all these undrained places. We may therefore look upon this part of the summit as being in the youthful stage of its existence. It is simply too soon for the rivers yet to have accomplished the dissection so spectacularly displayed in the front of the range.

Beyond Clackamas lake we pass within view of Mt. Wilson a rugged ridge of andesitic lava on the top of which the U. S. Forest Service maintains a lookout station during the fire season. Peavine mountain a few miles to the southwest appears to be of similar type, though the rock of which it is composed has almost enough of the iron-bearing minerals in its make-up to be called a basalt.

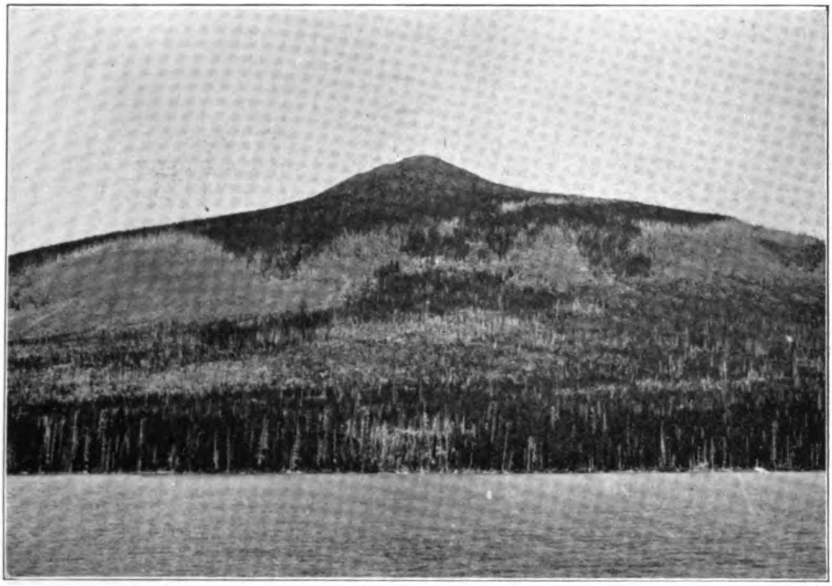
North Pinhead peak. Before reaching Olallie meadow the trail passes close to North Pinhead, a cinder cone some 800 feet in height. This cone represents the most recent of volcanic activity so far seen on our journey. Its base is of solid lava and at the northwest and south small flows have issued. The shoulder low down at the left in the view is one of these basal flows. In the top is a shallow crater and its rim and steep sloping sides are composed of loosely aggregated scoriaceous boulders, lapilli and volcanic ash. That these are the products of violent volcanic eruption and that the cone has been built up entirely by the materials from its own crater are the obvious conclusions to which one is led. In their fragmental nature they differ from the prevailing rock so far. The rock composing the cone itself is andesitic in character while the flows from its base are of a more basic, generally darker colored rock that differs little from the basalts. About the mountain and particularly on its south slopes the mountain lily blooms most profusely in July.

NOTE.—Since the interest and value of a paper of this nature must depend quite largely upon the photographs accompanying it, the reader in perusing this brochure is kindly asked to follow and read in order, as an essential part of the text, the descriptive matter relating to the views so that no connecting link or sequence of events may be lost sight of.

Looking south from the top of North Pinhead peak. Each day has brought us nearer to Jefferson Park and interest in what is ahead should be greatly stimulated by the view obtainable from the top of North Pinhead. Though still 20 miles distant, Mt. Jefferson dominates the sky-line towards the south. In part obscuring its east flank is the black dome of Olallie butte. To the right we look out across the headwaters of the Clackamas and far into the much broken Santiam country, and are again reminded of the remarkable and more or less even height of the mountains for many miles to the westward.

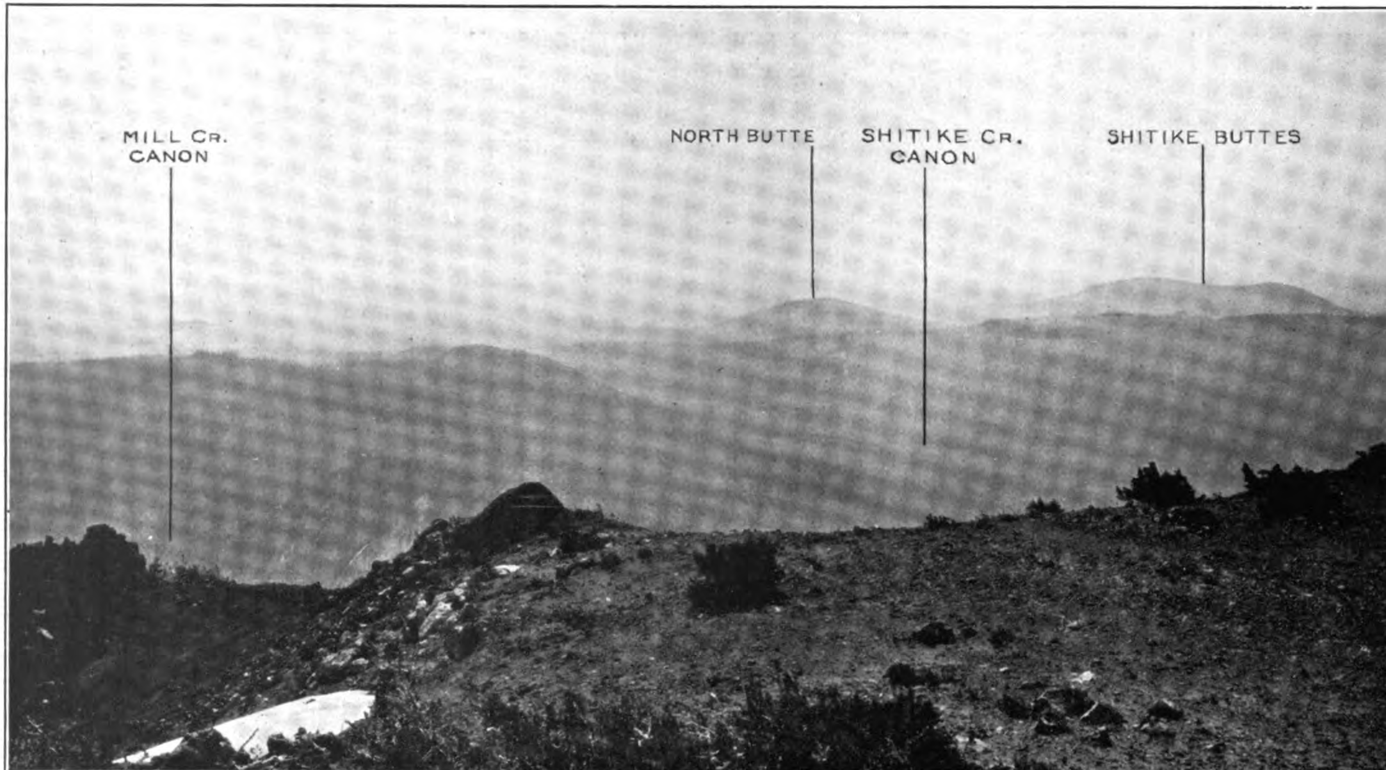


Mt. Hood from North Pinhead peak 30 miles to the south. The character of the country at our rear is in contrast with that ahead. The snow tip of Mt. Adams in the State of Washington may be seen at the right of Hood and well to the left is the symmetric snow-white cone of St. Helens also beyond the Columbia.

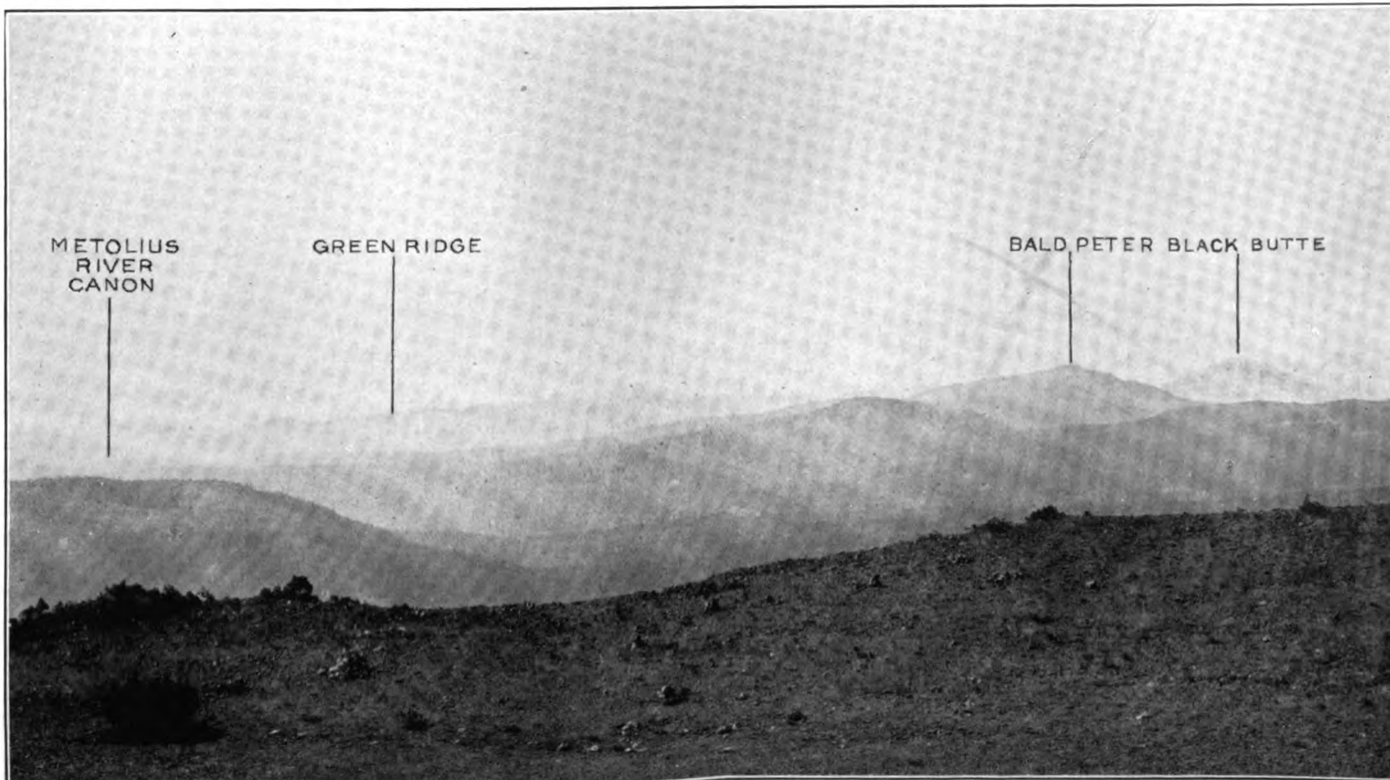


Olallie butte from the southwest across an arm of Monon lake. It is sometimes a disconcerting illusion that the nearer one approaches to a prominent mountain or peak the less imposing it becomes. Its dwindling is in this instance, nevertheless, quite unreal and a climb to the top of Olallie butte from Olallie meadow is a vigorous effort well repaid and a real treat not to be foregone. The summit is about three miles from the ranger station at the meadow and can be reached on horseback over a newly built trail. The butte has an altitude of about 7500 feet and rises 2500 feet above Olallie meadow. The cone is seen to be founded upon a base of lighter colored rock which on examination proves to be andesite. Upon this platform, which may possibly represent the earlier outpourings of lava from the same deep vent, Olallie butte rests, a vast pile of cinder, scoriaceous boulders, broken rock and volcanic ash. These contrast with the solid base only in physical appearance for the microscope proves them to belong to the same general class.

The following five photographs taken from the top of Olallie butte, when matched together, constitute a panorama of 200 degrees. The first view is toward the east, the second to the southeast, the third to the south, the fourth toward the southwest, and the fifth view of the series practically due west.

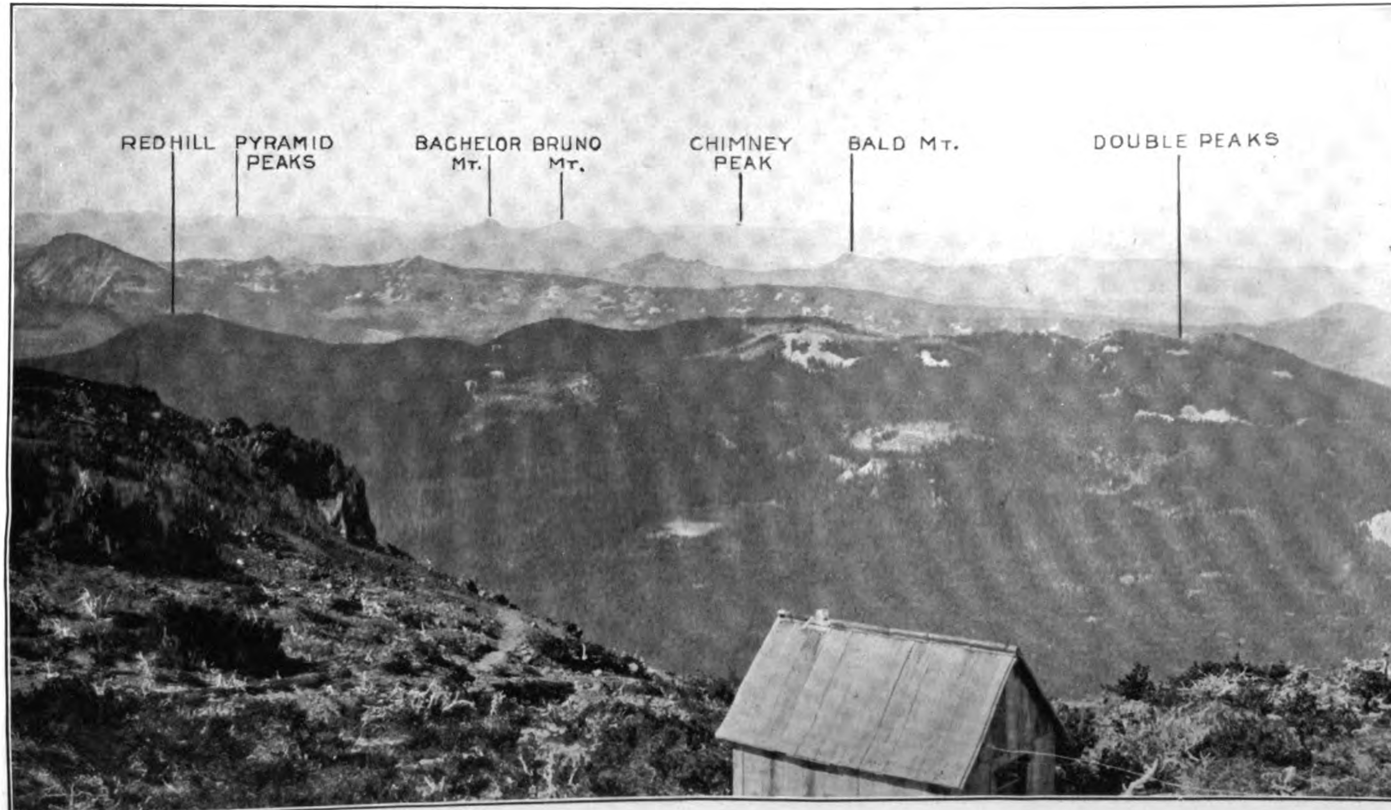


The top of Olallie butte affords a wonderfully commanding view in all directions. Here is located one of the Oregon "fire-finders" by which the Forest Service determines the location of forest fires. Toward the east one may look across the Indian reservation far beyond the Deschutes river into eastern Oregon.

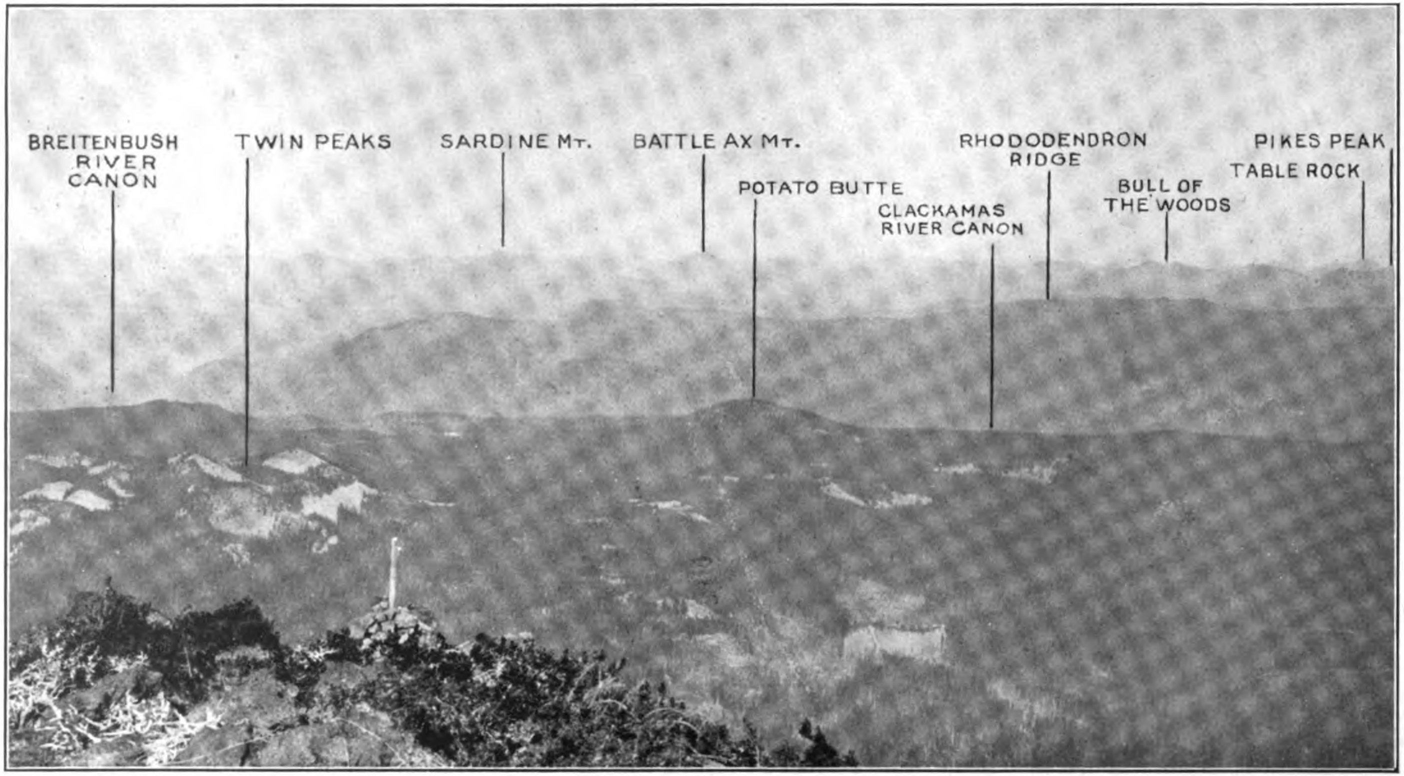


To the southeast, Green Ridge is prominent, parallel to which the Metolius river flows. At the left is the gap in this ridge where the Metolius turns towards the Deschutes and nearer is the deeply cut canon of Shitike creek.

Directly south Mt. Jefferson looms, flanked at the left by Black butte and Bald Peter, and less distinctly in the distance are the outlines of Black crater, Broken Top, and of the Sisters peaks.

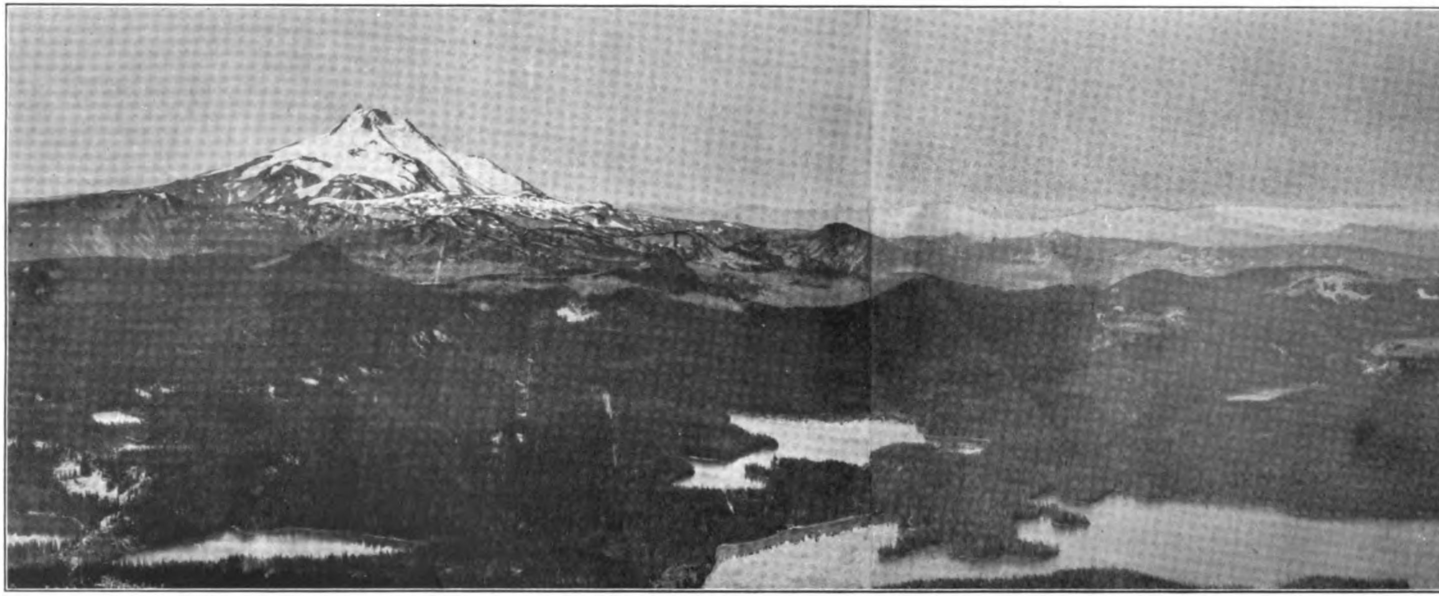


Towards the southwest the notched, spreading slopes of Jefferson grade away into the labyrinth of peaks among which Bachelor mountain, Bruno mountain and Chimney peak stand out conspicuously.



Due west is Battle Ax mountain and to the north of west Pikes peak and Table rock, the latter barely short of 30 miles away. Again as the gaze sweeps over this broad westward expanse one cannot but remark the notable uniformity of height of the major peaks, some of them sharply limned against the western sky.

Crags at the east side and near the top of Olallie butte. Its side slopes are often as steep as 30 degrees from the horizontal, in places more. In the top is a small depression and around its rim the softer parts of which have been in part eaten away, jagged crags project that appear to be the outcropping of dikes of harder rock that, while molten, forced its way outward through the more loose materials of the main body of the butte. Mt. Jefferson in the distance.



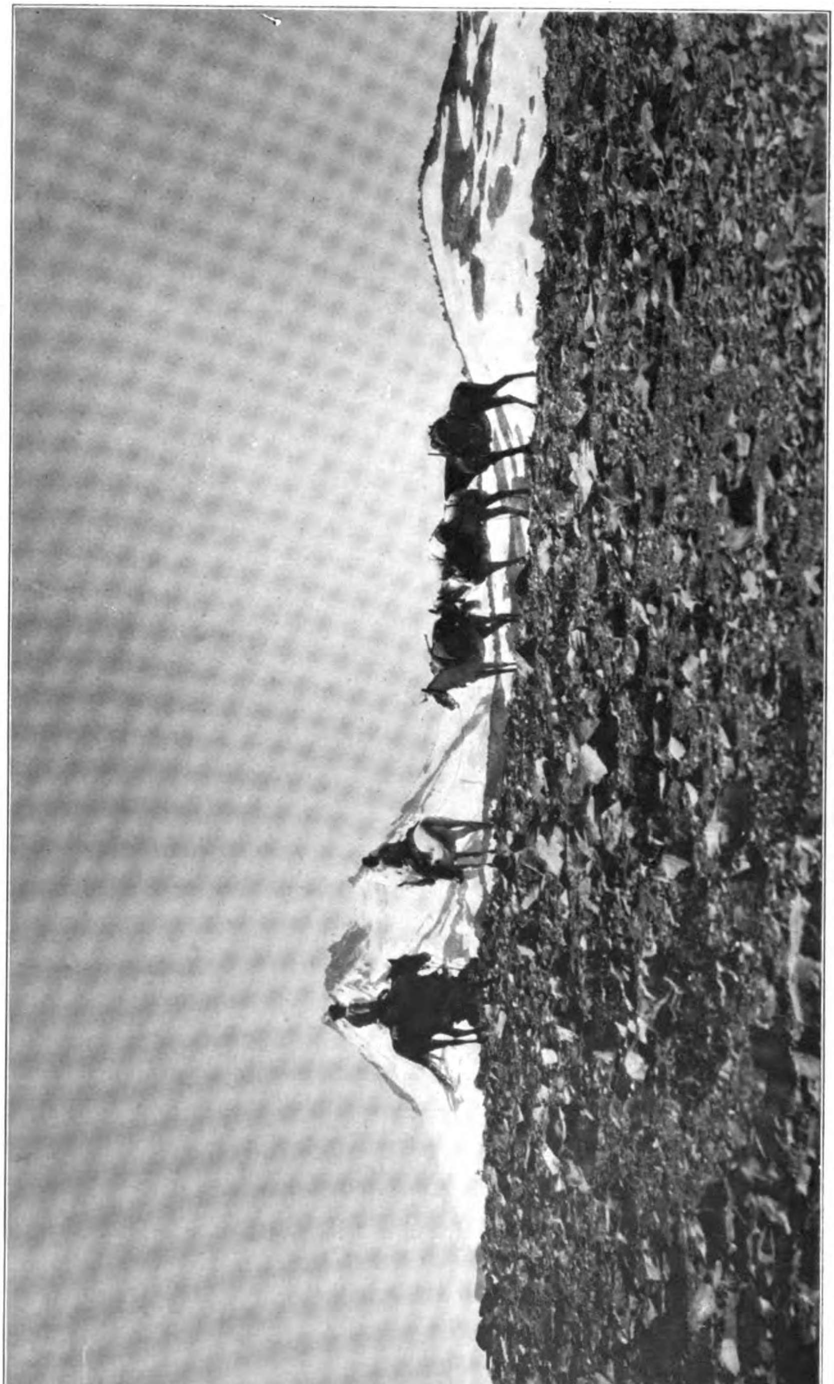
Lakes about the south base of Olallie butte. Toward Jefferson again our attention is irresistibly drawn. In the foreground at the south foot of the butte on which we stand the evenly-forested, hummocky surface for several miles is literally spotted with glistening water patches of all sizes. Lakes Olallie and Monon with their picturesquely digitated borders are nearby, while Horse lake and uncounted others are seen snugly shelved, yet in what appear such precarious positions that we wonder why they do not spill one into another. Many of them have no outlets whatever and the smaller ones dry up under evaporation by the warm summer sun. All of them occupy shallow depressions in the solid lava and as our trail later leads along a tortuous course among them we will learn that they are not swampy as have been most of the lakes heretofore seen. Their shores are clean-cut and usually stony, and there is an unmistakable mien of newness about them and their surroundings.

Summit lakes

We are led to soliloquize as to the origin of this great group of small bodies of water about Olallie butte, situated as they are on the very crest of the main divide. They rest upon a rock surface that is geologically new and they themselves are features of a new and unstable topography, as are lakes wherever found. It would require rather careful examination of the lakes and adjacent hills to determine definitely what has caused the numerous pits and broader rock basins which are so impervious as to fill to their limits with the water that runs into them from the melting snows. It is conceivable that the uneven top of a widespread flow of liquid lava might provide many depressions in which the water could accumulate. Although there is an abundance of evidence of recent volcanic activity here, yet this is a condition rarely found and not often to be expected, since the lava in coming to rest is usually more or less broken and cracks and cavities are produced through which water would quickly escape.

From even our distant viewpoint, light-colored bare rock shows through in many places as though whatever of loose materials may have covered it have been scraped away. And so our thoughts run to the probability of this region having been ground down and the hummocky unevenness brought about by the work of the ancient glaciers. The general resemblance to parts of the summit ahead to the south, where the results of glacial action are so glaringly distinct as not to be mistaken is very striking, and until we are permitted to inspect at closer range the various details of this region we shall not go wide of the mark in bearing away the impression that its chief attractiveness too is attributable to the same agency. At our distance we recognize its strong likeness to the land of characteristic ice-molding. The easy-curving ridges, dome-shaped knobs and rounded hills, amongst which are dropped here and there in rock-bound hollows gouged possibly from the softer parts by the moving ice, lakes of sky-blue or verdant green, and the moraines, all appear to be there. The veneer of forest is the only need to complete the picture and it too is present to lend its finishing touch to a scene more entrancing than which one rarely beholds. Just beyond Monon lake at the right is Red Hill, a mass of iron-stained sliding rock, either itself a volcanic cone or the ejecta from an erupting vent at no great distance. White against the lower slope of Mt. Jefferson is the line of the snow-covered divide that cuts off our view into Jefferson Park, now distant but one long day's journey.

From Olallie meadow to Breitenbush lake, called also Divide, is a half-day trip. After winding its way about several of the little lakes down upon which we have looked from the top of Olallie butte now rising commandingly at our rear, the trail climbs perhaps a thousand feet by Horse lake to the top of a dividing ridge of andesite, whence we pass from eastern into western Oregon and down to Breitenbush lake.



Cascade divide between the headwaters of Breitenbush and Whitewater rivers.

This lake is the head of the north fork of Breitenbush river, a tributary of the North Santiam, and much resembles those just passed on the other side of the divide. Here however we find indisputable proof of a glacial origin. As before, the topography suggests it, but at the south end of the lake a series of morainal ridges occurs successively one above another along the rocky slope and many bare rock surfaces are planed smooth or characteristically furrowed and striated. The lake itself occupies a depression plowed out by the ice, or at any rate formerly filled by it, and the further traces of its work will doubtless be found to extend to the westward far down this fork of the Breitenbush.

Breitenbush lake

Breitenbush lake is a beautiful spot. At its south end an ice-cold stream enters and here too is open meadow where horse feed is plentiful. Elsewhere the forest comes to the water's edge. Rock cliffs look down from both east and west and to the south the sharp conical outline and rocky slopes of Campbell butte stand out. The rock at its base is andesitic and is sometimes broken and cemented into an agglomerate. Fire-wood is abundant. So likely a place does this appear to be that one is almost tempted to unlimber rod and fishing tackle were it not known that none of the lakes of the region hereabout have yet been stocked. Despite this discouraging fact, a brief halt in such environment will be full of enjoyment; although if the time be early summer one's stay is apt to be quite rigorously contested by the mosquitoes. Their industry in the early evening hours is something marvelous, to combat which active, even arduous measures are necessary. An essential precaution on a trip of any length is a goodly supply of mosquito netting in one's outing equipment.

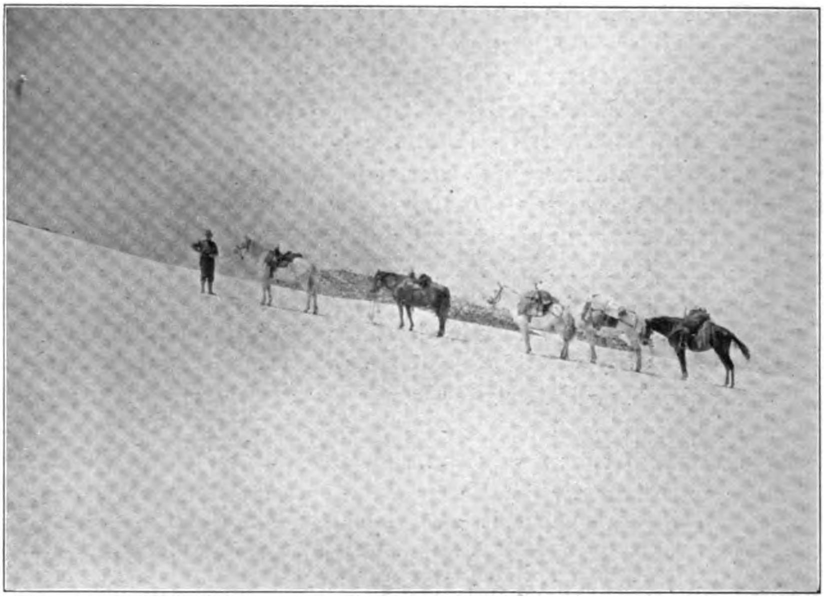
Cascade divide between the headwaters of Breitenbush river a tributary of the North Santiam, and Whitewater river an affluent of the Deschutes. There is no laid out trail between Mt. Jefferson and Breitenbush lake. The most favorable course will be found to lead nearly due south for a mile or thereabout up the uneven and glacier-scored slope of the rocky divide bearing somewhat to the right as the summit is approached. The rocks are covered with soil only in patches and a sparse open forest permits the keeping of directions and progress is made with little delay. Bare rock surfaces are planed smooth and it is notable that the numerous glacial markings run north and south, or up and down the slope, instead of parallel to it as would be the case were the ice that produced them moving in a down-stream direction in this part of the Breitenbush basin. The top of the ridge is reached at the head of a sharply V-shaped gorge cut by its stream into a bed of very loose sliding materials composed entirely of broken pieces of volcanic rocks of the andesitic variety. At the rim, which is windswept and barren of vegetation, is a low monument built up of flat stones. In the view this monument is directly in line with the horse at the left.

Head of north branch of Whitewater river. Mt. Jefferson.

Head of north branch of Whitewater river. From here one may gaze to heart's content down into the vast ampitheatre that encircles the head of the north branch of Whitewater river. It is one of the main streams that flow from the slopes of Mt. Jefferson toward the Deschutes river. From the snow patches that so plentifully bedeck the sides of the great semi-circular bowl on the northwest rim of which we are now stationed, streams course down, we hear their sullen roar, to join the parent stream which soon plunges headlong into the shadow of its main canyon at whose precipitous character we can only guess. The crumbly, disintegrating rocks that form the walls of this ampitheatric pit can be seen to be interspersed with jutting ledges of harder kind. And the combination is one that is yielding so rapidly to the vigorous attack of the elements that most of the few trees upon the slopes are seen to have gained only a precarious foothold. There is no question that in glacial times this depression was broadened to near its present size by the grinding action of the moving glacier which no doubt filled it to overflowing. Again, we may only conjecture as to how far down-stream the ice extended, but we are reassured of its former existence here by the remains of the crescentic or elongated morainal ridges which we can scarcely mistake at our right—rock detritus built into embankments by the glacier during the intermittent halts in its final melting away.

Our eyes naturally cling to the great rock-studded snow pyramid of Mt. Jefferson. In direct line it is yet fully five miles away. Between us and the mountain still intervenes the prominent rocky ridge whose darkened rim, in our view, almost blends into the bulk of the mountain. It is from the crest of this ridge that the first glimpse will be had of the objective point of our journey, Jefferson Park, which, while it is located squarely upon the very summit of the Cascade range, occupies a great cleft in the crestal ridge, and, as we shall see, snuggles closely within the shadow of the great peak itself.

Our further course towards Jefferson Park naturally appears to be along the broken and rocky rim on which we stand. This rim forms the divide on the east side of which the waters drain away towards the Deschutes and on the west into the south fork of the north fork of the Breitenbush and on to the Willamette river. The streams on either side, and the glaciers before them, have so vigorously contested the ground that the ridge has become sharpened in places to a jagged edge impossible of travel and deep notches cut from which the melting snows send their waters each way, to meet again where the Willamette pours into the Columbia, after traversing widely separated routes. It thus proves necessary to drop down the steep slope several hundred feet on the Breitenbush side where an hour or so of meandering over hummocky morainal heaps, through meadow-like soddy plots, across glacier-plowed bare rock surfaces and again up over a succession of slippery rockslides, brings us to the edge of the snow.



Crossing the snowfields. In places the snow is soft and mushy at midday, in others, firm and crusted with ice. The grade is steep and cautious judgment is required to steer a safe course. At intervals signs of the old Indian trail are detected where the flattened slabs of platy andesite that show through between snow banks have been settled into place or otherwise arranged to facilitate difficult crossings. A judiciously selected path across some half mile of snow lands us finally, though circuitously, at the coveted vantage place whence from one thousand feet above we may gaze down upon Jefferson Park.

MT. JEFFERSON

According to the most recent measurements Mt. Jefferson has an altitude of 10,523 feet. Its topmost pinnacle which is nearly due south and yet three horizontal miles away, thus towers still 3,000 vertical feet above our present position. Although every feature of the mountain proves it to have been built up by the eruption of volcanic materials, it does not now exhibit the characteristic cone shape of the typical volcano. Instead it is a peak of ragged rocky ridges that radiate from its apex point where they culminate in what appears from our distance to be a cluster of precipitous rock walls and spires. Those who have climbed Mt. Jefferson confirm this observation and further testify to their precipitous nature by the information that not so large a fraction of those who try are able to actually scale the uppermost rock of this vast pile. The depressions between the ridges of firmer rock are seen to be occupied by large snowfields, and as we trace these far down the mountain's side, we see the unmistakable blue of solid ice showing through, where in its movement the ice has been broken across in a series of crevasses or open joints.

Jefferson Park from 1000 feet above it. Mt. Jefferson. Irrespective of the time of day and at once oblivious to the many interesting features of our immediate surroundings, we find ourselves anxious to yield to the call with which is laden the very breeze that floats up to us from this beautiful spot. But we compel a rest of a few moments from the tedious trip across the snow to ponder the great white pyramid in our fore.

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Glaciers on Mt. Jefferson

These are small but nevertheless real glaciers. The snows of winter accumulate in such quantity above that a gravitational downward movement must follow. In this movement and as a consequence of continued melting and refreezing, as well as the effect of its enormous weight, the snow is compacted into firm ice. Literally a stream of flowing ice is thus formed that is constantly replenished by the snows above while below it melts away as it meets the warmer conditions of the lower altitudes. Before us and high up in the notch at the right of the center of the mountain can be seen a snow cliff where, apparently because of harder rock or more rapid cutting out below, there is a sudden change in the steepness of its bed and the snow breaks and drops down to become a part of the moving glacier. This head portion of a glacier where the snow accumulates is often semi-circular in shape and is thus called an amphitheater or cirque. As the snow passes to lower levels it is first changed to a granular or half-snow, half-ice condition, and in this intermediate state of consolidation is called névé. Even here the depth of the glacial stream is such that below the surface it is in large part solid ice.

We ordinarily think of ice as being a rather hard substance and therefore brittle and unyielding. It is actually found by experiment, however, and when we carefully observe its movement as a glacier slowly creeps its way down the mountain side, that it will bend and spread out and alter its form in many ways without breaking as a truly brittle material would. It in fact *flows* and therefore adjusts itself to irregularities in its bed and to changes in direction of movement without breaking apart, unless these be too abrupt. Where the ice in its downward flow passes over jutting crags or is forced by some obstacle to sharply alter its direction, the strain upon it is frequently so great that it can no longer hold together. It then breaks and open joints or crevasses appear, their long way being across the line of greatest strain and usually crosswise of the ice stream itself. We may thus in many instances as correctly refer to ice-rapids, ice-falls, and to eddies in a glacial stream, as we do to these same features of a stream of running water. So we account for the transverse lines of blue that are plainly discernible in the lower part of this central ice stream on Mt. Jefferson, and particularly numerous and distinct far down towards the end of the larger one at the extreme right, by their being breaks in the solid ice, some of which are only wide open cracks, others being faults in which one side has dropped down and exposed a sheer wall on the opposite and up-hill side of the break.

From our vantage point, better than which could not be chosen for studying the north side of the mountain, we can plainly note the increased amount of dirt and broken rock with which the surface of each of the three glaciers is strewn towards their lower end. The middle one even finally disappears beneath so heavy a covering of detritus that its lower limit cannot be made out. In the midway portions we detect in places dark streaks of rock materials running up and down parallel to the sides of the glacier. These are the result of the gouging action of the ice against the walls of its channel. At projecting points rocks are undermined and broken loose. These constantly fall or roll down upon the top of the ice and form rows along its sides that are later deposited as lateral or terminal moraines. At the same time the great mass of the moving ice-stream causes it to bear down so heavily upon its bed and against its side walls that it rapidly wears them away. Boulders and pieces of rock of all sizes are frozen fast and become most efficient tools with which the ice grinds away at every surface over which it moves. Both these and the rock powder, sand, etc., produced by its grinding are carried forward, not only beneath but are also gradually incorporated into the body of the glacier. Towards its distal or lower end, therefore, where melting is extremely active and, finally, at its very "toe" or "snout," where as a stream of ice it ends, it is to be expected that vast quantities of rock detritus would accumulate. This we see in the shape of ridges and bouldery heaps that are made up of a promiscuous mixture of all the different kinds of materials the ice has picked up on its way down the mountain slope. The stream or series of streams that always issue from under the snout of a glacier come out supercharged and milk-white or yellowish with the pulverized rock flour they are carrying away. The streams can transport only fine particles, however, and the remainder of the glacier's load is dumped as lateral moraines around the curving borders and as terminal moraine about its very tip.

At the left and a part of the sky-line the distinct outline of a dark low morainal ridge is seen at the lower boundary of the long snowfield. From this snow a glacial tongue swings towards us and far round and down the northeast slope of the mountain. It is pretty thoroughly snow-covered, the blue of the ice showing through only in places. We cannot mistake though the typical character of the lateral moraine that fringes its lower border, or of the great hummocky mounds of grayish black at its extremity; though more distant, the darkened rims that outline the borders of each of our other two ice-streams are likewise too characteristic to be questioned.

Names of glaciers

We see then that upon the north side of Mt. Jefferson there are three live glaciers. The one farthest to our right, whose snowfield we probably do not see, appears to be the largest of all. Among Oregon peaks glaciers are found on Mts. Hood, Jefferson, each of the Three Sisters and, farthest south in the range, a bare remnant still clings to the east slope of Diamond peak. Most of the glaciers about the best known peaks have been given names. So far as can be learned no names have ever been attached to any of the glaciers on Mt. Jefferson. The three within our present view are so well-defined and so frequently will, we predict, this region be referred to in the literature of the coming years, it would certainly seem that failure to appropriately christen each of them should in justice visit upon the writer properly-earned censure. It is proposed therefore to give to the center glacier, which from our position can be seen to rest in a mighty niche that it has cut for itself in the mountain side, the name Russell glacier. This naming is made in recognition of the brilliant pioneer geologic work done in Oregon by the late Professor I. C. Russell, who in 1904 described Mt. Jefferson and its glaciers. The glacier at our right which too occupies a similar deep cleft of its own will be called Jefferson Park glacier, inasmuch as the much crevassed blue-green ice of its lower end is in plain view from many parts of Jefferson Park. The glacier at the left whose snowfield rests high upon the mountain's northeast shoulder, may be termed with propriety the Whitewater glacier since its waters drain largely into Whitewater river and thence to the Deschutes river.

Permanency of glaciers

Although we are compelled to regard these glaciers as for the present, and so long as present climatic conditions prevail, permanent features of Mt. Jefferson, we can nevertheless see many indications that they are but diminutive survivors of ice-fields once much more extensive. Attention has already been called to the glacial work along the rocky summit behind us and in the higher portions of the river canyons that lead down both of its slopes. We now stand upon a rib of rock that was more than likely covered with many feet of ice. If this were the case we are at once forced to the further conclusion that the glaciers also once filled to over-flowing the depression before us, at the bottom of which is now laid out for our inspection a most handsome park. Our inferences in this particular will be fully substantiated when we descend to examine more closely this beauty spot. Along the mountain sides to the very tips of the present glaciers are found also some signs of their having slowly receded to their present positions.

Mt. Jefferson appears thus to have been a gathering ground for the snows that in ages past doubtless fell much more copiously than now. Surely the mountain must have been but a great white dome and so deeply snow-covered that scarce a point of rock showed through. From its sides great glaciers moved in all directions; far out to the north and south along the summit, as well as down the range slopes to the east and west did the sheets of moving ice spread, occupying the river canyons and grinding away at every surface over which they passed. We are very certain that the ice from Jefferson actually met and joined with that from other high peaks that were at the same time areas of snow accumulation from which glaciers emanated. An abundance of evidence is found that the entire Cascade summit from Mt. Jefferson southward for more than one hundred miles was not only entirely ice-covered, but the rocks everywhere along it were so profoundly eroded that we can gain little conception of the amount of rock material thus carried away.

There can arise little question therefore that the position of Jefferson park was formerly filled with glacial ice hundreds of feet in thickness. In fact when we consider the varying character of the rocks of Mt. Jefferson at the foot of which the park lies, we will be at once impressed with the probability that the indentation in the summit which it occupies has been cut out chiefly by the glaciers themselves. The body of the mountain is composed of a great deal of ash and scoria, and loose pieces of broken lava. Beds of harder rock stick out in places as though in the course of eruption this volcano, for such it is, had at times poured out liquid lava, or great dikes of harder rock have resulted by the hot liquid magma within pushing its way outward through the looser textured materials. In any case the combination of hard and soft materials in its make-up has rendered Mt. Jefferson quite susceptible to the action of the tearing down forces. The weather has crumbled the harder ledges wherever exposed and the glaciers have so riven its sides that what we see now seems but the partly dismembered skeleton of what was in all probability once a somewhat higher, much more symmetric and commanding peak than at present. It is rugged and reputedly difficult to climb because of the merciless rending it has suffered from the glaciers, and the tearing down process still proceeds unabated.

After thus making a hurried study of our surroundings, we may again look down upon Jefferson Park. It appears to be flat-floored and among the clusters of trees that are arranged in open order, there is a liberal speckling of lakes of many sizes. The park has a maximum width of one mile from north to south and the level portion is not over two miles in an east and west direction. At the far edge it is abruptly bounded by the steeply rising ramparts of Mt. Jefferson. To the west it breaks away in a succession of shelving meadows down into the impenetrable canyon of Whitewater creek and that of the south fork of the Breitenbush, while its east border is determined by a series of similar picturesque meadows that, too, soon give way to the rocky slopes leading down into the gorge of Whitewater river.

Summary of trip

From Government Camp to this point is about a five day trip by pack outfit. In the five days we have come south about 40 miles and with the meanderings of the trail have probably traveled a total of close to sixty miles or thereabouts. This route to Jefferson Park is a most satisfactory one during the midsummer months. Packers (and with pack horses, beyond Clackamas lake, is only way the trip should be attempted) will find an abundance of feed and water at convenient stopping intervals. The scenic features along the way thus far, coupled with the constant high pitch of anticipation of what is ahead, are certainly sufficiently ample and varied to not only ward away monotony but, except to him who borders on the stupid, thoroughly prove an outing of extreme educational as well as health building value. Before examining at closer range the various features that together make Jefferson Park so attractive a place, brief space will be given to a hasty reference to the other routes by which it may be reached.

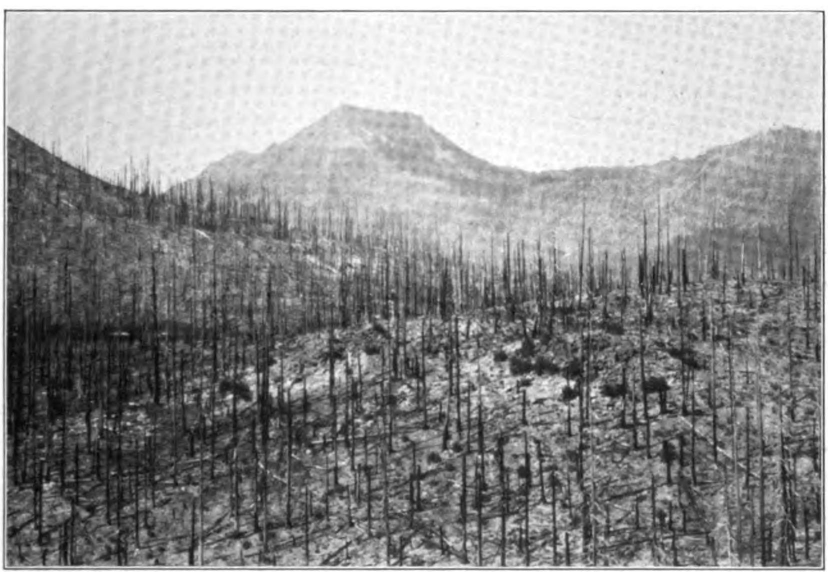
OTHER TRAILS TO JEFFERSON PARK

IT has been pointed out that Jefferson Park may be reached by trail from the railroad at Detroit. Instead of the railroad ride to Detroit one may enter the Cascades from the Willamette valley at many points, usually by wagon road that later gives way to trails as settlements are left behind and the less accessible sections reached. Along the front of the range are many railroad towns from which start may be made. The town of Estacada in Clackamas county, itself a resort of note, has proved a convenient outfitting point and one easily reached from Portland and all outside localities. Jefferson Park is in direct line something like 50 miles from Estacada but on account of the exceeding roughness of the country the trail between the two places will prove to be at least one-half longer than this distance. Though the part of the Cascade range through which one will pass is one of wildness and extreme interest geologically, unless time is an item of minor consideration this route should probably not be seriously considered. To the person with leisure, and who loves the out of doors, it will be highly gratifying.

Estacada to Elk lake

At Estacada a very coarse gravel may be seen resting upon the uneven surface of columnar basalt in the gorge of the Clackamas river. The altitude of the town is 464 feet above the sea. From this the road to the south climbs quickly to the top of a rather even-topped bench between 1000 and 1100 feet in elevation. This bench is soil-covered and the site of prosperous farms. It slopes gently towards the Willamette valley and in places angular and rounded boulders and gravel pebbles appear. At the north fork of Clear creek two miles southeast of Dodge the elevation is over 1200 feet and here our first glimpse of the rock strata is obtained. At this place and at the crossing over Clear creek a little farther on, are heavy ledges of a hard bouldery volcanic tuff, a vast bed of broken blocks of lava cemented together into solid rock. In the next 10 miles we rise rapidly to an altitude of 4000 feet at the Timothy Patch, and to 4500 on top of the divide near Cold Springs ranger station. At Baty butte six miles beyond this station we have climbed to 5000 feet. At all altitudes up to 2000 feet and, just below Baty butte, as high as 4000 we still note the presence of the rough volcanic conglomerate. In the canyons which here are both deep and precipitous it stands out far below the trail as bare cliffs and as crumbling pillars and pinnacles. The tops of most of the ridges thus far however, some not higher than 1500 feet, have a covering of lava, usually thin, at the most not over a few hundred feet in thickness.

From Baty butte to Elk lake the trail first drops over 2000 feet into the canon of the Hot Springs fork of the Collawash river to Bagsby hot springs and then climbs with the grade of this stream and by the Silver King mine to nearly 5000 feet at its head. This is the top of the divide that separates the Santiam drainage at the south from that of the Clackamas river. The hot water at the Bagsby springs bubbles out from several openings in a coarse volcanic conglomerate apparently similar to what we have seen at many points along the trail. The rounded pebbles and boulders of which it is made are firmly cemented together by what may have been fluid volcanic mud, or even of molten lava, that has picked them up or percolated into the openings among them so as to form a dense rock. The so-called Silver King mine though



Battle Ax peak from the southeast. Dunlap lake in front at the left. The rounded slopes are glacier molded. From the head of Hot Springs fork the trail continues southward first on one side then on the other of a sharp divide, across burns and over patches of glistening or loose sliding rock, to the base of Battle Ax mountain. Battle Ax is itself a part of this divide, because of its height so prominent and its horizontal sky-line so conspicuous as to be seen and recognized from almost every sightly point in the whole northern part of the Oregon Cascades (see panorama from top of Olallie butte). It is built of a series of volcanic beds with a platy augite andesite at the top. This variety of rock alternates with red and black scoriaceous or cellular lavas down for about 750 feet. Below this a great mass of lighter colored, less basic hypersthene andesite showing many distinct white or shiny crystals of feldspar forms the base and the ridges leading to the north and eastward from it.

1400 feet higher in elevation is similarly a nearly vertical gash in this coarse bouldery conglomerate that has been filled with quartz and some of the metal-bearing sulphide minerals. There are indications that considerable prospecting of this vein has been done.

The aneroid if carried to the top of Battle Ax, and it is a delightful climb not by any means to be let slip in the huckleberry season, will indicate its altitude to be a little over 5700 feet. Mt. Beachie one mile to the west of south appears to be a part of this same crumbling ridge at both the east and the west slopes of which the streams are so vigorously gnawing away that between these two mountains at the head of Elk Lake creek, the dividing wall has in places been reduced to a sharpened edge and parts of it nearly if not quite toppled over.

GLACIATION IN THE CASCADE RANGE

ALONG the northeast base of Battle Ax where the trail passes is a series of little lakes and swampy places and elongated embankments of earth and rocks, all perched high up on an irregular shelf of solid rock at the lower edge of which the land drops nearly precipitously for a thousand feet or more to the headwaters of several small creeks that flow eastward into the Collawash river. We do not need to search long to discover the origin of these features. Bare rock surfaces are seen here and there that are polished smooth or bear the unmistakable parallel facets or grooves that are produced only by the ponderous movement of great masses of glacial ice armed with sand and pebbles so that it can grind down the hardest of rocks. We are thus forced to conclude that in times not long past parts of this portion of the Cascade range, as we have seen is true of the summit, were also covered by ice during the glacial period. Far out on the ridge to the north of Elk lake the evidence of glacial molding is recognized, and on the divide to the south and east of it the bare rocks are still in sight as though just scraped clean and deeply scored by the ice. Here, too, about the head of the west fork of Humbug creek, are a number of small lakes that occupy shallow pits that have been scooped out of the hard rock by the movement of the glaciers. Dunlap lake is one of these. Elk lake itself, a pretty little body of water immediately at the southern foot of Battle Ax, is probably also of glacial origin though situated over 1700 feet lower than the summit of that peak.

We have been examining here but one of a great many places in this front and more rugged part of the range where evidence of the former work of glaciers may be found, yet where not even the remnant of one exists at the present time. Though we are more than 20 miles west of the summit of the range, the highest peaks are many of them fully as elevated and some more so than are parts of the summit itself. It is not surprising therefore to discover that from some of these peaks glaciers have flowed down from the heavy snows that must have accumulated upon them and have left their imprint upon the mountain sides, just as they did from the main peaks along the crest of the range. While here we see in the presence of the lakes, the moraines and the ice markings only the footprints, as it were, of the active agent that produced them, about the highest peaks along the summit, as Mt. Hood, Jefferson, and the Sisters, we actually find besides these marks the dwindled remains of the ice-streams themselves, insecurely clinging high up on their slopes, it is true, nevertheless a further convincing key to conditions once existing there. We have few data as yet to tell us much about the distance to which the streams of glacial ice moved down the slopes and into the river canyons from the various elevations in whose snowfields they originated.

Elk lake and summit peaks from the top of Battle Ax mountain. From Battle Ax the view to the east is one of sharp ridges and deep canyons. Olallie butte is due east and at the left in the picture. Mt. Jefferson stands commandingly at the right. While at one's very feet is Elk lake, all within its scope reflected from the water's surface as from a mirror. At the right we look lengthwise of the canon of the south fork of the Breitenbush river and across Whitewater creek and see the notch at the north foot of Jefferson where both take their rise in Jefferson Park. Just beyond the first dark forest ridge in the center of the view is the canon of Humbug creek, a tributary of the Breitenbush, and a little to the left the low gap marking the location of that of the north fork of the parent stream. Near the extreme left can be seen, far toward the summit and in line with Olallie butte, the position of one of the main head branches of the Clackamas river whose waters pass far to the northwestward to finally reach the Willamette near Oregon City. The Breitenbush discharges into the North Santiam and it in turn joins the parent stream between Albany and Salem. On the slopes of the hills beyond Elk lake, a number of mining claims have been located and prospecting is being actively carried on. The metal-bearing minerals appear to occur in cracks in an andesitic rock that has been broken somewhat by movement and in part altered and silicified.

Although in direct line still fully 20 miles from Mt. Jefferson, the position of Jefferson Park can be so distinctly made out that one is inclined to feel that the goal is nearly won. The course over which one must go, however, of necessity so greatly departs from "the shortest distance between two points" that instead of 20 the distance yet to travel will prove nearer 35 miles.

It will be recalled that the principal trails have so far followed for much of the way along the tops of the ridges that separate the river canyons, many of which are in places 2000 feet and more in depth. From this point on, however, our trail will follow for a goodly part of the way in the bottom of the canyons, while in places

Elk lake and Summit peaks from the top of Battle Ax peak.

for miles the forest cuts off our view and we see even little of the rocks over which we travel.

Elk lake to Detroit

From the ranger station at Elk lake we go over a low pass and descend between three and four miles to the Breitenbush where our trail joins the main trail from Detroit to the Breitenbush hot springs that are six miles farther up this river. These springs are well known and, although to be reached only on foot or by horse, have become the basis of a popular resort that is frequented by hundreds each year. We could turn here if we chose and, going up the Breitenbush to its head pass over into and across the Clackamas river canyon to join the main summit trail at Lemeti some six miles north of Olallie butte. But all will probably be found more satisfactory if, instead, we turn downstream six miles to Detroit, and then take a most excellently laid out trail up the North Santiam river for 11 miles to where Whitewater creek comes in.

Along the Santiam we are on what is called the Marion lake trail and its good repair can be attributed to its being a much traveled highway to that attractive body of water lying near the summit to the southwest of Mt. Jefferson.

Detroit to Jefferson Park

Since leaving Detroit the distance has been ticked off for us by a series of neat though conspicuous mile signs. One cannot but appreciate the spirit of helpfulness that has prompted the putting up of these signs, although had their inexorable accuracy not been tested time and again we might be constrained in case of haste to question their correctness. Nor do we marvel less at the cogency than variety of the advice that is persistently offered to us on the signs that warn against forest fires. Whatever impression they may make as to our moral or legal obligations they do at least remind us that we are traveling within the government domain, this the Santiam National Forest.

It may be with some misgivings therefore that, on leaving this main trail at Whitewater creek, we find our progress often much impeded if not at times actually blocked by, for the most part, a very stony trail and one from which logs have not been removed. It is a tortuous trail largely because of the detouring necessary to dodge these obstacles and to surmount sudden changes in elevation. Even the familiar signs fail and the journey through the forest for eight miles first up the Whitewater and then a tributary, Cheat creek, to Whitewater ranger station though of decidedly jostling interest proves an energy-consuming one to both man and beast. Along Whitewater creek glimpses may be caught of outcropping conglomeratic beds, and bouldery masses in the bed of this murky stream attest the presence of the same general type of fragmental volcanic rock that we have heretofore seen at these lower altitudes in so many places.

From the ranger station where the aneroid indicates an altitude above the sea of around 4750 feet, rapid rise is made in climbing to the summit of the rocky east and west divide that separates the waters of the Whitewater from those that go to the north into Breitenbush river. The green forest is left behind. We pass across open burns where the bare andesite is frequently seen, and meanderingly zigzag up the mountain side among stern tottering or fallen specters of once forest giants, with only rare signs of a trail to follow. Here, about the head of Cheat creek, is again observed abundant evidence of the work of glaciers. The rounded character of the rock forms some of which, far down towards the ranger station just left behind, exhibit the typical parallel scorings that only moving ice produces, and the U-shape of the stream gorges are unmistakable. The position and form of this ridge which we now follow nearly to Jefferson Park is such as to indicate with great probability that the elevation of Mt. Jefferson was a source of the glaciers that came for many miles down its western slopes. It has been whetted in places to so narrow an apex that one must cross and recross and then find only a precarious footing against its steep and slippery sides or on sliding rocks that are anything but secure. Since the time of the glaciers the streams have by their ceaseless cutting accentuated the abruptness of this ridge, so that at some points we have the sensation of passing along almost overhanging cliffs from which we gingerly peer down for a thousand feet or more into the depths of the canyon where we can occasionally see the debris whitened waters of Whitewater creek, less often hear their booming roar. This too is an old Indian trail and is so little frequented that no work whatever has been put upon its improvement. It is therefore not a trail that one, unless somewhat experienced in mountain travel, passes over with equanimity perfectly undisturbed. A reasonable amount of caution, however, and the exercise of ordinary judgment reduces the element of danger to such a degree that any one possessing these qualities in just normal quantity need not hesitate to pass over it. Relocation and rebuilding are, nevertheless, much to be hoped for, and something too, to be confidently anticipated as the fame of Jefferson Park furthers an already growing demand for a safe means of reaching it.

Park-like meadow at the west side of Jefferson Park. Within a mile of the west edge of the park the trail drops down off the ridge to the south or Whitewater creek side, but we continue to rise over successive rock-supported benches on which are located a series of most beautiful grassy meadows. They are deep-sodded, tree-dotted, covered with grass and a sprinkling of bright flowers and through each meander the branches of sparkling mountain streams that separate and unite, in anastomose fashion, amongst the quiet pools that mark their former courses. No one will question the appropriateness of the feeling that we are already passing through a portion of "the park," for no term could

Park-like meadow at the west side of Jefferson Park.

be more fitting. We are now at the very base of the mountain though not yet quite so entirely within its shadow as we shall be at the end of a further climb of a few hundred feet that will land us upon the summit.

THE TWO ROUTES TO JEFFERSON PARK

WE have now approached Jefferson Park over the two different routes by which it can be conveniently reached, one, following from the north along the comparatively even summit, and the other entering after a passage of greater or less length through the more rugged sections of the Cascade range. The former may be termed the *summit* route, the latter the *Detroit* route. The summit route, as may be seen on the map, is joined at intervals by branching trails, and, in the same way, besides coming to Detroit by rail, can the entrance by the "Detroit route" be used by way of tributary trails from various directions. Detroit to Jefferson Park is between 22 and 25 miles, a good long day's travel for the most hardy. For the average person the only satisfactory plan is to spend one night in camp on the way.

The trip from Estacada, if great haste is not essential, will take five days. The only mode of travel is by pack train and either afoot or in the saddle. Meadows occur at sufficiently frequent intervals to afford feed for horses in plenty and an abundance of good water is obtainable almost everywhere. There are many springs along the trail and innumerable mountain streams whose source is the pure water that seeps or bubbles from the porous rock strata that in turn catch their supply from the melting snows that rest upon them oftentimes until late in the summer season. In this particular is the summit trail somewhat disappointing, for there many of the early season springs disappear and the staleness of the standing water of lake or pond, never more than fit, renders very questionable its use for human consumption during the late summer months. One sees, however, on the two routes two different types of mountain topography. That of the summit, a new and immature one, the other a more pronounced and featureful land surface of middle age, if we may use the expression, where the natural agents seem more busily at work and we see in what way they have been and now are responsible for its shaping.

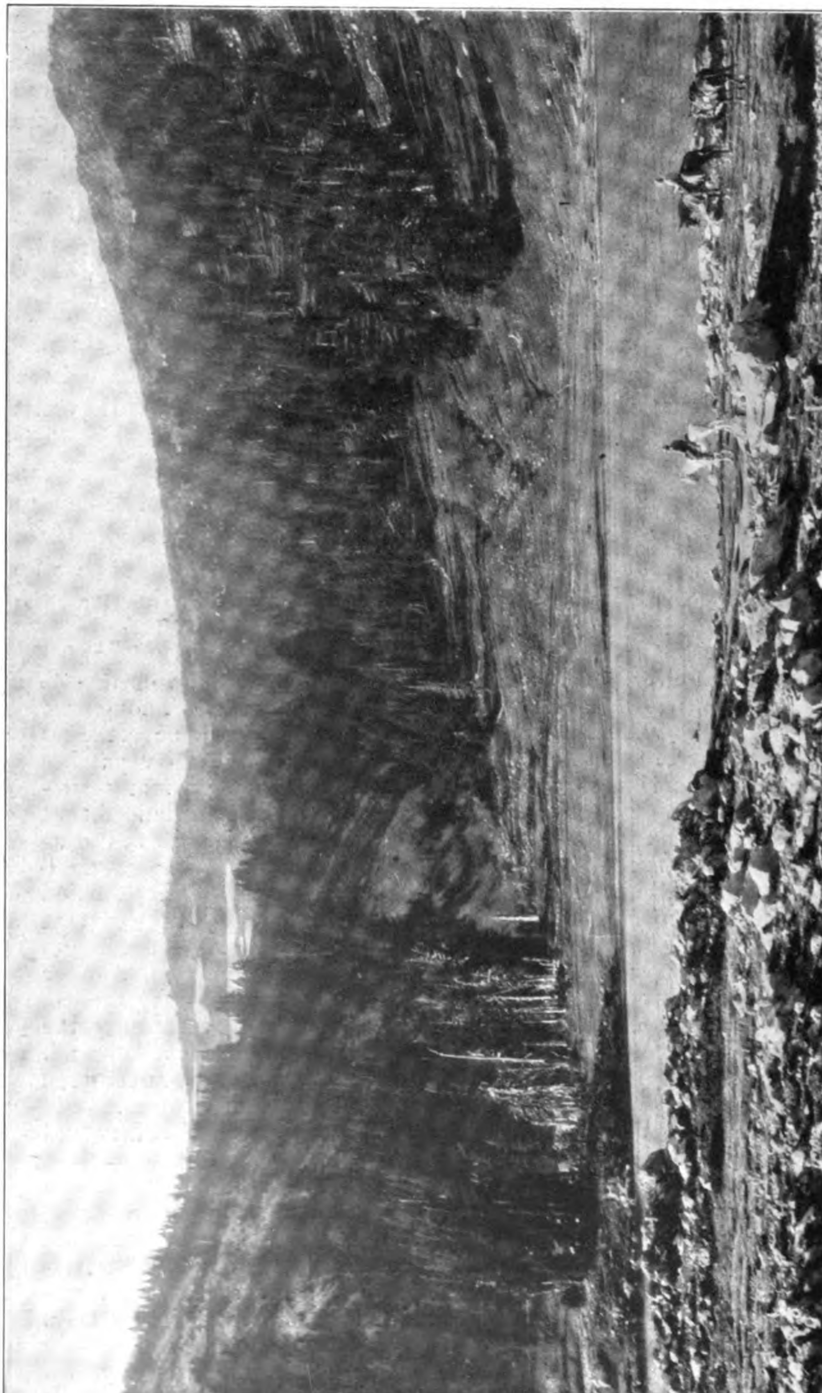
IN JEFFERSON PARK

THE descent into the park from its north rim is made down glaciated rock slopes, over morainal heaps, and across stretches of earth-filled slide rock. Occasional but scanty marks of an old trail are seen. In a distance of perhaps a mile the drop is about 1000 feet.

An appreciation of the beauties of this place, which those few persons who have visited it affirm is not to be equaled anywhere else in Oregon, could not be gained by reading volumes that might be written about it. It is one of those rarer gems that nature sets down here and there, that, like other jewels of price, must first be sought out by diligent, oftentimes protracted and tiresome effort. But unlike those jewels it needs not the hand of the lapidary to saw and polish, for nature has already done that part. And she holds out to the steadfast of her children the finished article, to touch which man would mar, not perfect. To reproduce the charm that only the environment itself can lend is an impossible thing. The thrill in its fullness comes only to him who is able to go and see. The camera fixes the bare cold outlines of rock and tree and lake and mountain. It furnishes the visual foundation on which depends the pleasure of a visit to a place like this. If the pictures, therefore, can be instilled by means of the right sort of a written word of explanation or casual suggestion, with ever so little of the spirit that pervades the very atmosphere of the places they represent, their presentation will be fulfilling the main purpose that photographs can serve. Their purpose in this brief story is in part but not so much to remind those who have already enjoyed a visit to Jefferson Park of what they have seen there, as it is to suggest to the many others who may or may never be able to go, something of the attractions and the delights that await them.

In Jefferson Park looking toward the divide at the north side whence entrance is made by way of the summit route. Though we are still on the summit of the Cascade range, we are nevertheless close to one thousand feet below the rim where the snow patches show. The lake in the foreground is but one of many similar bodies of water in the park and is so neatly balanced that one must search its borders to determine whether it will outlet toward the Deschutes or the Willamette. The rounded and moderate slopes beyond the lake have been glacier-molded and are strewn with pebbles and boulders left by the ice that the sod and forest growth have not yet covered up. In the immediate front is a rock-scattered surface from which many knobs of solid rock project that have plainly been worn down by the ice. So recent has this been that only on protected places among the rocks has soil enough been formed for plants to gain a foothold. The trees whose footing too is as yet rather precarious are not of large size and are principally Alpine firs whose natural habitat is only in the higher altitudes. Members of the Bureau of Mines and Geology party appear at the right.

At the immediate foot of Oregon's Matterhorn. The rocks of which the mountain is made are seen to be largely of loose, crumbly character. They produce unstable slopes that are rapidly cut into by streams and speedily eaten away by the glaciers. It is the physical character of the rocks and the intermixing of hard and soft that have made ascent so tedious a task. Unless the course is chosen with great care the climb is extremely difficult from this side. At the extreme left against the sky is a part of Whitewater glacier. At the right and starting high up



In Jefferson Park, looking toward the divide at the north, whence entrance is made by way of the summit route.

At the immediate foot of Oregon's Matterhorn, Mt. Jefferson.

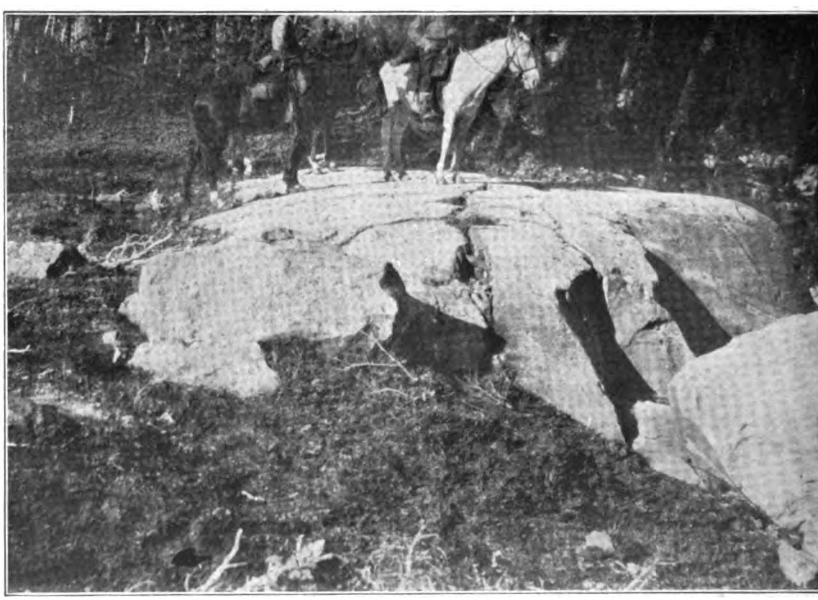
Lake near the west boundary of Jefferson Park.

in a deep cleft near Mt. Jefferson's summit is the Russell glacier. Toward its head, is a vertical wall or ice cliff produced by its passage over some obstacle or a sudden change in the steepness of its bed that has caused not only a transverse crack or crevasse but "faulting" or a dropping down on the lower side of the crack. This kind of crevasse has been given the name bergschrund by glaciologists. Formerly a branch of this glacier came down the depression leading toward us in which but banks of snow now lie. Across it are now thrown two barriers, one a tree-sprinkled ridge low down and the other, the thin dark band at the edge of the present glacier, what appears to be part of its lateral moraine. Without making a careful examination it cannot be said but that the first of these also is of morainal character, and if so, put there while in its retreat the lower edge of the tongue of ice temporarily halted in that position. Glaciers recede when melting of the ice is more rapid than the downward movement. Movement is determined by the amount of snowfall from which the glacier is supplied. It is found therefore that glaciers fluctuate, as do rivers of water, advancing after periods of heavy precipitation and receding when drought comes on. Russell glacier makes a turn to the right, that is, to the northwest, above the well-defined moraine near the top of the photograph at the extreme right, so that its terminus is not in view from this location. The foreground is literally a mat of flowers through which white boulders peep. Against the grass green the delicate pink of the red heather vies for dominance with the tender white of the less conspicuous moss heather. A liberal spattering of Indian paint brush crimson lends a pleasing touch of quality to the assemblage.

Lake near the west boundary of Jefferson Park. There is no dearth of camping places. Indeed, they fairly run riot so that one feels almost disconcerted at not being able to take advantage of more than one at a time. A sward delightfully clean and comfortable, enough of loose rocks handy for campfire and settees, lovely flowers to please the eye, ample fuel. Best of all, each may have an individual pool, or as many as may be desired and no need of competition, with borders that for convenience are sod-upholstered and fringed with heather. In them every outline of tree and cloud is mirrored. Their bottoms are stoneless and an unfailing solace to tired feet. At the left and neatly framed between stately noble fir and less pretentious mountain hemlock we look against cliffs that form a lower shoulder of Mt. Jefferson down which what we are to call Jefferson Park glacier creeps. Though it has obviously cut a path for itself it nevertheless is badly broken where the final plunge is made over the steeply declivous rock front to soon waste away, and melting, contribute its substance to the swollen waters of Whitewater creek. The ice shows blue and the crevassed and pinnacled surface makes this glacier an object of outstanding interest from many points in the park. A few hundred feet of climb carries one to its lower end where various features common to glaciers of this type may be studied at close range.

The prominent knob is an outstanding portion of the north wall of the park. At a distance the rock appears black and about its base the talus slopes are of gray and yellow colors. Without further corroborative evidence one might infer from its general appearance that this isolated peak, though entirely surrounded by the ice that gnawed away at its sides and base, may not have been entirely covered over by the glaciers. In any event the fact of its having so withstood the attack of all the natural conditions that tend to tear it down that it still defiantly lifts its castellated crags to commanding height is eloquent if mute testimony to its relatively resistant character.

There are countless lakes within the park. Some are a half mile across and others but pools in size. Some have outlets, others no outlet that can be seen. The surplus waters from some drain away to the eastward through Whitewater river. From others the excess goes down into the Breitenbush and (unfortunately so named) Whitewater creek, to find its way to the Willamette. The lakes invariably occupy pits or shallow basins that have been scoured out of the usually firm andesite by glacial action. Often the clean, fluted or polished rock surface may be seen about their shores. Again the shore lines are precipitous and erratically indented so as to form embayments and their complements, rocky capes and peninsulas if not islands, as if the hollow the water fills was made by the bodily plucking out of great angular blocks of rock at a place. None have as yet been stocked with fish.



Rock surface molded by glacier movement. At many points glaciated surfaces are found. Some are planed smooth, showing merely parallel scratches, others fluted or grooved, while yet again furrows or channels are seen whose depth and width must be measured in feet instead of inches. The direction of these markings is an index to how the glacier moved that produced them. The rock shown is in place and just at the brink of the cliff at the east edge of Jefferson Park where the slope begins to drop by a succession of precipitous benches into the canyon of the Whitewater.

The prominent knob is an outstanding portion of the north wall of the park.

A mere bank of flowers. Numerous are the secluded nooks where against a shadowed background of clustered fir and dignified hemlock, gardens of flowers are framed. Richly bespeckled with the gray-white of the andesite boulders that show through, and mirrored in the water of the sod-bound lake in the fore, such gorgeous spots as this it is futile to attempt to describe. Indian paint brushes profusely dominate in front and the white, pink and red of the heather are in clumps behind. Through the trees is the outline of a part of the divide to the north of Jefferson Park.

Where whole meadows of flowers bloom. In various parts of the park are flat areas that during the summer are daily irrigated by water from the melting snows of the mountain side. Streams of all sizes trickle down and from noon to late in the day when melting is most active, the water spreads, in places as an irregularly advancing sheet, in others a series of interlacing rills, across level open patches whose ashy soil greedily drinks it in. Mornings one may walk with little heed where at a later hour the way is barred by sticky mud or swollen creek. In the view the meandering course of the soil-charged rivulet may be traced for many rods across the open glade. Colonies of wild lupine adorn its banks among which the bladed leaf and navy blue of the shooting star appear in lesser numbers. Ever present, too, are the Indian paint brushes whose vaunting display of carmine hue imparts not alone dignity but harmony to the scene.

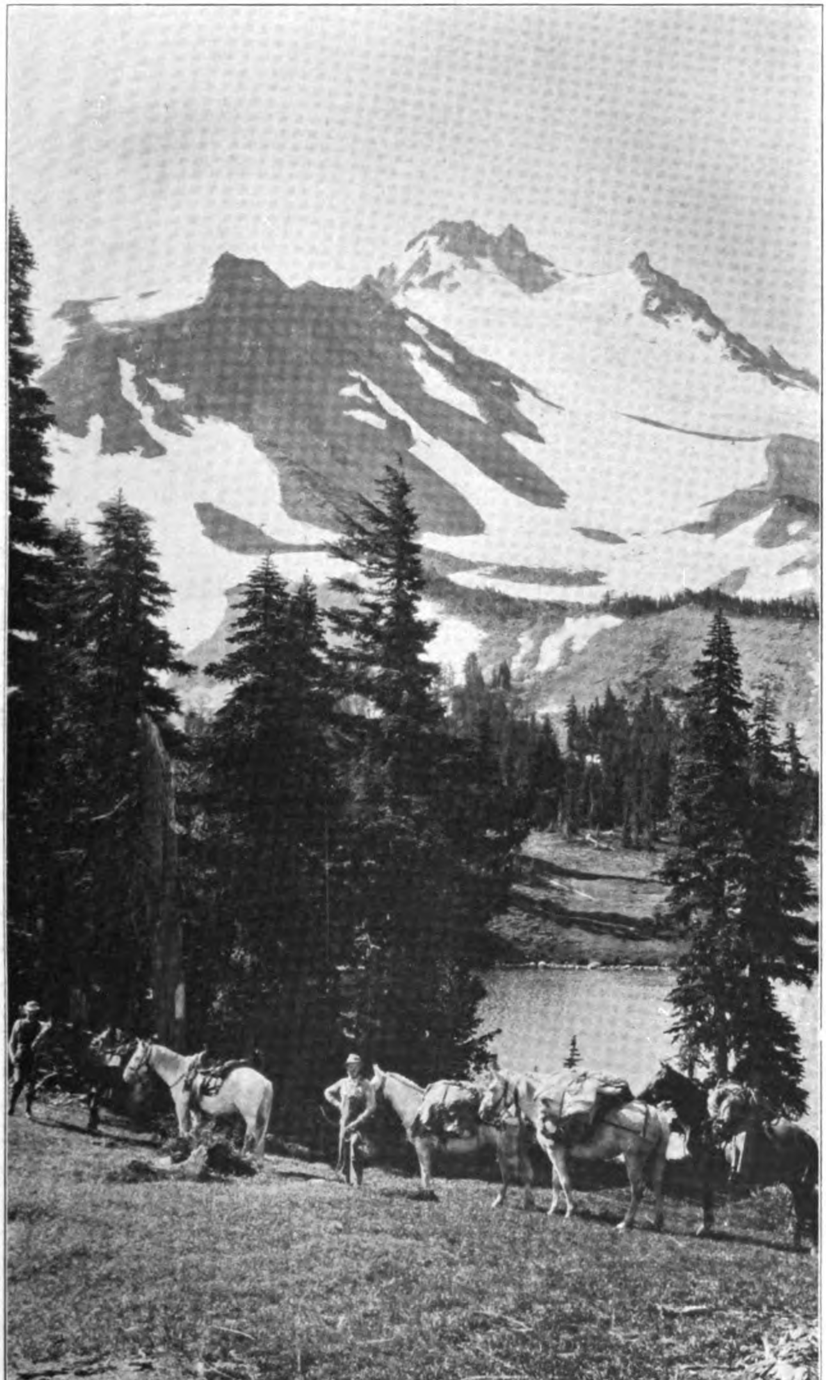
Glacial meadow near the east side of Jefferson Park.

Glacial meadow near the east side of Jefferson Park. At either end of the park, to the east and west, one may go down over a series of benches or rock shelves, one below the other, before reaching the main sharp canyons of the rivers that drain it. Each bench is separated from the one above by a rise and that below by a drop of varying height, sometimes almost vertical and always of exceeding rockiness. Upon these shelves which are flat, are sometimes one or more small lakes, but more often a group of sparkling clear pools or ponds, through or around and among which one or more gracefully meandering streams weave their way. The open space is invariably carpeted with a springy sod that supports grasses and here many of the more brilliant hued of mountain flowers find a congenial home. This type of meadow is one of the most pleasing of the many attractive features provided for the visitor to Jefferson Park, gratifying not alone to the eye of man but to the palate of beast as well. It is the result in some instances of the work of a glacier in the decadent stages of its occupancy of a region. While the edge of the ice remains stationary for a time a rim of earthy rock material is dumped across its channel. We thus sometimes find morainal heaps or ridges at the down-stream borders of the open meadows. During a period of rapid melting when the edge of the ice moves back rapidly, much less of material is deposited at any one point and what is left behind is spread more evenly. In this manner comparatively level stretches may result on which vegetation can gain a start by the filling in, first with water and then fine sediments, of the area across which the ice has receded rapidly and behind or above these recessional moraines that then act in a way as barriers across the drainage channel. Such may some of the prettiest of these mountain meadows be seen to be. The rock cliffs by which they are hemmed in above and below are the result of the plucking action of moving glacial ice that pulls away great rock blocks, fast to which the ice has frozen. The forest fringe at the farther border of the meadow is a typical growth of alpine fir.

A glade wherein wild lupine prevails. Here also are the paint brushes to grace the foreground, and blending with the lupine blue the sensitive yellow of the less pretentious Townsendia, an aster-like bloom of modest mien. Though not conspicuous, here is the still more demure saxifrage whose yellow or white-tipped spikes and tufted basal leaves bespeak its presence almost everywhere. Wild caraway too is frequently seen where moisture is more plentiful, lifting its umbellate head above its less spindly neighbors. In this photograph the rounded outlines of a topography that has been quite largely shaped by the grinding action of glaciers is rather clearly brought out. There is an evenness of curvature that water erosion alone does not produce.

A general view of Jefferson Park entire reminds us again that it occupies a deep cleft cut across the apex of the Cascade summit at the north foot of Mt. Jefferson. That it has heretofore been deeply filled with the ice of a giant glacier every evidence goes to prove. We catch signs enough of its work to show that the ice

A glade wherein wild lupine prevails.



Mt. Jefferson from near the west side of Jefferson Park. At present there is in Jefferson Park only such accommodations as nature has provided. These are not to be excelled, so far as nature's provisions go. But the visitor to this wonder region must bring along such of sustenance and the comforts of civilization as he may require. Moreover, the road is a long one and in places of exceeding roughness, which only goes to say that the amount of luggage taken must be reduced to a minimum, whether the journey is made by horse or on foot. Even now the rigors of getting there are as nothing against the gratifying delights of ever so brief a sojourn. Russell glacier as seen from the Park.

must have flowed outward both to the east and to the west and for an unknown distance down each of the river canyons that lead from the park. We further have strong grounds for believing that this two-part glacier of which only dwindled remnants now remain clinging high up on the sides of Jefferson, was responsible for excavating to bedrock and carrying away the vast quantities of mainly loose volcanic materials that formerly extended to the northward as they still do in all other directions as a series of radiating ramparts about Mt. Jefferson. How far into the solid rock the cutting action of the ice proceeded after the removal of the fragmental materials we know only that it must have been considerable. All of the many little lakes occupy basins scooped out by the glacier and the ever present grooves and scratches are its indelible footprints.

Some day, and with an increasing knowledge of its attractions there is reason to feel that the day may be hastened, there will be good trails from all directions into Jefferson Park. Slight improvement of the present Whitewater trail will make it entirely safe and satisfactory from the west side. From the east side, a careful reconnaissance should show a feasible way either down Whitewater river and across the Warm Springs Indian Reservation or, swinging to the southeastward, over the divide to connect near Bald Peter with the Jefferson creek trail and thence out along the Metolius river.

At the north side of Jefferson Park a judicious marking of the present all but obliterated old Indian trail from Breitenbush lake is something very greatly to be desired. Some day this trail too will be accurately laid out and made usable during the summer season.

It will be recalled that there is now a good automobile road along the Cascade summit southward to Clackamas meadow. For its construction the government Forest Service is to be highly commended. Its terminus is, in a straight line, yet about 27 miles away from the park. The extension of this road rapidly southward in the years to come is to be urgently hoped for. So far as the character of the country is concerned, from the scenic as well as engineering possibilities, it is not idle dreaming to believe that not so many years will elapse before automobiles will carry their passengers, without portage, to the center of Jefferson Park and among its beautiful lakes. The attractions of the place need only to be widely and persistently heralded to aid very materially in bringing this about. And then, possibly before that time, as a logical and orderly sequence citizens of Oregon are going to ask that Mt. Jefferson and its scenic environs of which Jefferson Park is but one, be set apart as a national pleasure place. The name Jefferson Park appears thus the more fitting in that but a single word will then need adding to a term with which every one will be familiar and Jefferson Park, expanding with the scope of its area, will become Jefferson National Park.

THE THREE SISTERS REGION

The Three Sisters region is a section of the summit portion of the Cascade range that is second to no other in scenic interest. It is so designated because of its domination by the Three Sisters peaks and they are so named ostensibly on account of their close association and fairly uniform height rather than upon marked resemblance. This group of peaks stands a little to the north of the middle point of the Cascade summit. It is located essentially half way between the Columbia river and the south boundary of Crater Lake National Park, the latter being still somewhat over 50 miles from the California line.

Three Sisters and other summit peaks from near Bend, Oregon. The first three snow peaks at the right in the photograph are the Sisters. Next to the south member of this group is Broken Top. It is really some four miles nearer to our present position than is South Sister at whose left it appears to stand as a formidable guardian rampart and which, indeed, it is. Slightly nearer at the left of Broken Top and apparently forming a lower shoulder of that mountain is the flattened white dome of Ball butte. Yet to the left and low against the horizon line the top of what is probably Soda hill peeps from behind the intervening forest. At the extreme left the symmetric snow-covered cone with wide spreading base is Bachelor butte, 9045 feet in altitude and, on account of its massiveness and even symmetry, one of the most imposing of the less known peaks of the Cascade range in Oregon. At the right of Bachelor butte and not quite so distant is Tumalo mountain.

The foreground is illustrative of the typical sagebrush land of central Oregon. Among the brush is a scattering of juniper, the dead and bleached remains of a few of which appear in the view. At the right beyond the team is the upper portion of Pilot butte. This butte stands at the east edge of the city of Bend and is a great heap of volcanic cinder, ash and scoriaceous rock with the depression of the crater still showing its top. Pilot butte has the appearance of having stood here and being surrounded as an island by a billowy sea of seething molten lava when the widespread flows of basalt came that now underlie many hundreds of square miles in this part of Oregon.

The McKenzie road

The Three Sisters region may be reached from both eastern and western Oregon by way of the McKenzie road. This road is so called because it follows for many miles up the McKenzie river, recognized to be the largest of the headwaters of the Willamette which it joins a short distance below Eugene, the county seat of Lane county. From Eugene regular auto stages run for more than 60 miles up the river to McKenzie bridge and to Belknap springs, over a road that in large part is in most excellent condition for automobile travel during the summer months. The Southern Pacific railroad station in Eugene has an ele-

Three Sisters and other summit peaks from near Bend, Oregon. The Sisters peaks stand a little apart from conspicuous summit peaks to the north, spine-like Mt. Washington 15 miles distant being separated from them by many square miles of impregnable lava flows of geologically recent date. From the southwest on the other hand the Sisters are but the culmination of a succession of snow-clad summit heights that, as one views them in early summer from the country to the east, stand deployed as would be the outlook sentinels of a distant great battle front.

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McKenzie road in the canyon of Lost creek.

vation of 426 feet above sea level. The climb in the first 60 miles to McKenzie bridge is somewhere near one thousand feet.

From McKenzie bridge to the summit is about 20 miles and the auto road continues on down the east slope of the range for another 20 miles to Sisters in the Deschutes valley, whence branch roads radiate towards all of the settled parts of eastern Oregon. In the 20 miles from McKenzie bridge to the summit one rises about 4000 feet or an average of 200 feet to the mile. Sisters has an elevation of 3175 feet, a drop of a little over 2000 feet from the summit height.

The Sisters peaks are reached by a trail that starts from the McKenzie road in what is known as Lake valley between six and seven miles west of the summit.

Volcanic rocks in McKenzie river canyon

On leaving Eugene the traveler first passes through a prosperous farming district in the lower McKenzie valley. At Eugene, at Springfield, and for some distance up the McKenzie we see hills of basalt, and this rock occurs also very frequently in the river channel. Before many miles are traversed the valley walls close in, farms become scarce because of lack of room, and the rock slopes get steeper and the mountainous ridges at either side increase in height and ruggedness. Small quarries have been opened at several points to provide road-making material where the character of the rocks may be nicely seen. At many places we see the pebbly and bouldery volcanic tuffs, often called conglomerates. Where the volcanic pebbles have somewhat sharp corners and edges as though but freshly broken and tumbled in together the rock is termed an agglomerate or volcanic breccia. Such rocks are frequently as hard as the lavas themselves so firmly are the fragments cemented together. As we progress farther and farther up the river more of the fragmental rocks are seen, less of the dark-colored columnar basalts, and at intervals masses of rocks of coarser grain, lighter color and crystalline appearance. Such a body of crystalline rock is noticed for a mile or so along the road above Gate creek some eight miles west of Blue river. It is attractive in appearance and at first sight might be thought a granite suitable for building or monumental purposes. Careful study with the microscope however, proves it to be of the character of a granodiorite such as in other places in Oregon has been pushed or squeezed or intruded, while in the highly heated condition, up beneath or through the heavy beds of other rocks that overlay them. These overlying rocks have since been removed during the process of the wearing out of the river canon so that the intrusion is now exposed at the surface. It is with bodies of rock of this class that many rich ore deposits are associated. At many points along the route are neatly environed summer cottages and some whose occupancy is obviously not restricted to the summer season. At Blue river a road goes north to the mining district of that name, and somewhat farther up are the flume and power house that supplied that mining camp.

How rocks are studied

From this point on we begin to see some of the dark gray andesitic rocks such as compose much of the superstructure of the Cascade range. These very often have a porphyritic texture, that is, a texture in which distinct crystals of one or more minerals can be readily seen but the matrix or groundmass in which they are set is of finer grain or so dense often that with the naked eye one cannot determine what its mineral composition is. In order to study a rock of this kind with any degree of satisfaction it is necessary to make a thin section for examination under the microscope. Thin rock sections are made by sawing, then grinding and finally polishing both sides of a small piece on an emery plate, to such a degree of thinness that light will readily pass through practically every one of even the darkest colored of the minerals it contains. All of the harder rocks are now studied in this manner and sections can with care be ground down to a slice as thin as .002 to .0008 of an inch. No other means has proved so serviceable as this for determining the physical character and mineral composition of igneous rocks.

The andesites form the capping and, as we go farther up, much of the mass of all of the river divides from here to the summit. At McKenzie bridge where the road crosses to the south side of McKenzie river an interesting side trip may be taken to the Foley hot springs, some four and one-half miles southeast up the canon of Horse creek. At this place strong flows of scalding hot mineral water issue from crevices in what appears to be a dense flow-breccia. A well known resort has been founded upon the bathing and healing properties of these waters.

Above McKenzie bridge where there is a flat gravel terrace of some width, the canon still narrows somewhat and our road is within the Cascade National Forest and through heavy stands of Douglas fir and hemlock for which the Oregon Cascades is noted. Between five and six miles above the bridge the road comes to Lost creek and here a branch road crossing this creek continues up the McKenzie for a mile or so to Belknap springs. At this place, which is a resort of wide reputation, the hot gas-charged water bubbles from openings in a coarse volcanic conglomerate that is exposed in the banks of the river for many miles.

About one-half mile below the junction with the Belknap springs road the main road rises rather abruptly over a series of bouldery hills that remind one very forcibly of the characteristic heaps of morainal rock detritus that accumulate about the lower end of a glacier. The embankments seen here may be the terminal moraine of a glacier that formerly extended from the summit this far down Lost creek canon, but to settle this point definitely one should look the region over more thoroughly than can be done by merely passing along the road.

New lavas along McKenzie road

As we pass on up Lost creek we soon begin to see unmistakable signs of the more recent lava flows that have coursed down the wide depression that this creek occupies. We are thus led to question whether the bouldery hills that at first sight appear to be morainal may be after all only the broken up peripheral portion of a tongue of once viscous lava whose surface is now obscured by soil accumulation and the forest cover.

On crossing the stream at Lost creek ranch we pass for a little distance over a bare black surface of contorted and ropy lava, and from this point forward the trip is largely up and over the edges of successively newer and newer basaltic flows that have come down from eruptive vents higher up. It will be conspicuously noted that the rocks in these recent flows are darker in color, sometimes have white or glassy crystals, show more iron stain, and the pieces into which they are broken have in general a jagged roughness and irregular shape. At out left to the north of Lost creek the high mountainous ridge at the foot of which we are traveling rises a thousand and, as we proceed, possibly two thousand feet or more. Its top has a uniform rise towards the summit and the rock layers are so disposed as to suggest that they too are a succession of lava flows that have spread one after another out upon a fairly uniform sloping surface. They, as contrasted with the newer flows over which our road takes us, are andesitic and of greater age. Very obviously the wide canon of Lost creek that has since served as the

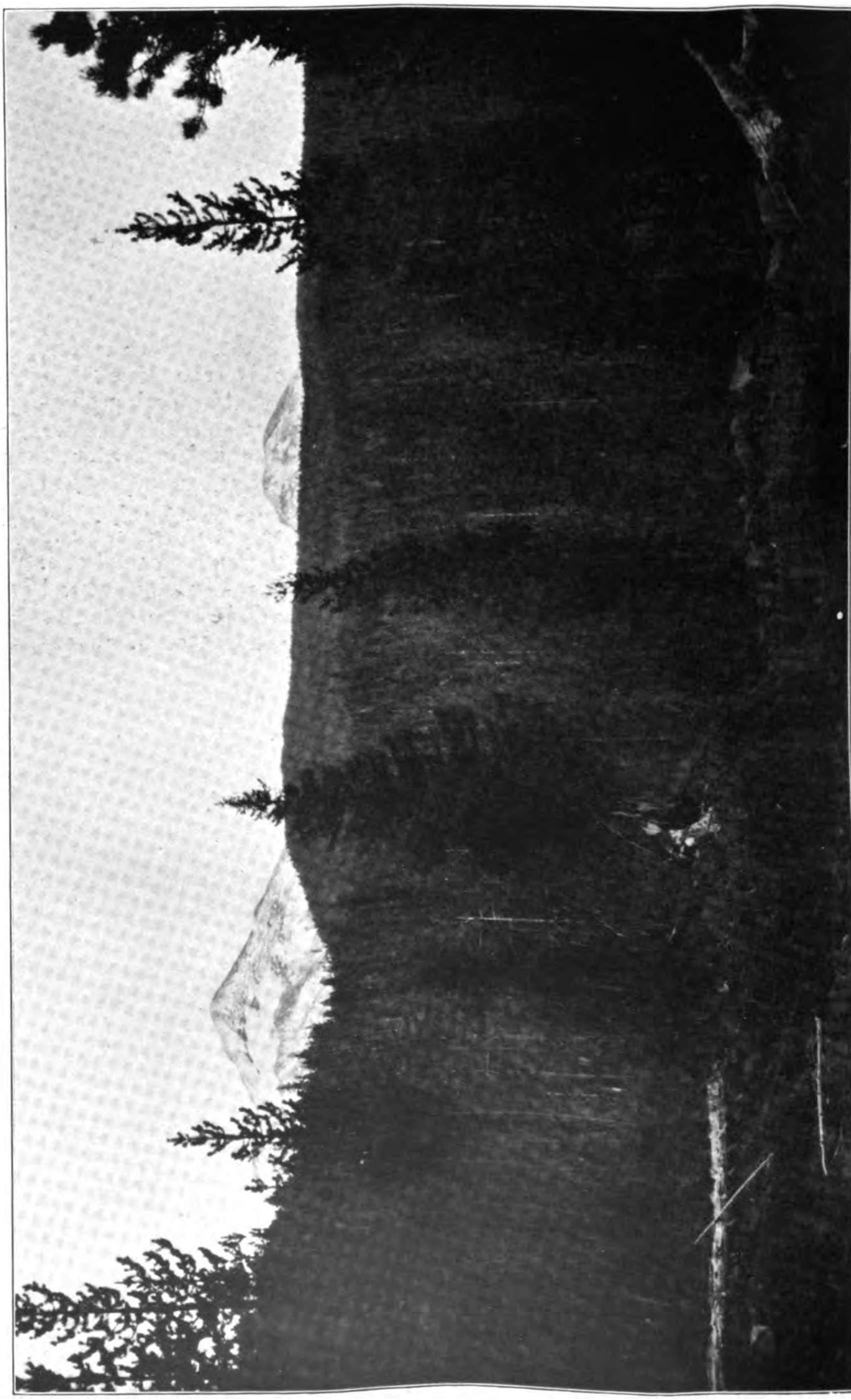
North and Middle Sister from McKenzie road. Beyond Belknap springs the grade becomes steeper and we surmount rim after rim of lava flow, an occasional acclivity testing not only motive power but at the same time the ingenuity and skill of the driver. Although rare glimpses of the Sisters may be had from some points along the way, they have seemed so far to bid us "keep our distance" as though wary of human approach. Shortly after crossing Lost creek, however, some 70 miles from Eugene, a straight stretch of open road affords a first good view of two of the group, North and Middle Sister. A veneer of early autumn snow has partly relieved the sharpness of their outlines, but they rise, notwithstanding, in towering proportions, as if gazing far down into our canon to ascertain who comes there.

channel down which these later more basic lavas came, was hollowed out or cut down through the many layers of earlier andesite whose outcropping edges we can now observe. In places we may pause almost within the shadow of beetling cliffs where great tumbling masses or jutting promontories seem as though to block the way. Again we occasionally see in juxtaposition the two kinds of rock strongly contrasted where we pass successively over a patch of one then of the other, or where as is frequent, on our right we have at the same instant the rough and scraggly heap of new basaltic lava and at the left the cubical blocks or platy talus of the old.

Middle and South Sister from McKenzie road. South Sister, although 300 feet higher than the other two is seen much less often from our route of travel. If one is watchful a fleeting glimmer of her sunlit head may be caught far to the south from near Alder spring, shortly after Lost creek is left behind and a start made up White branch a tributary of it. Alder spring is close to the road and at the base of Deer butte. It is an objective point of supply that all passers-by should not fail to patronize, for the grade is steep and water is usually scarce for some distance ahead. Immediately beyond Alder spring the McKenzie road swings round a bare mound of apparently glaciated rock and we soon come to the rough and broken edge of the newest lava yet seen, an extensive sinuous lobe that has flowed for several miles down the channel of White branch. Here the road gains several quick rises by a series of zigzag curves along the lava front, and again at intervals through the forest screen may be glimpsed the graceful profile of South Sister. Modestly standing somewhat apart from her associates, mere sight of her is a privilege that must be sought if it would be enjoyed. In the view the position of the crater in her top is plainly seen. The road here passes through a belt of heavy timber, mixed fir and western white pine, the latter standing out most distinctly in the foreground of the picture.

Three Sisters peaks from Lake valley six miles to the northwest. The level of a most enticing stretch of grassy park is reached at an elevation of about 4600 feet. At its western border a ridge of glaciated gray andesite shows. Here at the left, ahead and through the trees, one is greeted by the flattened dome of Belknap crater and, in striking contrast, the needle-like spine of Mt. Washington. Across this park which, although a part of Lake valley, we shall designate "west park," a spurt in "high" may be indulged in for a half mile or so. Rising again over a partially soil-covered, glacier-scored and polished rock surface we come to "middle park" at an altitude of about 4750 feet.

Here again for a couple of miles may heated engines gain relief and straining muscles move less wearily. These parks are attractive places. They are openly forested with fir and hemlock, and a plenty of open grassy glens where in the early season sparkling streams trickle and flowers bloom, allure one to linger. It is from middle park that the trail starts southward to the Three Sisters. The point at which it leaves the McKenzie road may

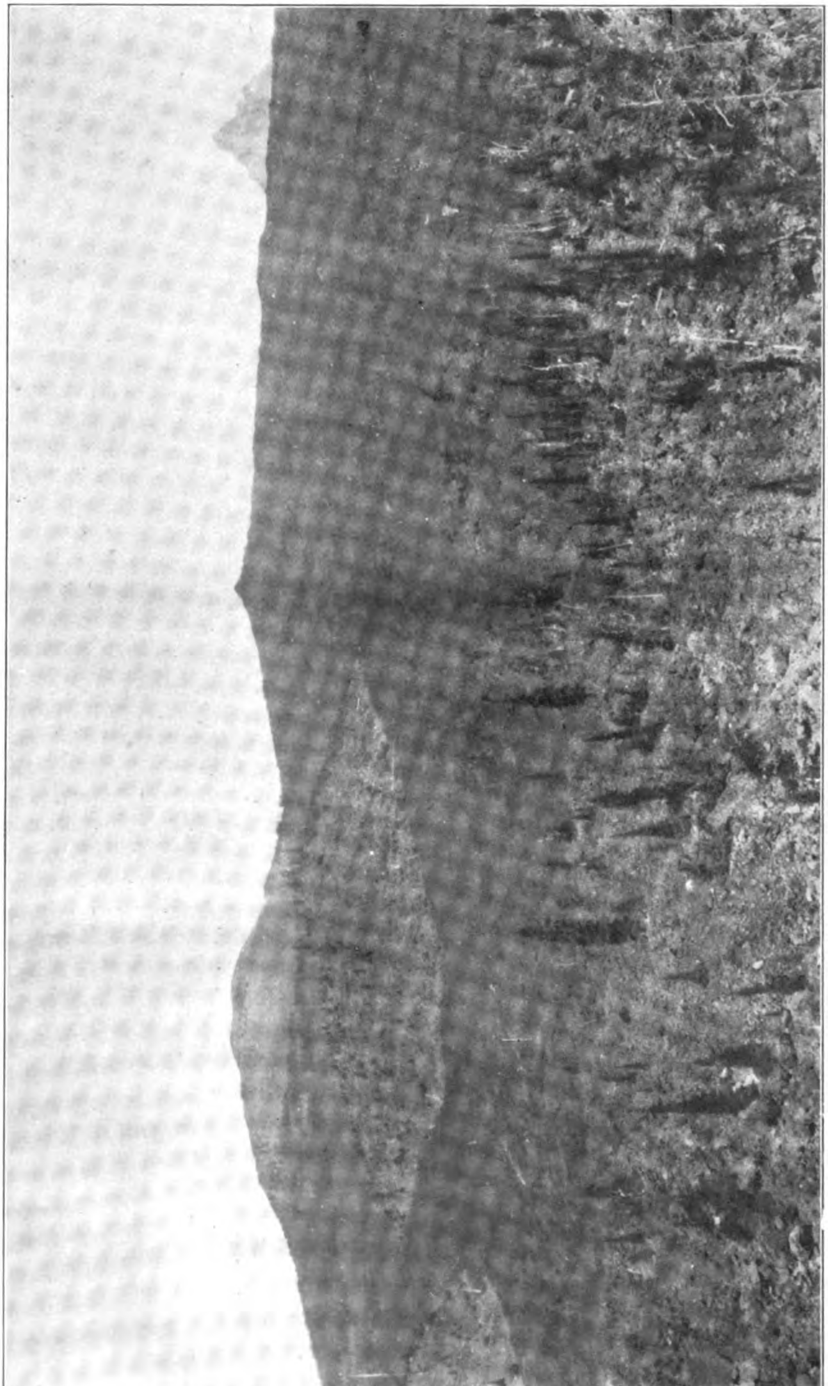


Middle and South Sister from McKenzie road.

Three Sisters peaks from Lake Valley six miles to the northwest.

be easily overlooked by the less watchful passerby. Since 1910 when the place was so styled by the members of the Mazama mountain climbing club, it has been known as Frog camp. From selected positions many good views of the range may be had, both of the Sisters to the south and of the lava beds to the north and the craters that produced them. The journey from here must of necessity be made on foot or by saddle. Before cultivating a closer acquaintance with the snow-clad Sisters, however, and in order to fully get our bearings, it will be well worth while to first make an excursion eastward some five or six miles further to the summit.

Barren lava fields on Cascade summit, McKenzie road. After rising again over irregular masses of the same andesitic rock we soon come at somewhat higher level to a third or, as we may call it, "east park." From all of the higher points of our road we may look to the northern horizon out upon a jagged sea of barren lava. We skirt its border for a few miles, the smooth and glacier-rounded, ash- and cinder-scattered domes of gray andesite over which the road goes, contrasting markedly with the ragged reddish brown and black scoriaceous tumbled blocks that form the front of the new flow. Its surface is rough beyond conception, largely a jumbled mass of great cakes of ropy, twisted or granulated lava that, as they solidified, were torn apart and tossed about upon the yet moving liquid hot stream beneath. Soon we see that the summit ahead is entirely lava-covered, flows having come



Barren lava fields on Cascade summit, McKenzie road.

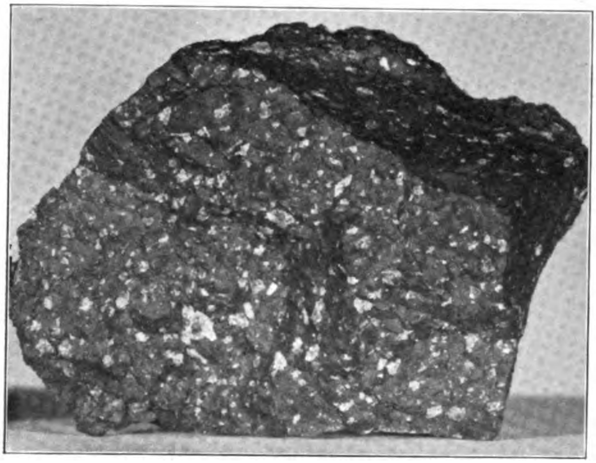
in from volcanic vents both north of the road and from the south far up the slope of North Sister. The road climbs to the top of this vast lava pile and continues for two or three miles across it. In places sand "islands" stick through, around which the new lavas have flowed. The islands are usually, but not always, elevated parts of the earlier andesitic lavas and are found to have been scored by the glaciers before they were strewn with the volcanic dust, ash and lapilli that now in part obscure them.

All along the edges of the new lava we can see where the former andesite, now sand veneered, passes directly under it. Here we have, then, before our very eyes, several open pages of record of what has taken place on this portion of the top of the Cascades. Here are three kinds of lava, all of which have come from open vents or volcanic craters. The oldest, an andesite, specifically hypersthene andesite, that has been deeply ground down by moving ice during the glacial period. Upon it is a layer of usually yellowish sand, in some places thin and in others of great thickness, particles from the size of dust to that of peas and larger, that were violently blown into the air by eruptive forces and that settled over the surrounding country. These explosive eruptions took place after the coming of the andesite and quite obviously since the melting away of the ice of glacial times in this locality. Finally, upon it all spread out from a series of openings into the earth's interior the heavy sheets of black basaltic lava that we behold today. They are almost barren of vegetation and in appearance so fresh and unweathered that we can with little stretch of the imagination yet see it come. First the dull red glow of the molten rock as it burst from the side of Belknap crater, then the advance down the slopes of shifting streams of hot viscous lava, great widening billows, elongating lobes, over which would rise and tumble blackening masses as parts of the cooling surface congealed to stony hardness. Though of geologic recent date, no one stood by to watch the process here, but in other parts of the world it may be seen going on at the present time. In the view Belknap crater stands at the left and at the right the pinnacle of Mt. Washington three miles farther away. The top part of Belknap is composed of volcanic sand and cinder and we conceive at once of its having very probably been the source of much of this class of material that was widely scattered over the country before it became in part inundated by the voluminous streams of liquid lava that broke out about its base.

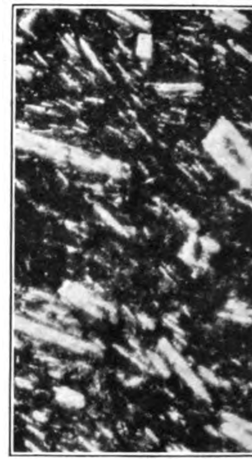
Belknap Crater

Belknap crater displays the typical outlines of a volcanic cone whose earlier eruptions were of an explosive character so as to build up a relatively high steep-sided heap made largely of smaller rock fragments, but whose final and decadent effort was the exudation of molten lavas from cracks in its sides and base. From the foot of the ash cone, therefore, the slope of the lava top is a comparatively flattened one. In

Two-thirds natural size

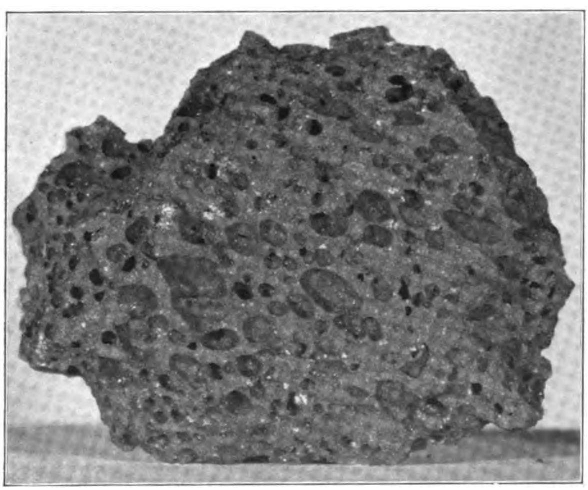


Magnified thin section

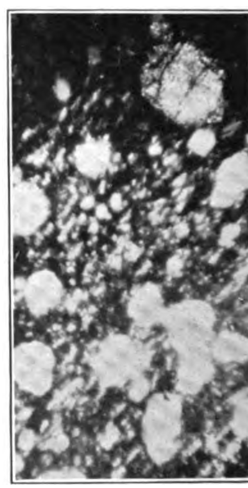


Cellular basalt. The cells, or vesicles as they are called, vary a great deal in size but are always rounded or oval in outline. They are caused by the presence of gaseous matter within the molten lava that would naturally rise toward the surface as movement took place. In this particular specimen the parallel elongation of the oval form of the cells is noticeable. This is a common feature and is due to the flowage of the magma after it had cooled to a stiffly viscous or pasty consistency. The long way of the ovals indicates the direction of flow. The thin section shows that there are also many minute cavities in the rock too small to be discerned by the naked eye. The white spots are cross sections of globular or oval gas-cells formed in the same manner as were the larger openings. The body of the rock is seen to be glassy and in it is a network of crystallites, or incipient angular crystals.

Two-thirds natural size



Magnified thin section



Glassy basalt. This is the prevailing type of lava that has issued from the newer craters on the summit of the Cascade range. The McKenzie road crosses extensive flows of this class of lava where it passes over the summit of the Cascades. The body of the rock is dark-colored, dense, usually glassy. In it are glistening white crystals of feldspar. Under the microscope the groundmass of this rock, which in the hand specimen looks only like a dull black glass, is seen to be shot full of needle crystals. The black background against which the glistening crystals show so well, is real glass, and they represent but the beginnings of the process of crystallization into separate minerals which, had conditions been favorable, would have produced a thoroughly crystalline rock instead of one in part crystalline and part glass. Quick cooling hinders or prevents the growth of crystals. We reason therefore that glassy rocks have chilled and hardened quickly, fine-grained igneous rocks less so, while those made up of coarse crystal mineral particles that can often be recognized with the unaided eye have cooled with great slowness and in undisturbed positions. Lava flows usually cool and harden rapidly; molten rock at depths cools slowly.

the center of the view the mammillated tip against the horizon is the plug that marks the final stoppage of the vent whence much of the lava over which we travel has come. One possessing the temerity to negotiate, much of the way on "all fours," two miles of right down tumultuous going would learn that this plug is a mass of brick-red vesicular lava surrounded on all sides by outpourings of the dense dark kind. The low moderate slopes of a cone built alone by the outflow of very fluid lavas are quite characteristic and in contrast with the steep-sidedness of the cinder or ash cone.

Looking southward along the summit of the Cascade range from McKenzie road. The photograph is taken from the side of one of the sand covered "islands." In the foreground is shown the irregular border and uneven surface of the recent lava flows. Other "islands" are seen in the middle distance and low down against the base of North Sister the dim outlines of subsidiary or adnate cones or craters from which these lavas have come. At the right is Middle Sister, much of her bulk obscured by the Collier glacier along whose snowy expanse we are looking lengthwise. The serrated top of North Sister is notable, and against the rocky northeast slope are the outlines of a diminutive glacier. At the extreme left McKenzie road appears, where it makes a winding way across a stretch of windswept sand and onto crumbling lava. It is an observation of exceeding interest that the scattering growth of alpine fir displays little choice of host, seemingly as much at home upon the fresh and soilless lava as the ash strewn slopes of an earlier generation.

Town of Sisters to Cascade Summit

The summit elevation is shown on the U. S. Forest Service map to be 5200 feet above the sea. Near the highest point is a government telephone for use in case of forest fires, and for the public service of course if aught goes wrong with brake or propelling mechanism. At the east the town of Sisters is 20 miles away and at better than 2000 feet less elevation.

It is located near the Cascade edge of the great central Oregon basalt plateau. From Sisters to the summit is a trip first through the open forest where soil and coarse rounded gravel seem to have so filled in the hollows of the former ragged surface that only here and there do the higher points now show through as mounds or ridges or scraggly bunches of dark basaltic rock. The gravels are composed of a mixture of both andesitic and basaltic lava pebbles and boulders. When the story of this region is at some later day written in more detail it will probably be found that this great outwash plain was in part buried with the gravels that were brought down by strong streams of water from the higher parts of the Cascades during the melting of the glacial ice that, in this latitude, mantled the summit as a great overlapping frigid roof. At that time none of the new and recent lavas that we have just seen existed there.

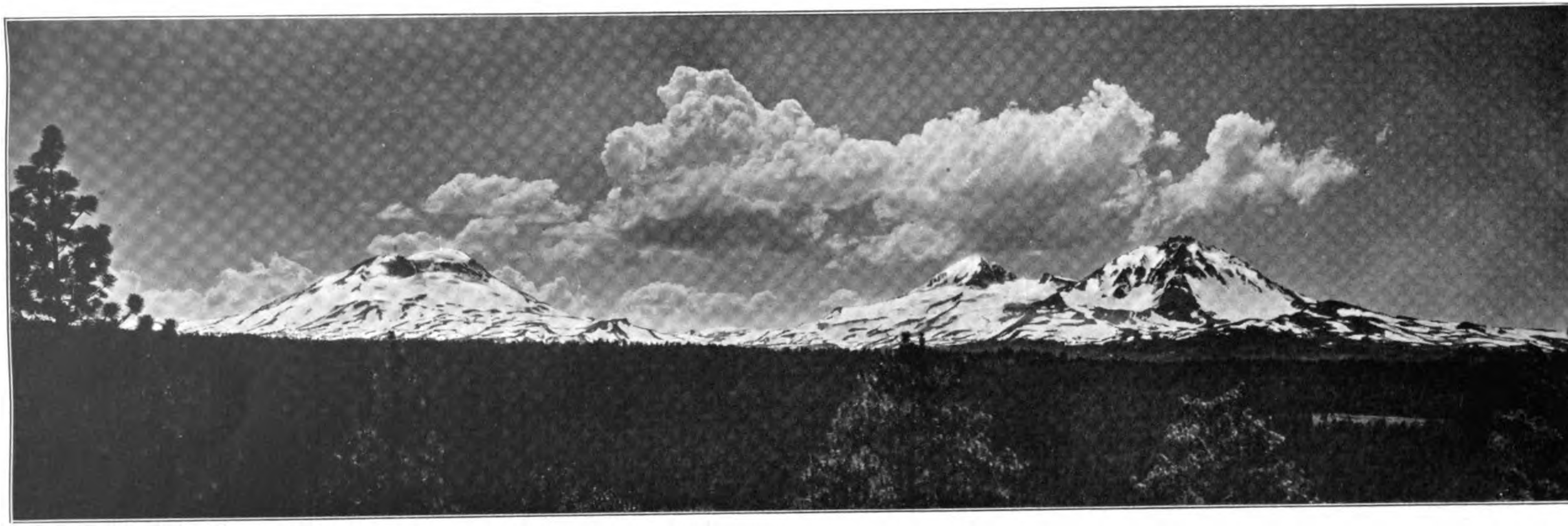
Looking south along the summit of the Cascade range from McKenzie road.

We are thus not surprised to find, as the grade rapidly stiffens and progress is made towards and about the north base of Black crater, that the gravels before long disappear beneath the edge of later flows that have likewise passed down to the eastward from the summit craters. We follow the south border of such a flow for several miles, in places as within the shadows of a sharp-walled moat, to Windy Point, rising from an altitude of 3175 feet at the town of Sisters to 4860 feet. Windy Point is the crossing of a sharp ridge of andesitic lava that in position has all the appearances of having issued from the north side of Black crater, a prominent cinder cone rising immediately at our left to a height of 7250 feet. From this point in the road the wide expanse and rough character of the lava fields of Belknap crater may be seen to excellent advantage. Volcanic sand covers the surface outside of the lava on this as on the other side of the divide, and with the exception of the outstandingly conspicuous glacial scorings we are here confronted with the same sequence of events that engaged the attention at the other side. Though we observe the results of the glaciers having been here, our knowledge of their extent down the east slopes of the Cascade range is not at all complete.

The Three Sisters from the east. Low down against the left base of North Sister are the shrunken remains of a glacier about the lower border of which is the dark crescentic morainal embankment. The several small glaciers now existing on the east slopes of the three mountains appear to be only what is left of the ice of a great cirque from which a glacier of extraordinary size formerly flowed eastward for several miles. The records of its existence are to be found in the rock materials that it scattered over an area of considerable extent far beyond the present forest line, though its exact limits at the time are not now known. We can not fail to note the more rugged appearance of North Sister. South and Middle Sisters exhibit a comparatively smooth cone-shaped outline while the profile of North Sister is a notched one, its cliffs are jagged and steep and its general appearance pyramidal not conical. Her sides have been deeply dug out and her former outlines so largely obliterated that we have little conception of how lofty a mountain North Sister originally was. It takes only another glance at the other members of this group to tell us at once that North Sister is but the ribbed skeleton of its former self and that it is therefore quite greater in age than the other two peaks. South Sister has suffered least of the three, Middle Sister somewhat more, and North Sister a very great deal from the tearing down activities of weather, water and ice, whose attack is a relentless one everywhere.

Road to Broken Top

Within the past few years a wagon road has been extended from Bend, which is on the railroad, and from the town of Tumalo both in Crook county, up Tumalo creek to the south side of Broken Top mountain. From Bend to the terminus of this road is about 20 miles. The state engineering department has here diverted Little Crater creek into the



The Three Sisters from the east. From this direction at all times of the year the Sisters peaks are a most fascinating feature of the landscape. The country about them is less broken and they rise above the fringing forest of yellow pine sheer and clean-cut against the western sky. South Sister at the left no longer poses with her reputed air of humility but from this side assumes a position, while apart from the two nominally sisterly companions, now appears one of commanding watchfulness and even filial concern for their welfare. South Sister can be seen from here to be a composite mountain, the outlines of a subordinate cone showing as a low hump against the east slope. This lesser cone marks a side opening from which lavas issued probably during the later stages of eruption. On the slopes of Middle Sister the position of the two small glaciers may be seen. One passes down to the left, the other apparently hugging close against the lower breaks of North Sister. Their snowfields are united above but their lower portions are separated by a rocky crag and the dark curving band of lateral moraine plainly to be seen from our viewpoint.

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head of the south fork of the Tumalo to provide an increased supply of water for irrigation on the lands of the Tumalo project.

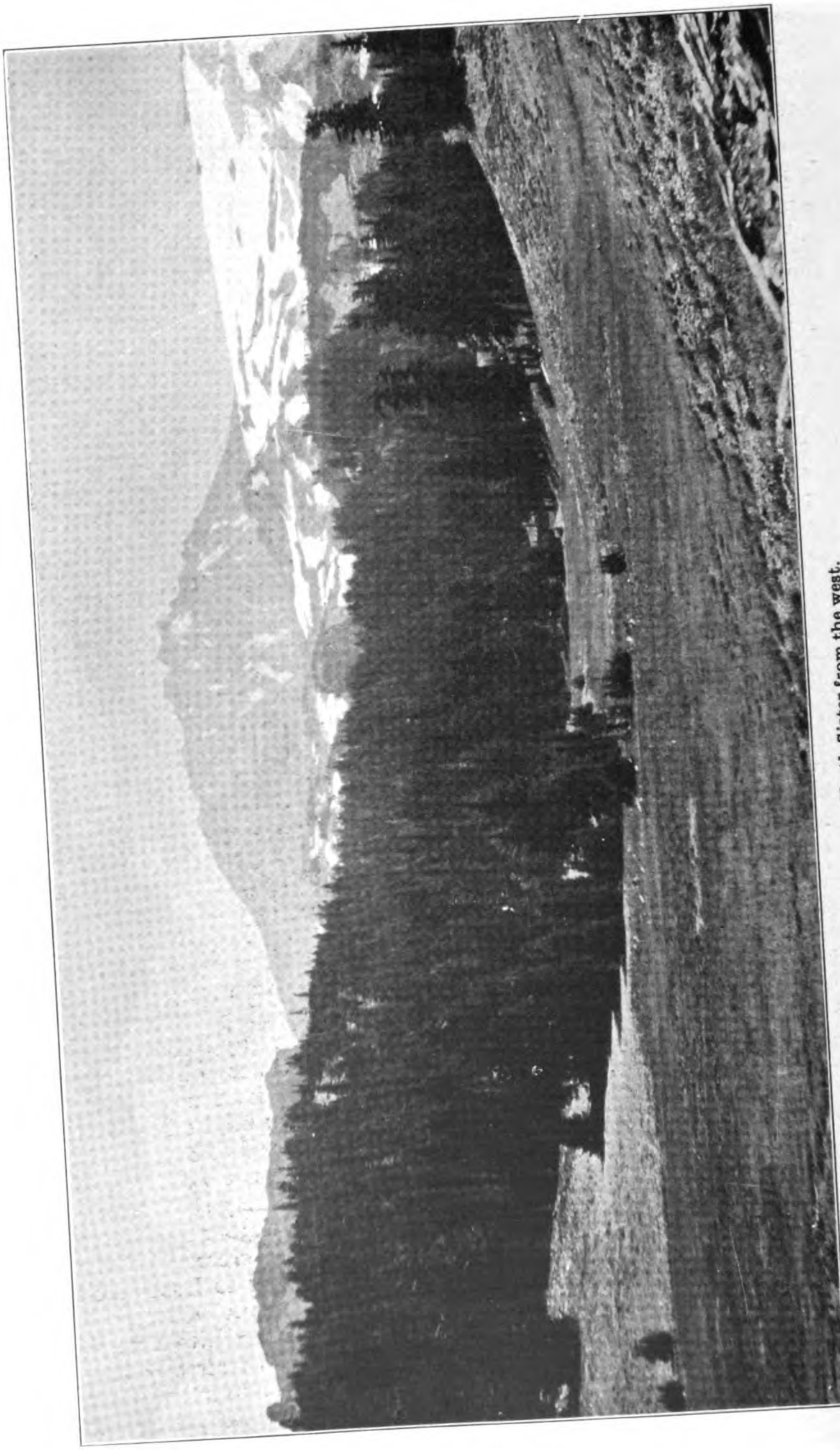
From Broken Top, which is the mere wreck of an ancient volcano, a trail goes southwest down Crater creek to Sparks lake thence west and south in the direction of Horse lake. From this trail it is not difficult to make one's way to the west side of South Sister and if care and judgment be exercised, on northward across the head of Lost creek canon to connect with the Frog camp trail at the north foot of Obsidian ridge. While this is of course a somewhat roundabout route, it takes one through a section of varied mountainous country, that for the beauty of its forests and its lakes, the variety of volcanic and glacial phenomena it displays is most intensely interesting and satisfying.

North Sister from the west. From "Frog Camp" in middle park the trail goes in a general but zigzag southerly direction for about three miles to the new lava flow a part of which we have already seen some miles back on the McKenzie road. The edge of this flow rises abruptly for 75 to 100 feet as a great broken stony wall which both horse and man must be given full freedom of limb to successfully negotiate. The trail meanders for a mile or so across its roughened top and drops down at the south side to White Branch, so called from its running murky to milk white with ground-up rock debris from the foot of Collier glacier.

Character of Three Sisters country

The country to the west side of the Sisters group is seen to be but scatteringly forested, interspersed with meadows, lakes and much of bare rock surface. The U. S. Forest Service permits sheep grazing in this section and the trail from the McKenzie road, we are told, has been traveled and maintained chiefly by the sheep owners. The construction of a branch wagon road from McKenzie road to the west side of the Sisters peaks is a future accomplishment to which we may look forward. The first obstacle to such a road is the White Branch lava flow to cross which will necessitate an expensive piece of construction. Though not over half to three quarters of a mile in width, its sides are steep and surface of exceeding roughness. Beyond White Branch to the south Obsidian ridge rises as, at sight, a forbidding barrier. Its circumvention can doubtless be best accomplished by following for some distance up the mountain along the north base of the ridge to near timber line, with the probability of finding an easier grade and even a gap through which a feasible passage might be made. The head of Lost creek canon will probably be found to be the only further serious hindrance to an easy route along the west side of the Three Sisters. Careful reconnaissance will likely show that a course must be sought either considerably above timber line where there would be much of loose unstable slope to be crossed, or one that would zigzag down the steep north canon wall to Lost creek and similarly search a somewhat easier way up its south side.

Close view of portion of Obsidian ridge. From White Branch the trail may be seen to climb Obsidian ridge, as already suggested on an earlier page, south of which very few further signs of a trail are to be found. Obsidian ridge is a series of prominent



North Sister from the west.

Close view of portion of Obsidian ridge.
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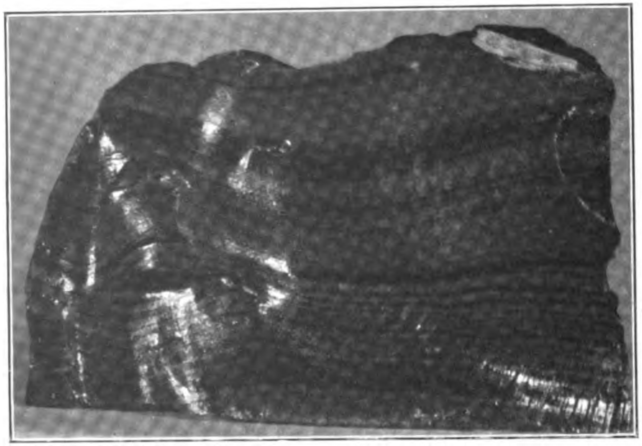
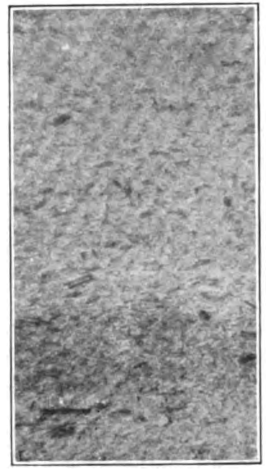
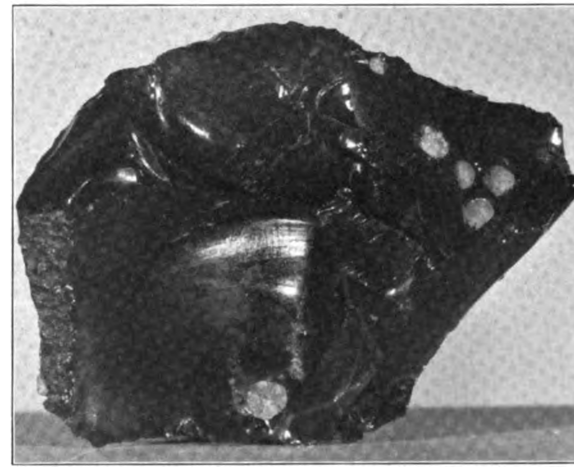
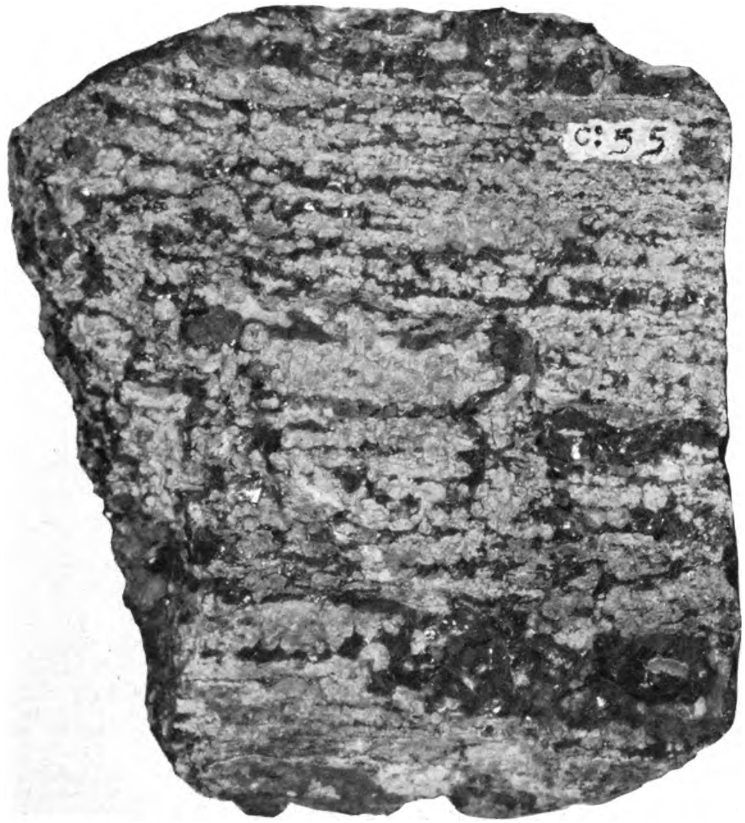






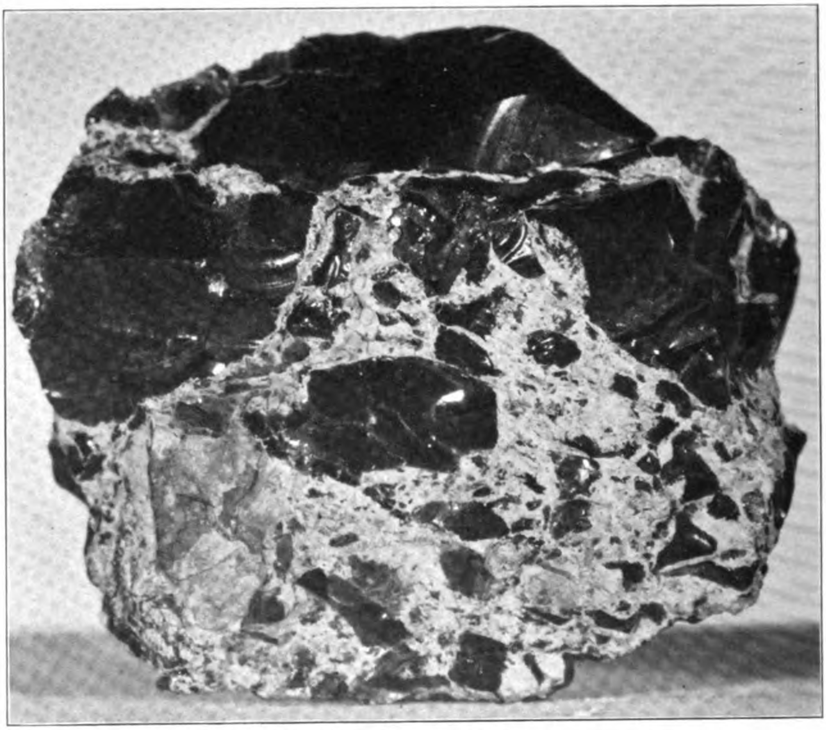
Volcanic glass from Obsidian ridge. Commonly called obsidian. Two-thirds natural size. The typical natural glass is black in color. When broken it displays a conchoidal or shell-shaped fracture and has sharp or splintery edges, much as does ordinary manufactured glass. The pebble-like globular inclusions are termed "spherulites." They occur in obsidian in size from microscopic to much larger than those shown, and are found to be made of minute needle crystals that radiate from the center point of the sphere. The radial structure is nicely shown in the spherulite near the bottom of the piece. The parallel wavy markings in the specimen at the left are flow-bands, and in the accompanying thin section may be seen the lines of flow and numerous crystallites all oriented in the same way, as would be floating logs in a moving stream. The volcanic glass of Obsidian ridge is the most highly siliceous of the lavas yet found upon the Cascade summit and is properly termed a rhyolite.



Banded obsidian from Obsidian ridge. Natural size. The dark bands are black, brown and red volcanic glass. Between them are layers, in part vesicular matter, but mostly of the globular bodies known as spherulites. The rock is frequently literally charged with them and their arrangement in fairly definite bands has no doubt resulted from the presence of flowage strains, or the friction planes or possibly zones of fracture, that developed during the final stages of its movement and cooling.

elongated cliffs made largely of black glassy lava that can be followed far up towards the west base of Middle Sister. In many places it has been smoothed down by the glaciers. In all probability this ridge represents the outpourings from a vent near the base of that mountain when it was an active volcano.

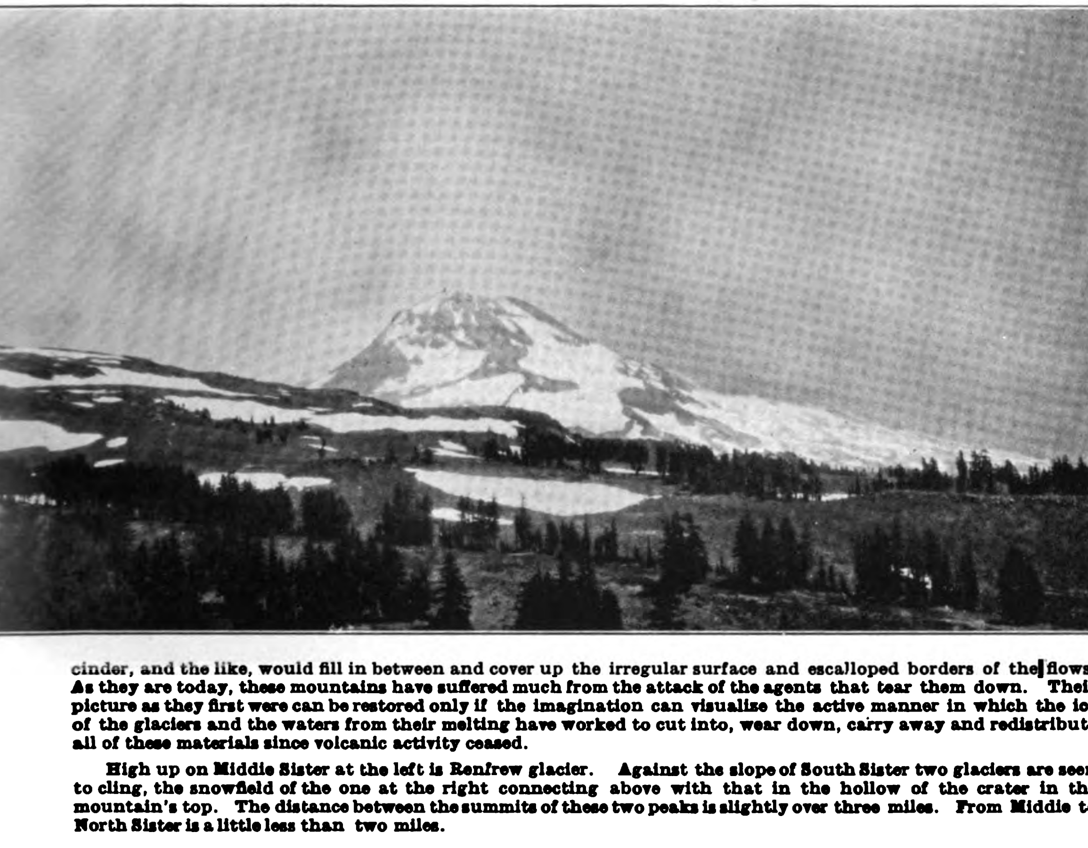
To satisfactorily enjoy a stay about the Three Sisters, supplies should be packed in and a camp established at some convenient place. Good camping spots are very plenty. Close to timber line on the side of Obsidian ridge one may find an abundance of grass, fuel, shelter and beautiful surroundings. Farther south opposite South Sister are aplenty of tree shadowed glades, mirror lakes, rills from the melting snows, all camp facilities to satisfy the most exacting.



Volcanic glass breccia. Natural size. In many places on Obsidian ridge the glassy obsidian may be seen to have been broken into angular pieces, then cemented together again. The cementing material appears sometimes to be only the finely granulated or pumiceous glass itself, but there seem to be also, nearly always, a layer or blanket of spherulitic bodies surrounding and in immediate contact with each of the chunks of glass of which the rock is composed. When broken apart the surfaces of the blocks are seen to be copiously marked with little pits that were occupied by the spherulites. Obviously the shattering of the glass took place at a time after it was cooled to complete hardness, otherwise the pieces would not possess such angularly sharp outlines. The enveloping layers of spherulites that now largely fill the interspaces and in part bind the pieces together have developed since brecciation occurred and similarly, therefore, after the rock had attained a condition of brittle hardness. Possibly the friction of movement and, to a probably greater extent, the presence of moisture may have had an influence in favoring the process of incipient crystallization that has produced these spherulitic masses to so marked an extent.

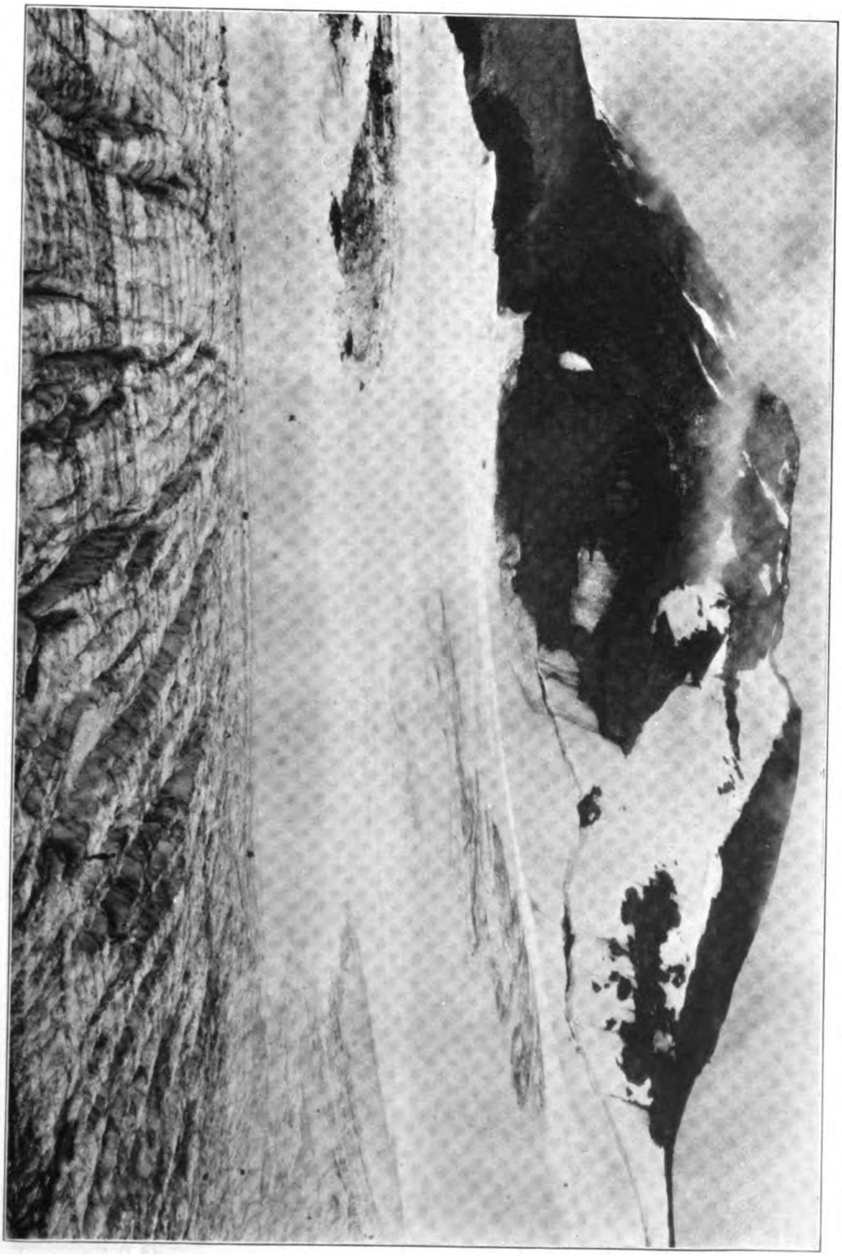
Summit of South Sister looking across the Lost creek glacier. One of the joys of spending several days in the Three Sisters region is the climbs of the peaks that may be made. Such close acquaintance with South Sister is well worth while. The U. S. Coast Survey gives its altitude as 10,351 feet. The climb is one requiring persistent effort rather than daring for with care the summit is attainable by safe routes from almost all directions. On the way up the northwest side one may conveniently travel nearly the full length of the Lost creek glacier, the best developed of any about this peak. No name has heretofore been attached to this glacier but its well-defined character and position are such that it seems wise not to longer defer giving it a name. The term Lost creek glacier is therefore proposed as a fitting title inasmuch as

Middle and South Sister from the west. In the panorama the characteristic volcano outlines of the two mountains are clearly brought out. The long even and not steep slopes that lead up to the base of the cone-like tops are notable. To all appearances both mountains have been built up by a succession of eruptions during which liquid lavas alternated with cinder, ash and scoria. The latter are the product of violent and explosive action, the lavas flow out more quietly. They are tossed or projected into the air to cool as they fall upon oftentimes quite a range of country; the lavas on the other hand well up and spill over the crater's rim to pass down outside as a spreading sheet or moving tongue of liquid rock. Or, as often has the fused and seething lava burst through crevices or melted its way out at many points about the sides and base of the mountain proper. The flowing molten lavas tend to produce flattened long slopes out about the main crater. The boundaries of these flows are always irregular, some being miles and others only rods in length. The intermittent eruption of quantities of ash,

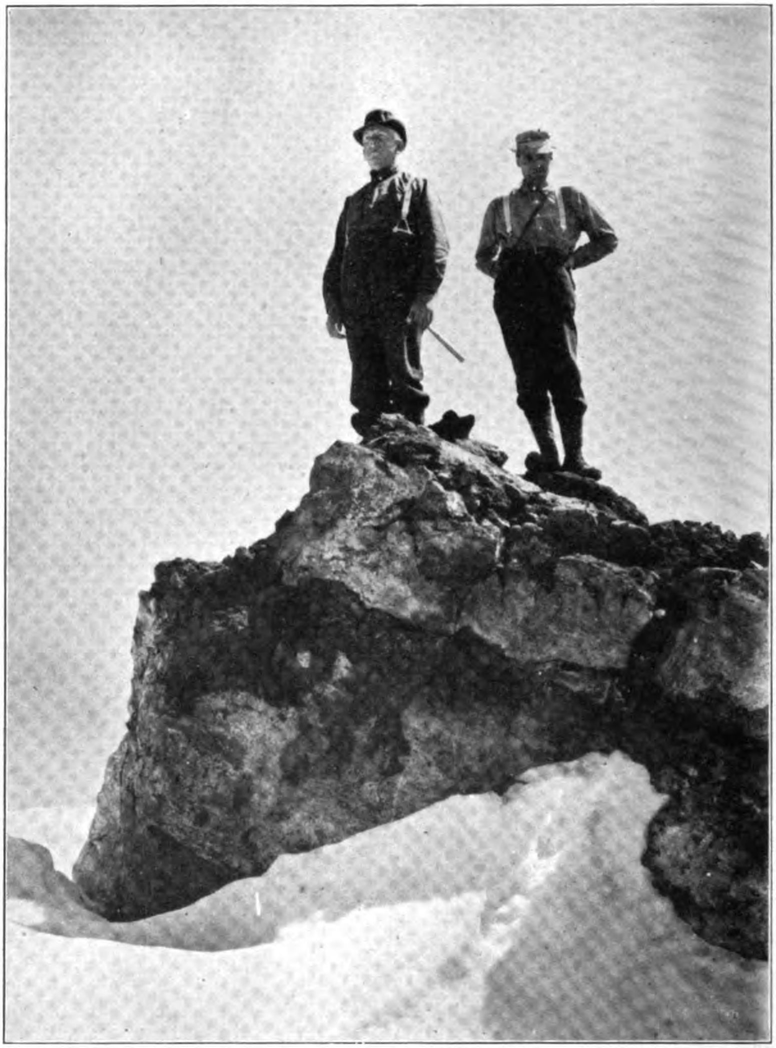


cinder, and the like, would fill in between and cover up the irregular surface and escalloped borders of the flows. As they are today, these mountains have suffered much from the attack of the agents that tear them down. Their picture as they first were can be restored only if the imagination can visualize the active manner in which the ice of the glaciers and the waters from their melting have worked to cut into, wear down, carry away and redistribute all of these materials since volcanic activity ceased.

High up on Middle Sister at the left is Renfrew glacier. Against the slope of South Sister two glaciers are seen to cling, the snowfield of the one at the right connecting above with that in the hollow of the crater in the mountain's top. The distance between the summits of these two peaks is slightly over three miles. From Middle to North Sister is a little less than two miles.



Summit of South Sister, looking across Lost Creek glacier. Note the two persons in the foreground.



The topmost point of South Sister, 10,351 feet in altitude, according to the U. S. Coast Survey.

those of its waters that do not sink from sight, ultimately drain away by way of Lost creek into the McKenzie river and to the Willamette. At the head of this glacier may be observed the cruel and relentless manner in which it is digging a vast pit for itself into the very vitals of the mountain. In the photograph just below the filmy cloud scarf is a bed of hard rock beneath which the ice is pulling away the looser rock fragments, so that perhaps a hundred feet or more of ironstained scoriaceous and ashy materials are exposed. A part of the structure of the top part of South Sister is here laid bare, as it is also at the head of a small glacier that rests against her southwest slope. The process by which a glacier digs into the rocks as its very head or top portion so as to produce and maintain a steep cliff there is known as "plucking" and is an interesting one. The ice of the glacier is by gravity always moving down the mountain, away from the upper rim of its basin. As it freezes onto the rocks of this rim they are literally pulled or "plucked" from their places by the downward motion. As the head cliff heightens, loosened materials fall upon the top of the ice and ride slowly away, rather than accumulate in talus slopes as is the case in ordinary crumbling and breaking down of rocks. More water and then ice fill in the gap, freeze tight, and the rock-pulling process goes on—always tending to cut deeper and actually headward toward the center of the mountain, and to maintain a steep, oftentimes vertical or overhanging, cliff in the hardest of rocks. The cross cracks in the ice, or crevasses, are nicely shown in the foreground of the picture.

The topmost point of South Sister. The summit of this peak consists of a circular crater about one-fourth mile in diameter whose rim is continuous except where joined at the northwest and at the southeast by the snowfields of the glaciers in these two directions. The rim is for the most part blocks of broken lava or ledges and crusts of brown, red and black cellular character. The rock is hypersthene andesite, hypersthene being the chief characteristic iron and magnesium bearing mineral it contains. The word andesite came to be applied to this type of rock on account of its occurrence in the Andes mountains of South America. The andesites are ordinarily light to dark gray or almost black in color, sometimes pinkish. They commonly have a porphyritic texture, that is, one in which the crystals or grains of one or more minerals stand out so as to be seen distinctly in a body or groundmass of finer texture. It sometimes, though less often, occurs too in the form of pumice or a black obsidian or volcanic glass. In the photograph two sloping layers are noticed separated by a band of scoriaceous matter. The inside of the crater which is filled with snow, is at the right in the direction these rock beds dip. At the left is a perpendicular crag, the outside of the rim almost overhanging a steep snowfield on the east side of the mountain. This crag appears to be the result of the same kind of undercutting or plucking action of heavy masses of snow and ice as already described.

Broken Top and South Sister from the south slope of Middle Sister. Broken Top appears to be the jagged remains of a portion of an old crater. Upon it snow remains the year round and there is possibly the much shriveled remnant of a former more pretentious glacier. High up on South Sister the sharp crags of a much frayed shell of a crater appear where formerly lavas issued. Within this old crater a small glacier emanates to join an ice-stream heading high up on the south of east side. A diminutive glacier also flows north towards Middle Sister. This makes a total of at least five glaciers on this peak. All extend down to 7500 feet or below, display crevasses and have lateral and well developed terminal moraines.

From the summit of any one of the Sisters the view in all

Broken Top and South Sister from the south slope of Middle Sister.

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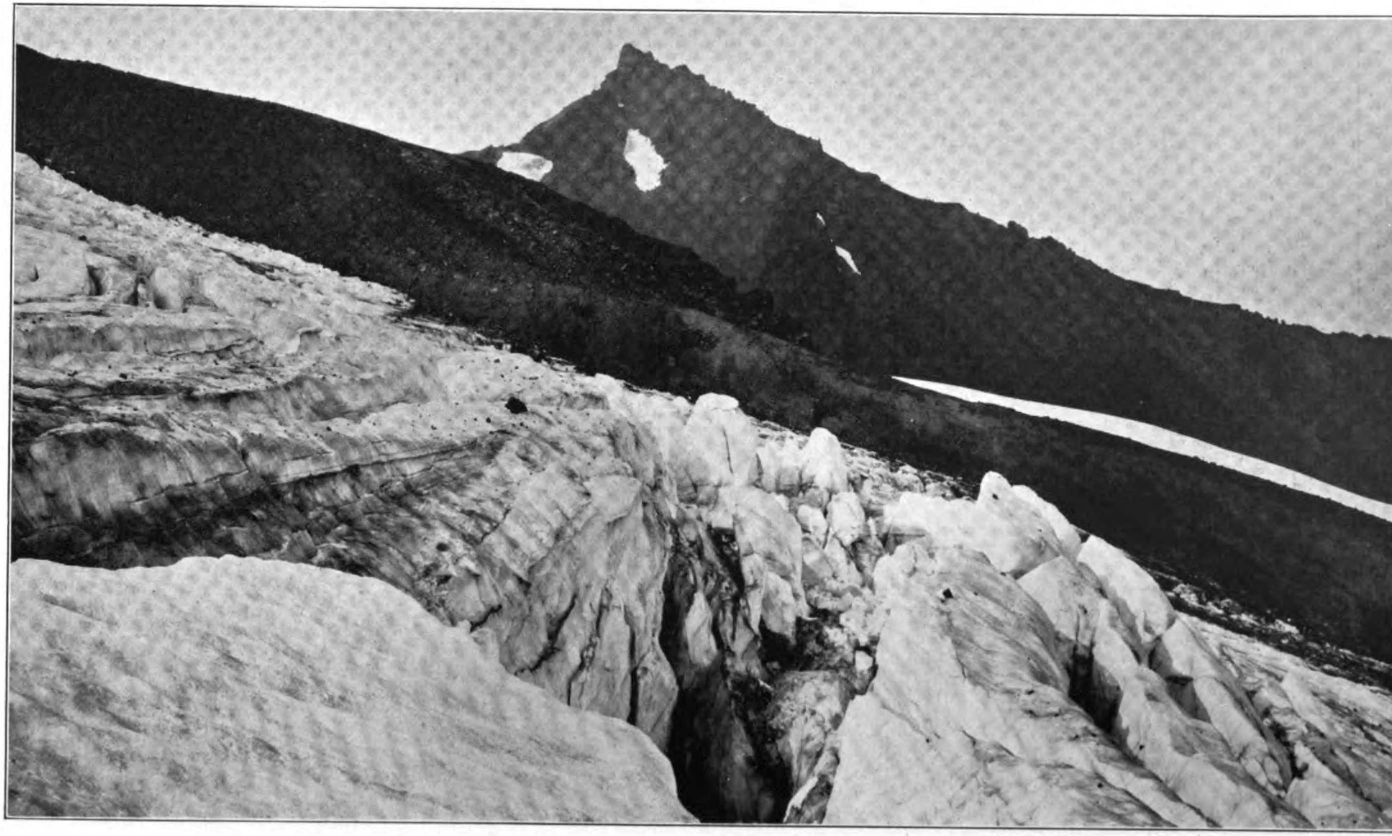
directions is most gratifying. Particularly well from South or from Middle Sister may the array of peaks to the south be singled out. Nearby to the west stands the Husband and safely beyond to the southwest the Wife, both mountains of rugged though not of suspiciously belligerent type. Next in position is Bachelor butte whose darkened profile shows dimly at the left of South Sister in the view, 9045 feet in height and 12 to 14 miles southeast. Thence down the summit come Packsaddle and Irish mountain, each better than 6000 feet, and at about 35 miles the Twins, 7250 feet in altitude. Still beyond and some 40 miles away is Maiden peak, 7750 feet, a crag-studded cinder cone of far from demure mien or delicate proportions. Countless lesser unnamed peaks and craters are within the range of vision to the south and east. It is worthy of note that of the family group only the brother seems absent, but it is not hazardous presumption to believe that even he may yet be present in disguise. The Twins or Bachelor butte may either or both encompass him; in case the latter be the truth the shame of the situation being that so discouraging a space intervenes between him and the maiden member of the group that we can scarce conceive a wooing nod or coyful glance to pass across between them. On clear days Mt. Thielsen is in view and not so rarely Mt. Shasta far beyond the state line in California.

Middle and North Sister from the top of South Sister. At the right of North Sister in the view is the rounded dome of Black crater, at the north foot of which the McKenzie road passes east of the summit. Again is the contrast between North Sister and Middle strongly in evidence. The former rises by ribs of ragged rock to an equally ragged set of pinnacles at the top. To all appearances much more fitting would it seem to call this north member of the triumvirate an "elder brother" or even parent, for his hoary head is relatively "bowed with age" and his shaggy framework shows through as, we can imagine, but a mere shadow of his former self.

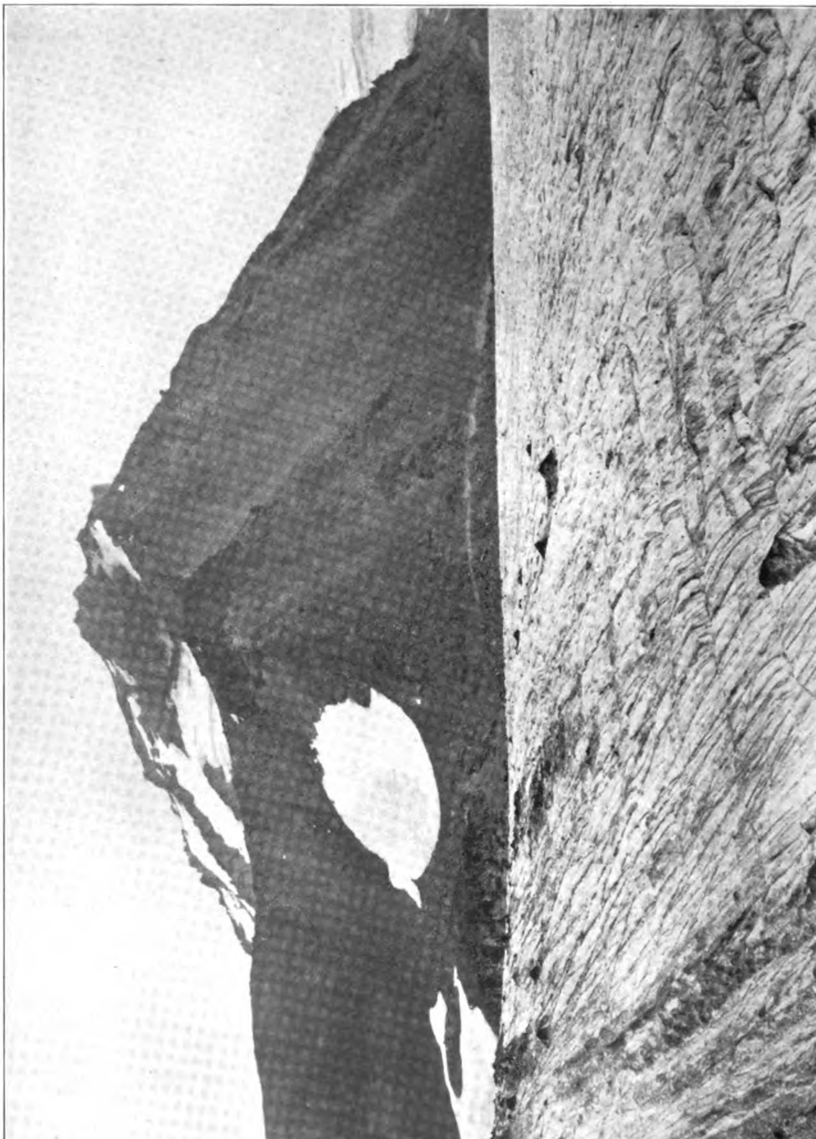
Middle Sister still preserves the cone shape of the volcano she formerly was, though less perfectly than does South Sister on which we stand. From this side the apex of Middle Sister exhibits a cusp-like crescent outline as though the eastern edge of the rim had been gnawed away. Two small glaciers hang at the east side of Middle Sister, their neves confluent above. The nearer one has been named the Diller glacier and the more distant whose whitened top obscures the base of North Sister, Hayden glacier. Two small lakes may be seen in the foreground. These rest in glacial hollows and are supplied by the summer melting of the perennial snows that ever cling about the peak. Middle Sister is not difficult of ascent from the west and southwest sides and has an altitude according to the U. S. Coast Survey of 10,039 feet above the sea.

A portion of Diller glacier. North Sister. At the far edge of the ice rocks are being gouged loose and carried along upon its surface. Here is quite vividly demonstrated the fact that, as in the case of water streams, the center portions of the ice-stream flow faster than the sides. Movement is very much retarded by friction with the walls and bottom of the channel while the middle

Middle and North Sister from the top of South Sister. Middle Sister is 10,039, North Sister 10,067 feet in height.



A portion of Diller glacier. North Sister.

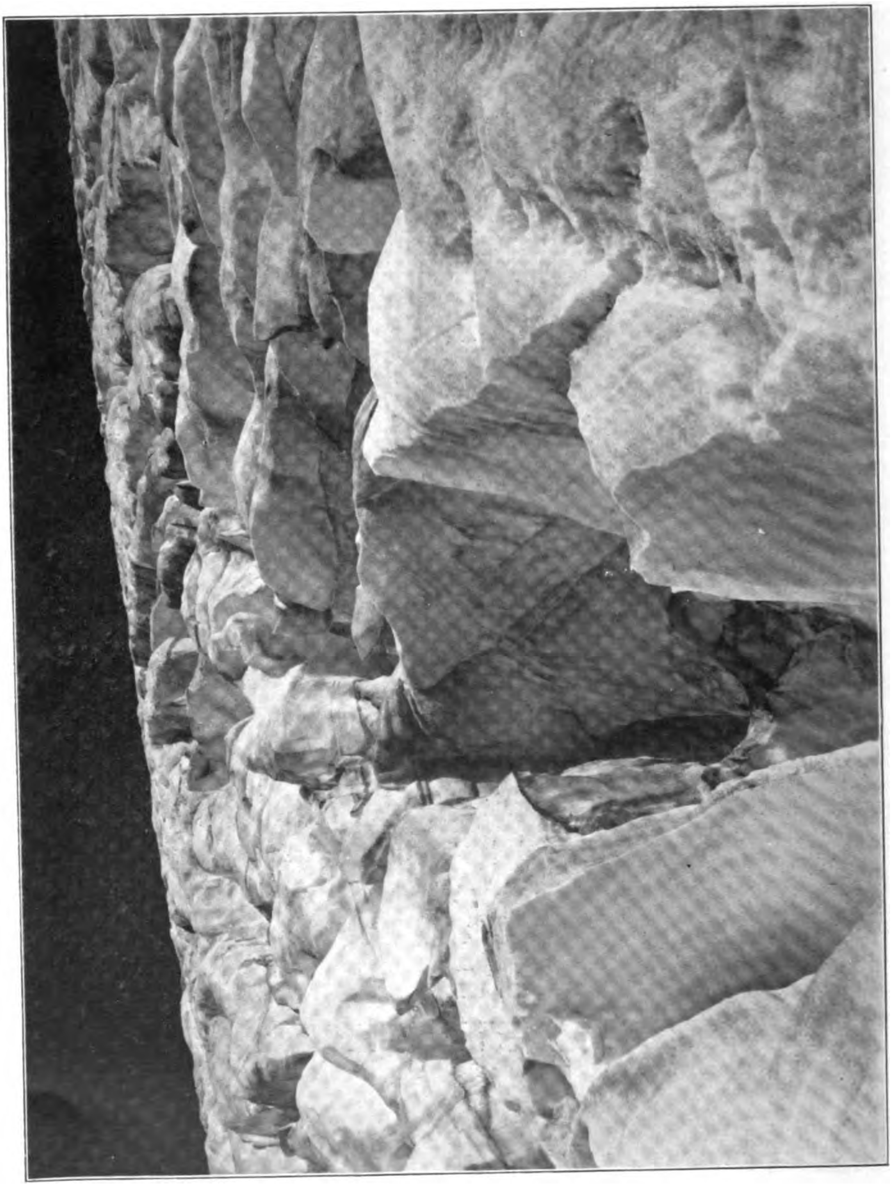


North Sister from the south across Hayden glacier.
Photo by G. M. Weister

portions forge ahead. In a stream of water there are no visible markings by which we can study this phenomenon while it is taking place. In a glacier, on the other hand, curving lines or planes of weakness, or actual break, are very commonly developed by such differential motion that can be distinctly seen and that frequently open up as parallel crescentic crevasses where the ice passes over irregularities that test its strength beyond the yielding point. At the center and to the left in the view corrugations may be seen, each trough the site of a wide open crevasse. Their curvature is very evident and is produced by flowage down the slope, in the photograph, from left to right. Horizontal banding in the ice is also apparent.

North Sister from the south across Hayden glacier. The character of the surface of the ice is shown in this view. It is marked by longitudinal corrugations and cracks that form across the direction of flow, where the bed is very irregular. As a rule the top of the glacier is roughened somewhat by the presence of heaps of broken rock, boulders, slabs or still larger masses that have fallen upon it. The carrying capacity of a glacier is unlimited. Blocks that are tons in weight are transported as readily as are silt and sand. Large thick pieces protect the ice beneath from melting as rapidly as where the sun's rays strike direct, and are therefore often seen perched upon mounds or even pillars of ice that rise above the general surface. At the left in the picture are many dirt covered mounds. While large pieces insulate against the sun's heat, small stones or thin slabs on the other hand speedily melt their way into the snow and ice. Everywhere the glacier is strewn with more or less of broken rock and where the pieces are small its surface is pitted with holes of varying size and depth at the bottom of each being a gravel stone, pebble or comparatively thin flat rock. This phenomenon is due to the greater amount of heat transmitted by the lesser pieces. During the day they become actually hotter throughout than the temperature of the air, hence convey more heat to the ice on which they rest than would be absorbed directly from the sun's rays. Rocks of all kinds, especially those of dark color, absorb much heat, but if their thickness is such that they do not become warmed through during the time the sun is shining they protect and, as it were, keep cool, the portions of the ice they cover so that it melts more slowly than it otherwise would.

Badly broken glacial ice. Just as long stretches of steep and stony bed produce rapids in water streams, so do the extent of crevassed and broken up stretches of a glacier surface largely depend upon the nature of its channel. Sometimes the ice is shattered in almost every conceivable direction in intersecting series of joints and open cracks that produce a surface impossible of travel. Such cordons of broken ice blocks as shown in the view, after they have been further accentuated by melting and movement are termed seracs. It is a not uncommon notion that the motion of a glacial stream is rapid if not even tumultuous in places. No conception could be farther from the truth. Although the ice may be much sheared, jointed and rent apart, movement can rarely be detected by any means except the most careful of measurements.



Badly broken glacial ice, Collier glacier.

Photo by G. M. Weister

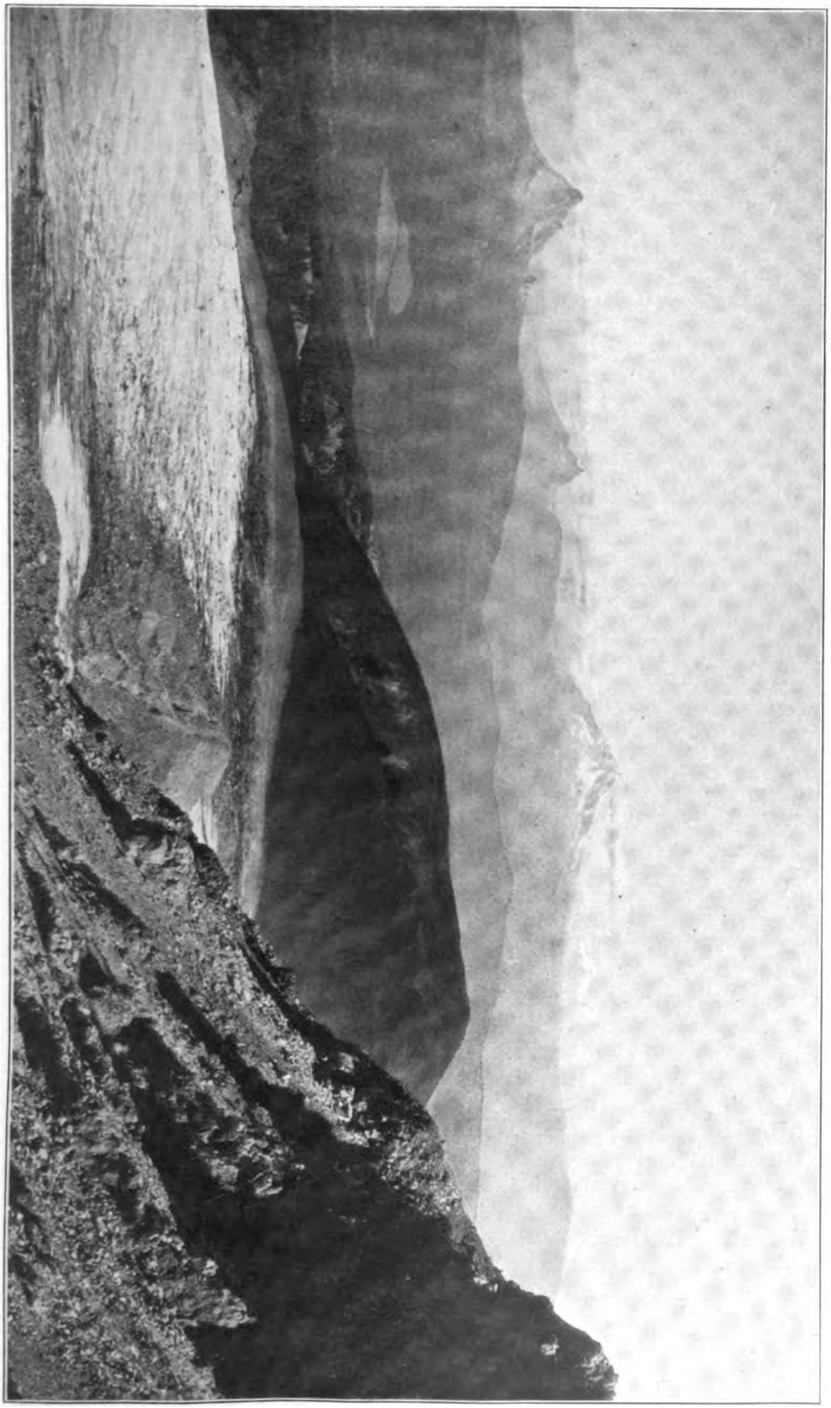
Crevasse or huge open crack in the ice. Crevasses open up where the glacier passes over projections in its channel, as a ridge of hard rock, or where it breaks over sharp rock cliffs.Crevasses are a sore menace to travel upon the glacier for they are often many feet wide and of indeterminable depth. Their walls are sheer blue ice or banded blue and white, the latter being due to included air or the former granularity of the snow, and they usually offer no foot or hand hold whatever to one who is so unfortunate as to approach too near. In the photograph is a morainal embankment from which rocks tumble upon the ice and perchance drop into crevasses to be frozen fast or swept along below.

Photo by G. M. Weister

There is no crashing crunch of crushing ice, no swiftly swirling eddies. All motion is quiet and orderly, so quiet and so slow indeed that unless patience and days are given to the task one may need to come again another season to observe it. Painstaking observations on some of the glaciers of Glacier National Park in Montana have shown movements ranging from one inch per hour down to a scarcely perceptible two hundredths of an inch. The rate of movement varies with the size of the glacier, its steepness and the season. A run of years of heavy snow fall may accentuate movement somewhat, and the glaciers may extend noticeably farther down, but the lesser climatic changes from year to year are apt to be felt but little. Unusually warm summers and in some instances even a series of warm moist days, may likewise cause the ice to creep downward a little more rapidly.

Looking north along the Cascade summit across the foot of Collier glacier. In this view Mt. Hood, 85 miles up the range, shows dimly at the right of Mt. Jefferson a snow-striped pyramid 35 miles away. Next in order stands Three-Fingered Jack and sharpened Mt. Washington, the latter about 15 miles distant. Towards Washington the gaze is across miles of bare lava in which the lighter spots are sand covered "islands" such as we have already seen along the McKenzie road. The photograph is taken from the west foot of North Sister, the disintegrating slope of which is at the right. In the foreground the surface of Collier glacier is seen to be deeply blackened with rocky talus that has fallen upon it. A little beyond and at the right of the main area of white we look lengthwise of a triple-crested morainal ridge. Moraines are built along the melting edges of the glacier by the material which it dumps there. Sometimes, as in this instance, the appearance of a series of closely packed parallel ridges is given by the crease or longitudinal V-shaped notch in the top. This is usually due to fluctuations in the height and width of the glacier surface. The deposition of successive rims of materials marks a diminution in size, which, we judge is the case here. Similar composite embankments fringe the ice border as far as our view extends.

A further most vivid bit of testimony on the course of recent geologic events is to be gained from an inspection of the large black mound in the center of the view. This is a typical cinder crater, its rim being continuous except to the west, our left. This side of it has been broken through and largely removed by a stream of liquid basaltic lava that has flowed down the west slope of the range top and which we have already seen at several points along White Branch. The course of this stream, whose source is the tip of Collier glacier, seems to have been determined and in part changed by this tenuous tongue of lava. We conceive of this great pile of cinder and ash as having been produced by violent volcanic eruption. Following which, as in the case of Belknap and other craters already cited, liquid lavas broke out around its base. Here the materials of the western rim, none too stable at the beginning, have crumbled and slipped into the seething molten stream to be absorbed, or to float upon its surface and be carried away.



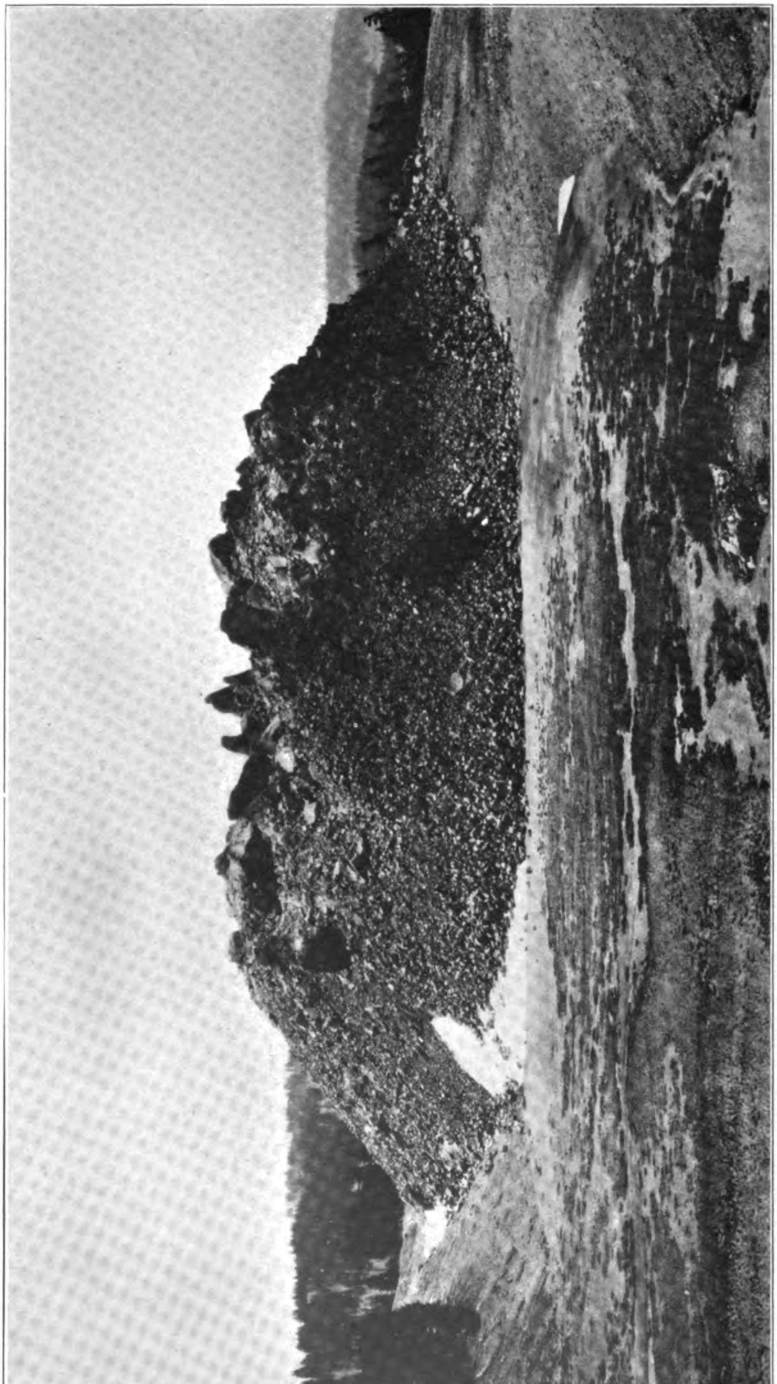
Looking north along the Cascade summit across the foot of Collier Glacier.

Photo by G. M. Weister

Here too an interesting chapter of the geologic book of records is open for our appreciation. Our cinder crater stands almost directly in line with the lengthwise dimension of the glacier, which turns within the field of view toward the left, into the head of White Branch. It is plainly to be observed that the glacier has been and is now actively gnawing its way into the side of this volcanic pile which rises in its path. We have not as yet unassailable grounds for maintaining that the glacier was here long before the throwing up of this barrier but the surroundings all indicate the correctness of such an inference. Far along the summit to the McKenzie road and beyond we have seen the evidences of scouring glacial action prior to the coming of the recent lavas. The Sisters were no doubt elevated sources whence extensive glacial streams emanated to flow outward down the slopes in all directions. And so here the conclusion is inevitable that the large ice stream of which Collier glacier is the shrunken remnant, formerly sent a branch, if not its main current, onward across the present site of this volcanic cone, and doubtless much beyond, where new rough lava now entirely conceals much of the old glaciated surface. Glaciation and the glacial period thus antedated the erection of our diminutive volcano and of the flows of liquid lava that came from it. Whether the materials actually came up through the ice itself or were erupted at a time when the glacier did not reach so far down the mountain as it now does, is a question over which we may only conjecture. Its position relative to the glacial stream leaves no question as to its having been born since glacial times. And while in all probability it then managed to rapidly increase its stature in the face of opposing glacial conditions, now the tables are turned and the contest is a one-sided one in the other direction. With the fires of volcanism dead little resistance can be offered to the agents that are proceeding to undermine its structure and it is being torn apart and piecemeal borne away.

Looking south lengthwise of Collier glacier, from red lava crag near its extremity. North Sister at the left. Middle Sister at the head of the glacier. The Collier is probably the most extensive glacier in the Oregon Cascades. From cirque to snout it is close to three miles in length. It heads far up against the northwest side of Middle Sister but in all of its lower course is frightfully gouging away at the west base of North Sister peak. Note the two figures on the snow at the lower right. This glacier is in places very much disrupted by crevasses and other flow breaks. Toward its head the ice is seen to be covered by a more or less continuous mantle of snow. At the left is a typically developed lateral moraine. It is composed of rock fragments of all sizes intermixed and so gently placed that the whole is a most unstable heap. One scarcely knows in clambering across it whether to trust less his step to boulders, gravel or slab in size, for either seems as apt as the other and all seem most anxious to settle, roll or slide beneath a minimum of avoirdupois upon them.

Looking south, lengthwise of Collier glacier, from near its lower end. The observer is facing almost directly opposite in this view from the position in the preceding photograph.

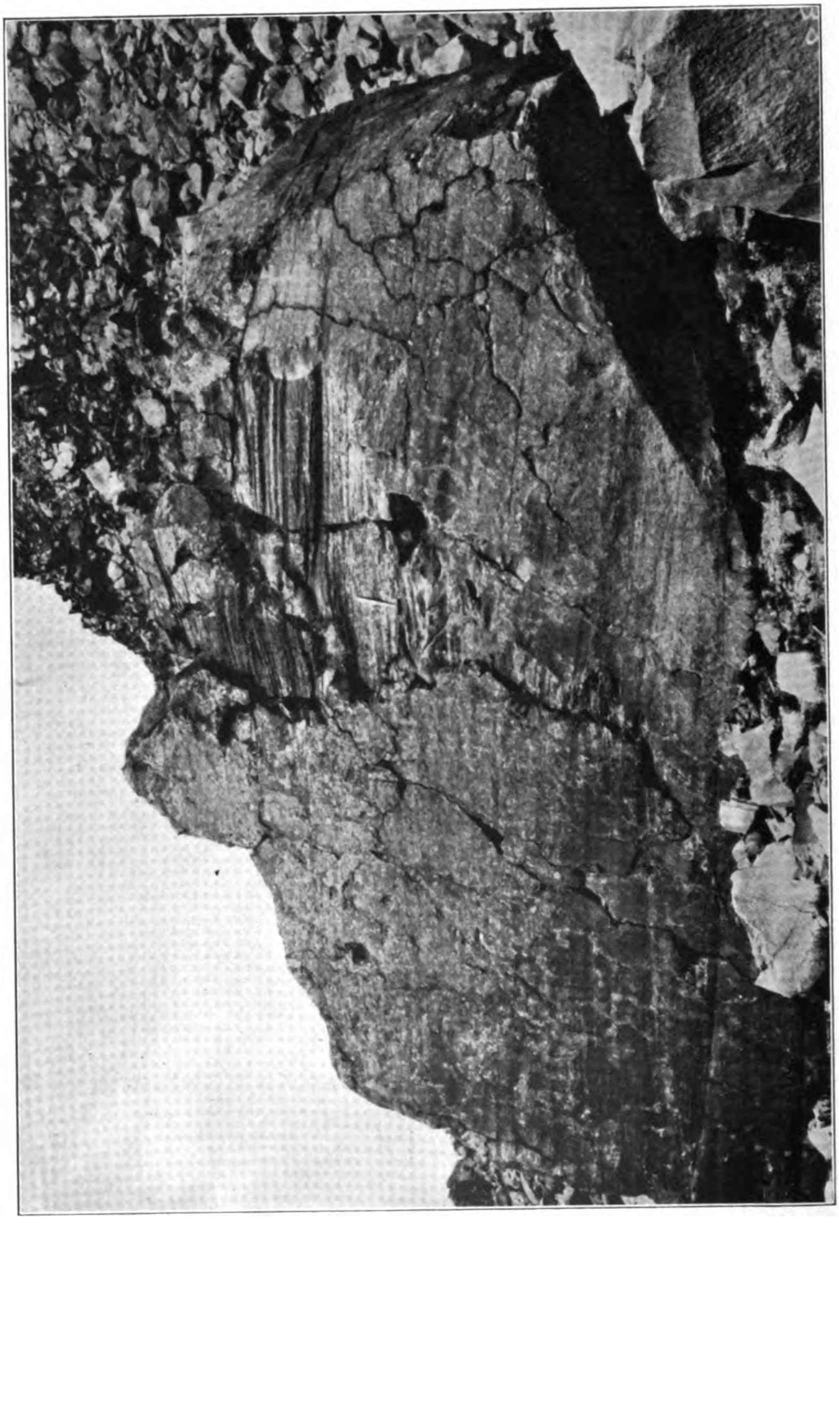


A diminutive but full-fledged lava flow at south base of South Sister.

A diminutive but full-fledged lava flow at south base of South Sister. Encircling the south base of South Sister in open order is a series of small craters some of which are cinder cones but the most interesting of which, as we look down upon them, appear like great pimples that have broken out here and there. Of this type at least seven may be counted, each a complete and finished flow in itself. The largest of them lies a little less than three miles to the southwest and the total of its outpourings covers not over one square mile. Each of the others occupies not over a few thousand square feet. Were it not apparent that they had been formed by the oozing out through small vents of viscous lava, they resemble as much as anything rough oval heaps dumped from some outside source. We can see from above, however, the successive curving flow-lines, the marks of twisting eddies, the circular boundaries and the center whence the welling molten lavas rose and spread. The complete little flow shown in the photograph is not over 500 feet in diameter. Its sides are of broken blocks of glassy to pumiceous andesitic lava and rise perhaps 100 to 150 feet to a group of almost inaccessible spines and pinnacles at the center. All of the evidences are present that the pile has been formed by the slow exudation (perhaps more properly forcible extrusion) of a viscous magma, so slowly as the end drew near that the final issue was already sufficiently stiffened by cooling that it pushed upwards as a set of central sharp spires instead of flattening down as would a more liquid medium.

From the top of South Sister many lakes of many sizes and all degrees of irregularity of outline can be seen within a distance of a few miles, all of which on closer acquaintance prove to be of glacial origin. Sparks lake, and Devils lake, Green, Lost, Elk and Mud lakes are a few of these to which names have been given.

Close view of a part of one of the lava spires shown in the preceding photograph. The suggestion of a partial solidification before extrusion took place is further corroborated by close examination. It is found that one or more of the faces of these central lava spires are curved and planed smooth or marked with parallel scratches or grooves resembling in many ways the characteristic glacier scorings we have seen in so many other places. Indeed, in the absence of any part of the entire story that is here so unmistakably held up before us, what we see might pardonably be taken for glacial work. Many of the grooves it is clearly apparent were made, not upon the hardened rock, but upon rock that, while still hot and somewhat soft, was nevertheless sufficiently rigid to retain its form and to take and hold impressions made upon its surface, much as would a cake of soap take and retain the imprints of one's finger nail. The markings are parallel because the spires were formed by being pushed upwards without change of direction, and were made by friction against the already solidified portions through which they were being upheaved by the irresistible but dying forces beneath. In the language of the geologist such planation by the forcible extrusion of partially hardened lava would be designated as a species of "slickensides," this term being applied to the smoothened surface produced where rock masses under heavy pressure rub together.

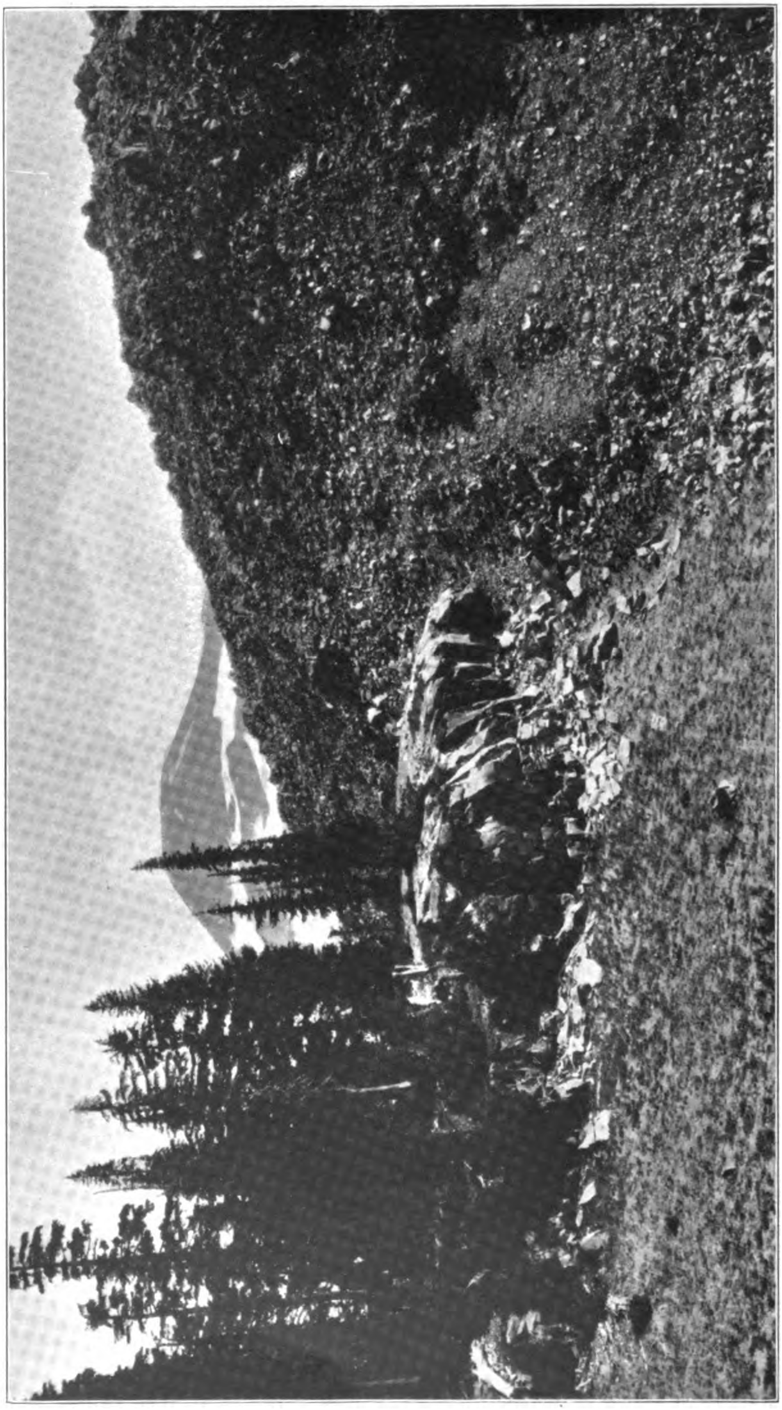


Close view of a part of one of the lava spires shown in the preceding photograph.

A final open page in the life history of the Sisters region. South Sister stands sharply outlined against the sky when viewed from the border of the new lava flow at her southwest base. At the right is a great uneven wall of broken blocks of glassy lava that rises one hundred feet or more in most places. It is devoid of vegetation with the exception of moss and lichen stains and an occasional scraggly and scantily nourished clinging evergreen shrub. In this respect the group of stately firs at the left and the thickly tufted grass in the foreground are in striking contrast. They grow to the lava's edge and while we question not, still we divine a most gruesome fate for their neighbors that formerly stood where the great heap of broken lava now rests. The smoothed rock platform on which the trees stand has been rasped and rounded by the glaciers long before the coming of this recent flow.

The course of events here is thus made plain. From what can be seen at this place and from our former knowledge of South Sister peak, it is properly concluded that the mountain elevation once served as a source whence glacial ice spread in all directions over wide stretches of surrounding country. Whether the activity of South Sister as a volcano had ceased before that time cannot with certainty be said. Some features of the mountain suggest the likelihood that it was in eruption during if not after the culmination of the glacial period. However that may be, there is before us full evidence that, succeeding occupancy by ice, a sufficient space of time elapsed for the accumulation of a soil and the growth of forest trees, how many generations of them we do not know. Then followed, and the time seems not so long ago, fresh outbreaks of viscous glassy lava, such as shown in the view and as we have seen at a number of places about and to the south of South Sister. Although these lavas are of a less basic character than the flows we have already observed at the north base of North Sister, the date of their outpouring must have been about the same. The difference in the character of the rocks suggests at least that although they were issuing at the same time they did not come from the same subterranean source. When it becomes possible to more carefully study North Sister, whose obviously greater age has been noted, and its relation to the other two Sisters made out, it is not beyond the range of expectation that the rocks of which it is composed may be found to be rather different. This would only go to strengthen the inference that North Sister probably raised high a lofty snow-capped head some time before the other two Sisters came into existence; and again that the reservoir from which its lavas came was not the same as that which furnished the materials for the other two mountains.

Glancing again at the photograph we are impressed with the fact that the glaciated rock surface passes directly beneath the new lava. Around its edges fir and hemlock everywhere approach, but is it imagination that a wary instinct has taught them caution? The clusters are



A final open page in the life history of the Sisters region.

the alpine fir, the more stalwart individuals mountain hemlock. These lavas are the most recent products of volcanic activity in the entire Cascade range in Oregon and as new as any known within the boundaries of the state. How long it has been since they flowed out can not be stated in years. They may be five hundred years old, perhaps nearer a thousand or more. Though they are treeless and so fresh that they still exhibit every line of motion, every swirl of current, yet no signs of heat remain and no indication is there that both they and the fount from which they came have not attained once and for all a condition of permanent coldness and solidity. Their appearance was the closing act of an epoch of volcanism, the same epoch that produced all of the main peaks throughout the Cascade range from Lassen peak in California to the Canadian line.

SUMMARY

This number of the Mineral Resources of Oregon contains some general considerations on the outstanding geologic features of the higher parts of the Cascade range in Oregon, and particularly the surface features or physiography of portions of the summit between Mt. Hood at the north and Crater lake 150 miles down the crest of the range. The particular purpose of this paper is to call attention to the economic importance of Oregon's scenery by emphasizing the wealth of scenic advantages existing in parts of the Cascade range. Scenery depends primarily upon the working of geologic processes, and its development in a state like Oregon is in large part a problem of economic geology.

A portion of the large scale relief map and a great many photographs are used in the paper and the discussion concentrated principally upon two parts of the summit that are little known, yet are of abundant interest from the pleasure and scenic standpoint. These two localities are Jefferson Park and the Three Sisters Region.

Jefferson Park

Jefferson Park is an area of a few square miles at the immediate north base of Mt. Jefferson. It is accessible by trail from the west only, but can be reached also from the north in midsummer, entrance being made from along the rocky and in part snow-covered Cascade divide. The park proper is a flat area squarely upon the summit of the range that has been scoured out by the once much more extensive glaciers than today exist on Mt. Jefferson. It is sparsely wooded with mainly alpine fir and hemlock, dotted with lakes of all dimensions, and sprinkled with brilliant flowers. Its surroundings are intensely pleasing, its sporting possibilites unlimited, and, though not at present easy of access, Jefferson Park and Mt. Jefferson should in the near future rank as one of Oregon's greatest scenic assets, comparable in economic importance with Mt. Hood and Crater lake.

Three Sisters region

The Three Sisters Region is not difficult to reach by way of the McKenzie automobile road from Eugene in the Willamette valley or from any one of several railroad points on the Deschutes river east of the range. The Three Sisters are a group of prominent peaks situated at the corners of a flattened triangle whose longest side is not over five miles in length. All three are former volcanoes, South Sister still showing a well developed crater in its top. North Sister is by far the most rugged and, to all appearances, of considerably greater age than the other members of the group.

South Sister is 10,351 feet in altitude, Middle Sister 10,039, and North Sister 10,067 feet high. On the slopes and in the crater of South Sister are large snowfields and clinging about its sides are at least five active glaciers. Emanating from Middle Sister are four glaciers, all having names; one, the Collier, being probably the most extensive in the mountains of Oregon. At the east side of North Sister the remnants of two or three once more extensive glaciers still remain.

Round about the Three Sisters peaks are many evidences of recent volcanic activity. Besides the peaks themselves, small cinder craters are quite numerous and flows that have oozed out from the base of these peaks. Many of the flows are very recent, so new in fact, that their lavas are practically unaltered and upon their surface no vegetation has yet gained a foothold. These recent lavas have been erupted since the period of maximum glaciation, and in many places are seen to rest immediately upon the scored surfaces of earlier lavas, though at times separated by a veneer of volcanic sand that no doubt came from the many cinder craters.

The country about the Sisters peaks is ruggedly scenic and one of attractiveness to the tourist and the mountain climber. It is openly forested and there are uncounted lakes, mostly small, pretty streams and flower-trimmed glacial meadows. Obsidian ridge is a prominent shoulder of glassy lava extending westward from the base of Middle Sister. Red Lava Crag, and a conspicuous cinder cone at the north base of North Sister standing directly in the path of Collier glacier, are objects of scenic interest and study.

Rocks of Cascade range

It is found that the upper portion of the Cascade range is built entirely of volcanic materials. From altitudes of a few hundred feet to two or three thousand feet in places there is a great thickness of bouldery volcanic tuffs, depending upon their exact character, sometimes properly called volcanic conglomerates, volcanic or tuff-breccia. In some of the deeply eroded canyons, bodies of intrusive, usually largely crystalline igneous rock will probably be found that have pushed up beneath or broken through the tuff strata. It is in connection with such intrusives that ore bodies are most commonly to be expected.

Resting upon these fragmental volcanic rocks are heavy flows of lava of intermediate acidity known as hypersthene andesite. This type of lava covers not only much of the summit but is also the capping of a large number of conspicuous peaks and ridges throughout the entire width of the range. The lavas of Mt. Hood, Mt. Jefferson, and the Sisters are prevailingly of this same general type.

Glaciation in Cascade range

These great flows of andesite came prior to glacial times and are responsible in considerable degree for the present bulk of the Cascade range. In all the higher parts their surface was covered by the ice of the glacial period and deeply scored by the moving glaciers. While evidence of glacial action is unmistakable and abundant about many of the peaks far toward the Willamette valley front of the Cascade range, the most spectacular display of glacier work in the area treated in this paper is to be observed for better than 100 miles along its summit, chiefly from somewhat north of Mt. Jefferson south to Crater lake and beyond. The myriads of beautiful lakes and meadows, many of the canyons, the sculpture of the peaks, and what is left of the glaciers themselves clinging about the slopes of the major elevations, exist today for our enjoyment and pleasure largely because of the former frigid period of ice and snow that we have come to call the Glacial period.

Recent volcanic activity

Following and probably in part during the time of profound glacial activity, and, to date, the latest epoch in the history of the making or growth of the Cascade range, there came the great lava flows and ash and cinder eruptions whose products we now see at many points along the summit. Lavas broke out in places about the lower slopes of the larger peaks or issued from fissures or separate vents to deluge the surrounding country. Cinder cones were built and ash and scoria scattered about by the force of explosive eruption. The evidences of this recent activity may be best observed at a great many places from Mt. Jefferson southward for more than a hundred miles. The McKenzie road skirts a long tongue of this lava known as the White branch flow that extends far down the canyon of Lost creek; and upon the summit of the range the road crosses for several miles the roughened, broken and barren surface of the newer lavas that have come from Belknap crater at the north and from vents at the foot of North Sister to the south.

The newer lavas are, in the main, somewhat more basic than those of earlier date. Some are augite andesites, while those crossed by the McKenzie road which represent the most extensive flows upon the summit of the range, are dense, black, brown or red, usually porphyritic, and show every indication of being true basalts.

"See Oregon First"

Within the higher parts of the Oregon Cascades there are a number of intensely interesting scenic places that are at present frequented only by those who can endure a trip of some length on foot or in the saddle. There are also many other scenic spots that are accessible and equally satisfying to the sportsman and the tourist.

Facilities for reaching the less accessible localities are being rapidly perfected. Oregon scenery is not to be excelled anywhere on the continent, which in this day of exploiting the resources of our own country, is equivalent to saying that Oregon scenery is unsurpassed the world over. The development of Oregon's scenic resources is going on apace, and from the financial standpoint promises to become of importance equal to that of her other established industries. *See America*—but *See Oregon First!*

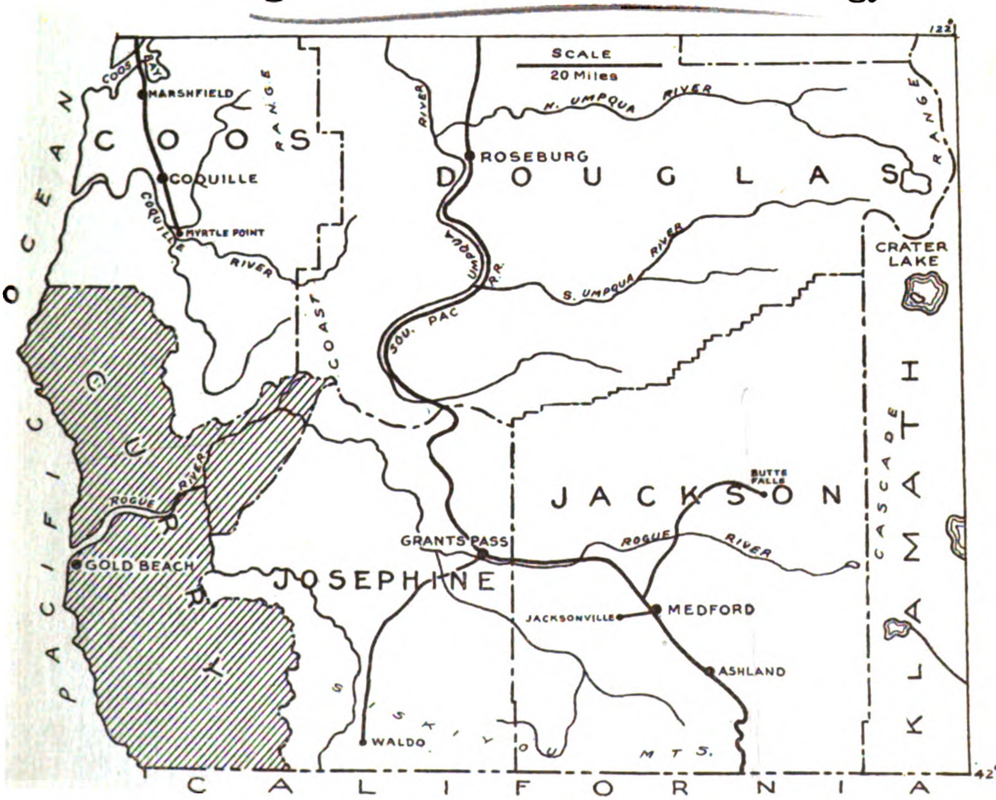
VOLUME 2 NUMBER 2

OCTOBER, 1916

THE MINERAL RESOURCES OF OREGON

Published Monthly By

The Oregon Bureau of Mines and Geology



Sketch Map Showing Location of Curry County

Preliminary Survey of the Geology and Mineral Resources of Curry County, Oregon

By G. M. BUTLER and G. J. MITCHELL

136 Pages 41 Illustrations

Entered as second class matter at Corvallis, Ore. on Feb. 10, 1914, according to the Act of Aug. 24, 1912.

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1916

ANNOUNCEMENT

The present (October) issue of the Mineral Resources of Oregon constitutes the second number for the year 1916. It treats of the resources of a section of the state concerning which there has been heretofore but little information available.

Two more issues of this journal will be published in the present year. One of these will be a descriptive handbook or directory of the mining companies, mines and prospects in Oregon. The other will comprise an illustrated geologic explanation of the scenic features of the gorge of the Columbia river through the Cascade Range, semi-popularly interpreted from the celebrated Columbia River Highway.

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ILLUSTRATIONS

VOLUME II NUMBER 2

OCTOBER, 1916

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of all her Minerals

PUBLISHED MONTHLY AT CORVALLIS BY
THE OREGON BUREAU OF MINES AND GEOLOGY
H. M. PARKS, Director

PRELIMINARY SURVEY OF THE GEOLOGY AND MINERAL RESOURCES OF CURRY COUNTY, OREGON

By G. M. BUTLER and G. J. MITCHELL.

INTRODUCTION

The ensuing report has been prepared from data obtained by the writers in the employ of the Oregon Bureau of Mines and Geology during the summer of 1915. The field party consisted of G. Montague Butler of the Department of Geology, Oregon Agricultural College in charge; G. J. Mitchell, Department of Geology in the University of Oregon, and Harry B. Hillis, guide, of Powers, Oregon. Mr. Butler paid especial attention to the ore deposits and economic features of the region covered and Mr. Mitchell more particularly to the areal geology.

The area assigned to the party included all of Curry county and an effort was made to cover this territory as well as could possibly be done in the time available. It was soon recognized, however, that the time was too limited to permit even a cursory examination of the whole of the county. Since the United States Geological Survey has already published a folio dealing with the resources of the northern portion of the county, it was decided to concentrate attention to a considerable extent on that portion south of Rogue river.

The first locality visited was the Mule creek district, and from here the course of the party was about as follows: Shasta Costa copper district, Agness district, Boulder Placer creek district, Rock creek district (Coos county), Wake-Up-Riley iron district, Dry lake, Pebble Hill copper mine, Frank Fry's ranch on the Illinois, Frank Berry's ranch on Lawson creek, Frank Berry's upper camp on the divide between Lawson and Horse Sign creeks, Burt camp south of Horse Sign butte, Collier creek camp, Sourdough camp, Meadow camp near the head of Collier creek, Craggie camp southwest of the big Craggies, junction of Miss Latney creek and Chetco river, Harbor, unnamed camp a little west of the junction of Smith river and Baldface creek, summit Mount Emny, Lone ranch borax mine, R. C. Walker's ranch near mouth of Pistol river, Gold Beach, McKinley copper district, MacGrubble ranger station near Elk river, Port Orford, mouth Sixes river, south fork Sixes river, Barklow ranch, Powers, Johnson mountain chrome-iron district.

The localities just named represent camping places, but do not, perhaps, give a proper idea of the territory covered, as horse-back and foot trips were taken from these as centers to distances of as much as 10 miles. It is believed that all of the most promising mineral-bearing areas in the county were visited, excepting those in and around Gold Basin, in the southwestern part of the county.

Great difficulty was experienced through the lack of reliable

Fig. 2. A portion of Gold Beach, the county seat of Curry county

maps. The few available were found incorrect in many details, and it was impossible to rely upon many of the trails indicated thereon. In fact it would have been almost impossible to satisfactorily follow the route selected without the willing assistance and cooperation of prospectors and others met in the field during the course of the investigation.

Owing to the large area involved, a lack of suitable base maps, difficulty of transportation, and other factors, it was found impossible to make the examination anything more than a reconnoissance. There was not sufficient time for a detailed examination of any district, and the conclusions herein expressed must necessarily be regarded as tentative. The aim of the whole investigation was to ascertain whether any promising mineralized areas exist in the county, and to corroborate or disprove reports concerning various deposits that have come with increasing frequency from prospectors and others. It was at first hoped that a rather detailed description of the petrography of the county might be included in this report, and many specimens were gathered with this end in view. This plan later proved impracticable for a general report such as this is, so few microscopic thin slides were made or studied. The very great diversity in and common fineness of grain of the igneous rocks encountered, and the consequent uncertainty in their detailed classification, have made it necessary to group rocks probably quite distinct under general family names, such as greenstone, and has been one reason for the subordination of all questions of geologic theory to economic considerations.

ACKNOWLEDGMENTS

Mr. Frank Berry who lives near the mouth of Lawson creek spent 11 days in the field and Mr. M. C. Woods of Harbor and A. M. Collins of Agness, each donated several days' time in the capacity of guides for the party. In addition to the gentlemen named, there were many others who extended aid in various ways. One of the pleasant memories of the summer will be the uniform cordiality with which the party was greeted by every one encountered during the course of the trip.

The reports of J. S. Diller[1] were found extremely useful and many quotations therefrom will be found in the following pages.

1 U. S. Geol. Surv. Folio No. 89 and Bul. No. 546.

HISTORY, GEOGRAPHY, TOPOGRAPHY AND CULTURAL FEATURES

History. The first settlement in Curry county was made by nine men under J. M. Kirkpatrick in June, 1851, at Port Orford. These men were, however, attacked by the Indians and forced to flee to the northward, reaching settlers at the mouth of the Umpqua on the 8th day after their flight commenced. Captain William Tichenor of the *Sea Gull,* who had brought this party to Port Orford, returned to San Francisco after their apparent establishment there and gathered forty men with whom to reinforce those he believed to be already settled at Port Orford. The second party arrived on the 23rd of June, and the town was then firmly established. Information concerning the date of the establishment of Gold Beach was sought unsuccessfully, but it is known that this town was formerly called Ellensburg, and was selected as the county seat in 1858. Six years earlier than this, gold had been discovered on the beach, and near the mouth of Whisky Run at Port Orford, and in 1856 a mining town called Elizabeth had sprung up thirty miles south of Port Orford. This name is no longer found on any map. The county was named after Governor George L. Curry, and was organized December 18, 1855. Indian wars occupied the attention of the settlers from 1851 to 1853, and during 1855 and 1856. Since that period, the history of the county has been an uneventful one.

Fig. 3. Big Craggy from Sourdough camp

Geography. Curry county lies in the extreme southwestern corner of the state of Oregon, is bounded on the south by the state of California, on the west by the Pacific Ocean, on the north by Coos county, and on the east by Josephine county. Its length in a north-south direction is 66½ miles, and its greatest width about 36 miles, although the average width is considerably less than this. Its general configuration and the location of the principal streams, towns, and mountains can best be ascertained by referring to Figure 1, op. page 7.

Topography. Curry county is decidedly mountainous, in fact it is completely covered with mountain ridges and peaks, all of irregular contour. These mountains form a portion of the Coast Range. Although the altitude of the higher peaks seldom runs much above 3,500 feet, the bases of the mountains are often but a few hundred feet above sea level, and this makes the scenery quite bold and impressive. J. S. Diller[1] states that these mountains are the eroded remnants of an old plateau or peneplain which he calls the Klamath Plateau or Peneplain, and he cites[2] the comparatively even crest of Iron Mountain in the northern part of the county as a proof of this hypothesis. Although observation to the east and south seems to point to the likelihood of the former existence of such a plateau at an elevation of about 4,000 feet, very few evidences of the correctness of this supposition were found during the trip. Flat-top peaks are comparatively rare, and what even-crested ridges are found have altitudes much less than those of the peaks. The only sky-lines observed which strongly bore out Mr. Diller's theory were seen along the Oregon-California line. Erosive agencies seem elsewhere to have been so unusually effective that they have not only excavated deep valleys, but have also obliterated all traces of the Klamath plateau or peneplain.

Although mountains are perhaps the most striking topographic features in the county, the river valleys are decidedly interesting. As a usual thing they are narrow and show quite precipitous slopes near their bottoms; and in some cases where the rock structures are favorable, the streams flow through picturesque canyons or gorges. This is especially true of Rogue, Illinois, and Elk rivers. In the case of the first named, west of Mule creek the stream flows for several miles through a narrow, vertical-walled rock gorge, with sides

1 U. S. Geol. Surv. Bul. 546, p. 13, 1914.
2 Idem.

Fig. 4. View southeast from Sourdough camp across a sea of fog. Photographed at 5:00 A. M.

some thirty feet high. Above this gorge is a rather flat bottomed valley a few hundred feet wide bounded by steep slopes a few hundred to a thousand feet high. The steep lower slopes wherever found usually give place rather suddenly, at varying distances above the water level, to gentler slopes rising to the crests of ridges or peaks. This gives most of the valleys a cross section similar to that shown in Figure 5. In explanation of this peculiarity, it may be said that the Klamath peneplain was probably originally a surface of gentle relief near sea level, and was subsequently raised so gradually as to permit of the erosion of broad, shallow valleys. One or more periods of sudden elevation then followed, and the rejuvenated streams cut rapidly downward to the bottom of the broad valleys, forming the steep sided valleys. A still more recent uplift has caused the development of the gorges.

The peculiarly shaped valleys resulting from the processes just

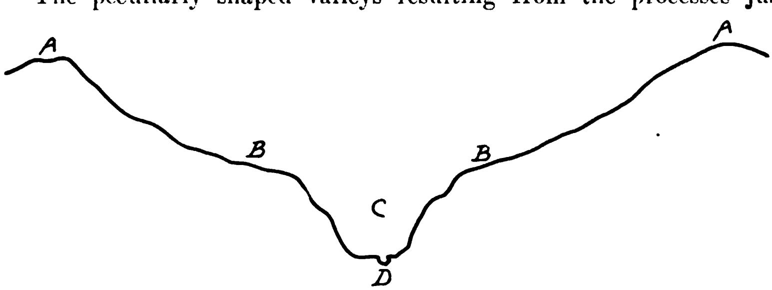

Fig. 5. Generalized cross-section of a typical Curry county river valley. A, mountain peaks; B, first river valley; C, second river valley; D, present gorge

outlined have been in some cases materially modified by landslides. These are not uncommon and have sometimes occurred on a very large scale especially in serpentine areas (see fig. 6).

A third feature of topographic interest is the coastal plain, and the marine terraces sometimes found adjacent to it. This plain varies from nothing up to about four miles wide, and usually lies at an elevation of one hundred feet or more above sea level. It reaches its maximum width and is best developed north of Port Orford, but narrower coastal plains exist elsewhere, especially south of Gold Beach. North of Port Orford, the mountains rarely slope uniformly down to the water's edge or to the coastal plain. Instead, the descent is interrupted by one or more steep slopes and flats or terraces. The former represent the remains of old sea-cliffs, and at their bases are sometimes found remnants of ancient beaches. The long, gentle slopes or flats are wave-cut terraces which were below sea level when the sea beat against the corresponding sea-cliffs. Such wave-cut terraces are now found at about 500, 1,000, and 1,500 feet above sea level, although the last is much less distinct than are the other two. The elevated ancient sea beaches are of economic interest as they are sometimes gold-bearing, as is the present beach.

Cultural Features. With the exception of a rather narrow strip along or close to the coast, and other still narrower areas along the streams, Curry county is an almost uninhabited wilderness. This condition is especially noticeable south of the Rogue river where there are several townships without a single permanent inhabitant, and many square miles without known trails. It is probable that the total population does not exceed 2,500 persons, and most of these are concentrated in the towns of Langlois, Port Orford, Wedderburn, Gold Beach, Brookings, Harbor, and Lakeport, along the coast.

All of the towns mentioned are connected by a fair to good wagon road, and roads also run for short distances up some of the larger streams, notably the Chetco river along which two roads have been built as far inland as the Moore ranch. Elsewhere, all travel must be done afoot or on horses over trails. Some of the trails, such as those used by mail carriers and the employees of the U. S. Forest Service, are in excellent condition, but the majority are so little used that they are difficult to follow, and in many places, almost impassable.

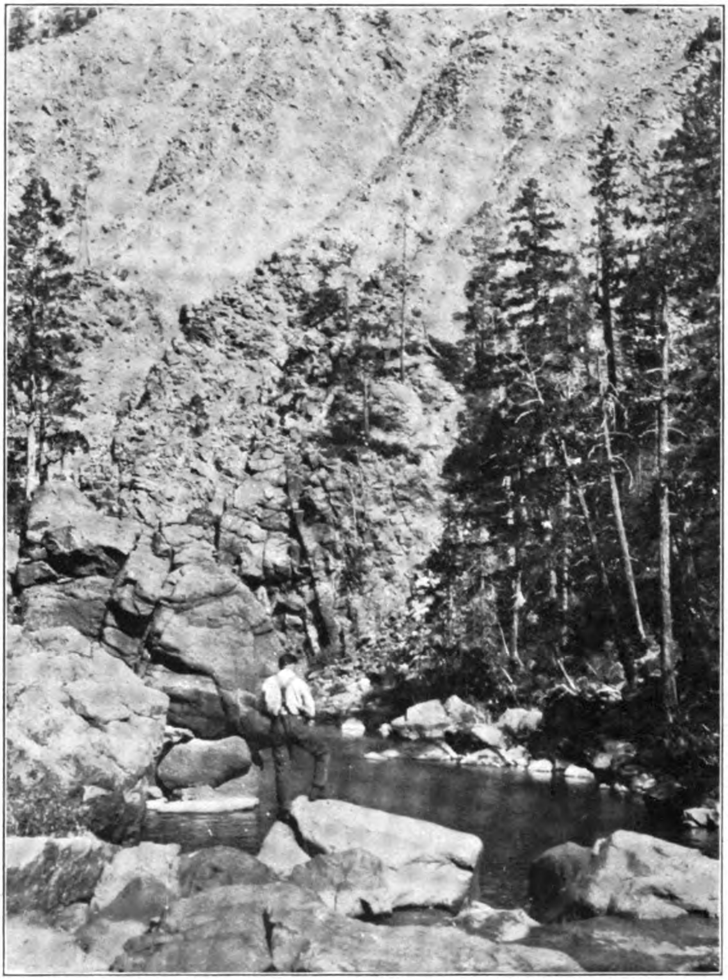

Fig. 6. Bald Face creek, a tributary of Smith river. In the background is a great cliff of unweathered serpentine recently exposed by an enormous slide

Second-growth timber and under-brush is so rapidly filling trails once well defined and easily traversed that it will not be long before many will be utterly unusable. Within the National Forest, main lines of communication are kept open, but there are, nevertheless, many square miles of virgin, almost jungle-like wilderness without trails. This condition has greatly retarded prospecting and development of the country. In the old days it was customary to start a forest fire whenever it was desired to prospect a certain slope, and the country was kept comparatively clear by such means. With the creation of National Forests, such methods have become unlawful, yet no substitute for the drastic measures earlier employed has been suggested. It is not to be wondered at, then, that some prospectors feel much dissatisfaction with present conditions, and sometimes revert to old practices, especially when the ground which they wish to clear is covered with under-brush and scrub-growth of no value, yet so thick as to be impenetrable. The Forest Service has built some splendid trails, but at the present rate of work, it is improbable that a large part of the interior of the county will ever be opened up by such means. In fact, it is getting less and less accessible as time goes on. Whether the benefits accruing from timber protection overbalance the stagnation in development resulting from the presence of extensive areas of thick under-brush is a question that should receive careful consideration at an early date.

Most of the mountain slopes are heavily timbered with various species of conifers of which the most valuable are the Port Orford cedar and the redwood, the latter observed in two patches of considerable size near the California boundary.

The best farming land in the county is found on the coastal plain or terraces bordering the Pacific. The soil there is frequently sandy, but in some localities consists of a dark loam that is extremely productive. Good tillable soil is also found bordering some of the larger streams, and there are a few farms on the gentler slopes of the

Fig. 7. Cultivated coastal plain south of Harbor

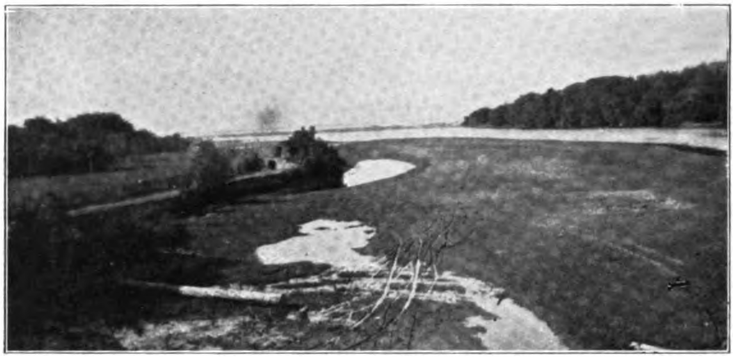

Fig. 8. Pistol river crossing coastal plain at its mouth. In the background is a sandspit such as exists at the mouths of most of the Curry county rivers

mountains. The total amount of tillable land is, however, extremely limited, and distance from market and lack of transportation facilities are not conducive to much activity in agricultral lines.

One of the most important industries of Curry county is the salmon fishing in the Rogue river. Great quantities of these fish are caught every year, and canned by the Wedderburn Trading Company near the mouth of the Rogue. This cannery gives employment to many people residing in Wedderburn and Gold Beach.

It is doubtful if there are many other places in the country as

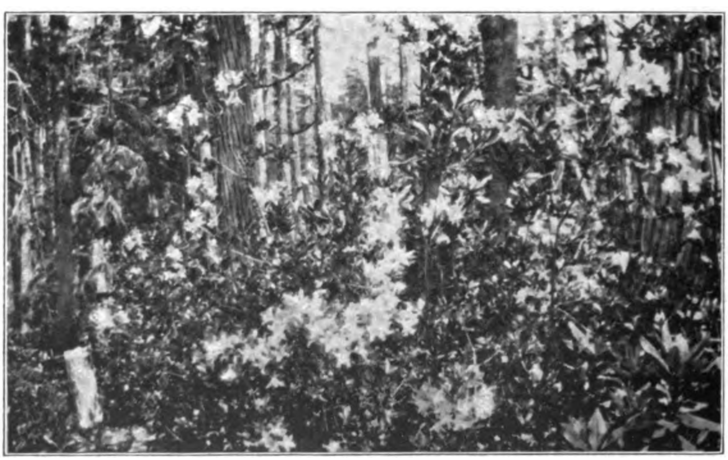

Fig. 9. Port Orford cedar and rhododendron. The latter is often so thick as to make travel through it impossible unless cutting is done

well stocked with game as is the interior of Curry county. On two or three days' trips from the main trails great numbers of deer were seen, and many of them were so tame that it is very doubtful if they ever before saw human beings. Black and brown bear and cougar are also fairly plentiful, and two or three elk were sighted. Most of the streams teem with trout; in fact, the region is a sportsman's paradise.

GEOLOGY AND PETROLOGY

GEOLOGIC HISTORY

The oldest geologic record left in Curry county is found in the Colebrooke schist, a body of highly schistose rock which was probably originally an argillaceous and sandy sediment laid down under the sea. Crustal movements followed the deposition of this material, crushing, folding, and finally uplifting it above sea-level. The age when this rock was deposited has not been determined, although evidences existing in Curry county prove it to be pre-Jurassic. Diller suggests[1] that it may be pre-Devonian, or Carboniferous, or even later. There is a possibility that it is the equivalent of the Abrams of Hershey.

Following the deformation and uplifting of the Colebrooke beds, occurred a period of erosion in which the waste derived from their disintegration was deposited in the bordering ocean. These clayey and sandy sediments were finally indurated, and now constitute the Dothan shale and sandstone. The period of deposition of these rocks has been placed as Jurassic by Diller, who has described[2] their occurrence in other sections of southwestern Oregon. The deposition of the Dothan beds was followed by another epoch of crustal movements which brought them above sea level and left them, in many places, in a highly tilted position.

Extensive erosion followed the uplifting of the Dothan, and the gravel, mud, and sand derived from the wearing down of the surface was deposited in the adjacent sea, to be later transformed into the Myrtle conglomerate, shale, and sandstone. The alternation of different types of sediments comprising the Myrtle suggests changes in the elevation of the land and the depth of the sea during that epoch.

1 U. S. Geol. Surv. Bul. 546, p. 14, 1914.
2 Idem, p. 17.

Fig. 10. In camp southwest of the Craggies

Fossils found on the trip, and mentioned later, prove that the Myrtle was deposited during the latter part of the Knoxville or Horsetown epochs of the Comanchean or Lower Cretaceous. Following the deposition of the Myrtle sediments, occurred a third epoch of deformation, which left the Cretaceous strata tilted to angles of 35 degrees or more, and raised them far above sea level. The forces which acted upon these later formed terranes doubtless acted also upon those beneath, hardening, crushing, shearing and folding them. At about the time of this third diastrophic movement and likely coincident with it, masses of igneous rocks, such as pyroxenite, and peridotite, which now may be altered to greenstones, were intruded into the Myrtle and earlier formed strata. This third deformation was the last severe one affecting the region. At its close, the surface was lifted well above sea level, and the streams engaged vigorously in their work of land-sculpture. The resulting products of erosion, consisting of gravel, sand and mud, were carried down into, and deposited in, shallow seas; and were later changed by pressure and cementation to the rocks which make up the Eocene system. Gentle folding of the Eocene beds indicates that slight crustal movements occurred at the close of this period, and this was doubtless accompanied by the elevation of the Eocene beds. Another epoch of erosion ensued, and Miocene beds were formed by the depositon of the waste products in the sea. If these deposits were once widely distributed, they may have since been removed by erosion. It is not improbable, however, that the greatest part of this deposition occurred along the continental border beyond the present coast line. In any event, the only Miocene known to exist in the county occurs in two narrow strips, one about half a mile north of Blacklock Point, and the other extending south of Cape Blanco for three miles. After the Miocene period, continued erosion resulted in the formation of the gravel terraces of Pleistocene age, the terraces formed being the result of interruptions in the erosion cycle as previously explained. No further changes occurred until comparatively recent times, when the alluvium deposits formed, and still continue to form, bars and benches along the streams, and flats along the coastal plains.

The approximate distribution of the various geologic formations just mentioned, as well as of several types of igneous rocks, is indicated on Fig. 1. The delineation of the areal geology of the Port Orford quadrangle, in the northern half of the county, may be regarded as fairly accurate, since it is simply a generalization of the map prepared by the United States Geological Survey and published in Folio No. 89. Much of the mapping in the rest of the county, is, however, nothing but the roughest kind of an approximation, since the time available for gathering the desired data was too short to permit the running out of a single contact. Where contacts were encountered, the fact was noted on the rough base maps with which the party was provided; and considerable information could sometimes be secured, or guessed at, by observations from high peaks. Occasionally prospectors made statements concerning the nature of the rocks in regions not visited, and, when these appeared sufficiently reliable and definite to make it possible to interpret them in geologic terms with a fair degree of certainty, they were used in preparing the map.

It was found especially difficult to map the igneous rocks with any degree of satisfaction. In fact, nothing definite along this line could have been done without a good large-scale base map and extensive petrographic investigation. This is because of the wide variety of such rocks encountered and the small size of many of the masses. Where the map indicates the presence of a certain type of igneous rock, this should be understood to mean that it is the prevailing species found in the area involved. Where two masses petrologically identical were noted in areas not too far separated, it was always assumed that the same rock filled the intervening country; and this rule was extended so as to apply to quite widely separated outcrops if they were very extensive. In a geologic map prepared in the manner just outlined, accuracy in details should be expected by no one.

PETROLOGY

The petrology of Curry county is very interesting since representatives of each of the three great groups of rocks—sedimentary, igneous, and metamorphic—are to be found, and numerous varieties of each occur. In fact, a decidedly interesting monograph might be written on this subject alone, and such a paper may be prepared at some time in the future. As such a discussion would possess possibly greater theoretical than practical value, and would consume more time in its preparation than it seemed possible to give, it was decided not to include it in this report.

As indicated on Fig. 1, the sedimentary rocks, consisting of many varieties of sandstone, shale, and conglomerate, are prominent in the northern half of the county, along the coast, and in the southeastern corner of the area examined; while the igneous masses, which are almost entirely of intrusive character, outcrop in the northeastern corner along the Rogue river, and extend southward along the eastern border of the county as far as the Oregon-California line, and probably further. In addition, outcrops of igneous rocks, often numerous, and frequently of large size, can be found cutting through the other types of rock in nearly every township. The metamorphic rocks are confined chiefly to an irregularly shaped mass in the central part of the county, which extends from the latitude of Mussel creek and Lake of the Woods southward approximately to Pyramid peak. Another smaller mass of different nature occurs in West Craggy and northward to a point a little beyond Collier creek. Some small masses of metamorphosed sediments lie adjacent to masses of igneous rock. These were formed as a result of the heat and chemically active solutions given off by the cooling igneous mass with which the now metamorphosed material is in contact. The slaty Dothan shale on Mule creek is a fair example of this type of metamorphism. The slaty shale doubtless owes its hardness and other unusual characteristics to the intrusion of the rocks now greenstone with which it is in contact.

In the ensuing descriptions of the various types of rocks, the modes of occurrence, relations to other rocks, textures, and other megascopic features (those which can be determined by examination with a handlens and pocket knife) have been emphasized. In fact, practically all other data have been excluded, since it was felt that such a treatment would be best suited to the needs of those who will be most interested in this report, namely, prospectors and those developing prospects. In a few cases, microscopic examinations were made when the identity of specimens was unusually doubtful and exact data on this point seemed desirable. A full petrologic description of the rocks in the Port Orford quadrangle has been given[1] by Diller, so the information herein offered will refer especially to the rocks of the south half of the county and the strip in the northeastern portion along the Rogue river. While the formations and species there found do not usually differ materially from those to the northwest, some distinctive peculiarities were noticed which will be stated on the following pages.

SEDIMENTARY FORMATIONS

Alluvium. The alluvium is the loose, heterogeneous mixture of soil, sand and gravel that occurs along the rivers as bars and flood-plain deposits, and along the coast at the mouths of streams. This material varies in size from fine mud or silt to boulders several feet through. The fine-grained alluvium is very fertile, and is in some localities renewed whenever flood conditions prevail. As has already been mentioned, many of the streams flow through rather narrow, steep-walled valleys in which there is no opportunity for the formation of extensive deposits of alluvium. In some places where the rocks are comparatively soft and easily eroded or where other favorable conditions exist, fairly extensive alluvial flood-plains have developed. Notable deposits of this nature occur as bars at varying intervals along the Rogue river from Mule creek to the ocean. Good illustrations of these exist at Big Bend, about six miles up the river from Illahe, and at the mouth of the Illinois river. Others are found at the Fry ranch on the Illinois river, at Collier Bar, a flat covering several acres along the Illinois river a short distance below the mouth of Collier creek, near the head of the south fork of Sixes river, and elsewhere. Remnants of an old bar, now converted to a very hard

1 U. S. Geol. Surv. Folio 89. pp. 2-4. 1903.

conglomerate were found several hundred feet above the present stream bed on the northern side of Bald Face creek in the southern part of the county. Most of the other bars examined were less than a hundred feet above the valley bottoms.

Alluvial deposits, some of which cover large areas, occur along the coast at the mouths of all the larger streams, and constitute some of the best agricultural land in the county (see fig. 8, page 16). Although extensive deposits of alluvium along the valley bottoms are the exception rather than the rule, some of this material was found in nearly all the streams visited. This formation is of considerable economic interest since it is the usual source of placer gold, which is being recovered from it at Agness on the Rogue river and at the head of Boulder creek.

Marine Sands and Gravels. Sand and gravel deposits in the form of elevated beach terraces occur at many places along the coast where the deposits are more or less indurated, and vary in thickness from a few feet to approximately 80 feet. Good exposures of this material can be seen at Gold Beach in the road-cut just south of Rogue river, also on both sides of the Chetco river near the mouth, and at intervals all along the coast (see fig. 11, page 23).

These sands and gravels are of interest because of the occasional presence of gold and platinum in them. The age of these deposits has been determined as Pleistocene by Diller.[1]

MIOCENE SYSTEM

Only two narrow strips of Miocene rocks occur in Curry county. They lie along the coast in the Port Orford quadrangle, and have been described by Diller in U. S. G. S., Folio No. 89 in the following way:

No rocks of Miocene age were found by our party in the previously unmapped portion of Curry county, and, if they ever had a

1 U. S. Geol. Surv. Folio 89, p. 3, 1903.

The Empire formation is composed chiefly of sandstone with some conglomerate and shale, and a bed of volcanic dust. * * * The strata are tilted southerly to an angle of 25 degrees, rest directly upon the Myrtle formation, and are overlain unconformably by marine sands of the coastal plain. Fossils are very abundant and, after an examination of a large number of them, Doctor W. H. Dall reports that the strata are Miocene and of the same age as the Empire formation of Coos Bay. Much of the formation has been washed away, but it probably never extended far inland along this portion of the coast. To the north, however, along Coos river and also near the Columbia, it reaches further inland.

Fig. 11. Highly inclined Eocene beds overlain by horizontal Pleistocene sands and gravels, between Pistol river and Gold Beach. (The haziness of this picture is due to fog which was blowing in from the ocean.)

more wide-spread occurrence than noted above, erosion has removed them.

EOCENE SYSTEM

The Eocene rocks comprise conglomerate, shale, and sandstone. So far as noted, the conglomerate is confined to the base, and consists of pebbles averaging an inch or more in diameter, which are rather strongly cemented together. The thickness varies from nothing to several score feet, while the dip varies from 10 to 25 degrees, and is generally to the southeast or northwest. This bed forms the east wall of the Rogue river at the mouth of Shasta Costa creek, where it rests unconformably on the steeply dipping Myrtle (Lower Cretaceous) shale exposed just below the mouth of Shasta Costa creek in the south bank of the Rogue river, as well as elsewhere in the vicinity (see fig. 12, page 24). This conglomerate is liable to be confused with the Myrtle conglomerate described later, but in general it may be said to differ therefrom in that the pebbles average larger, a much greater proportion of them consists of quartz, and the unweathered conglomerate is somewhat less thoroughly indurated; also, no fossils were found in the basal Eocene conglomerate, while some were taken from the conglomerate at the base of the Myrtle.

The shale has a bluish-black color and is interbedded with sandstone which is gray when unweathered. Both of these rocks alter on exposure to yellowish, brittle, shaly matter, and to soft, crumbly, yellowish or brownish sandstone, respectively. Bedding planes are

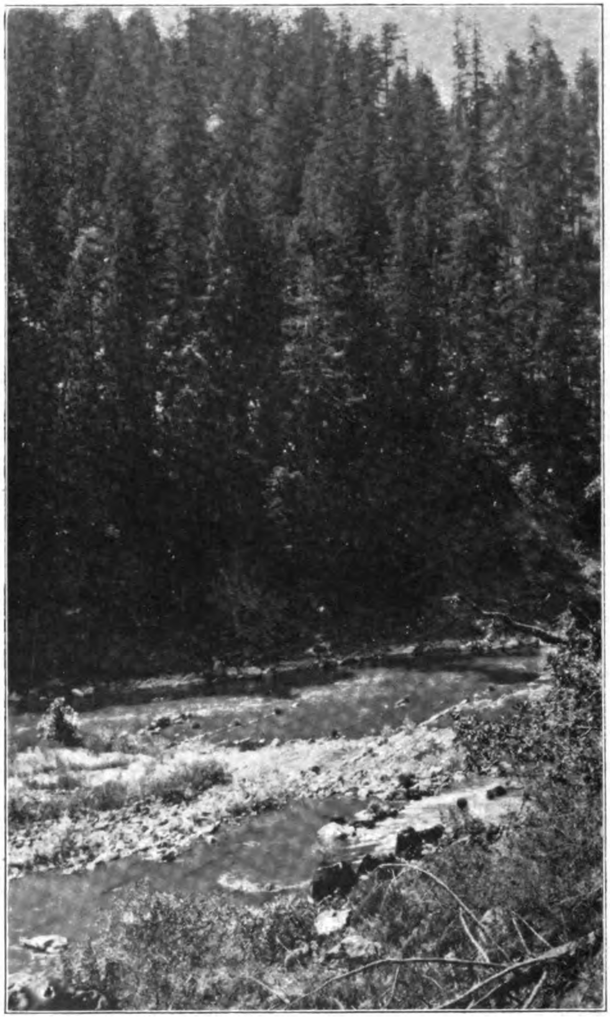

Fig. 12. Steeply inclined Myrtle beds exposed in the bed of Rogue river between Agness and Illahe

well preserved and indicate dips as high as 35 degrees, but the tilting is generally less than this.

Fine exposures of the sandstone and shale occur on Foster creek from one to two miles above its junction with Rogue river. Here the interbedded character of these two materials is marked. The beds are relatively thin, the sandstone being the thicker. The strata dip gently to the northwest, and the conglomerate appears below the shale and sandstone as the Rogue is approached. Other fine exposures occur along the Rogue river trail below Illahe where some fragments of leaves were found in the sandstone. The specimens were, however, so fragmental that their age could not be determined with certainty. They resemble closely those found in the shale and sandstone of Eden Ridge which have been classified as Eocene. These same beds outcrop very prominently on the east side of the Rogue river as well and were examined along Shasta Costa creek for a distance of over three miles from the mouth. A number of fossils were found in the sandstone along the trail up Shasta Costa creek about one hundred yards above the bridge, but they proved to have no determinative value. Large areas of Eocene rock, principally sandstone, were also found in the southwestern part of the county. These usually occur fairly close to the ocean, but along the Windchuck river the Eocene sandstone was found several miles inland.

From a body of Eocene sediments examined in the neighborhood of Eckley were secured two excellent specimens of *Venericarida planicosta*, a characteristic Eocene fossil.

The Eocene shales and sandstones are often very difficult to distinguish from the Myrtle (Lower Cretaceous) beds of the same nature unless the rocks are fossiliferous. This is especially true in the Rogue river section and south thereof. Northeast of there Diller[1] describes the Myrtle sandstone as having been generally so crushed as partially or wholly to obscure the bedding planes, and says that the shales are only local thin beds, but these features were not found elsewhere in the county, and could not be used in distinguishing the two horizons. The most distinctive characteristics of the Eocene beds were usually found to be a relatively flat dip and the complete lack of quartz veins or indications of crushing in the sandstone. The geologic position of the beds relative to an identifiable basal conglomerate was also sometimes found a useful criterion. Another peculiarity usable in the field is the usual lack of large igneous intrusions into or through the Eocene strata, while masses of such rocks commonly intersect Myrtle beds.

The Eocene system in Curry county is of special interest as it contains all the coal known to exist there. This feature will be discussed later.

1 U. S. Geol. Surv. Folio 89, p. 2, 1903.

LOWER CRETACEOUS (COMANCHEAN) SYSTEM

Rocks of this age, known as the Myrtle formation, occupy a large portion of Curry county, but due chiefly to erosion and to the presence of igneous intrusions, they are not continuous over very large areas. Like all the sedimentary formations already described, the Myrtle formation comprises conglomerate, sandstone, and shale.

Conglomerate is much more common at or near the base of the formation than elsewhere; in fact, only basal conglomerate was found during the course of the investigation. This material is relatively fine-grained, since the component pebbles average less than an inch in diameter. Notable quantities of quartz and chert are present, and these pebbles are very strongly and compactly cemented together in the unweathered conglomerate. When fresh, the rock is white with a slightly pink tinge, and when disintegrated yields many whitish pebbles about the size of marbles. These often completely cover surfaces underlain by decomposing Myrtle conglomerate, and constitute a very striking and a characteristic feature of such outcrops, as at Pebble Hill, Horse Sign butte, and Bunker Hill.

Diller states[1] that the bivalve *Aucella crassicollis* characterizes the Myrtle conglomerate in the bluffs above the Rogue river below Agness. Although considerable time was spent hunting for fossils there, none were found. In fact, no fossils were found in the Myrtle until Butte creek was reached. This is a small stream rising in Horse Sign butte and flowing into the Illinois river. There, at a point about a mile southwest of Horse Sign butte, sandy layers in the Myrtle conglomerate yielded both *Aucella crassicollis* and *Aucella piochii.* These fossils were so numerous and well preserved that it seems unlikely that an error could have been made in identifying either form, yet the former is supposed to be older than the latter, and they are not reported to occur together elsewhere.

A fine exposure of the Myrtle sandstone occurs in Butte creek near the locality mentioned in the preceding paragraph. Here the rock is a hard, massive, grayish stone containing an appreciable number of quartz and calcite veinlets. Both *Aucella crassicollis* and *Aucella piochii* are found in this sandstone, as in the neighboring conglomerate.

The difficulty of distinguishing this Myrtle sandstone from the Eocene sandstone has already been mentioned, and the peculiar fea-

1 U. S. Geol. Surv. Folio 89, p. 2. 1903.

tures of each indicated. Perhaps an even greater chance of confusion exists as regards the Myrtle and Dothan (Jurassic) sandstones, but it seems best to defer the discussion of the means used in distinguishing between these two until the later formation is described.

The Myrtle shale is nearly black in color when fresh, but weathers grayish or yellowish. It is very brittle, and sometimes somewhat slaty in structure. Good exposures occur in the fossil locality on Butte creek, but it outcrops even more prominently near the mouth of Lawson creek, on Rogue river in the vicinity of Agness, and below the Eocene conglomerate at the mouth of Shasta Cósta creek. The beds are usually thin, and alternations of shale and sandstone similar to those found in the Eocene rocks are common from lower Foster creek southward. Elsewhere in the Port Orford quadrangle the shale is comparatively inconspicuous.

JURASSIC SYSTEM

The Jurassic rocks called by Diller[1] the Dothan formation consist, so far as observed, entirely of shale, sandstone, and chert. They are found in the region from Mule creek eastward as far as this survey extended (four miles), also they are very extensively developed in the southeastern corner of the county. In general, the shale seems subordinated to the sandstone so far as quantity is concerned, but in some places the former outcrops prominently. This is true on the east side of the bridge over Mule creek on the Rogue river trail, near the mouth of Miss Latney creek, and elsewhere. In the first mentioned locality, in contact with greenstone the shale has a pronounced slaty structure, and similar effects were noted in other areas where rock now serpentine or greenstone has intruded into the shale. In a few places, as near the mouth of Miss Latney creek, the shaly structure is not very evident, and the rock has been so hardened as to form almost an argillite. Here, also, the rock contains numerous calcite veinlets (see fig. 13, p. 28). The fresh shale is black in color, but becomes somewhat grayish or brownish on weathering; and surfaces where it outcrops are often covered with numerous, small, shiny plates or flakes.

In general, it appears that the Dothan shale differs from the Myrtle shale in that it is apt to occur in thicker beds, to be harder (either slaty or argillitic), or, occasionally, to contain calcite veinlets.

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1 U. S. Geol. Surv. Bul. 546, p. 17, 1914.

The Dothan sandstone is extremely plentiful in many districts. Good exposures are found along the trail to Johnson butte via Cedar and Windy camps, and at a number of points south and west of there. This rock is also encountered on the Marial trail about two miles east of Mule creek where it occurs in fairly thick beds from which the large pieces now standing close to the trail have been broken.

The sandstone in the locality last named is very hard, and exposed surfaces have a grayish color. On fresh fractures the color is a darker shade of gray. Some fragments of black shale are present in this sandstone, but this is not characteristic of the Dothan material since the Myrtle sandstone often shows this feature also.

In the southern part of the county the color of the rock is usually gray on fresh surfaces, but brownish where exposed to the weather: and there it is frequently full of quartz veinlets. Some of this venation was noted east of Mule creek, but it is not nearly as common a feature as is the case further south. It is decidedly difficult to distinguish between hand specimens of Dothan and Myrtle sandstones. In the field, however, the following features were found to be useful criteria. First, the Dothan sandstone is apt to be more plentifully veined with quartz than is the Myrtle, although locally the latter may show as close venation as the average Dothan. Second, the Dothan sandstone is usually associated with less shale than the

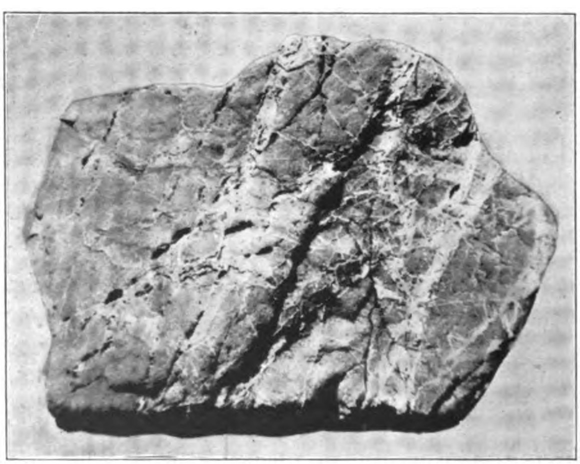

Fig. 13. Black Dothan argillite containing calcite veinlets from near the mouth of Miss Latney creek

Myrtle, especially south and east of Rogue river. Where shale does occur in the Dothan it differs from the Myrtle shale in the manner already outlined. Third, south and east of Rogue river no chert was found associated with the Myrtle sandstone, although Diller says that very thin lenses of this material are found in many places in the Myrtle formation of the Port Orford quadrangle. Fourth, no conglomerate was noted in association with the Dothan sandstone, while this rock is not uncommon in the Myrtle formation, especially near the base.

The Dothan chert is a very hard, compact, fine-grained, flinty rock of red, green, white, yellow, or intermediate tints, that is composed almost entirely of quartz. When examined under a compound microscope the chert is seen to be made up of the remains of minute organisms such as now live in the ocean. This rock occurs in lens-like masses sometimes one hundred feet or more long and a score or more of feet thick, which outcrop very prominently due to the fact that they resist weathering better than the adjacent rocks. Splendid illustrations of this material occur at the so-called Marble Ledge a mile east of Marial, on the ridge west of Cedar camp, and elsewhere. This Dothan chert differs from the Myrtle chert occurring north

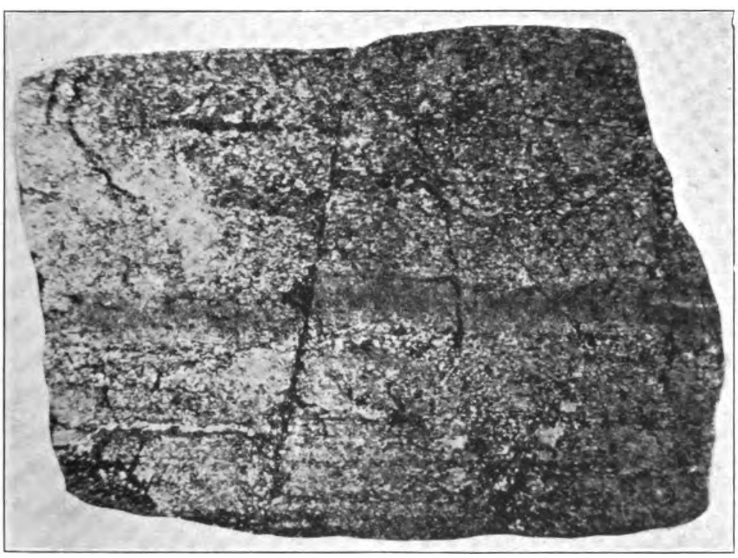

Fig. 14. Dothan sandstone showing a small fault, from the ridge east of Sugar Loaf mountain

of Elk river as described[1] by Diller in that it occurs in very large masses instead of in thin layers interbanded with other materials. The writer had no opportunity to examine these so-called Myrtle cherts, however, and cannot forbear suggesting the possibility that they are of Dothan age and that this may also be true of other portions of the Myrtle formations as mapped in the Port Orford quadrangle, a possibility which Diller himself suggests.[2]

The age of the Dothan formation has been placed by Diller[3] as Jurassic, and it is believed that it lies at about the same horizon as do the Mariposa slates of the California Mother Lode region. Diller recognizes two formations, the Dothan and the Galice, of the same age, which are separated by a mass of igneous rocks, but it was impossible to extend this two-fold classification to the region under consideration.

IGNEOUS ROCKS

Greenstone. The term greenstone as here used covers a rather extensive and varied series of rocks occurring usually, if not always, as intrusive masses. It seems almost certain that in a given area they are differentiation products of a single rock magma. By differentiation is meant the development of two or more kinds of material, differing more or less from each other, in a magma reservoir originally filled, perhaps, with homogeneous molten matter. The cause of this segregation of more or less unlike matter in different portions of the reservoir cannot be discussed here, but it is evident that, the process once having taken place, molten material issuing from different parts of the reservoir, or from the same part at different periods, may solidify as rocks of unlike, although in some respects allied, character.

In general, the greenstones are fine-grained. In fact it is customary to confine the use of this term to rocks so fine-grained that their constituents cannot be recognized without the use of thin sections. However, in this report, as well as in Diller's[3] covering adjacent areas, the term has been extended so as to include rocks of fairly coarse grain to which other terms might probably be ascribed. This was done because of the small size of many of the masses, and the frequent variation in texture found in large masses. These features make it impossible to map the igneous rocks under more

1 U. S. Geol. Surv. Folio 89, p. 2, 1903.
2 Idem.
3 U. S. Geol. Surv. Bul. 546, p. 17. 1914.

specific names unless this can be done on a very large scale map and after detailed investigation. In Diller's report on the Port Orford quadrangle, the rock here designated greenstone is called gabbro.

As the term is commonly employed, greenstone refers, as is to be expected, to a rock with a greenish tinge due to the presence of chlorite or other greenish constituents; but the varieties herein included under this term vary from black to almost white in color. The species grouped under the name greenstone in this report include, then, diorite, gabbro, porphyrite, diabase, basalt, and perhaps others.

A large and important body of this rock occurs in the Mule creek district between Dothan shale and serpentine on the east, and Myrtle sandstone and serpentine on the west. An idealized section through this mass is shown in Figure 15, the material now exposed

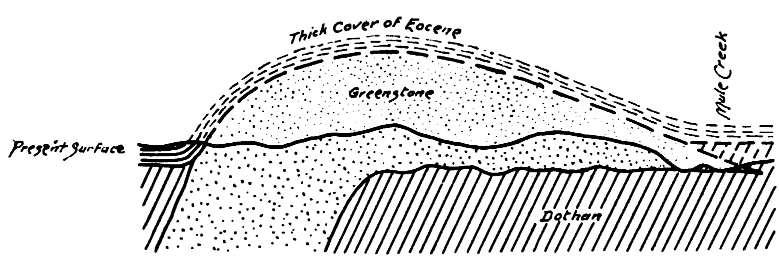

Fig. 15. Suggested section (idealized) through the greenstone intrusion west of Mule creek

being shown by solid lines, while the probable original conditions are indicated by broken lines. An intrusion of this type is known as a laccolith. Near the boundaries of this mass of greenstone, the material cooled rapidly and is fine-grained; while the rate of cooling in the interior was slower and this resulted in the formation of decidedly coarse-grained rocks. In some places, notably on the trail to the upper workings of the Mule mountain group of claims, the rock has been squeezed while still plastic and shows a decided gneissoid or layered structure. This large mass of greenstone is of especial interest because of the presence of gold-bearing quartz veins in it. Many other areas of greenstone occur in the county, as is indicated on Fig. 1. The common presence of gold veins in this rock in the Mule creek region and in Jackson county suggest the advisability of prospecting all such areas with care.

The age of the greenstone is certainly later than Lower Creta-

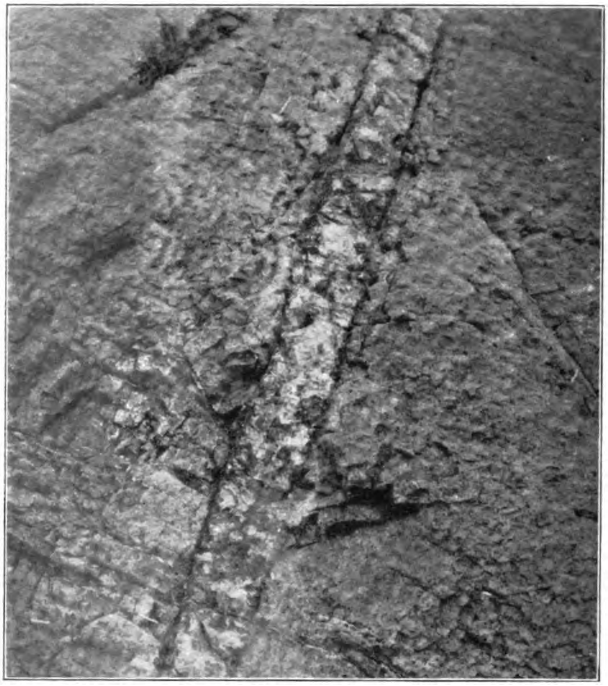

Fig 16. Ten-inch vein of platy enstatite in peridotite on ridge west of Collier creek

ceous, for it was found cutting the lower beds of the Myrtle formation two miles east of Horse Sign butte, and elsewhere.

Peridotite. Peridotite is a rather heavy, coarse-grained rock composed chiefly of olivine and pyroxene. In some places the former may be almost entirely lacking, and then the rock may, with greater propriety, be called pyroxenite. Occasionally some hornblende is present, and grains of chromite and magnetite are usually visible. The pyroxene is commonly either diallage or the orthorhombic variety known as bronzite or enstatite. It weathers much more slowly than the rest of the rock and occurs as scattered, dark-brown grains with a platy structure, which project from a lighter brown matrix. This makes the weathered surface very rough, and such material is known locally as "buck skin" rock. In some specimens of similar appearance, the projecting grains are made up of olivine instead of pyroxene. When freshly broken, these have a greenish color, an oily lustre, and are not platy in structure. This last described variety is also called "buck skin" rock. It is really peridotite or peridotite-porphyry, while the type first described should be called, at least in many cases, pyroxenite or pyroxenite-porphyry.

Exposures of the "buck skin" rock are numerous in many parts of the county and are especially plentiful in the serpentine areas later mentioned. So common is this material, in fact, that it is difficult to select any one exposure as especially typical, but splendid illustrations of the features described are found all over the ridge between Smith river and Bald Face creek in the southern part of the county.

In some places the pyroxenite is cut by numerous veins of practically pure platy enstatite. These are usually only a fraction of an inch wide, but occasionally reach a thickness of as much as eight or ten inches. Figure 16 shows a good illustration of such a vein on the ridge west of Collier creek. The age of these rocks, so far as can be determined, is the same as that of the greenstone previously discussed.

Dacite-Porphyry. This rock occurs, so far as noted, invariably in dikes, and is decidedly porphyritic, that is, it contains numerous fairly large and well formed crystals imbedded in a much finer grained groundmass. In this case, the crystals are mostly white plagioclase feldspar, although the hexagonal outlines of a few glassy quartz crystals are usually visible in a hand specimen. The groundmass is compact, of white or grayish color, and is so fine-grained that the constituents are unrecognizable with the unaided eye.

The largest outcrop of this rock noted occurs near the head of Rock creek in Coos county, near John R. Smith's property. Here, however, the porphyritic character is not nearly so plainly developed as elsewhere. As the dacite-porphyry is here much harder than the surrounding rock, it has more strongly resisted erosion and outcrops in masses with dimensions running up to several scores of feet. Figure 17 shows one of these outcrops.

Two typical dikes of this rock were crossed on the trail from Sourdough mountain to Bunker hill, one about a mile south of Sourdough mountain, and the other one-half a mile north of Bunker hill. Another such dike or sill lies below the Myrtle conglomerate on the north side of Pebble hill. Several dikes of this material occur in the Collier creek district also, and Collier butte is capped with dacite-porphyry. A few other occurrences were noted, but in general

Fig. 17. Outcrop of dacite-porphyry west of Rock creek, Coos county

it may be said that this rock is considerably scarcer than the other types already described.

The dacite-porphyry is younger than the serpentine and peridotite, since the dike a mile south of Sourdough mountain intersects both of these rocks. This dike dips 70° N. W. and strikes N. 75° E.

Diorite. Diorite has the general appearance of granite, but is composed largely of plagioclase, instead of orthoclase feldspar, contains little or no visible quartz, and the prominent dark colored mineral is hornblende. The feldspar occurs in slender, lath-shaped grains which often show numerous parallel lines on fresh cleavage surfaces.

Although this is a comparatively rare rock in the area studied, good examples were found at the base of Collier butte, and in the Mule creek greenstone area; and a similar rock (called gabbro by Diller[1]) makes up most of Granite peak, a mile west of the Gold Slug placer claim on Boulder creek in the Port Orford quadrangle. This rock differs from that just described in that it contains considerable quartz visible to the unaided eye, which makes it more properly a quartz diorite. The diorite is probably of the same age as the greenstone discussed previously.

Syenite porphyry. This rock also looks considerably like granite. It contains much orthoclase feldspar and hornblende in grains of such size as to be plainly visible to the unaided eye. In fact, some of the rectangular orthoclase sections are over three-quarters of an inch long and an eighth of an inch wide. These, together with some large hornblende crystals, are imbedded in a fine-grained groundmass composed of hornblende and feldspar. This gives the rock a porphyritic texture. The lack of visible quartz is what distinguishes the syenite-porphyry from a granite or a granite-porphyry. The only occurrence of this rock noted is on Mount Emily, east of Harbor. There the rock under consideration is closely associated with a body of rhyolite. Considerable detailed field work will be required to determine the exact relation of these two species, but the impression gained in a hasty examination of the region was that the rhyolite occurs as a flow, while the syenite seems to have the form of a dike below the rhyolite flow.

Rhyolite. The rhyolite found in Curry county shows numerous, small, fairly well formed quartz crystals and a few small crystals of glassy orthoclase imbedded in an extremely fine-grained groundmass. The color varies from nearly white to gray, the last named tint being most commonly shown by weathered specimens.

Only four areas of this rock were noted, one being on Mount Emily, where the material has the appearance of a flow, as already mentioned under the discussion of syenite-porphyry. Other areas exist one mile north of Brookings, four miles north of that town, and about half way between Brookings and Pistol river along the main highway up the coast. The rock in the first of these areas is some-

1 U. S. Geol. Surv. Folio 89, 1903.

what grayer than the Mount Emily rhyolite and contains flakes of graphite. It outcrops prominently as "stacks," which appear to be the eroded remnants of a fairly large northwesterly striking dike cutting through Eocene sediments. The second area just mentioned is similar to the first, but no graphite was noted in the rock. The third occurrence appears to be more extensive than the others, but it was impossible, because of limited time, to determine the geologic relationships of this mass. On exposed surfaces it alters readily to soft white material that has been used with indifferent success as road metal on the main highway for a distance of five or six miles.

In all the occurrences described, fairly well formed doubly-terminated quartz crystals are plentiful, and the existence of other points of resemblance leaves no room for doubt that the rock is the same in all the areas mentioned, even though they are somewhat widely separated.

The fact that the rhyolite is found cutting Eocene sediments in at least two localities along the coast makes it possible to fix its age as post-Eocene.

Basalt. A dark colored, fine-grained, unaltered rock was found along the trail from Frank Berry's cabin to Horse Sign butte. It occurs as a dike, and was classified in the field as basalt. The later examination of a thin section showed it to be composed chiefly of plagioclase feldspar and pyroxene, proving the correctness of the field classification. Other occurrences of this kind of rock in the northern part of the county are mentioned by Diller who states[1] that it becomes more and more numerous as the northern boundary of the county is approached, and that there the outcrops from "stack-like" ledges rising considerably above the general level. He also says that the mode of occurrence strongly suggests that these rock stacks are volcanic necks connected with larger masses of gabbro below. The age of the basalt is probably the same as that of the greenstone already discussed.

METAMORPHIC ROCKS

Colebrooke schist. This rock is fine-grained and has a decidedly schistose or platy structure. Muscovite (white mica) and quartz are the most plentiful constituents, and in most localities the material is a typical quartz-mica schist. Frequently, quantities of very fine-grained white mica (sericite) are present, giving the parting sur-

1 U. S. Geol. Surv. Folio 89, p. 4, 1903.

faces a silky appearance. In some sections subordinate amounts of rock of a more or less slaty character are interbedded with the mica schist, but this is more plentiful in the northern than in the southern half of the county. Everywhere the formation is decidedly folded and is often crumpled or contorted; and it has not infrequently been subjected to considerable crushing. Numerous small quartz veins are present in some localities, although these are totally lacking in others.

The largest area covered by this rock extends from Mussel creek on the west and Lake of the Woods on the east southward to the vicinity of Pyramid peak, and has somewhat the shape of a triangle with the angles at each of the three points mentioned. Another occurrence of considerable size surrounds White and Summit mountains in the northern part of the county, while several small outcrops are found between the last mentioned area and Mussel creek. Splendid exposures are shown along the Rogue river from the mouth of Lobster creek eastward for about twelve miles, and on Wake-Up-Riley ridge. In the last named locality the formation appears first as slaty material about one-half mile south of Seven Mile peak, but this soon gives place to the quartz-mica schist already described.

Although there are evidences that the material forming the Colebrooke schist was originally largely or entirely of sedimentary character, no fossils have been found therein, so its age is more or less uncertain. It is certainly unconformable with the Jurassic (Dothan) rocks which overlie it, so it is at least pre-Jurassic. It may be pre-Devonian.[1]

Craggy gneiss. West Craggy is made up of a metamorphic rock which is different from any other found in the southern part of the county. Diller has described a similar rock under the name of amphibole schist as occurring in small masses in the northern part of the county, and states that they are more numerous north of the Sixes river than south thereof. He considers this material to be a metamorphosed phase of the Myrtle formation, and a description of these masses has been incorporated in the discussion of the Myrtle formation included in this report. As the writer had no opportunity to examine these northern exposures, he is uncertain whether they are identical with what is here designated the Craggy gneiss. The published descriptions vary, however, in several particulars from

1 U. S. Geol. Surv. Folio 89, pp. 1 and 2, 1903.

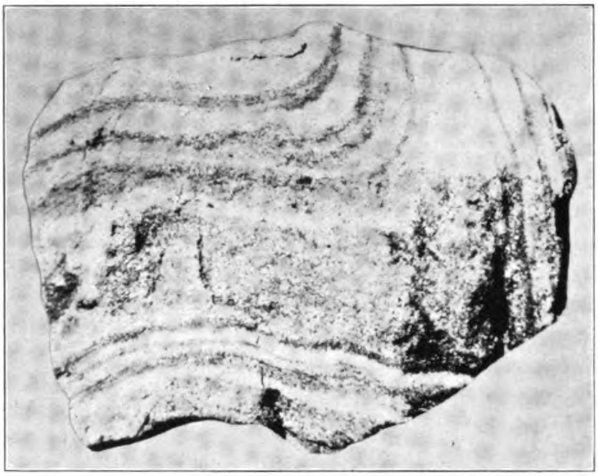

Fig. 18.—Specimen from west Craggy peak showing folding in craggy gneiss. (Dark material is largely hornblende, while the white is orthoclase and quartz)

those applicable to the southern area, so it seems best to give the material in the southern district the name herein used.

The Craggy gneiss consists chiefly of hornblende, feldspar, and quartz, with minor quantities of biotite (black mica). A very little epidote was noted in one or two places, but there seems to be much less of this mineral present than is the case in the amphibole schist masses further north. Another point distinguishing the rocks in the northern and southern areas is the lack of actinolite, glaucophane, and garnet in the southern district. At least, these three minerals are not present there in sufficient quantities to be recognized without the use of a compound microscope.

The Craggy gneiss has a decidedly schistose structure, that is, it is made up of layers of the different constituent minerals. In some places the bands of light and dark minerals are drawn around white, eye-like aggregates of quartz and feldspar, giving to the rock a spotted appearance. Such a rock is called augen gneiss. The Craggy gneiss has not generally been subjected to the folding commonly shown by the Colebrooke schist, and close crumpling is absent. Some evidences of folding are present, however, and this is illustrated in Fig. 18.

The time available for the study of this interesting rock was so short that no definite decision as to its origin could be reached, but it seems likely that it is a metamorphosed phase of the adjacent Dothan sandstone. If later investigation proves it to be the same as the amphibole schist found further north, this will bear out the suggestion already made that at least a portion of the material mapped as Myrtle in the Port Orford quadrangle is of Dothan age.

Serpentine. Serpentine is one of the commonest rocks exposed in Curry county, and is especially plentiful in the southeastern part, where it constitutes all, or a major portion of, whole mountain ridges and peaks. This rock is formed as a result of the alteration of peridotites and pyroxenites, and all gradations are encountered from the unaltered igneous rocks, in which all the ingredients are plainly recognizable, to homogeneous serpentine. When the alteration process has been completed, the product is a soft, soapy-feeling mass which usually breaks out in irregular fragments bounded by smoothly polished faces which frequently have a somewhat oily lustre. The color is, in the great majority of cases, some shade of green, although yellow and red tints are sometimes found, and flakes or stringers of white material are not uncommon. Where the alteration process has not been carried to completion most of the rock is apt to consist of a rather dull-lustered, compact, dark-green or nearly black substance upon which a knife-blade leaves white scratches. In this may be embedded still recognizable crystals of enstatite, diallage, or other primary constituents. In several localities the serpentine masses seem to be made up of smoothly rounded boulders imbedded in a matrix of softer material. This peculiarity is probably the result of the presence of numerous joints in the original rocks, which broke it up into more or less cubical blocks. The alteration proceeded from these joints in toward the center of the blocks, and the boulder-like masses represent kernels of still relatively unaltered material. In a few places the more massive material is traversed by veins of somewhat fibrous serpentine, but nothing was found on this trip which could properly be termed chrysotile, the most valuable variety of commercial asbestos.

The weathered slopes of hills composed of serpentine have a brick-red color due to the oxidation of the iron in the decomposing material. Vegetation is scanty on such slopes and is confined to scrub pines and short brush. Even on comparatively level tracts underlain with serpentine where there has been an opportunity for wind-blown or alluvial material to accumulate, trees other than "bull" pines are rarely found. These localities often constitute good grazing land, however.

The rock is of such a soapy, slippery nature and is so sheared that it does not stand long on steep slopes, especially after these have been saturated with water. This leads to the development of numerous landslides where streams cut through serpentine belts, and such slides form a noticeable feature of the topography in these areas (see fig. 6, p. 14). In most instances the serpentine occurs in the form of wide dikes which can sometimes be traced for many miles. In fact, it seems likely that all the occurrences of this rock have a dike-like character, although in the southeastern part of the county the masses are so wide that it would lead one to believe they are of some other form of intrusion.

As serpentine dikes are found cutting the Myrtle formation, but have not been found traversing the Eocene strata, intrusions of the rocks of which the serpentine is the alteration product must have occurred sometime toward the close of the Cretaceous period.

GOLD RESOURCES

Gold is known to occur in a number of localities in the county. The deposits are of three types, namely, veins, stream placers, and beach placers. The most important characteristic of each of these will be outlined in the order given.

VEINS

A vein is a deposit of more or less tabular shape, containing varying proportions of ore and worthless minerals (known as gangue), which have been deposited from solutions in pre-existing openings produced as the result of earth movements. The openings mentioned may take the form of a single crack or fissure, a great number of small, more or less parallel cracks, or a large number of branching, inter-lacing, non-parallel cracks. In the two cases last mentioned the broken ground usually occupies a long, narrow zone to which, after mineralization has occurred, miners commonly assign the term vein. Strictly speaking, however, in these cases a very large number of small, narrow veins are involved rather than one large one. Each of the three types of so-called veins mentioned has its own peculiarities and these will be briefly discussed.

Simple and fault fissure veins. The mineralization of a single crack or fissure in the earth's crust results in the formation of what is known as a simple fissure vein; and, if movement (faulting), of the rocks on one or both sides of the fissure has occurred parallel to the plane of the fissure, and previous to the introduction of the mineral contained therein, the deposit formed is called a fault fissure vein. Either constitutes the so-called "true fissure vein" so popular with miners. This popularity is probably due to the known fact that such deposits are usually fairly extensive both horizontally and vertically, and are not apt to be of as "pockety" a character as are many of the other types of ore deposits. The simple fissure veins do not average as long as do the fault fissure veins, but their width is more uniform. In fact, fault fissures are frequently characterized by the presence of more or less numerous wide portions known as "swells" separated from each other by very narrow stringers called "pinches." Such veins may be distinguished by the presence of soft clay or talc-like gouge along one or both walls; by the presence of more or less polished and grooved walls which are said to be slickensided; or by evidences of considerable crushing of the wall rocks. Faulting parallel to the plane of the vein not infrequently occurs after the deposition of the mineral, in which case slickensiding, gouge, or crushed material may be formed within the vein itself.

The walls of simple or fault fissure veins are usually sharply defined, and may contain little or no valuable material even though the vein itself is rich. Sometimes, however, the mineralizing solutions penetrate the wall rocks and impregnate them with valuable minerals or even cause them to be dissolved and replaced by ore. In such cases, there may be a gradual transition from high grade vein matter to valueless wall rock. Off-shooting stringers from either type of vein are not uncommon, but are probably more numerous in the case of the second type mentioned.

Persistence of simple and fault fissure veins at depth. The features exhibited by the simple and fault fissure veins examined in Curry county are such as lead to the belief that they were formed at considerable, although not abysmal, depths; that, in other words, the outcrops now found were originally covered by several thousand feet of earth material subsequently removed by erosion. Such deposits are apt to be persistent with depth, that is, there is no reason to expect that ore-shoots will become much less numerous or valuable with deep development than they are near the surface, but below the ground-water level. That there has been abundant time for the removal of enormous quantities of the rocks containing the original upper portions of the veins will be appreciated when it is known that the majority of the fissure veins were probably formed at the close of the Jurassic or the beginning of the Cretaceous period.

Oxidation of outcrops. Prospectors should not expect to find that the mineral filling of veins is the same at the outcrops as at greater depths unless erosion is taking place very rapidly. The portion of a vein above ground-water level is usually quite different in appearance, and often in value, from that below the ground-water. This is due to the fact that most sulphides are readily attacked by the constituents of the atmosphere and are converted to oxides, carbonates, or, less commonly, silicates. Since iron or copper-iron sulphides are the commonest in many veins, and since these are readily converted into limonite (yellow or brown hydrous oxide of iron) on exposure to atmosphere ingredients, it follows that the outcrops of many veins are notably stained with iron-oxide and have a rusty appearance.

Secondary enrichment. Sometimes the reactions accompanying the oxidation process just discussed result in the total or partial leaching out of one or more metals, leaving the outcrop more or less barren of elements which constituted a considerable portion of the original vein. This is especially apt to occur in the cases of copper and zinc. Occasionally the metals thus leached from the outcrop are carried downward and deposited at or near the ground-water level. This process is known as secondary enrichment, and results in the formation of a mass of very high-grade ore between the leached outcrop and the lower grade, primary ore beneath.

It is the fact that such high-grade deposits have not infrequently been located comparatively close to the surface beneath low-grade outcrops, that has lead many prospectors to believe that ore always gets richer with depth. After finding such an inrichment they have trouble with water, and usually dispose of their prospects to operating companies financially able to take care of the water. They are then unfamiliar with the future history of the property and never learn that beneath the enrichment the low-grade ore is again encountered.

In view of the facts just outlined, and of the presence of numerous leached, iron-stained vein outcrops in Curry county, it becomes important to discuss the probability of the occurrence of secondary enrichments there.

As regards gold, it can be said that in practically every case the oxidizing of the vein, while resulting in the removal of some of the ingredients leaves the gold unattacked, so the oxidized outcrop is often richer than was the original vein. Not only is the ore there of higher grade, but it is wholly or partially free from sulphides. It is then said to constitute "free milling" ore, and the gold is much more cheaply recovered than when enclosed in sulphides.

When decomposing sulphides and oxides of manganese occur in a gold-bearing vein free from calcite, the gold may be taken into solution, carried downward, and precipitated as an enrichment near the ground-water level. Such conditions were noted in no vein in Curry county, however.

It is, of course, true that irregular shoots of high-grade ore are apt to occur anywhere in a vein, but these are usually even more numerous horizontally than vertically; so an outcrop exposed for a considerable distance yet containing no gold ore worth mining, is hardly worth investigation below. Before leaving the subject of fissure veins it should be pointed out that not all of those in Curry county are gold-bearing. Some seem absolutely barren, while others contain metals other than gold, and will be discussed under the proper head later.

Shear-zones. Strictly speaking a shear-zone is a more or less tabular mass of earth material traversed by numerous, small, closely spaced, approximately parallel cracks, but miners use the same term for the ore body formed when such cracks have been filled with ore and gangue minerals. Not infrequently, one or more simple or fault fissure veins are included within such shear-zones, and these partake of all the peculiarities of such veins already discussed. Shear-zones are in general more pockety than simple or fault fissure veins, but average considerably wider, and sometimes reach thicknesses measurable in tens of feet.

The filling of such a zone is usually largely country rock, but sometimes the solutions which have caused the formation of the accompanying veinlets have impregnated or replaced this rock so that the whole zone is made up of ore. When this is not the case, some form of concentration is usually necessary in order to separate the valuable material in the veinlets from the gangue and the accompanying worthless rock.

Some shear zones have sharply defined walls, which are usually plainly fault surfaces, while, in other cases, the little cracks become less and less numerous as the side of the deposit is approached, and finally disappear altogether. Shear-zones frequently contain more or less slickensiding and gouge, which indicates that they commonly mark the location of fault movements. Whether faulting results in one clean-cut fissure or in a number of closely spaced cracks is probably dependent both upon the depth and the nature of the rocks involved.

While most of the shear-zones observed in Curry county traverse the country rocks without apparent regard to their structure or position, it has been noted elsewhere that they are especially common in dikes of igneous rocks and parallel to the walls thereof.

Persistence of shear-zones at depth. It is likely that, other conditions being equal, a fault in earth material is more apt to take the form of a shear-zone when comparatively near the surface than when occurring at considerable depths; and a relatively rapid decrease of the grade of the ore contained therein is to be expected when the upper portions of such zones are still uneroded, as appears to be the case on Mount Emily. That shear-zones do, however, extend to considerable depths is indisputable. In such cases the ore minerals present are apt to be confined largely to pyrite and, less frequently, chalcopyrite, which may or may not be gold-bearing. The grade of such deposits may be expected to persist with little change to considerable depths.

All that has been said previously regarding oxidation of outcrops and secondary enrichments of fissure veins applies in equal degree to shear-zones.

Stringer lodes. A zone of shattered rock cemented together by a network of small, non-parallel veins is called a stringer lode or a stringer lead. The fragments of country rock involved usually lie with their greatest dimensions parallel to the plane of the zone or lode, but are still so thick and irregular that the veinlets between them depart too far from parallelism to make it possible to call the deposit a shear-zone. In case the fragments are extremely irregular in shape, and are not oriented in any definite fashion relative to the trend of the shattered zone, we have the conditions which lead to the formation of brecciated veins, after mineralization has taken place.

All that has been said relative to oxidation of outcrops and secondary enrichment of fissure veins applies with equal truth to stringer lodes and brecciated veins.

Source of the gold-bearing solutions. It appears highly probable that the gold now contained in the various types of veins already discussed was deposited in its present position from solutions that have worked upward from unknown, though doubtless great, depths. The frequent association of igneous rocks with such veins suggests that they may be genetically related. It is likely, indeed, that both the mineralizing solutions and the molten magma (which formed igneous rocks after solidification) came from a common source, and that the former are either the result of the process of differentiation already described, or else they represent gases and vapors expelled from magmas during solidification.

STREAM PLACERS

A placer is a deposit of rock waste, composed either of angular or rounded fragments, which contains grains or nuggets of valuable substances that were deposited contemporaneously with the material surrounding them; and stream placers are such deposits which have accumulated along the banks of, or as bars in, creeks or rivers.

Nature of the deposits and source of the valuable contents. Such deposits will naturally vary greatly, not only in thickness and extent, but also in the nature of the waste material of which it is composed, and the distribution and quantity of the valuable material contained therein. In general, however, since the contents represent waste derived by erosion from the sides and head of the stream valley, it is possible, unless erosion has removed all traces of such outcrops, to find the source of all the materials present in a placer at some point in the surrounding valley. This statement applies with equal truth to both valueless rocks and valuable minerals. It is not always possible, however, to trace a valuable constituent, such as gold, back to its source, for the reason that it may not have come from a single vein or group of large veins. In fact, it seems to be often true that in southern Oregon the source of the placer-gold is frequently the tiny veinlets of the Colebrooke, Dothan, or Myrtle formations, which are not themselves worthy of exploitation. The gold may, in other cases, have been distributed originally in small quantities in the sediments themselves, where it may still exist in amounts too small to attract attention. Some idea of the distance which the placer gold has come may be derived from its appearance. If smoothly rounded or flattened, it has probably come a long way; while if rough and angular with projecting points and indications of crystallization, its source is likely to be near at hand. If coarse, it may be expected that the gold in the source will be visible to the naked eye; while, if very fine, it may be almost or quite invisible when in its original position. It should be remembered, however, that coarse placer gold does not always indicate that the gold at its source will be also coarse, for it has been repeatedly proven that some placer gold particles grow by precipitation from solution after deposition in the placer itself.

The great weight of gold, as well as of other valuable minerals frequently found in placer deposits, gives them a tendency to work to the bottom of the bed, and such deposits are frequently, although not always, richest along the bed-rock. Sometimes, where impervious layers exist above bed-rock, the valuable material may be concentrated on top of these, which then constitute false bedrocks.

Placers of the first cycle of erosion. Diller recognizes[1] three cycles of erosion each of which was marked by the formation of placer deposits. The first of these resulted in the formation of the Klamath peneplain already mentioned (see p. 11). Streams flowing across this surface deposited placers which were probably once numerous and extensive, but which have now, in most cases, been completely carried away, and the constituents deposited elsewhere. The few remaining examples of such placers are said to belong to the first cycle of erosion, and are represented in Curry county by those in Gold Basin.

Placers of the second cycle of erosion. Following the uplift of the Klamath peneplain, the streams started to wear their channels deeper; and broad, gently sloping valleys developed on both sides. This constituted the second cycle of erosion, and the resulting placer deposits differ in no way from those first mentioned except that they lie well down toward the bases of the mountain slopes. No undoubted examples of such placers were found in Curry county, although they are known to exist in Josephine county to the east.

Placers of the third cycle of erosion. Another uplift of the region followed the second cycle of erosion, and the rejuvenated streams cut steep-walled valleys or gorges in the bottoms of the broad valleys previously eroded. Some localities show indications of still a fourth uplift and period of gorge or valley making, but no attempt has been made to distinguish between the placers resulting from the

1 U. S. Geol. Surv. Bul. 546, pp. 95, 97-98 and 102, 1914.

Fig. 19. Panning third erosion cycle gravels on Rogue river

two last mentioned cycles. Both together are considered as belonging to the third cycle of erosion. Although these are probably less extensive than those originally formed during either of the two earlier cycles, they have not been subjected to degradational agencies for so long a period, so are comparatively common and extensive, and constitute the most important placers in the county. They are closely related to all the modern streams, along which they formed terraces or bars. The highest beds lie about 500 feet above the present stream levels, but those extensively mined are usually within 100 feet of the water. The bars, of course, lie under the streams themselves, at least during times of high water. Although the gravel and sand deposits in or along most of the streams in the county probably contain more or less gold, the most important deposits are along Rogue river, Sixes river, and Boulder creek. Similar important deposits lie along Rock and Johnson creeks in Coos county, not far from the Curry county boundary.

Further descriptive matter relating to the placer deposits of Curry county will be found in the discussion of the individual placer mines on later pages.

Gold-bearing nature of the Cretaceous conglomerate. It is deserving of mention that south and west of Curry county the Cretaceous (Myrtle?) conglomerate has been found[1] to be gold-bearing, and in some places it has been proven to be quite rich. Not only has this conglomerate been mined by placer methods where disintegrated by exposure to the atmosphere, but it has also doubtless furnished some of the gold now present in placers of the third and, possibly, second cycles of erosion. In view of the richness of this conglomerate elsewhere, the numerous outcrops in Curry county should be carefully investigated.

Effect of landslides on placer operation. The very severe weather of the spring of 1890 caused numerous landslides, which in many places covered placer ground that had previously been mined with profit. Whether erosion will ever remove this material is problematic; it will certainly be many years before several such buried placers can again be worked.

BEACH PLACERS

Diller states in U. S. G. S. Folio No. 89 that:

> Gold was first discovered along the beach at Gold Beach, Port Orford, and the mouth of Whisky Run, where work was commenced in 1852; * * and work on the elevated beaches at the eastern edge of the coastal plain, the Blanco and Sixes mines, followed in 1871. The beach mines were very rich in places and were extensively mined, but within the last few years they have received little attention.

The last successful attempt on any considerable scale to catch the gold on copper plates was made by Mr. Ed. Yates near Gold Beach about thirty-nine years ago. Some sixteen or seventeen years later, San Francisco people installed a "gold machine" near Gold Beach. They intended to fill the hopper by means of horse-drawn scrapers, but tried out their apparatus with material delivered from wheel-

1 U. S. Geol. Surv. Bul. 546, pp. 88-95, 1914.

Fig. 20.—Camp on the beach at the Lone ranch, 5½ miles north of Brookings

barrows; and, as the sand never came out of the machine, the operators at once left for San Francisco "to get more machinery with which to improve the machine." They never returned, and the boilers and other equipment on the beach were sold on attachments.

Seven years ago Mr. W. H. Williamson of Gold Beach, and associates, made a serious attempt to save the gold by concentrating it on tables and cyaniding the concentrates. Mr. Williamson is convinced that the failure of this process was due to the dishonesty of an employee, who, he believes, precipitated and cleaned up the values at night, and left camp suddenly with the proceeds. Mr. Williamson states that by the process of concentration used, they lost 56 per cent of the values in the sand, but succeeded in gathering 182 tons of concentrates which averaged $4.40 per ton.

During the summer of 1914 a number of attempts were made to use the centrifugal concentrating machines manufactured by Sweet Bros., of Marshfield. This machine is designed to save both gold and platinum values. Experience has shown that it does good work when the conditions are favorable. Attempts to use the apparatus along the Curry county coast met with little success, however, due apparently to no fault of the machine. Efforts to work the beach near Cape Blanco proved unsuccessful because the wind blew so strongly and continuously that pits dug to the pay-streaks could not be kept open. During the comparatively short time that the machine was in actual operation, considerable amounts of both gold and platinum were saved, however. Another attempt to use this machine about three miles north of Brookings met with negative success due, apparently, solely to the fact that the sand was not of pay grade at that point. Careful panning of the tailings revealed only one or two minute colors of gold and no platinum. It is reported that parties operating the machine a short distance south of the Oregon-California line cleaned up several thousand dollars during the same season.

Diller reports[1] that the Eccleston tension concentrator was used with apparent success on the Meeks mine, near Port Orford, as well as in the Bandon region. At the time of the examination upon which this report is based, the use of this apparatus had apparently been abandoned along the Curry county coast. Canvas or burlap covered tables have been much used for the recovery of the gold and platinum present in the beach sand. Although they appear to have given a considerable degree of satisfaction, and are doubtless the cheapest form of apparatus that can be used, it is doubtful if the precentage of recovery is as high as could be wished.

Mr. Henry E. Wood, of Denver, Colorado, has done a great deal of work on the problem of extracting the valuable materials from the beach sands. He is so well and favorably known to mining men that some extracts from a personal letter to the writer will doubtless prove interesting. He says:

> Many years ago, after fully investigating the recovery of the platinum associated with the free gold of the Pacific coast beach deposits and also the platinum which came in the placer cleanups, I built a small mill at Grants Pass, Oregon. The plan adopted was dependent upon the use of the Wilfley table for a reconcentration of all sluice-box or other black sand concentrates we could secure. We found that there was practically no gold in the black sand particles themselves, so over 90 per cent of it was cut out and discarded, as it rarely assayed more than a trace. Our high-grade concentrate was then re-cleaned on a Wetherill magnetic separator. Frequently we found and separated other rare minerals, such as monazite, rubies, garnets, nickel, etc. Our final concentrate, containing the platinum, osmiridium, and gold, we found could be treated by a certain amalgamation process so as to separate the gold. The platinum scales were then separated at a high current from the osmiridium. * * * Mr. Gordon Land was then, and is still, associated with me. We are now trying to finance a small plant on the coast, as we have great faith that our views can all be proven to be right. Mr. Land has since developed a practical demonstration of my claims upon a ton sample from the a system of simple classification directly from the sluice-boxes. After

1 U. S. Geol. Surv. Bul. 546, p. 128, 1914.

Camp Carson mine in Oregon, Mr. Land installed the plant at that mine. I refer you to descriptions and photographs in the Engineering and Mining Journal, September, 1915. * * *

Origin and nature of the deposits. The disintegration of land surfaces under the action of atmospheric agents releases the gold, platinum, and a number of other valuable and rather unalterable substances that may be contained in the rocks and various types of ore deposits originally outcropping on such surfaces. The valuable minerals, together with other valueless materials, are washed by rain water into the beds of streams; and under favorable conditions eventually find their way into the ocean. There they may work outward and form a part of the sedimentary deposits accumulated beneath the surface of the sea; or they may be driven by the action of waves and wind up onto the beach, where the action of the waves tends to concentrate the heavier material at the highest point reached by the water. This is not so much because heavy substances are more likely to be carried there than is lighter matter, but is rather due to the fact that the lighter material is more easily washed oceanward by the water retreating down the beach. In this way a mass of mixed heavy and light sand, hurled high upon the beach by the waves, will eventually be "panned down" until little or no light material remains. A portion of the valuable contents of the beach placers may also be derived from sedimentary rocks which have been disintegrated by wave action.

As is to be expected, the particles of heavy minerals concentrated in the manner described are apt to be small. In fact, the pieces of precious metals contained therein are often so minute as to float readily on water when dry. It is in fact the "floury" condition of this gold that presents the principal difficulty in its recovery.

The material concentrated in the fashion outlined consists principally of the magnetic black oxide of iron called magnetite. In fact, the prevalence of this mineral is responsible for the term "black sand" so frequently applied to the purer deposits. When smaller proportions of this substance are present the name gray sand is often used. Many other minerals have been found along the Oregon coast, some of which have considerable value. Among these are monazite, garnet, zircon, chromite, gold, platinum, osmiridium, and other minerals of the platinum group.

The beds of black or gray sand formed in the manner just described may be as much as several miles long, but their width varies from a few score to a few hundred feet, and their thickness from less than an inch up to ten feet or more, the thickest beds being usually the widest. They are interstratified with thick or thin layers of sand usually of much lighter color, which contains little or no valuable material. In some localities several black or gray beds are present within short vertical distances of each other. In most cases, the highest values are found near the contact of a black sand layer with a relatively hard impervious bed-rock. This bed-rock may be an old erosion surface formed by the wearing down of hard sedimentary or other rocks, or it may be a layer of beach sand hardened by cementation with oxide of iron or other material.

The beach placers are not confined to the present beach, although they are certainly being formed there at the present time; but are also found in connection with the elevated beaches already mentioned (see p. 13). In such cases the beds of black or gray sand are often covered with varying, but sometimes great thicknesses of unworkable material; and such deposits must often be developed by means of adits in a fashion similar to that used when mining coal seams or flat veins. The grade of these old beach deposits is, however, not often high enough to warrant the use of such methods.

The elevated beach deposits occur up to altitudes of nearly one thousand feet above sea level, but the most profitable beds have been found to lie between one hundred and two hundred feet above the present beach.

The modern beach placers are in beds which have a gentle slope toward the water, but the dip of the black sand layers in the elevated beaches is sometimes away from the water. The amount of inclination varies, although it is usually less than 15 degrees from the horizontal.

Grade of the beach placers. Mr. W. H. Williamson, of Gold Beach, states in a letter to the writer that he is convinced that the sand upon which he operated seven years ago is worth, on an average, about $1.00 a ton in gold and platinum. He says that he has secured this information as the result of about three hundred assays, and has found that the platinum values occur principally in the four feet of sand directly above the bedrock.

Mr. A. H. Gauntlett, of Gold Beach, states that black sand running at least $10.00 a ton exists near the mouth of Hunters creek, but is buried under from ten to twelve feet of gray sand.

Mr. John R. Smith claims that a bed 12 to 14 feet thick on South Slough, in Coos county, runs from 40 cents to $13.60 a ton in the precious metals. He states that this bed lies about 60 feet above the level of the slough, and that another bed, 10 to 20 feet above the one first mentioned, is 30 inches to 7 feet thick, and runs from $3.57 to $130 a ton in gold and platinum. The second bed is covered by from 4 to 20 feet of overburden. He further claims that each of 5 samples selected from the smaller beds yielded assays of better than $70 a ton.

Mr. A. M. Collins, of Agness, states that he took some 200 samples from bore-holes, and that he was employed to do this by Mr. Henry E. Wood, of Denver, whose opinion of the commercial possibilities of the black sand deposits has already been quoted. Although no figures as to the result of Mr. Collin's work were obtainable, the fact that Mr. Wood is willing, and even anxious, to develop these deposits seems sufficient proof that the grade of the material was found to be thoroughly satisfactory.

Some additional details concerning the nature and grade of the beach placers will be found in the descriptions of the mines and prospects of Curry county, which constitutes the last section of this paper (p. 130).

COPPER RESOURCES

It has long been known that Curry county contains deposits of copper ore, and many extremely rich specimens, including chunks of native copper weighing many pounds, have found their way into collections. Little or nothing was known, however, as to the quantity available in other localities than those along the eastern border of the county, some of which were described briefly by Diller in U. S. G. S. Bul. 546. The desire to obtain information concerning the copper resources of the county was, indeed, one of the principal considerations that led to the investigation which yielded the data included in this report.

Mr. E. G. Hurt, of Agness, was interviewed upon the arrival of the party at that point. He claimed that Dr. T. R. Hines took 45 tons of copper ore from Hurt's copper properties near Collier creek, and shipped it to San Francisco in 1908. The ore is said to have been brought to Agness on pack-horses, carried to Gold Beach in small boats, and then shipped by water to San Francisco. No information concerning the outcome of this venture was obtainable as Dr. Hines was never heard from after taking out the ore. It is claimed, however, that 2,700 pounds of the ore, which happened to be left in Agness, was shipped by Mr. Ed. Miller in order to secure reimbursement for packing expenses incurred; and that it paid the cost of shipment and treatment, and yielded a net profit of $45. It is said that this ore consisted chiefly of bornite, but contained some native copper.

These reports, as well as others which reached the writers, naturally aroused considerable curiosity and interest; and led to a rather careful investigation as to the nature of the deposits from which the ore just mentioned came. As a result of this examination, as well as of work done elsewhere in the county, it can be stated that the copper deposits of Curry county are of the three types discussed in the next section.

NATURE OF THE DEPOSITS

Veins in rocks other than serpentine. Several of the veins in the Mule creek district, as well as elsewhere, contain more or less chalcopyrite and low-grade cupriferous pyrite. It is likely, however, that the copper values will prove decidedly subordinate to the gold values; and it is certain that none of these veins will ever be worked primarily as copper mines. As the characteristics of these deposits have been described in the preceding chapter, it is unnecessary to discuss them further here.

"Boulder" or float deposits. These constitute the most interesting and, probably the most important deposits of copper in Curry county, and are so unusual in many of their features as to deserve somewhat extended description. This is especially true since this type of deposits seems rarely to have been described in the scientific press. Oscar H. Hershey, has given, in the Mining and Scientific Press of March 28th, 1908, an account of seemingly almost identical deposits which occur in Del Norte and Humboldt counties, California. Although the deposits he describes seem to differ in some minor particulars from those in Curry county, there is no doubt of their essential identity. J. S. Diller[1] and G. F. Kay[2], also, have briefly described Josephine county deposits which are evidently like those under consideration.

1 U. S. Geol. Surv. Bul. 546, pp. 81-85, 1914.
2 U. S. Geol. Surv. Bul. 380, pp. 76-78, 1909.

The first peculiarity to be noted is that the deposits are confined to serpentine, or to peridotites or allied ultra-basic rocks which have been almost completely altered to serpentine. While copper deposits in such materials are not unknown they are so rare as to make this association in itself a feature of rather unusual interest.

The second point worthy of consideration is the unusual mode of occurrence of the ore, as it is found in more or less boulder-like or lenticular masses which are usually unsystematically distributed throughout the serpentine. These individual masses vary from a few ounces to several tons in weight, and commonly appear to be absolutely unconnected by stringers or anything else. The ore (described later) resists weathering to a notable degree, although exposed portions are sometimes partially converted to limonite, and often outcrops prominently so as to have the appearance of rounded fragments which have broken off from some higher deposit of great size, and have rolled down to their present position. In fact, practically all the prospectors with whom there was opportunity to talk were of the opinion that these masses are merely float, and that, when the mother lode is discovered, it will be found to be a very large and rich vein of some kind. A little investigation in the field sufficed, however, to prove conclusively that each mass of ore is in place in the serpentine. Although this rock is sometimes more or less sheared and softened around the ore bodies, the ore minerals are usually confined to the nodular masses of ore themselves. In some places these little bodies of ore are comparatively close together, while in others they are widely separated, and often there seems little or no system in their distribution or magnitude.

The third unusual feature shown by these deposits relates to the nature of the minerals found in them. These consist mainly of magnetite (magnetic oxide of iron), which is often rather coarsely crystalline. Cavities frequently show the typical octahedral crystallization of this mineral, but, in at least one locality, the crystals are cubical. Associated with magnetite, are copper minerals of various kinds of which one of the commonest is chalcocite (sulphide of copper). This mineral has an unusually high luster, is notably sectile, and differs from the ordinary type of chalcocite in that the prismatic cleavage is uncommonly distinct.

Other minerals usually present in greater or less abundance are cuprite (red oxide of copper), bornite (a sulphide of copper and iron, which has a brownish color when untarnished), and native copper which is sometimes present in nodular masses weighing several pounds. Less frequently are found malachite (green carbonate of copper), azurite (blue carbonate of copper), chrysocolla (blue silicate of copper), tenorite ? (black oxide of copper), and erythrite (pinkish hydrous arsenate of cobalt). Occasionally thin crusts or films of a bright green chromium mineral of uncertain nature are also present.

In one or two localities, notably in the McKinley group east of Gold Beach, chalcopyrite (sulphide of iron and copper) and pyrrhotite (mono-sulphide of iron) constitute the bulk of the sulphide minerals. Not infrequently chromite replaces the magnetite to varying extent.

Practically no quartz or calcite, and little or no pyrite or other minerals common in ordinary vein deposits are present. In fact, the only gangue in the ore bodies is magnetite, chromite, or one or more of the other minerals already mentioned.

Mr. Frank Berry, of Agness, who has done considerable work on this material, expressed the conviction that the copper ores are always overlain with the magnetite or chromite. It is hard to explain such an occurrence, although it is true that the relationships seen in the field seem to substantiate this theory. It may be that the magnetite or chromite originally formed a core around which the sulphide minerals were deposited, and that the relative ease with which these may be disintegrated and leached away when exposed on the surface of the ground accounts for the fact that the core of magnetite or chromite is the material usually exposed. Unfortunately, most of the ore bodies examined had been so cut up or so largely removed by mining operations as to make it impossible to prove or disprove this hypothesis without the expenditure of more time and labor than could be given to the problem.

The deposits in question seem to be more closely allied to those at Monte Catini and Libiola in Tuscany and Liguria, Italy, than to any others which have been carefully investigated. Similar deposits are reported to occur in Serbia, Cuba, and elsewhere. In all these localities, the copper ores occur principally in rounded masses and are imbedded in serpentine or other closely related rocks, but there are several notable differences of detail in the Italian districts, such as the presence of calcite, prehnite, datolite, analcite, and laumontite in the gangue, the occasional occurrence of the several sulphides in concentric inter-growths, and the presence of clay-like crushed serpentine or other basic rock immediately surrounding the masses of ore.

Authorities differ widely as to the origin of the type of deposits under consideration, although all of them seem to have placed this type under the heading "magmatic segregations." On page 45 of Weed's translation of Beck's "The Nature of Ore Deposits," it is stated that "the best authority on these formations, B. Lotti, now regards them as originally segregations," while some masses of chromite certainly originate in this way, and while fewer occurrences of magnetite appear to have been so formed, no proof can be advanced that bodies of mixed oxide and sulphide minerals, such as are those under consideration, have ever thus originated.

E. Reyer considers that the Monte Catini deposits were originally a vein of some kind which has subsequently been much faulted and broken during the swelling incident to the serpentinization of basic rocks. The fact that the masses of ore are so irregularly distributed mitigates against this theory. Several authors, including Lindgren, Hershey, and others, are inclined to the view that the ore minerals were originally distributed throughout the igneous rocks, but have been segregated in the positions now found during the changes accompanying the serpentinization of the containing rocks. Such a process is believed, confidently, to account for the presence of many masses of magnetite in serpentine, and, in all probability, also produces some of the bodies of chromite therein.

The nature of the chemical and physical conditions which would lead to such a concentration of copper, iron, and chromium minerals can hardly be suggested, but Lindgren ventures[1] the assertion that "it is probably safe to say that the present ground waters have had nothing to do with the formation of the ores." Hershey suggests[2] that "perhaps the molten rock came in contact with and absorbed rocks containing copper deposits, thus deriving an unusual copper constituent which was widely disseminated in certain portions of the peridotite and related basic rocks, but during serpentinization became segregated with the iron minerals. However, it remains an open question as to whether the segregation was connected with the solidifi-

1 Mineral Deposits, p. 411, 1913.
2 Min. and Sci. Press, Vol. 96, p. 430, 1908.

cation of the magma or with the subsequent serpentinization." The truth of his last statement must be admitted, but authorities exhibit a growing tendency to accept the segregation during serpentinization theory.

Among those who do not admit the validity of the explanation just suggested is G. F. Kay, who, in describing the Queen of Bronze and neighboring mines in the vicinity of Takilma, Josephine county, first makes the statement[1] that the ores (presumably he includes those of the boulder type) are not confined to serpentine, but are also associated with gabbro and peridotite. He then mentions chalcopyrite as the principal unoxidized ore mineral, and states that pyrite and pyrrhotite are associated with it. In this respect, the Josephine county ores evidently resemble those in the Starr (McKinley) group more closely than they do those found elsewhere in Curry county.

In discussing the origin of the Josephine county ores, Kay says:[2]

> These ore bodies are apparently the result of precipitation from mineral bearing solutions which entered the rocks after they had been fractured and fissured by earth movements. Whether these solutions were set free from cooling magmas as they solidified to form igneous rocks; or whether they were of meteoric origin it is impossible to determine. Although dikes cutting the peridotite and gabbro were not observed in the vicinity of the mine, their presence in other areas of these rocks would suggest that the solutions may have been associated with the magmas from which the dikes were formed. In places in the serpentine below the zone of oxidation, chalcopyrite with slickensided surfaces has frequently been found. The chalcopyrite appears to have been subjected to all the movements which accompanied the process of serpentinization. This indicates that the ores are older than the serpentine.

As the boulder deposit minerals examined in Curry county showed no evidences of slickensiding, or of having been subjected to movements accompanying serpentinization, and, as all of the ore of this type examined in this county is strictly confined to serpentinized material, the validity of Kay's conclusions seems open to question, at least so far as the Curry county deposits are concerned.

Shear-zones in serpentine. In most of the serpentine areas which contain the boulder-like masses of ore already described, there also occur zones of copper-impregnated serpentine, locally called veins. In these the ore minerals are confined to the joints and slips everywhere plentiful in the serpentine, but which appear to be especially numerous at the points where the copper mineralization is most pronounced.

1 U. S. Geol. Survey Bul. 380, p. 77, 1909.
2 Idem.

Surface exposures usually show no copper minerals excepting malachite (carbonate of copper) and chrysocolla (hydrous silicate of copper), but the presence of considerable limonite (hydrous oxide of iron) at some points indicates that the original minerals were sulphides of copper and iron.

The ore resulting from such impregnation as just described is very low-grade, at least where oxidized, but these deposits are of interest since they seem to be the loci of an unusually large number of boulder deposits of the type already described. While the latter are not by any means confined to such shear-zones, in some localities they are so closely connected therewith as to make it appear possible that the systematic development of these zones will expose a sufficiently large number of boulder deposits to make mining profitable.

An interesting feature of the type of deposit under consideration is their common presence parallel and in close proximity to dikes of dacite-porphyry. This suggests that the copper-bearing solutions have come directly from the dacite-porphyry after the serpentinization of the basic rocks into which they have been intruded, or that they have risen along the dacite-porphyry contact and spread into the adjacent sheared serpentine. They may have come from the same magma reservoir as did the dacite-porphyry. It has been suggested that the shear-zone deposits represent contact deposits originally of quite different types, which were later changed to their present condition as a result of the serpentinization process. The fact that the fragments of serpentine between the films of copper minerals do not themselves appear to be cupriferous, makes it appear unlikely that any considerable metamorphism has occurred after the introduction of the copper minerals; and the small size of some of the dacite-porphyry dikes mitigates against the theory that the mineralizing solutions were expelled directly from them during solidification. As some decidedly sheared zones of serpentine in the neighborhood of boulder deposits show no copper stains, and as it is difficult to understand how serpentinization could produce two such distinctly different types of deposits as the boulders and shear-zones, it seems most likely that the ore solutions have risen along the dacite-porphyry and spread into the adjacent sheared serpentine.

Economic importance of the serpentine copper deposits. Mr. O. H. Hershey, in the article previously quoted does not hesitate to state, in speaking of the boulder deposits, that "none of them is of economic importance," and, also that "the little ore bodies are not sufficiently plentiful to make it practicable to work any part of the shear-zone as a large low-grade concentrating proposition." Still later he adds when referring to the deposits in Humboldt county "my impression is that nothing of value will be ever found there; that the float boulders have been derived through the weathering of small, hard bodies of ore distributed unsystematically and at wide intervals through the serpentine. There are no seams leading to them, nothing whatever to guide explorations under-ground, and searching for a sufficient number of them to make a mine would be economically futile."

Prospectors in the southern part of Curry county state that the principal mines of the type under consideration in northern California are known as the Cleopatra, Union, and Alta; and, that these are about 6 or 7 miles south of the California-Oregon line. It was reported that they, or some of them, were quite extensively developed when copper was very high, but that, although some high-grade ore has been shipped from them, their operation has resulted in loss rather than profit.

The Curry county deposits are so similar to those in California which have proved non-profitable that it is hard to regard their future optimistically. Mr. Hershey in his description of the California deposits does not mention the presence of mineralized shear-zones connecting some of the boulder deposits, and this feature may be peculiar to Curry county. Whether the boulders connected with such zones are sufficiently numerous to make profitable mining possible is doubtful, however. The boulder ores are so rich and sometimes occur in masses of such size that attempts to find and develop them along shear-zones may be justifiable.

What is really needed is some means of locating the many boulder deposits which doubtless exist, but do not outcrop on the surface. At present there seems to be no practical method of securing such data.

It is unlikely that the copper deposits of Curry county can ever be worked profitably on anything but a comparatively small scale.

IRON RESOURCES

In the summer of 1914 considerable excitement was caused in southwestern Oregon by the report that enormous quantities of iron ore existed on Wake-Up-Riley ridge, southwest of Agness, and that one of the great Lake Superior iron mining companies stood ready to purchase claims located there as soon as they were convinced of the truth of the reports concerning the great quantity of the ore there found. The man responsible for these rumors succeeded in inducing a considerable number of people each to put up a few hundred dollars, for which he agreed to locate iron claims for them. He carried out his agreement so far as locating the claims is concerned, but it later developed that there was little or no basis for his assertions as to the interest of the Lake Superior iron mining company in the region under consideration. At the time this investigation was made his whereabouts was unknown to those interested, and considerable interest was expressed as to the value of the claims he located.

No one doubted that iron ore existed in the county, for several specimens had found their way to the State University or to the Bureau of Mines and Geology. The question at issue was, then, not the existence of iron ore, but the quantity present and the manner of occurrence.

NATURE OF THE DEPOSITS

As a result of the investigations on which this report is based, it can be stated that three distinctly different types of iron (?) deposits exist in Curry county, although but one representative of one of these was found. They may be called boulder deposits, bedded deposits, and impregnations. Each will be discussed in the order given.

Boulder deposits. The fact that magnetite is frequently found overlying the copper ores forming the so-called boulder copper deposits has already been mentioned, and in some cases, the amount of this mineral developed is considerable. It is also possible that "boulders" or lenses of magnetite unaccompanied by copper minerals occur in the serpentine. In fact, Hershey seems convinced of this, for he says: "Magnetite and chromite * * * are common throughout the serpentine areas; * * * but the association of the copper with the magnetite and chromite is comparatively rare." Whereas it is certainly true that chromite unaccompanied by copper minerals is not uncommon in the serpentine, it is an open question how much magnetite so occurs. Even if later developments show it to be comparatively plentiful it is unbelievable that any considerable iron mining industry involving the use of this ore will ever be developed. It is possible, however, that if a practical means is ever discovered for locating the boulder copper deposits which do not outcrop, considerable magnetic iron ore will be mined as a by-profit. Whether this can ever be shipped profitably will depend upon the presence of transportation facilities much superior to those now in existence.

Grade of the ore. Pure magnetite should contain 72.4 per cent iron but the highest iron percentage found in the boulder deposits is 69.23. The sample which yielded this analysis was very slightly oxidized, and this doubtless accounts for the deficiency in iron. Other samples of decidedly magnetic iron ore yielded various percentages of iron down to as low as 56.59. The last mentioned specimen was considerably oxidized and contained 2.43 per cent copper. None of the samples analyzed contained more than a trace of sulphur, phosphorus, arsenic, or titanium, so should make a very good quality of steel.

Bedded deposits. The bedded deposits occur in Colebrooke schist, and are of special interest since those on Wake-Up-Riley ridge are of this type.

As no development work has been done on these deposits with the exception of the small, open discovery cuts required for a valid location of the claims, it was found very difficult to secure convincing data as to the form and size of the ore bodies. They have the appearance of lenses in the schist, which lie parallel to the foliation. Most of them appear to be small—only a few feet thick, but in one or two cases the cuts were entirely in ore, indicating a thickness of perhaps 10 feet or more. Mr. A. M. Collins, of Agness, who assisted in the location of the claims, and who acted as guide to the party during the examination of them, states that some of the location work was done by means of a dipping needle, and that in certain localities the needle stood practically vertically over an area of as much as 50 or 60 feet long by a score or more feet wide. This suggests that some of the ore bodies existing in the district are of considerably larger size than any of those exposed in the open cuts.

The iron mineral present is mainly magnetite (magnetic oxide of iron) which is considerably finer-grained and less noticeably crystalline than the same mineral in the boulder iron ores that occur in serpentine. It sometimes has a slightly brownish appearance, possibly due to hydration. This variety is considerably softer than ordinary magnetite and occasionally shows a slightly brownish streak. Its appearance suggested the presence of psilomelane (impure hydrous oxide of manganese), and two or three fragments of the softer material yielded good bead tests for manganese when tested in the field. Two of the best looking samples, when analyzed, proved to contain respectively 28.29 per cent and 23.47 per cent iron, 12.95 and 7.30 per cent manganese, and a trace of phosphorus, but no titanium, arsenic, sulphur or copper. From these facts, it seems likely that all this ore is manganiferous.

The iron ore is in most cases perfectly transitional into the schist, becoming less and less massive and pure-looking as the edges of the bodies are approached. A few cubes of unaltered pyrite, evidently of a secondary nature, were found in some of the cuts, but most of the ore, including the samples analyzed, contains no sulphides. In one or two cases quartz streaks, parallel to the schistosity of the country rock, occur near the outside of the ore bodies; and in one cut some small, black, radiating crystals of tourmaline are associated with the quartz. The small quartz veins already noted as being common in the Colebrooke formation cut across the masses of iron ore, proving, of course, that the latter were formed before the veins.

The schists in the neighborhood of the deposits, although composed principally of muscovite mica and quartz, are quite granular, have a somewhat sandy texture, and show a slightly greenish tint in some of the cuts. This is due, doubtless, to the presence of some chlorite. They seem to dip at a rather small angle to the southeast; and this is also the direction of dip of the ore lenses or blankets.

The extent of the area over which the ore lenses are distributed is unknown, but the two cuts from which the samples analyzed were taken are both on the east side of the ridge, and are about 600 feet apart. There are several cuts on the west side of the ridge and some of these are probably at least a quarter of a mile from those first mentioned. From reputable authorities it was learned that a very large outcrop of the iron ore occurs in the first gulch southeast of Dry lake, about 7 miles southwest of the locality where the iron claims are located. An earnest effort was made to find this deposit, but no guide being procurable, the search was fruitless. The country rock all around the lake and for at least 2 miles further south is Colebrooke schist, and the presence of a large lens in that vicinity is not unlikely.

It is unknown whether other lenses exist between the outcrop unsuccessfully sought and the main iron locality.

Until more development work has been done on the deposits, it will be a difficult matter to decide with any degree of certainty as to how they originated. There seems little doubt that the enclosing rocks are largely or entirely metamorphosed sediments. This makes it impossible to consider the ores magmatic segregations. Neither have they the characteristics of the Lake Superior iron deposits, which are believed to have been leached from the surrounding rocks and concentrated in their present positions. Most authorities regard iron deposits in schistose rocks as being genetically connected with igneous rocks contained therein, that is, they consider them to be in the nature of metamorphosed contact deposits; but the absence of igneous rocks in the area under consideration makes this theory untenable in the case in question.

In view of the facts outlined, it seemed most likely that these deposits were laid down contemporaneously with the enclosing metamorphosed sediments. They may originally have been deposited as bog iron ore or glauconite, and been changed to their present condition as a result of the dynamo-metamorphism to which the whole formation was subsequently subjected. Their lenticular form is easily explained as due to the squeezing and shearing which accompanied the metamorphic processes.

While the theory just suggested seems, in the present state of our knowledge, to be the most probable one, it is recognized that subsesequent more thorough investigations may prove it erroneous. The term "bedded deposits," as applied to the iron ores in the Colebrooke schist, should then be regarded as a tentative one.

Economic importance of the bedded iron deposits. It is unlikely that any of the lenses now developed by open cuts could be mined profitably even if transportation facilities were much more favorable than they are. It is not improbable, as already stated, that larger lenses than those already located exist, and they may some time prove valuable. A careful magnetic survey of the region is needed, and, if this should indicate the presence of any considerable amount of ore, the means for transporting it would doubtless be provided, as there is a good market in the northwest for this material.

Impregnation deposits. The only iron ore found which can properly be classed as an impregnation deposit occurs on the ridge running easterly from Horse Sign butte between Horse Sign and Collier creek. The deposit in question is about 2 miles east of the butte proper, at an elevation of about 3,050 feet.

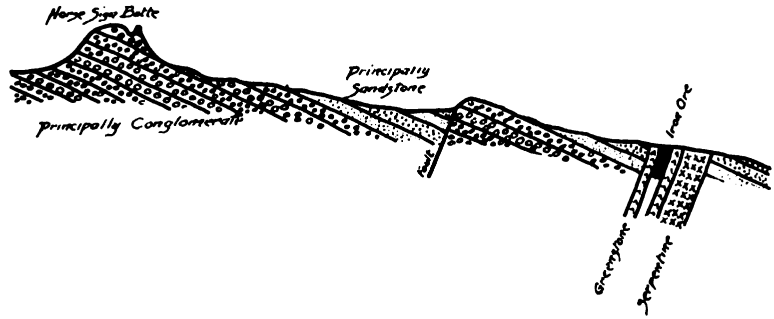

Fig. 21. Generalized section through ridge east of Horse Sign butte, showing the geologic relations of the iron ore in the Oregon prospect

Figure 21 is a generalized section of the ridge above mentioned and shows that the country rock is of Myrtle age, but is intersected by two or more dikes of igneous material, and is faulted at one point. The iron ore is magnetite, and it occurs as an impregnation in Myrtle sandstone between two greenstone dikes. The contacts of the sandstone and igneous rocks are not well exposed so it is impossible to ascertain the width of the impregnated sandstone; but little pits scattered here and there over the surface indicate that it may be as much as 50 to 100 feet wide, and that it runs for some distance down both sides of the ridge. There seems no doubt that a large body of ore could be developed here. The beds appear to strike about N. 20° E., and to dip 51° to the northwest.

The weathered ore looks like a highly jointed brown sandstone, but its great weight at once suggests the presence of metallic material; and the use of a hand-lens shows that the pores between the sand grains are completely filled with magnetite. So thoroughly impregnated is the sandstone that an average sample proved to contain 51.45 per cent of iron. Phosphorous, sulphur, titanium, arsenic and copper are entirely absent.

It seems likely that this deposit originated by deposition from solutions developed in the neighboring serpentine during the serpentinization process. Such solutions would normally have led to the formation of one or more masses of the boulder type of iron deposits in the serpentine itself, but accidentally finding their way to the border of the serpentine, they worked outward through the greenstone, and impregnated the neighboring sandstone.

Economic importance of the impregnation deposit of iron. Although the iron ore as mined would be of rather low grade, it could readily be concentrated magnetically so as materially to increase its purity. As there is almost unlimited water power at no great distance this would not be an expensive operation.

The absence of detrimental elements, the apparently large size of the ore body, and the comparative ease with which it could be mined combine to make this deposit well worthy of a careful investigation, and of exploitation if transportation difficulties can be overcome.

MISCELLANEOUS MINERAL RESOURCES

CHROMITE

Reports of the presence of chromite in Curry county have been in circulation for many years, and many fine specimens have been brought in by prospectors. It was, then, a matter of no surprise to find the mineral rather widely distributed and present in masses which were not infrequently of considerable size.

The chromite of Curry county always occurs in serpentine or basic rocks in the process of alteration to serpentine. This association is the normal one, not only in Curry county, but all over the world. In fact, workable deposits of this mineral are not known to occur in other rock.

Lindgren states[1] that "late investigations, particularly those of Vogt, have shown that chromite in large masses mainly represents purely magmatic separations in peridotite magmas." He prefaces this statement, however, by expressing the opinion that "in part the ore may have a secondary origin, being developed together with magnetite during the process of serpentinization from primary chromite, picotite, chromium-diopside, etc." It seems probable that both processes have been active in the production of the Curry county chromite deposits, for some of them occur in connection with the boulder copper deposits which were probably formed by the method last mentioned, while others are entirely free from copper ores, though in a district where the boulder copper deposits abound.

Most of the masses have more or less boulder-like or lenticular forms, but some are quite irregular in shape, and a few have the ap-

1 Mineral Deposits, p. 747, 1913.

pearance of veins in the serpentine. In size, the single masses probably average larger than do the magnetite or copper-magnetite boulder deposits. In fact, solid chunks of chromite float were found which measured, roughly, about 5 by 10 by 10 feet.

The chromite varies considerably in appearance, as in some occurrences it is very fine-grained and rather dull-lustered, while in others it is coarse and decidedly metallic in aspect. Although sometimes slightly magnetic, it is never as noticeably so as is the magnetite, and can always be distinguished from the latter by the fact that it has a brown streak or powder, whereas the magnetite streak is black. The octahedral crystallization of the mineral is sometimes apparent, although not as commonly shown as is the case with the magnetite.

Two specimens from widely separated localities were analyzed and proved to have the following compositions:

Chromic oxide 45.99 and 48.09 percent, iron 20.41 and 16.44 per cent, silica 21.33 and 19.78 per cent, alumina 2.14 and 8.12 per cent, no magnesia in either sample, and a trace of titanium in the second sample.

These analyses indicate that the ore is of fair grade so far as the chromium content is concerned, but that it is of unusual character in two particulars. The first of these is the total absence of magnesia, and the second is the unusually high percentage of silica. No effort was made to determine what effect the presence of the high percentage of silica would have upon the physical or chemical properties of the ore.

METALS OF THE PLATINUM GROUP

For many years it has been known that the stream and beach placers of southwestern Oregon not infrequently contain platinum, osmiridium (iridosmine), iridium and, sometimes, other members of the platinum group; and for a number of years that part of the state has been credited with a yearly production of a few thousand dollars' worth of these metals. In fact, southwestern Oregon has, with the exception of northern California, been the only steady producer of platinum in the United States; and it is likely that the two localities mentioned have yielded more platinum than all the rest of the country put together.

The platinum metals are, like gold, very heavy, and occur in stream and beach placers in exactly the same way as does gold. Unlike gold, however, the individual grains are practically always very small and difficult to save, so do not attract attention as quickly as does the gold. In the early days when the value of platinum was not appreciated, it, together with other rarer substances in the so-called black sand, was thrown away, and large quantities have doubtless been lost in this way. At present it is eagerly sought, however, but is always mined as a by-product in the production of placer gold.

The platinum found in Curry county has a bright metallic luster and is usually steel gray in color, although lighter tints are sometimes found, and silver white platinum is not unknown. It usually occurs in tiny scales which are malleable (can be pounded out into thin sheets) and sectile (can be cut with a knife). Some of the metal is magnetic, although this is not always the case. In fact the Curry county platinum rarely appears to be as magnetic as is the magnetite with which it is associated, and magnetic methods may frequently be used to separate the two.

The osmiridium (iridosmine) differs from the platinum in being considerably harder (will scratch glass), rather brittle, silver-white (usually) in color, and in its tendency to occur in hexagonal scales.

The iridium is as hard as the osmiridium, and, like it, is rather brittle. Fractured surfaces are, however, apt to be gray, although the color on the outside is usually silver-white with a slight yellowish tint. It is more apt to occur in angular grains than in scales.

Other members of the platinum group which may be present cannot be recognized with any degree of certainty without chemical tests.

The platinum is usually the most plentiful of the minerals just described, but Diller mentions[1] one locality on the Sixes river where osmiridium was detected without any accompanying platinum. The ratio of gold to platinum group metals varies widely in different localities. It is claimed that at the Blanco mine the ratio of these two substances is as twenty is to one, while at one Sixes river locality these two substances occur in the ratio of about seven to one. Not a few very productive gold placers contain no platinum whatever.

As to the source of the platinum, little that is definite can be stated. Diller says [2] that "where it (platinum) has been traced to its source in other regions it has been found in serpentine, and in Oregon it probably has the same association." Mr. Frank Berry, of Agness, makes the positive assertion that in each of many cases that he has investigated it has always been possible to trace the platinum back to

1 U. S. Geol. Surv. Folio 89, p. 6, 1903.
2 Idem.

a serpentine area. He also believes that all the serpentine areas in the county contain platinum. Several prospectors in Curry county described deposits of platinum in serpentine. In some cases they claimed to have found extremely thin veinlets of the metal, while in others it was stated that the serpentine when crushed and panned yielded scales of platinum. It was, however, impossible to substantiate any of these rumors. Recent investigations of the subject indicate that this metal is considerably more widely distributed, especially in connection with deposits of copper-ores than has been thought probable. It is not at all unlikely that it occurs in Curry county as a decidedly minor constituent of the boulder or other types of copper deposits in serpentine; and that considerable primary segregations of the pure metal do not exist. Prospectors should, however, always keep this metal in mind, especially when investigating the placer deposits of streams draining serpentine areas.

COAL

Coal has been found in the Eocene beds of Curry county at a number of points. The two most promising regions are in the vicinity of Eckley and near the mouth of Shasta Costa creek. Diller describes[1] the former occurrences as follows:

Within the Arago (Eocene) formation of the Eckley area coal is known only close to its base where it comes in contact with the Myrtle formation, and the most important outcrops yet found are along the southern border near the head of the Middle Fork of the Sixes, and two miles nearly west of Eckley, on the eastern slope of Sugar Loaf mountain.

Near the southern line of Sec. 14, T. 32 S., R. 13 W., a number of tunnels and open cuts have been run in various directions into a mass of coal and coaly shale that varies greatly in structure and composition. Much of it is crushed and slickensided, but other portions appear to be good coal with bright luster on fresh fractures.

A short distance further south at an elevation of over 2,000 feet above the larger mass an outcrop of coal and coaly shale similar to that already noted occurs in place, and is penetrated by a tunnel running almost directly east and parallel to the strike of the bedding. The total thickness of the coal and associated carbonaceous shale is not well exposed, but may be nearly fifty feet.

Another outcrop which has been developed is in section 35 at the eastern part of Sugar Loaf mountain, close to the contact of the Arago beds with the underlying rocks. Here the coal-bearing beds at the base of the series have a thickness of not much over fifty feet and are overlain by nearly one hundred feet of firm sandstone. The coal-bearing series are shales and soft sandstones, and contain two beds of coal, one of which is so much crushed that its thickness (said to be twenty feet) cannot be definitely measured. Near it are a few feet of sandstones and shales, and then a five-foot bed of the best looking coal seen in the

1 U. S. Geol. Surv. Folio 89, pp. 4-5, 1903.

region. * * * A number of other outcrops occur on the small streams tributary to the main stream flowing through section 35 and along the North Fork within a mile below Eckley, but the best coal cannot be identified at any other point.

The coal beds vary greatly and abruptly indicating that they are not of great extent. Aside from the difficulty of transportation it is not believed that there is sufficient coal in that country to warrant the expectation of profitable mines.

The Shasta Costa coal beds are well exposed and are on the right hand bank of Shasta Costa creek near its mouth. The material there is mostly bone and shale. In fact, no seam of pure coal over one inch wide was found. Mr. Harry Hillis claims that he has made attempts to burn this coal in camp-fires, and, that although it did burn under these conditons, the chunks retained their shape and were approximately the same size after burning as when put in the fire. Diller states[1] that

An attempt to mine the coal has not proved successful. It has a thickness of not over four to six feet, and looks on the whole to be of poor quality, but in composition it is remarkable, resembling in some respects the pitch coal, and in others the normal lignite of the Coos Bay coal field. * * * It contains a remarkably low percentage of water, and, when heated, partially fuses like pitch coal; but, like the normal lignite, it contains a larger percentage of ash and a much more nearly equal amount of volatile matter and fixed carbon. It appears to coke well, but the large amount of non-combustible ash in the coke reduces its value. Where exposed on Shasta Costa creek the coal shale has a thickness of ten feet.

The coal shale is overlain by sandstone containing Eocene fossils, while beneath it is a heavy bed of conglomerate. These strata dip gently in an easterly direction, and are underlain unconformably by highly tilted and crushed shale, and other Myrtle sediments. These last are well exposed along the bank of the Rogue river.

Coal is also reported to occur in the Eocene sediments along the coast in the southern part of the county, but the reports which reached the field party were of so indefinite and unpromising a nature that the occurrences were not investigated. It is claimed, however, that outcrops of small beds exist at several points along the north fork of the Chetco, and that Jeffries and Aikens have opened a 10-foot bed in the bluff above Thomas creek at its mouth. Still other outcrops are said to occur along the creek next north of Thomas creek.

Probable economic importance of the coal beds. From all the data available the conclusion is inevitable that known occurrences of coal in Curry county are hardly of sufficient importance to compete

1 U. S. Geol. Surv. Folio 89, p. 5, 1903.

successfully with the more extensive deposits of the Coos Bay region. As the widespread use of the cheap California crude oil has made it impossible to work many of the last mentioned beds profitably, it is unlikely that any of the Curry county deposits will prove valuable until the purer coals more plentiful elsewhere have been exhausted.

BORAX

Priceite is believed to represent a massive and not entirely pure variety of colemanite, which is the principal substance from which borax is manufactured. It is a hydrated borate of lime, that occurs in soft, loosely adherent, somewhat chalky, snow-white masses. Dana's "System of Mineralogy" speaks of it in the following terms on page 884:

> **Priceite is from Curry county Oregon, five miles north of Chetco, where it occurs in a hard, compact form in layers between a bed of slate above, the cavities and fissures of which it fills, and blue steatite below; also, it occurs in boulders or rounded masses completely imbedded in the steatite. Many of these masses weigh two hundred pounds each. Others are smaller, from twenty pounds down to small pellets the size of a pea. Named after Mr. Thomas Price, of San Francisco.**

The description of the material in the extract just quoted would seem to apply better to the variety known as pandermite than to material now commonly called priceite, since the former is firm and compact rather than friable and chalky. The question of nomenclature is not a matter of much moment, however.

The Borax mine, as it is known throughout Curry county, is on the Lone Ranch owned by Moore Brothers. It lies along the coast, 5 and one-half miles north of Brookings, and at least 8 and one-half miles northwest of the hamlet of Chetco, instead of 5 miles as stated in the paragraph quoted. The country rock containing the borax is entirely serpentine of the type common throughout Curry county. Not the slightest trace of slate or talc (steatite) was found. The serpentine is typical in every respect, and bears little superficial resemblance to the other substances mentioned.

It is claimed that considerable material was mined here many years ago and was shipped to San Francisco, but that "no one could reduce it" and that the property has lain idle since. It is reported that the Pacific Borax Company now controls the deposit. The property was evidently developed by means of a number of open cuts and short tunnels, but all of these have caved with the exception of one tunnel which is 75 or more feet long, but which was so full of water as to make an examination of the material exposed a difficult and unpleasant proceeding. A few streaks and lenses of soft, white material are present, however, and samples from these yielded reactions for boron, as did also a few badly weathered fragments picked up on the old dumps.

From the testimony of men who have worked on the property, there seems no doubt of the essential correctness of the description of the manner of occurrence given by Dana. It was utterly impossible, however, to secure any information as to the frequency with which the large boulder-like masses were encountered, but residents of the locality say they were not plentiful. Little is known of the extent of the area over which they are scattered, although one man stated that one or more similar masses were found while building a bridge across the creek a mile south of the so-called Borax mine.

So far as known, this occurrence of borax minerals is unique, and it is unfortunate that it could not have been carefully studied and described at the time the various cuts and tunnels were made. With the scanty information at hand it would be idle to attempt any explanation of the manner in which this deposit originated, but it is interesting to note that the general manner of occurrence is identical with that of the copper deposits in serpentine, namely, boulder-like masses and shear-zones.

MERCURY

Nuggets of the heavy, red mercuric sulphide (cinnabar) are occasionally found in the southwestern Oregon placer deposits, and one or two deposits of this mineral in place have been located. None of these were found during the field work in Curry county, however, and only one report of the existence of cinnabar in this county reached us. This rumor was to the effect that the mineral occurred in place north of the Moore ranch on the east side of the Chetco river, near the point where this stream changes its course from an easterly to a southerly direction. Nothing was learned concerning the nature of these deposits, as no one could be found who would guide the party to them, and no indications of their presence were seen while passing through that district.

LEAD AND ZINC

The only zinc ore found in Curry county occurs in the Florence prospect near the summit of Mount Emily, and this occurrence will be described in later pages.

No lead ores of any kind were seen, although it was reported that during the Indian wars lead ores were mined and converted near the mine into metallic lead which was used as bullets. It was further stated that a hollow stump was used as a blast-furnace in this operation, and that particles of metallic lead and slag can still be found in the vicinity. The locality where these operations were conducted could not be learned, however.

DIAMONDS

It has long been known that diamonds have occasionally been found in the placers of northern California. Kunz states[1] that they are very likely to be found in the flumes and sluices not only there, but "in the vicinity of Coos Bay in Oregon." Whether any have ever been found in Curry county could not be ascertained, but the geologic conditions there are identical with those existing in the diamond localities of northern California, and their possible presence should always be borne in mind by placer miners. Any transparent, light colored mineral of such a weight as to tend to collect in sluice-boxes should be carefully investigated, especially if it is unusually hard and occurs in octahedral or rounded crystals or grains.

The source of the diamonds found in this part of the country has never been ascertained, but many of the basic rocks existing in this region are very similar in composition to the material containing diamonds in South Africa and Arkansas. This is true of the peridotites, especially; and diamantiferous masses of these rocks may sometime be found. Whether the gems will be sufficiently plentiful therein to make the deposits profitable is a question on which it is useless to speculate.

LODE MINES AND PROSPECTS

No pretense is made of furnishing a complete directory of the lode mines and prospects of Curry county. There are doubtless many of these, some of which have considerable merit, that are not mentioned herein. Those included are the ones examined during the course of the investigation, or concerning which apparently reliable data could be secured from other sources. The various properties are numbered consecutively according to their locations, beginning in the northern and western part of the county and progressing to the southern and

1 Gems and Precious Stones of N. Amer., pp. 28-29, 1890.

eastern portion. The approximate locations of the deposits described are indicated on the map which constitutes Figure 1.

SOUTH FORK SIXES RIVER DISTRICT

The presence of workable gold placers along the south fork of Sixes river and along the main stream, especially below the forks, has lead to considerable prospecting for the lodes from which the gold came. These efforts have in the main been unsuccessful, and this has led Diller to state[1] that "the original source of the gold is in the quartz veins of the Myrtle formation." Whether he is correct in this conclusion is a matter that must remain undecided until the region has been developed to a considerably greater extent than at present. A few well defined veins not in the Myrtle formation have already been discovered, and it is not unlikely that diligent search will reveal others. The two prospects described below both lie largely or entirely within a mass of greenstone (called gabbro by Diller). Observations elsewhere in the county have shown that this rock is apt to contain veins some of which are rich, and this indicates the advisability of prospecting thoroughly the occurrences under consideration.

Lode 1. P. L. Wallis' quartz claim. This property is located on the South Fork of Sixes river between the fork and Rusty creek. It was discovered May 1st, 1915, and was being developed on August 21st, at the time the examination was made. An open cut with a 20-foot face then exposed a quartz seam varying from 1 to 4 feet in width, which was considerably iron-stained and showed no sulphide minerals. The prospect was not sampled, and no information concerning the grade of the vein matter was procurable.

Lode 2. Harrison property on Rusty butte. Diller describes[2] the deposits at this point as follows:

> Greater success has attended the efforts of prospectors on Rusty Butte, where the Harrison's and others have discovered some promising but small ore bodies, which occur partly in sedimentary but mostly in igneous rocks.
>
> The first discovery was made at St. Patrick's, nearly 1,000 feet below the summit of Rusty Butte, on the southern slope, in slaty rocks, but not far below the contact with the overlying igneous rock which has altered the slates. Both walls are of slate, and strike N. 45° E., with a dip of 65° N. W. The ore in the small irregular vein is usually quartz full of pyrite, which by its decomposition liberates the free gold, stains the rock with oxide of iron, and softens the mass. Other portions contain calcite instead of quartz, and associated with the pyrite are small quantities

1 U. S. Geol. Surv. Folio 89, p. 5. 1903.
2 U. S. Geol. Surv. Folio 89, p. 6. 1903.

of bluish-gray mineral which from its cubical cleavage is regarded as galena. Tellurium is said to be present, but a test by Dr. W. F. Hillebrand for that element in the most promising specimens the writer obtained at the mine showed no trace of it. Instead, however, Dr. Hillebrand found considerable arsenic and some lead, indicating that part of what looks like pyrite is arsenopyrite, and that the gray mineral is galena.

The Golden Fleece and other openings near the summit of Rusty Butte are wholly within igneous rock, which where best displayed is an altered gabbro composed of plagioclase feldspar and a greenish hornblende. In places near the mines the rock is decidedly porphyritic with dark crystals of augite which are changing to hornblende. Quartz is not one of the original constituents of the rook here, but it is permeated with small veinlets of quartz of secondary origin.

These minute veins are altogether irregular as to size, direction, and distribution. The deepest openings examined were at the Mountain Daisy and Golden Fleece, where the open cut and shaft reach fifteen feet into the decomposed gabbro. Small irregular cavities occur in it without order, here and there containing black to reddish-brown powdery material which is generally rich in fine gold. Much of the gold is wiry and cross-striated in various directions, as if from contact with striated quartz crystals, with which it is associated in the seams. The powdery material is a mixture of black oxide of manganese and reddish-brown oxide of iron resulting from the alteration of the pyrite.

At the face of the Golden Fleece tunnel the gabbro is rotten, with a belt of little seams nearly a foot in width. The seams are irregular, but more or less lenticular and approximately horizontal. They contain the auriferous black and red oxides of iron, but are not persistent. The crushing of the Cretaceous rocks near the close of that period was extensive, leaving a multitude of small fissures, and the fissures were filled with quartz and locally with calcite. They contain chiefly pyrite, a little galena, and perhaps some other ores which on alteration and concentration yielded the little pockets now sought for.

From the Mountain Daisy, which was discovered in 1899, 7½ ounces of gold were taken out in a very short time. The gold, containing considerable silver, is low-grade. The pay seam in this claim was nearly vertical and soon ran out below. It is pockets and seams of this character chiefly that have supplied the placer gold of the stream and beach gravels. Their small size, irregularity, and lack of persistence are not encouraging features.

ELK RIVER DISTRICT

The gravel deposits along the Elk river have not proven to be very auriferous, and Diller's map in U. S. G. S. Folio No. 89 shows no placer or quartz mines along this stream. Men who have prospected this district claim, however, that rich bars exist at certain practically inaccessible parts of the canyon below the mouth of Bald Mountain creek, and it is known that Chinese recovered a considerable amount of gold from a bar less than half a mile below the mouth of that stream.

It is noteworthy that the two prospects mentioned below are in or very close to greenstone (gabbro), as were those along the South

Fork of the Sixes river, and that no prospects in the surrounding sedimentary rocks were brought to the attention of the field party.

Lode 3. Moss Rose group (Axtell Mine). At the time the field party was in the vicinity of this property Mr. Geo. W. Axtell, the owner, was away and no one could be found to act as guide to the various prospects in the district. After considerable search, however, one of the main veins was located, and was found to consist of a series of quartz veins in greenstone, which strike N. 60° E. and dip 53° N. W. They are exposed in an open cut which reveals perhaps half a dozen veins varying in width from a foot down, and forming a mineralized zone with a total width of something over 12 feet. Faulting has occurred along both sides of this zone. The quartz veins seem to be slender over-lapping lenses, are very compact, and contain no visible ore minerals except chalcopyrite which is fairly plentiful, but is segregated in bunches here and there through the quartz. Pyrite is present in the greenstone near the quartz veins.

Samples were taken across the whole mineralized zone and of the sulphides and quartz separately. These were mailed to Corvallis, but were, unfortunately, never delivered. A sample across the whole mineralized zone was sent in subsequently by Mr. Axtell, which yielded on assaying a trace of gold and 0.4 of an ounce of silver. It is only fair to state, however, that this sample was nine-tenths country rock, and even the vein matter included was comparatively free from sulphides. It would be interesting to know how well the pure sulphides, such as could be obtained by concentration, would run.

Mr. Axtell has opened three other ledges all within 800 feet of each other, but these could not be found. At least one other group of claims has been located by other parties in the vicinity of the Moss Rose ground. Samples from these, as well as from Mr. Axtell's other unexamined claims assayed from nothing to a trace of gold.

Lode 4. Free gold claim. This property was located by Mr. C. W. Curl on June 21st, 1915, the discovery cut being almost at the water's edge on Elk river a few hundred yards below the mouth of Bald Mountain creek. At this point a vertical dike of dacite-porphyry which strikes about S. 10° W. cuts through a mass of Colebrooke schist near the contact of the latter with greenstone. It is about side. There, along the contact, it is practically pure quartz and is said 75 feet wide, and becomes more and more siliceous toward the western to have yielded ore in which free gold was visible. None of this metal was seen during the hurried examination made, and, as samples taken were lost in the mail, the grade of the material remains uncertain. It is an interesting fact that the Chinese who worked the placer already mentioned recovered gold from a bar just below this dacite-porphyry dike, but could find none above it.

MULE CREEK DISTRICT

The mines of the Mule creek district, in the northeastern corner of the county, are all in a mass of greenstone whose nature has already been discussed (see page 30).

The first work in this locality was done in 1891 by John Billings, and the son, G. W. Billings, is still mining here. Attention was first given to the placers along Rogue river, especially the one on Red river bar, half a mile below the mouth of Mule creek; but the search for the sources of the placer gold soon resulted in the discovery of a number of veins, and it is upon these that most of the work was being done at the time the examination was made.

In general, it may be said that two classes of lode deposits occur in this district. One of these takes the form of rather narrow, considerably faulted, high-grade quartz veins containing more or less free gold. Important examples of these are the Lucky Boy (Tina H), Paradise, and Big Devil's Stairs veins. While some of the deposits of this type have been profitably mined, their small size, faulted condition, and irregularly distributed values are factors which mitigate against their profitable development. The ore contained therein is sometimes so rich, however, that numerous attempts to mine them have been made, and doubtless will be made in the future, regardless of the difficulties and discouraging features already mentioned.

The second type of deposit found in the area under consideration consists of mineralized shear-zones of considerable width and of relatively low grade. Good examples of these are the so-called "Iron Dike" of the Red River Mining Company and the Excelsior vein on the south side of Rogue river. These are wider than the deposits first mentioned, and have not been subjected to much faulting, so are decidedly easier to mine. The ore is comparatively low grade, and much of it is in the form of sulphides, so the shear-zones have not received the attention that has been accorded to the small quartz veins. It is believed, however, that if mined on a sufficiently large scale, they may prove remunerative, and they certainly seem deserving of careful investigation.

Lode 5. Paradise. The Paradise mine, in which G. W. Billings owns a two-thirds interest which he purchased from J. J. Kenney in 1905, is situated on the west face of the southern peak of Saddle Mountain near the top, about six miles by trail from the mouth of Mule creek. The elevation, as determined by means of a barometer, is 3,220 feet. About one-half of the work has been done under lease and bond, and 1,000 pounds of selected ore are said to have been shipped from the property. A map of the workings and vein is given on figure 22.

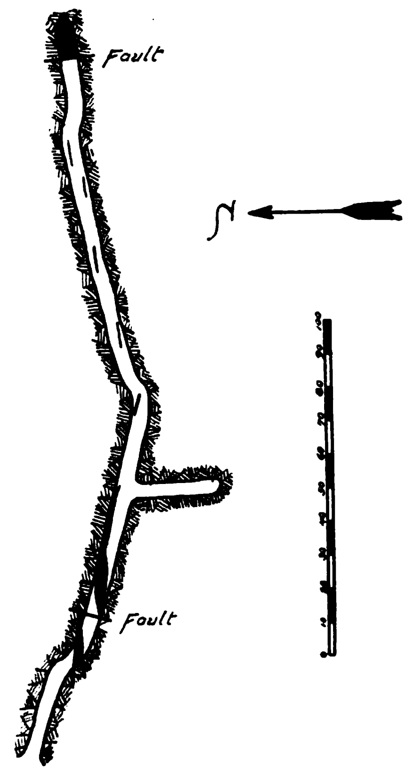

Fig. 22. Paradise workings. Vein matter shown in solid black

At the mouth of the adit no vein matter is shown, but about 34 feet from the portal ore which strikes N. 84° W. and dips 62° S. W. is seen. There it consists of 3 or 4 feet of vein matter which is mostly quartz. This pinches out along the left wall 12 feet further in; and 4 feet further toward the face, a fault perpendicular to the line of the tunnel brings the vein into the workings. Where first shown it is narrow, but gradually widens until the mineralized zone is 3 feet in width. This condition persists for about 18 feet. Then the quartz in the vein suddenly pinches out along the left wall; but 12 inches of soft sheared material is exposed for a distance of about 12 feet along that wall, after which quartz reappears in the same line as the sheared zone. This quartz vein is only 2 inches wide at first, but gradually widens to 6 inches and finally disappears 91 feet from the portal. At a point about 111 feet from the mouth a quartz vein dipping 70 degrees to the south comes in along the left wall. It varies from 2 to 8 inches in width and disappears about 119 feet from the mouth of the tunnel. Only occasional narrow stringers of quartz show for the next 80 feet, and no quartz is visible after this until a point 10 feet from the breast is reached. There a fault-plane is cut beyond which is a wide mineralized zone clear to the face. The face is entirely in vein matter, although only about one-half is quartz, and the vein at that point dips 74 degrees to the south.

The only ore mineral recognizable is free gold, although numerous unrecognizable gray stains appear in the quartz and are reported to be tellurides. A qualitative test for tellurium made upon them revealed no trace of that metal. It would be easy to select samples which would run several hundred dollars a ton, but the vein matter as mined is said to run about 10 dollars per ton.

The great irregularity of this deposit is typical of the small quartz veins of the district. Not only are they themselves fault fissure veins and are therefore subject to variations in width, but cross faulting has further magnified this irregularity, although the slips appear to be comparatively small.

Lode 6. Lucky Boy (Tina H). This property was located in 1902 or 1903 and was formerly called the Tina H. It is at present held by Charles Tucker who relocated it in 1910, the title of the former owners having been allowed to lapse. The former owners put in a two-stamp mill to which Mr. Tucker has added a cyanide plant. He owns two claims (end to end) along the main Lucky Boy vein and another north-south claim on a vein said to run under the bunkhouse. The property is located about two and one-quarter miles from the mouth of Mule creek on the west side of the west fork of that stream not far from where the trail crosses the creek. The mouth of the tunnel is at an elevation of 1,000 feet as determined by means of the aneroid barometer.

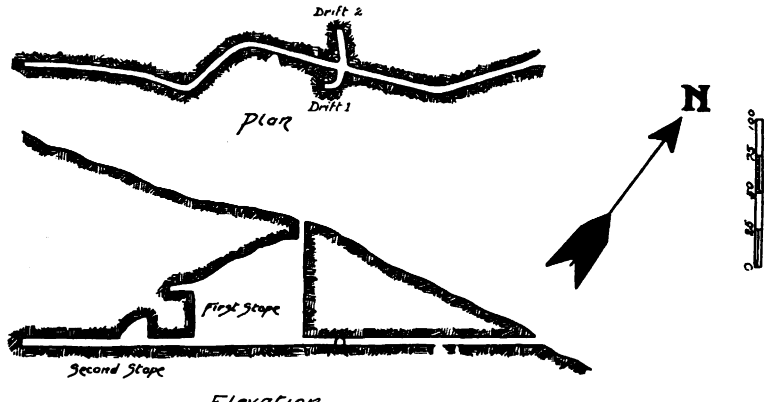

Fig. 23. Lucky Boy (Tina H.) workings

G. W. Billings is said to have taken out over $48,000 of ore from the first large stope during the time he acted as superintendent of the mine. The present owner had mined only about 30 tons at the time the examination was made, but it was his intention to start a new tunnel for the purpose of tapping the ore shoot at about 75 feet below the present workings. He tried to sink a winze on the ore-shoot but found it impossible to handle the water. Figure 23 shows a sketch map of the workings.

The tunnel was driven on a quartz vein which varies considerably in width and splits at some points into a number of stringers separated by country rock and containing more or less chloritic material. One of these stringers is usually much larger than the rest, however, and may be designated the main vein. Drift 1 follows a small offshoot from the main vein, and between the entrances of drifts 1 and 2 the vein is badly broken up and faulted to the northwest, which doubtless accounts for the opening of drift 2. One prominent fault in drift 2 is nearly vertical and strikes approximately north and south. Many other such north-south faults are shown at other points in the property. These are usually of the normal type with small slips. A few feet beyond the entrances of drifts 1 and 2 the vein is again encountered in the main tunnel, and can be followed there without difficulty until the face is reached. At that point the mineralized zone is at least 3 feet wide, but only a comparatively

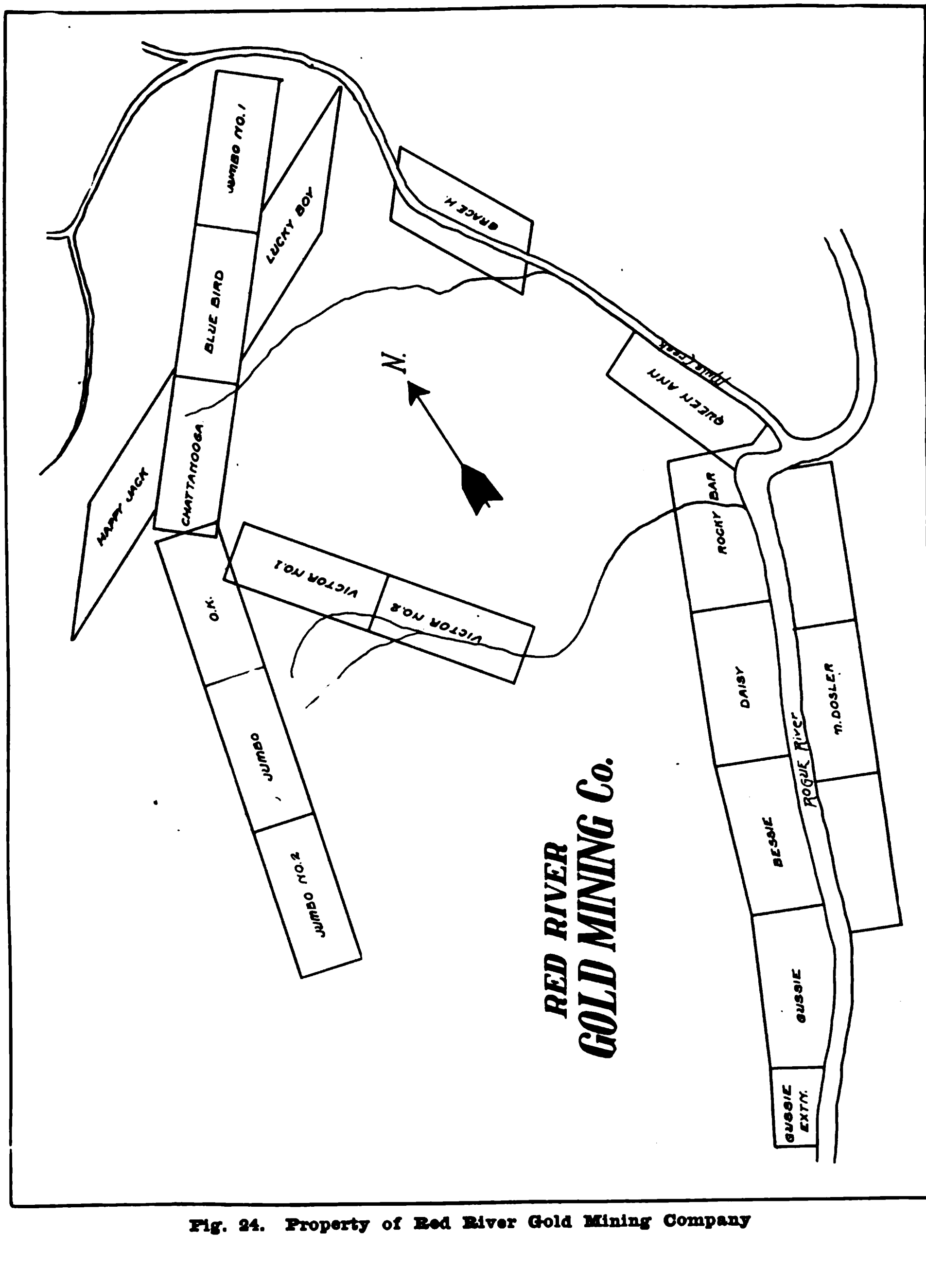

Fig. 24. Property of Red River Gold Mining Company

small portion of this is quartz. In general, it may be said that the width of the main quartz vein varies from an inch or two to over a foot, and that it dips to the northwest at angles varying between 49 and 68 degrees.

Most of the ore produced has come from the first stope, but some still remains in the second stope, and Mr. Tucker claims that it will run $27 in gold. He also states that the ore at the face will assay only $5; and claims that it is impossible to distinguish visually between good and poor ore.

The ore minerals visible are free gold and a little chalcopyrite. Some green stains due to the presence of carbonate of copper also occur. The gold is very yellow and the particles are minute, but it is plentiful in patches in the quartz which is itself very compact and "tight." Gray stains often show in the quartz around patches of free gold. These suggest the presence of tellurides, but qualitative tests for tellurium resulted negatively.

Another opening on the main vein, which is considerably above and some distance south of the first, shows one foot of perpendicular quartz striking S. 30° W. Near the end of the cut the vein is offset a foot to the southeast by a fault striking N. 39° W. and dipping 72 degrees S. W.

The mill, which is run by water power, is so arranged that the ore first goes over a one-inch wooden grizzly. The over-size is crushed in a 6-inch jaw crusher and is then, together with the material that is passed through the grizzly, fed into a 2-stamp mill, after which the tailing is cyanided. It is claimed that 40 per cent of the gold in the ore is caught on the plates of the stamp mill.

Lode 7. Red River Gold Mining Company. In June, 1906, this corporation purchased from R. A. Matoon six lode claims and nine placer claims. The former are on Mule Mountain, north of Rogue river and west of Mule creek, while the latter lie along Rogue river and Mule creek. The location of the various claims is shown on figure 24. Subsequently, four lode claims and one placer claim were located by the Red River Gold Mining Company. These are the Victor No. 2, Happy Jack, Lucky Boy, Jumbo No. 1, and Grace H.

The company stopped work in April, 1912; and George M. Cheney, of Indianapolis, Indiana, and W. H. Corwin, of Marial, Oregon, are now the sole active bond holders. Cheney owns most of the bonds but Corwin is developing the property under an option from the former. He began work September 20th, 1914, and at the time this examination was made had done little but prospect. The lode claims have not been developed except by such open cuts and short tunnels as constitute the annual assessment work. In all, however, there are about 250 feet of tunnels on the property.

The principal vein owned by the company is the so-called "Iron Dike" which traverses the Jumbo No. 2, Jumbo O. K., Chattanooga, Blue Bird, and Jumbo No. 1 claims. It is said that this deposit may be traced many miles, but no attempt was made to substantiate this claim. The deposit is essentially a shear-zone in greenstone, containing numerous narrow quartz stringers. It varies from 10 to 50 feet in width, and averages about 20 feet. The visible ore minerals are chalcopyrite, which is sometimes plentiful, and lesser amounts of pyrite. The zone does not appear to have undergone much cross faulting and it usually stands nearly vertically. Samples are said to run between $2.50 and $4.50 in gold, with a probable average of about $3. Picked samples from the Blue Bird claim, where the mineralized zone averages 10 to 15 feet,, are said to run as high as $300 a ton in gold.

The vein on the Victor No. 1 claim is a narrow quartz vein in greenstone, very similar to that found in the Lucky Boy (Lode 6) already described. It is more or less broken up by cross faults, and varies in width from an inch or so up to a maximum of a foot; the average is probably about 4 inches. Like Tucker's Lucky Boy it contains free gold. It is, in fact, in nearly all respects except width, a replica of that vein.

Lode 8. Mule Mountain Mines. This property consists of one placer and eleven lode claims as shown on figure 25. These were all located between 1896 and 1898 by George W. Billings and J. T. Milner, now dead. Mr. Billings now owns and is developing the group which lies about 3 miles below the mouth of Mule creek on both sides of Rogue river. While Mr. Billings feels confident that many veins traverse the group, 3 are much more prominent and have been more extensively developed than the others, so these only were examined. They are the Mule Mountain, the Big Devil's Stairs creek, and the Keystone veins. These will be described in some detail.

The principal workings on the Mule Mountain vein lie at an elevation of about 1,940 feet, as determined by means of a barometer. They consist of an open cut about 25 feet long with a maximum

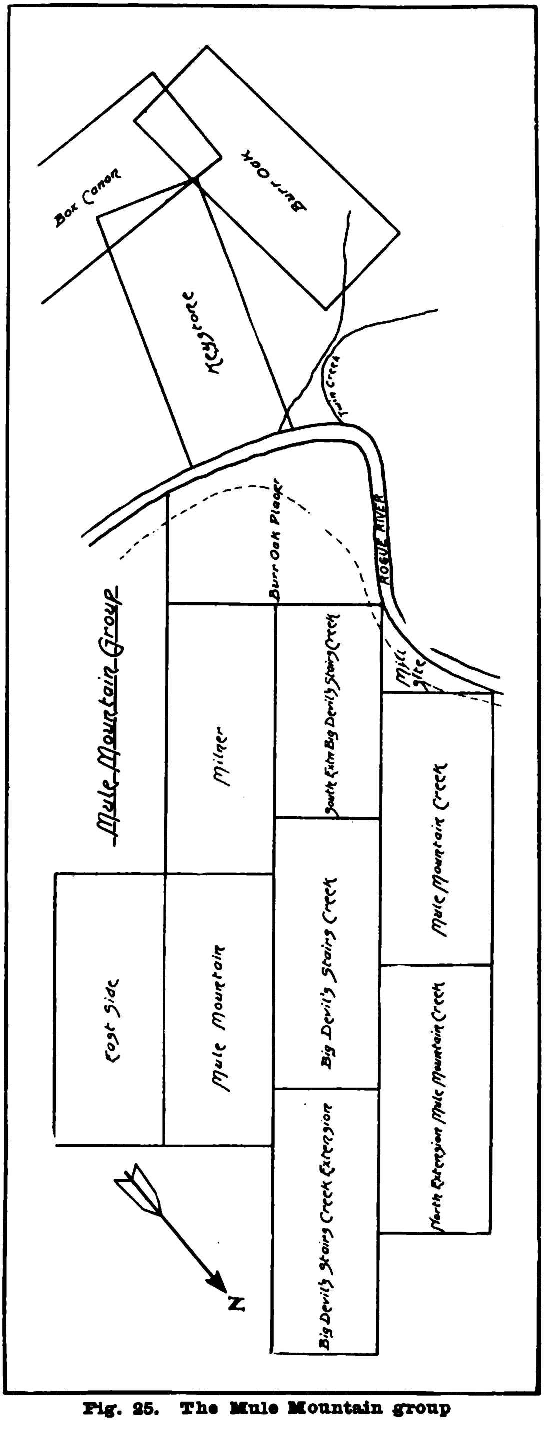

Fig. 25. The Mule Mountain group

width of 12 feet, an 86 foot shaft a short distance southwest of this cut, and several smaller cuts farther to the southwest. In these exposures the vein strikes about N. 60° E., and dips 58° S. E.

The country rock of all the veins in this group is greenstone, which is at some points on the mountain so coarse-grained as to constitute a typical diorite. Elsewhere it is decidedly porphyritic, and, in at least one locality, quite gneissoid in appearance.

The Mule Mountain vein, as exposed in the shaft and cuts to the southwest thereof, consists of about one foot of rather solid quartz, which is white as a rule, but contains brown patches that doubtless represent oxidized sulphides. In this quartz are several streaks of country rock, and narrower streaks of quartz parallel to the main vein on both sides, making the deposit a combination shear-zone and fissure vein. On the northeastern face of the open cut the conditions are as sketched in figure 26. The country rock is more or less sheared

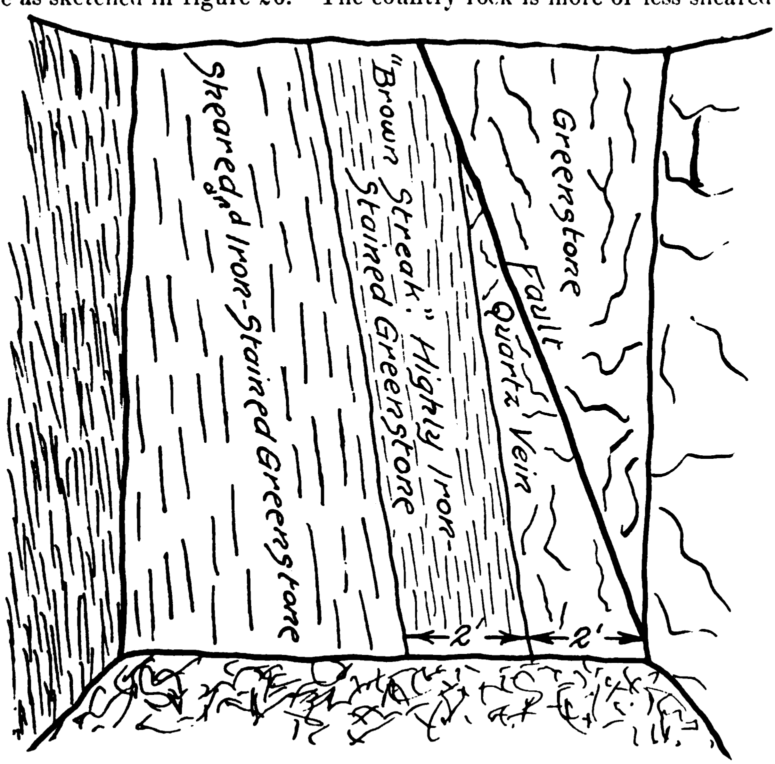

Fig. 26. Sketch of northeastern face of open cut on Mule Mountain vein

and iron-stained for a distance of 15 feet northwest of the main quartz vein, but the 2 feet nearest the quartz is so homogeneous and highly impregnated with iron as to constitute a separate streak. Mr. Billings reports that the 18 inches of this brown streak nearest the quartz runs from $400 to $500 a ton in gold, but a sample of the material taken during the course of this investigation yielded but a trace of gold.

The quartz is itself considerably sheared and broken. No free gold could be found therein, but it is said to occur in the iron-stained patches and along the joints, which are often filled with what appears to be a combination of manganese and iron oxides.

Mr. Billings states that this vein was opened in 1898, and that 45 tons of ore have been shipped from the bottom of the shaft. He claims that there it ran $15 a ton as mined, but was hand sorted so as to yield $75 a ton.

At the time of the examination the 2-stamp mill and cyanide plant on the property were running on ore from the open cut, which included all of the quartz exposed therein and 18 inches of the brown material adjacent thereto. Considerable amalgam was evidently collecting on the plates, but the results of this run were not learned. Mr. Billings said that about 50 per cent of the values are caught on the plates.

Mr. Judson C. Hubbart, who has examined this property, reports that four samples taken near the shaft on this vein yielded as follows:

(1) Sectional sample through shaft dump: gold, $9.50; silver, 50 cents.

(2) Average of 12, 14 and 16 inch cross sections of vein near shaft: gold, $11.10; silver, 45 cents.

(2a) 20 inches footwall gouge adjoining (2): gold, $4.00; silver, 30 cents.

This gives about 34 inches of vein matter that averages about $7.28 per ton.

Another small quartz vein parallels the Mule Mountain vein about 15 feet to the northwest thereof. It is exposed in several cuts. It was sampled by Hubbart who reported upon it as follows:

(3) 6 inches of quartz and gouge; gold, $5.00; silver, 57 cents.

Big Devil's Stairs creek vein. The main workings on this vein are some distance (500 or 600 feet) to the northwest, and about 340 feet below the Mule Mountain shaft with which they are connected by a small wire-rope tramway. A larger wire-rope tramway is used to transfer the ore to the mill, which is perhaps 1,000 feet below, near Rogue river.

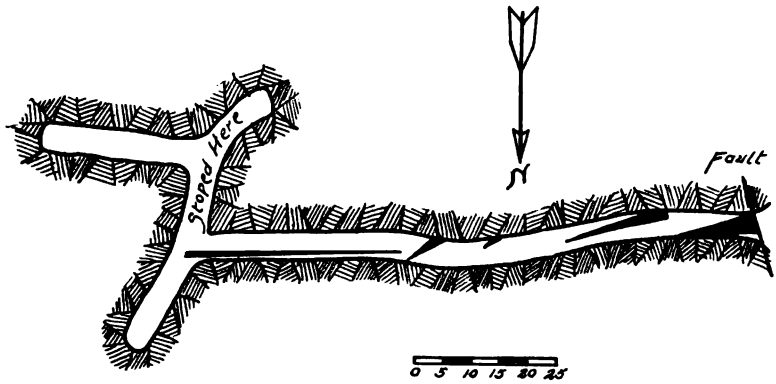

Fig. 27. Big Devils' Stairs creek workings. Vein matter shown in solid black

The vein has here been developed by means of a tunnel 100 feet long from which three diverging drifts have been driven at the end. At the mouth of this tunnel is a fault striking S. 70° W. and dipping 66° S. E. East of this the vein shows as a badly jointed quartz streak about 4 feet wide. Sixteen feet from the portal it disappears along the left wall and is faulted to the right so that it shows along the right wall as a one foot streak. This streak pinches out about 35 feet from the mouth of the tunnel and does not show again except as a small 6-inch lens until a point 56 feet from the mouth of the tunnel is reached. From here the vein persists as a 4 to 6-inch streak of quartz until the end of the main tunnel is reached when it appears to have been faulted almost at right angles, and is then so broken and crushed that its extension has not been found. The vein changes strike and dip frequently, and the walls are often slickensided. The longest portion shown in the tunnel strikes N. 85° E., but in other places the strike is as much as 10 to 15 degrees further to the north. The dip varies from 54 to 64 degrees S. E. The variation in strike and the badly faulted condition of the vein is indicated on a sketch map of the workings which constitute figure 27.

The vein is more or less iron-stained, but shows some pyrite and chalcopyrite. Although no free gold was seen, the whole deposit bears a very close resemblance to the high grade Lucky Boy and Paradise veins already discussed. This deposit differs, however, from those just mentioned in that, in the main stope which runs up for scores of feet, the single quartz vein splits into a mineralized zone about 4 feet wide which consists of many small veins separated by country rock. Above this point the deposit fans out into a broad zone 15 feet or more wide, which contains 4 or 5 quartz veins, each nearly a foot in width, with many smaller ones between. Of these, the southeastern most large quartz vein has been most extensively stoped.

A man sent down by the Merrills of San Francisco spent 40 days on the ground and sampled the ore in the tunnel and stope carefully. He ran this ore through the mill and claimed to recover an average of $26.80 from each ton milled. Mr. Billings milled 42 tons of the same ore last winter and recovered values at the rate of $18 a ton. He explains the discrepancy by stating that Merrill's man used an agitator when cyaniding, while he (Billings) used none. Mr. Hubbart reports the following figures from samples taken on this vein.

(5) 4 feet of quartz in the Devil's Stairs creek vein: gold, $14.00; silver, 32 cents.

(5a) 40 inches quartz and gangue forming east wall adjacent to (5): gold, $5.00; silver, 62 cents.

Samples (5) and (5a) average $10.37 a ton over a width of 7 feet 4 inches.

(6) 5 feet of quartz 10 feet from the portal of the tunnel: gold, $2.50; silver, 58 cents.

(7) 20 inches of quartz near the end of the tunnel: gold, $38.00; silver, $1.30.

(7a) 30 inches of gangue and quartz stringers east of and beside (7): gold, $3.00; silver, $1.17.

(7b) 6 feet of gangue and quartz west of and beside (7): gold, $8.00; silver, 25 cents.

Samples (7), (7a) and (7b) together constitute 9 feet, 2 inches of ore which has an average value of $13.67.

(8) From sack of ore on dump: gold, $42.00; silver, $1.30.

Amalgamation and cyanide tests were made by Mr. Hubbart on samples (5), (7) and (8). On (5) amalgamation showed a saving of 22.8 per cent and cyanidation a saving of 71 per cent, making a total saving of 93.8 per cent by both processes. On sample (7) amalgamation showed a saving of 14 per cent and cyanidation a saving of 66.6 per cent, making a total saving of 80.6 per cent. On sample (8) amalgamation showed a saving of 39.5 per cent and cyanidation a saving of 43.81 per cent, making a total saving of 83.31 per cent.

Mr. Hubbart notes that samples (7) and (8) contained some chalcopyrite and believes the relatively low saving by the cyanidation process to be due to the presence of copper.

Mr. Hubbart further reports that tests made upon sample (7) resulted in a concentration of 78 into 1, so far as weight is concerned, but that the concentrates assayed only $108.90 per ton instead of $2,635.62 as would have been the case if all the values in the ore

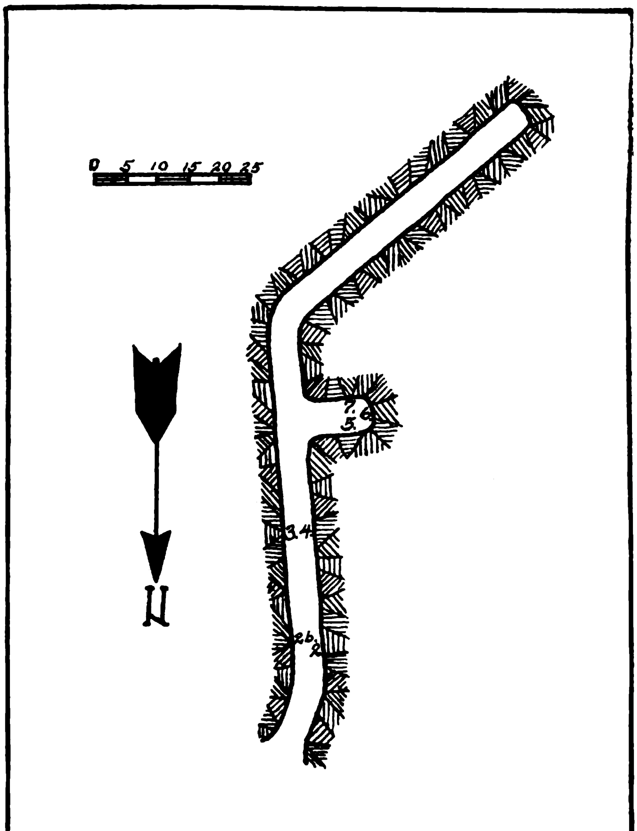

Fig. 28. Keystone tunnel, showing location of samples referred to in text

could have been thrown into the concentrates. The low percentage of values present in the concentrates indicates that the valuable metals are in a very finely divided condition and that a portion, at least, is probably included within, or firmly attached to, the quartz, even after this has been finely crushed.

The Keystone vein is on the south side of Rogue river, and may be an extension of the Mule Mountain vein. It differs sufficiently from that vein in character, however, to make its continuity with the Mule Mountain vein doubtful. It is first exposed about 400 feet above the river, and above this point it outcrops in a number of places, and has been opened at other points by means of open cuts and tunnels. The deposit is essentially a shear-zone striking about S. 25° E., and dipping 76° E. As is the case with the other prospects in this neighborhood, the country rock is greenstone.

The shear-zone contains one or more quartz veins varying considerably in width, and a considerable amount of gouge is also present in some places. A soft, greenish mineral, which is probably chlorite, is also present. The total width of the mineralized zone varies from a few inches up to 20 feet or more, but it is not certain that the smaller measurements were taken on the same zone as were the larger ones. It seems likely that development work will show the presence of one large vein accompanied by one or more smaller, parallel veins. If this is the case, some of the openings now on the property must have been made in the narrower and some in the wider of these zones. It seems hard to explain the variable width of the vein exposures on any other assumption, as no indication of sudden widening or pinching was observed in any of the tunnels or open cuts.

Mr. Hubbart sampled the Keystone vein at a number of points and reports the following results:

(1) 25 inches of quartz below the main tunnel: gold, $5.00; silver, 47 cents.

(2) 30 inches of vein matter 8 feet from the portal of Keystone tunnel: gold, $2.00; silver, 50 cents.

(2b) Decomposed wall-rock near (2): gold, $4.00; silver, 35 cents.

Mr. Hubbart points out that patches in this rock were discolored by a brownish material resembling oxide of manganese, and states that in his experience in this district such material has always yielded assays for gold.

(3) 7 inches of quartz along the west wall of the Keystone tunnel. 33 feet from the portal: gold, $6.00; silver, 72 cents.

(4) 12 inches of quartz along east wall of Keystone tunnel, 30 feet from the portal: gold, $5.00; silver, 27 cents.

(5) 30 inches of gangue and quartz along north wall of drift from Keystone tunnel: gold, $9.00; silver, 37 cents.

(6) 12 inches of quartz at end of drift from Keystone tunnel: gold, $96.00; silver, $1.15.

(7) 24 inches of gangue along south wall of drift from Keystone tunnel: gold, $3.00; silver, 50 cents.

Figure 28 shows a plan of the main Keystone tunnel and indicates the locations of samples (2) to (7) inclusive. Mr. Hubbart points out that samples (5), (6) and (7) were taken from a point west of the others, and mentions that the material exposed in the drift is of a different nature from that in the main tunnel between the drift and the mouth. He further states that the material exposed at the end of the tunnel is of the same character as samples 5 and 7. It seems, therefore, likely that here we have exposed one of the smaller quartz veins which parallel the main Keystone shear-zone.

Other samples taken by Mr. Hubbart at points on the vein above the main tunnel assayed as follows:

(8) 7 feet of quartz along east wall of Keystone vein above tunnel: gold, $2.60; silver, 38 cents.

(9) 5 feet of quartz and gangue west of and adjacent to (8): gold, $6.00; silver, 75 cents.

(10) 32 inches of vein matter in an upper tunnel: gold, $3.00; silver, 42 cents.

Amalgamation and cyanide tests made on samples (2b), (6) and (9) resulted as follows:

(2b) 60 per cent of the values were extracted by amalgamation and 27½ per cent by cyanidation, making a total saving of 87½ per cent.

(6) 2.69 per cent of the values were extracted by amalgamation and 96.25 per cent by cyanidation, making a total saving of 98.94 per cent.

(9) 17 per cent of the values were extracted by amalgamation and 75.5 per cent by cyanidation, making a total saving of 92.5 per cent.

Tests conducted upon the amalgamation tailing of sample (6) resulted in a concentration of 91 into 1. The concentrates thus produced contained 35.75 oz. of gold per ton valued at $715, and 34.1 oz. of silver per ton valued at $17.50. This gives them a total of $732.05 a ton, instead of $8,628.62 a ton which would have been their grade if all the values in the ore could have been included in the concentrates. Mr. Hubbart does not state in his report what methods of concentration were employed.

Mr. Hubbart concludes his report on this group by stating that he considers "that the property should offer very favorable inducements for the careful expenditure of capital."

ROCK CREEK DISTRICT

Rock creek is in Coos county, but John R. Smith's property on this stream is situated so near the Curry county boundary and has aroused so much interest within the past year that it was visited and examined.

The area is a complex of Myrtle sandstone, dioritic greenstone, and serpentine. West of and approximately parallel to the creek is an enormous dike of apparently very acid dacite-porphyry. This outcrops in masses as large as big buildings, and one such outcrop is shown in figure 17. Some of the greenstone is heavily impregnated with pyrite.

The finding of a rich deposit of placer gold in Rock creek during the fall and winter of 1914-15 attracted much attention to the district and led to an extended search for the source of the gold. Mr. Smith has exposed contacts of serpentine and diorite with Myrtle sandstone, and also a water-course in diorite. He is inclined to think that at least some of the gold has come from these sources, but although the water-course in diorite is much softened and iron-stained, and the contacts mentioned have evidently served as water channels to some extent, it seems highly improbable that any considerable proportion of the placer gold could have come therefrom. In fact, Mr. Smith himself is inclined to think from the panning he has done that most of the gold has come from a hill west of the creek which is underlain with Myrtle sandstone. This sandstone contains many small quartz veins such as are common in the formation at several points, and which Diller has suggested as the probable source of much placer gold. Mr. Smith claims that this quartz pans satisfactorily and has yielded one scale of gold worth $1.85. He states that the placer gold often has quartz and dark green chloritc material, such as is common in the Myrtle quartz veins adhering to it. He hopes to find a large vein of this character some place on the hill mentioned, but there is not sufficient grounds for predicting whether or not his hope will be realized.

Lode 9. Copper King No. 1. One-fourth of a mile west of Mr. John R. Smith's placer ground on Rock creek is a thick lens of quartz included within serpentine, and which itself encloses small quantities of the latter. It contains considerable chalcopyrite and the upper portion is seamed with veinlets of malachite and some azurite. A mass of this material measuring about 30 feet long and 20 feet thick is exposed by open cuts. Several prospectors who have examined this deposit consider it a boulder or a large chunk of float which has rolled down from some higher point. There is no doubt, however, that it is in place in the serpentine and represents a "boulder copper deposit" allied to those found further south in Curry county, but differing notably therefrom in the large quantity of quartz present. This deposit lies about 100 feet east of a big outcrop of dacite-porphyry and may be genetically connected therewith. A general sample taken from all the exposures proved to contain 2.23 per cent copper, .05 oz. gold, and .08 oz. silver. Concentration would doubtless produce a fairly high grade ore, but the decidedly lenticular form of the ore body makes it improbable that the deposit can ever be mined profitably.

BOULDER CREEK DISTRICT

Boulder creek, a tributary of Lobster creek, has yielded, and is still yielding considerable placer gold; and, following the excitement attendant upon the discovery of gold in Rock creek, this area was extensively prospected for veins. Nothing promising was found, however, although a number of claims were located. The only one of these examined is mentioned in the following paragraph.

Lode 10. Alta. This claim, which is owned by Mr. Charles D. Lash, is situated on Ophir Mountain about half a mile above Ink and Barr's placer claims. The open cut exposes a contact between basalt and shale (Myrtle?). Faulting has evidently taken place along this contact and an inch or two of soft gouge separates the two rocks, which are themselves somewhat crushed and softened near the contact. The deposit appeared so unpromising that it was not sampled.

SHASTA COSTA COPPER DISTRICT

The Shasta Costa Copper district is situated about 3 miles from the mouth of Shasta Costa creek. Although an attempt was made to examine the few properties that have been opened there, no guide to them could be secured and they could not be located. It is known that the copper ores are similar to, and occur in the same way, as do those in the Collier creek region elsewhere described in detail. Since they lie in the same belt of serpentine as do those further south, it is likely that the conclusions reached relative to the southerly deposits apply equally to those on Shasta Costa creek.

PINE FLAT COPPER DISTRICT

The Pine Flat Copper district is situated about four miles southwesterly from Agness on the ridge which farther to the south is known as Wake-Up-Riley ridge and is composed largely of Colebrooke schist. Along the eastern edge of Pine Flat there is a body of serpentine overlain by dacite-porphyry the latter underlying Myrtle conglomerate. Pebble Hill, a prominent topographic feature, is made up of this last rock.

Lode 11. Pine Flat mine. The copper occurs as thin seams and stains of malachite in jointed and sheared serpentine, near and below the dacite-porphyry. The latter strikes N. 80° E., and dips 32° S. E. Two short tunnels have been driven along the serpentine-dacite-porphyry contact, and several open cuts have also been made along the same horizon.

The whole occurrence bears a strong resemblance to the shear-zone deposits in the Collier creek district. Whether any high grade ore was found is unknown. A general sample of the ore on various dumps yielded 9.87 per cent of copper and traces of gold and silver.

DISTRICT SOUTHEAST OF AGNESS

Comparatively little work has been done in this area, and only two properties were examined.

A large mass of serpentine crosses the Illinois river at the mouth of Indigo creek, and then runs a little east of north through the Shasta Costa copper district, and on to Mule creek. West of this serpentine dike, between it and the sediments along Illinois river, is a mass of greenstone. The two prospects described are largely or entirely in greenstone.

Lode 12. Night Hawk. This prospect, which is owned by Frank

Fry and C. W. Sinniger, occurs at an elevation of about 1,750 feet as determined by the barometer, about 4 miles southeast of Agness on the ridge between the Illinois river and Indigo creek.

The deposit is a sheared and brecciated zone in a very basic greenstone which is partially altered to serpentine at some points. The ore consists principally of pyrite which occurs in kidneys or nodules irregularly distributed throughout the zone. These rounded masses are very hard and solid, and some of them are a foot or more in diameter. Attention was first attracted to the deposit by a bluish-green efflorescence which appears on the surface of the rock in wet weather. No free gold has been found in this prospect, and an assay of one of the nodules of solid pyrite yielded not a trace of that metal.

Lode 13. Stephens and Stear. This property, which is owned by a Mr. Stephens and Charles Stear, is situated about 3,000 feet north of the Night Hawk. It has been developed by means of a tunnel which is said to be over 300 feet long, but was locked at the time the examination was made. The dump is of such size as to indicate that considerable development work has been done. From material on the dump, it seems probable that the deposit consists of relatively narrow white quartz stringers through a sheared or brecciated zone, which is said to be more than 20 feet wide in some places. The country rock is mostly greenstone, but there is some serpentine on the dump, and it is evident that both rocks are penetrated by the workings. There is so much wash on the surface that the relationship of these could not be determined. Some calcite and a little pectolite and red hematite are present on the dump, but it is evident that these are not common. The quartz is said to occasionally show free gold, and it is also claimed that gold can be panned from it at many points. It is reported that this property was last worked in the spring of 1915.

WAKE-UP-RILEY RIDGE IRON DISTRICT

The general geologic conditions in this district, and the character of the iron deposits have already been described in the chapter on the iron resources of the county.

Lode 15. Iron Hill group. This group includes all the claims on the ridge. The deposits exposed are so similar in appearance that only two were sampled. These are called the Iron Hill No. 3 and the Iron Hill No. 4. Each is developed by an open cut, the former being about 600 feet south of the latter. The Iron Hill No. 4 is a typical small lens of manganiferous magnetite which analyzes 28.43 per cent iron, 12.95 per cent manganese, 0.72 per cent phosphorous, and no titanium, arsenic, copper, or sulphur.

The Iron Hill No. 5 was the best looking deposit examined. An open cut 5 feet wide, 8 feet long, and 5 feet deep at the face was entirely in ore, although the manganiferous magnetite is traversed by numerous quartz seams. A sample from this prospect analyzed 22.87 per cent iron, 7.30 per cent manganese, and 0.56 per cent phosphorous, and no titanium, arsenic, copper or sulphur.

DISTRICT BETWEEN LAWSON AND HORSE SIGN CREEKS

The highest point on the ridge between Horse Sign and Lawson creek is capped with serpentine. To the northwestward lies Colebrooke schist, and southeastward greenstone. One or more dikes of dacite-porphyry cut through all of these rocks. A prominent one is said to run from Mr. Berry's house northwestward to Lawson creek. Mr. Frank Berry owns a house on this ridge and has done some prospecting in the vicinity. Two deposits located by him were examined by the field party.

Lode 16. Name unknown. One-eighth of a mile west of Frank Berry's house, about 4 miles from the end of the divide between Horse Sign and Lawson creeks, is a sheared zone in serpentine or greenstone altering to serpentine. It has not been developed, but the outcrop shows a heavily iron-stained porous mass of gossan which is said to pan gold. However, a sample of this material assayed not a trace of gold.

Lode 17. Name unknown. About 100 feet down the Lawson creek slope of the ridge above Frank Berry's house below a saddle in this ridge occur numerous good sized chunks of chromite. This material is associated with serpentine near the contact with greenstone. No work has been done upon this deposit, but from the quantity of float present it seems likely that a considerable amount of ore may occur here. Analyses of a general sample secured from a number of float fragments yielded: 45.99 per cent chromic oxide, 20.41 per cent iron, 21.33 per cent silica, 2.14 per cent alumina, and no magnesia.

COLLIER CREEK DISTRICT

The general geologic conditions of this district, which includes the entire watershed of Collier creek, is shown on figure 1. The conditions are not as simple as is there indicated, for it was found impossible to include all the occurrences of igneous rock on a map of the scale used.

Most of the ore deposits are in serpentine or peridotite more or less altered to serpentine, but some of them, while still in serpentine, are adjacent to dacite-porphyry dikes. The deposits in the serpentine or serpentinized peridotite are all of the boulder or shear-zone type already fully discussed elsewhere in this report (see page 43).

A large amount of work has been done in this area at one time or another and innumerable openings exist. It was not possible to examine all of these, and at least one large group (the Reed claims) was not visited at all. It is believed, however, from observations made that all the properties are of such similar nature that descriptions of those here given will apply with minor changes to all of them.

Lode 18. The Collier Creek Copper Company. This property includes a number of claims running from the neighborhood of Horse Sign butte southward. Mr. Frank Berry, of Agness, is either the sole owner of this property or else possesses a controlling interest. Most of the work on the property was done 20 years ago, and the only openings now accessible consist of open cuts and shallow shafts.

The principal mineralized zones on the property are known as the Collier creek vein, the Eagle vein, and the Mohawk vein. Of these, the first is the most persistent, and is exposed in an open cut about 300 yards somewhat east of south of Burt camp over a low divide, as well as elsewhere. This deposit is of the shear-zone type in serpentine, and contains a number of the boulder-like masses of iron and copper ores which have been already discussed. One hundred feet or less west of the zone, and parallel to it, is a dike of dacite-porphyry, while east of the zone lies comparatively unaltered peridotite of the "buck skin" type already described (see page 32). The mineralized zone itself averages about 4 feet wide, and the outcrop consists largely of limonite or limonite-stained serpentine. At many points the gossan is very porous and highly ferruginous, so the zone, which strikes S. 25° W., is easily traceable on the surface. At some points, however, the iron-stain disappears, giving place to a mass of serpentine containing numerous bluish or black veinlets.

Many fragments of good looking copper and iron ore occur in the various dumps along this zone, but most of these have been exposed to the weather so long that a considerable portion of their copper contents has doubtless been leached out. Analyses running as high as 30 per cent copper are said to have been obtained from the freshly mined ore.

The Mohawk vein appears to be an off-shoot of the Collier creek vein. It leaves the latter in the saddle just south of Burt camp, finally disappears under Horse Sign butte, and strikes about N. 10° E. Like the Collier creek vein, the Mohawk is paralleled to the west by a ledge of dacite-porphyry. The two zones are in fact decidedly similar in most respects, but the Mohawk is marked by association with a dark-brown serpentine instead of with the greenish material commonly found in connection with the Collier creek vein.

A fairly fresh sample taken from a small cut on the Mohawk vein was found to consist of magnetite (magnetic oxide of iron), cuprite (red oxide of copper), and malachite (green carbonate of copper); and proved to contain 9.87 per cent copper and traces of gold and silver. Another sample of extremely porous, heavily iron-stained gossan from an outcrop of this vein yielded not a trace of copper, gold, or silver.

The Eagle vein, probably an off-shoot of the Collier creek vein, is best exposed just south of the saddle west of Horse Sign butte. A fairly deep shaft at this point exposes a great deal of copper-stained serpentine. The material now on the dump looks low-grade, but the prospect is said to have produced at least one nugget of native copper weighing 26 pounds.

Lode 19. Oregon. This is the impregnation deposit of magnetic iron ore, the location and nature of which have already been fully described on page 64. Mr. Frank Berry, of Agness, is the owner.

Lode 20. Kessler and Frys' property. This prospect, which is owned by William Kessler and John, Walter and Marshal Fry, is on the ridge between North Collier and Lawson creeks, about two and one-half miles northwest of Game lake, at an elevation, as determined by the barometer, of 4,200 feet. The country rock here is serpentine, but a dike of quartzite-like dacite-porphyry about 100 feet thick occurs a short distance to the east. Beyond this are a few hundred feet of greenstone, then several hundred feet of Colebrooke schist, followed by a succession of serpentine and peridotite masses down almost to the Illinois river. How far to the west of the claim the serpentine runs is unknown, but it undoubtedly eventually gives place to Colebrooke schist in that direction.

A 50-foot tunnel which bears S. 34° W. has been run into the serpentine not far from the dacite-porphyry contact. No ore is exposed in this tunnel, and it was doubtless driven with the intention of cutting a mineralized zone nearby. Some copper-stained material occurs in a wash near the tunnel, and big chunks of good ore are said to have been picked up on the flats below, but their exact source is unknown.

Lode 21. Bonanza King copper group. This consists of three claims which are owned by E. G. Hurt, of Agness. He purchased one, the Bonanza King, of W. W. Whitton, in 1898, and another, the Bonanza King extension, from R. J. Canfield, in 1912. He located the third, the Spotted Faun, in 1912. Two tunnels, one 60 and the other 48 feet long, were driven on the property, which was also opened up by means of 8 open cuts and shafts. Although work was done as late as 1914, all of the openings have so badly caved as to make it impossible to secure accurate data concerning the deposits. From what observations it was possible to make, they appeared to be largely of the boulder type, although one or more mineralized shear-zones may also be present. In several cases a little moderately deep development has gone under the ore into seemingly barren serpentine, bearing out the conclusion that most of the deposits are of the boulder type. Hurt claims that it was ore on the various dumps of this group which was taken by Dr. T. R. Hines, heretofore mentioned.

The principal ore mineral is undoubtedly chalcocite or copper glance (sulphide of copper), although considerable cuprite (red oxide of copper) and native copper are also present. Magnetite (magnetic oxide of iron) seems to have been invariably associated with the copper ores, and it is claimed that this mineral itself carries copper in every case. This is borne out by the fact that a specimen of seemingly pure magnetite from the Copper King tunnel on the Collier creek group proved to contain 50.05 per cent iron, 2.43 per cent copper, and no sulphur, phosphorous, titanium, or arsenic.

Where the copper ores outcrop on the surface, they have been oxidized to malachite (green carbonate of copper) and azurite (blue carbonate of copper). Occasionally a little erythrite (pink arsenate of cobalt) is also present. These substances are said to give place to chalcocite, cuprite, and native copper a few feet from the surface in every case. Some of the ore still on the dumps is apparently very rich, and a general sample of such material from a number of points on the Bonanza King group yielded 20.137 per cent copper, .06 oz. gold, and .12 oz. silver per ton.

Mr. John Rae, of Harbor, Oregon, presented the writer with a chunk of native copper supposed to have come from this group, which, although only a fragment of the original piece, weighs 3½ pounds. It is coated with malachite and other oxidation products.

Lode 22. Reid group. These claims are said to have been located 12 or more years ago and to have been last worked by Frank Alley, of Roseburg, Oregon. They lie about a mile east of the Bonanza King group and are doubtless of similar character. They were not visited, and no definite information concerning them is available.

Lode 23. Cobalt group. This group of claims is owned by Frank Berry, of Agness, and is situated at the base of Bald Mountain on the east side of the Illinois river. Here is a serpentine hill about 800 feet high, 2 miles long, and two-thirds of a mile wide. It looks like a slide, but as Bald Mountain is composed of different material, the serpentine is doubtless in place.

The serpentine is practically free from overburden, and great patches of it are heavily iron-stained at the surface. It has been opened by means of numerous cuts and shafts, and it is claimed that all these openings run into sulphides, principally pyrite, at no great depth. It is stated that independent examinations showed that the ore ran on an average about $10 a ton in gold and silver, and that other elements present, including copper and cobalt, brought the total value to between 15 and $16 a ton. The quantity of ore available is certainly enormous, and if the figures quoted prove correct, it ought to be possible to develop a mine here. It was impossible, because of limited time, to visit more than a few of the openings. From one of these in which many feet of solid pyrite was exposed, a sample was taken which assayed not a trace of gold. Another sample of the porous, iron-stained gossan yielded the same result. From this, it is evident that all the mineral is not gold-bearing, but there are so many exposures and the mineralization has been so extensive that it is not unlikely large bodies of good ore exist elsewhere on the hill.

DISTRICT EAST OF GOLD BEACH

The country rock for at least 6 miles east of Gold Beach is serpentine, but eastward of this belt of solid serpentine some greenstone and several lenses or zones of Colebrooke schist exist; and the Starr or McKinley group, which includes the only important prospects

SiH MAP OF
URBU NTU OREGON

in the region, lies east of one such lens. The main mass of Colebrooke schist is not far to the eastward of this group.

Lode 24. Starr (McKinley) group. This group is located about 7 miles south of east from Gold Beach at an elevation of 3,950 feet, as determined by the barometer. It was originally located as the McKinley group by Col. I. E. Munsey about 1893. He held possession of the property until he died in 1912. The property was re-located in 1915 by Charles Starr, Harriet Starr, R. G. Starr and J. R. Stannard, all of Gold Beach, who now hold 15 claims. It is reported that Col. Munsey was offered $60,000 for the property, but that he considered it worth $6,000,000, and would not consider the lower figure.

As previously stated, the country rock is serpentine, but at least

Fig. 29. Primitive dump car running on wooden rails used in driving a tunnel of the Starr (McKinley) group

one lens of Colebrooke schist exists in the vicinity, and some greenstone occurs west of the property. The main mass of Colebrooke schist lies not far to the east.

On the Starr No. 2 claim, above the trail, a cross-cut tunnel 275 feet long has been driven N. 60° E. Figure 29 illustrates the primitive dump car used in driving this tunnel. No ore is shown in this opening. It was undoubtedly put in for the purpose of cutting at depth the deposits outcropping above the mouth of the tunnel.

The first cut above the tunnel measures about 15 by 10 by 6 feet. The deposit is a shear-zone in serpentine and shows considerable copper carbonate or iron-stain in the cracks. A general sample from the dump yielded 8.18 per cent copper and no gold.

North of the last mentioned opening is an open cut 30 or more feet long, 15 feet wide, and 12 feet deep. In this is exposed about 12 feet of sheared serpentine stained in the same way as is the deposit described in the last paragraph. A sample carefully cut from across the whole mass yielded 3.17 per cent copper, 1.61 oz. gold, and .27 oz. of silver per ton. A little chalcopyrite (copper-iron sulphide) was present in this ore, and the amount would doubtless increase at greater depth. The high proportion of gold is an unexpected feature which may lead to interesting developments.

Above the cut just mentioned is the large open cut or pit, 40 feet in diameter, shown in figure 30. In this occurs a highly iron-stained, porous gossan to a depth of about 5 feet. Then comes massive sulphide ore for a foot or two; while beneath this is limonite-stained serpentine. The sulphide ore consists of chalcopyrite and pyrrhotite (monosulphide of iron), which latter has a peculiar fibrous appearance. A sample of the gossan proved to contain no gold, as was also true in the case of the limonite-stained serpentine below the sulphide. The sulphide ore yielded 5.158 per cent copper, but no gold or nickel.

A tunnel has been driven directly beneath the open pit just described. It runs S. 45° E. for 20 feet, then gradually curves to the southward for 55 feet so as to bring the breast directly below the pit and at a depth of no more than 10 or 15 feet beneath the material there exposed. Near the mouth this tunnel cuts a copper-stained sheared zone from which considerable ore has been taken. A conical pile of this material, 4 feet high and 12 feet in diameter, was sampled and proved to contain 1.04 per cent copper and no gold. It is but fair to state, however, that this ore gave evidence of considerable leaching and it is not unlikely that the grade was considerably higher when it was mined. This material, as well as one or more copper-stained shear-zones, are exposed in a trench 250 feet long north of the tunnel and open pit.

The open pit and tunnel described in the preceding paragraph are of especial interest as here we seem to have pretty conclusive proof of the boulder-like nature of the deposit of copper ore. No one can doubt for a moment that the material is in place, and yet, within a depth of a few feet, an ore running better than 5 per cent copper gives place to fresh, unstained serpentine.

About 100 feet east of south of the big pit is an open cut in which some slightly oxidized magnetite is exposed. This material is of the lodestone variety. That is, it is itself a magnet and will pick up small particles of iron or steel. Analysis proves it to be the highest grade iron ore found on the trip, since it contains 60.13 per cent iron, .36 per cent phosphorous, and no sulphur, arsenic, or titanium.

Numerous other openings exist on this property, and several others were visited, but they appeared so similar to those already described that they were not sampled. Enough time was spent in examining the deposits to prove their essential similarity to those in the Collier creek region, both the boulder and shear-zone types being represented. The principal points of difference are the relative scarcity of mag-

Fig. 30. The large pit on the Starr (McKinley) group

netite, and a substitution of chalcopyrite and pyrrhotite for chalcocite, cuprite, and native copper. It may be that the scarcity of magnetite is due to differences in climatic conditions, since the greater rainfall in the vicinity of the McKinley group may have hastened the decomposition of any magnetite that once existed there.

DISTRICT IN THE VICINITY OF COLLIER BUTTE

Two or three prospects are located within a mile or two of Collier butte, but the nature of these is so varied that it would hardly be worth while to discuss the geology of the district as a whole. The descriptions of the prospects which follow include brief discussions of the geologic features surrounding them, and further information on this point may be secured by reference to the map which constitutes figure 1.

Lode 25. Name unknown. About a quarter of a mile southeast of Sourdough camp (see figure 31) is a quartz vein in schistose Dothan sandstone. Not enough work has been done upon it to expose it entirely, but indications are that it is 10 or more feet wide. The outcrop is extremely porous, heavily iron-stained and forms a promising looking gossan. A sample of this material assayed only a trace of gold, however.

Lode 26. Bunker Hill group. This group is composed of 6 claims situated on and to the northwestward of Bunker Hill. Their owner is Mr. Frank Berry. Only a few small pits have been dug on this property, but these are sufficient to show that the deposits are practically identical in character with those in the Collier creek copper region; that is, they are boulder and shear-zone deposits in serpentine.

Fig. 31. Sourdough mountain from west Craggy

The magnetite associated with the copper ores has, however, crystallized in small, but well formed cubes instead of octahedrons, which type of crystallization of magnetite is so unusual as to seem deserving of mention. Another peculiarity of the Bunker Hill outcrops is the relatively large proportion of erythrite (arsenate of cobalt). Whether sulphides of cobalt are present in any quantity in the ores could not be ascertained.

On the northeastern slope of Bunker Hill occurs a dike of dacite-porphyry through which more or less pyrrhotite (monosulphide of iron) is disseminated. This mineral occurs in both irregular grains and as small tabular hexagonal crystals in miarolitic cavities. Mr. Frank Berry stated that this material has yielded assays for gold, one return being as high as $80 to the ton; but a general sample taken from a number of fragments lying on the surface yielded not a trace of gold.

Lode 27. Name unknown. On the top of the ridge above Little Meadow camp are numerous fragments of chromite float. They lie on serpentine not far from its contact with Dothan shales, and are sufficiently large and numerous to indicate the existence of one or more ore bodies of considerable size in that vicinity. A general sample taken from a number of fragments proved on analysis to contain 48.09 per cent chromic oxide, 16.44 per cent iron, 19.78 per cent silica, 8.12 per cent alumina, a trace of titanium, and no magnesium.

CHINA DIGGINGS DISTRICT

The rocks in this district comprise several varieties of greenstone and a great deal of serpentine. They outcrop in several bands with a general north-south trend.

The gold ores in this area are usually found in the greenstone at no great distances from the serpentine contact. In at least one case, however, the contact itself is mineralized.

Lode 28. Higgins mine. This property was not visited, but Diller describes[1] it as follows:

The Higgins mine, at the head of Slide Creek on the Chetco side of the divide, twelve miles on a direct line or twenty miles by trail nearly west of Kerby, has recently attracted much attention. The holdings embrace ten claims taken up, at least in part, by L. G. Higgins in 1903. They extend northeast and southwest along a contact of greenstone and serpentine. The contact has been sluiced at a number of places and most of the gold has been won in this way. The gold is very fine and flaky. It has

1 U. S. Geol. Surv. Bul. 546, pp 64-5, 1914.

not been transported, but was set free by decomposition of the rocks in place along the contact. The gold does not occur in quartz veins, according to Mr. Higgins, but between the folia of the talcose minerals in the shear zone along the contact.

The latest strike of this mine is in the "Golden Dream" at the head of Slide Creek, at an elevation of about 3,500 feet, and has been sluiced by lessees. The ore was rich but not richer than that obtained by Mr. Higgins years ago on the same contact, three-quarters of a mile further southwest. Mr. Higgins has erected a three-stamp mill with a concentrator to mill the contact rock. A one hundred foot tunnel, somewhat meandering, has been run along the sheared contact to open it up, but there is no evidence to show the relative value of the rock at and beneath the surface. A short distance west of the mine some slaty rocks outcrop which may be of sedimentary origin, but no gold is reported along their border.

The Higgins mine affords one of the best examples of the general character of the pockety lode-gold deposits in southwestern Oregon.

Lode 29. Empire. This property lies about a quarter of a mile south of the "Golden Dream" claim mentioned in the preceding section. It is owned by W. G. Cooley and Ben Miller of Harbor. It was not visited, but the deposit is said to consist of quartz stringers in porphyry (greenstone?). It is said to have been worked for at least 14 years, and was being actively developed during the summer of 1915. It is claimed that at least 2 feet of free milling gold ore averaging $12 a ton is exposed.

Lode 30. Hustis and Anderson group. This property was not visited, but is described by Diller as follows:[1]

The Hustis and Anderson claims are on the northwest slope of the Chetco divide on Miller Creek, nearly a mile southwest of the Higgins claims, at an elevation of nearly 2,300 feet. The main contact of serpentine, running N. 20° E., lies just west of the mine which is mainly greenstone. A 100-foot tunnel to the east in greenstone reaches another contact in serpentine.

An old arrastre, now in ruins, gives evidence of milling some years ago. The principle serpentine contact with greenstone extends directly from the Higgins mine to the Hustis and Anderson claims, where it meets another body of serpentine from the east.

Lode 31. Bacon group; and Lode 32. Miller group. These groups were not visited, but Diller describes[2] them together as follows:

Recent strikes of the Higgins mine have greatly invigorated prospecting in that region, and numerous claims have been located near the same horizon to the south on Miller creek and Baby Foot creek, tributaries of the Chetco.

The Miller and Bacon prospects are on the ridge between Miller creek and Baby Foot. At the northern foot of this spur, along Miller creek, a mass of serpentine strikes nearly east and west and cuts the volcanic greenstones which form the body of the ridge. The greenstones are well exposed in the great bluffs overlooking Baby Foot, and are

1 U. S. Geol. Surv. Bul. 546, p. 65, 1914.
2 Op. Cit., p. 65-6.

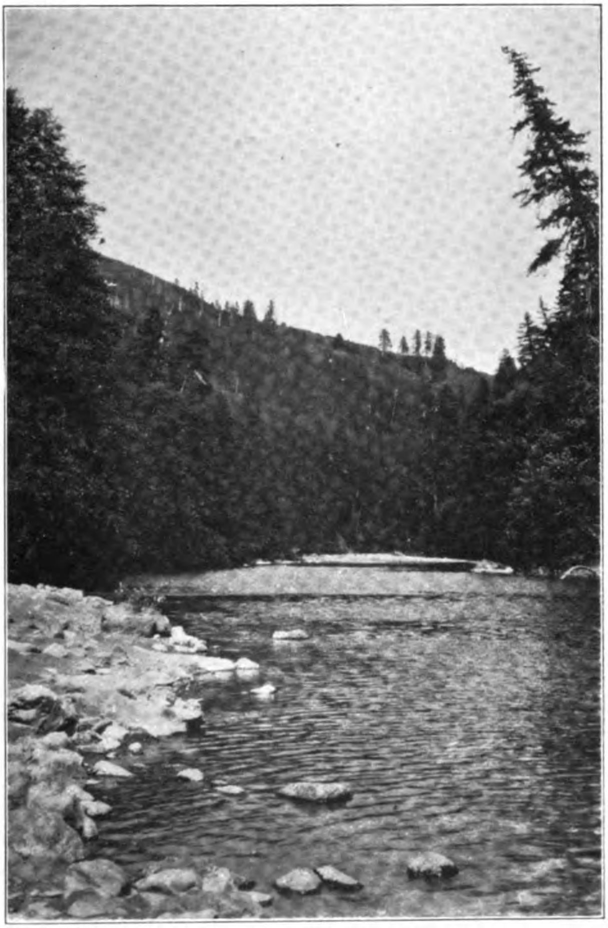

Fig. 32. Chetco river scene, near the mouth of Miss Latney creek

intruded by smaller masses of serpentine, off-shoots of the larger masses which lie at some distances on both sides.

Considerable quartz occurs in irregular veins or bunches in the greenstone, especially near the contact with serpentine, where it is impregnated with chalcopyrite and pyrrhotite. The veins strike in general about N. 60° E. and dip S. E. Their gold content is not evident, though it is said that assays show a considerable amount. The gold at present remains in the decomposed and rotten rock ready to be released by sluicing.

In the Miller Group of ten claims a portion of the contact has been sluiced. A ditch is being opened from Miller creek to the crest of the

Fig. 33. Distant view of Mt. Emily from the northeast

divide at an elevation of about 2,760 feet, for the purpose of sluicing the available auriferous residual material clinging to the slopes on both sides of the spur.

Although Diller does not mention the fact, it is evident from his map that the Bacon group is on the Miller creek side of the divide, while the Miller group is on the Baby Foot slope, about a mile southwest of the Bacon claims.

DISTRICT AT HEAD OF THE NORTH FORK OF CARTER CREEK

Near the head of Carter creek just west of the divide at the head of Canyon creek Diller shows[1] two copper prospects. They evidently lie in serpentine, and from his description of them it seems likely that they closely resemble the deposits of the Starr group or those in the Collier creek district.

Lode 32. Bailey; and Lode 33. Chetco Copper Company groups. These groups were not visited, and Diller does not mention the former by name although its location is indicated on his map as being perhaps half a mile north of the latter. Diller refers[2] to the property as follows:

The same serpentine belt with which the copper deposits are associated on Fall and Rancherie creeks extends southwest by the head of

1 U. S. Geol. Surv. Bul 546, Plate VI, 1914
2 Op. Cit., p. 84.

Canyon creek to Chetco river, where a number of similar deposits occur and have been prospected by the Chetco Copper Company and others, by tunnels aggregating more than 250 feet. The ore appears to be mainly chalcopyrite, but Dixon's prospect has furnished some native copper, and some remarkably beautiful specimens of the bright red oxide of copper, cuprite, in minute cubic crystals. A small amount of ore is said to have been shipped from this locality.

MOUNT EMILY DISTRICT

The Mount Emily (or Mount Emory or Emny as it is called by some) district is situated in the neighborhood of Mount Emily (see figure 33), 6 miles northeast of Harbor. The mountain proper rises from the Chetco river to an elevation of about 2,900 feet as determined with a barometer. From the summit a magnificent view of the Pacific Ocean as far south as Crescent City, California, is obtainable. At the top of the western slope where the view is especially good are located a number of Indian structures which take the form of rings of stone. These are uncemented, and some of them have been partially destroyed. Others are still in a good state of repair. They vary from 2 or 3 to 20 feet in diameter, and the better preserved ones are as much as 2 feet deep. The Indians living in the vicinity say that their forefathers used to build fires in the centers of these rings and then sit in a circle around the blaze. The smallest rings are barely large enough to hold one man and a small fire. When asked the purpose of this ceremony, the Indians reply that the rings were alters or open air temples from which their ancestors "talked to God." Figure 34 shows photographs of three of these rings.

Mount Emily is extremely interesting from a geologic point of view. The main mass of the mountain seems to be made up largely of a thick flow of rhyolite which has thrust its way through, and spread over, Dothan sandstone and shale. These latter are exposed on the western slope, and near the top have been metamorphosed until they form hornfels. This metamorphosed Dothan material has been crushed and broken near the contact, after which the broken zone has been invaded by rhyolite which on cooling cemented the fragments together, forming a beautiful breccia of notably unusual type. The fragments of metamorphosed Dothan are decidedly angular and vary from a fraction of an inch to many feet in diameter. Figure 35 shows one of the largest of these. It is entirely surrounded with igneous material and is composed of banded hornfels.

Below the rhyolite cap of the mountain occurs a mass of syenite-porphyry which seems to have the form of a dike and may represent

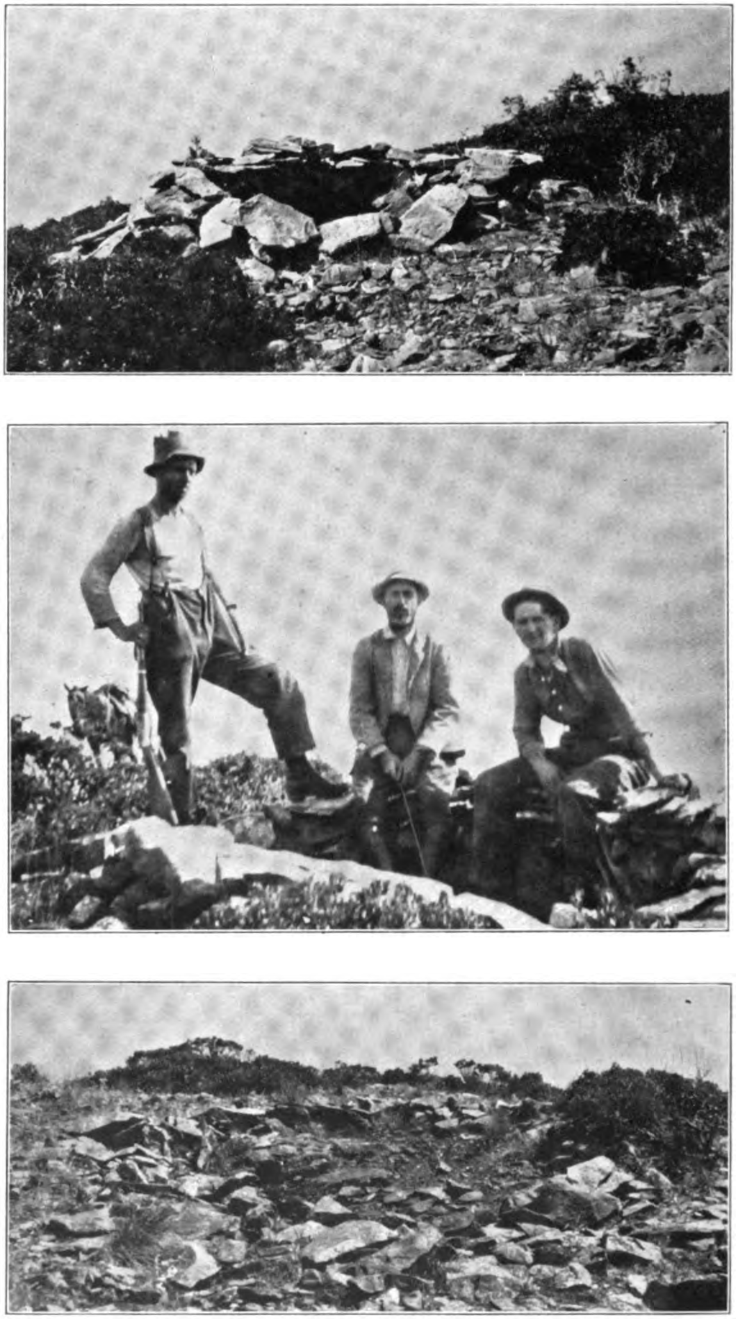

Fig. 34. Remains of stone ceremonial rings constructed by the Indians near the summit of Mt. Emily

an earlier stage of volcanic activity. Besides the main rhyolite mass, the syenite-porphyry and the brecciated metamorphosed sediments, there also occur several dikes of basalt and of a variety of rhyolite which is more porous than the one already described. These cut through the other rocks alluded to and seem to have been formed at a later stage of igneous activity than the main rhyolite flow represents.

The description of the geologic relationships of the various rocks constituting Mount Emily which has just been given, should be regarded as tentative, as the time available for the examination of this area was decidedly insufficient to permit the reaching of positive conclusions. It is believed, however, that conditions existing there are substantially as outlined.

Lode 34. Florence prospect. The Florence prospect was located March 4, 1914, and is owned by Charles M. Warren. It is situated just below the crest on the northern slope of Mount Emily. The deposit is along the contact between metamorphosed Dothan sediments and rhyolite. The hornfels resulting from the metamorphosis of the Dothan shale has been crushed, sheared, and silicified at this point, and in the crevices thus formed sphalerite and pyrrhotite have been deposited. The total width of the mineralized zone is about 8 feet; the strike is N. 35° E. and the dip 75 degrees S. W. A sample taken across this mineralized zone proved to contain 3.57 per cent zinc and a trace of gold, while a sample consisting largely of pyrrhotite yielded but a trace of gold. It is certain that this ore would yield a high-grade zinc concentrate, but the only opening on the vein consists of an open cut, and it is decidedly uncertain how extensive the deposit will prove to be. It seems likely, however, that the sulphides will be confined to points along the contact where an unusually great degree of crushing has occurred, and this will tend to give the deposit a "pockety" nature.

An eighth of a mile west of the Florence prospect, across a small gulch, is a cliff the face of which is heavily iron-stained and covered with pot-holes. It proved on examination to consist of a brecciated mass of rhyolite containing rounded cavities and seams filled with pyrite and quartz. A sample of the sulphide yielded not a trace of gold, however.

Lode 35. Lucky Warren prospect. This deposit is also owned by Mr. Charles M. Warren and is situated a short distance south of the

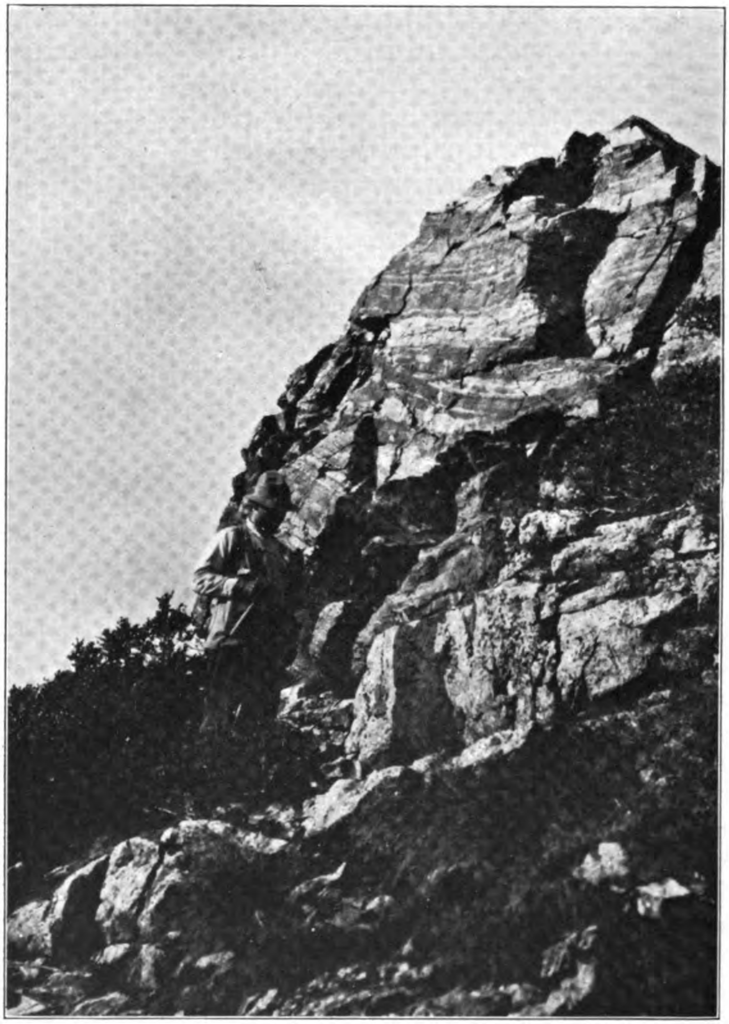

Fig. 35.—Large fragment of metamorphosed Dothan shale (banded hornfels) included in rhyolite, near summit of Mt. Emily

crest of Mount Emily. The deposit is similar in nature to that on the Florence claim, but the mineralized streak is narrower, and the interstices between the fragments of hornfels contain molybdenite. A sample across the whole ore body yielded on analysis 3.10 per cent molybdenum.

Another peculiarity of this deposit is the presence of considerable hornblende which was not seen in the Florence prospect. The mineralized streak is said to yield high gold values when panned, but a sample proved, when assayed, to contain not a trace of gold.

A number of other prospects exist on Mount Emily, and some of these are reported to be very promising. Lack of time and proper guidance made it impossible to inspect any except those already described, but it should be mentioned that at one point a shallow pit has exposed a veinlet of smaltite (arsenide of cobalt and nickel). This deposit is altogether too small to permit of profitable mining so no samples were taken.

From what has been said it must be evident that Mount Emily exhibits much of interest both to the geologist and the miner. The presence of ores of zinc, molybdenum, cobalt, nickel, and gold, 3 or 4 varieties of igneous rock, and sedimentary material which has been at some points metamorphosed in an unusual fashion form a combination of circumstances so unusual as to seem deserving of much more thorough investigation than it was possible for this party to give. It is hoped that some time in the future a party of geologists may map the district in detail and investigate the mineral deposits carefully. It is impossible to predict whether such an investigation is likely to prove economically profitable, but there is no doubt of the scientific interest and value which the work will have.

BALD FACE CREEK DISTRICT

This can hardly be said to constitute a district since very few prospects occur in this region; and only one of these was visited by the field party.

West of Smith river is an extensive occurrence of Dothan shale cut by at least one large north-south trending mass of serpentine. The Dothan shale extends west of Smith river also for about half a mile up Bald Face creek. Here the serpentine comes in once more, and doubtless extends beyond the eastern boundary of the county. This last mentioned serpentine mass is cut at various points by smaller masses of greenstone and dacite-porphyry, and what gold has been found here seems most probably to have had its source in one of these two igneous rocks.

Lode 36. Mark Wood's prospect. This is situated not far from Spokane creek which enters Bald Face creek from the north about

Fig. 36. Pit produced by ground sluicing on Mark Wood's prospect near Spokane creek

6 miles from the mouth of the last named creek. Gold was found here in the loose surface wash which has been ground-sluiced to such an extent as to leave the large pit shown in figure 36. Above this pit numerous trenches have been dug in an endeavor to locate the source of the precious metal. In this way it was found comparatively easy to trace the gold up the hillside to a contact of serpentine and igneous rock which resembles andesite rather closely, but is probably the equivalent of the dacite-porphyry found elsewhere in the county. This last named rock is itself in contact with a mass of greenstone which may be more specifically classified as gabbro. Both the dacite-porphyry and gabbro are decidedly altered and softened where exposed. It seems possible that they might themselves have been mineralized by solutions working up at the contact between them and the serpentine. Specimens of these rocks were therefore assayed, but neither contained a trace of gold.

While it is possible that the source of the gold beneath the wash has not been discovered, it seems likely that it comes from the contact between the dacite-porphyry and the altered gabbro where it occurs in a manner similar to the deposit in the Higgins mine in the China Diggings district about 13 miles north. If this is the case, there seems little likelihood of developing a mine in this region, since the mineralized contact is very narrow, and the ore could hardly be mined profitably unless of very high grade which it shows no indication of being.

STREAM PLACER MINES AND PROSPECTS

It was found utterly impossible to prepare complete descriptions or even a complete list of all the stream placer mines in Curry county. There are scores of old workings on some of the streams, which have been long abandoned and concerning which no data were obtainable. Diller indicates a number of these in U. S. G. S. Folio No. 89, and describes some of them. Others are not mentioned in the text of the Folio.

The Sixes river placers were examined by Mr. Mitchell. It may be that some of the claims he describes are identical with ones referred to by Diller under different names, and it is quite likely that their relative positions are not accurately shown on the map which constitutes figure 1. It is believed, however, that the information given will serve to indicate the general nature of the stream placers in that part of the county, and will suffice to show how generally gold-bearing are the upper stretches of the Sixes river. Diller in the Folio just mentioned writes as follows concerning the Sixes river district:

> Passing westward from the head of Salmon Creek in Coos County, the gold belt enters Curry County on the head waters of the South Fork of Sixes river in the vicinity of Rusty butte, where interesting discoveries have been made recently. Many years ago there was great activity along the Sixes, in mining the benches which rise to about fifty feet above the river. The mines were most abundant from the Forks westward, and are represented by a number of cabins long since deserted. The bed rock is generally Cretaceous conglomerate, sandstone, and shales, and the gravel is composed of pebbles of the same material. At the mouth of Elephant Creek the terrace mined exposes about twenty-five feet of gravel, of which about an acre has been removed. Above the junction of the Middle Fork there has been but little mining, the region being covered largely by Eocene sediments; on the South Fork mining in a small way is still carried on, but is confined to the present stream beds during the low water of summer. Some of the earlier mines were in gravel benches as high as 130 feet above the present stream. * * * The bed of Butcher Gulch, on the northeast slope of Mount Butler, has been washed for a long distance from its mouth. Above the mouth of Rusty Gulch the bed and benches of the South Fork have not been found productive.
>
> For five or six miles below the Forks of the Sixes the placer mines have been idle for many years, but after reaching Edson Creek four active mines are found, one operated by Mr. Corbin and the others by the Messrs. Divelbiss. * * * The Sixes, especially in its lower course, is over-loaded by the large amounts of debris brought in by the great slide of February, 1890. One slide 200 by 150 feet in extent, covered a house and other buildings and killed three persons and twenty-one head of stock. * * *
>
> Beyond the mouth of Edson creek in the Sixes region all the placer mines are in marine deposits.

The stream placer deposits described in this report are consecutively numbered according to their locations, beginning in the northern and western part of the county and progressing to the southern and eastern portions. Their approximate locations are indicated on the map which constitutes figure 1.

Placer 1. The Sixes Mining Company. This company has an option on a number of claims originally owned and worked by the Divelbiss family. They first gave an option on the property to C. Inman who transferred his interest to the Sixes Mining Company, and now has no interest in the property. Diller describes[1] the claims owned and once operated by N. C. Divelbiss as follows:

> The most extensive (of the placer mines then being operated below the Forks of the Sixes), operated by N. C. Divelbiss, is on the left bank in the sharp bend two miles above the mouth of Edson creek, and covers a large part of an acre. The gravel bank, worked by water under pressure, is fifty feet high and rests on Cretaceous sedimentary rocks. Farther west, near the mouth of Edson creek, on the right bank, is an upper terrace of large extent which has been mined on the edge, but with scarcely sufficient success to warrant the fluming necessary to supply the water that is needed to do the work satisfactorily.

.Diller also states[2] as follows relative to the platinum content of this ground:

> In order to get a clew to the source of the platinum (in the beach placers), if possible, concentrates were obtained from the placer mines at several points along the Sixes. Ascending the river, the first was obtained from Mr. N. C. Divelbiss's mine on the left bank of the stream about three-quarters of a mile above the mouth of Dry creek. The sample submitted contained the concentrates from a clean-up after removing the gold. It weighed about 22.87 grams, of which 5.78 grams (about 25 per cent) were separated by the magnet. Platinum scales were found rather abundant, and non-magnetic, so they remained in the non-magnetic portion. The scales generally were very small, but one well-rounded by attrition weighed .03 gram. The scales are generally malleable and sectile and of steel-gray color, distinguishable from the nearly tin-white and almost brittle scales of iridosmine, which are about one-third as abundant as those of platinum. In the estimates given below the platinum and iridosmine are counted together. The residue was passing through a series of sieves ranging in size from 60 to 100 mesh per inch, separating it into six lots which were then panned out. Nearly all the platinum was caught in the 60, 80 and 100 mesh. The total yield was .384 gram—about .0168 per cent of the total sample examined. A ton of such sand containing the same proportion would have about $7,500 worth of platinum alone. This material is highly concentrated, and there is no means of determining how many cubic yards of original gravel it represents, so that the value of the platinum per ton of gravel is unknown. Besides magnetite, the other minerals are chiefly chromite and ilmenite, with much zircon, epidote, and garnet and a trace of cinnabar.
>
> Another sample of concentrates from the same mine, weighing 60 ounces, contained platinum at the rate of about $17.00 a ton, and the gold was about seven times as abundant as the platinum, but in this case as in

1 U. S. Geol. Surv. Folio 89.
2 Op. Cit., p. 6.

the first the amount of gravel represented by these concentrates is unknown.

In order to get an idea of the relative values contained in the gravel of the mine, the concentrates from two pans of gravel next the bed rock were obtained from Mr. N. C. Divelbliss. They contained 32½c in gold, but no platinum was found. Two pans of gravel from 25 feet above the bed rock contained 3c in gold and no platinum.

Mr. W. A. Bechtel of San Francisco the General Manager of the Sixes Mining Company very kindly furnished the following information about the work being done, under date of May 26, 1916:

LOCATION: The Sixes Mining Company is operating on the Sixes River in Curry County, Oregon, about 11 miles from Port Orford and 70 miles south of Marshfield, on what is known as the Divelbiss property, approximately 300 acres.

WATER RIGHTS: The water rights of both the Little and Big Edison Creeks have been obtained and their waters are being confined by a dam on the Big Edison, and will be used in mining operations on this property.

FLUME: The Sixes Mining Company has constructed a very substantial 3′ x 4′ flume, four and one-half miles in length, from the above mentioned reservoir. This gives a fall of sixteen feet to the mile, and delivers water into the penstock with a 296′ head, measured from bed rock. We avoided construction of ditches on account of the porosity of the soil; in fact, from the very nature and ruggedness of the country traversed by the flume, we decided it would be more economical to build a flume and thus avoid the loss of water which generally occurs in ditch lines, to say nothing of the annoyance and loss of time.

CHANNELS: We have three distinct channels traversing this property, but the magnitude of these is not clearly defined as much of the surface is covered by a heavy growth of timber. The first channel, the present bed of the Sixes River, varies in width and depth. We expect to sample and prospect this channel methodically this coming season in an endeavor to determine the value of the gravel. Mining here will be done with dredges which will be operated by electric power developed by the same water as is now being used in washing on the second channel. The second channel is now being washed with water taken from Edison Creek as before mentioned. We have found this channel to be 100′ wide from rim rock to back wall, with a depth of 55 feet of gravel and a layer of well packed sand about two feet thick and twenty-five feet above bed rock. We have encountered no heavy boulders, and found it possible to handle this material very satisfactorily. We have found excellent values in the first six feet of blue gravel on the bed rock, with profitable values to the grass roots. The third channel lies above the second channel, but its extent has not been fully ascertained. It has been prospected, however, and seems to carry very good values. In fact, uninterested people maintain that this channel carries better values than either of the other two.

OPERATIONS: We have been operating for the past thirty days using one giant with a six inch nozzle. This supplies our present sluice flume with as much material as it will carry with best results. This "run" is in the nature of an experiment to determine the best methods to be employed to save the values existing in our grounds.

GOLD, PLATINUM AND BLACK SANDS: We find that our property contains much black sand and platinum; and our earlier prospecting indicates that at least 10% of the values are in platinum. The black sands have received much attention and study from everybody who has

tried to work in this district since it has been found difficult to extract the gold and platinum contained therein. We have devised a method for doing this which, if it proves successful, will be given to the mining world in general, for we realize that the extraction of the values in this material has been a stumbling block to the success of many mining companies. The gold in our property runs better than $18.00 per oz., as determined by many assayers' reports. It is what is known as fine gold, nothing of nugget size having yet been found. The largest grains are about the size of a kernel of rice and are usually considerably flattened. The superintendent of our property is of the opinion that he will catch most of the gold in the first three or four riffles. We are, however, using undercurrents for additional production.

Placer 2. Corbin property. Diller has already been quoted as stating that at the time of his examination 4 placer mines were active between the forks of the Sixes and Edson creek, and that one of these was operated by Mr. Corbin. This property was not in operation during the summer of 1915, and the only information available concerning it is the following statement[1] by Diller relative to the platinum content of the gravel:

On the right bank of the Sixes about a mile above the mouth of Dry Creek, nearly opposite Mr. N. C. Divelbiss's mine is a placer operated by Mr. W. O. Corbin, who informed the writer that one winter he saved $11.00 worth of platinum from his washings. He sent 44 ozs. of sand from the mine, which was sieved and washed; it yielded .176 gram of gold, less than one hundredth part as much iridosmine, and no platinum. The relation of the concentrates to the gravel being unknown, the value of the gravel per ton cannot be given.

Placer 3. Hydro Sixes Mining Company. Mr. C. C. Inman, of Denmark, Oregon, is the owner of 3 claims which were being operated under the above name at the time this investigation was made. Of these 3 claims, one, the Fariar, was acquired by purchase in 1914, while the others, the Tilly B. and Mazie, were located in June, 1914. The building of ditches was begun in August, 1914, and work had progressed steadily on the Tilly B. up to the time of the examination, half a mile of ditch having been finished during the fall of 1914. The claims are said to be located 12 miles from the highway bridge across the Sixes river. Whether this is an airline distance, or is the length of the trail to the bridge is not stated.

The deposit is an old high bar 30 feet above the present level of the river, and consists of a gravel bed about 20 feet in thickness. The ground has been prospected by means of shafts and pits and it is claimed that it averages about 25 cents a yard. It is further claimed that fine water-worn shot gold occurs scattered throughout

1 U. S. Geol. Surv. Folio 89, p. 6, 1903.

the gravel bank. Considerable platinum is found with the gold, and the grains of this metal are said to be coarse.

Forty men were employed on this property during the fall of 1914, but only two men were working there at the time the examination was made.

Placer 4. Byers and Hollenbeck claims. A. G. Byers and G. H. Hollenbeck own two placer claims on the south side of the South Fork of Sixes river, which they acquired by location in August, 1915. At the time this examination was made they had just begun work, and had panned about 50 pans of gravel which averaged one good color per pan.

The gravel bank is an old bench 15 feet above the present water level, and averages about 10 feet in thickness. The best values are said to exist on the bedrock. When interviewed, the owners were planning to sluice the gravel.

Placer 5. Wagner claim. Diller says[1] that at the time of his examination the Wagner claim, about a mile below the mouth of Butcher gulch, was being worked by Mr. J. L. Searle and others from the state of Washington. "The whole stream was dammed to a height of about 5 feet and 2 lines of sluice boxes were suspended on numerous logs felled across the stream. A steam pump and 9 men were employed."

Placer 6. Way claims. At the time of this investigation, Mr. C. A. Way was working 3 placer claims, the Rainbow, Robert Harrison fraction, and the Nugget Patch, acquired by purchase in 1912. These have been worked by hydraulicking from the time they were purchased. The property is equipped with 800 feet of flume and 600 feet of pipe. It is claimed that $700 worth of gold has been taken out of this ground, and that the values are confined largely to a point in the gravel just above the bedrock.

Mr. Mitchell gives the location of this property as being just below the Wallace and Hadley claims next described.

Placer 7. Wallace and Hadley Claims. Tom L. Wallace and Oliver C. Hadley own 2 placer claims known as the South Fork Nos. 1 and 2, the relocation of which was recorded January 1st, 1915. This property was originally called Thompson Flat. They began work in March and had 160 feet of pipe on the claim when the examination was made. The first gravel was washed in May, and

1 U. S. Geol. Surv. Folio 89, p. 5, 1903.

it is claimed that $165 worth of gold was taken out during the spring of 1915. It is said that the values are confined to within about one foot of the bedrock with the greatest proportion of the gold directly on the bedrock, and that no clay is present to interfere with the saving of the gold. Very little platinum is found in this ground, and no attempt to save it has been made.

Placer 8. Guerin claim. The only information obtainable concerning this deposit are the statements[1] of Diller that at the time of his investigation

The Guerin brothers were ground sluicing just above the mouth of Butcher Gulch. * * * From one of the Guerin brothers who works a placer along the South Fork of the Sixes, the writer obtained about 5 ounces of concentrates, to examine for platinum. Nearly 85 per cent of the concentrates was magnetite, and the remainder was chiefly ilmenite or chromite. Numerous scales of gold were present, but no platinum or iridosmine was found."

Placer 9. Crawford and Fay claims. Mr. and Mrs. S. B. Crawford and Emmet Fay are the owners of 4 placer claims which they were developing at the time of this investigation. These are the Old High Channel, located in June, 1915, the Dixey purchased for $500, and the Dixey Extension Nos. 1 and 2, which were located during July, 1915. The first named is an old high river bar, but all the work was being done on the other claims and was confined to sluicing along the creek bed. The owners said they had taken out $20 worth of gold in 3 days' mining, and that most of the values were found directly on the bedrock.

Placer 10. Smith and Robinson claims. M. A. Smith and J. B. Robinson own 3 claims at the mouth of Rusty creek. These are the Big Nugget, located in 1915, and the Big Foot and Nut Wood, located the previous year. The owners were ground-sluicing in the bed of Rusty creek, and they claimed to have recovered $14.60 in gold at the date the examination was made.

Placer 11. Old Chinese workings on Elk river. Just below C. W. Curl's prospect on Elk river is a small bar which the Chinese worked in the early days. Some of their equipment is still on the ground, but no information concerning the property was procurable. It is claimed, however, that a great deal of gold was recovered, and that the values persisted up stream as far as the mineralized zone on Mr. Curl's claim, but that no gold was found above this point.

Placer 12. Rock Creek claims. This property, which is owned

1 U. S. Geol. Surv. Folio 89, pp. 5-6, 1903.

by Mr. John R. Smith, is situated in Coos county, but is so close to the Curry county line, and was the seat of so much excitement during the spring of 1915, that it was deemed worth while to examine the district.

Mr. Smith reached the property in October, 1914, and claims to own by right of relocation 4 placer and 8 lode claims. His title has been disputed by former owners, but he insists he has evidence that no work had been done upon the property for at least 3 years prior to his arrival.

He has made and installed 500 feet of sluice boxes, and has done a great deal of additional productive work. He states that 3 men, working with pick and shovel and often contending with 9 feet of snow, took out $3,500 worth of gold in two and one-half months during the fall of 1914. He says that he left the property on January 18, 1915, and freely showed the gold he had recovered. This caused two men to go to the property during his absence and to work thereon without permission from him. From what could be learned from Mr. Smith, it seems likely that at least one of these had some title to the property or at least supposed this to be so.

Mr. Smith further claims that he recovered $2,000 worth of gold after his return to the property in the spring of 1915. At the time of this investigation, he was putting in ditches and laying plans to mine the ground on a large scale. He says that the gold is coarse and unworn, and is very pure, averaging about $19.50 an ounce in value. He has found that it hugs the bedrock closely.

Placer 13. Solitude bar, and Placer 14. Paradise bar. Extensive gravel terraces exist at both Solitude and Paradise bar on the Rogue river, and a great deal of work has evidently been done in these localities in past years. It was found impossible, however, at the time of this investigation, to secure any information concerning these properties.

Placer 15. Red River Gold Mining Company. Diller describes[1] the property of this company as follows:

> **The Red River Gold Mining and Milling Company has eight claims on the low terraces on both banks of Rogue River, just below the mouth of John Mule Creek, about 30 miles below Galice. The slate floor of the mine is 20 feet above the river. It is capped by 30 feet of gravel, which is covered by an overburden of fine material 35 feet in thickness. The overburden is slippery, and is separated from the gravel by a sharp line.**

1 U. S. Geol. Surv. Bul. 546, pp. 115-6, 1914.

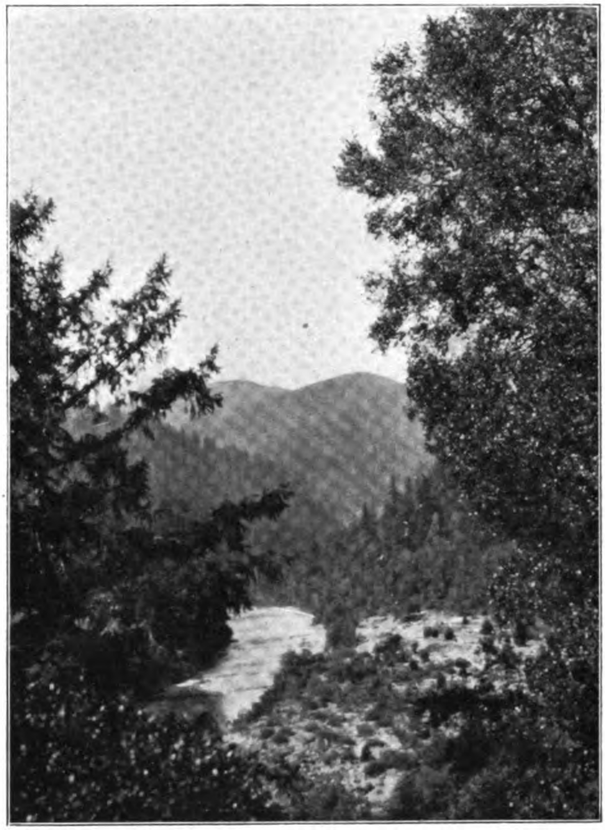

Fig. 37. Placer ground owned by the Red River Gold Mining Company on Rogue river below Mule creek

The gravel is mostly coarse, the largest bowlders being 15 inches in diameter.

The water supply comes from John Mule Creek through 3½ miles of 4-foot flume and ditch (Figure 38 shows the high trestle over which the flume crosses the western fork of the creek), giving at the mine approximately a 260-foot head for one 9-inch and two 6-inch nozzles.

The gravel is forced up over a grizzly twelve feet wide to a height of 15 feet. (Figure 39 is a photograph of this grizzly). Only about 5 per cent of the material covering the gold goes through the screen of the grizzly to the sluice boxes. The gold is fine and in general hard to save. On the left bank it is said to be coarser.

Much of this property was mined over years ago, and several acres have been mined recently, leaving but a small portion of the original available material.

Statements vary greatly as to the amount of production. The removal of the overburden has been a serious handicap. The present

owners secured the property within the last few years and are making preparations for more extensive work.

Farther down the river, especially at Paradise Bar and Big Bend, a number of other companies have operated more or less extensively, but none of them appear to have been successful.

Mr. W. H. Corwin states that the 8 claims mentioned by Diller, together with another fraction, were purchased in June, 1906, from R. A. Mattoon for the Red River Gold Mining and Milling Company, a corporation, and another claim, the Grace H., has since been acquired. He says further that about a third of the development shown on the property was done by Billings and Marks previous to the purchase of the ground by the Red River Gold Mining Company, and that this company quit work in April, 1912, after taking out between $8,000 and $10,000. Mr. Corwin acted as superintendent for the company and he and George M. Cheney of Indianapolis, Indiana, are now the sole active bond holders. Cheney now owns most of the bonds, and Corwin is working the property under an option to purchase given him by Cheney. Corwin began work September 20, 1914, and up to the time of this investigation had done little but prospect.

Corwin claims that the gravel runs about 9 cents per yard, but that the material which passes through the grizzly and into the sluice boxes averages 18 cents. He has found that the upper 8 feet of the bar contains the best average values although the larger particles of gold lie deeper. He says that the available head of water is 180 feet instead of 260 feet as stated by Diller. At the time of the examination he was using four 6-inch giants, but was planning to employ at least 8 giants during the winter. The flume which furnishes water for this property is said to have cost $80,000.

Placer 16. Cardwell placer claim. W. W. Cardwell, of Roseburg, owns a placer claim on the west fork of the west fork of Mule creek. It can be operated only when water conditions are favorable, as the gold is being recovered from the gravel in the present creek bed. No data concerning the success of these operations could be secured, but it is reported that they have been quite profitable.

Placer 17. Winkle bar. Diller describes[1] this property as follows:

Nearly a mile below the mouth of Ditch creek and 26 miles below Galice, on the right bank of Rogue river, is a large terrace known as Winkle bar. It contains perhaps 30 acres. The slate bed-rock terrace

1 U. S. Geol. Surv. Bul. 546, p. 115, 1914.

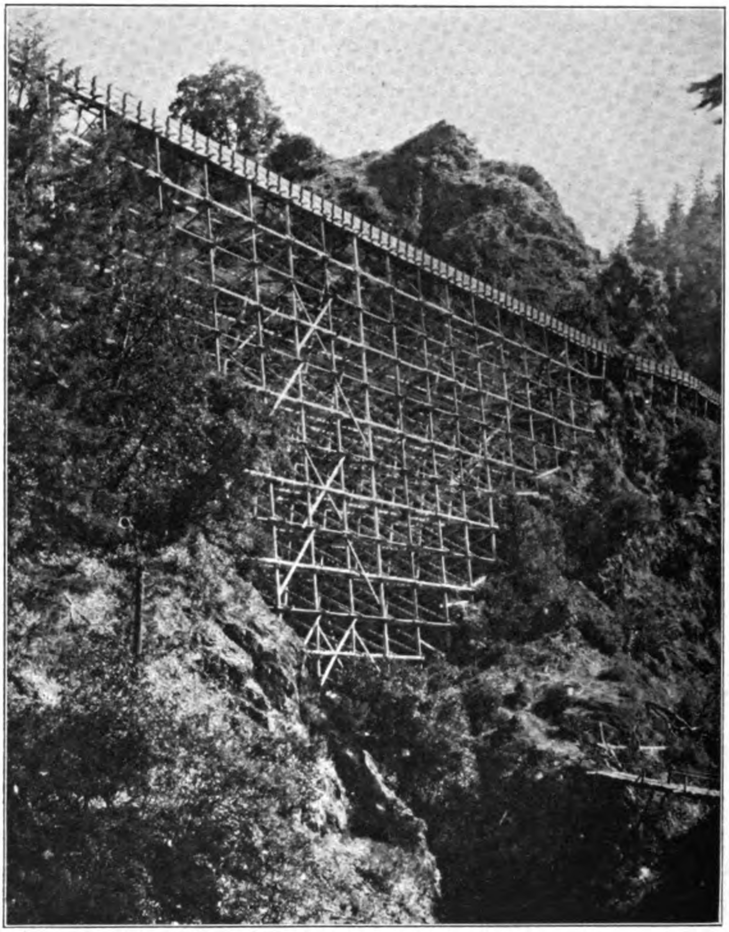

Fig. 38. High trestle on which the $80,000 flume of the Red River Gold Mining Company crosses Mule creek

rises about fifteen feet above low water in the river, and is capped by 20 to 30 feet of gravel which is generally coarse, half of it consisting of boulders over 5 inches in diameter. A small placer operated here some years ago and a test shaft encourages the Winkle Bar Developing Company to plan for larger operations. Ditch creek, with a few miles of ditch, will supply water with a head of 120 feet. The gold is fine and will require special precaution for its recovery.

Placer 18. Battle bar. Diller describes[1] this property as follows:

1 U. S. Geol. Surv. Bul. 546, p. 115, 1914.

Fig. 39. Grizzly and flume of the Red River Gold Mining Company. Only the material passing through the grizzly goes through the sluice boxes

At Battle Bar, on the left bank of Rogue river a little above the mouth of Ditch creek, a terrace 20 to 25 feet above the river is capped by gravel that has been tested by a small placer and said to yield good values. I

saw it only across the river, but the deposit appears to be similar to that of Winkle Bar a mile farther down the river.

Placer 19. Ink and Barr property. When this investigation was made, L. G. Ink and Will Barr were working the Old Bonanza claim, now called the Gold Slug, which they purchased from George Curry. They also located on March 10, 1915, three other claims along Boulder creek below the Gold Slug, which they called Iron Mountain, Nugget Bar, and Lilly, making their total holdings a mile in length. $1,500 worth of gold is said to have been taken from the Gold Slug claim before the present owners purchased it.

The present owners began work in April, and at the time of the examination were sluicing the loose surface soil on the south side of the creek, in which they were finding gold from grass roots to a depth of about a yard. This gold was coarse, the pieces averaging 25 to 50 cents each and including nuggets worth $6 to $10 each, and often larger, although the largest they had on hand at the time of the examination was worth something over $2. They state that Curry secured one nugget worth $65 from this claim, and that they found another weighing 4 ounces, 9 pennyweights for which the Mint paid them $93.60. Most of the gold is decidedly worn, but some is so jagged that it could not have come any considerable distance.

One or more old terraces exist on the southern hillside above the present workings, and it seems likely that the gold has slid down from these, although they do not appear to be as rich as is the loose material now being sluiced, of which 250 cubic yards are said to have yielded $100 in gold. The bedrock beneath the present workings is serpentine, but the contact between this material and Myrtle sandstone crosses the Gold Slug claim.

Below the Gold Slug the stream widens and a decided flat has developed. That gold is present here seems well established, but the nature of the ground is such that it must be worked, if at all, on an extensive scale by means of giants. At the time of the examination two men were prospecting on the lower end of the Lilly claim, but had not done sufficient work to indicate the value of the deposit.

Above the Gold Slug claim is the Blue Bell placer owned by D. Chapin and H. Rowlan; while above this is the Big Nugget claim located by John R. Hurst during the rush to this district occasioned by the Smith discoveries on Rock creek. Practically no work has been done on these claims, and no further data concerning them were obtainable.

Placer 20. Schulz and Ainsworth claims. At the time of the investigation, R. Schulz and C. Ainsworth were prospecting on the Great Falls and Tender Foot claims below the Lilly. They were doing the work under an option from Dan Rowlan, the owner.

In the lower end of this property the bedrock is smooth serpentine, and runs down to a V, so that little gold has been caught there, and they had saved almost nothing during the month while they had been at work. A short distance above their present location, however, there is a flat toward which they were working, and where they expected to find gold.

Placer 21. Boulder Creek Mining Company. At the junction of boulder creek and the south fork of Lobster creek is an extensive bar known as Old Diggings. The Boulder Creek Mining Company intended to work this property extensively with giants during the winter, and, with this end in view, had ordered 1,000 feet of piping to communicate with a long ditch constructed by A. W. Wilheit. This property was not visited, and no information concerning the success of the undertaking could be secured.

Placer 22. Gold bar. This property is located at the old post-office of Illahe, three-quarters of a mile below the present postoffice of the same name. It is on the northwestern side of the Rogue and is owned by T. W. Billings.

Mr. Billings states that the first work on the property was done in 1856, and that the present ditch was started 11 years ago by H. J. Russell who began to mine 7 years ago. The present owner bought the property from Russell's heirs on October 6, 1911, and it has been worked every winter since then. He says he took out $156 in one month the first year; and that during the second year he cleaned up $300 in gold dust, and stored seven and a half tons of sand averaging $272 a ton, which was subsequently washed away. During the third winter, Post and G. P. Murch tried to use a Sweet Gold Machine on the property, but the result was unsatisfactory as there was so much clay in the gravel that the machine became badly clogged.

That portion of the gravel which has been most extensively mined averages 9 feet thick and is covered with about 4 feet of overburden. It is an old high terrace, and the owner claims that at least 2 other such terraces or channels exist on the property. Several engineers have examined the property, and one named Post claimed that the gravel averages 40 cents per yard in gold. Another named G. P.

Murch claimed that it ran only 25 cents per yard. Most of the gold is fairly coarse, and of a flaky nature. The larger pieces are found near bedrock and some of these are worth as much as 25 cents. No attempt to save platinum was made until the winter of 1914-15. During an 80 hours' run made then, a quarter of an ounce of this metal was secured. The bedrock is black Eocene shale together with some sandstone.

A thousand miner's inches of water is brought to the property in a ditch. This gives 180 to 200 feet fall where Mr. Billings has done most of his work, and 100 feet fall to the higher bars.

Placer 23. Name unknown. Many have expressed the opinion that there must be much gold in the bed of Rogue river beneath the present channel, and, just as the field party was leaving Agness, it was learned that an attempt was to be made to dam a portion of the stream between Agness and Illahe where it is split into two portions by a low island. It was proposed to divert all the water through the western channel and to mine the eastern channel laid bare by this means. It was stated that a similar attempt in the past had met with failure because the dam could not be made to hold. As the party did not again visit this locality, details concerning the success of this last experiment could not be learned. It was rumored, however, that although the dam held satisfactorily, so much water

Fig. 40. Long Tom operated successfully by A. M. Collins and G. W. Way on the bank of Rogue river at Agness

worked through the gravel beneath the dam that no attempt could be made to extract the gold in the bed of the river.

Placer 24. Collins and Way prospect. During the time the field party was in the vicinity of Agness, A. M. Collins and George W. Way were working on the north bank of Rogue river, just below the mouth of the Illinois river. At that time the water in the Rogue was very low, and a considerable stretch of gravel deposited in the stream during high water was exposed along the bank, where it rested on some natural riffles produced by the outcropping of hard bands of Eocene shales and sandstones, which at this point stand almost perpendicularly, and have a strike at nearly right angles to the direction of stream flow. The gravel here varied in thickness from an inch or two up to a foot or more, and the total amount available was comparatively small, but the two men mentioned were making good wages with a very primitive plant consisting principally of the "Long Tom" shown on figure 40. Much of the gold they were securing was fairly coarse (as large as a grain of wheat), but was decidedly flattened and worn, indicating that its source was a long way distant. A considerable, but unknown, amount of platinum was associated with the gold and was being saved.

Placer 25. Evans prospect. Mr. Frank Berry is authority for the statement that in 1895 an old man by the name of Evans found a great deal of rough gold, some in nuggets worth $20 or more, in Blue Slide creek just west of the Craggies (see figure 41), but that he was driven out by a great slide and escaped with nothing but his life. When totally destitute and suffering from privation, he was

Fig. 41. Sugar Loaf and the Craggies from the west

given succor by Mr. Berry, and in gratitude, revealed the exact location of his find. The slide mentioned still covers the gold-bearing gravel, but the source of the gold must be close at hand, and it would seem well worth while to do some careful prospecting in that district.

Placer 26. Gold Basin. This locality was visited, but Diller describes[1] the deposits there as follows:

About the head of Tin Cup creek, fifteen miles northwest of Kerby, there is a V-shaped remnant of the Klamath peneplain known as Gold Basin on a large mass of granodiorite. The apex of the V points east, and across its southern arm is a broad, shallow valley filled by an old stream bed running approximately N. 20° W. The surface plain of the stream bed is more than 1,000 feet in width and 2,000 feet in length and is limited at both ends by deep, rugged canyons. The gravel has a thickness of 110 feet where best exposed on the steep southern slope. Near the bottom the gravel, though somewhat decomposed, is more or less firmly cemented, and this condition exists throughout the mass. It has been tunneled on bed-rock for thirty feet. The material is generally coarse, mostly cobblestones up to boulders 4½ feet in diameter mixed with pebbles and sand. There are no layers of sand to afford definite evidence of stratification. The pebbles are well rounded and are for the most part composed of basic eruptive rocks, greenstone, gabbro, peridotite, and pyroxenite, with some of granite. Though generally greenish, they are in places colored reddish by a surface deposit of oxide of iron. The top portion of the deposit is finer, with some fine gravel capped by a reddish soil. Wherever I saw the pebbles in place the course of the stream was not clearly indicated by their position, though they appeared to be inclined southward, and it is believed that the stream came from that direction. The gravel was tested in 1875 or 1876 by sinking a shaft (now filled with water within twenty feet of the surface) and found to contain very little gold. Most that was found is said to have been in the fine material of the surface.

The only available water is snow water, which is obtainable only in small amounts during a short season. It is gathered by a mile or more of ditch, but reaches the mine with scarcely 15 feet of head, and only a small amount of gravel was mined before work was suspended.

BEACH PLACER MINES AND PROSPECTS

The old high beaches, as well as the present ocean beach, have been worked in scores of places with more or less success, and a book migh be written of these attempts if one had the time and inclination to investigate the matter. Considerable data concerning these deposits have already been given (see page 48); and it seems to be most closely in accord with the purpose of this report to add only the descriptions of placers working at the time this investigation was made, together with those of a few others concerning which definite information was obtainable from the reports of others.

Beach 1. The Sixes mine. Diller describes[2] this mine as follows:

The Sixes Mine is located about 2½ miles south of Denmark, near the line between Secs. 27 and 34, T. 31 S., R. 15 W., and is operated by

1 U. S. Geol. Surv. Bul. 546, p. 96, 1914.
2 U. S. Geol. Surv. Bul. 546, p. 127, 1914.

Mr. W. P. Butler of Lakeport, Cal. Like the Blanco mine, it lies along the eastern border of the coastal plains, at an altitude of nearly 200 feet above sea level. The mine covers about an acre and has a depth below the surface of about 12 feet, exposing along the eastern border the following section:

Section of the Sixes mine, 2½ miles south of Denmark.

	Feet
Surface material, wind-blown sand and soil	5
Gray sand with boulders	2
Black sand with boulders	2½

The whole 9½ feet of material is more or less distinctly stratified and dips gently westward, away from the shore, which is formed of crushed sandstone and shale of Cretaceous age. This bedrock series is well exposed in the eastern portion of the mine and contains rock oyster borings. The decomposed fine sediments yield tough bluish clay, which on the surface for six inches or so is stained reddish and becomes more granular, affording a good bedrock for mining. The gravel is washed into a pool and raised 15 feet by a hydraulic elevator to get drainage for sluicing and tables. Much of the gold is fine and is associated with platinum metals in sufficient quantities to make the saving of them a matter of some importance.

The lack of adequate water supply and good drainage renders mining so expensive as to retard the development of hydraulic mining along this promising old beach. It would seem to be an encouraging locality to test by a modern dredge.

Beach 2. Cape Blanco ocean beach. The present ocean beach in the vicinity of Cape Blanco is reported to be unusually rich, and there seems no doubt but that large quantities of gold have been extracted from the sand by means of primitive methods. As has already been mentioned (see page 49), a Sweet gold machine was installed on this beach during the summer of 1915, but while considerable gold and platinum was recovered, it was found impossible to work the sand profitably, as the strong winds which prevail there filled up the cuts as fast as they could be made.

Beach 3. The Blanco or Madden mine. Diller describes[2] this mine as follows:

The Blanco Mine is about midway between Port Orford and Langlois, along the inner border of the coastal plain, at the foot of Madden butte, in the N. E. ¼ Sec. 4, T. 32 S., R. 15 W. When last seen it was operated by Mr. Cyrus Madden with about 500 feet of sluices and 7 burlap tables for catching the fine gold which constitutes about one-half the whole product. Platinum metals occur with the gold at this point and are about one-twentieth as abundant. The section exposed in the mine includes about 8 feet of wind-blown material next to the surface, below which lies from 12 to 20 feet of sand with small, black layers and some gravel. Some of the dark layers are coated by oxide of iron, and one of these is used as a bedrock on which to wash the overlying material. The real bedrock, which lies 10 feet below, is Cretaceous shale, but it is too low for drainage across the plain. The working season usually lasts six months, from November to May, and the mine from 1898 to 1900 yielded over $1,100 annually. The beds of sand and gravel of the ancient beach dip gently (10°) westward and over-lap the older rocks at the base of

2 U. S. Geol. Surv. Bul. 546, p. 126, 1914.

Madden butte. The mine already covers an area of several acres, and there is reason to expect that it will continue profitable farther along the shore, especially at deeper levels, if possible to drain to bedrock.

Beach 4. Meek's (Eckis) mine. Diller describes[1] this mine as follows:

On the Meeks mine, near Port Orford, Mr. R. G. Eckis has been running an Eccleston Tension Concentrator twenty-four hours a day for some time. He is using a giant to wash the sand into a sluice box in the bottom of which he has the screen, thus taking the heavy black sand out in an undercurrent. This product is then run over the concentrator. He reports that he is securing 80 per cent of the gold, platinum, and iridosmine, and he says his concentrates run over $8,000 a ton total value. One machine handles the undercurrent from 150 cubic yards a day.

Mr. Diller does not say whether the Meek's mine is on the present ocean beach or one of the old high beaches, and its exact location is unknown to the writer.

Beach 5. Kalamazoo ocean beach mine. No data concerning this property were procurable, but it seemed worth while to mention it since Diller states[2] that at the time he made his last investigation of this region it was reported to be the most productive mine in Curry county. He says that it is located in the Ophir district near Corwin, but as Ophir and Corwin are about 6 miles apart its location (as shown on figure 1) may be erroneous.

Beach 6. Collins mine. During the winter of 1914-15, A. M. Collins, of Agness, worked a black sand deposit on ground owned by the Wedderburn Trading Company, about 4 miles north of Wedderburn. He says the deposit is in an old beach about 30 feet above the present water level, and consists of from 12 to 18 inches of nearly pure black sand containing good gold and platinum values, with several feet of lower grade material above, which was separated from the lower streak by 2 to 3 feet of low-grade gray sand. He caught the gold on canvas tables, and, in spite of the fact that he had to pay 30 per cent royalty to the owners of the ground, he succeeded in making good wages throughout the winter.

Beach 7. Idaho mine. This property, which is situated on the present ocean beach a mile south of Gold Beach, is the one which Mr. W. H. Williamson of Gold Beach attempted to work 7 years ago. The failure of this attempt, and the reasons which Mr. Williamson assigns for this, have already been mentioned (see page 49). Although a number of deep pits were dug on this property, they have since been so filled with wind-blown sand that it was impossible to examine the gold-bearing beds. From what was seen, however, it seems certain that these are here covered with many feet of worthless or low-grade sand.

1 U. S. Geol. Surv. Bul. 546. p. 127, 1914.
2 Idem.

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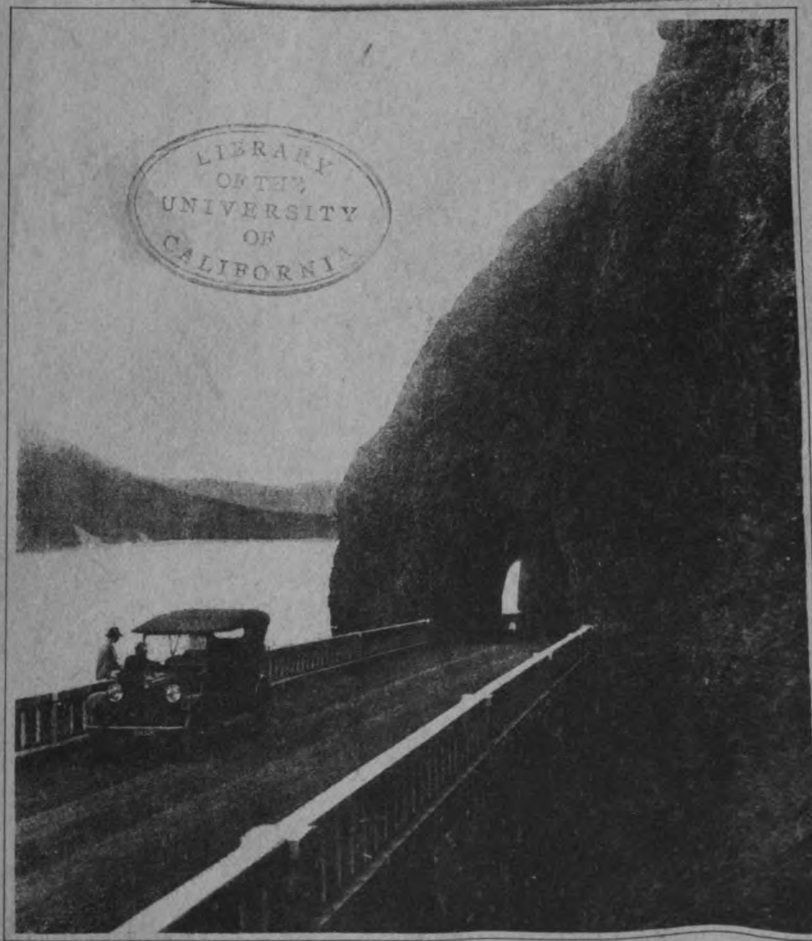

Mitchell Point tunnel and viaduct, Columbia River Highway
The "Axenstrasse" of America

The Columbia River Gorge: its Geologic History
Interpreted from the
Columbia River Highway

By IRA A. WILLIAMS

130 Pages

77 Illustrations

OREGON
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CONTAINING

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1916

ANNOUNCEMENT

The present number of the Mineral Resources of Oregon is devoted to a discussion of the salient geologic features of the Columbia river gorge. The work upon which this paper is based involved a somewhat detailed study of the structure of the Cascade Range, as it is exposed in the walls of the stupendous gorge which the Columbia river has cut, from summit to base, directly across its main axis.

In the May 1916 issue, the geologic features of the higher parts of certain sections of the Cascade Range were given general consideration. The work in the Columbia gorge is a continuation of the investigation thus started, by which the foundation is being laid for a comprehensive understanding of the occurrence, distribution and value of the ore deposits of economic importance in this mountain range. It is of interest to announce that there has been found in the Columbia gorge, where its age and relationship can be made out, a great body of intrusive rock that is similar to the granitoid masses which have apparently influenced the deposition of workable bodies of ore in the various mining districts southward in the Cascade Range in Oregon.

The concluding (December) number of the Mineral Resources of Oregon for 1916 is a handbook or directory of the mining industry of the state. This work will consist of two parts, a discussion of the various mining districts, and a classified list of mining companies, mines and prospects, alphabetically arranged.

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VOLUME II NUMBER 3

NOVEMBER, 1916

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of all her Minerals

PUBLISHED MONTHLY AT CORVALLIS BY
THE OREGON BUREAU OF MINES AND GEOLOGY
H. M. PARKS, Director

THE COLUMBIA RIVER GORGE: ITS GEOLOGIC HISTORY INTERPRETED FROM THE COLUMBIA RIVER HIGHWAY

By IRA A. WILLIAMS

Oregon's scenery is a vital commercial asset that awaits development only

THE COLUMBIA RIVER

THE Columbia river ranks as one of America's greatest waterways. Among the rivers of the United States it is for many reasons one of unquestioned distinction. It drains a total area of 259,000 square miles, 38,700 of which are beyond the 49th parallel. Into the Columbia and its tributaries pass the surplus waters from 55,370 of the total of 95,607 square miles within the boundaries of Oregon. More than one half of the acreage of this state thus drains into this master stream, which, from the Pacific, forms for better than 300 miles its northern boundary.

This great river annually discharges into the Pacific Ocean seventeen and one half trillion gallons, the equivalent of five hundred fifty-five and one half billions of barrels or about sixteen cubic miles of water. Which is to say that if its flow were uniform in all seasons, it would pour into the sea each of the 365 days of the year nearly fifty-four million acre feet, enough to cover almost seven of every eight acres in the entire state of Oregon one foot deep with water. More than twenty-one hundred miles of the Columbia and its tributaries are navigable waters. It thus affords a commercial outlet for a vast inland territory, not only in Oregon but as well for all of her neighboring states except California. In the timber-lands of the Pacific Northwest the Columbia is said to drain what is probably the largest consolidated area of forests in the world.

The Columbia river is further distinguished because of its having cleaved from summit to base, completely through the structure of a giant mountain mass—the Cascade Range. This is a feat of achievement to which comparatively few of the rivers of the world may claim title. As a result of her prowess in geologic times past, this river has become the front doorway to a vast empire. Is there conceivable feat of nature that could be more abundantly serviceable and more fortunate to the life and movements of the people of a nation, than the provision of such an ample, ready-made channel of intercourse and communication through what would otherwise be a great land barrier?

Commercial value of the Columbia

The course that the Columbia has forged was followed by early explorers and many of the first settlers in this northwest country. The first wagon travel to the Pacific Northwest naturally sought passage down the Columbia and through its gorge. As much of the journey was necessarily made by raft as along its in many places precipitous shores. So that, great as may present necessities seem to be, early pioneers no doubt realized the need of a continuous roadway far more keenly than any one of later days. Link by link through the years has the feasibility of the thoroughfare become established which today, in our Columbia River Highway, is one of the greatest of monuments to modern road construction, and truly a scenic highway if rivaled anywhere, certainly unsurpassed. On the Washington side of the river a permanently built parallel highway is rapidly nearing completion. Crossing the Cascade Range this river now affords an avenue of easy grade through which two paralleling transcontinental railroad lines have built. Its waters teem with shipping, and the fisheries of the Columbia are legion.

We see that again, then, the Columbia is a river of unique renown. Skirted on either shore for hundreds of miles by steel rails, bordered again by vehicle thoroughfares of up-to-date type and permanence, and capable of bearing upon its own surface a traffic of unlimited proportions, it has indeed become through the enterprise and ingenuity of man a commercial avenue of the first magnitude. What besides has this magnificent waterway to contribute to the contentment and prosperity of the people which it so efficiently serves in a commercial way, that further establishes its supremacy among those of its kind?

In the history of men, it is sometimes ancestry by which one is endowed with fame. Less often, perhaps, though more substantially, is a person made famous by individual achievement. Not exactly so in the case of rivers. Notoriety rarely attaches to them by inheritance. Somewhat more often are they celebrated because of some particular accomplishment in the course of their own life history. Then again their renown among men is sometimes greatly enhanced by the labors and genius of man himself. To the Columbia was bequeathed by its ancestors little that is recognizable except by the discriminating eye of the geologist. It has had of itself a spectacular career, as already pointed out, to which it would seem scarcely likely that man should be able to add. But strange as it may seem, man has contributed immensely to the fame of this great river and its gorge, aside from its development as a carrier of the nation's commerce.

Scenery of the Columbia

Since the time of Lewis and Clark we have been told of the scenery along the Columbia river. It has been distantly pictured to us as impressive, wonderful, awe-inspiring. Until the nearly present time, relatively few have beheld this wealth of scenic beauty, and that few only by stress of hardships endured or great inconvenience. The Columbia River Highway has not only unlocked the way to the very heart of this wonder region but it has thrown wide the gates, and all are bidden to enter and to enjoy the thrill of intimate touch with one of nature's most stupendous bits of handiwork.

It is doubtless true that nowhere else has a more substantial and thorough-going project of highway construction been carried to so successful a completion as the building of the Columbia River Highway. Conceived in the face of scepticism, laid out and built amidst almost insurmountable obstacles, it was the foresight and tenacity and enthusiasm of its promoters that have made both it and the river the enchanting beauties of whose wonderful canyon it has opened to the world, known far and wide.

While thus the great river by its industry both designed the drama and, with ultimate skill and consummate patience, set the stage in all detail, it remained for man to provide the means of entrance to its hitherto exclusive observation halls. There the play is ever on, and the scenes are passed in unerring order, but curtains are never rung, no acts omitted—for it is nature's way. The river merely provided the opportunity, which man has so taken advantage of that instead of being rivals, both the river and the Highway now inseparably contribute each to the illustriousness and glory of the other. As a result the Columbia River Highway is rapidly becoming a name to conjure with. It is being heralded the country over, and justly, as the scenic highway of the United States, if not of the world.

Columbia River Highway

The Columbia River Highway has at the present time been definitely projected, and in large part completed, from the sea at the mouth of the Columbia river, to Hood River by way of the city of Portland, a distance of somewhat less than 200 miles. It is a hard-surface roadway uniformly 24 feet wide paved with bitulithic, has no grade greater than five per cent, and the radius of its sharpest curves is 100 feet. It is being built by the State of Oregon, the counties which it crosses, and by contribution of private funds. Within the past two years a very great deal has been said and written about the building and attractions of this Highway. Some of its attractive features are unique and it would seem that too much publicity can scarcely be given to it. Mr. Samuel C. Lancaster has written a most instructive illustrated book entitled, "The Columbia, America's Great Highway." The scenic features of mountain and river to be viewed from it are many of them unusual, and on a scale to excite in those who look upon them not merely interest but inspiring awe.

To some who travel the Highway there is much of meaning in the rocks that overhang the way, stories in the waterfalls that rush from precipitant heights to greet the traveler, a sermon in the master river itself. To most, however, this may not be so. It is the purpose of the writer of this paper to so dwell upon the interpretation of what is to be seen along the Columbia River Highway that he who travels it with eye and mind alert, and few can fail to do this, may more fully realize and appreciate the story, dramatic in general, though vividly tragic are some of the details, that is most eloquently recorded along this wonder way. In the main the following discussion will pertain only to that portion of the course of the Columbia river popularly referred to as the Columbia River Gorge. The course of the Highway for almost 70 miles, between Portland and Hood River, is in large part within the shadowing walls of this gorge, and it is as though unfolded to the traveler as he comfortably rides along its devious way that the story will be told. Here parapeted against the face of sheer cliff, there within the shadow of beetling basalt wall; dampened again by the spray from clinging waterfall the purr of whose downward rush lures us to linger, now by graceful weaving curves through cool forest, again within the dark of rock-bound tunnel; at times hundreds of feet above the swiftly flowing Columbia, then at its water's edge—these are the view points, and no more advantageous could they be, from which our observations will be made.

THE CASCADE RANGE

THE Cascade Range is the dominating mountain uplift of the Pacific Northwest. The main range extends from far to the south of the Oregon-California line, northward completely across both Oregon and Washington and into the Dominion of Canada. The altitude of its summit varies from four to seven thousand feet, but along its crest is arrayed a most imposing series of snow-capped peaks that rise, in some instances, to elevations above sea level more than double the average height of the range. From the north in the state of Washington the most commanding and well known peaks are Mt. Baker, near the Canadian line, 10,750 feet high, Glacier Peak almost 10,500, Mt. Rainier 14,508 feet, St. Helens and Adams, 9,697 and 12,307 feet respectively, the last two being within 40 miles of the Columbia river which is the south boundary of the state. In Oregon our own revered Mt. Hood, in a straight line less than 25 miles south of the Columbia, overlooks that noble river from an altitude of 11,225 feet. Fifty miles south of Mt. Hood stands Mt. Jefferson 10,523 feet in height, then follow the Three Sisters each over 10,000 feet, Mt. Thielsen 9,178 feet, and Mt. McLoughlin beyond Crater Lake within 35 miles of the California line, 9,491 feet high. In California, massive Mt. Shasta, 14,162 feet, towers over all, and Lassen peak, now an active volcano, lifts its rest-less head 10,466 feet above sea level. Many other peaks of lesser prominence are scattered along this 600 mile stretch of the Cascade Range.

Practically all of the higher peaks of the Cascades have been built up by the outpouring of lavas from volcanic openings. They are, in other words, volcanos that have been very active but are now, with the exception of Lassen peak, all quiet, most of them probably extinct. From these volcanoes great quantities of hot lavas have issued and spread widely upon the summit and down the slopes of the range. While we thus find that much of the super portion is made of cooled lavas that have come from this series of vents, the conspicuous peaks that have been formed themselves rest upon a base of different character. This base is not the same in all parts of the Cascade Range. In the portion of the Cascades contiguous to the Columbia river in Oregon and Washington, this base is composed of an extensive series of earlier lava flows and of associated volcanic and sedimentary beds whose exact source we do not now know in detail. Up beneath and through these earlier formations welled the liquid lavas that gave us what today are the principal elevations of the Range.

Structure of Cascade Range

A study of particularly the northern portion of the Cascade Range of mountains in Oregon discloses, therefore, that a part of its apparent height is due to the previous elevation of the underlying formations which thus served as a massive uplifted foundation upon which grew the great peaks of the present time. Perhaps the two processes continued together, uplift and the outpouring of molten lava. Doubtless also were lines of weakness developed, and even breaks, in these slowly rising rock beds, through which the lavas from beneath rose to the surface in voluminous seething streams, or were discharged in clouds of explosion fragments to drop upon the surrounding country and to build to the skies the many cone-shaped heaps that now strike awe and wonder to our gaze; the seething craters of yesterday, the Mt. Hood, Mt. Adams, the St. Helens, even Larch Mountain and Mt. Defiance of today.

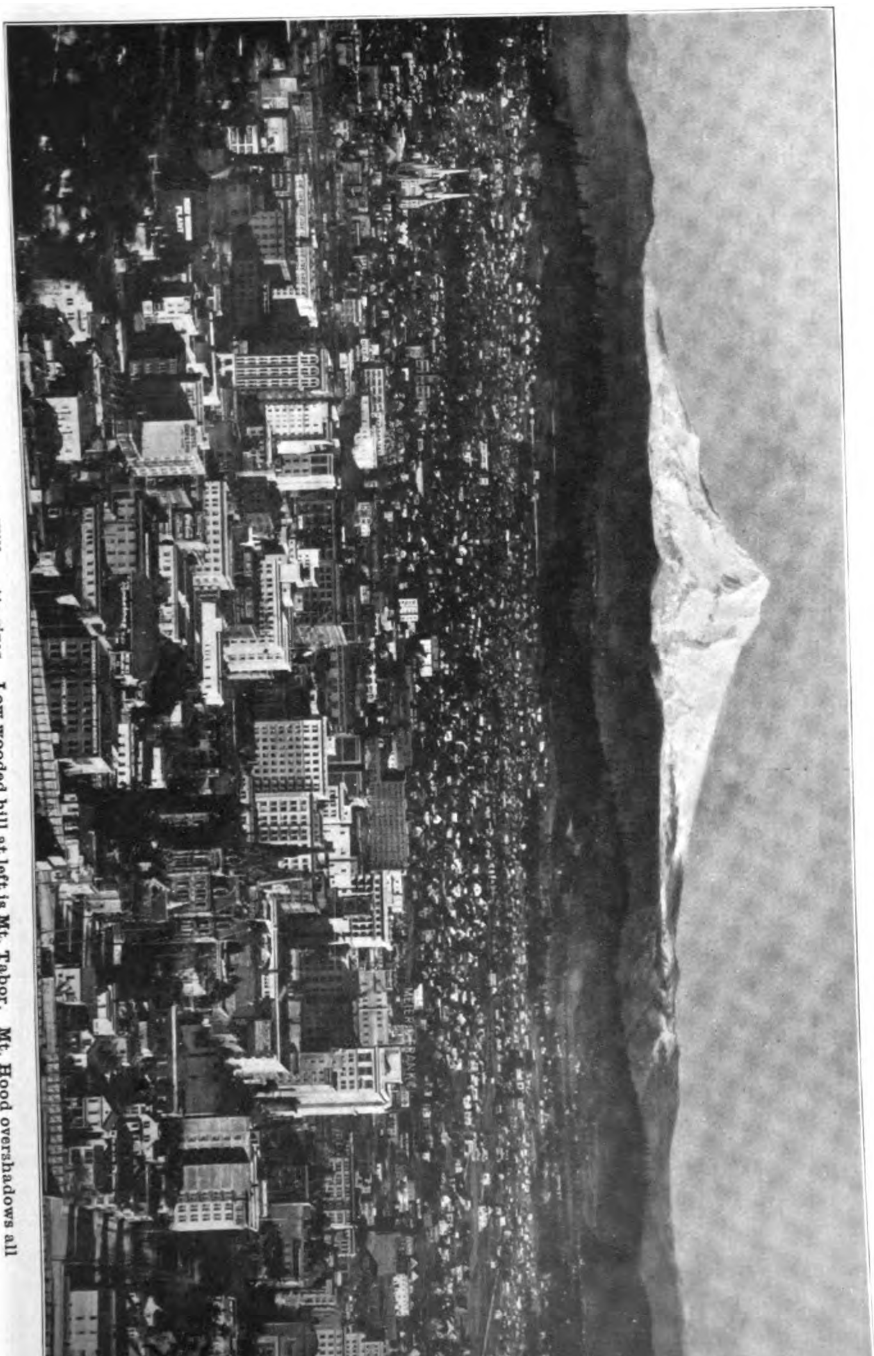
The life history of a mountain range, as in the case of an animate being, can be worked out only by intimate study of its structure, its form and extent, and its relationship to other and neighboring land features. The geologist looks carefully at all surface indications and must very often be content to reach conclusions without the information that a cross section of the mountain range would afford. He searches diligently in river canyon, mine shaft and road cut, for every possible peep at the order of arrangement and character of the rock materials that compose the range. What a wonderful stroke of good fortune is it then, that instead of such scattered and often meagre opportunity to actually observe the nature of the deeper make-up of so vast an earth structure as a range of mountains, there should be found ready-made and waiting for the interpretive eye of the geologist so grand a section of the Cascade Range, from top to bottom, as the Columbia river has made. It has cut directly across and at right angles to the axis of the range, a gigantic trench, in the walls of which on the north in the state of Washington and at the south in Oregon, every characteristic of rock formation may be studied, each chapter in the growth of a mountain range may be read in its entirety. From the very roots of the range to its summit heights are the records thrown open for our reading and appreciation. And no peer is there among the chronicles of human history to compare in wealth of revelation, no testimonial of human achievement one half so inspiring as the story that may be read there.

The Columbia River Highway has been a very great help in the deciphering of the history of this portion of the Cascade Range. It not only penetrates the depths of the Columbia gorge, and reaches some points heretofore practically inaccessible, but in its construction the necessary excavations have brought to view in many places most excellent and instructive exposures of the different rock formations of which the Range is composed. So serviceable has it proved in this particular, that along portions of the Highway one may catch many of the conspicuous features as he rides. But so frequently is the nature student enticed by glimpse of fresh cut cliff, sheer canyon wall or of river vista, to read more deeply than the fleeting glance permits, that he will quickly decide that occasional stops are quite essential to an understanding appreciation of what is thus opened up to him.

A Columbia gorge tour

It is therefore proposed to pilot the reader through the gorge in a tour of a little short of 70 miles, over the portion of the Columbia River Highway between the city of Portland and Hood River. Between these two points the road passes through the most profoundly impressive parts of the chasm, and the journey will end at the outlet of the celebrated Hood River valley, interest in whose geologic features must prove scarcely secondary to its horticultural pre-ëminence. To take this trip, to enjoy and to profit by it, cares must be abandoned and a composed and not merely receptive but alert condition of mind assumed. It should be borne in mind that, if looked for, there is much of fascinating interest in every inch of the Highway that is passed over, that the materials on which that thoroughfare is founded are letters in the spelling out of the history of the country through which it passes, the pits from which these materials came the paragraphs and chapters that, matched together, progressively evolve the completed narrative of the Cascade Range.

Much there is of legend and tradition associated with the Columbia river and its gorge. The geologic story is neither fable, myth nor tradition, but one of fact, facts that indisputably stand out in every rock and waterfall, as if begging for recognition. We shall, therefore, not need to draw upon else than truth for the framework on which to string the facts of our observations, and the connected story that these will tell. For, while true, they shall be no whit less romantic, not one point less inspiring and wonderful, than the weird tales of Indian lore and tradition of mythical foundation, that have come to us down the years.



East Portland, overlooking the Willamette river. Low wooded hill at left is Mt. Tabor. Mt. Hood overshadows all

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East Portland, overlooking the Willamette river, from Portland Heights. The city of Portland is the starting point for our journey. Had we time to glance about, it would be learned that besides being a metropolis of large proportions, Portland is located on the lower course of the Willamette river some 8 or 9 miles up from its confluence with the Columbia. At the west, beyond a narrow flat close to this river, its business streets rapidly climb to the foot of steeply rising hills whose summit elevations are 1,000 feet and more above the sea. East of the Willamette the city covers many square miles of an even rising slope which, with the exception of a few rocky knobs that rise abruptly above it, rarely attains an altitude of much over 300 feet for 18 miles due east to the Sandy river.

Portland geology

If we take a more careful look at conditions here it will be learned that the prominent hills west of Portland, up which many most attractive residence streets are being extended, are composed very largely of a dark lava called basalt. It is largely obscured by a heavy mantle of silt or loam, some of which without doubt resulted from the weathering of the basalt itself, some possibly deposited in the waters of a bay or sound, but much of which was probably shifted by the winds from the lower levels of the river floodplains. Resting against the lower slopes of these basaltic hills are masses of a similar sandy loam and beneath it stratified sand, silt and gravel to the river's edge. If, again, we search these hills, there will be found at different places along their flanks and extending far up the slopes, large masses of coarse, iron-stained gravels the pebbles of which are usually so firmly cemented together than when dug into they will hold a vertical face for years. At the west edge of Westover terrace, in part entering into the construction of these terraces, and for a half mile or so westward, an almost continuous exposure of these gravels may be seen at an elevation of between 300 and 400 feet to the Cornell road.

In the face of the quarry on the Linnton road, opposite the St. Johns ferry, several feet of these same ancient gravels rest upon the uneven surface of the basalt. They are composed of pebbles of volcanic rocks, mainly basalt, and usually from one quarter to one half of quartzite pebbles. Quartzite is a metamorphosed sandstone, the pure varieties being almost entirely silica. In this gravel formation they appear as white to pink or yellowish, smooth, hard, rounded pebbles showing comparatively little alteration. Those of the volcanic varieties are badly decayed, so thoroughly indeed that in some places the gravel bed has passed into the condition of a gritty clay in which the outlines of the original pebbles can frequently be seen, but where the quartzites alone remain largely unchanged and resistant. We shall find on our excursion many opportunities to examine other outcrops of this gravel-bearing formation, and will in every instance be greeted by the conspicuous presence of the friendly quartzites scattered among the usually weathered rocks of other varieties. So constant a feature are they, that they may be employed as a serviceable criterion for recognizing the gravels of this particular age.

It is at first a rather startling thought that these gravels were placed in their present position by the swiftly running waters of a river. We can conceive of no other origin for them. When they were deposited, the surface on which they rest was at a much lower level, probably but little above or actually below the level of the sea, and the great stretch of country over which, as we shall see, they are found, tells us that they have been accumulated in large part from very great distances. While the volcanic rocks were at that time doubtless already plentiful, and would furnish to the streams a supply of their kind, we know that masses of quartzite from which so abundant a quantity could have come were in existence in only very distant areas in eastern Washington and far north near the Canadian border. We see no other inference than that they have traveled from these places hundreds of miles away. And their association and distribution lead us to no other conclusion than that the Columbia river some of whose main feeders extended into these far regions, was the agency responsible for their carriage and deposition.

Old and new gravels

Again, our departure would be ill-timed if a hasty though critical examination of certain features of East Portland were not made. We will note that the land in most places rises rather abruptly along the east shore of the Willamette for 75 to 150 feet, beyond where the height increases more slowly by a series of low benches or terraces. Close along the river, as well as wherever exposures are made in street or railroad cut, fresh and evenly stratified or crossbedded gravels and sands are to be seen. In places fine sand may predominate, or silt may cover the surface, but always all of these materials have the appearance of newness, they are never strongly cemented together, and the larger cobbles rarely show an advanced state of decay. In these particulars these beds are quite different from the ancient gravels observed about the slopes of the hills in West Portland. The latter are but clinging remnants of an earlier formation, while the newer gravels of the lower lands east of the river are a deposit of more recent age that the heavily burdened rivers, the Willamette, Columbia and tributary streams, have filled in among the upstanding irregularities of an earlier land surface.

Ancient lavas

We are able to get an occasional clue as to the character of this former surface. Mt. Scott and a series of other nearby hills to the southeast have all the appearance of being higher parts of this old land, today sticking up through, as it were, and above all of the surrounding and flanking deposits of more recent date. Practically all of these elevations appear to be of volcanic lava, some of them of the basaltic variety. Kelly Butte at the west base of which is the city quarry, Mt. Tabor and Rocky Butte, all bear a similar relationship to the sheets of gravel that have been spread about them.

If now, the inferences thus far drawn from our observations east of the river are correct, viz., that there are here as on the west side, elevations of earlier lavas around the base of which the more recent river-laid materials have accumulated; we should hope to find also some signs about the higher slopes of these same elevations of the older, weathered, quartzite gravels that we have seen along the Cornell road and elsewhere west of the river. Our search in this direction is rewarded with almost alarming, certainly unanticipated promptness. The main bulk of Kelly Butte is a hard variety of lava which the microscope assists us to classify as basic andesite. The Butte is 577 feet high, rising rather sharply 275 feet above the surrounding plain, which is strewn with and built up of hundreds of feet of the recent gravels. An ascent from the Powell valley road, which passes at its south base, proves at once the presence of the old gravels. The entire south slope is aproned with the loosened pebbles from higher up, and the summit of the Butte is heavily covered with undisturbed gravels that in position and other particulars, are so similar in every way, that there is no hesitation in pronouncing them the same as already seen in West Portland.

Mt. Tabor

Mt. Tabor is the site of one of Portland's prettiest parks. Here too these same water-worn iron-stained old gravels show themselves on every slope, and over its entire main summit they obscure all else. The altitude of Mt. Tabor is 645 feet, and we find the ancient river-laid gravels to the topmost point. How much higher they extended originally, we have no means of knowing. Nevertheless, we can safely say that they were several hundred feet in thickness, and, by the position of the remnants of the formation we have seen on both sides of the river, properly conclude that they formerly filled all of the space now occupied by the Willamette and the filling of recent gravels, between East and West Portland, to a depth at least as great as the present height of Mt. Tabor. Studies made far up the Willamette, also across the Columbia river in Washington, show that this old gravel plain, for such it was, covered a wide scope both to the north and south. We shall see when our journey is really begun that it extended far to the eastward, and fragments of it still mark its former borders at intervals along the lower course of the Columbia, while the same formation is known to be represented by marine sediments both north and south along the ocean shore for practically the entire length of the states of Oregon and Washington.

We find evidence without going much beyond the confines of the city of Portland of several epoch-making changes. Without at this time undertaking to pry further into the past, we have first, the conspicuous hills supported invariably with cores of lava that likely represent a much dissected land surface whose original character was determined by great lava flows and the planation of rivers. In order that the great gashes by which these hills are now separated, could be filled with the hundreds of feet of ancient gravels only small patches of which remain here and there, subsidence must have taken place, so that the highest of these hills were carried down close to sea level. The fact that these gravels have been largely removed, shows that elevation of the Portland region followed the period of lowering, in which the Willamette actively excavated the gravel beds it had but finished depositing, down to the remnants that we find today clinging about the slopes of Portland Heights and covering Kelly Butte and Mt. Tabor. Geologists term this process of cutting away, degradation, and that of filling in, aggradation. Following the period of degradation there was again a depression of the land during which time the heavy mantle of the more recent gravels, sands, etc., was spread out, so much of which we see over many square miles in East Portland and beyond. That these beds are now exposed to our view and unmeasured quantities of their substance removed, elevation must have in turn succeeded subsidence by which a returning energy enabled the Willamette river to proceed to the cleaning out of its valley once more. That it is no longer actually cutting downward, suggests a state of quiescence, and there are some evidences to indicate that yet another slight downward movement has taken place in recent geologic times, by which the lower courses of both the Columbia and its chief confluent are in part inundated and the streams themselves thus robbed of their ability to carry clear to the sea the load brought to them by their various tributaries.

We must for the present be satisfied with this preliminary survey of the environs of our starting point. The journey over the Columbia River Highway should be begun, though, with the ever present thought that each mile has something new and, as we have seen about Portland, a history, a life story that but awaits our interpretation.

Geologic map

In connection with this paper, a folded map will be found (opposite page 3) covering a narrow area on each side of the Columbia river from Portland as far east as Hood River. The main roads, railroads and established trails are shown, besides the location of the Columbia River Highway. Contour lines are drawn to indicate the character of the land surface, insofar as the U. S. Geological Survey topographic maps and field data were available. Upon this map are shown, in colors, the approximate areas in Oregon covered by the outcroppings of the various geologic formations to be seen in and bordering the Columbia River gorge.

Cross-section Cascade Range

The writer has prepared also a cross-section sketch (see page 130) extending across the Cascade Range from Portland to The Dalles, a distance as the section is taken, of 80 miles, which is an effort to show the relation among the different rock formations of which the Range is made. The field work on which is based the preparation of both the map and the sectional sketch, has not been carried to the fullest degree of completion. While the author is confident therefore that they represent in general, and correctly, the geologic conditions, too much importance should not be attached to any slight failure to conform perfectly and in detail to such geologic field measurements as may in the future be made. The portion of the cross section drawing between Hood River and The Dalles has been added to represent diagrammatically the general geologic structure along this portion of the Columbia river, and no claim can be made for instrumental accuracy.

In the reader's perusal of what is here written, it is urged that the map and sectional drawing be constantly referred to, for in them is portrayed in far more vivid manner than words can be made to express, many of the fundamental features of the story our trip over the Highway is to reveal. A preliminary study of these as available sources of information should be made, just as do explorers into other unknown fields first search out every scrap of knowledge pertaining to the problem in hand.

Acknowledgment

Most of the field work on which this paper is based was done during the past summer with the assistance of J. H. Bretz of the University of Chicago who was in the temporary employ of the Oregon Bureau of Mines and Geology. Credit is thus to be shared with Mr. Bretz for the broader conceptions relating to the geology of the Columbia river gorge and of the Cascade Range. His helpful counsel has also been had in the preparation of certain parts of this paper. G. E. Goodspeed, Jr., identified many of the rocks studied in the Columbia river gorge and his determinations have been employed in their classification and correlation.

Roads

Departure from the city of Portland may be made by any one of three paved highways, Sandy boulevard, Base Line road, or Powell Valley road, for 18 miles east to Troutdale at the mouth of the Sandy river. Sandy boulevard is easily reached from the Burnside bridge across the Willamette, by going east to 16th street, thence north three blocks, and turn to the east. This road passes to the north of Rocky Butte a prominent ridge of basic gray andesite, rounded from the west but sharp-walled, even sheer in places at the east side, and at the north end of which extensive quarrying has been done. In its structure there is some suggestion of proximity to a vent of eruption. In general character this lava resembles the rock of Kelly Butte and probably belongs to the same eruptive period as do the scoriaceous beds on Mt. Tabor, the time of accumulation of the ancient quartzitic gravels. Along the east base and parallel to the long way of this rock mass is a marked depression, as though an active stream of water had not long since been there, had etched its channel beneath the face of the cliffs, then once for all abandoned its bed. From Rocky Butte to Troutdale this road parallels the Columbia and in elevation is but little above it at any point. The Powell Valley road passes to the south of Mt. Tabor and at the south base of Kelly Butte, running to Gresham, in its general course parallel to the Base Line road which it joins one and a half miles north of that enterprising town.

Inclined volcanic ejecta, Mt. Tabor. The Base Line road is so called because of its location on the dividing parallel of latitude from which, to the north and south, the numbering of townships is begun. This road is a continuation of East Stark street and passes, by a slight offset, at the north foot of Mt. Tabor. So sightly an outlook is to be had from the summit of this eminence that we cannot for-

Inclined volcanic ejecta, Mt. Tabor, within the city of Portland

bear to take a passing stroll up its shaded slopes. Recalling that its top is one great heap of time-stained gravels, we are then not so much surprised to catch a glimpse where street excavations have scathed its sides, of what our general observations have already told us almost certainly must be there—the base or core of volcanic rock. But we are quite astonished to see that its character here is so different from what we have elsewhere found in the vicinity of Portland. Mt. Tabor consists of two parts, a rounded shoulder at the north being some 200 feet lower than the main summit. Earth for grading purposes is being taken from this lower portion and it is thus shown to be a massive pile of volcanic cinder, scraggly and scoriaceous bombs, clinker and ash. And these are not thrown promiscuously together, but are arranged in parallel and highly inclined layers, exactly as are the products of explosive volcanic eruption arranged about the slopes of more recent cinder craters by the fall of successive showers of this class of lava fragments. To us, it is not thus merely a mass of volcanic detritus, but it is a deposit whose nature and position tell unmistakably of a nearby crater from which they were forcibly thrown and on an outer slope of which they fell.

We may now speak with perfect correctness of Mt. Tabor as representing the site of an ancient volcano. During a time of land depression, gravels and sands accumulated around the base of this volcano, rose to the level of its rim, filled the hollow of its crater, and finally buried its topmost points beneath we know not how many feet of these same water-borne sediments. We are now permitted the exhilarating satisfaction of unraveling its checkered career, because of the fortunate circumstance of its having again come above the level of the waters that engulfed it. And, though once deeply sealed from sight, it has been to such an extent uncovered by the very agent that concealed it, that, no matter if torn and battered, this bit of familiar topography speaks out today, as with defiance, of the exigencies of its early life.

For ten miles due east the Base Line road, with but little rise and fall, passes across a gravel built plain. Just where the newer gravels leave off and the old begin we are not certain. We know that the new lap up on the truncated edges of the older beds, just as they surround and overlap them at Mt. Tabor. It is remarkable, however, that the watershed between the Sandy river and the Willamette, over which we pass, is very close to the former stream. This divide is not elevated nor at all prominent. We shall observe later that only the old gravels appear opposite this place in the gorge of the Sandy river, which rather strongly suggests that these older more firmly cemented beds, and therefore, their less rapid wearing down, may in large part account for both the unsymmetric location of the divide and be responsible as well for the bulk of its structure.

THE SANDY RIVER

AFTER crossing Beaver creek, a small tributary of the Sandy river within one mile of which we now are, we will turn to the north to join the Sandy boulevard at Troutdale. The Sandy river is crossed at Troutdale and thenceforth we are on the Columbia River Highway proper. One mile beyond Beaver creek we may also depart from the Base Line road by turning southeastward, up-stream and round a curve in the Sandy for a mile or so, to cross that river and connect with the Highway just beyond the grounds of the Portland Auto Club.

On the Sandy boulevard, and before reaching Troutdale, a reminder of the old gravel formation of Mt. Tabor and Westover terrace is had by the appearance of low outcrops of gravelly sand in the road cuts, and a farm house of modest brown is seen built of the sandstone from this formation.

Lava cliff along Sandy river at Troutdale. Approaching the bridge after Troutdale is passed, we are confronted by an abrupt wall which the eye may scan from here far up the river. But here is

NOTE—The general plan of this story of the Columbia River Gorge is such that the photographs necessarily constitute an essential and vital part of it. They are the nuclei, the way stations as it were, round which center the successive chapters of the story, and upon which their sequence depends. The matter descriptive of the views should therefore be read continuous with the remainder of the text in order that no connecting link may be lost sight of.

Lava cliff along Sandy river at Troutdale

Gravel and sandstone cliff along Sandy river; Columbia River Highway beyond Troutdale
Photo Gifford and Prentiss

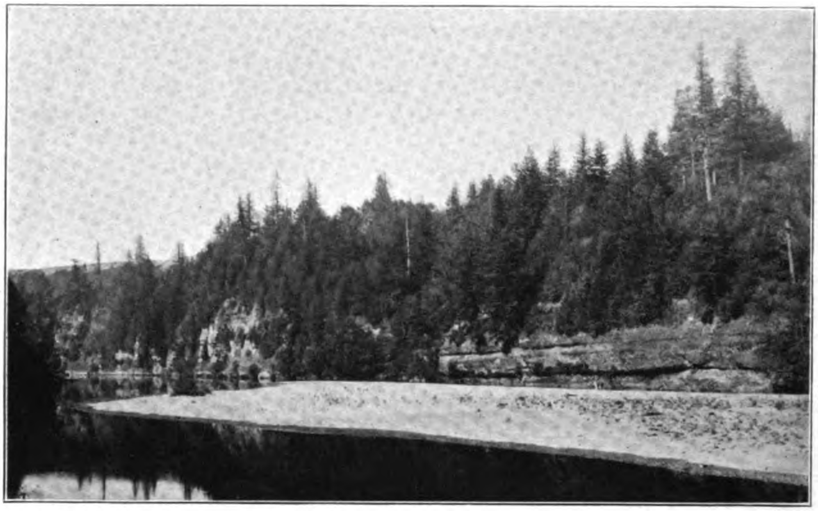
something new. Heretofore we have seen almost nothing but water-laid materials, sands, silts, gravels and the like, and the country has been fashioned chiefly by the action of running water. Now, though, we come face to face with a great protruding cliff of hard rock, itself as much as 200 feet or more above the river and 50, 75, sometimes 100 feet thick, and from which tumbling blocks strew the steep slopes below it to the border of the Highway. Running water had no hand in the making of this rock, although it will be decided at once it would not be so finely exposed to view were it not for the busy work of the Sandy river, that has severed it and underlying beds to the depth of its present level. In its upper course this river is still actively digging out its canyon, simple testimony of this fact being found in the mass of fresh sand and soil that it spreads beyond the limits of its channel during each successive high water stage.

Examination of the cliff before us shows promptly that the solid and in places columnar layer at the top is a thick sheet of volcanic lava, the microscope aiding in the determination that it is not basalt, but a somewhat less basic variety called andesite. The lava here rests upon heavy beds of the old consolidated quartzitic gravels whose acquaintance we have already made, and above, it is in turn covered by an increasing thickness of strata of similar character.

Gravel and sandstone cliff along Sandy river beyond Troutdale. As we pass southward after crossing the Sandy river, the Highway comes at times close within the shadow of a perpendicular face of coarse quartzitic gravel, interbedded with streaks and heavy layers of sand, most of which has been so compacted and the grains so cemented together as to make the term sandstone a proper one.

Inclined gravel strata along Sandy river beyond Troutdale. On both sides of the Sandy river this formation is in view almost continuously for over two miles and until the Auto Club bridge is passed. In places it is inclined at a low angle up-stream, that is, to the south, as though it has been uplifted since its deposition, and somewhat tilted out of its original position. The bed of andesitic lava that we have just seen, fits into this formation, and is thus to be considered an integral part of it. Along the lower course of the Sandy the same beds are present in the walls of its gorge for many miles. We find them 10 miles and more up-stream reaching to the very bottom of a canyon several hundred feet deep where Bull Run river comes in. The associated lava bed and sometimes two of them, is ever present. In places there are great thicknesses of fine sand at times beds of clay or shale and porous ash.

We have already noted the fact that besides a plenty of quartzite pebbles in the gravels, they are composed of various species of volcanic rocks. And the grains of sand are likewise mostly small scoriaceous, slaggy or pumiceous pieces that have been brought directly from a close-by region of stirring volcanic activity. Could we have looked on at the time there might have been cause for alarm, though certainly at this late date there is none for wonder that in addition to these merest of fragments there should come a great moving sheet of molten lava to overwhelm all in its path. Exactly where may have been its source we can only conjecture, but we do know that its coming seems to have disturbed the course of events but



Inclined gravel strata along Sandy river beyond Troutdale. Across the Sandy to the west from the Columbia River Highway

little if at all. For as observed near Troutdale and elsewhere, the accumulation of sediments long in operation prior to its appearance, continued merrily on without noticeable break, upon its tossed and ropy surface. Since the general character of this lava is similar to that which enters into higher contiguous parts of the Cascade Range, we infer that it too is probably but a forerunner, coming from one or more vents from which voluminous flows were soon to course their way down the slopes and among the foothills of a slowly rising range.

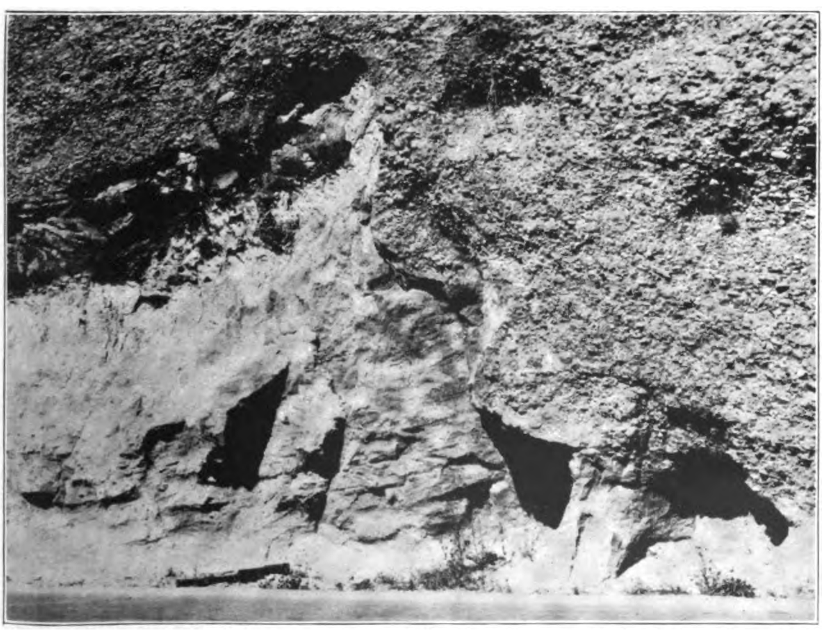
It is thus beginning to more fully dawn upon us that, aside from being merely a formation of wide extent, when it was put down conditions were not uniform but varied from time to time in the same spot, as well as differing in separate parts of the area in which the sediments were accumulating. The gravels, sand and sandstone are all river-laid materials such as are spread about in the river floodplains and deltas of today. The coarser gravels are carried and left where the current is most vigorous, the clays in protected pools, the cut-offs of river channels, or in shallow arms of the body of water into which the streams may flow. Here too would settle the leaves and stems and seeds of plants, and the trunks of trees be buried by the impervious sealing of fine sediments. Such remains are often so well preserved that their exhumed fossil forms may be recognized in every particular. The general character of the sedimentary beds before us, and the fact that the fossil remains which they contain (to be referred to later) are of land plants only, shows that the whole is a river valley deposit, probably in part of delta formation or spread out upon a low-lying coastal plain.

The Satsop formation

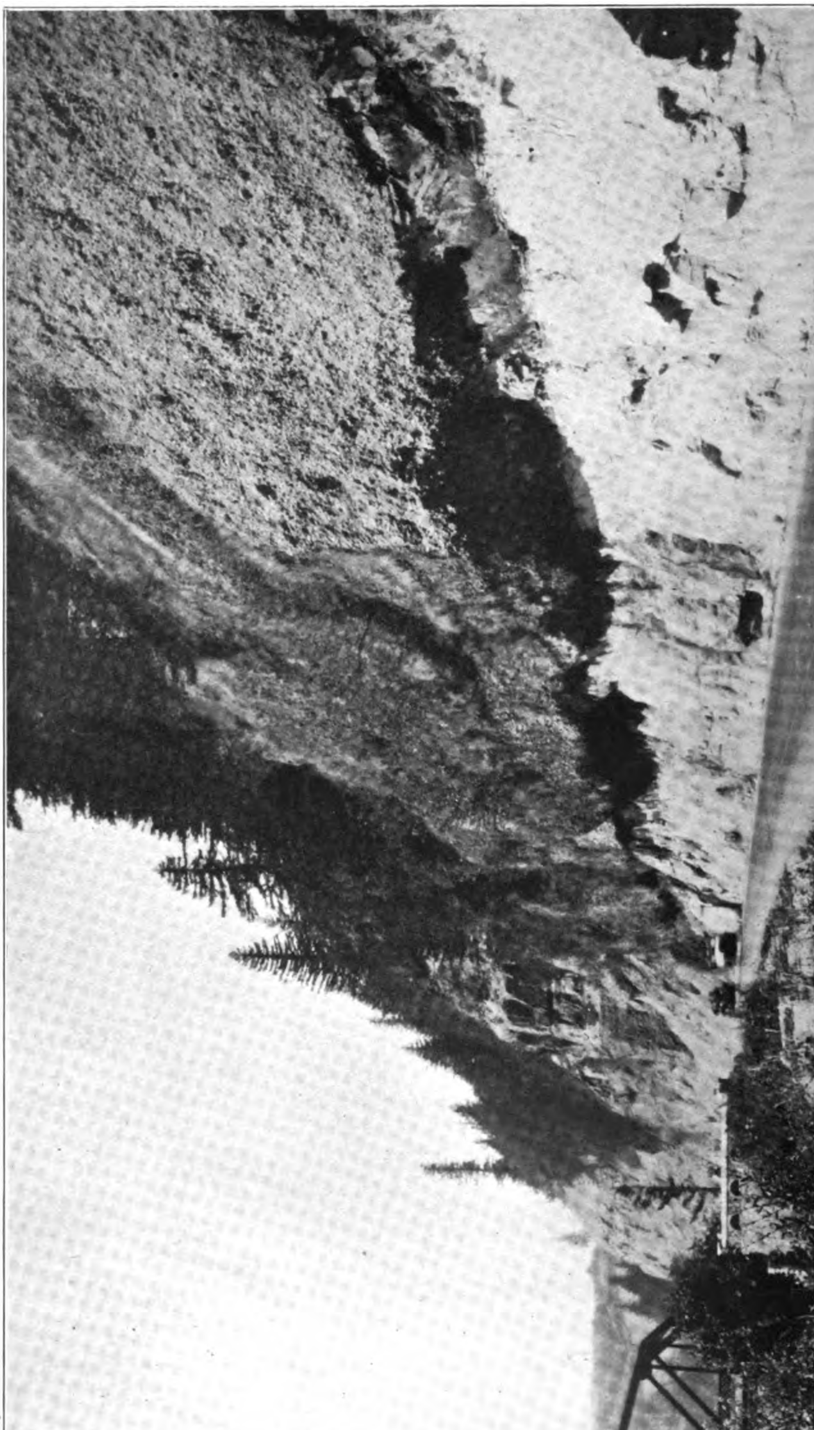
We must pause one moment longer. We have now studied at several points the make-up of this series of geologic strata that once were spread out to considerable depth over, we now know, a large scope of country. Geologists are in the habit of attaching names to rock formations that are of wide extent, distinctive character, or whose equivalence in age shows that they represent an important period, be it chapter, paragraph or meager line, in the history of the earth. As our story unfolds, the increasing significance of the chapter which our present formation stands for will be more and more appreciated. That it therefore deserves a name is without question. Within the state of Washington, this formation, as has been intimated, is of wide distribution. It has been studied there to some extent in years past and has been designated the Satsop formation by J. H. Bretz on account of its typical occurrence in the valley of the Satsop river, a branch of the Chehalis, in the Olympic mountains of Washington. Inasmuch as the lines by which states may be conveniently bounded seem to have been in the past, as now, ruthlessly ignored in the establishment of geologic boundaries, we are really left no alternative but to accept and adopt the name already in established usage in our sister commonwealth. Henceforth, then, this will be for our purpose the Satsop formation.

Auto Club to Chanticleer

From the Sandy river at the Auto Club bridge the Columbia River Highway swings to the north of east and seeks an even grade by way of Springdale and Knights Corner to the top of the Columbia-Sandy divide at



Bed of sandstone overlain and cut off by the coarse gravels, ¼ mile east of Auto Club bridge. Angular blocks of the sandstone are in places enclosed within the gravels. The sandstone was eroded and in part broken down, after which the gravels filled in and covered over all irregularities. The uneven contact is termed an unconformity



Cornice of coarse cemented gravel overhanging less resistant sandstone. Auto Club bridge and Columbia River Highway about 900 feet; whence the traveler slowly descends in the next mile and one half to Crown Point, approximately 725 feet above sea level. Occasional shallow road cuts leave no question that we are passing across a land surface that has been carved in the Satsop formation. Where best seen, the sands are deeply iron-stained and all except the quartzite pebbles are more or less thoroughly disintegrated. Over the top in general is a mantle sometimes thick, elsewhere thin, of a silt or loamy material that the winds have very likely been instrumental in spreading about in comparatively recent times. The evident prosperity of the farms that are passed attest the fertility of the soils derived from it.

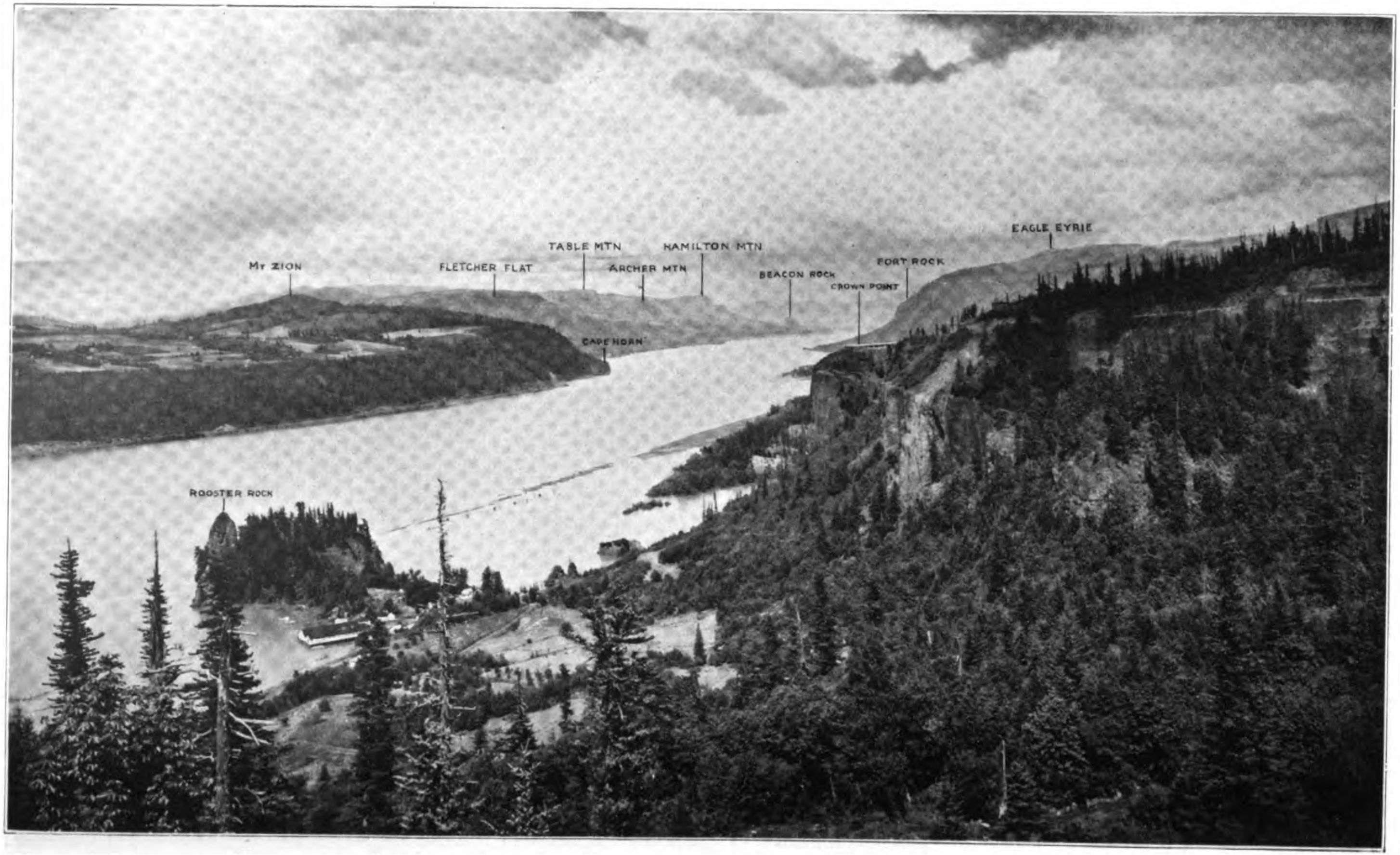
THE COLUMBIA RIVER GORGE

The Columbia river and its gorge from Chanticleer. Within approximately one mile from Crown Point, at Chanticleer Inn, a first satisfying view up the Columbia river may be had. Here the Highway comes to the western rim of a broad circular amphitheatre at an elevation of 925 feet above the river. Diametrically across to the northeast is Crown Point the gleaming white of its encircling pillared parapet, and Crown Point chalet above it, in every line distinct and in contrast with the great black cliff below.

The Highway skirts the edge of this vast pit and, seeming to cling precariously within its niche against the sparsely forested gravel slope, creeps a full-fledged and magnificent thoroughfare, with perfect security, out upon the causeway of Crown Point. Below is an upright face of dark columnar basalt in places sheer for 400 or 500 or 600 feet, again aproned to the Columbia's shore with a talus slope of gravels, soil and shattered blocks of its own kind. Above this perpendicular wall of basalt, the line of contact sharply marked in the photograph, appear the gravels and sands of the Satsop formation. The less steep slope is particularly noticeable, and it is along this slope and through the materials of this formation that the Highway at and above Crown Point (in the view) is built.

Mt. Zion

A brief pause at this wonderful viewpoint and we are overwhelmed with anxiety to hurry on to that most sightly station of all the Columbia River Highway has to offer, Crown Point, now but a short span away. But there will perhaps be found no better place than this to linger for a moment, while the gaze progressively follows up the Columbia to the limit of vision, where the blue of the summer haze dims to indistinction the horizon, and the white ribbon of water is lost within the shadows of the great gash through which it pours. At the left across the river in Washington, the low dome well up the sides of which the geometric outlines of cultivated fields distinctly show, is Mt. Zion. It is an extinct volcano. The ropy scoriaceous lavas of its crater may yet be seen at its summit. A little below the top on its south side, hard gray basic andesite shows through. What relation does Mt. Zion bear to its surroundings? The broad slope of the upland, occupied by farms, that stretches down the river far to the west from Mt. Zion is determined by the position of the strata of the Satsop formation. Satsop gravels are found intermittently along the railroad from the town of Vancouver for 20 miles and more to and beyond Mt. Pleasant. One and a half miles east of



The Columbia river and its gorge from Chanticleer
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the latter place and within sight of the Cape Horn tunnel, beautifully columnar basalt appears beneath these gravels, and to the eastward they are carried gradually higher and higher upon the slowly rising surface of the basalt a prominent wall of which, distinctly seen from our viewpoint, rises perpendicularly from out the waters of the Columbia. Resting upon these gravels, which here as elsewhere carry an abundance of smoothly rounded quartzite pebbles, and are a few hundred feet in thickness, is a heavy bed of andesite at the base of Mt. Zion, to be seen also from our present position. Mt. Zion is 1,658 feet in altitude. Upon its slopes a scattering of the Satsop gravel pebbles is to be found as high as 1,000 feet, much above the outcropping andesite between which and the underlying basalt, gravels of this formation are seen to be.

It would thus seem that we have recorded here a somewhat similar series of events as along the Sandy river, where the andesite was found to have flowed down during the time of gravel accumulation, and to both rest upon and be covered by the strata of the Satsop group. In Mt. Zion, however, we have what appears to have been rather probably an active volcano during the Satsop epoch. If we were to assume that the andesitic lava exposed about its base came from Mt. Zion as a vent, we would then be confident that not only was it in eruption in Satsop times, but about it, as it grew, the accumulating gravels and sands and silts slowly rose, possibly originally to complete submergence for aught we know. Of its birth long after the coming of the basalt we have positive evidence, for at its summit pieces of its scoriaceous ejecta are found, that enclose and have fused fast to pieces of the basalt that were caught up as the fiery mass forced its way upward through the more basic lava.

Peaks along the gorge

Yet another glance at the photograph will enable us to pick out in order as we overlook the river beyond Mt. Zion, Fletcher Flat a plateau of even but gently sloping top at about 1,600 feet; the conspicuous cliffs of Archer mountain at 2,000 feet or thereabouts; and 5 or 6 miles still farther, the notched profile of Mt. Hamilton whose summit is more than 2,400 feet above the sea. At the foot of Mt. Hamilton and, from our distance, apparemtly rising from the river's edge is Beacon Rock, commonly known as Castle Rock. It is a massive lone pinnacle of jointed lava with clean sheer faces for hundreds of feet on all sides, and for long a defiant challenge to all comers of mountain scaling inclination. Shortly beyond Beacon Rock the narrows of the Columbia begin which culminate in the impassable rapids at Cascade Locks, from us, by the Highway, full 23 miles up the river. The flat top of Table mountain, 18 miles away, is distinct against the sky-line, its main bulk hidden behind Mt. Hamilton. Its summit is 3,420 feet above sea level.

At the right and on the Oregon side, we look beyond Bridal Veil and against a rising mountain wall that largely cuts off a detailed view of what is farther on. The jutting castellated front of this wall which is called Fort Rock, lifts its pinnacled head 1,500 feet above the river. Fort Rock was formerly termed Angels Rest, one might imagine on account of its attitude of guardianship between the great river and Devils Rest, now called Eagle Eyrie, a prominent former volcanic vent one thousand feet higher and but a short mile farther back. In the dim distance we catch the faint outline of the main summit of the Cascade Range beyond Carson and Wind river in the state of Washington, and were the atmosphere sufficiently clear, could probably recognize some of its features though as much as thirty miles away.

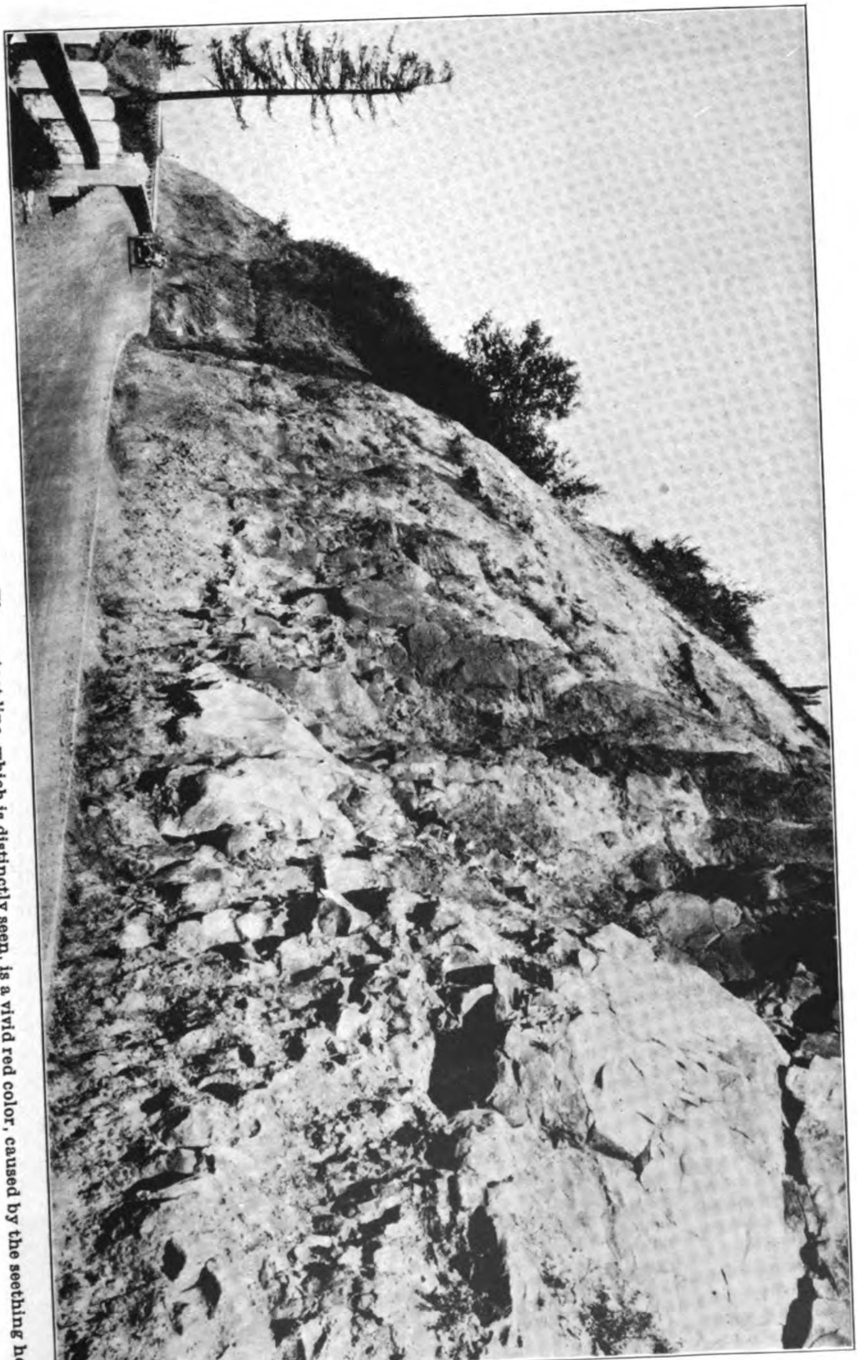
Crown Point

It seems indeed scarcely fortuitous that so favorable a body of materials as the Satsop gravel bed should be found just where it proved necessary to locate the Columbia River Highway in order to find a safe course out upon so spectacular and, at first sight, rather inaccessible a lookout place as Crown Point. Our ride from Chanticleer to Crown Point is entirely over a roadbed carved along a steeply sloping face of this formation. The encircling concrete base and railing, and within the curve the Vista House, are all founded upon this same old gravel bed.

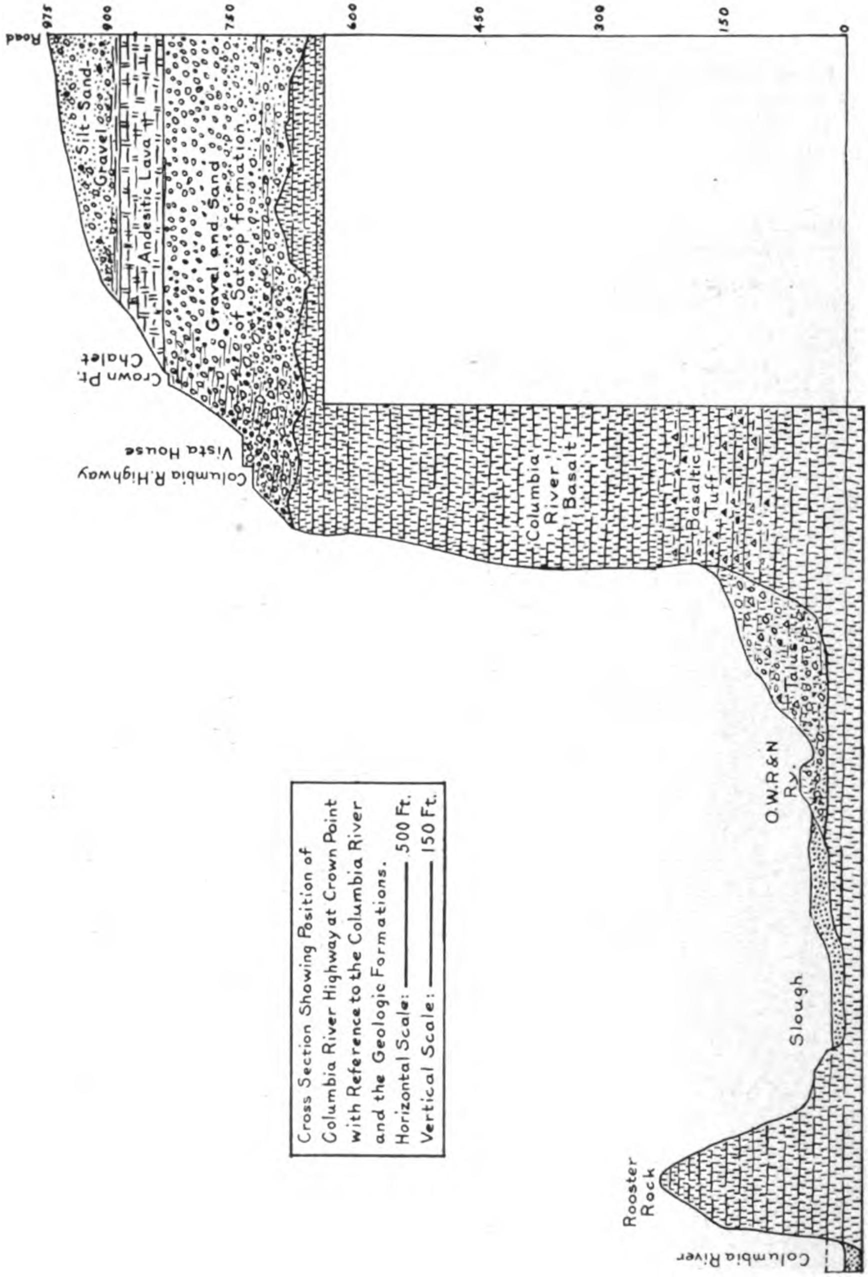
As the auto coasts almost effortless for the last half mile of approach, we are again permitted as along the Sandy river, to examine at close range some of the characteristics of the Satsop formation. Instead of being down at river level it is here perched hundreds of feet above the river, these lower hundreds of feet upon which it rests being a succession of heavy flows of basalt. Our study of the Washington side has showed plainly that there, too, the gravels rise upon the top of a westward sloping surface of basalt, very well seen at Cape Horn. Were one to follow the railroad track east from Troutdale, no trace of the basalt is seen until within a mile of Corbett, only a great threatening wall of cemented gravels and sandstone enclosing a single layer of andesitic lava. And from here to Crown Point its surface rises to a height of, as we see before us, at least 500 feet above the river. It is an uneven surface, and although the gravels have filled in to obscurity all irregularities, they too rise in conformity with the inclined basalt on which they rest.

Hard lava resting upon coarse gravels, near Crown Point. Just before reaching Crown Point we pass along a clean face of the intra-gravel andesitic lava, and can see to an inch the line of contact between it and the gravels below. We cannot fail to remark that the top foot or 18 inches of these gravels, which are clayey here, has an unusually reddish hue. Yet closer inspection will show that this thin band is harder, as if more firmly cemented than is usual, and when shattered many of the pebbles break through, rather than pull loose from, the cementing matrix. We are then reminded that this sheet of lava, a molten hot, seething, flowing mass, came out upon a gravel surface, whether beneath or above the surface of a body of water we cannot say for certain. At any rate its contact with these gravels raised the temperature of the upper foot or so to such an extent as to produce a hardening or baking effect, exactly as the solidification of clay is brought about when bricks are burned in a kiln. The temperature here must have been at least a glowing red heat.

The lava bed is at this place 30 to 40 feet thick and above it again is more of iron-stained clayey sands and of gravel similar in all



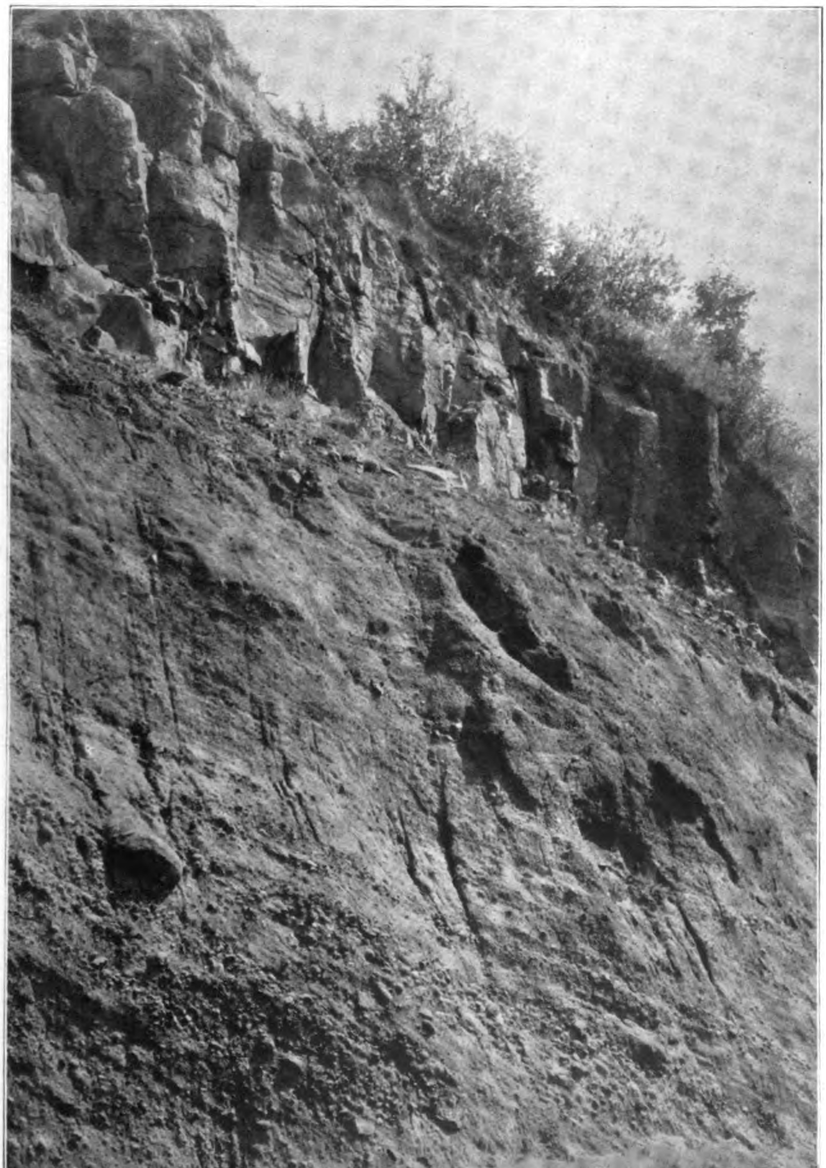
Hard andesitic lava resting upon gravels, near Crown Point. The contact line, which is distinctly seen, is a vivid red color, caused by the seething hot lava flowing out upon the weathered surface of the gravels



Diagrammatic section through Rooster rock and Crown Point

respects to those below. At once we realize the intra-gravel position of this lava, our thoughts promptly hark back to the exposure along the Sandy river opposite Troutdale, where a heavy andesitic layer resembling this in every phase occurs in the same identical relationship; yet there its base was but 200 feet or slightly more above the river, while here we are overlooking the Columbia by fully 750 feet.

Cross-bedded Satsop gravels overlain by blocky andesitic lava, near Crown Point. The gravels themselves offer a wealth of suggestion as to the course of events in which they have had a part. Immediately beneath the lava the pebbles and boulders, always



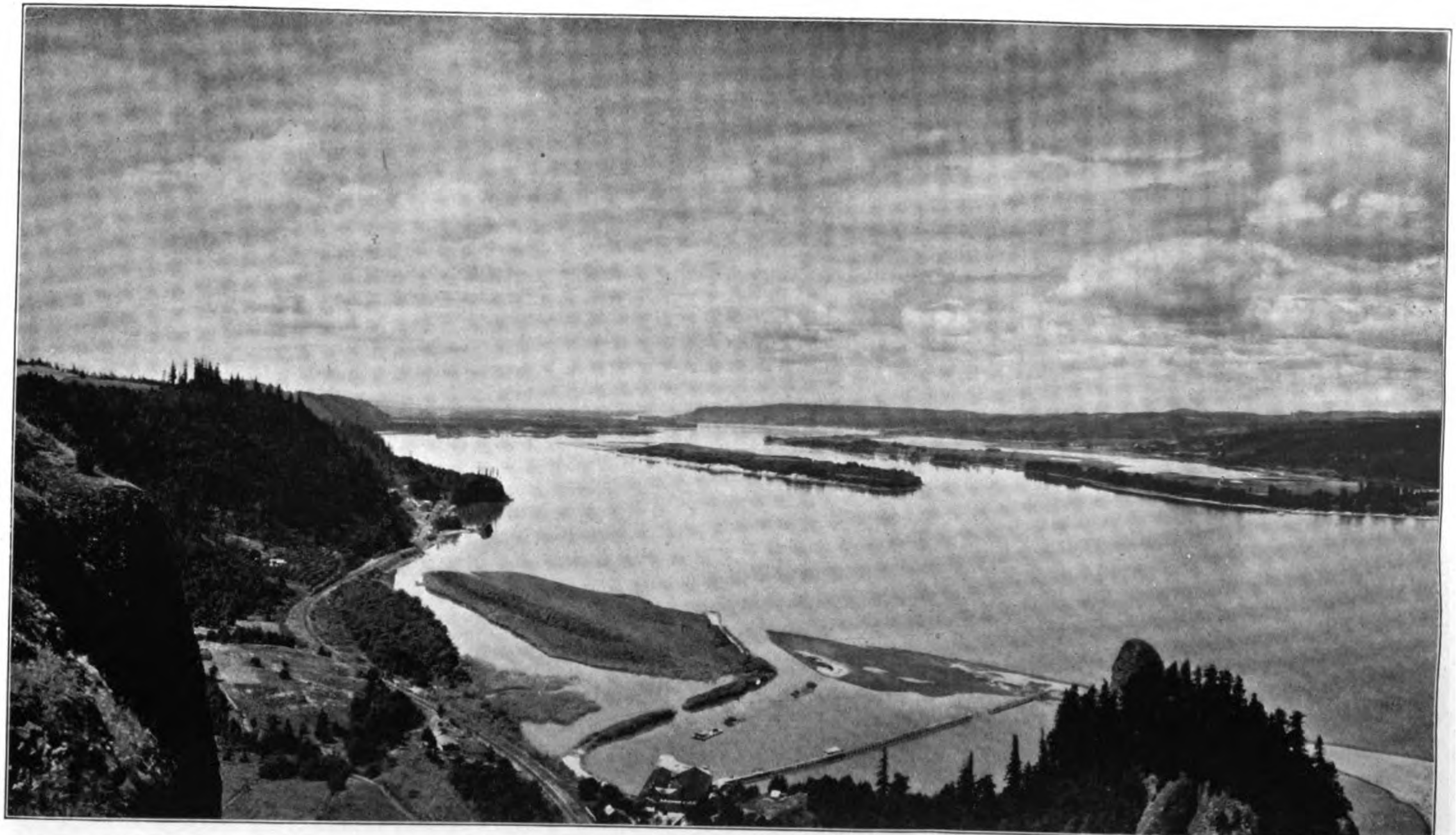
Cross-bedded Satsop gravels and overlying lava, near Crown Point

rounded and waterworn, are predominantly of gray, cellular andesite with a filling of scoriaceous sand and ash, as if they were a great outwash carpet produced by the breaking down of a not distant mass of its own kind and distributed ahead by the waters in preparation for its hurried oncoming. This phase of the gravels is typically shown in the foundation of the Vista House. As a usual thing the layers, or bedding, of the sand and gravel are fairly even, as thouugh they had been spread out with care upon a comparatively even surface. In some places, however, there is great variation in the altitude of the layers within a short distance. In the Highway cut, about opposite Crown Point chalet, is an excellent example of "cross-bedding" in the gravels. For the space of a few rods the alternating bands of sand and gravel pebbles which mark the manner in which the water put them down, are inclined to the southward as high as 30 degrees from the horizontal. Contiguous to those of such marked dip are relatively flat-lying strata that give the impression of abutting against the ones of steeper inclination. This is distinctly shown in the photograph.

Delta Structure in gravels

This variation of structure is quite characteristic of sedimentary beds that are deposited where the velocity of streams is checked as they flow into still water of some depth. It will be recalled that deltas are built up at the mouths of rivers and grow progressively farther and farther out as the river is forced to drop its burden. The heap thus built is one of steep slope on the down-stream or quiet water side, and sediment put down upon this slope will share the inclination of the surface of deposition. When streams are heavily charged with coarse materials, such as gravel and sand, we have all seen them clog their own channels, and shift position first one way then another in order to avoid their own obstructions. That, as the growing delta slowly rises toward the water's surface, is precisely what takes place. The channel forks into various distributaries, each depositing its load, then shifting, again depositing in its own way, again squirming about to circumvent the result of its work. In some later age when a former delta is elevated to become land surface, we find that the materials of which it is constructed have, as would be anticipated, the very same type of structure variations as we are now observing in the old Satsop gravels along the Columbia River Highway. What is our inference? There is but one conclusion, and that is that we are examining a cross-section of a portion of an old river delta; whether formed in the edge of the ocean, an inland lake or in the meanderings of the river itself we are now perhaps not quite ready to say. The materials of which it was built are largely river-worn gravels. And since we know that down the Columbia only could the abundantly plentiful quartzites have come, we are thereby compelled again to place at the door of that river the bringing down from parent ledges, and distribution, of at least a large proportion of the bulk of this formation.

Down the Columbia river from Crown Point. Arriving at Crown Point, we shall find of nearly as great interest the view to be had for miles down the river as that up the gorge from Chanticleer.



Down the Columbia from Crown Point. Rooster Rock and fish cannery in the foreground. The flat sandy islands are a feature of this portion of the course of the river. The distant low horizon line is the dim shadow of the Coast Range more than 30 miles away

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Our position is at the very brow of a basalt cliff 725 feet above the Columbia, whose proximity is so deceptive that it would seem a stone vigorously tossed would land in its waters. Rooster Rock, down upon which we look, is a group of spires, the culmination of a jutting ridge of basalt, that appears to be a remnant which the river in its task of cutting a channel has not yet cleared away. The notable cylindrical form with symmetric conical top is due in large measure to the presence of the characteristic columnar jointing of the basalt, because of which it tends in crumbling down to maintain steep if not vertical faces. Could one examine the face of the sheer basalt wall over which we now stand, it also would be seen to be coarsely columnar, with a hundred feet or more of its base (to be observed at the railroad level) of fragmental iron-rust brown basaltic tuff.

Across the river in Washington stretches of farming country mark the top of the Satsop formation, which surrounds or rises upon the flanks of prominent knob-like hills. Some of these hills doubtless represent, as we have seen in the case of Mt. Zion, former volcanic centers, whether or not their lavas can today actually be seen projecting above the surrounding gravels. Prune Hill, plainly outlined against the sky 15 miles to the west, and Mt. Pleasant directly across the Columbia are two of these elevations. Down stream the channel of the river is broad, for many miles bordered by tidal sloughs, and its even flow is broken by a series of low wooded islands, sand points and bars. These features are produced in the course of a river when for some reason it is provoked to put down a considerable portion of its load of sand and silt before reaching the deep water of the ocean. We have already referred to the fact that, within comparatively recent geologic times, depression of the land has carried the lower Columbia to such a level that its old channel, which was doubtless well defined, was "drowned" by incoming of the ocean water. Its great width, low gradient and the presence of the islands are some of the observable results of this accident in its normal development.

Looking into the Columbia river gorge from Crown Point, 725 feet above its waters. One is in a far more favorable position on Crown Point to study the region on both sides of the river than at any other place reached by the Highway. On the Washington side we plainly observe the series of relatively even-topped elevations already named, whose summits rise successively higher with distance, and culminate in the prominent outstanding profiles of Mt. Hamilton and Table mountain. It is no illusion that the evenness of their summits is due to the slowly rising surface of a massive series of lava flows that, beneath Mt. Zion is a few hundred, and in Table mountain near 3,500 feet above sea level. On the Oregon side, similarly, we look beyond Bridal Veil where the jutting bulk of Fort Rock (Angels Rest) cuts off further details of the view close along the river. The base of Fort Rock is likewise basalt, but its top, as we shall also later learn, is hypersthene andesite, resting upon 500 to 600 feet of Satsop gravels that come in between the two great masses of lava of different types. Back from the Columbia and its bold canyon the mountain slopes rise to the summit of Larch mountain and, ever up, beyond the range of sight towards the major heights of the Cascade Range. We catch glimpses of the Columbia River Highway at intervals where, in finding its way to lower levels from our present elevated position, it has been necessary to seek out a sometimes devious course.

Looking into the Columbia river gorge from Crown Point. Larch mountain, 4,045 feet, at the extreme right against the sky. Bridal Veil on the Oregon side at the foot of Fort Rock. Cape Horn at the left across the Columbia in Washington.

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We are at the entrance to one of nature's great workshops wherein her forces have been and can now be seen actively at work. Crown Point and its environs is indeed a fitting introduction to the plethora of interesting things ahead, for it has given us just enough of a revealing glimpse to whet both curiosity and desire to a suitable state of keenness which will, we resolve, allow no single feature to escape our appreciative eye.

Bouldery Satsop gravels resting upon weathered basalt, east side Crown Point. From here we coast down even but exhilaratingly tortuous grade nearly to river level within the first two miles. We are told that the road in crossing a single 40-acre plot traverses a distance of 4,200 feet and drops in elevation 200 feet. At Crown Point we stood upon a great gravel bench; at the river, as would be anticipated, the rock is all basalt. At some point in the descent our watchful eye must not fail to note where gravels leave off and basalt appears. A start is but barely made when, within a few hundred yards, at the second turn, we see in a deep cut a great bouldery mass of the one resting undisturbed upon the other. Over all is a thick veneer of silty material such as we can conceive may have been shifted from the river flats by the wind. But so different than usual is the appearance of the basalt upon which the gravels lie, that we may excusably hesitate at this, our first immediate introduction, to recognize any familiar mark or pleasing trait to excite particular desire for further acquaintance. Since however long before our trip is over, almost continuous association must make of both inseparable friends, it will be well indeed to pause at this point to take advantage of the congenial introduction so freely extended.

Contact of gravels upon basalt

We may trace the contact between the gravels and the basalt along the Highway for many rods at an elevation of 650 to 675 feet. It is an uneven contact; as if the gravels and sand were hurriedly tumbled in upon an old land surface that had been roughened by water and weather into gullies and ridges, possibly hills and canyons. And the testimony of the basalt itself that such was the case is strongly corroborative. Its upper portion is usually crumbly, iron-stained or yellowish with streaks of clay that has come from its alteration. The top weathered part is sometimes a few feet, sometimes 15 or 20, or how thick we do not know, and its original blocky or columnar structure is so entirely obliterated that resemblance to the fresh lava is quite lost.

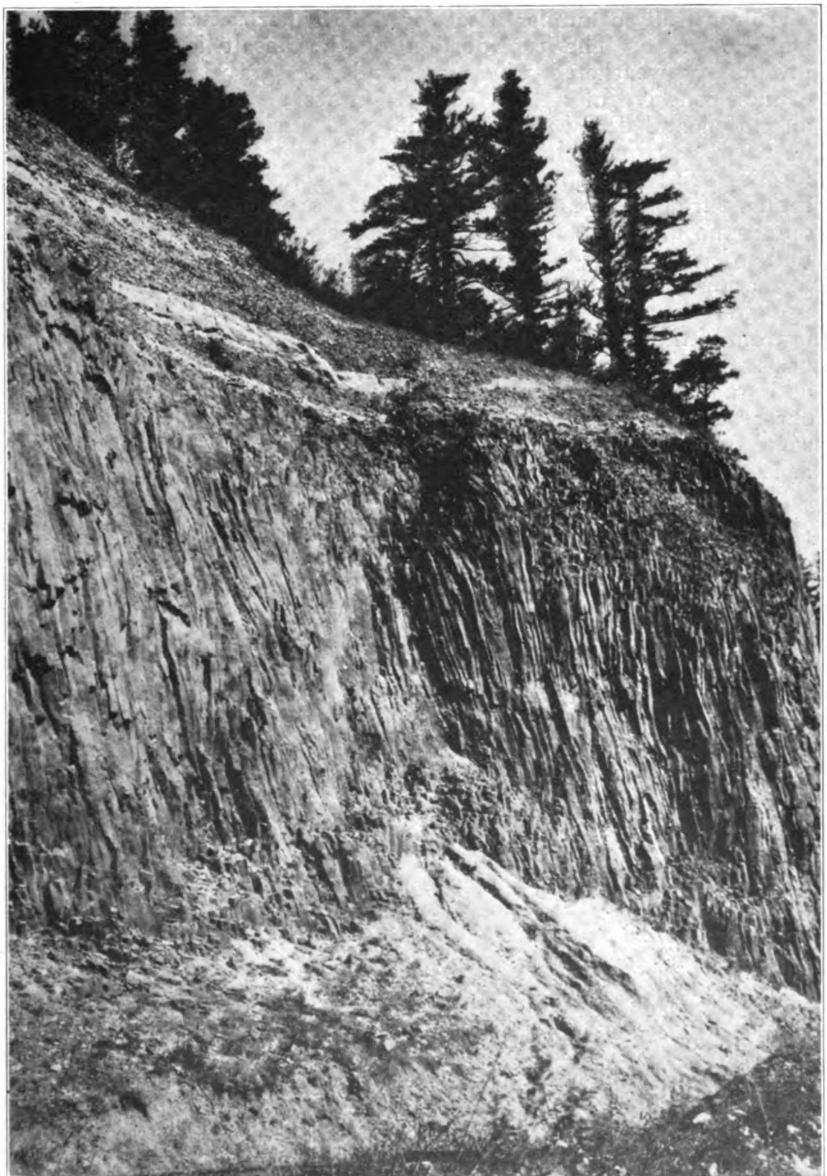
Weathering of the Columbia river basalt, east of Crown Point. In places the weathered basalt presents the appearance of a bed of great rounded boulders separated by a filling of yellowish or bluish clay. In the view the development of these "boulders of weathering" as they are called, is plainly brought out. Due to the jointed nature of the original basalt it is possible for water to find its way through the rock with little difficulty. Naturally in certain places channels become established along which the bulk of the slowly seeping water moves. The surface waters containing oxygen and carbon dioxide from the air, and acid constituents from vegetable matter decaying at the surface, attack the rock with which it comes in contact. The changes brought about in this attack are largely

Bouldery Satsop gravels resting upon weathered basalt, east side Crown Point chemical, by which certain constituents are dissolved and carried away, while insoluble ones remain to mark the position, if not so very much as to the nature of the rock itself. Streaks of such residual material surround boulders in the middle part of the view, and grow less and less if followed either towards the top or bottom of the section. Low down the rock is less altered, some of its former columnar

Weathering of the Columbia river basalt, east of Crown Point

jointing being still in evidence, while above, much of its mass is so thoroughly decayed that even the boundaries of the boulders of weathering, if they once existed, have long since disappeared and the whole become a softened largely structureless earthy residue.

We read from these observations that, prior to the coming of the overlying gravels, a long period of time passed while the basalt was a land surface, and during which erosion took place and deep alteration gave rise



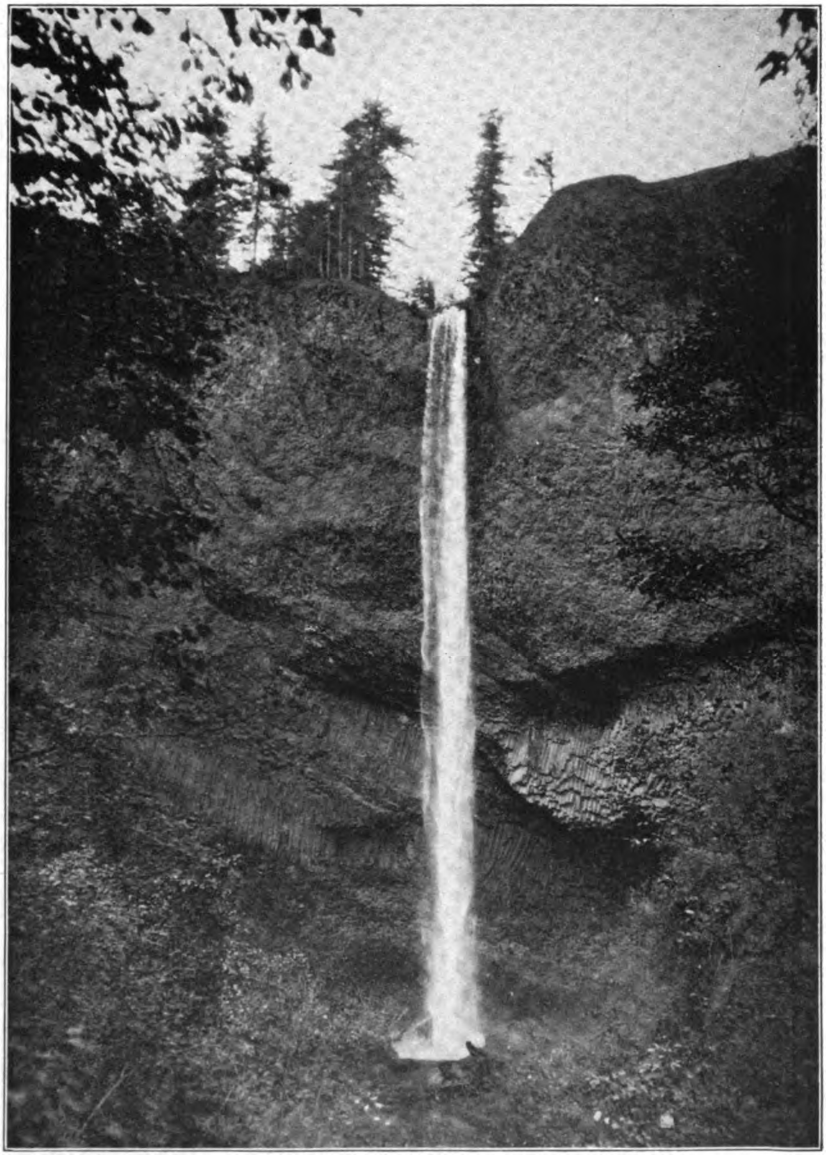
Beautifully columnar basalt overlain by horizontal layers of gravel and sandstone

to a mantle of basalt soil and rotted rock. For the length of this interval in the past when tearing down of the land surface was going on we obviously have no direct measure. The fact that such a period did elapse is however shown conclusively by the erosional break (called unconformity) between the two formations before us, the gravels above resting upon the eroded basalt.

Beautifully columnar basalt overlain by horizontal layers of gravel and sandstone. The top portion of the basalt is not always so profoundly weathered where we find the gravels upon it. We cannot conceive of a land surface on which the residues of rock alteration and decay would remain or accumulate uniformly on all its parts. At one point every particle is swept away, elsewhere the forming soil remains in place or is even added to by mineral particles brought from a distance by wind or water, precisely as we see going on around us today. There is thus no occasion for surprise when we find so clean-cut a contact between these same gravels of the Satsop formation and the basalt as shown in the photograph. The long, hard upright columns of black basalt appear to break square off at the bottom of the gravel. The tops of the columns form a rolling surface upon which parallel layers of alternating partially cemented sandstone and gravel lie. This relationship between Satsop and basalt may be observed from the railroad along the north side of the Columbia for some distance west of the entrance to the Cape Horn tunnel and, as before us, is identical with their position on the Oregon side.

Latourell falls. Latourell creek is crossed at a little less than two and one half miles from Crown Point. Here it is that we are greeted by the first of the thrilling series of waterfalls which has made famous the gorge of the Columbia river and is every day adding to the renown of the scenic Highway which threads its depths. Latourell creek is not a stream of large volume, and this fact it is in connection with the comparatively great height, that lends to its falls and to each of more than a full dozen of others along the Columbia River Highway, so splendid a tinge of the awesome to their charm. Latourell falls is a practically vertical drop of 224 feet, as determined by Samuel C. Lancaster. Its position is at the apex of a broadly wedge-shaped alcove formed by the recession of the falls as the stream has slowly eaten its way into the hard basalt of the canyon wall. It is a bold sheer front of black columnar basalt down which the water plunges. The maintenance of perpendicularity is largely favored by the pronounced columnar jointing, the columns being in general upright so that when they break away they do so parallel to the face of the cliff. Near the base of the falls the columns are conspicuously larger and vary in position from vertical to inclined or nearly recumbent. The large undercut or cavernous recess back of the falls is doubtless due to this varying attitude of the columns and to the additional fact that the columnar basalt here is in contact with one of a more platy structure, that gives way more rapidly under the incessant pounding action of the falling water and its load. At the east end of the bridge is Falls Villa, an attractive refreshment and lunch station.

Falls of Shepperds Dell. Three and one half miles from Crown

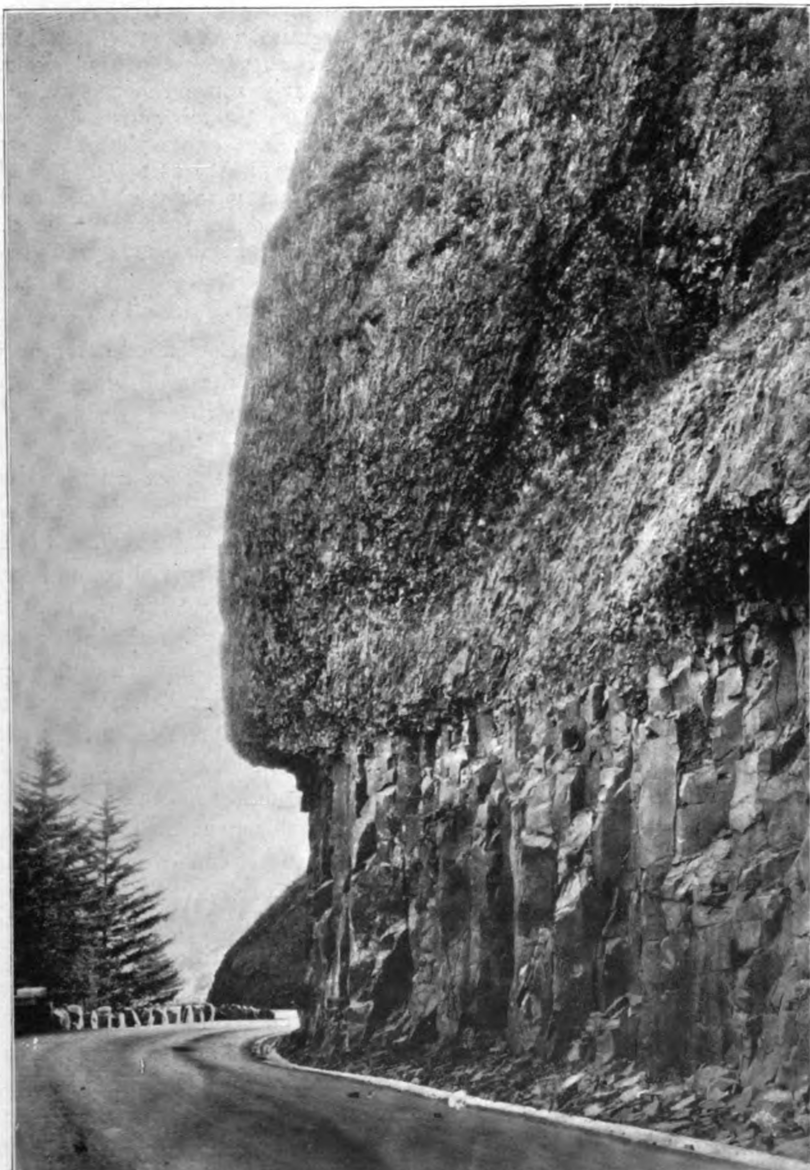


Latourell falls. 224 feet high. Note the curved columnar jointing of the basalt

Photo Cross & Dimmitt

Point is Shepperds Dell, a most fascinating rock-sheltered cove whose attractiveness is much enhanced in the series of cascades down which Youngs creek makes its hurried way towards the Columbia. From both the east and the west the approach along the Highway is at the base of an almost unbroken vertical wall of basalt that cuts off the view except on the river side. The long low wooded ridge,

The falls of Shepperds Dell
Photo by Weister



Overhanging wall of columnar basalt east of Shepperds Dell

erstwhile island, has been built by the river of the sand and silt with which its waters are ever loaded.

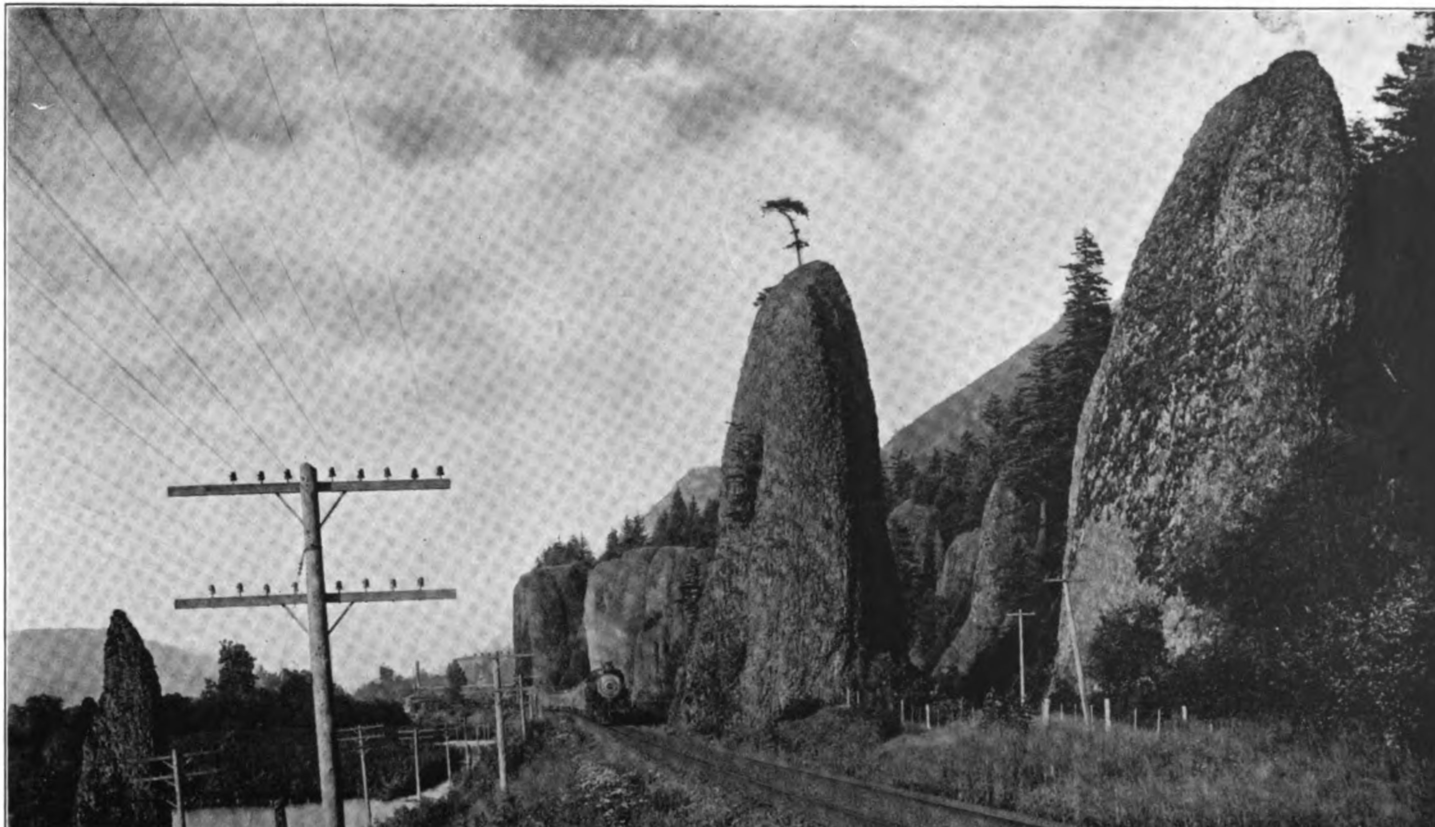
Overhanging wall of columnar basalt east of Shepperds Dell. Just beyond Shepperds Dell great columns form a splendid natural palisade, which is surmounted by a great thickness of basalt whose columns are on a much smaller scale. The latter breaks into small angular blocks which, as they loosen, occasionally fall to the pavement, and thus automatically provide a subtle reminder to those who might unintentionally or otherwise forget, that an avenue of numerous no matter how graceful curves, cannot safely serve the purpose of a speedway. The heavy columns appear as though purposely designed to support the great overhanging rock load above them. They can be seen in some instances to possess a regularity as to number of sides, and they separate from each other along fairly smooth and even joint faces as if for some cause these had been predetermined. Upwards the columns apparently grade into the less coarsely columnar rock.

Columnar structure in basalt

Columns are a common characteristic of basalts everywhere. Along the Columbia river a species of jointing in which well-defined columns are not always apparent is quite prevalent, by which the rock breaks out in angular chunks usually of not large size. Whatever the particular phase, this tendency of a once molten lava to separate along fairly definite planes, we are told, has been induced by strains set up in the rock while it was cooling. Oftentimes the lines or parting planes, and therefore the columns, are seen to stand at right angles to the surface of the flow, as though they had developed thus ahead of and perpendicular to the zone of more rapid cooling as it progressed inward. Sometimes the columns are at the base of a flow, their lower limits being the contact with an earlier rock surface from which cooling doubtless took place somewhat rapidly. Very frequently groups of columns display a radial arrangement. We are not always able to determine that columnar structure bears a fixed relation to cooling surfaces, although it does seem that in all cases the particular conditions of cooling and hardening from the highly heated and viscous or even fluid state, has been the chief cause of this structural feature.

Henceforth we are to be treated to a succession of most pleasing waterfalls, interspersed between promontories of increasing height and magnificence as we penetrate farther into the depths of the gorge. One fourth mile beyond the Dell is Forest Hall the gentility of whose service and the attractiveness of the surroundings having quickly made for it an established reputation. The falls of Bridal Veil creek, one mile beyond Shepperds Dell, though in perfect view from the O.-W. R. & N. railroad, is below the Highway. It is not perhaps so serious a desecration as might at first seem, that the volume of these falls is lessened, or in late summer even reduced to a bare trickle, by the needs of lumbering operations. For, though in its pristine vigor and surroundings, Bridal Veil falls was a thing of entrancing beauty, we may possibly condone its partial loss with the thought and knowledge that, before we are scarcely beyond hearing either to the east or west, others of its kind will greet us in all the fullness of their native splendor.

But we must not fail, as we traverse the distance from Crown Point to Bridal Veil, to note the occasional presence by the way of smoothly rounded gravel pebbles, many of them quartzite. These come down from



Pillars of Hercules. South of O.-W. R. & N. track and just north of the Columbia River Highway east of Sheppards Dell. This peculiar type of pinnacle is a characteristic erosion form of the Columbia river basalt. They are remnants that the river has not yet torn down and carried away

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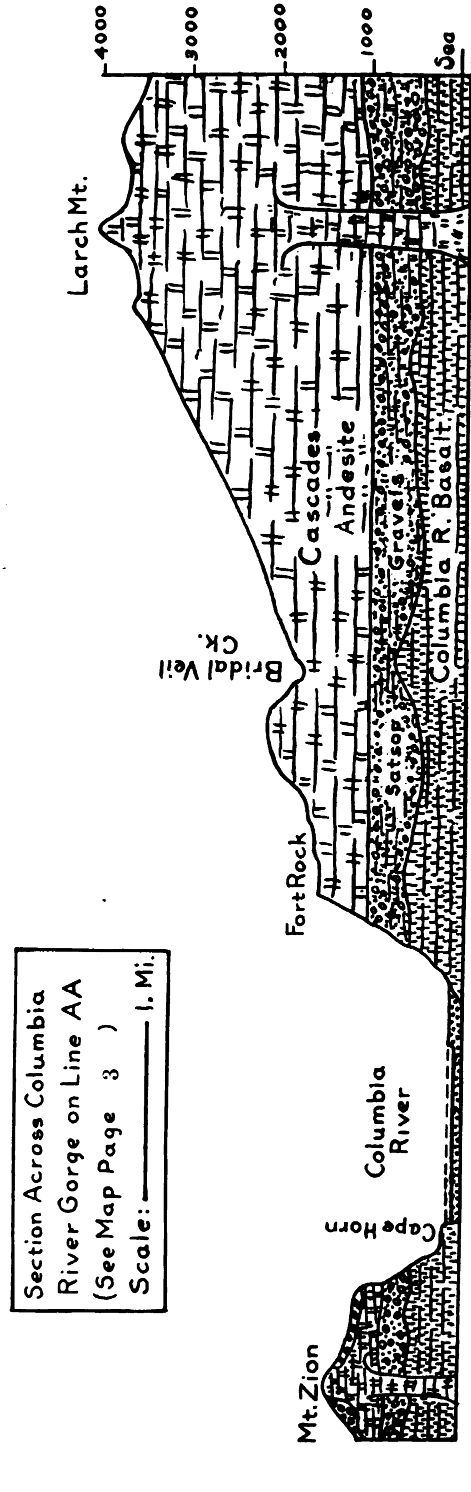
the Satsop formation whose intimate acquaintance we have already made, it resting here as elsewhere upon the top of the basalt. The contact varies in altitude from about 675 at Crown Point to 900 feet on the trail to Fort Rock, where a total thickness of fully 500 feet of this formation is present. Opposite Bridal Veil, and to the east of it a few hundred feet higher than our roadway, the outcropping edge of this bed forms a steeply rising wall above the basalt which is so studded with projecting boulders and pebbles that its character cannot be mistaken. Up Latourell creek we find it at less than 1,000 feet and here too, as well as beneath Fort Rock, is a bed of andesitic lava that appears to be enclosed within the gravel and scoriaceous sandstone of the formation.

Fort Rock (Angels Rest) from near Bridal Veil. Fort Rock looms up directly ahead from Bridal Veil, its crest surmounted by an encircling palisade or rim of platy hypersthene andesite. Its summit is 1,500 feet above the river. Here we have our first glimpse from the Highway of the lavas that overlie the Satsop gravels. We have seen that heavy layers of basalt come below, and, as at Troutdale and Crown



Sketch showing probable structure of Mt. Zion and Larch mountain

Fort Rock (Angels Rest) from near Bridal Veil. Old Columbia river road before the Highway was built

Point, at least one flow of a dark gray basic andesite came while the gravels were accumulating. But until now we have not been certain that upon the Satsop rested directly the lowest or first of the great series of andesitic lava flows of which much of the superstructure of the Cascade Range in Oregon is composed. We shall see that at many points ahead this same andesite is present in sufficient thickness in the upper part of the canyon wall, to very decidedly enhance many of its features of attractiveness.

Coopey creek comes out at the west side of Fort Rock. Its attractive lower falls, 117 feet in height, is to be seen a few steps from the Highway. The upper falls, which is passed several hundred feet up on the Fort Rock trail, appear to mark the contact of the gravels and the basalt, as if, in its downcutting the harder lava had proved so much of a barrier that the stream was compelled to tumble precipitately over, instead of taking the time to deliberately saw through it a channel of more uniform grade, such as it was able to do in the less resistant gravels above.

Wahkeena falls. 242 feet high
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From this portion of the route a glance to the Washington side is of interest. Directly opposite, the heavily bedded basalt that supports Mt. Zion dips down-stream 2 to 3 degrees; and to our right beneath Fletcher Flat, its summit 1,600 to 1,700 feet high, the same lava beds have a slope in the same direction of 3 to 4 degrees. We should expect to find the gravely beds of the Satsop, at least here and there, if not continuously resting upon the basalt. This it will be recalled has already been observed to be the case upon the slopes and at the river foot of Mt. Zion. Whether the gravels continue into the higher parts of the Range on the Washington as on the Oregon side, is a question to which a definite reply cannot now be made. Cape Horn at the river's edge is in the center of the view. **Across the Columbia**

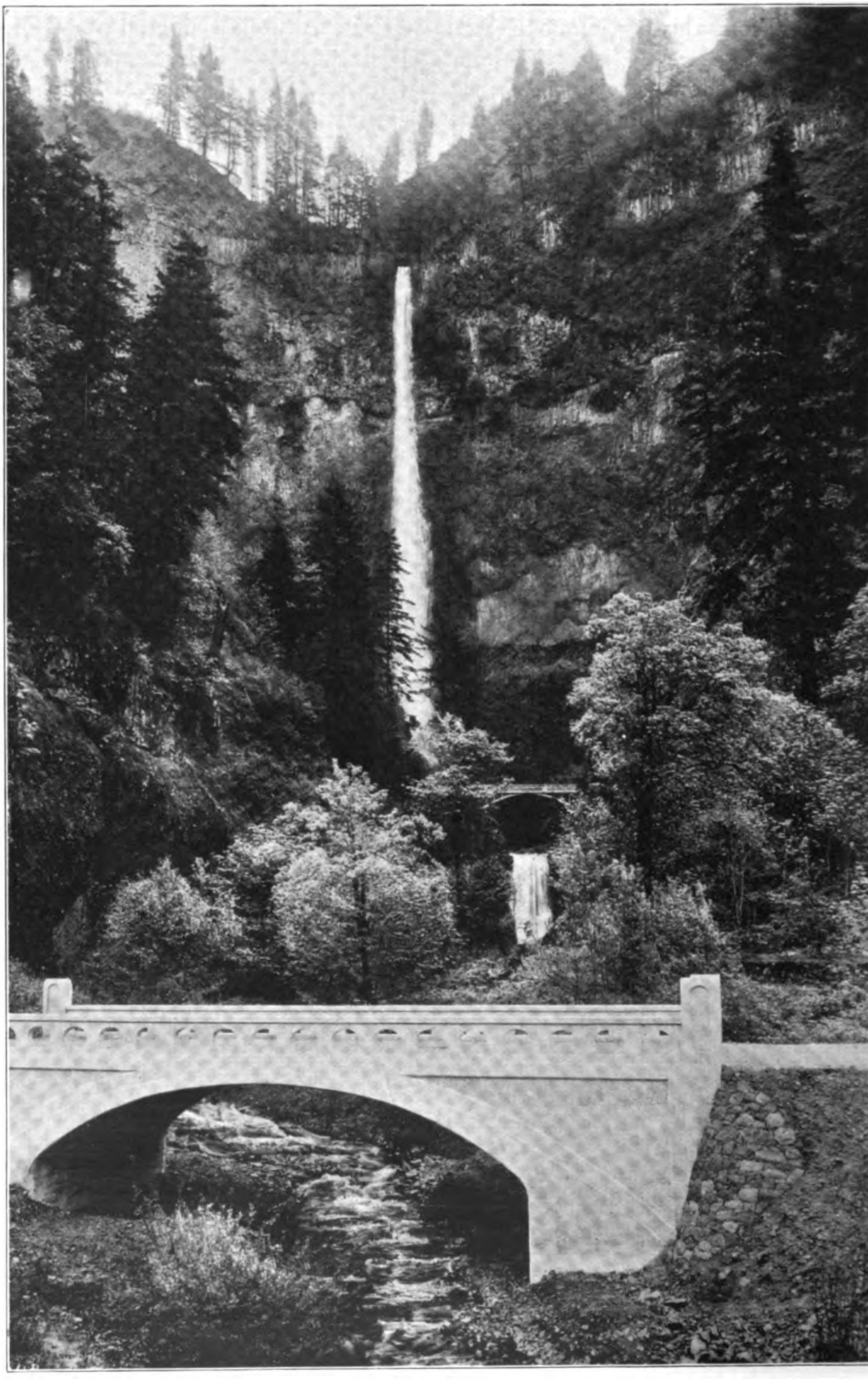
At the foot of Fort Rock and thence to Wahkeena falls, gravel, gray andesite, and basalt talus mingle, to show that each is present in the cliffs above. Multnomah Lodge is three and one half miles beyond Bridal Veil, a delightful hostelry, where visitors find both cheer and the fullest satisfaction of ordinary physical needs. Mist falls is a mere filament of water, so slender that before half of its sheer drop of near a thousand feet is made, it is none else than a spray of mist—hence its name.

Wahkeena falls. Wahkeena falls is without doubt in some ways the **most beautiful** of the many falls along the Highway. We are told that this is the Indian meaning of the name. The falls is a series of alternating vertical drops and rushing cascades, in total height, 242 feet. The waters come down a steeply sloping front of basalt. As much as the nature of the falls itself, is character and charm given to the place by the towering rock cliffs from high up between which in a niche of its own making, the whitened stream suddenly leaps into view. A foot bridge spans the stream at the foot of the falls and it is from here that the trail may be taken for the summit of Larch mountain. At Wahkeena falls is a public comfort station and, it is well perhaps to know, a station of the motorcycle Highway police patrol service.

Multnomah falls. Benson foot-bridge and Columbia River Highway. Less than one half mile beyond Wahkeena, and barely less than thirty-six miles from the center of the city of Portland, is Multnomah falls. It is within one half mile of equidistant from Portland and from Hood River. No mention of the Columbia River Highway is complete but with and a part of it is the falls of Multnomah. Long have its praises been sung, and as our familiarity and knowledge of its idiosyncrasies grow, we come to realize that only the sweetest of strains can begin to express the love and reverence that this pygmy-giant but master stroke of Nature's busy hand must stir in every open heart. The rush of its waters is music that enthralls and its picturesque surroundings beyond the skill of the artist's brush to portray.

The main falls is 541 feet in height according to recent measurement by the U. S. Forest Service. The lower falls is 69 feet with a lowering of 10 feet in the Cascades between; in all, from brink to base, 620 feet.

In the main falls the waters of Multnomah creek spring from the edge of a slightly overhanging ledge of hard basalt, which carries



Multnomah falls, 620 feet high. Benson foot-bridge and Columbia River Highway
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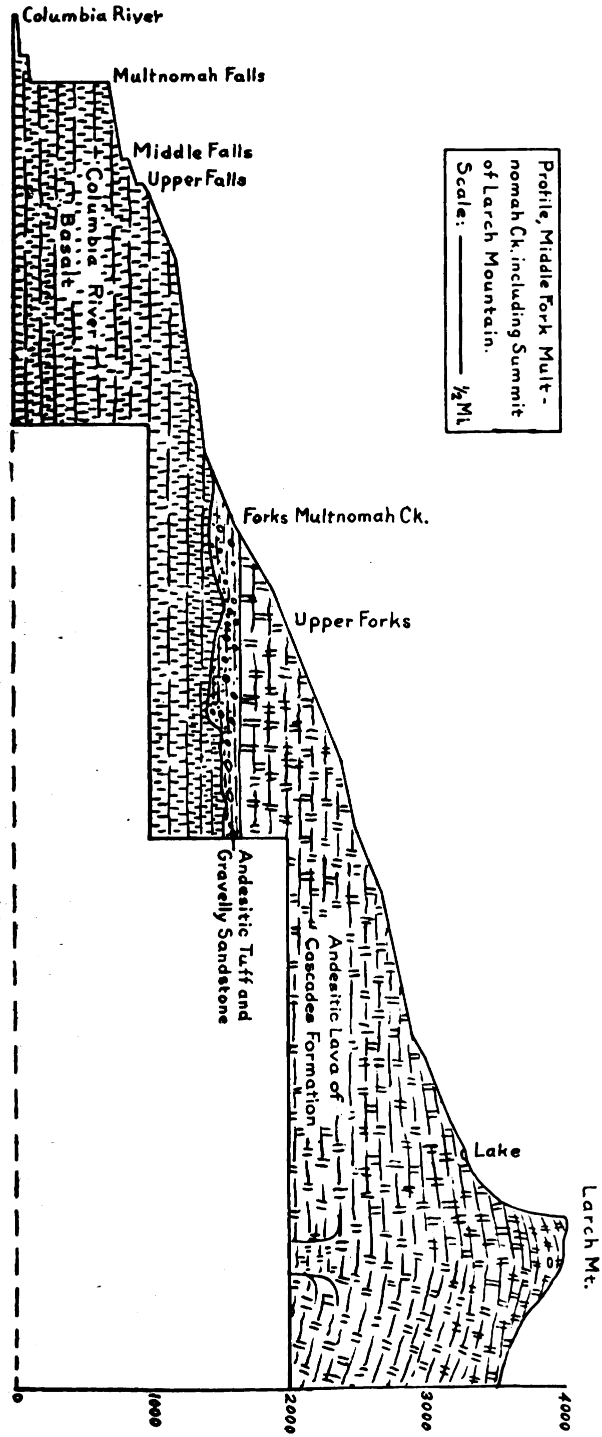
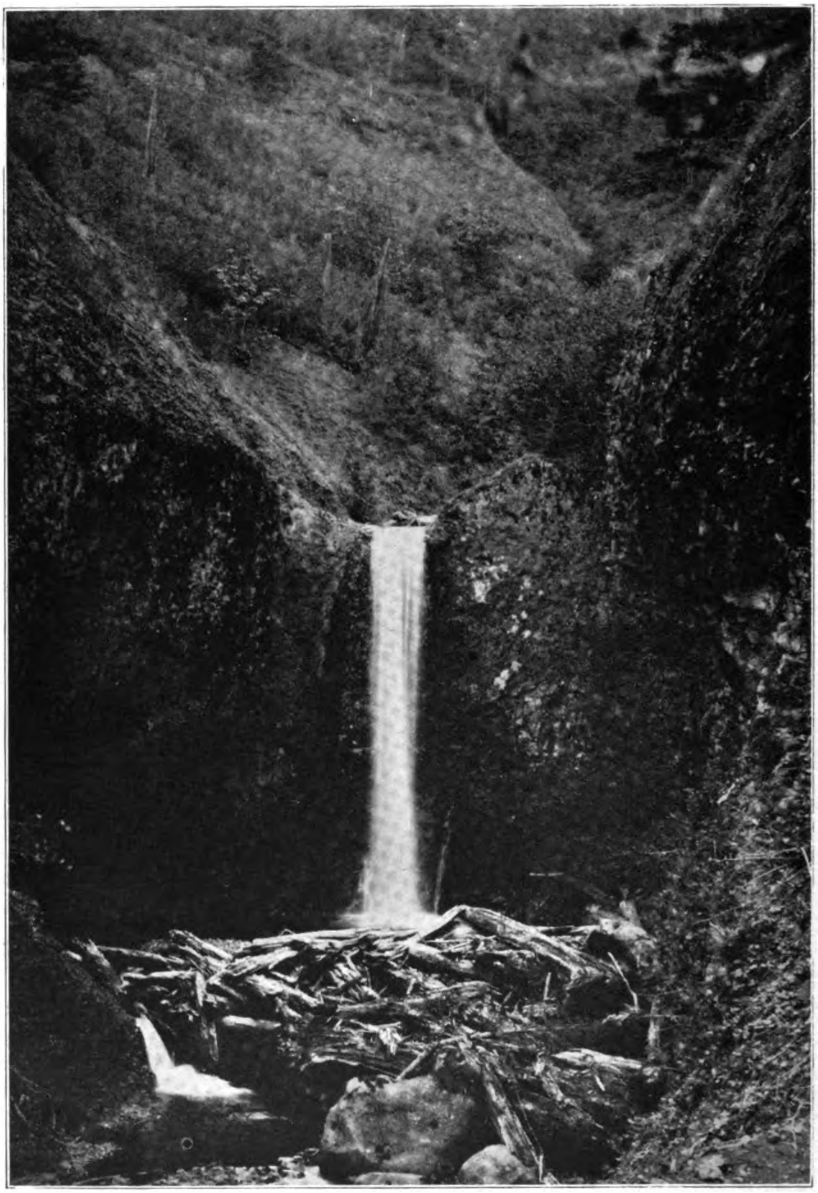


Profile Multnomah creek

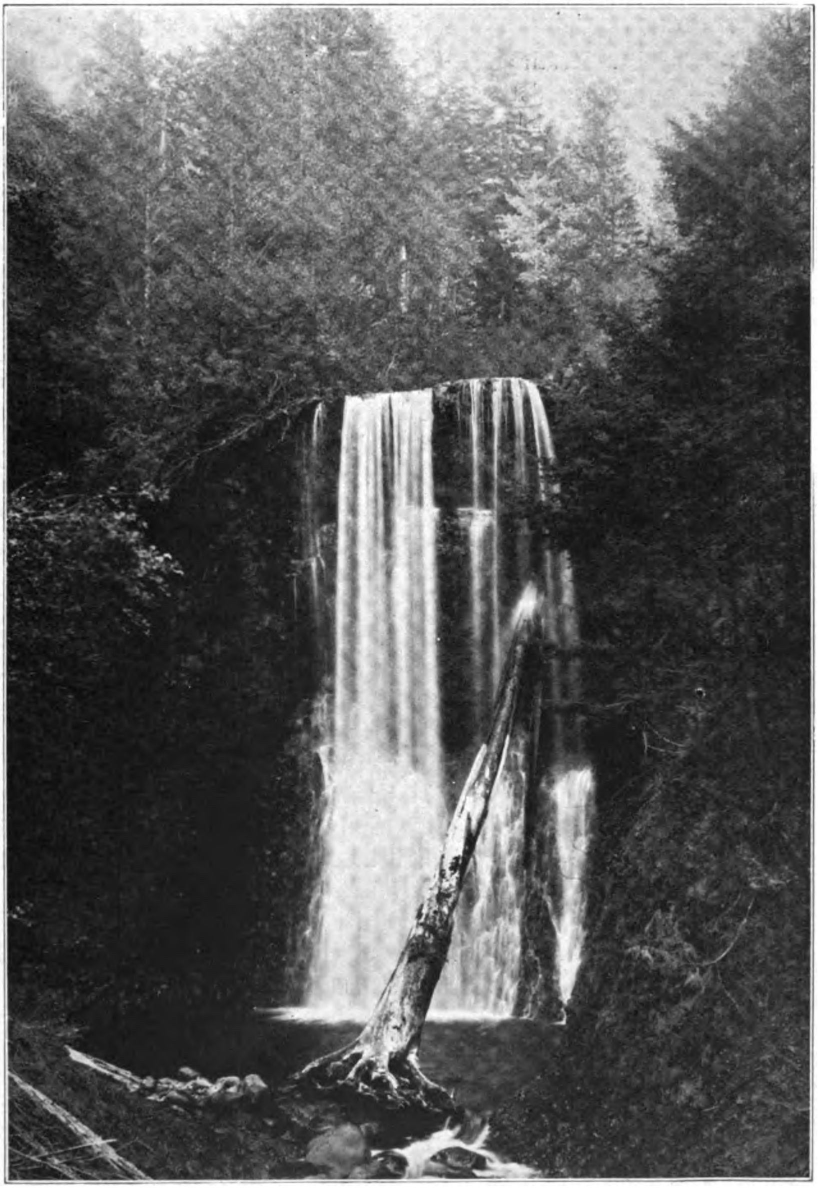
them entirely clear of obstruction to drop vertically in midair for better than 500 feet. In late summer when the flow of the stream is lessened, it is not an uncommon sight to see the entire, then frail ribbon of water shifted aside by each eddying breeze, like the quavering vibrations of a waving ensign, and beaten into spray long before its half thousand foot leap is over. In winter at times the entire setting is a frigid one of frost-fretted shrub and tree. The great rock wall is faced with a glittering ornate veneer of rime-coated stalactites and stalagmites, in all the intricacy of their most splendid design; and the turbulence of the plunging water itself seems calmed to so peaceful a state that, beyond the range of sound, we are constrained almost to feel that it, too, has congealed to permanence in its place.



Middle falls of Multnomah creek, on Larch mountain trail

LARCH MOUNTAIN

THE rock section behind the falls is a series of thick beds of basalt each bed representing an individual flow. It is typical Columbia river basalt, although columnar jointing is not developed on so grand a scale as in some other places. The trail to Larch mountain crosses Benson foot-bridge (shown in view, p. 52), safely makes a zigzag way to the level of the top of the falls, and thence up the canyon of Multnomah creek, which it later



Upper Falls of Multnomah creek, on Larch mountain trail

leaves to seek a devious way ever up with increasing steepness until, in a distance of six and one half miles the full summit altitude of 4,045 feet is gained. This trail was constructed jointly by the Progressive Business Men's club of Portland and the U. S. Forest Service. It is a popular climb and one not difficult for those whose pulmonary power is in a state of ordinary repair, and whose frame of mind is such that the primitive, the wild and the supreme in nature is of strong appeal. Up to about 1,250 feet above the Columbia river we see nothing else than columnar basalt, passing in the first two miles two beautiful falls each 60 to 75 feet in height. Resting upon the basalt is a 75-foot bed of beautifully cross-bedded yellow sandstone, containing scattered masses of cellular andesite. The sand particles are made of volcanic ash and gray to black lapilli. This deposit is clearly water-laid and occupies the position of the Satsop formation as seen elsewhere, for the next exposed rock in the trail above it is a porphyritic gray andesite that continues to the top of Larch mountain. Here, then, is better than 1,200 feet of basalt, which means that we are finding its surface higher and higher as we pass eastward towards the center of the Cascade Range. The comparatively thin bed of pebbly lapillaceous sandstone marks the interval between the great floods of basalt and the coming of the newer andesites.

Summit of Larch mountain

The highest point of Larch mountain is a platy augite andesite. In the low saddle between this highest point and that on which the U. S. Forest Service lookout station is located, is a great mass of red scoriaceous cellular lava resembling in every way those that accumulate immediately round a vent of eruption. There seems little question that the commanding height of this mountain represents a point of issuance for liquid lavas in great quantity; but whether they came from a fissure or crater cannot be stated, since later erosion has so profoundly modified its original slopes as to eliminate many of the marks by which its character may be recognized.

At the north base of the mountain there is an almost vertical drop of nearly 500 feet. This perpendicular rock wall, over the brink of which one is inclined to peer with extreme chariness, is a portion of a widely semicircular front at the foot of which a broad depression opens out to the northward. The three forks of Multnomah creek, and Oneonta creek, take their rise in the marshes, springs and small lakes within this depression. One is reminded very strongly of the glacial cirques so common in the higher Cascades and some of which are at altitudes no greater than this. In fact, so strong is the resemblance, that we can yet even almost see the great amphitheatre filled with the snow of centuries, from which streams of ice led down towards the Columbia, we know not how far. If we have thus correctly diagnosed conditions here, though we have climbed 4,000 feet to do so, we are now observing for the first time on our excursion the results of the work of an agent new to us, the glaciers, and whose activities represent a period of time more recent still than the andesite flows, the Glacial Period.

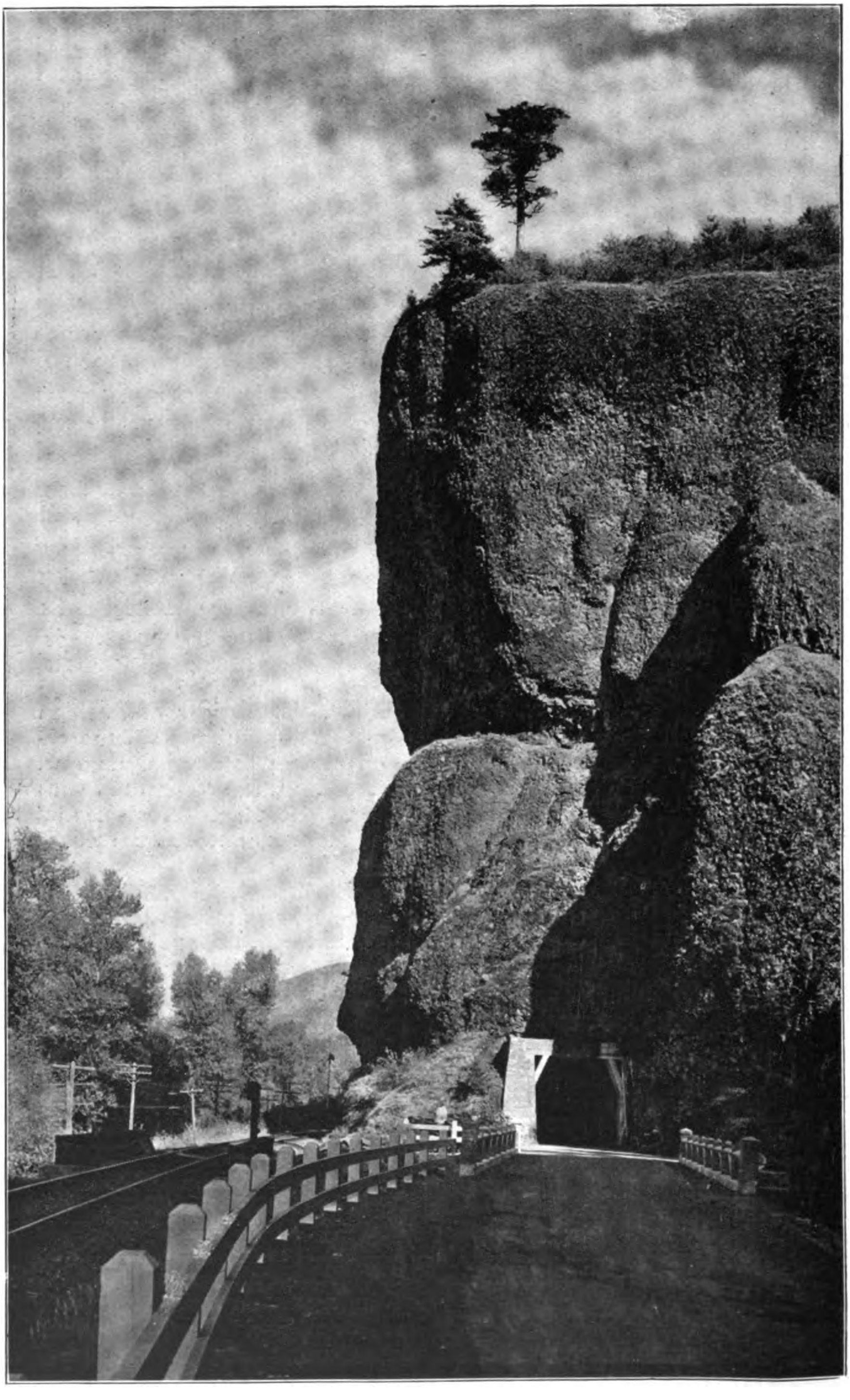
Geology in passing

To review in reverse order the series of events therefore, as we return to the Highway, we have nearest the present (a), the stage of ice or glacial erosion, passing into and followed by the active cutting of the present streams; prior to which (b) a great succession of andesite lava flows, exemplified before us in Larch mountain; preceded by (c) the deposition of the gravels and sands and clays of the Satsop formation, already seen at many places; (d) a period of active stream erosion and weathering in which deep canyons were cut in the basalt and its surface intensely altered; to be antedated still again by (e) the time during which the inundating floods of basalt swept over a wide range of country. We shall be interested to know, if, in the Columbia gorge, there will be exposed to our view anything to give us a glimpse yet farther into the past. If satisfaction be not too long delayed, an anticipative state of mind is a healthful one. In partial relief of which at any rate it may now be promised that, before many miles, not merely glimpses but wide open panoramic views, so to speak, that none can mistake, will abundantly speak out the events of yet earlier days.

In the course of the descent from Larch mountain to the Columbia River Highway, we shall be able to correlate to a satisfying extent the rock strata to be seen across the Columbia in Washington with those on our own side of the river. Directly opposite are the silent dark rims of Fletcher flat and Archer mountain, obviously made of the same formerly continuous layers of lava, but now separated by a shallow intervening canyon, and these are the same layers that, at a lower level, show beneath Mt. Zion at and above Cape Horn at our left.

Both eastward and to the west from Multnomah falls, the Columbia River Highway and the railroad have, as it were, been compelled to sparingly edge their way between the base of thousand-foot cliffs and the river's shore line. The cliffs are basalt but the presence of blocks of the lighter colored andesite indicates that it too, above the basalt, extends to the brink of the canyon.

Massive basalt flows. Oneonta tunnel. Both sides of Oneonta creek, which is two and one half miles beyond Multnomah, the exceeding massiveness of some of the basalt flows is impressed upon us. From its bridge, and facing Oneonta tunnel, we are confronted with a perpendicular blank wall said to be over 200 feet high. Nor is 'blank' in any way an appropriate adjective, for more expressive than this is wall of stone scarcely ever found to be. Its entire height appears to be made of but two flow layers of basalt, each when it came, therefore, more than 100 feet in thickness. Bearing in mind that we are looking at but a minute portion of a body of lava, each sheet of which spread out over a great many, perhaps hundreds, of square miles; and perhaps pressed forward for many miles as a great seething flood before coming to rest, what conception may we gain of how prodigious was its quantity or of the vastness of the reservoir of supply whence the lavas issued. In the cliff before us, there is resting upon each horizontal square foot at the bottom, say, 200 cubic feet of rock; upon each 10 feet square, 20,000 cubic feet, or about 25 tons. But this meagre 200 feet of height is but a mere drop in the bucket in comparison with the thousands of feet of the same basalt, made up in the same way to be observed as we pass on through the Gorge and far into eastern Oregon. Even at 2,000 feet thick, it would take but two and one-half square sections of land to carry a cubic mile of lava. But it runs three and four thousand and more feet thick in places, and for hundreds of square miles in area. The wonder of the whole situation is that all this enormous bulk of rock came out from the interior of the earth. And when we ponder this fact we are, if anything, more concerned than ever that more surface evidence is not seen in this region



Massive basalt flows. Oneonta tunnel
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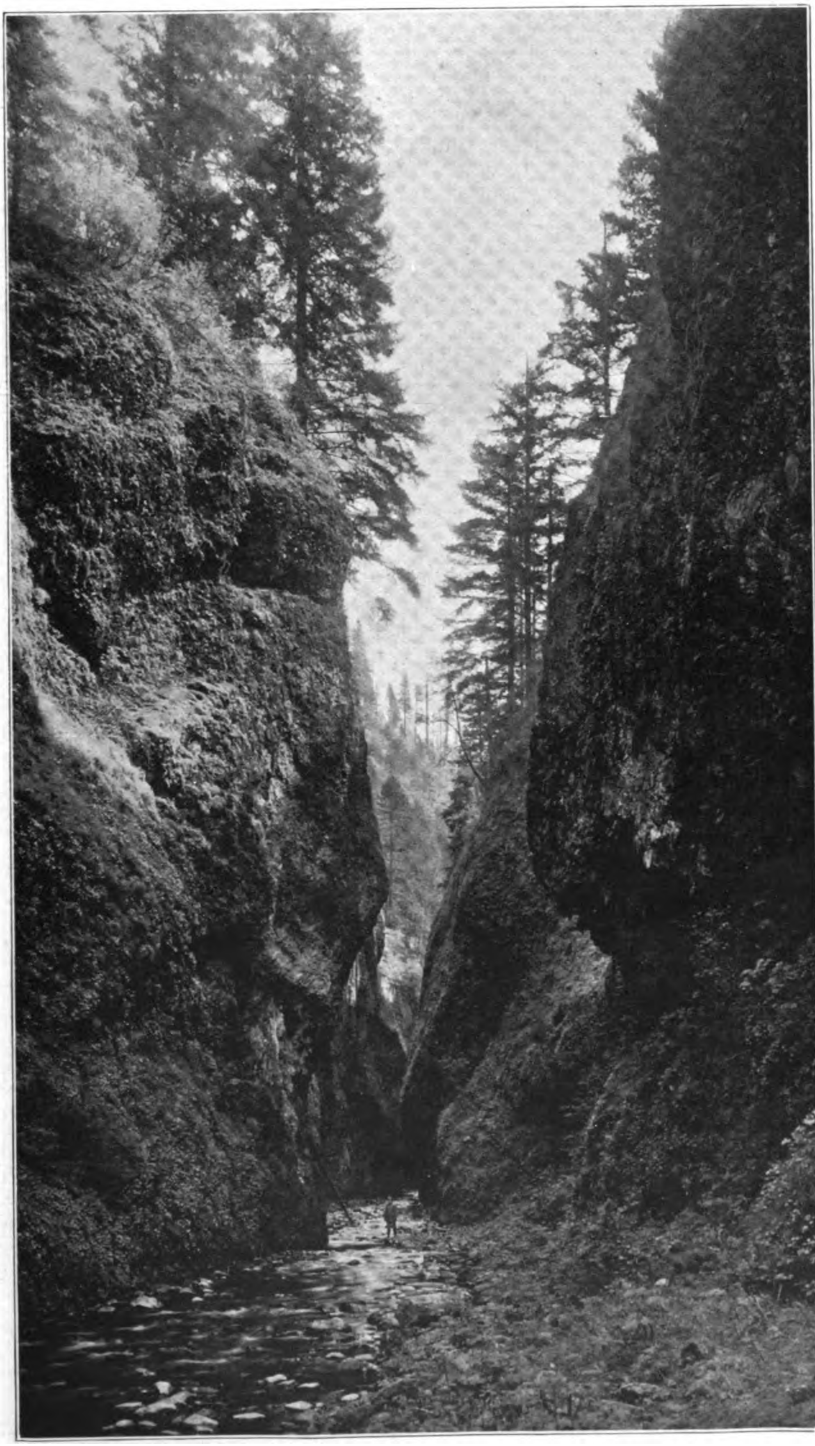

Oneonta gorge as seen from the Columbia River Highway
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of the existence, or filling in, of the profound void that, at first thought, it would seem must result from the disgorgement of a quantity of lava so great.

Oneonta Gorge as seen from the Columbia River Highway. Of the streams that enter the Columbia from the Oregon side, all of which are crossed by the Columbia River Highway, none presents to the passerby a more unique type of gorge than does Oneonta creek. We have seen thus far that these streams, in full view as a rule, drop from the brink of the Columbia canyon in picturesque waterfalls, as though for some reason they were prevented from seeking a more gentle slope to join the parent river. Streams in general and particularly those having such steep gradients as the ones before us, are never at ease, but are always busy in an effort to lower their grade and to reduce it to one of gentle and uniform slope. Here however the great river seems, on account of its added capability, to have so completely outstripped its comparatively puny tributaries, as to have left many of them, as it were, hanging high above its present shores with no alternative whatever but to spill their waters from the precipice rim, reck what will, in order that they may join those of the parent channel. Not all of the tributaries have been so outdistanced. Others have been able to retrieve lost ground by cutting their outlets to the level of the river.

Our first glance at Oneonta shows us no falls. On the other hand, it flows in a narrow gash between vertical basalt walls, whose very verticality tells not only that the creek has itself cut this narrow slit, but that the process has been one of such rapid incision that but little widening has been brought about by the crumbling of the rock. It is well not to resist the temptation to explore this chasm, for its lessons are several. And it must matter not if in its doing knee-deep pools a-plenty are to be negotiated, and if progress is at times one of hand and toe hold along the face of slimy wall or beneath dripping ledge. Along the way we will note the distinctly marked boundaries of the layers of lava, each an individual flow. In places a band of clay permeated with black carbonaceous matter, the remains of vegetable growth, marks the contact. Here and there are circular horizontal caverns whose full nature is not disclosed until one makes the discovery that they are lined or their floor strewn with broken fragments of fibrous partly petrified wood. These observations teach us that between at least some of the many flows by which the thousands of feet of lava have accumulated, enough of time elapsed for soil formation and for vegetable growth. Even forests flourished, but only to be overwhelmed, as all else of plant kind, by the succeeding flood of molten lava. It is the presence here of the charred remains entombed between these lavas that opens to our understanding one more page of record of the fiery ordeals of the past.

Oneonta falls. At somewhat less than a thousand feet from the entrance we are not surprised to come to Oneonta falls. In its seclusion it occupies so suggestive a position with reference to the "box" gorge through which we have just come as to leave little question that this gorge has been produced by the slow up-stream movement of the

Oneonta falls. Less than a thousand feet from the Highway. Approximately 100 feet high
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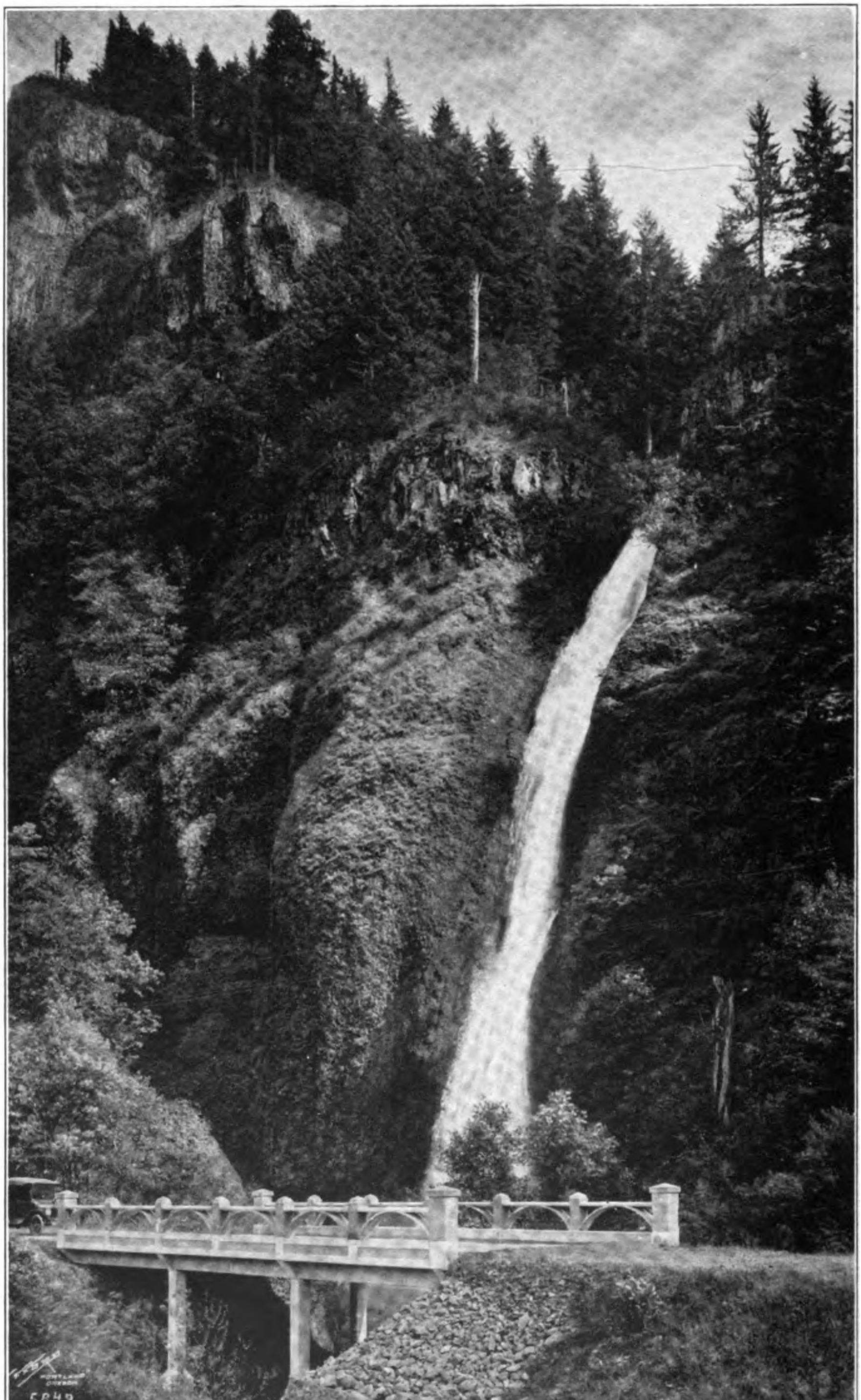


Horsetail falls. Within one half mile from Oneonta gorge and tunnel is Horsetail falls. This wonderful falls is 208 feet high and is rather a tumbling sheet of water than a true falls. The water catapults down a very steep front of columnar basalt to land almost at the base of the Highway grade

falls itself. Its recession is brought about by the vigorous erosive action of the stream and it is the normal history of a waterfall that, as it recedes, its height becomes less and less until self-elimination is accomplished. We conceive therefore that the falls of Oneonta was originally at the mouth of its sharp gorge, but that owing probably to the size of Oneonta creek, hence its ability to do work, it has cut its lower course for a fraction of a mile back from its mouth, down to an even grade, its falls progressing correspondingly towards its head. It is an observation that one will not fail to make as we proceed that, though present, the falls in all of the larger streams that flow into the Columbia are not, as of Multnomah creek, at the brink of the canyon, but have receded a greater or less distance up the course of these streams. It is doubtless due to the way in which this process is favored by the columnar structure of the basalt that the falls, as they recede, are not more speedily eliminated than they are.

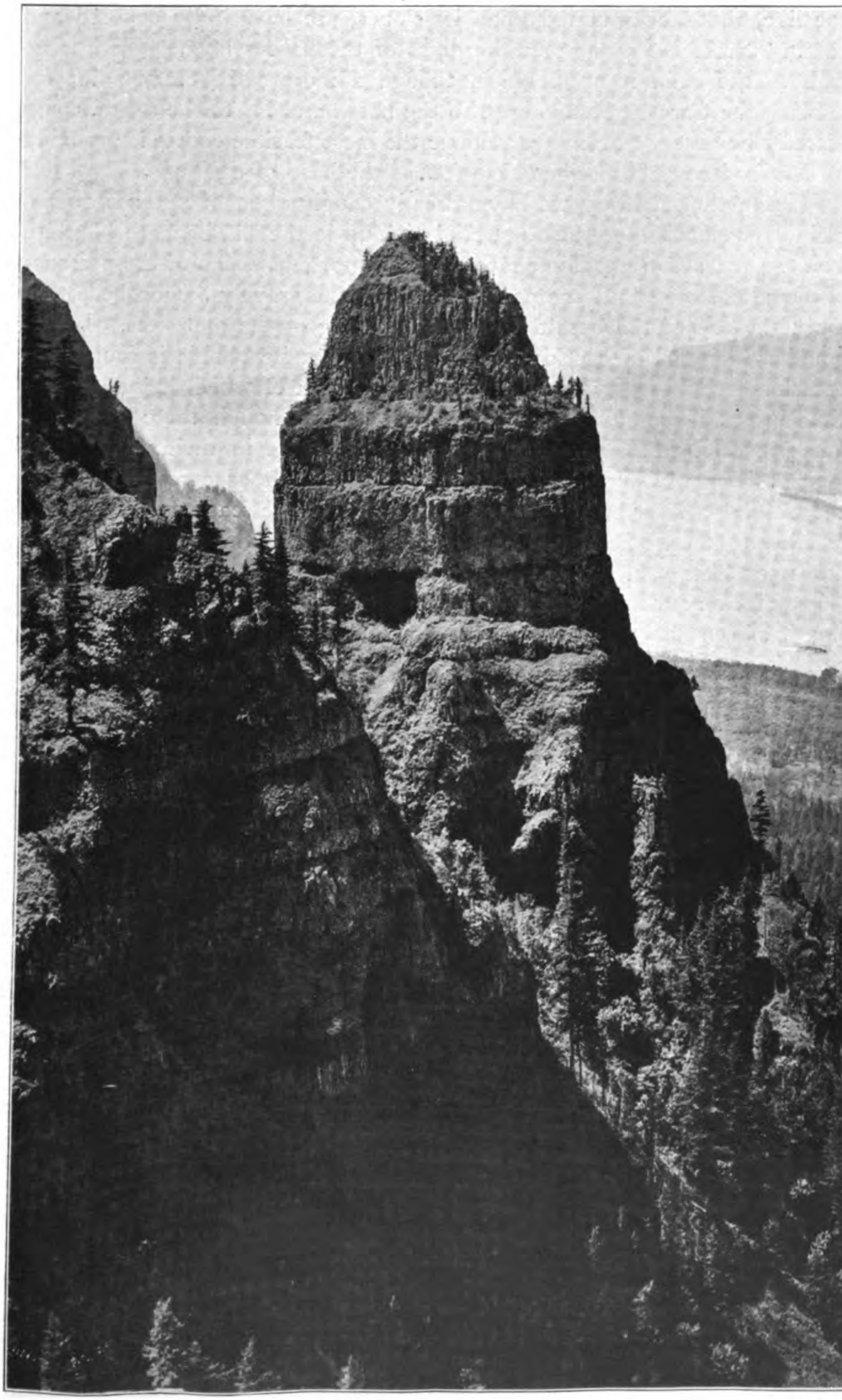
South wall of Columbia river canyon west of Warrendale. From Horsetail falls for four miles to Warrendale the bluffs have so receded from the river that, for the first time, they really rise to their full stature within our line of vision, and we gaze to a clear-cut horizon 3,500 and more feet vertically above the Columbia River Highway. In no other portion of the gorge have the great crumbling cliffs been more spectacularly carved than here. Protruding ridges have been whittled to jagged point or serrate edge, isolated turreted pinnacles stand out, castellated towers, terraced battlements.

St. Peters dome and Columbia river. St. Peters dome and Katani rock stand sufficiently apart to appear now as far-seeing guardian mentors for the great rock wall behind. But whatever of threat there may seem to be in their vigilant attitude is speedily dispelled on close approach; for both are seen to be but trembling fragments of these same parent cliffs, beyond whose protecting influence they are now unfortunately themselves separated. Each is made of a set of layers of Columbia river basalt, at first sight, as though the great cakes were carefully placed in horizontal position, each upon the one below. It is appreciated however that the method of construction was far more widespread, when we observe the continuation of each of these lava layers in the nearby canyon wall. And come thus to understand, that, instead of permanence, such forms as these are significant of an advanced state of deterioration. Soon as geologic time flies, they will be no more. Today we see scattered upon their flanks and shelved upon each corniced ledge the sliding talus that is each season being added to from scaling wall higher up. Both Katani rock and St. Peters dome rise 2,000 feet above the Columbia.

Nesmith Point

As Warrendale is neared, we may look far back into the angle at the head of Tumalt creek (formerly Devil creek) to where, near the top of the cliff, a series of flat lying beds occur, alternating in color from red to light gray or, at our distance, almost white. These beds lie at the flank of Nesmith Point, the summit of which we also see. It rises 3,878 feet above the Columbia and when examined at close range is seen to represent, without question, the site of a former vent whence much of scoriaceous and fragmental andesitic lava issued. Erosion has so gashed into the structure of this volcano that, while the conduit through which the lava rose is not actually in view, the inclined layers of ash, lapilli and

South wall of Columbia river canyon west of Warrendale. Katani rock at left. Yeon mountain and St Peters dome near center of view
Photo Oregon Commercial Studio



St. Peters dome and Columbia river. The Dome rises more than 2,000 feet above the Columbia
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the like, that accumulated upon its slopes, are beautifully exposed and cutting across them one or more dikes of the harder lava. There is no trail to the summit of Nesmith, though a more satisfactory point for viewing the Cascade Range both to the north and far to the south, could scarcely be asked. From Warrendale the most feasible course is probably up McCord creek from about 950 feet at the head of the flume.

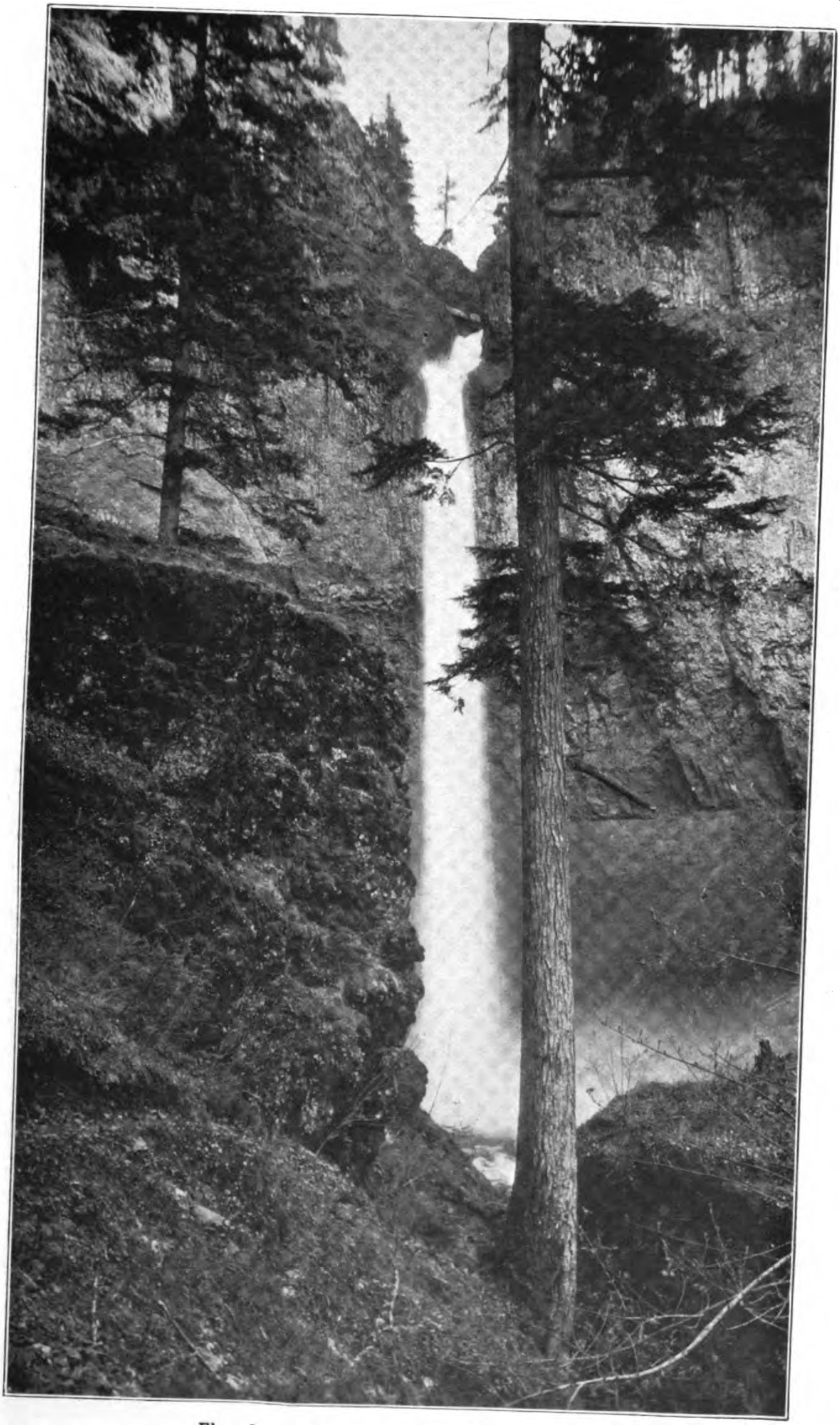
From the Highway we have already caught sight of patches of suspiciously yellowish to brown material high up in the cliff beneath Nesmith Point. We are naturally on the lookout for every sign of the presence of our almost constant companion thus far, the gravely Satsop beds that mark the top of the basalt and the beginning of the andesites. In the bouldery channel of McCord creek a rare quartzite pebble is found and occasional masses of yellowish pebbly tuff, both of which belong to the time interval about which we are concerned. Though these sediments are not seen in place, evidence of their presence in their usual inter-lava position was such as to locate with reasonable exactness the top of the Columbia river basalt at about 1,800 feet above sea level. It will be recalled that on Multnomah creek its top was in the neighborhood of but 1,300 feet.

Tuff below basalt

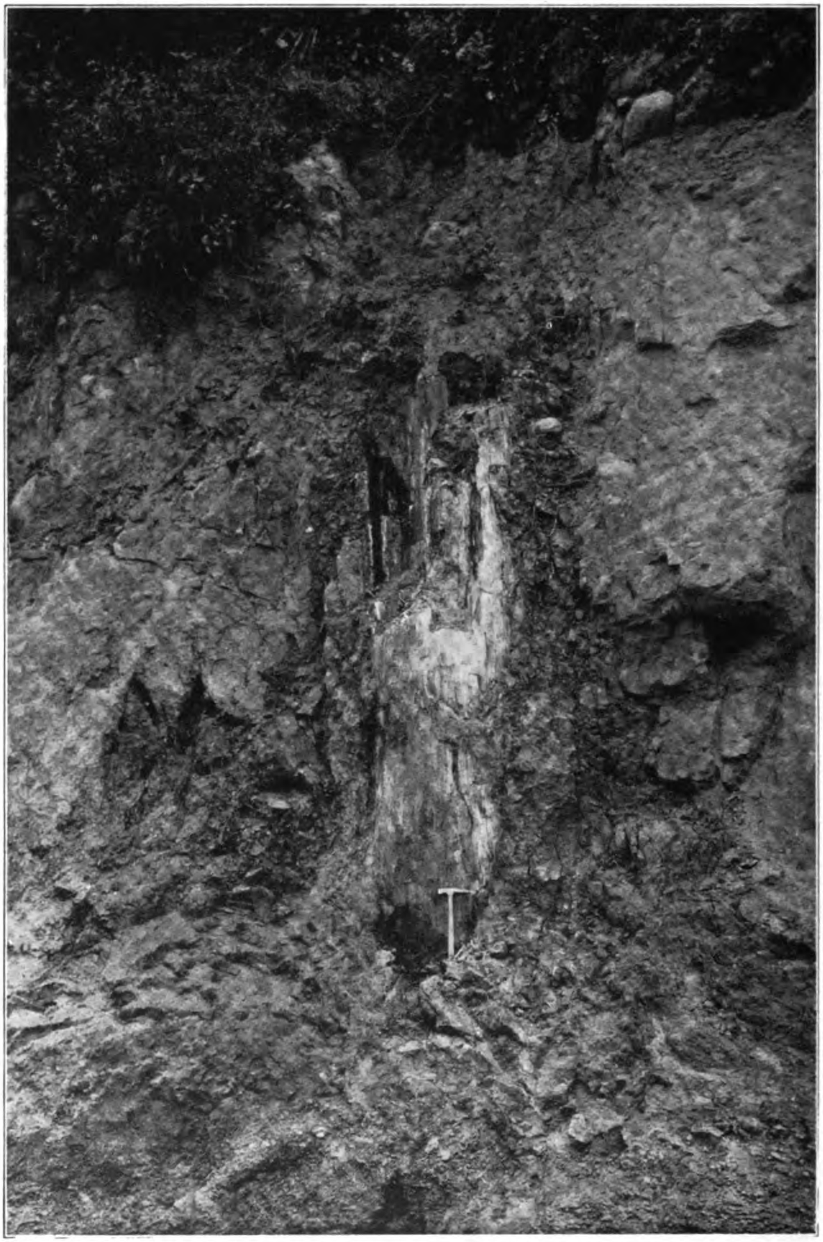
So far on our Highway tour the oldest rock formation to which attention has been directed is the Columbia river basalt. Although at times curiosity has been piqued almost to the point of resignation, we have as yet seen nothing below this. At the crossing of McCord creek, ample satisfaction on this score may now be enjoyed for here, in the cuts along the Highway itself and in the canyon walls below the falls, as if waiting in subdued expectancy our approach, we are suddenly face to face with better than 200 feet of pebbly gray volcanic tuff in general filled with angular blocks of andesitic lava and a variety of other boulders. Better still, for many rods along the creek the basalt can be seen resting upon and in contact with this underlying tuff-conglomerate upon which its whole enormous thickness of in places 2,000 to 3,000 and more feet is foundationed.

Elowah falls. At the foot of the falls of McCord creek, called Elowah falls, these basal materials are more rapidly eaten back by the falling water than is the basalt so that the latter breaks off from time to time as its support is removed. Perfect columns of basalt rest upon a pebbly basaltic tuff which in turn passes into the ash gray unsorted bouldery mix so characteristic of this formation. The undercutting of the softer materials helps to maintain the perpendicular wall over which the water drops, yet at the same time, is apparently a factor that contributes to the more rapid up-stream shifting of the position of the falls. Elowah falls is a practically vertical drop of 289 feet, and in the sheltered solitude of its setting, one of the most attractive spectacles of its kind along the Highway.

Petrified tree trunk standing upright in tuff-conglomerate, McCord creek bridge. Aside from the cheer of its instructive presence, for the next 15 miles the congeniality of this sub-basalt formation

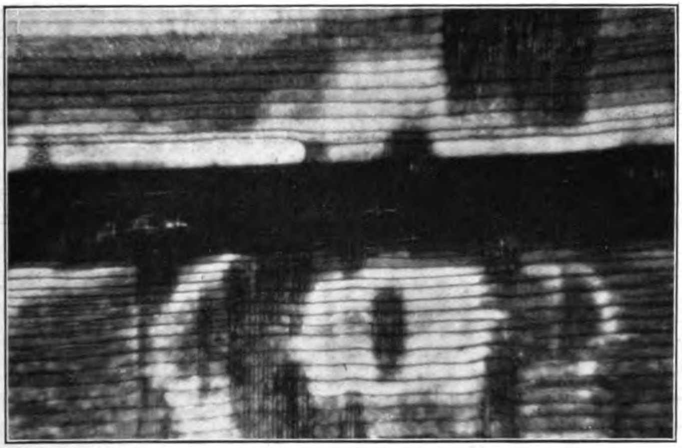


Elowah falls, McCord creek, 289 feet in height
Photo by Weister



Petrified tree upright in tuff-conglomerate. McCord creek bridge

will be expressed in various ways. A few steps from the east end of the McCord creek bridge the Highway excavation has exposed the partially petrified trunk of a large tree. The tree stands upright and is entirely enclosed within the friable bouldery tuff. Were it capable of relating its life story we should probably hear of ancient

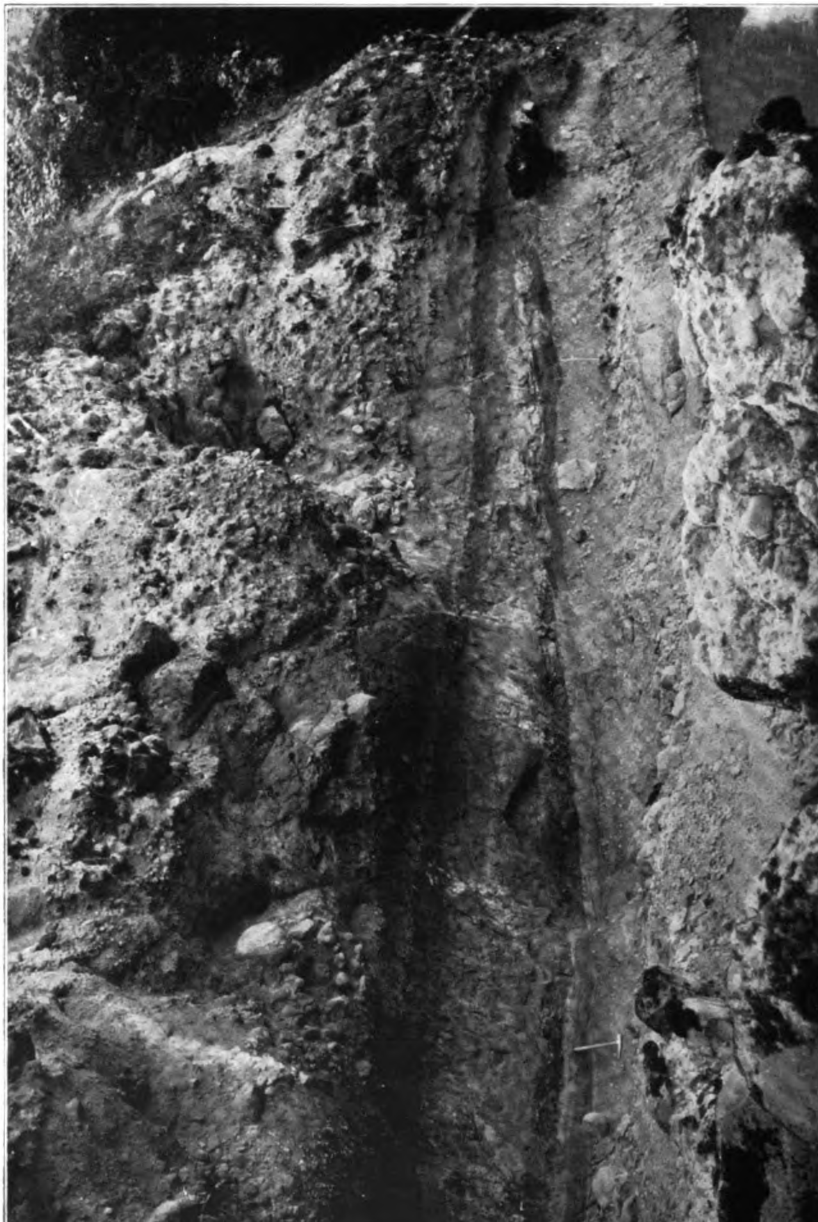


Magnified thin section of petrified wood from the Eagle creek formation. So thoroughly is the structure sometimes preserved that the paleobotanist can very often determine not alone the kind of tree it represents, but as well the general character of the climatic environment in which it grew. This section is of silicified coniferous wood

days when, as now, coniferous forests flourished, and in a climate not widely different from the present; of a time when rains fell and rivers flowed and a luxuriant vegetation lived and died much as today. But we should doubtless further hear of the beginning days of threatening volcanic activity, when the light of sun was obscured by an increasingly dense fall of ashy dust that settled in smothering profusion upon all living things; when volcanic bombs pelted dangerously from the air; and of how our tree, among its neighbors, finally succumbed and the spot where once it grew in full-fledged vigor became the tomb in which so gently yet mercilessly was its interment brought about, that it was compelled to pass into the great future, though cruelly battered and worn and seared, still upright and in the attitude of vigorous youth.

Fossiliferous beds

Fossil-bearing bed at mouth of Moffet creek. In many other places the partially silicified remains of trees are found, some standing as they grew, others recumbent. Interbedded sands and gravel occur in this formation and here and there lenses of ashy clays or shale contain the leaves and stems, branches and seeds from the flora of the times. At the mouth of Moffet creek, which is crossed about a mile and a half east of McCord creek, the coarse firmly cemented conglomerate gives rise to a projecting cornice that overhangs the re-entrant made by a few feet of more readily weathered sandy shale. Beneath the west abutment of the railroad bridge the etching away of this softer layer has necessitated additional reinforcing with concrete at this level. It is from a dark carbonaceous band in this shaly layer which in July, 1915, was not over 8 feet above water in the Columbia, that Professor LeConte of the University of California in 1871 and 1873, and later Mr. Diller of the U. S. Geological Survey, collected the fossil leaves that gave us perhaps our first accurate knowledge of the age of these beds. In the view the hammer indicates the dark band that is most prolific in fossils. Above it is a friable pebbly shale likewise carrying the leaves and stems of plants, besides



Fossil-bearing bed at mouth of Moffet creek. Bouldery conglomerate above. Water of the Columbia at right

fragments of partly preserved wood. The extremely bouldery nature of the tuff above the fossil-bearing layer is also very nicely shown. It appears to be a vast boulder-bed filled in and bound together with light gray ash and likely some clayey matter.

It is an observation we are certain to make that while occasional pieces of wood, petrified tree trunks, etc., are rather common in the coarse bouldery portions of this formation, the more fragile parts, particularly leaves, stems and seeds, are found only once in a while in the finer textured beds, where clay or mud predominates. In order that they may be preserved to even the slightest extent, these organic remains must, after falling from the parent plant, be promptly covered or sealed away from the oxidizing and decaying influence of the atmosphere and of moving waters. This happens only when they are at once permanently buried in a dense mud or river silt or clay. Ordinary sand, or gravel, or a porous volcanic ash would afford poor protection from these agents of decay. We see the process going on today in the beds of streams and at the mouths of rivers, for example, where a little digging will always bring to light the parts of present day plant life in more or less perfectly preserved condition. Here, then, enclosed within this ancient volcanic conglomerate, is what was perhaps once a bar or spit of river mud, now filled with pieces of the plants that then flourished along its banks. All was soon imprisoned beneath an overwhelming mantle of volcanic detritus, the same as that upon which it rests, compressed and solidified to a more or less firm rock. The fossil bed today contributes its own small but integral part to the story of the past because, in the normal course of earth events, its contents have been again brought to light; exhumed, so to speak, from their burial place by the erosive cutting of the Columbia river.

BEACON ROCK

Beacon Rock from the Columbia River Highway. Lest we become too entirely absorbed in the nearby features of the Oregon side our attention should needs be called occasionally to things not to be missed across the Columbia. Opposite Warrendale, and to be seen from many points of the Highway, is Beacon rock, so named by Lewis and Clark in 1806, although since frequently called Castle rock. In the view, we look across almost two miles of water at the head of Pierce island. Beacon rock stands practically at the water's edge and rises, according to approximate determination with the aneroid, better than 800 feet above the river. Its sides are perpendicular for hundreds of feet and exhibit most beautiful pillar jointing on a large scale. In the main the columns are horizontal, or nearly so, as if the cooling surface of the lava were a vertical one. At the south or river side of the Rock the long giant columns stand upright, this face appearing to represent an inner portion of the mass from which the outer casing of inclined or horizontal cooling columns have been taken away by the Columbia. Its base is said to cover barely less than 17 acres, while the top is a sharp serrated hogback of uncomfortably narrow width. At present Mr. Henry J. Biddle is building a substantial trail to the summit, which for many years remained unscaled. This trail will securely zigzag up the face of the cliffs for much of the 4,000 feet of its length, and will offer not alone a most exhilarating bit of exercise in ascent, but a thrill unparalleled in the view, in all directions, from its top. A ferry will take passengers from Dodson on the Columbia River Highway across to Beacon rock. This will also afford access to the warm mineral springs four miles further up the river that are now being developed by Dr. J. G. Swensson of Portland, near Cascades station on the S., P. & S. Ry.

Beacon rock from the Columbia River Highway. Fish wheels in the Columbia. Slopes of Mt. Hamilton at right
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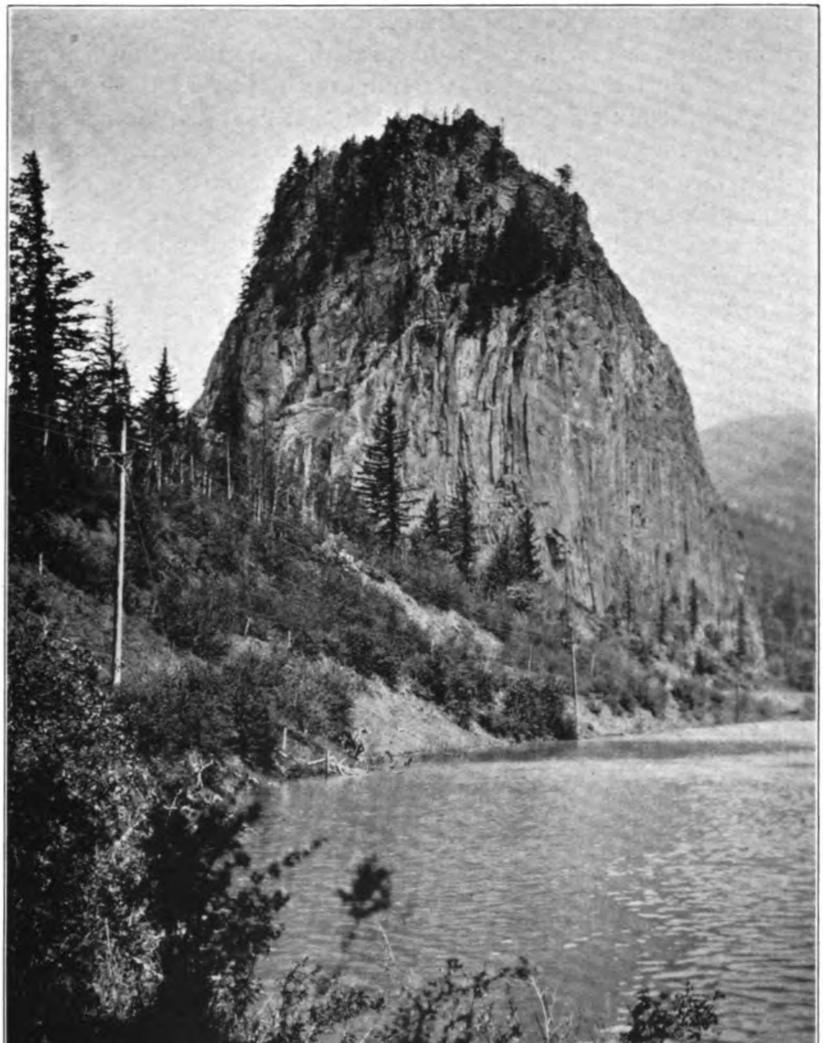


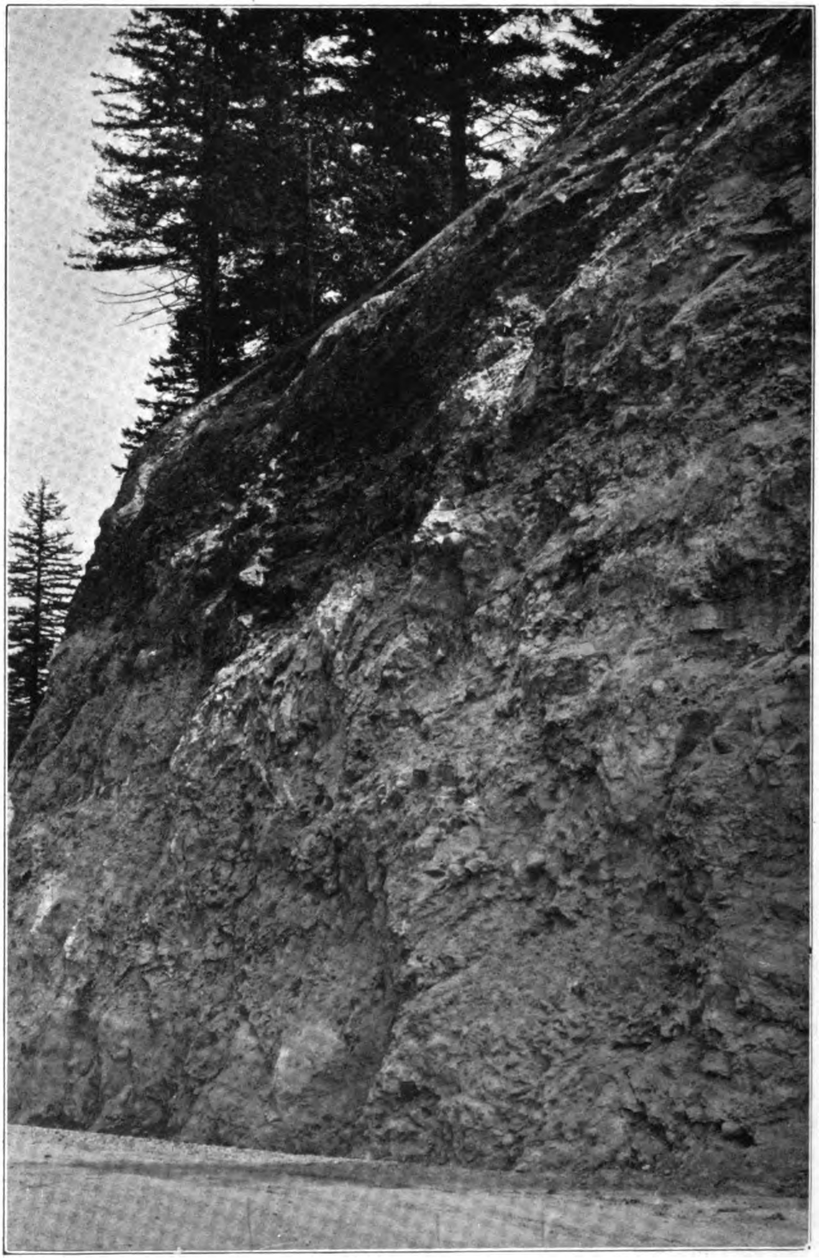
Beacon rock from south of west, showing columnar structure and jagged summit.
New trail along the face of the Rock
Photo by H. J. Biddle

And into what part of our story may this massive isolated monolith enter? That all of its immediate surroundings have been cut out and carried away by the river is apparent. That it itself has not been destroyed is obviously due to its structure and greater resistance. At its right, in the view, and in part obscured in the forest, is little Beacon rock, rugged points of rock which are to all appearances similar to the more conspicuous pinnacle. We may easily conceive that both represent the site of former **Geology of Beacon rock** volcanic vents from which lavas issued, or that they may be but separated parts of a dike, or the filling of an elongated fissure through which molten rock escaped to the surface. Careful examination of the neighboring country will doubtless give definite additional light on this point, but a most interesting clue in the rock itself must not be overlooked. At its summit, the texture of the rock, which below is somewhat granular and light gray in color, is in places red and of scraggly scoriaceous character; and there are scattered, cindery looking chunks, as if this upper portion were exposed to the air and there was movement as it cooled.

In other words, our inference is that Beacon rock is a part of the hard plug in a former conduit through which volcanic eruption took place. And that its top is about the level of the surface opening or, somewhere near the bottom of the crater, at the time of eruption. That there may have formerly been a volcanic cone here of considerable proportions is entirely within the bounds of logical conclusion. The further natural question to be asked is as to the time of the volcanic activity now indicated only by this outstanding remnant. For now, that must be answered by saying that it may represent either a recent period of eruption in which it is possible a great cone crater may have grown up, at the base of which lapped the waters of the Columbia, and the structure of which these waters at once proceeded to undermine and remove as any other barrier. What is left, we see today as Beacon rock. Or, on the other hand, the likelihood is even greater that this old plug belongs to the time of the accumulation of the tuff-conglomerate that is to be seen in contiguous hills along both sides of the river, before the coming of the Columbia river basalt, before there was a Cascade Range or a Columbia river. That it broke up through these sediments and contributed its products to their upbuilding either locally or in a widespread way, then to grow quiet, the filling of its active vent to harden and in entirety be buried beneath these and the hundreds and thousands of feet of later lavas. In this case we would explain its present condition in the same way as already observed with reference to Rooster rock near Crown Point, and the pillars of Hercules, namely, that it is but a portion of the rock formation to which it belongs, that the Columbia in the normal cutting of its gorge has not yet quite entirely torn down and taken away. Slopes of Mt. Hamilton at the right in the view. Fishwheels in the river.

Mount Hamilton and Table mountain (Washington) from the Columbia River Highway. Across the Columbia in Washington also the bold face of Mt. Hamilton presents such striking features, even at our distance, that it must not be passed by without comment. It is evident that its fairly even top which rises to 2,432 feet is capped, as found on our own side of the river, with heavy layers of basalt. The lower boundary of the basalt is however seen to be uneven, as if the surface of the underlying tuff beds had been eroded into hills and valleys before the lava poured out upon it. The added thickness of the basalt showing beneath the center of the main part of the mountain appears at a little distance to be due to the filling of a former de-

Mt. Hamilton and Table mountain (Washington) from the Columbia River Highway
Photo by Weister



Gray-white bank of Eagle creek tuff-conglomerate west of Bonneville. Protruding petrified log near middle of view

pression, although on close approach one may still be somewhat in doubt as to whether or not it may represent the position of a former vent for the issuance of the basaltic lava. The conspicuous shoulder at the left in the view is of bedded basaltic tuff the layers dipping toward the mountain, as though part of the structure of a former cinder cone whose center was yet farther to the westward. Stately Table mountain stands at the right. The applicability of its name is most apparent from this view point.

Gray-white bank of Eagle creek tuff-conglomerate west of Bonneville. There is upwards of 175 feet of the tuff-conglomerate at Moffet creek. It outcrops almost continuously in the banks of the Columbia, along the railroad, and on the Highway, from the first exposure at Warrendale to Bonneville, a distance of over two and a half miles. At Bonneville the Highway excavation has opened a vertical gray-white wall of it 75 and more feet high, from which all sizes of boulders protrude, and an occasional petrified log adds its tinge of the tragic to the record. Bonneville is at the outlet of Tanner creek, an attractive resort place where travelers are amply taken care of at Craighill Inn. The government fish hatchery here is said to be the largest in the world for trout and salmon. Tanner creek is one of the largest of the streams flowing into the Columbia in this central part of the Cascade Range. Its lower course is cut in the conglomerate whose surface rises to nearly 500 feet above the river.

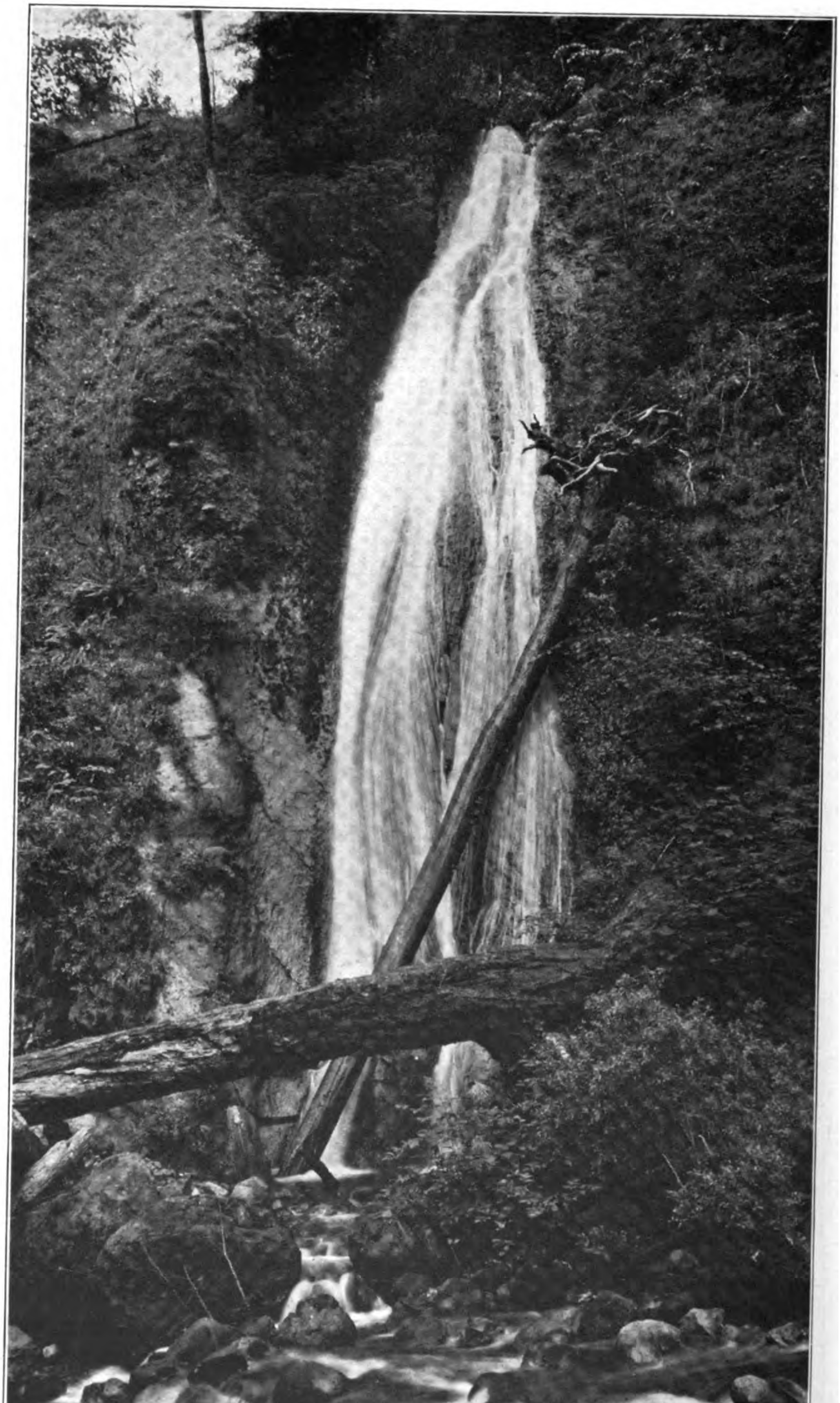
Wahclella falls, Tanner creek. The falls of Tanner creek, called Wahclella falls, is nearly two miles upstream. It is a falls of great beauty, 125 feet high, the rock over which the water pours being the basalt that overlies the conglomerate, which in all streams so far has been responsible for the waterfalls.

Since passing Warrendale, we have been within the boundaries of the Oregon National Forest. At Warrendale, too, we entered the recently established Columbia Gorge Park. This park, which is a relatively narrow strip parallel to the Columbia river (see map), extends for 22 miles to Viento, a public playground dedicated forever for "recreational purposes."

Oldest rock in Columbia gorge

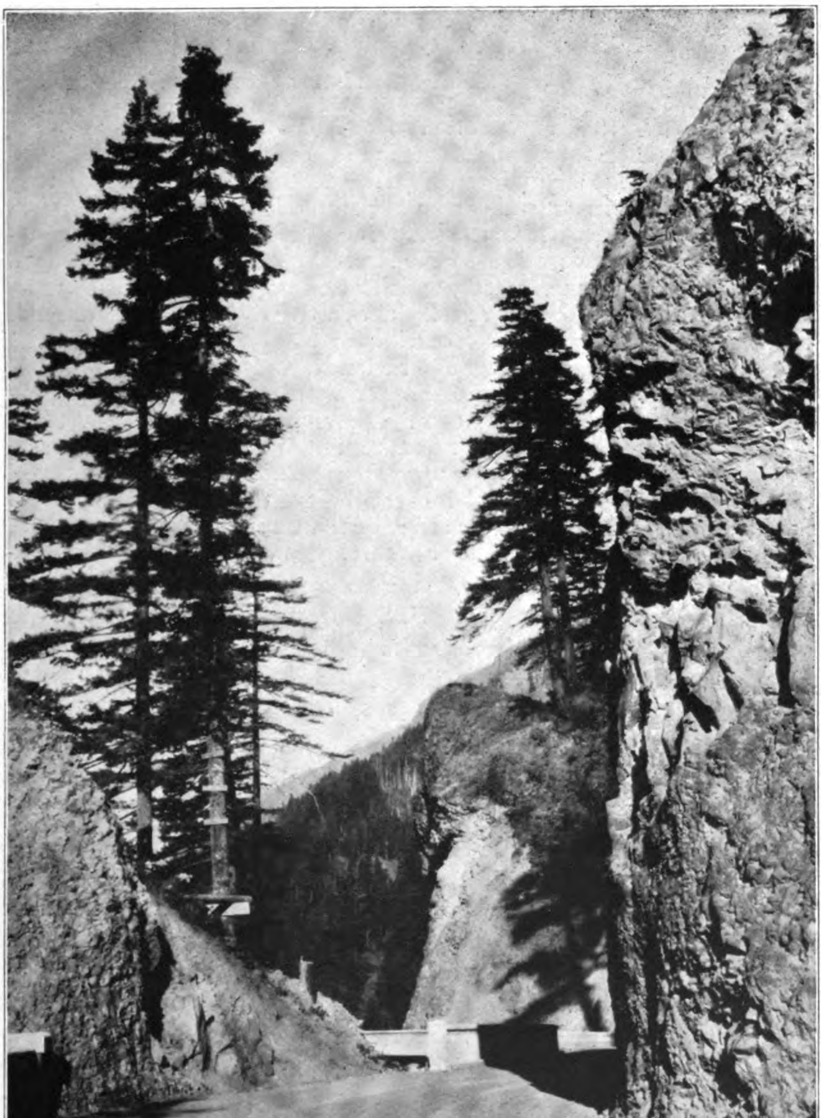
As our journey lengthens we are passing farther and farther into the depths of the Columbia river gorge. We have been permitted to make most pleasurable and fairly intimate acquaintance with a succession of rock formations as this great river has opened them up for our inspection. Gravels at Portland, older gravels along the Sandy river, above which, in the Cascade Range, are the massive andesite flows; hundreds of feet of basalt at Crown Point beneath the old gravels; and finally below and older than the basalt the tuff-conglomerate of the past few miles. As each of these has in turn presented itself, and we have studied its characteristics, the question has ever arisen, what will come next? Shall we have a peep yet farther into the past and what will that peep reveal? What was here before the coming of the deluging falls of volcanic ash and boulders that buried forests in their path?

In the hatchery grounds at Bonneville and extending from the east end of these grounds to and across the railroad, and into the waters of the river, is a conspicuous ridge of hard, dark gray or black semi-crystalline lava. In the railroad cut and at the banks of the Columbia its layers are bent as though the whole mass had at some past time been warped and disturbed. Against its southeasterly slope the tuff-conglomerate may be



Wahclella falls, Tanner creek. 125 feet high
Photo by Weister

seen in contact with its surface in such a way as to leave little question that this bouldery material formerly covered it over completely. In other words, here, showing through where the river has washed it bare, is a small area of the old country rock surface of the days before the tuff-conglomerate came. It appears to be basaltic, and either before or soon after it was covered over, was subjected to pressures by which its former structure was



Giant slip-block of basalt. West approach to Eagle creek bridge

deformed and distorted, as we see it today. Perhaps we may call this a portion of the center or core of the Cascade Range, inasmuch as it is the lowest or deepest of the rock layers that the cutting of the Columbia river will enable us to examine. And it tells us the interesting fact that at that early time, before there was a Cascade Range, when the unthinkable quantities of lava that compose its vast bulk were yet in the interior of the earth, before, it is probable, the Columbia itself was in existence, that even then volcanos were active, and earth movements took place, just as we know has happened since that time.

EAGLE CREEK GORGE

Giant slip-block of basalt (Tooth Rock). Approach to Eagle creek bridge. For the present therefore we will return to the cultivation of a further acquaintance with the sub-basalt bouldery tuff, in its various phases, of which we have seen a little but shall see much for miles ahead. Only it is present along the Highway east of Bonneville for the next two miles to Eagle creek, with the exception of a great tilted slip-block of basalt which at one point carries that thoroughfare nearly 200 feet vertically above the river and the railroad. From here one may gain a first view of the lower Cascades of the Columbia, of many bouldery small islands, and against the horizon, of Table mountain, to the meaning of whose great crumbling cliffs more mystery attaches perhaps in the popular mind than to any other of the many equally spectacular features of the Columbia River Gorge. Eagle creek, whose bridge we now approach, issues from a canyon that for rugged wildness and inaccessibility, therefore scenic value, has few peers within the whole scope of the Cascades. That we must explore it, within the limits of our leisure, goes without saying.

The great recreational value of the valley of Eagle creek, and of its canyon, has been foreseen by the U. S. Forest Service, which has in the past two years actively undertaken its improvement. At the Highway is now a well-appointed comfort station, camp grounds, abundant parking space, and other public accommodations.

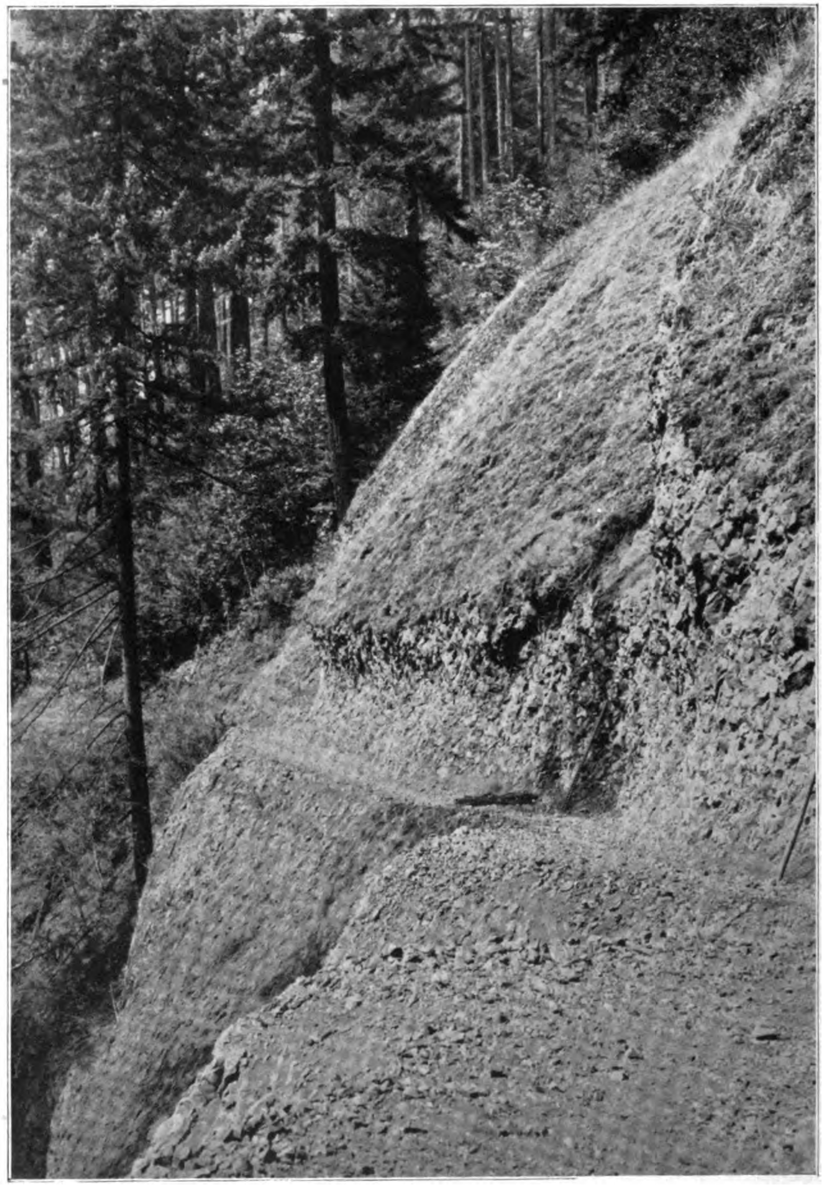
The "Punch Bowl," canyon of Eagle creek. At two and one half miles is the so-called "punch bowl," a large circular pit with overhanging walls of basalt, at the bottom and sides of which the tumultuous fall is ever vigorously beating away. Words do not begin to convey a conception of the enthralling attractiveness of places such as these.

Eagle creek formation

Before leaving Eagle creek canyon it should be said that in the building of the new trail, a bed of hardened ashy clay was opened up in which were found a great abundance and variety of most excellently preserved fossil plant remains. Their character and the tale they relate will constitute a later page in the story of the Columbia gorge. But the finding of so wonderful a fossil-bearing bed in the Eagle creek canyon has given us just the excuse for which we have sub-consciously been seeking to attach a definite and appropriate name to the formation in which they occur. We have seen that it lies below the Columbia river basalt, that it is persistent in general character, and that it represents a definite period in the

The "Punch Bowl," canyon of Eagle creek

past, just as does each of the distinct groups of rock strata above it. We see typical exposures of it along Eagle creek where its surface rises nearly 200 feet above the river, and here we find beautifully preserved fossils in it. It shall therefore be christened and referred to henceforth as the Eagle creek formation.



Eagle creek trail cut in solid basalt. One of the finest of mountain trails is under construction by which the heretofore most inaccessible depths of Eagle creek gorge may be reached. For over a mile from the entrance this trail is cut in part into the tuff-conglomerate, but as it rises with the grade of the stream the superincumbent basalt is reached, and thence the trail becomes an almost continuous miniature shelf along the face of the basalt canyon wall; in places within the shadows of the forest, elsewhere worming a tenuous way along the front of perpendicular cliffs thrilling hundreds of feet above the water and, we know not nor guess how far below the canyon's rim. Four and a half miles of the new trail are completed, so that one may now conveniently reach the first two of the falls of Eagle creek

Metlako Falls in Eagle creek. At about two miles from the Highway, this falls is most unique as viewed from the trail on account of the disappearance of the foaming stream into the dark depths of a box canyon. The falls is 108 feet in height

Black basalt intruded into the tuff-conglomerate. And now that a speaking acquaintance has been gained, shall we not call attention before proceeding on our way to one more feature in connection with the Eagle creek formation. At the west end of the approach to the bridge over Eagle creek there is a fresh exposure to which one is attracted in passing, by the unusual amount of mixed

Black basalt intruded into the tuff-conglomerate, Eagle creek bridge

light gray and vivid purple color it displays. A careful examination of this section will, if not with surprising promptness, at least ultimately reveal the group of ramifying "fingers" of semi-crystalline igneous rock that has pushed up from below into the conglomerate. The latter is baked at the contact into a hard dense condition, by which we know that the intrusion, as it is called, was at the time in a highly heated state. At the lower side of the Highway grade, more of the intrusive rock is in view as though, as would be expected, it widens downward, and more "baked" or metamorphosed contact may be seen.

All this tells us that although itself composed mostly of the products of volcanic eruption, much of which no doubt was allowed to peacefully settle into place and so repose for untold ages, the Eagle creek formation was not in all its parts to remain entirely undisturbed. From beneath it, at vulnerable points as it were, highly heated lavas sought their way upward, at times melting into and assimilating the substance of the overlying beds, again squeezing in along joint or bedding planes, and yet again bodily uplifting the load by which they were weighted down. We are rather certain that this process was in operation at a great many points during the elevation of the Cascade Range, and doubtless some if not many of the prominent peaks of the Cascade Range of today had their beginning where such uprising lavas were able to reach and flow out upon the surface of the land.

Axis of Cascade range

We should be reminded that we are now very nearly in position of the axis of the Cascade Range. Thus far, the inclination of the successive rock formations has been to the south of west, that is, each has slowly risen higher and higher as we have gone farther into the gorge. Were we to climb now to the summit of the divide between Tanner and Eagle creeks we would reach altitudes of over 4,000 feet in but a few miles back from the river. A well-improved trail starts up the mountain side shortly west of Eagle creek bridge to Mt. Wauna, a delightfully satisfactory outlook point, in direct line not over one half mile from the river and between 2,500 and 3,000 feet above it, from which the Columbia is in sight for many miles in both directions. This trail continues to the boundary of the Bull Run division of the Oregon National Forest, beyond which, no matter how urgent or sufficient the excuse, the public is not allowed to go, as it is from within this portion of the Forest that the water supply for the city of Portland is drawn.

On the other hand, wherever we are able to observe the attitude of the main rock strata to the eastward from Eagle creek, it will be seen that they now incline in general at a low angle in an easterly direction. It would thus seem that we are here passing beneath the crest of the broad spreading arch, or up-fold, by which the main elevation of the Cascade Range was produced. Further evidence that this is the case will be found if, from Cascade Locks, which is but three and a half miles ahead, we make our way from the Highway up Dry creek over an all but abandoned trail to the top of the divide east of Eagle creek and between it and Herman creek. Benson plateau, the summit of this divide, is between 4,000 and 4,100 feet A. T., and is so noticeably even as to leave little question that it is but a remaining portion of the former great andesite carved upland, or sloping lava roof, if we may use the word, into and through which the streams have since gashed in all directions to great depth. On the way up to Benson plateau we find blocks of the bouldery Eagle creek formation to 500 feet, as large a thickness as we have yet seen. The falls of Dry creek are at about 1,000 feet. From the top of the Eagle creek beds, there is the usual type of basalt in heavy layers to about 3,000 feet, approximately 2,500 feet of this lava, the greatest thickness observed thus far. Between the basalt and the less basic andesites above, at least a thousand feet of which enter into the structure of Benson plateau, is the customary unconformity marked by the sedimentary material of Satsop times. Here the Satsop is from 125 to 250 feet of yellow to brown ash or tuff so conspicuous as to be seen from the Highway, filled with scoriaceous masses, much of the smaller lapilli and some rough and rounded volcanic bombs. This shows no signs of being a water deposit, yet was put down upon the basalt and later covered with newer andesitic lavas, so it is properly correlated as representing the Satsop formation.

V

CASCADES OF THE COLUMBIA

FROM Eagle creek to Cascade Locks we see little else than Eagle creek tuff and gravels along the road, although we are riding almost within the shadow of some of the most precipitous rock cliffs in the entire gorge. We note that the Columbia river is unusually narrow and its waters rough. Opposite the mouth of Eagle creek is the rocky lower rapids where broken blocks of tuff-conglomerate appear to partly choke the channel. A careful inspection of the topographic map (opposite page 3) will better than anything else indicate the unique character of the country here for several miles along both sides of the river. Back of the town of Cascade Locks many closed contours show the presence of isolated sharp hills and intervening depressions far up the slopes above the river where we should least of all expect to find them.

Table mountain at left, Red Bluffs, and landslide area between. More particularly, and on a much greater scale, are these features displayed on the Washington side where between Table mountain and the river, several square miles are dotted with lakes and ponds and the contour lines are in places most intricately irregular. One can however gain a full conception of the exact character of these places only by actual exploration on the ground. And when with the map as a guide we climb back into these hills, particularly toward Table mountain, we are not only almost bewildered by the clearness with which we can see what is taking place, but as well, if the trip is not carefully timed, apt to be overwhelmed by the force of one's own enthusiastic exertions. For from the river's bank to the very base of the thousand-foot sheer face of Table mountain and Red Bluffs, we find a most complicated jumble of shifted and intermixed masses of Eagle creek conglomerate, with blocks and loosened ledges of andesitic and basaltic lava. The land surface is one of pit and ridge, of enclosed swale and crumbling tilted divides, of clogged drainage wherein streams drop from sight, springs issue and disappear, ponds fill then mysteriously depart. To add to the meleé all is clothed with forest, and if evidence were needed that this whole great honey-

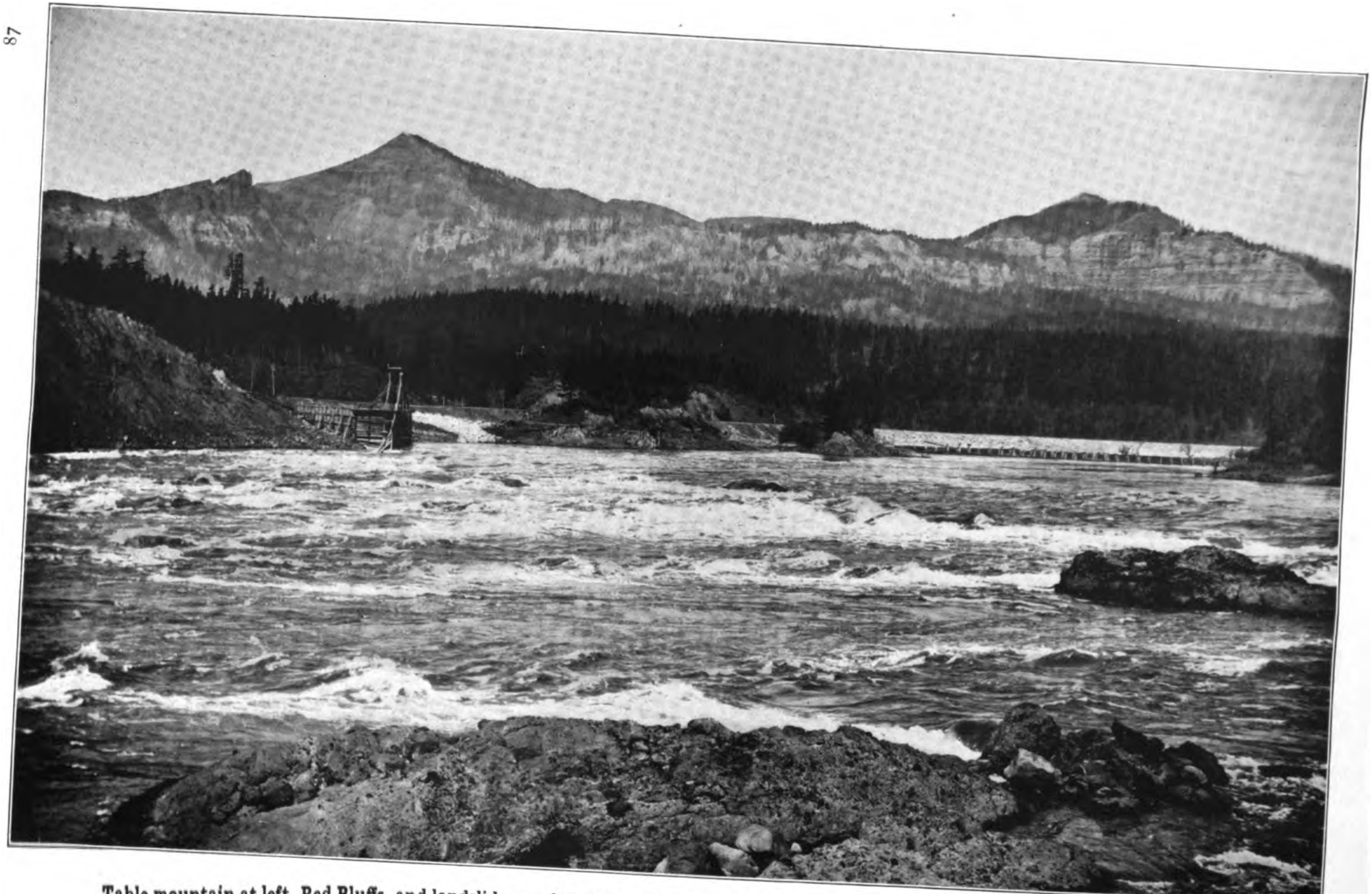


Table mountain at left, Red Bluffs, and landslide area between. **Cascades of the Columbia. Eagle creek conglomerate in the foreground**
Photo by *Weister*

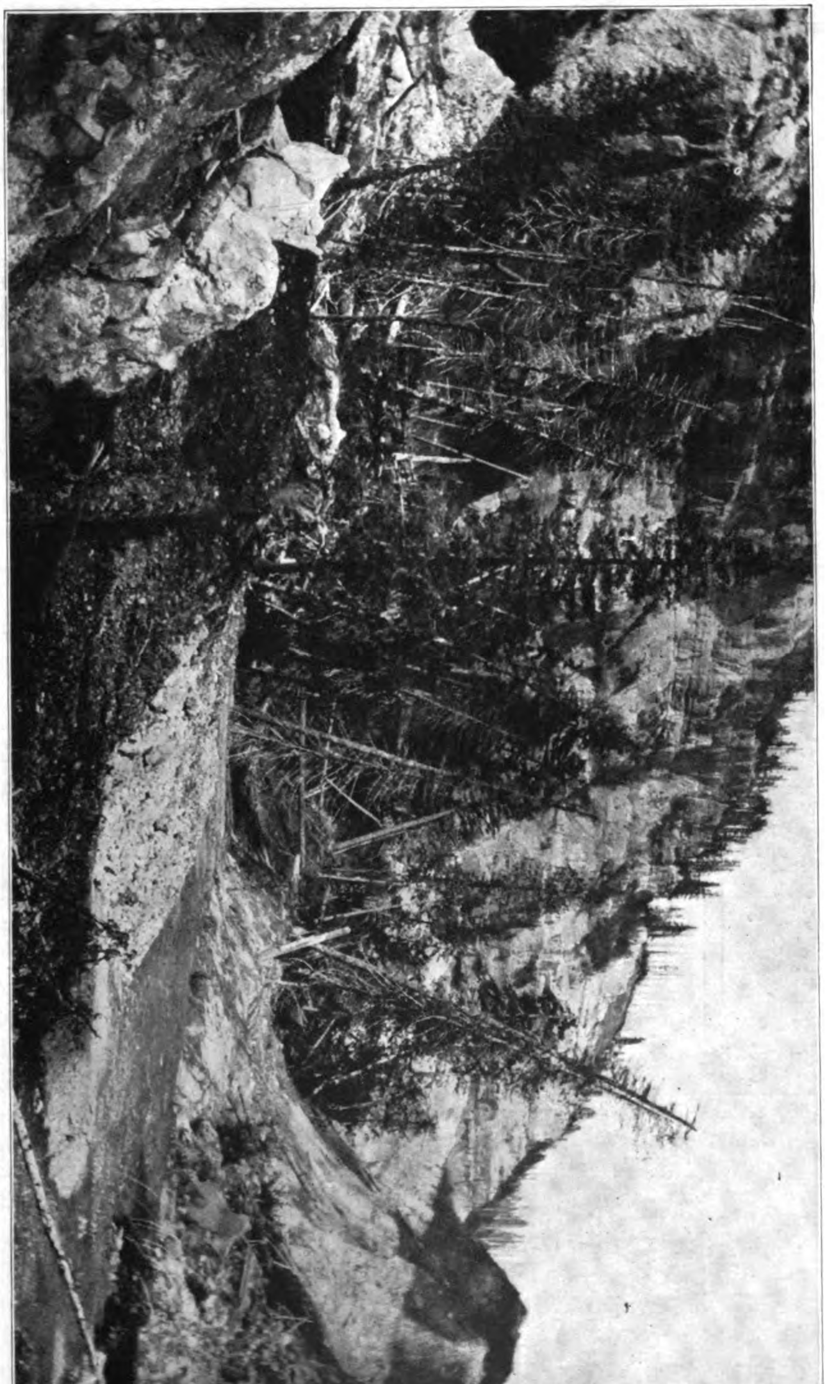
combed slope not only has been but is now slowly in motion, none more conclusive could be asked than the abundant forest wreckage that is present everywhere. Giant firs, individually and by the acre, lie flat and at all angles from prostrate to vertical. Tops lean together, foundations settle away. Even the works of man are not exempt; buildings are carried out of plumb, trails offset, roads upheaved; and at the river's edge on both sides, we are told, the railroad rights-of-way refuse to remain within statutory bounds. In a word, this entire area is one of landslides, landslides of the past and landslides that are now, while we watch, taking place.

Landslides

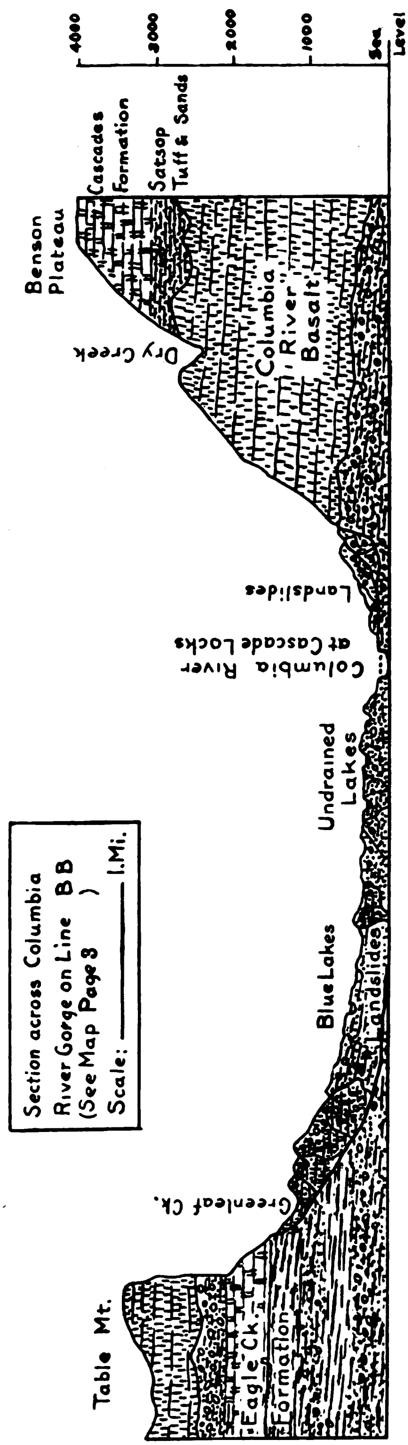
An inquiry not only natural but insistent is as to the cause of so much slipping in this region. It is to be expected that in so deep and constricted a gorge as is the Columbia, bodies of rock would here and there overbalance or by gravity settle from higher points in the canyon walls into more stable positions lower down. Some will be undermined by the cutting of the river and pass suddenly or by degrees to lower levels. If we explore the entire gorge, however, we will learn that the region in which landslides predominate coincides exactly with the area of exposure from beneath the basalt, of the bouldery, tuffaceous, sandy, sometimes clayey beds of the Eagle creek formation. Where these are thickest above the river level, there landslides are and have been most plentiful. If we now examine the Table mountain region with this thought in mind, we are not surprised to discover that instead of the paltry maximum of 500 feet as on the Oregon side, the entire base of this mountain, and of its equally prominent east limb the Red Bluffs, is made up of Eagle creek beds. They rise beneath Table mountain close to 2,000 feet and in Red Bluffs to full 2,700 feet. They contain interbedded gravels, ash, bright red and brown scoria, and some clay, besides the usual tuff-conglomerate phase. Near the south end of Red Bluffs is a feature of this formation not so far observed elsewhere. Apparently enclosed within it is 200 to 300 feet of hard platy andesitic lava and associated with this lava is a mass of inclined layers of cinder-like ejecta that are evidently in precisely the position they assumed about the vent whence they were erupted. Where the waters of the east fork of Greenleaf creek tumble down the front of this composite cliff, there is a fine dike of horizontally columned lava cutting almost vertically through the Eagle creek beds and reaching to the lava above. We are thus convinced that not only were volcanos active in Eagle creek times but right here was one of the centers of eruption. We read from the section before us that contemporaneous with eruption, accumulating Eagle creek sediments from other sources slowly rose about the base of the growing cinder cone, finally probably covering it over entirely.

Cause of landslides

Resting upon the Eagle creek beds are the usual overhanging thick layers of black basalt to a total thickness in Table mountain of 1,000 to 1,200 feet. Compared with the dense stony lavas, the fragmental Eagle creek beds are soft, and they crumble and disintegrate much more readily when exposed. Streams cut into them with greater ease. It would natur-



Recent landslips at base of Red Bluffs. If evidence were needed that this great honeycombed slope not only has been but is now slowly in motion; none more conclusive could be asked than the abundant forest wreckage everywhere. Giant firs lie flat and at all angles; tops lean together, foundations settle away



Relationship of formations at cascades of Columbia

ally be expected that in this portion of its course the channel of the Columbia river would be a broad and roomy one, rather than one so anomalously narrow and deep as we observe it to be. There appear to be two principal reasons for this exception to the general rule. First, the enormous thickness of the series of only partially consolidated Eagle creek beds. It is not difficult to conceive that, were all talus cleaned away, there would open to view in Red Bluffs as much as 2,000 vertical feet of these loosely aggregated sediments. The face of Table mountain and of Red Bluffs has doubtless experienced slow recession from a former position very close to if not at the river's edge. The position of the river too has from time to time doubtless shifted materially. Formerly these cliffs rose as precipitously as today, though not, it is likely, to so great a height; nor would there be by several hundreds of feet as much of the Eagle creek series. But such materials when and wherever exposed in even moderate thickness are notoriously unstable. We need today to hesitate but for a single second within hearing distance, or even sight, of Red Bluffs' precipitous wall, to be reminded of its wayward character. The air resounds with the clink of tumbling pebble, the rattle of trains of gravel as they start from cliff high up and gain in force and numbers with descent, the thud of ricocheting boulder. At times undermined masses of the lava top come down. There is constant movement, and all is in response to the pull of gravity by which unbalanced objects of whatsoever sort or station are ever moving to positions of repose.

But this alone is not enough to account for conditions here. We must turn in addition to the fact there is in the Eagle creek formation occasional, more or less persistent, though usually thin, strata of readily softened shale or ashy clay. Such a phase of the formation may be seen along the Oregon shore of the Columbia, in stages of medium low water, within the first mile below the Locks, if not indeed, its lubricating efficiency demonstrated where moistened by seepage, should habitual surefootedness not be kept religiously uppermost in mind. These intercallated clayey layers, as is well known, become most exceedingly slippery when permeated with moisture. They thus comprise as it were self-lubricated gliding planes along which, if there is the least excuse, slipping movement will take place. It is probably rare that such clayey layers are perfectly horizontal, in fact, we already know that the entire Eagle creek series has a decided inclination southward, that is, toward the Columbia river. If, in connection with this fact, we recall also the obvious condition that in a cliff such as that of Table mountain, the open face is quite unsupported against whatever tendency there is to move, we are really surprised that these great hills have not slumped yet more rapidly into the chasm the Columbia has for ages been sawing at their feet.

Narrow channel at Cascade Locks

At the present time the extreme constriction of the channel from Cascade Locks for several miles downstream is accounted for entirely by the constant pinching in, to some extent from both, but mostly from the Washington side, of the slowly moving miscellany of materials from the cliffs above. These cliffs will continue to recede, until, if conditions do not change, they eliminate themselves, and an even slope is established. At some even more distant date slipping towards the river may cease. But until that day arrives, and its coming is not to be expressed in any man-made unit of human history, the grand old Columbia will have before it as it has today, the task of clearing away as rapidly as it can in order to keep its channel open, not alone that which falls from its banks, but, as now, all that promiscuous mixture of rock detritus that is being constantly fed to it by the bodily movement of chiefly its north confining wall; and who knows but from the bottom of its channel as well.

North abutment of legendary Bridge of the Gods. Cascades of the Columbia. The appearance from Cascade Locks of the precipitous bold fronts of Table mountain and of Red Bluffs, particularly the latter, is such as, it is easily conceived, might inspire unquestioned belief in the Indian legend of the Bridge of the Gods. Little stretch of an absorbed imagination is needed to make of the terraced rock wall before us the stupendous abutment of a once giant span across the Columbia. But the absurdity of the thought becomes apparent when we reflect that this span must have stretched across a minimum space of full five miles in order to reach secure footing on the Oregon side of the river. As legend, it is one of several that have come to us from without the haziness of the past in connection with historic points along the Columbia river. Like others, its romantic plot is a

North abutment of legendary Bridge of the Gods
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most beautiful and inspiring conception, and as tradition based upon the mythical facts of a primitive intelligence, may possibly be worthy of perpetuation. But to our cruelly searching workaday mind the possibility of its concrete truth must be denied.

Bridge of the Gods

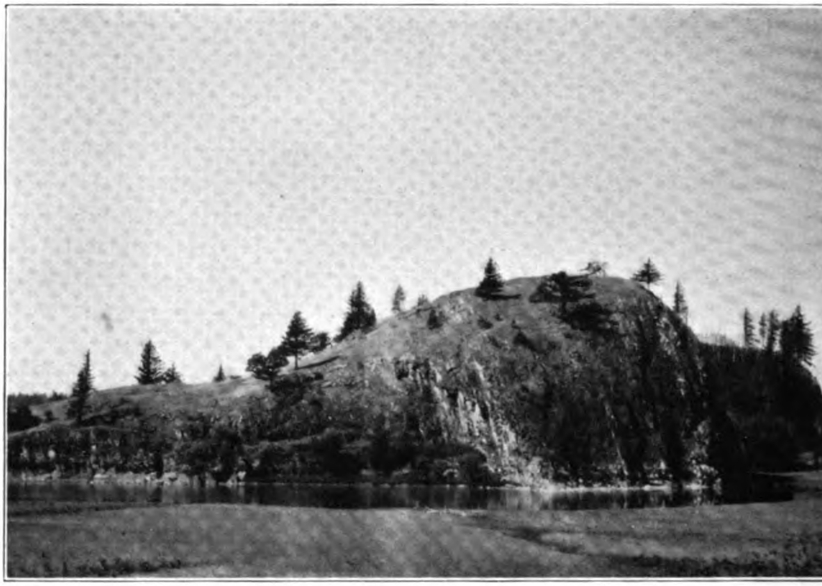
No one however, may ponder over the past events that have given rise to the cascades of the Columbia, or study their present characteristics and environment, without at least a possible twinge of resentment at the entire loss of so captivating a link between the present and the past. When the Columbia gorge was somewhat younger, and the sweep of its waters was more energetically eating its way into the slowly rising Cascade Range, its walls rose steeper and its shadowing cliffs stood closer by than now. It is no far-drawn speculation that at times large bodies of rock would suddenly slump from these cliffs into the river. Particularly would this be expected from the Table mountain side where so favorable and unsubstantial a combination of strata still exists. We are not at all certain but that many times may the trough of this masterful river have been partially or entirely clogged and its current checked if not actually ponded by gigantic landslides. Each such interruption in its eventful career followed by the reopening of the channel through its own undaunted efforts. What more natural then, than that the latest of these cataclysmic slides of which the channel is not yet wholly cleared, may have swung the river far aside and formed temporarily so much of a barrier as to completely dam the river, and even to permit passage across of the native inhabitants, whomsoever were they, of those early days. As one soliloquizes over the question the likelihood of the idea grows. Indeed there is tangible evidence on the ground to further strengthen the essentials of it.

Sprinkled about in midstream today at the main rapids are rock masses, some small-island in size, others covered over in times of high water, a part of which are seen to be jutting points of beds of hard Eagle creek conglomerate, while many others have unquestionably moved down from neighboring cliffs. Above the cascades for miles there are in places erect stumps of trees that were obviously killed by the encroachment of the water about their base, just as would happen were an obstruction unexpectedly thrown across the river at some point below. That the low water level of the Columbia above its cascades was markedly raised for a time there seems little question. Whether it has receded since to any considerable extent can be said only after a more detailed study of it has been made. That the cause was the choking of its channel by a barrier at the site of the present cascades available evidence seems to point. And not beyond the range of reality is the possibility that at one time this barrier may have constituted the causeway about which grew the enchanting tale of the Indian maiden Lowit and the contesting rivals for her hand. But far from fabulous "Bridge of the Gods" was this, rather instead plain tottering blocks of lava and a crumbling, sloughing clay-stained bouldery assemblage from yon proud cliff was its makeup, over the rise or fall of which, in our humble judgment, inexorable gravity, not Sahale the Great Spirit, Klickitat nor Kiyeast, exercised complete control.

The town of Cascade Locks is built in part upon a gravel terrace of comparatively recent formation. The government locks are here by which in a two-stage lift boats are enabled to pass the unnavigable rapids. The locks are founded upon a hard conglomerate phase of the Eagle creek formation, and it may be that the rapids itself is in part caused by its greater resistance to erosion and the comparatively ready wearing away of the pebbly shale beneath, that we see outcropping along the water below the locks.

It should be said that at the time of writing, the surfaced portion of the Columbia River Highway ends one mile east of the Multnomah-Hood River county line and about two miles down the river from Cascade Locks. From here its course has been surveyed to Hood River, a distance of 20 miles, though the present road between these two places follows the projected location of the Highway only in part.

Eroded remnant of lava flow, Columbia bottom east of Herman creek. Just beyond the crossing of Herman creek, two miles up the



Eroded remnant of lava flow, east of Herman creek

river from Cascade Locks, our attention is attracted by the presence in the road and to our left along the railroad, of a hill of light gray rock along the west base of which Herman creek flows to the Columbia. A mile further on an isolated dome-shaped monadnock of the same rock stands out in the overflow flat next to the river, opposite the Herman creek U. S. Forest ranger station. The rock is marked by two sets of joint planes which give to it in places a massive columnar structure. About its base is a stagnant slough very obviously a portion of a former channel of the Columbia, which is doubtless responsible for its sharply rising walls and for the narrowing down of its large bulk to the present proportions. Along the railroad there are occasional exposures of this same rock to within two miles of Wyeth which is a total distance of seven miles from Cascade Locks. Examination shows its presence too, as a more or less continuous ridge or series of knobs, at our right and at the foot of vertical cliffs of basalt and top andesite that rise 3,000 feet and over, as high as 500 feet above the river.

Though apparently a fine-grained lava, the rock is sufficiently different from others with which we are familiar to excite more than passing interest. Our map shows that instead of taking a hurried shortest possible course to join the Columbia, as would properly befit one of its high gradient and volume, Herman creek turns sharply to the west behind an even-topped ridge of this same new lava, and runs parallel to the larger river for better than a mile, before by another right angled turn the former direction is assumed to bring it to its final exit. At no point does the new-found lava extend across or to the west of Herman creek, but that stream appears to skirt its border for the last two or three miles of its course. And its observed distribution from west to east is limited to the scant three and a half miles from Herman creek to about two miles west of the town of Wyeth, beyond where there is again the usual basalt and an occasional cropping of Eagle creek conglomerate.

The Carson lava

Were we limited along to what can be seen on the Oregon side we would be compelled to confess a somewhat puzzled state of mind as to the exact nature of this body of lava. But the fact that eroded knobs of it stand apart in the sloughy bottom land along the river, and indeed menacing rocky points dot its entire mile width of current, opens at once the question whether enlightening evidence may not be found in the prominent gray wall of layered lava that, directly across, rises promptly for 500 feet above the railroad station of Carson in Washington. The ferry at Cascade Locks lands one conveniently at Stevenson. Close examination of what we could but indistinctly discern at a distance discloses the presence, as on the Oregon side, of the Eagle creek conglomerate a little west of Carson, and what is less common, a flow or lava-filled variety of it. Resting upon the Eagle creek strata, as Carson creek is approached, is not the customary dense black basalt, but instead what appears to be the same kind of lava already seen along Herman creek in Oregon. The cut-off edges of a great series of flows rise above Carson station and extend eastward to the deeply incised canyon of Wind river. The town of Carson is located at the outlet of a broad fairly even stretch of country between Carson creek and Wind river, whose oval soil and gravel scattered surface is broken here and there by protruding bunches of scoriaceous ropy lava. A few miles north of Carson at the Wind river bridge that stream runs in a "box" canyon more than 250 feet deep. In the walls are dark gray beds of blocky lava, resting upon southerly dipping Eagle creek beds.

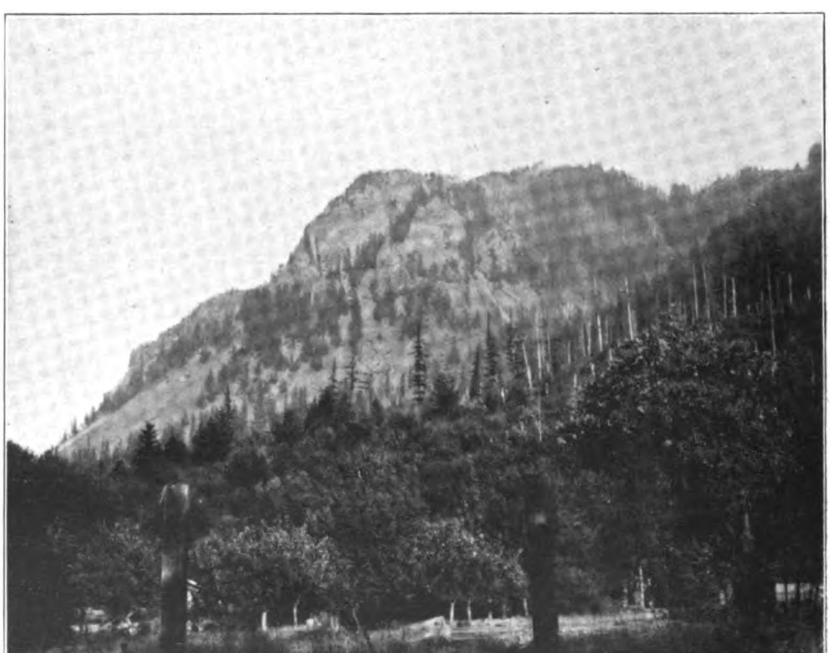
We are thus left no other inference than that an erosional valley cut deeply through the basalt and into the Eagle creek conglomerate, while the Columbia too was safely establishing its position, was later filled with deluging waves of lava from a source somewhere to the northward. Its unheralded oncoming seems to have recognized no priority right of possession; for the stream whose valley it filled was ruthlessly pushed aside and, if again we read aright, no ceremony whatever delayed its spreading embouchment into and across the Columbia itself. Reaching the Oregon side, mighty basalt cliffs stood in the way, at the base of which its crumpling viscous borders could shift only downstream, and it spread in that direction covering all in its path. Herman creek, whose exact former course we do not know, was protestingly thrust ahead and into the position it occupies today.

The Carson lava as we will henceforth call it, obviously came as a series of heavy flows which, in order to reach the Oregon side followed each other in rapid succession. Though the Columbia river must have unavailingly retreated ahead of this invasion of its rights, they rose as high as 500 feet above its level, and it is difficult to conceive else than that that river was for a time dammed to essentially that height. But no such minor obstruction could more than momentarily check its powerful waters; for had they not and in the face of untold obstacles already sawed through a few thousand feet of rock strata, whose ominous shadows even now stand by in frowning acknowledgment of the humiliating fact!

Search along its upstream borders shall in some future day yield more details of this now historic emergency. Until that time we must be content with our hurried observations on the outcome of the contest here between the forces of volcanism and of river erosion. That the channel of the Columbia was choked with lava at geologically a relatively recent time, and since its gorge was fully established much as we see it today, seems certain. That the undaunted assault of its sweeping current has all but cleared away the obstruction, yet not quite, is likewise strongly evidenced by the similarity of the lavas on the two sides of the river, by the detached remnants which first attracted our attention along the Highway, and the solitary wave-dashed points of rock within view in the stream itself. These are the fragmentary records of a stirring incident in the growth of the Columbia river; the, for us, fortunately belated ripples in its waters so to speak, that make both legible and credible the story they relate.

Trail to Summit resorts

From Herman range station a well constructed forest trail goes up Herman creek over which, with its connections, some of the most elevated and wildest adjacent portions of the Cascades summit may be reached. We are still within the limits of the Oregon National Forest and of Colum-



Shellrock mountain from Wyeth on Columbia River Highway

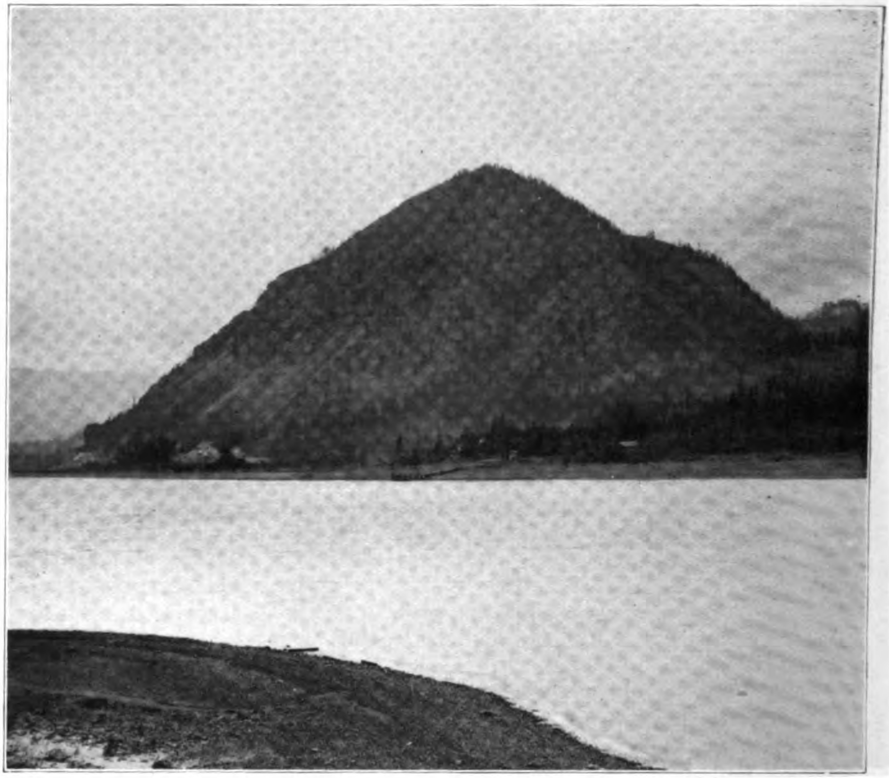
bia Gorge Park and all trails are constantly being improved and extensions made by the U. S. Forest Service. Wahtum lake and Chinidere and Indian mountain are accessible by way of this trail, as are also Green Point mountain and Rainy lake, all places of recreation and delight rarely surpassed.

SHELLROCK AND WIND MOUNTAIN

Shellrock mountain from Wyeth on Columbia River Highway. At Wyeth station we are 57 and one half miles from the city of Portland. Ahead the great glistening whitish-gray cliffs of Shellrock mountain appear, at a little distance, to almost block the way. We are struck with its lack of resemblance to anything we have seen before. Before proceeding to its very base however, as inclination would prompt, it may be well to learn if possible something of its surroundings, particularly of the steeply rising dark canyon wall at the foot of which we now are. It is not the good fortune of the geologist to always find satisfactory trails leading to points of interest. On the contrary, it is frequently if not more often the case that places least readily reached are the very ones that harbor the most illuminating of geologic secrets. It is to elicit the giving up of these secrets that the nature student braves the hills, thankfully accepting the assistance of such as trails if they take him where he wants to go, though if needs be oblivious to their absence. And so up a branch of Gorton creek to the south of Wyeth a few hours' of uncharted solid clamber takes one to an altitude of about 3,900 feet before the top of the Columbia river basalt is surmounted, and where upon it, without the customary inter-lava Satsop, the andesites begin. This is, by over a thousand feet, the greatest thickness of the basalt seen in the entire Columbia River gorge; and this too, appears to be a part of the east limb of the main Cascades uplift, the summit of which we have passed by between Eagle and Herman creeks.

Shellrock mountain is a mile beyond Wyeth, a great conical pile with hundreds of feet of loose, sliding "shell" rock about its lower slopes that reaches to the river's edge. It rises to an elevation of 2,068 feet and on all except the river side is hemmed in with walls of basalt. At the east side close to the Highway the latter is seen to rise somewhat upon its flanks as if it may originally have covered over or been uplifted by the Shellrock mountain mass. In places partially absorbed enclosures of pieces of dark basalt are to be noted in the lighter colored rock, which again suggest the idea of disturbance or intrusion during which basalt fragments were incorporated into a yet viscous and yielding hot magma.

Wind mountain. Almost directly across the Columbia in Washington is the companion to Shellrock, Wind mountain. It is in every way similar though something more than 100 feet less in height. Between these two crumbling sentinels the Columbia's waters hurry, as if, one might imagine, they had courteously stepped apart to let the river pass. But we can scarce attribute to them so much of civility, and particularly knowing the Columbia as we do, we are more certain that it instead, when the occasion arose, in silence but firmly, forced its own way across what would otherwise, but for its prowess, have been an unsurmountable barrier. In which case Wind and Shellrock

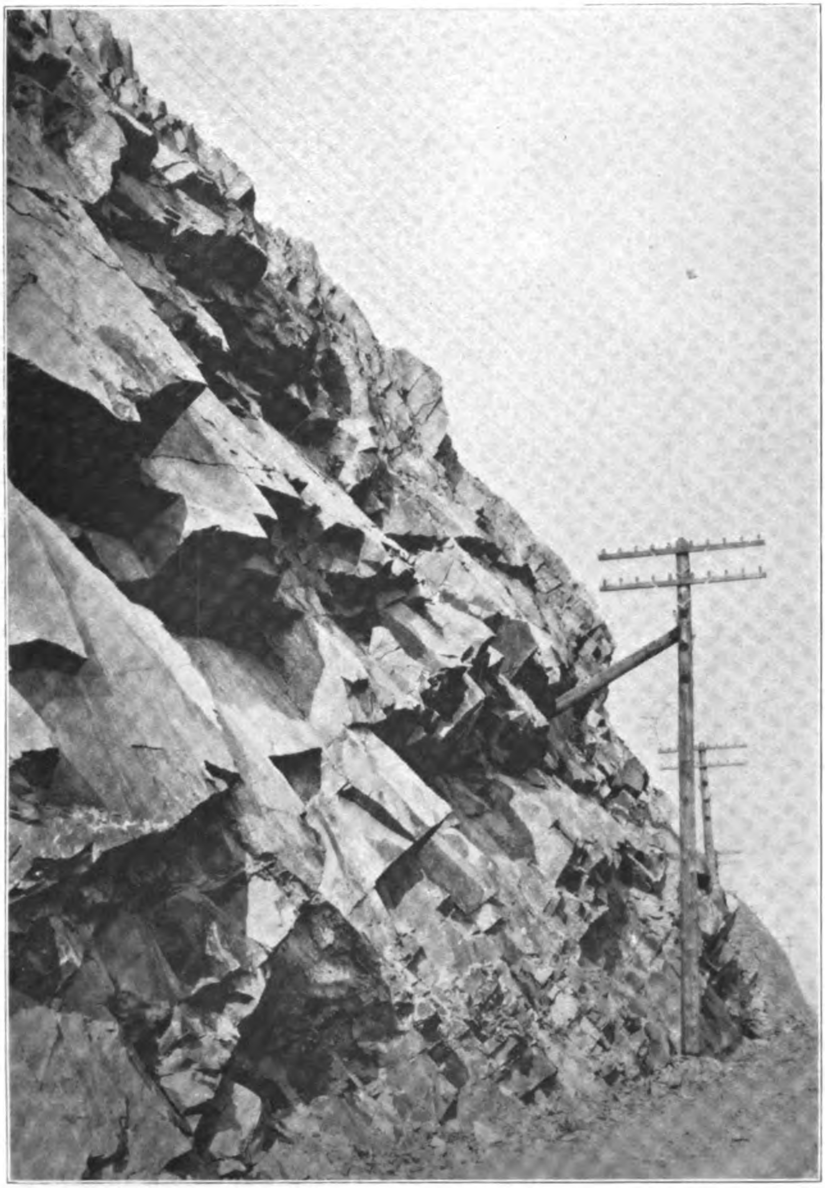


Wind mountain from the Oregon side
Photo by Weister

mountains of today are but the tattered stub ends of a once connected rock mass with which, while it cautiously rose as though to thwart the prior designs of that master stream, the Columbia promptly proceeded to deal in its own implacable way. North of and in line with Wind and Shellrock mountain the same type of rock is seen to stand out in a prominent low jutting hill.

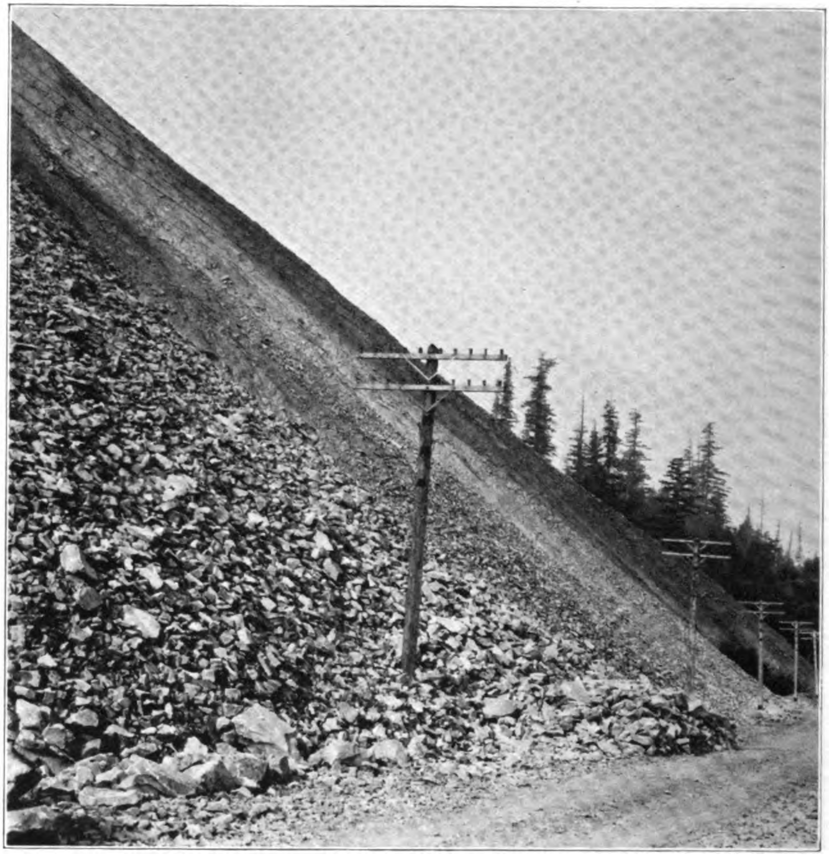
Shellrock—Wind mountain intrusive

Let us now before deserting this, another new found friend, inquire somewhat more intimately into the individuality of the rock of Shellrock mountain and its relation to its surroundings. In the hand specimen it is seen to be finely granular and light in color. A thin section under the microscope proves it composed of larger crystals of plagioclase feldspar, augite and hypersthene, set in a matrix of finer texture, but largely made of crystalline grains of some of these same minerals with possibly some quartz. As compared with its closest associates, the basalt and andesites, its texture is wholly crystalline, holo-crystalline as petrographers say it, while they typically possess a stony or even glassy unresolved groundmass in which the few crystallized minerals are set. When a rock is cooled slowly from the molten state, there is opportunity for all of its ingredients to combine



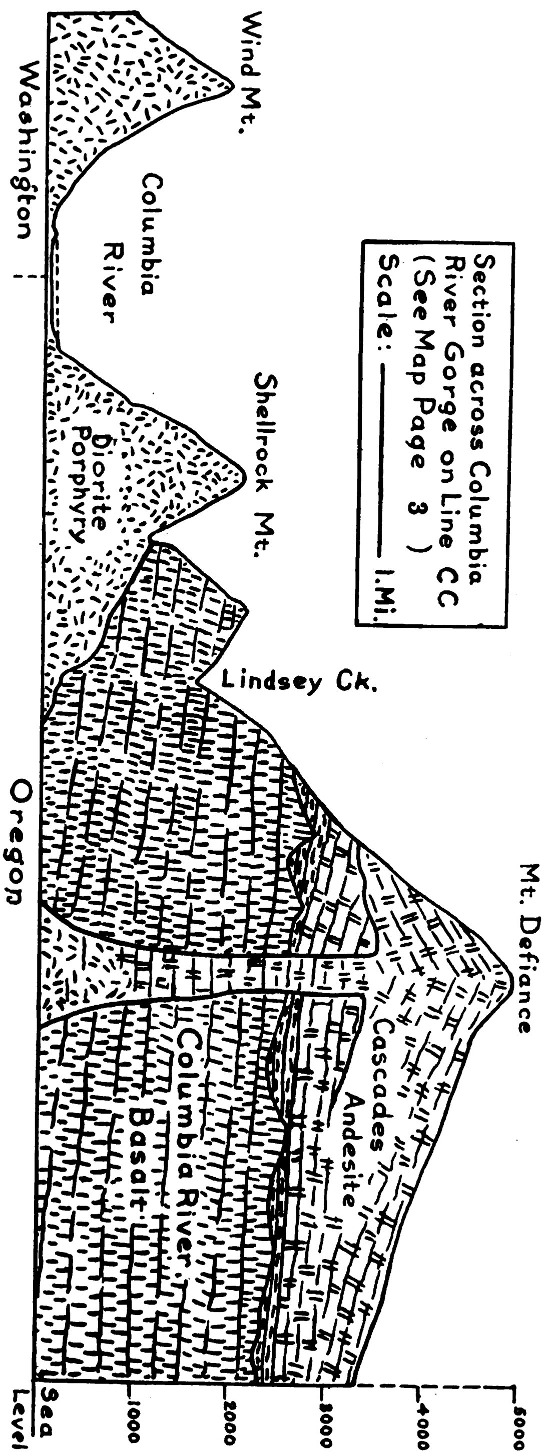
Close view of a freshly opened face at the base of Shellrock mountain. The rock naturally breaks out in angular flattened pieces by reason of intersecting sets of joint planes. In places higher up it appears columnar on a broad scale

and to separate out as definite crystalline mineral species. Under sudden chilling only minerals of quick growth have sufficient time to form. Hence we infer from the granitoid texture of this rock, whose species is probably most closely designated by the name diorite porphyry, that cooling and solidification took place while it was still buried to such a depth



Rockslide at base of Shellrock mountain. Wherever the rock scales away, long unstable talus slopes result. In the view it is evident that constant vigilance must be practiced to maintain the road in passable condition. A hundred feet or so up we see occasional signs of the old state road whose position could not but be a notoriously insecure one

that its temperature decreased with great slowness. We have already remarked the presence of included pieces of basalt near the contact where heavy beds of this lava lap up against the steeply sloping sides of Shellrock mountain. These and other indications there are that Shellrock and Wind mountain represent a large, probably connected body of granitoid rock that rose beneath the Columbia river basalt, to some extent at least melting its way into that lava, "stoping" geologists call the process, but in general uplifting the superincumbent strata for a thousand feet or more. We have no way of proving whether breaks or fissures were produced through which some of the intruding rock reached the surface, but it is entirely within the range of probability that this dioritic mass may have contributed some of the less basic lavas now found high up on adjacent parts of the Cascades summit. Since the basalt is bowed up around its borders, we



Cross-section Wind and Shellrock mountain. Mt. Defiance

know that the introduction of the Shellrock mountain mass occurred after the country was entirely overspread with the basalt flows. As yet we do not know whether the still later andesites and the Satsop were likewise uplifted, nor have the field data yet obtained disclosed its exact relation to the Eagle creek beds, evidence of the presence of which we still see both to the west of Shellrock mountain and for several hundred feet up to the north and east of Wind mountain. Fairly safe it is to say, however, that the Shellrock-Wind mountain intrusive was in place and had come to rest before the widespread elevation of the Cascade Range began, and that the Columbia simply uncovered or, as a matter of fact, discovered and brought to light, that which beneath long lay concealed from view. These two conspicuous peaks thus stand forth today, first, because in their own upward movement the overlying formations were entirely eroded away; second, because of their unstable character little of forest growth can gain a foothold, and lastly, the provoking reason at the bottom of it all, because the Columbia in its down-cutting was left no alternative but to cleave an unerring way, dividing into two, the menacing obstacle that essayed to rise across its laid out path.

Mt. Defiance

Beyond Shellrock mountain and for the next seven miles to Mitchell Point, though beyond its central axis, we have little reason to feel that we are not still within the overshadowing depths of the Cascade Range. At our right are cliffs that rise a thousand feet to the sky-line, waterfalls leap from their brink and our way is cheered by the echoing murmur of their music. Approaching Lindsey creek we pass Lindsey Inn where satisfactory transient accommodations are to be had. The falls of Lindsey creek are 104 feet in height and are not visible from the Highway. Just before crossing Warren creek, where signs of former flourishing habitation still exist, a watchful eye will catch a passing glimpse through a screen of firs of a most charming little fall over 200 feet in height, where for most of the year an as yet unnamed stream from the slopes of Mt. Defiance spills its waters to the flat below.

And this calls to mind the fact that we are at this moment within a horizontal distance of not over two and one half miles slightly east of north from, next to Mt. Hood, the highest peak in the entire region of the Columbia gorge, Mt. Defiance. Its summit, as the map shows, reaches an altitude of 4,960 feet above the sea. Its ascent from the Columbia river side has ever proved a most strenuous undertaking. At present, thanks are due to the Mazama mountain climbing club for seeking out and marking a most feasible course up this mountain along the divide between Warren and Lindsey creeks. The start is made by first climbing the slide-rock slope to near the top of the beautiful 90-foot falls of Warren creek from about opposite the end of the Lindsey switch; whence the course is to the right alcng the rim until about a thousand feet of elevation is gained, and then through forest due south to the foot of the open rock slides that skirt the summit. On the north slopes of this peak and at its top, scoriaceous lava and scattered volcanic bombs leave no question as to its having been a vigorously active volcano. By its outpourings, which are in general a rather basic andesite, its vast bulk was built and doubtless much of surrounding country covered with lava. As is true of other neighboring peaks, the upper slopes of Mt. Defiance have been modified somewhat by the scouring action of glaciers which, owing to its height, originated there in glacial times. The little lakes at the head of both Warren and Lindsey creeks occupy what appear to be the position of former glacier cirques from where valley streams of ice flowed down their gorges, we know not exactly how far, towards the Columbia. From the slopes and top of Mt. Defiance a most wonderful panorama for many miles in all directions may be enjoyed. The celebrated Hood River valley culminating in Mt. Hood at the south is spread

Starvation falls. Back upon the Highway again at Lindsey, from the ascent of Mt. Defiance, our sigh of relief is in one short mile quickly transformed to burst of rapture if perchance we fail not of one brief peep into the restful nook whence rush the turbulent waters of Starvation creek. Not so close that the sound of its falling interferes with composure of speech, nor so far away that the pulsating rise of its spray shall obscure the beauty of its setting is Starvation falls, in a series of playful leaps springing from the confinement of a constricted channel above to make, from us, a hidden landing 186 feet lower down. Belying its name, the source of which we are not aware, this last of the spectacular waterfalls in plain view as we pass eastward along the Columbia River Highway, does nothing if not provide a gratifying though fleeting repast of delight to every keen lover of the finest that Nature affords

Photo by Weister

out as though a great map, to the north the Columbia only seems to separate us from a magnificent array of snow-capped peaks in Washington, and to the west the line of sight entirely clears the highest corrugation in the Cascades summit and reaches to where, beyond the limit of clear vision, the dark bulk of the Coast Range alone is between us and the Pacific Ocean.

From the town of Viento, four miles from Shellrock mountain is caught the first glimpse of Mitchell Point yet three miles ahead. The renown of this, as between man and nature, combination masterpiece, has whetted our anticipation to a scarcely controllable state of apprehension. But undue haste must here of all places be foregone, that our journey's end may be approached understandingly.

Satsop in Viento canyon

A brief excursion up Viento creek reminds us that for some distance we have seen very little of a former most persistent companion, the gravelly Satsop beds between the Columbia basalt and the later lavas. We are thus impulsively determined to make a hurried ascent of Viento canyon to learn of the source of the occasional beautifully rounded quartzite pebbles discovered in the bed of this creek. The top of the basalt is reached at about 2,000 feet and here begins a series of clayey, sandy, ashy, bouldery water-laid beds that continue for more than 500 feet. Quartzite pebbles are still found in the creek bed at 2,500 feet, so it is clear that this is again the Satsop formation on the east flank of the Cascade Range, and developed too, to an unusual thickness.

Looking across the Columbia. Wind mountain and west slope of Cook Hill. Yet again will we briefly delay to inspect the dome-like mountain on the opposite side of the Columbia that rises to barely short of 3,000 feet. It is called Cook hill, formerly known as Bald mountain. In the view its long westerly slope leads down towards Wind mountain now nearly four miles away. We can see that from the river's edge the heavy layers of basalt of which it is composed rise to the eastward beneath the mountain, their dip as measured at the railroad one and one fourth miles east of Collins, being 12 degrees in a direction 50 degrees south of west. The beds continue to rise until truncated by the canyon of Dog creek. Near the outlet of this stream the dip is 26 degrees, its direction having changed from southwesterly to 20 degrees east of south. East of Dog creek the beds have a general southeastward inclination rising thus towards the west and north. As we reach Mitchell Point and pass beyond we shall be better able to see that Dog creek has cut its gorge into the top and apparently parallel to the axis of a great curving upward arch in the basalt strata. To the east and to the west the layers incline away from this axis, whose position is marked in a general way by the course of Dog creek; and besides this, the entire series of lava flows, axis and all, plunges rather steeply in a southeasterly direction towards the river.

We shall be anxious to discover on the Oregon side some evidence of this rather unusually marked deformation that so plainly shows across the river. At intervals between Starvation creek and Viento we have already interpreted the southerly inclination of the basalt in outcrops along

Looking across the Columbia from near Viento. Wind mountain and west slope of Cook Hill the Highway as due to slipping of large masses from the cliffs above. Now that suspicion is aroused, we see, however, that their disposition is not out of harmony with what we observe across the river. And we are further assured by the finding of other croppings of the basalt beyond Viento that display similar deformation. About one mile west of Mitchell Point measurement shows the lava to be dipping all of 35 degrees practically due southeast.

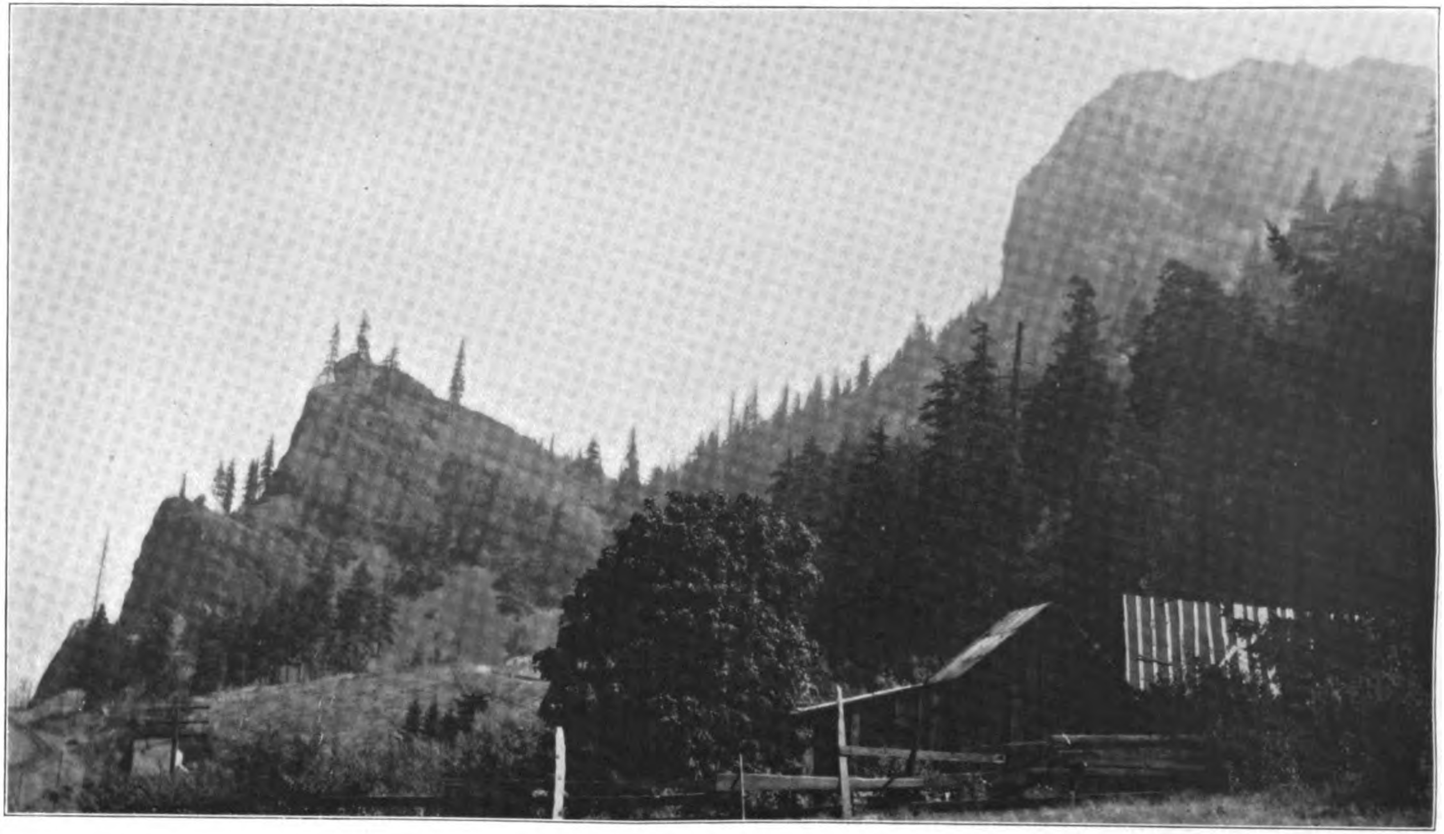
MITCHELL POINT

Big and Little Mitchell from the west. Mitchell Point itself, the first open view of which is had from Sonny, a small lumber town one half mile to the west, is seen to be likewise made of layers of basalt that dip steeply away from the river. In the view notched "little" Mitchell is at the left. At its base and close to the river is to be seen the railroad, and a hundred feet or more up, the cleft along which the Columbia River Highway rounds the Point before entering its spectacular tunnel. Central in the photograph is the pass through which the old wagon road went, its grade a steep and harrowing one now abandoned. At the right is "big" or "high" Mitchell, its structure too, being one of southeasterly dipping beds. Big Mitchell rises about 1,400 feet above the river. Its face is seen to be precipitous and is really the protruding point of a jagged ridge the sides of which have been so gnawed away that its crestline is now one of unstable moldering crags, the negotiation of which is a task for only the most daringly intrepid to undertake.

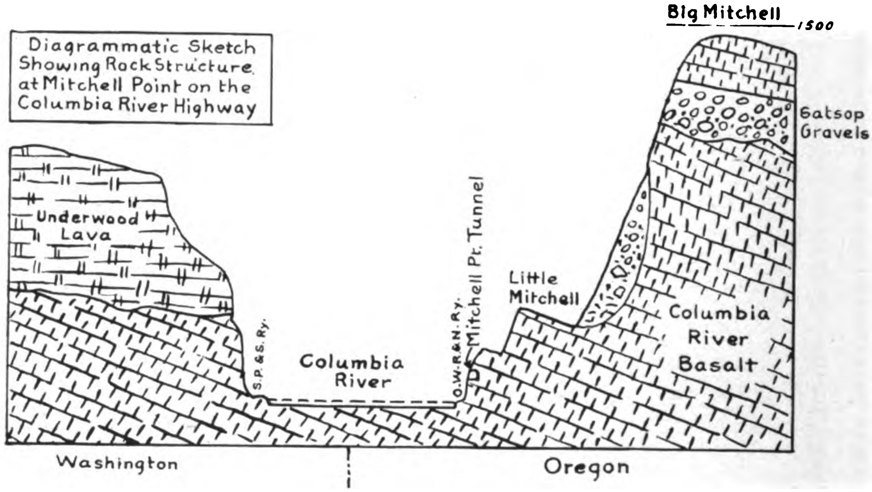
About the foot of big Mitchell is an abundance of iron-stained gravel talus intermixed with that of blocky basalt. Again, as though by some link of common concern, we seem not to be able to lose touch with the familiar Satsop formation. High up in the walls of big Mitchell close to a hundred foot bed of it glares down at us. The gravels are in part the cause of this one of the most spectacular headlands in the whole Columbia river gorge. They rest as usual upon an irregularly eroded surface of Columbia river basalt and are in turn buried by the later lavas that cap the ridge of big Mitchell. The overlying lava here seems not to differ in general nature from that below, while elsewhere the gravels have almost universally separated the basalt from superjacent lavas of somewhat less basic character. Since igneous rocks often grade into each other without regard for specific dividing lines, it is to be not unexpected that some of the earliest of the great series of flows that cover over the entire summit of the Cascade Range would be strongly basic, or even basalt.

Geology at Mitchell Point

At any rate, the time interval which these gravels represent would seem to be the same. We found them low down in the region of Portland, rising on the flanks of the range at Crown Point and many other places, up nearly 3,000 feet beneath its crest in the walls of Herman creek canyon, at 2,000 in Viento gorge, and here in big Mitchell between 1,200 and 1,400 feet above the sea, again contentedly dropping with the eastward slope of the underlying basalt. As we study the situation here, and



Big and Little Mitchell from the west. O-W. R. & N. railroad at extreme left; Columbia River Highway in first rock-shelf above the railroad across the river, we can see that the dipping beds at Mitchell Point are in general conformity with those at the east side of the axis of the Dog creek arch, and are a component part of a great upward bend in the strata, or anticline, that pitches to the southeast parallel to its axis; which may in part be illustrated by calling attention to the fact that a given stratum rising from water level on the Washington side can be seen to reach into the heights of the mountain east of Dog creek. Deeper beds pass below the river; those above, as shown in accompanying sketch, having been truncated by the Columbia and their substance carried away; until, as we



Geologic structure at Mitchell Point

come to the Oregon side, Mitchell Point, both little and big, represent just as truly similar truncated layers, but their edges happen now to occupy an uplifted position in one wall of the Columbia gorge rather than in its bottom beneath the water of the river. What was the former extent of the basalt flows composing Mitchell Point, we dare hardly conjecture, but certain it is that before they were uplifted and folded as a part of the Cascade Range, they extended across the space now occupied by the Columbia and to probably a great distance beyond.

Mitchell Point tunnel

Construction of the Columbia River Highway beneath Mitchell Point necessitated the blasting out of a shelf-like niche for some distance along the vertical face of the basalt cliff that formerly rose vertically from the bank of the Columbia. At the water's edge a rock fill carried the railroad safely by. No alternative was there then for those who laid out and built the Columbia River Highway but to tear away and finally bore through the rock itself. In so doing, it must be said, a roadway was produced that for security and substantialness cannot be improved upon, while from the scenic standpoint, we are assured by those who know, in the Mitchell Point tunnel there is added to this already celebrated thoroughfare a feature unparalleled, go where you will.

Coaly seam between basalt flows, Mitchell Point. What has thus been accomplished through necessity and intention from the engineering and scenic points of view, has fortunately at the same time, without previous design not to say expectation, thrown open intensely interesting records of some incidental happenings of the geologic past. At the entrance of the first rock-cut we more throughly than ever appreciate that the Point is made of inclined layers of basalt, one on top of another. Here, for a couple of hundreds of feet we may view

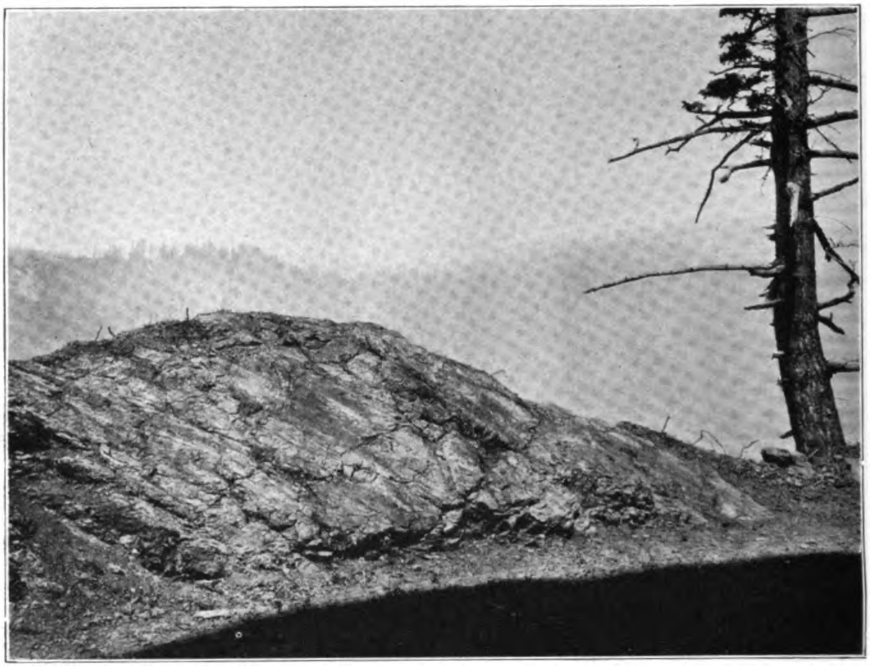
Coaly seam between basalt flows, Mitchell Point

Clay-soil seam penetrating basalt, Mitchell Point

at close range the contact between two successive flows. We have continuously marveled at the hundreds, sometimes thousands of vertical feet of lavas that rise above us in all parts of the Columbia gorge. Everywhere we see that these great thicknesses are built up of relatively thin individual layers, how many at any one place we usually cannot count, each representing a separate flow. It is easy to drop into the habit of thinking that these flows followed each other in rapid order, and that therefore their accumulation would pile up into hundreds of feet within comparatively short periods of time. Every once in a while, however, the opportunity is thrust in our way to see that at least in many instances, not merely few but a great many years must have elapsed between the successive coming of the flows of basalt. Before us is a seam of carbonaceous clay containing some actual coaly matter, pinched in between two massive flow layers of the basalt. The under surface of the upper basalt is twisted, full of caverns and pillowy, as though it may have pushed while cooling, into and finally come to rest in the water and slime of a muddy swamp. On the other hand, the top surface of the lower lava, beneath the coaly seam, is not so definite, the rock is more altered and crevices extend into it to greater or less depth. From these facts we promptly infer that upon the older lower lava a soil once accumulated, and conditions were favorable for the growth of plant life and at death, for its partial preservation as the black, carbonaceous or coaly residue we find today. That this soil and its organic matter were not bodily carried here in the course of lava movement is shown by the alteration of the underlying rock, meaning that it contributed its own substance to the forming soil.

Clay-soil seam penetrating basalt, Mitchell Point. That plant life flourished is evidenced by the way in which the soil and carbonaceous matter extend into the irregular vertical cracks, just as we see ramifying roots penetrate and draw sustenance from disintegrating rock surfaces of today. In the view the dark band across the top is the main clay-coal seam, and branching from it below is a narrowing crevice several feet in depth that is wedged full of the same sort of clayey soil containing the carbonized remains of vegetable life. There can be no question that this inter-lava soil-bed represents a time interval of considerable length. The under lava was exposed long enough to first become cold and solid, and then for its upper part to sufficiently alter that plants could gain a foothold, and indeed develop in some degree o' luxuriance it would seem, in order to leave so much of a residue. How long in years we can gain little notion, for our knowledge is slight of the climatic conditions of those times, but it is quite safe to venture that, under the most favorable environment, at least a few hundreds of years must have gone by before again the lava came on to wipe away, or entomb, all of living thing to which the interim may have given rise. Even in the great basalt formation alone we count the flows by the score, between many of which, could we but ascertain the truth, would probably be found some signs of a time interval of duration long or short. Be the individual interval ever so brief, as geologic time flies, in our units whether centuries or generations, their sum must be immensely great.

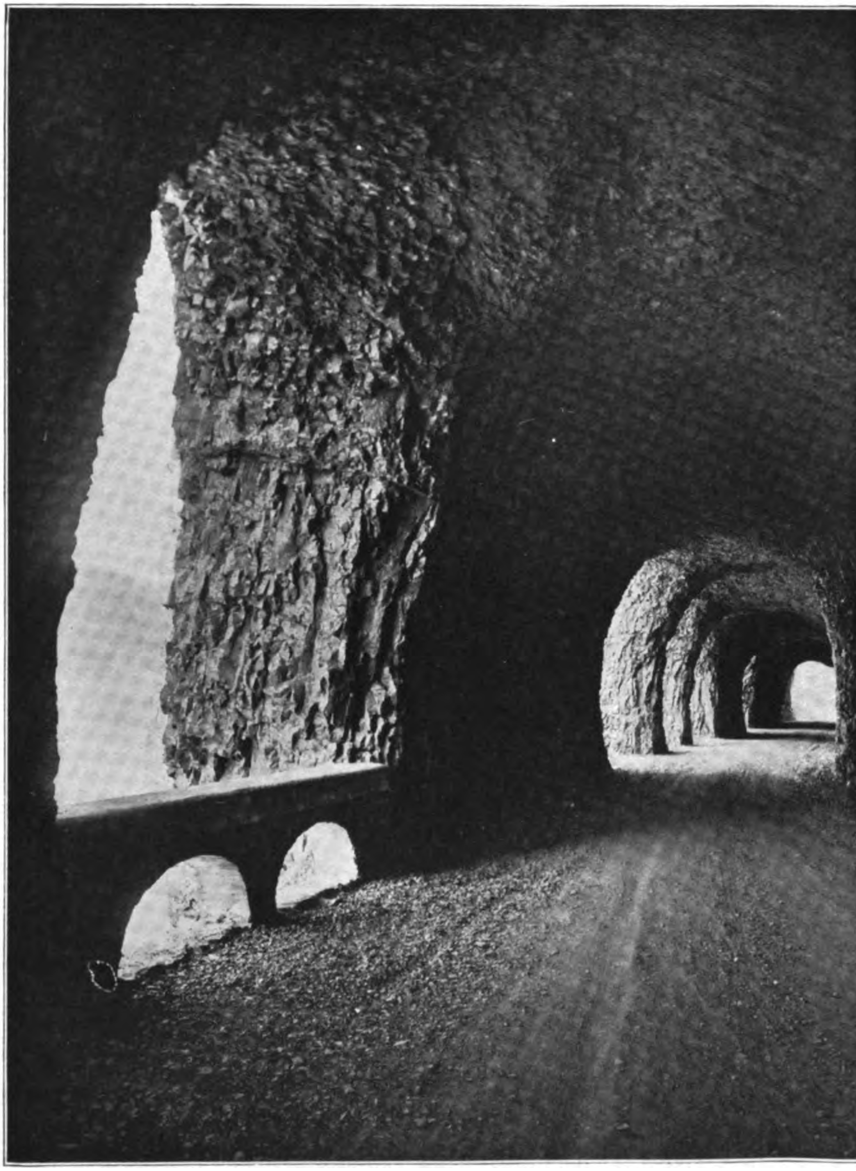
Slickensided basalt, Mitchell Point. We are again reminded that since the basaltic lavas came to rest the entire series has been uplifted and tilted at various angles from the position they at first assumed. It is very evident that the soil-band we have just examined accumulated in a much more nearly flat-lying position than is its attitude today. Just how an enormous thickness of rock like the Columbia river basalt composed of many individual layers, submits to being heaved up and bent into arches and intervening troughs is



Slickensided basalt, Mitchell Point

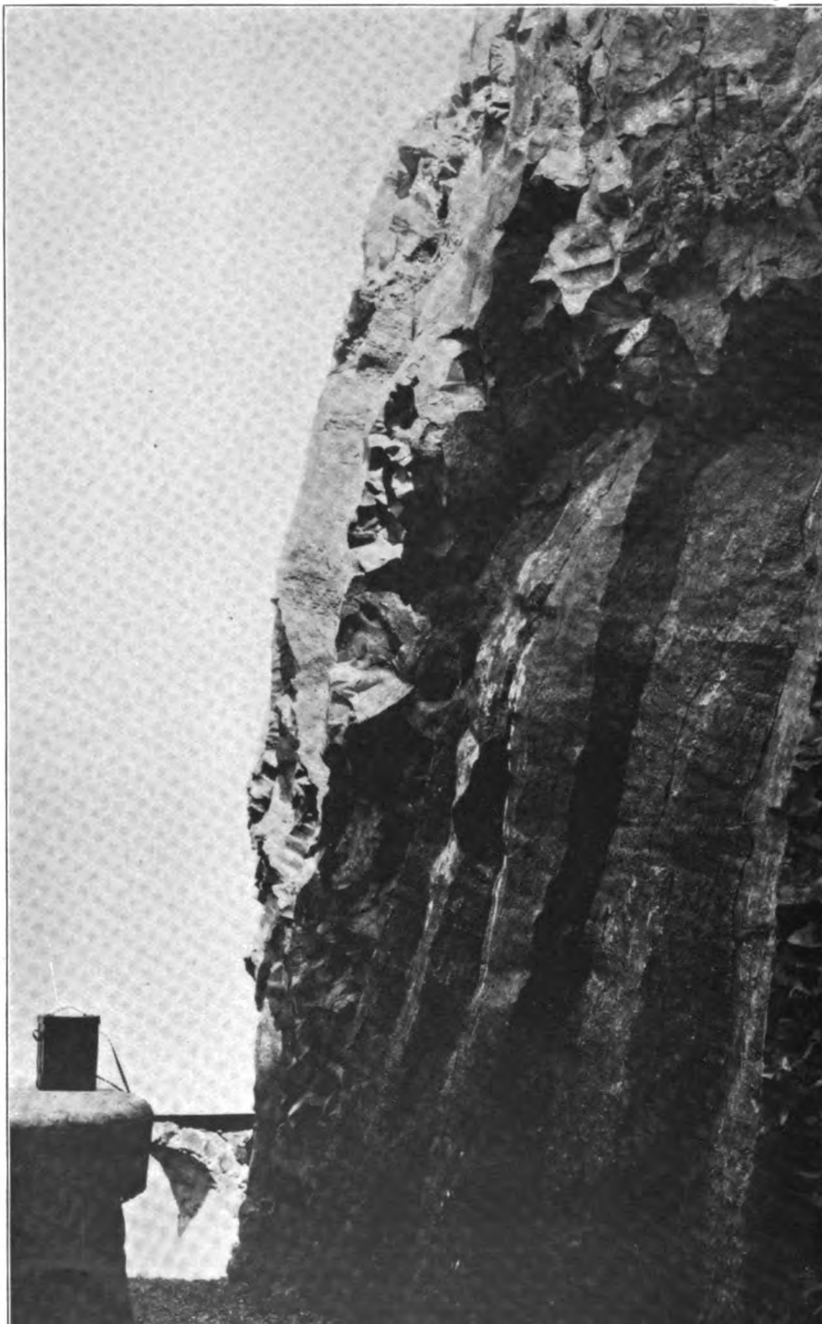
not at first the easiest possible of conceptions to grasp. That stretching must take place on the outside of curves and compression on the inside is apparent. That so strong and brittle a substance as a hard lava can stretch very much under ordinary conditions is scarcely to be imagined. As a matter of fact, we know that fracturing takes place, fissures form, and there is often slipping along lines of break called faults or fault planes.

Nor can we comprehend the possibility of any great amount of movement after the lavas were cold and rigid without some adjustment between the separate layers, the slipping of one layer bodily upon another, just as would the leaves of a book if kinked up by pressure along the edges. Shortly beyond where at its eastern terminus the coaly seam referred to disappears below the level of the roadbed, and on the river side of the floor of the Highway, the rounded dome-like and smoothened lava surface shown in the view may be observed. It is grooved and shows some parallel scratches though in general seems to have been rubbed to an almost slippery smoothness. This surface is the probable continuation of the contact between beds represented by the coaly soil layer, where instead the two lava surfaces were in immediate contact. During the uplift and crumpling that gave rise to the Dog creek anticline, of which we have seen Mitchell Point is a part, movement doubtless occurred in many places between flows. The friction and heat developed by one hard rock rubbing upon another, particularly under the enormous pressure of their weight and the elevating forces, often produces profound changes in the rock along the surface of movement. The polished surface is



Mitchell Point tunnel. Cramped into yet closer quarters, the Columbia River Highway for the last four hundred feet around the base of Mitchell Point passes through its celebrated tunnel. The passage is cut through solid columnar basalt and is lighted by means of five windows artistically carved through the river side of the tunnel wall. It was the fortunate favorable structure of the basalt at this point, and particularly the attitude of the main sets of columns, that contributed largely both to success in driving the tunnel and to the tasteful shaping of its portals, pillars and archways. And the very factors that promoted ease of construction seem providentially to likewise promise enduring permanence for time to come

Photo Oregon Commercial Studio



Structure of rock wall, Mitchell Point tunnel. Close view showing structure of pillar at one of the windows. Heavy basalt columns from floor to spring of arch where they curve inward from sight, as though to more strongly brace and bind together the structure of which Nature had already made them an integral part. Where is man-laid masonry more designedly methodical than this!

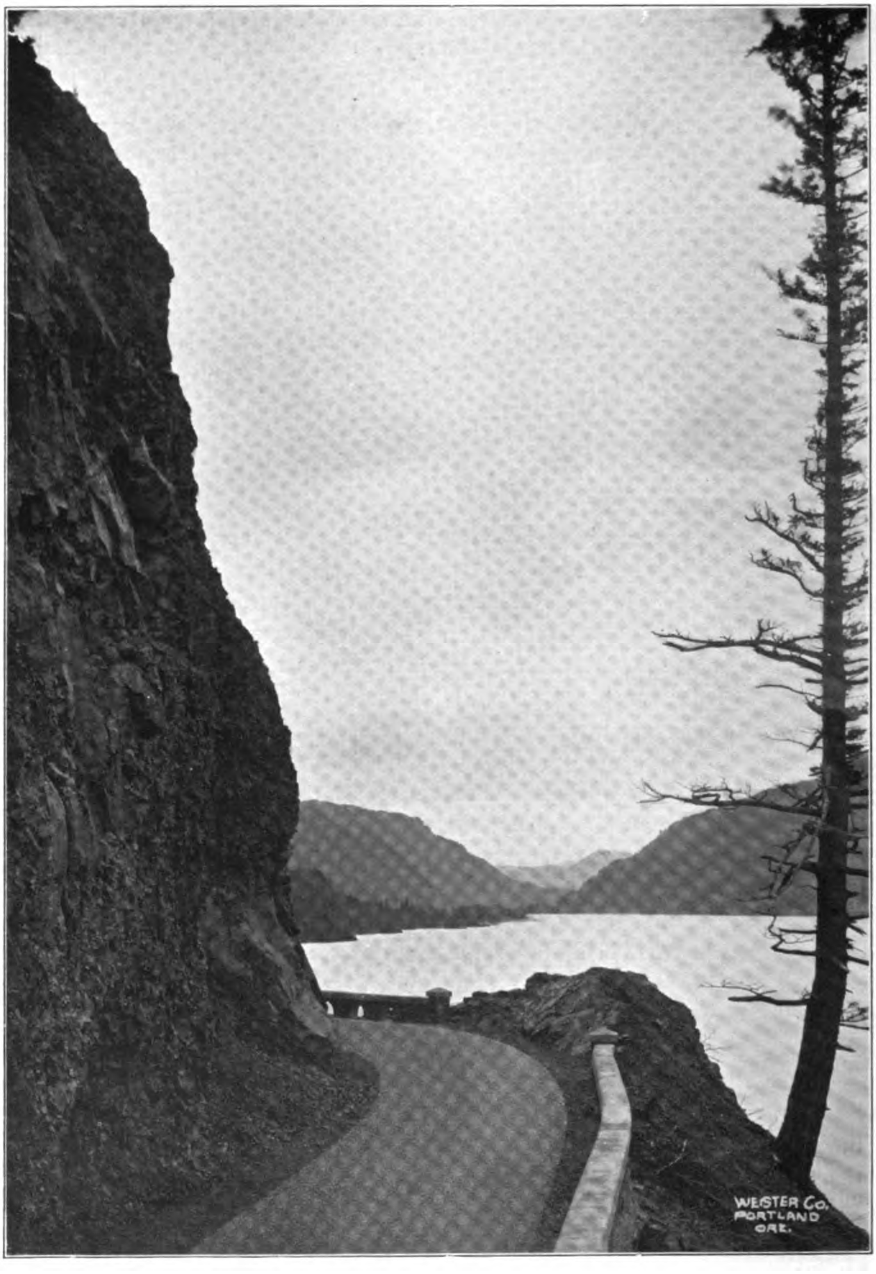
spoken of as "slickensides." The film of greenish-yellow with which it is coated is the alteration product of the friction movement. All of which is but a bit of additional testimony as to the former course of events here.

Down the Columbia from Mitchell Point. From the roadway or the tastefully railed windows of Mitchell Point tunnel there is an unobstructed view both up and down as well as across the Columbia river. Downstream we gaze to the horizon back into the Titan of chasms through which we have come. At the left the angular sky-line is the high divide east of Herman creek, and in shadowy outline against its dark bulk is Shellrock mountain. In the hazy distance is the even top and sloughing slopes of Table mountain, full 19 miles away. Cook Hill whose interesting structure we have but recently studied is near-by on the Washington side. Dog creek has carved into its eastern base and east of this creek the southeasterly sloping layers of basalt stand out, their bold broken edges in places showing as abrupt revetment walls that rise diagonally toward the axis of the Dog creek anticline. The deep notch through which the Little White Salmon flows, and its lakes, are slightly to our left.

Underwood lava

Directly across and low down next the river, we see the same inclined beds of basalt, their successive jutting edges punctured repeatedly for the S. P. & S. railroad to pass. But here, above these dipping beds, and as though resting upon their cut-off edges, is a series of massive strata that lie practically horizontal. Up the river, as far as the eye can discern, this great wall of flat-lying beds extends, except where its continuity is interrupted by the sharply incised canyon of White Salmon river at Underwood, four and a half miles from us. It rises precipitously to a maximum of 1,400 feet above the river, and at intervals from the crossing of the Little White Salmon river for ten miles to Bingen, beyond the town of White Salmon, the eroded surface of the basalt shows below. Opposite the Hood River valley its inclination flattens out in the trough of a syncline as we shall see the basalt does also beneath the valley of Hood river. We are at a loss to explain this apparently anomalous state of affairs by what can be seen at our distance, and our curiosity shall be satisfied only by taking the ferry at Hood River which will land us at Underwood and at the very foot of the cliffs we would examine.

We see at once that they are a series of flows of dark gray lava that have come since the basalt was distorted by the folding of the Cascades uplift. The basalt rises as prominent hills a few miles back from the river, the newer lava having obviously filled in about their lower slopes. Not all of the higher points are of basalt however. Underwood mountain, the prominent rounded peak that stands about midway between Little White Salmon and White Salmon rivers is found to be a comparatively recent volcanic cone. It rises between 2,900 and 3,000 feet above sea level and its upper steep portion is entirely of cinder, ash, lapilli and scoriaceous volcanic fragments. The lower wide-spreading slope of about 10 degrees that reaches to the brink of the Columbia, west to the Little White Salmon and lowers eastward so as to reach the river level beyond



Down the Columbia from Mitchell Point

White Salmon town, is with little doubt a lava surface, its slope determined by the cooling position of the final liquid flows. And all indications go to show that Underwood mountain, and possibly other nearby hills to the north of it, was at least in part the source of these new born lavas. That they were squeezed out through a number of vents is most likely. The hill at the northwest edge of the town of White Salmon, rising, all told, about 1,000 feet above the river, possesses many of the features of a volcanic cone from which lavas issued similar to those about the base of Underwood, sometimes called Storm mountain. Whatever their source, these relatively flat-lying lavas are new, younger by far than the Columbia, at the edge of whose gorge their cut-off edges form so spectacular a wall, as we view it from Mitchell Point and as it can be seen from the Hood river valley. When we project across the Columbia the average inclination of the lava surface from the foot of Underwood mountain, we are impressed with the extreme likelihood that the flows must have pushed at least part way if not entirely across that river, although we find no certain evidence of their encroachment upon Oregon shores.

HOOD RIVER VALLEY

FROM Mitchell Point to Hood River is a little more than five miles, when the Highway is completed, an uneventful stretch of easy grade. Geologically, we must not fail to observe that the southeastward dipping basalt at Mitchell Point is succeeded by similarly inclined less basic lava to be seen along the railroad and the river at Ruthton and particularly at the roadside in the Ruthton hill. Here a climb of a few hundred feet is made to one of the lower levels of the broad Hood river valley. Were we to continue along the river we should see that the inclination of the lava slowly flattens out so that beneath at least the lower part of the wide valley of Hood river the beds are practically horizontal. East of Ruthton some interbedded scoriaceous materials, to all appearances water-laid, may represent the inter-lava Satsop formation, the basalt being carried by its dip so low that its upper surface is now little if any above the river level. Upon it and partaking of the same general inclination is from 300 to 500 feet of Cascades lava, whose position, while at one and two and even three thousand feet in the center of the Range, is now depressed to as many hundreds of feet above the river. The general level of the northern part of the Hood River valley floor is about 500 feet. From the Columbia we rise to this altitude over a series of rather abrupt benches that are strewn with gravel and show signs of once having been overrun by the river. That these terraces may have been produced by the intermittent lowering of the Columbia from these higher levels is a possibility that promptly enters our minds. And particularly since there faces us from the other side of that river the great mute wall of lava whose eloquent silence has already definitely told us that its strata must formerly have extended far towards if not to actually touch the Oregon side. It would seem quite in order therefore to postulate the not distant day in the past when the Columbia was without compunction thrust aside by a great filling of lava from its northern shore, when its waters rose and it was compelled to seek

Hood river valley, from near White Salmon in Washington. Mt. Hood, 11,225 feet, at the head of the valley. Mt. Defiance at the right, 4,960 feet high. City of Hood River and mouth of Hood river itself near center of view. Hood river valley is a broad synclinal trough or down-fold in the rock formations that rise to the west (right) into the main Cascades uplift, and to the east (left) to form the sharper upward flexure, or Bingen anticline, between the city of Hood River and Mosier. The Columbia river, as we have seen, has cut through and opened thus for our inspection the entire series of deformed rock strata

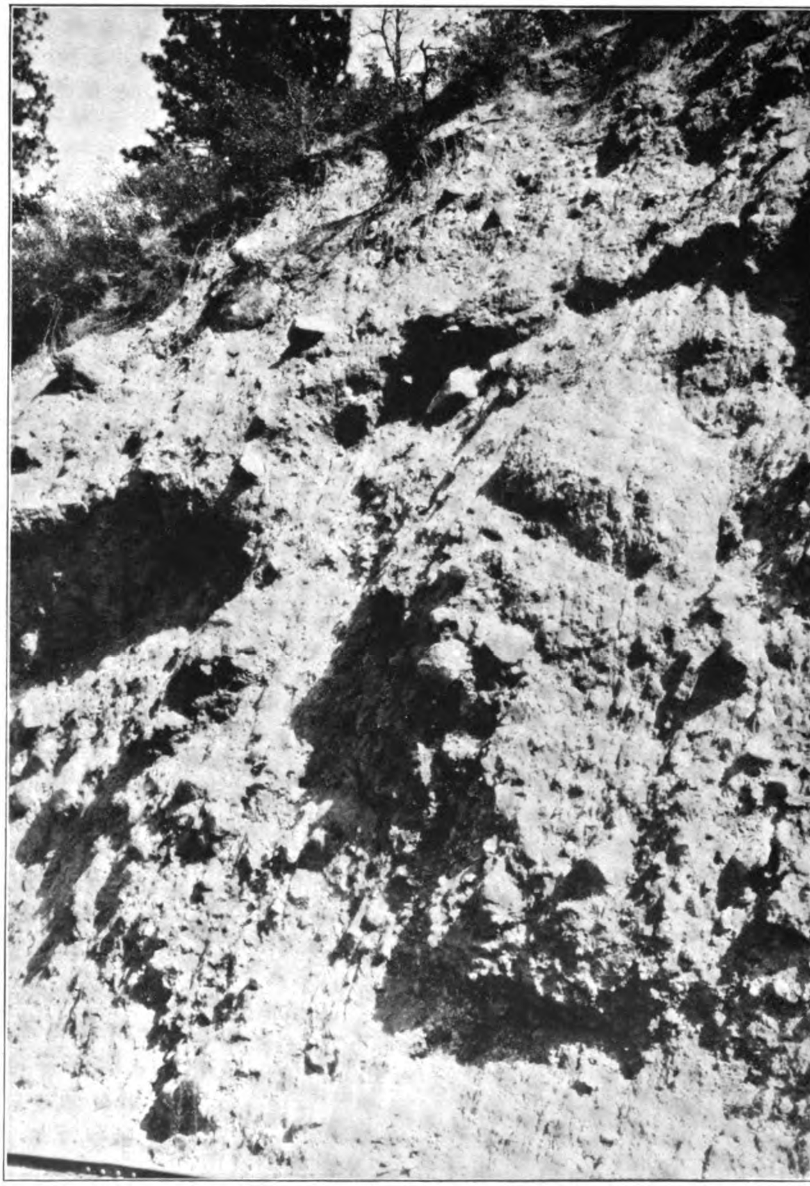
Photo courtesy S., P. & S. Ry.

a devious shifting way around the obstruction on Oregon soil. After quiet was restored, in course of time the river undismayed tore down the barrier in its path, and stage by stage comfortably settled again into its former and present restful bed.

Hood river valley. The city of Hood River is but three miles of boulevard beyond the climb up Ruthton hill. It is situated where Hood river joins the Columbia and is the outlet for the vast fruitage from its celebrated valley, whose productive acres stretch for 15 miles and more due south to the very base of Mt. Hood itself. The valley is a great sloping lava plain broken here and there by protruding groups of basalt hills or of heaps of ejecta from more recent vents of eruption. Van Horn butte is a cinder crater of the latter class, while Booth Hill at Dee will represent the former.

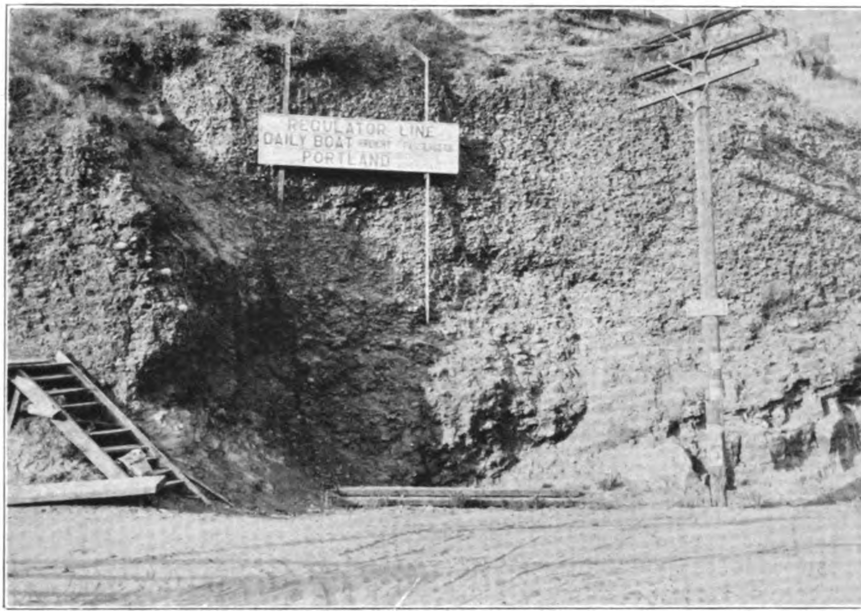
Glacial till in Hood river canyon. And we will not scurry over this undulating valley platform for long before we begin to see the prints of yet another most eventful day. The summit of Mt. Hood is today surrounded by a group of miniature active glaciers. In glacial times this mountain was the elevated source whence glacier streams, verily ponderous sheets of ice, coursed we know not how much farther down than do the meagre remnants of the present time. Hood river has cut and occupies a literal gash below the general level of the valley floor. In its canyon walls we catch a not infrequent clue to what has happened in days by gone. The Mt. Hood railroad threads for its first few miles the deepening canyon of Hood river. And we need to go only some three miles up, to the switch-back, by means of which this railroad ascends the canyon wall, to be fully reassured that the glaciers were once busy here. In the railroad cut high banks of sandy, bouldery clay are exposed, each boulder fresh and unweathered and but little if any rounded. The clay is light gray or buff in color and through it pebbles and boulders are promiscuously scattered with no sign of definiteness or order in arrangement. "Till" is what glacialists call it and its structure is characteristic of the unsorted manner in which the moving melting ice lay down the load it carried. We are thus convinced that during the frigid glacial period, which as earth events accrue is but one brief moment past and gone, the glaciers quite thoroughly dominated the valley of Hood river. Doubtless much of its fertility of soil is due to the contributions of that period, just how much we are not now able to say. Nor are we at all certain but that in the wintry heyday of that climatic swing of pendulum, glacial streams extended to the Columbia, and its sweeping waters may have been called upon to clear its channel of heaps of morainal rock debris if not of tongue of solid ice itself.

Old gravels resting upon basalt, east end Hood river bridge. Reluctant to feel that our journey through the gorge of rhe Columbia river, a journey so replete with thrills, must end here, we cannot forego with peace of mind the opportunity to take at least yet one look ahead. At the east end of the bridge across Hood river we are face to face with a wall of iron-stained gravel whose familiar appearance it is impossible to mistake. It is sprinkled with quartzites and, in the view, at the right we can see where the gravel bed rests upon a weathered surface of basalt. The railroad cuts through it, and it is present for miles along the wagon road eastward between Hood river and Mosier. Wherever found these gravels mantle the basalt just



Glacial till in Hood river canyon, along Mt. Hood railroad

as have the Satsop gravels always. They creep up to scarcely less than 1,800 feet on the divide between Hood River and Mosier, and yet on to more than 2,000 on the Ortley ridge, thence down towards The Dalles where they seem to join with The Dalles beds whose exact age has long been in question. That the latter are the exact equivalent of the Satsop in age cannot now be definitely stated. Between the



Old gravels resting upon basalt, east end Hood River bridge

forks of Mill creek a sheet of andesitic lava overlies The Dalles tuff, but this may prove to be a recent valley flow, which would not therefore preclude the possibility of more or less of these hundreds of feet of bouldery volcanic sediments having accumulated in the slackwater of an inlaid lake temporarily formed by the waters of the Columbia drainage after the Cascades uplift had begun or was nearly completed.

We saw the Satsop gravels high up in Big Mitchell, we now find them nearly at the water level of Hood river, again on top of two high divides between, and yet again coming low down in the region of The Dalles. How much farther into eastern Oregon the formation may be traced remains to be determined. On the Washington side of the Columbia Satsop gravels are found upon the basalt at intervals along the Klickitat river to Goldendale, over the Simcoe divide to an altitude of over 3,000 feet, and on into the Yakima country. And it is of interest to recall, that these gravels of such wide distribution are the equivalent, in time of deposition and character, of those of Westover terraces in the city of Portland, the top of Mt. Tabor, for miles along the Sandy river, at Crown Point, and of an unrecorded number of other places where they have been seen to enter into the structure and uplift of the Cascade Range.

Hood River-White Salm syncline

We have seen that the great Hood River valley depression and its counterpart and continuation, White Salmon valley in the state of Washington, the latter since partly filled with newer lavas, are the result of a downward curving of the same series of formations that have by being arched upward produced the foundation of the Cascade Range. Andesitic lavas of the Cascades formation as well as the basalt pass beneath its floor. At the eastern edge of this valley we find that the basalt promptly rises again and it is the successive waves or folds into which it is thrown that give rise to the two prominent divides between Hood River and The Dalles. We shall designate the first the Bingen anticline inasmuch as Bingen on the Washington side is very near the axis of this uplift. The succeeding trough or syncline in which the town of Mosier is located is appropriately termed the Mosier syncline. Beyond Mosier is the Ortley anticline, before passing down into The Dalles trough. East of Hood river the Cascades lava rises in places upon the flank of the Bingen anticline, from the upper portions of which, if it were once there, it has been eroded away. Southward towards Mt. Hood, along the strike of this anticline, andesite is found upon its crest.

Looking up the Columbia above Hood River. A trip from Hood River to The Dalles by boat reveals in a most enlightening way the structure of this section of the Cascades; for a part of the Cascade Range we must call these minor oscillations as well, since so far as our present knowledge goes, they grew as did the main Cascades uplift, by the same forces and in the same period of time. From the river the severed edges of alternating arch and trough give one at a glance a correct view of their relationship. The Bingen anticline, the dipping basalt in the eastern limb of which can be seen in the view, strikes somewhere near northeast-southwest, and is paralleled in direction somewhat closely by the Mosier syncline. The Columbia for a short distance above Mosier appears to run in and be influenced somewhat by the trough of this syncline. East of Mosier the slope of the basalt layers rises but slowly for several miles until about opposite the mouth of the Klickitat river and nearly to the town of Lyle. Here their change in dip is notable and is as high as 30 degrees where they enter into the sharply flexed limb of the Ortley anticline. The axis of this anticline is some two miles beyond Lyle and it too has a general northeast-southwest trend. Its eastern limb is less abrupt, and in the vicinity of The Dalles the basalt can be seen to flatten out and to pass beneath the tuff beds of The Dalles formation.

RESUMÉ OF COLUMBIA GORGE TOUR

WE have now traversed for nearly 70 miles the course of the Columbia river. We have followed the windings of that powerful stream in its deepcut canyon across the Cascade Range of mountains. It has severed that range so that in the walls of its gorge many of the details of its mountain structure stand out. Now that our hurried examination is completed and we have partaken of the varied scenic joys that in all the world only the Columbia river gorge and its Highway afford, there must indelibly remain in mind the graphic picture of the building of this mountain range. So far back as our records go, volcanic action has been the dominating force. When the Eagle creek beds were deposited volcanos were active. and their products were scattered far and wide, some to settle in bodies of water, others upon the surface of the land. There was no Columbia river then, and of the drainage systems we know but little. There followed protracted

Looking up the Columbia above Hood River. Inclined lava layers at the left across the river are a part of the eastern limb of the Bingen anticline floods of basic lavas, the Columbia river basalt, that overwhelmed and obscured all else. Of their source, we are not certain, although from their widespread distribution they were doubtless poured out from many vents generously scattered over a large area of country. And even yet we know of no Columbia. Then, in our region, came a time of comparative quiet. The surface of the basalt lay relatively low with reference to sea level, yet not so low but that it was subjected to the action of all the forces of atmospheric weathering and erosion. As a land surface the rock was deeply decayed, soils formed, stream gorges and gullies, hills and ridges were carved upon it. And the courses of rivers and their ramifying tributaries must have been established by which the surplus rains that fell were carried back to the sea. One of these became so overgrown that all others were compelled to pay tribute to it, and when a general lowering of the land took place it so spread out, and repeatedly shifted its course that many of the former irregularities of surface were filled with its gravels and sands. And when finally, from its western edge this basalt land surface progressively sunk beneath the waves, this master stream as many others for hundreds of miles both north and south along this ocean shore, with herculean effort heaped hundreds of vertical feet of far-borne sediments into the slowly widening pit along its border.

Birth of the Columbia

Thus was the Columbia born. And it continued its work for many many years, throughout minor oscillations of level, by which in land-locked lakes, lagoons, bays and in its own partially drowned valley there came about just such a various assortment of gravels, sands, silts and clays as comprise what we know as the Satsop formation of today. During this time its branches were reaching far into the contiguous country where a new era of volcanic activity was about to begin. Already they were bringing down the abundance of mixed basaltic and andesitic gravel, of lapilli, sand and ash we now find in the Satsop. Until at last there came from inland a great devastating sheet of the new lava itself that filled in upon the gravels and clays, and was in turn covered by them, as we see today at Troutdale and at Crown Point. So was presaged the beginning of a new volcanic era, the era of eruption that soon gave us the lavas of the Cascades formation that rest above all today.

But our river did not cease its constructive labors until forced to do so by the commencement of another uplift, which brought the old land surface, now loaded with gravels, up to not merely its former position, but hundreds of feet higher as shown by the present elevated remnants of the Satsop beds. Contemporaneous with its progress, the andesitic lavas came in increasing profusion. And at its beginning was the Columbia river established in practically its present course, and set to the Cyclopean task of forging its way through a rising mountain range; a task in the doing of which it has never for a moment faltered and the fruits of whose accomplishment are ours to enjoy for time to come.

This was the main Cascades uplift; a long drawn out period of elevation, during which the Columbia river basalt was arched upward as one broad fold, and at least three sharper ones, carrying above it its load of Satsop gravels, and, wherever they had yet arrived, the still younger Cascades flows. Beneath the basalt the earlier strata of the Eagle creek formation as we know entered into the deformation. To how much greater depth the disturbance extended there is no way of knowing. The upward movement was slow, not cataclysmic, with probably intermittent pauses. The river cut downward as rapidly as the land uplifted, else it would have been diverted from its place; and scarcely a conjecture have we as to how different the story might have been had so entirely possible a thing have taken place.

Nor has time been uneventful since, in the not long ago, the bodily elevation of the Cascade Range ceased. Volcanic action then begun has continued; volcanos almost without number have grown, some of which now virtually cast their shadows into the Columbia gorge, as though grudgingly acknowledging its priority. Streams of liquid lava, these however certainly without design from the sister state, have even attempted to fill it up, as from Carson across to Herman creek and between the two White Salmon rivers, but without success. It is lean assurance to observe that just now no such catastrophic happenings are under way. True they neither come on in a moment nor unannounced, and their passing is not to be measured in terms of human generations. Nevertheless, as geologic time goes, our peerless Columbia gorge is ever threatened, if not by such as we see have essayed its destruction in the past, then by the hand of the majestic river that flows through it. For by its own efforts will the confining cliffs in time be undermined and eaten away. But for appreciable harm to familiar scenic features in our day we need feel no concern. They are ours today and they shall outlast all human habitancy ere they crumble away.

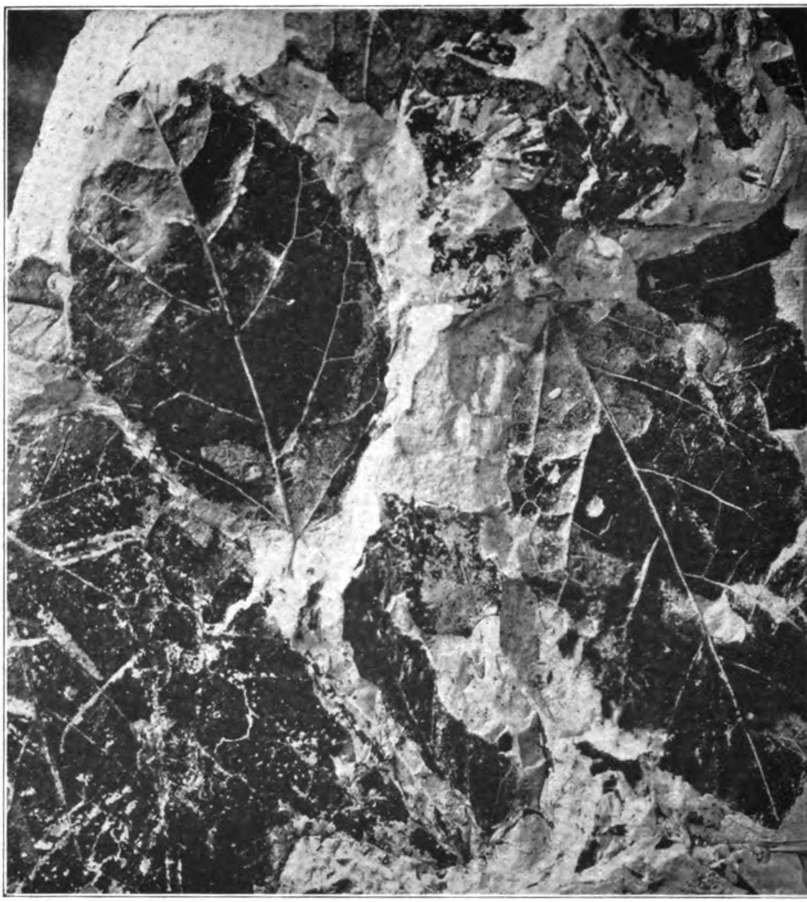
AGE OF THE CASCADE RANGE

IN the history of earth features, eons, eras, period and epoch correspond to the generations, the life-times, cycles, and the seasons of human development. The occurrence of important human events is chronicled in terms of years and centuries, of kingdoms and dynasties. So too, may we separate and denominate the various stages of earth history and classify the evolutionary changes through which it has passed. As now, both plant and animal life have long existed on the earth. All life has been slowly changing, early forms disappearing to be succeeded by new and in general more highly organized types. We find the evidence of these changes entombed today as fossils in the rocks that were formed when each lived and died. And their recognition provides the measuring stick whereby the age of the rocks may be determined.

Eagle creek flora

What more natural thought than to ask as to when did the Cascades uplift occur? In other words, what is the age of the Cascade Range, and how long ago did the Columbia begin to cut its gorge? We recall that the bulk of its structure is composed of lavas that were highly heated or molten when they came to rest, in which, therefore, there is little hope

NOTE:—Reference to the cross-section sketch of the Cascade Range accompanying this paper



Fossil leaves of the birch or alder, found in a bed of ashy shale in the Eagle creek formation, canyon of Eagle creek, near the Columbia River Highway. Geologists say these trees lived and died in upper Miocene time, how many millions of years ago we do not know; and their leaves were entombed and preserved in the river muds in which we now find them
Photo by R. W. Chaney

of finding recognizable remains of the organic life of their day. Both above and below the Columbia river basalt however, there is a sedimentary formation, and in both of them has our search been most abundantly rewarded. As already stated, in the Eagle creek formation, at the mouth of Moffet creek, along Eagle creek, and elsewhere, ashy clay beds have been discovered that carry the fossil remains of a fairly extensive flora. At the former place Professor LeConte long ago identified the leaves of two different species of oak and one of conifer; and Mr. J. S. Diller later found in addition both poplar and maple. The Eagle creek fossil-bearing bed was opened up the past summer in the progress of trail-building by the U. S. Forest Service. Among the many perfect specimens collected from it by Mr. Ralph W. Chaney of the University of Chicago, he has recognized at least 20 different genera and some 40 species. These include the maple, black oak, sweet gum, smilax or greenbrier, elm, walnut, sycamore, magnolia, sumac, cherry, poplar, horn-beam, birch,

Fossil leaf (natural size) of a species of the black oak, not now living, occurring plentifully in a bed of ashy shale in the Eagle creek formation (upper miocene) Eagle creek canyon, Columbia river gorge. This formation represents a time period prior to the coming of the thousands of feet of Columbia river basalt, hence long before the present Columbia river or its gorge were in existence

Photo by R. W. Chaney

alder, pine, and almost certainly spruce, chestnut, and willow. What luxuriance of forest growth must this have been! And though of types that yet flourish upon the earth, the individual species found in these ancient beds are now all extinct.

Age of Eagle creek formation

It was the conclusion of both LeConte and Diller that the flora found in what we are now to call the Eagle creek formation was representative of the Miocene epoch of Tertiary times. From the new flora, we may now more definitely say that this formation belongs to the latter part of that epoch, the upper Miocene. In this period, the Tertiary, geologists are practically agreed, there still followed another epoch, the Pliocene, before the beginning of the Quaternary in which man first appeared. It would seem then that the Columbia river basalt, which rests upon the upper Miocene Eagle creek formation, may belong either to that epoch, or more likely, to the succeeding Pliocene, inasmuch as the top of the Eagle creek is an erosional surface, and represents thus a border line or interval of physiographic adjustment.

Satsop flora

Yet above the basalt and entering into the deformation of the Cascade Range, is the ubiquitous Satsop. From its occurrence in the state of Washington this formation has been correlated by J. H. Bretz* as the equivalent of sedimentary beds widely distributed along the Oregon coast that were considered by J. S. Diller† in 1895 as belonging to the Pleistocene epoch of the Quaternary. In the absence of more definite data, we might accept such long range correlation and decide that the Satsop, as we have found it, is likewise Pleistocene. But fortunately for our cause, and through the efforts and knowledge of an enterprising citizen of Portland, Mr. J. B. Winstanley, have these sedimentary strata themselves been allured into the yielding up of their own secrets. Mr. Winstanley several years ago discovered a fossil-bearing bed of compact ashy shale in immediate association with the gravelly members of this formation, in the bed of Buck (also called Trapper) creek, a tributary entering the Sandy river about four miles barely west of south from Crown Point on the Columbia. Through the enthusiastic co-operation of this gentleman, and the assistance of R. W. Chaney, a representative collection of the plant remains from this locality was obtained. The fossil horizon is exposed three-fourths of a mile back from the Sandy river road, in the south side of the canyon of Buck creek, 25 feet above the water, beneath an overhanging cliff of conglomeratic phase in which pebbles of polished quartzite are common. Mr. Chaney states that in this one exposure of the Satsop, four genera and at least seven species of plant life are represented. They include the oak, willow, walnut and the sequoia. The latter is apparently the living redwood of California. Both the oak and the willow likewise closely resemble their living relatives in that sister state at the south.

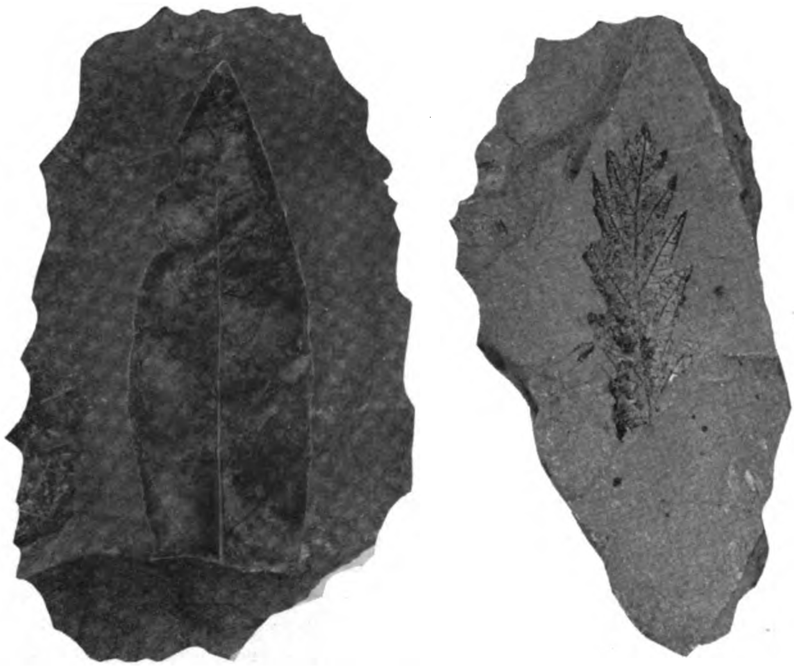
Age of Satsop formation

There are in this Satsop flora above the Columbia basalt, remains of several of the same genera found in the Eagle creek strata below that great body of lava, but their specific characters are so markedly more modern as to brand this flora at once as belonging to a distinctly later

*Unpublished manuscript.

†17th Ann. Rep. U. S. G. S. 1895, part I.

age. On the other hand, this flora includes plants that at present grow upon the earth, most of them, however, flourishing only in the warmer climate of lower latitudes. Such equivalence to living forms might imply enforced migration, the retrieval of lost territory having not yet, to the present, been made. Or more likely, that the climate in which they grew, and prior to their displacement, was a more equable one than ours of today. In any case, similarity with land plants found elsewhere in undoubted Pleistocene strata, as well as with those of the present, affords



Fossil leaves from the Satsop formation on Buck creek. These represent living species of the oak and willow, though long entombed in the ashy shale where they are now found. Specimens loaned by J. B. Winstanley.

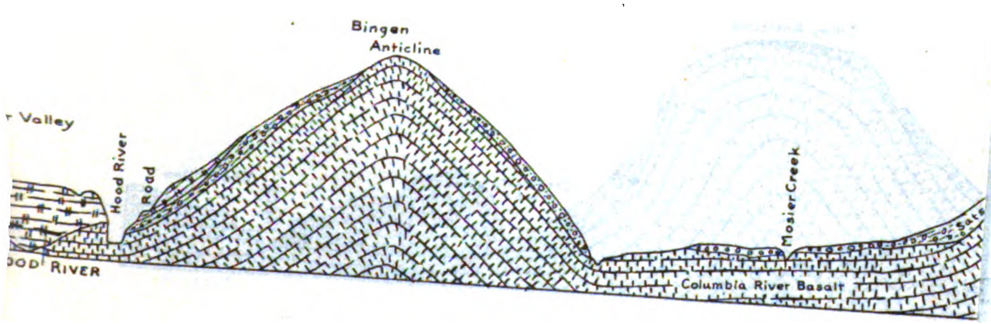
us tentative grounds at least for saying with added confidence that the Satsop formation, as it enters into the structure of the Cascade Range, appears to belong to the Pleistocene.

In many parts of the world the Pleistocene epoch of the Quaternary period is characterized as a time of predominatingly widespread glaciation, the Glacial period. With the exception of the higher altitudes in the main mountain ranges, Oregon was not covered by the ice during glacial times. Portions of the state of Washington were ice-covered, a large part of Canada, and in the United States a vast area from the Missouri river to the Atlantic coast. There must have been a general lowering of temperature to bring about frigid conditions, which, with the proximity of the great ice mantle itself could not but markedly affect the climatic conditions of Oregon. Ours was perhaps a sub-arctic, or even arctic climate, when glaciation was at its height. Both plant and animal life would, it would seem, be in part destroyed, and those surviving forced to migrate.

At any rate, the character of our Satsop flora indicates a set of climatic conditions far more moderate than probably existed in glacial times, whether or not they were more so than now. And the fact that these plants grew in this time period whose dominating feature elsewhere was the accumulation of ice and snow, makes us reasonably certain, that, here at least, a warm climate of considerable duration prevailed before frigid conditions came on. It would seem thus from the best evidence that the Pleistocene was an epoch of relatively greater length than ordinarily assumed, in which glaciation was an incident near its close, if it may yet be past, rather than the dominant event either in duration or evolutionary importance. Certain it is that the effect of the Glacial period in the Cascade Range of mountains in Oregon was but as a minor aftermath in comparison with the revolutionary significance of the master stroke of that geologic day, the uplift of this great range itself, and the outpouring of the thousands of feet of liquid lavas upon its summit. For we have seen that the Satsop beds, containing the remains of what is apparently Pleistocene plant life, enter into that uplift, as do also some of the andesitic lavas of equivalent and in some instances somewhat later age. The materials of which they are composed were thus accumulated before this mountain-making elevation began. We are led to the plausible inference that uplift, the eruption of lavas, and glaciation may all have been taking place here at the same time.

Youth of Cascade Range

How long ago was this? Those who have studied farthest into the evolutionary history of man are not agreed as to the definite geologic date of his coming upon the earth. It is fairly well established that he was present during certain of the later stages of the Glacial period. Some say man lived prior to the advent of the ice age. Yet others have found evidence of a possible ancestry antedating the Pleistocene entirely. We are thus not absolutely certain but that human beings may have trod the land of Oregon in Satsop, therefore pre-glacial times, and indeed while yet the position of the Cascade Range was but a rolling land surface with little relief, and the Columbia a meandering river of relatively sluggish mien. The chances that man was present at that early time, or that he existed anywhere upon the earth, are acknowledgedly rather scant. But the possibility is a fascinating as well as serviceable thought, insofar as man's connection with the course of recent earth events affords a comprehensible standard of measurement for their duration. And it shows to us that as earth changes go, the elevation of the Cascade Range, accompanied by its complete severance by the river which gave us the peerless Columbia gorge, is a momentous event of almost the immediate geologic past. If our deductions are proved correct, the uprising of its massive basalt foundation, accompanied and succeeded by the building of its summit heights, began at so late a day as to make of the Cascade Range one of the very youngest of the great mountain ranges of the world. This portion of it would be younger even, and by far, than the Oregon Coast Range, to which a state of comparative youth has long been ascribed.



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Anticline
Valley
Hood River
Road
Mosier Creek
RIVER
Columbia River Basalt

VOLUME 2 NUMBER 4

DECEMBER, 1916

THE MINERAL RESOURCES OF OREGON

Published Monthly By

The Oregon Bureau of Mines and Geology

Handbook of the Mining Industry of Oregon

Alphabetical List of Properties; Description of Mining Districts

By H. M. PARKS and A. M. SWARTLEY

306 Pages

Entered as second class matter at Corvallis, Ore., on Feb. 10, 1914, according to the Act of Aug. 24, 1912.

OREGON
BUREAU OF MINES AND GEOLOGY
COMMISSION

OFFICE OF THE COMMISSION AND EXHIBIT
OREGON BUILDING, PORTLAND, OREGON

OFFICE OF THE DIRECTOR
CORVALLIS, OREGON

Volume 2 Number 4

December Issue

of the

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1916

OREGON'S RELATIVE ANNUAL METAL PRODUCTION FOR PAST FIFTEEN YEARS

Scale—1 inch, $1,000,000.

Oregon's 1916 production includes the metals gold, silver, platinum, copper, lead, antimony, quicksilver, tungsten and chromium.

The total mineral products sold in the State during 1916 including the non-metallics, will amount to about $5,500,000, the largest part of which furnished local and cash markets for labor and supplies.

It is the desire of the Oregon Bureau of Mines and Geology to have in its files at all times, up-to-date information regarding mining properties in the state. Users of this handbook will confer a favor by sending in any data that will make the Bureau reports more complete and accurate.

CONTENTS

SOURCES OF INFORMATION

The preparation of this "Handbook of the Mining Industry of Oregon," is based upon field work carried on in the mining districts during 1915 and 1916. The previous reports of the Oregon Bureau of Mines and Geology have been used freely without giving credit to individual authors. The papers in the "Mineral Resources of Oregon" from which material has been taken are:

Petrology and Mineral Resources of Jackson and Josephine Counties, by A. N. Winchell, (August, 1914).

Geology and Mineral Resources of the Sumpter Quadrangle, by J. T. Pardee and D. F. Hewett, (October, 1914).

Preliminary Report on the General and Economic Geology of the Baker District of Eastern Oregon, by U. S. Grant and G. H. Cady, (October, 1914).

Ore Deposits of Northwestern Oregon, by A. M. Swartley, (December, 1914).

Preliminary Survey of the Geology and Mineral Resources of Curry County, by G. M. Butler and G. J. Mitchell, (October, 1916).

The following publications of the U. S. Geological Survey have been quoted, giving credit to the author in each instance, without stating the particular publication or the page from which the quotation is taken:

The Gold Belt of the Blue Mountains of Oregon, by Waldemar Lindgren, (22nd Ann. Rep. part II, 1901).

Mineral Resources of Southwestern Oregon by J. S. Diller, (Bul. 546, 1914).

Roseburg folio, (No. 49), by J. S. Diller.

Coos Bay folio, (No. 73), by J. S. Diller.

Port Orford folio, (No. 89), by J. S. Diller.

Mineral Resources of Grants Pass Quadrangle and bordering districts, by J. S. Diller and G. F. Kay, (Bul. 380, 1908).

Placer Gravels of the Sumpter and Granite districts, by J. T. Pardee, (Bul. 430, 1910).

The reports of the Mineral Resources branch of the U. S. G. S. have been consulted for statistics of production.

The State Corporation Department has willingly given information relating to the organization and capital stock of the various mining companies.

Officers of the different companies have responded generously to requests for information; and while in the field, mine operators and prospectors have uniformly rendered valuable assistance at all times.

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VOLUME 2 NUMBER 4
DECEMBER, 1916

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of all her Minerals

PUBLISHED MONTHLY AT CORVALLIS BY
THE OREGON BUREAU OF MINES AND GEOLOGY
H. M. PARKS, Director

ALPHABETICAL LIST OF MINES, MINING COMPANIES AND PROSPECTS IN OREGON

ABEL MINE **GREENHORN DISTRICT** **BAKER COUNTY**

Same as "Red Bird Mine," which see.

ADVANCE MINING AND MILLING CO. (gold) **QUARTZVILLE DIST.** **LINN COUNTY**

Office: 1434 Northwestern Bank Bldg., Portland, Oregon. W. J. Makelim, Pres.; W. M. Rasmus, Sec.; Leonora Makelim, Treas., all of Portland. Capital stock, $50,000; par value $5.00; $34,245 subscribed; $34,095 issued and paid up. (1916 report).

This company owns 5 claims between Lawler and Albany in Sec. 23, T. 11 S., R. 4 E. A small amount of development work has been done on the property, but information concerning the nature of the ore deposit could not be obtained. It is reported that 2 men are at work on the property at present.

ADYLOTT MINE **ILLINOIS RIVER DISTRICT** **JOSEPHINE COUNTY**

See "Williams and Adylott" mine.

AFTERTHOUGHT MINE (gold) **UPPER APPLEGATE DIST.** **JACKSON COUNTY**

The Afterthought mine, 2 miles south of Applegate, is in Sec. 27, T. 38 S., R. 4 W., near the top of a ridge at an elevation of about 2300 feet. It is owned by J. R. Bailey. The country rock is a dark gray or green to black argillite. The ore is white to bluish quartz with some sulphides and rare calcite. The vein is nearly vertical and strikes N. 70° E. The walls are not clearly defined and they show no gouge. The vein is opened by an adit crosscutting N. 20° E. 50 feet and then drifting N. 70° E. 150 feet. The ore has been milled in an arrastre in the gulch below. A granitic intrusion outcrops on the southwest slope of the ridge about 600 feet from the mine.

AINSWORTH CLAIMS **OPHIR DISTRICT** **CURRY COUNTY**

See "Schulz & Ainsworth" claims.

AJAX MINE (gold) **GRANITE DISTRICT** **GRANT COUNTY**

The Ajax mine is about 5 miles north of Granite in Lucas gulch, several hundred feet below the Magnolia and explores a parallel vein. The workings include 2 tunnels, a lower extending 280 feet northeast and an upper 112 feet above it and about 500 feet long. A small production from a shoot 90 feet long in the upper tunnel, now inaccessible, is reported over the period 1905-1906.

The lower tunnel follows a gouge-filled fissure for 280 feet, but the shoot has not been encountered. The material on the dumps resembles that from the Magnolia vein. Manganese oxide was noted along secondary fractures and is reported to have been common in the upper tunnel.

ALASKA COAL OIL COMPANY **ALASKA**

Office: 405 Dekum Bldg., Portland, Oregon. Thomas Milburn, 405 Dekum Bldg., Portland, Pres.; Otto Roeber, 405 Dekum Bldg., Portland, Sec.; D. B. McBride, Royal Bldg., Portland, Treas. Capital stock, $250,000; par value $50; capital stock all subscribed and paid up; $159,600 of capital stock issued. (1916 report).

This company's properties are located at Katalla, in Kayak District, Alaska.

ALASKA DOUGLAS GOLD MINING COMPANY **ALASKA**

Office: 809 Electric Bldg., Portland, Oregon. F. W. Bradley, 256 Mills Bldg., San Francisco, Cal., Pres.; F. A. Hammersmith, 256 Mills Bldg., San Francisco, Sec.-Treas. Capital stock, $100,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located on Douglas Island, Alaska. $308.38 worth of improvement work was done in 1915.

ALICE GROUP (gold) **GOLD HILL DISTRICT** **JACKSON COUNTY**

The Alice group, 4 miles south of Gold Hill on Kane creek, owned by J. H. Beeman of Gold Hill, is in N. E. ¼ Sec. 11, T. 37 S., R. 3 W., not far from limestone quarries, at an elevation of 2300 to 2400 feet by barometer. Lessees are now (1913) taking out a footwall streak of high grade oxidized ore near the surface next to old workings. The main vein consisting of solid quartz is not being mined, as it is too low grade for lessees; it strikes N. 12° E. and dips about 60° E. An old adit about a quarter mile to the northeast discloses about 250 feet of workings on a vertical quartz vein averaging 2 to 3 feet in thickness, containing some pyrite, abundant pyrolusite, and some gypsum. A lower adit opens a 3-foot quartz vein which strikes north and dips 48° E.; it is on or near an irregular contact between dark argillite and an andesitic intrusive. As shown in the drawing, the crosscuts from the main drift are wholly or partly in quartz which is supposed to be part of a large vein which is represented in the main crosscut entry by quartz seams in wall rock.

ALMEDA CONSOLIDATED MINES COMPANY **GALICE DIST.** **JOSEPHINE COUNTY**

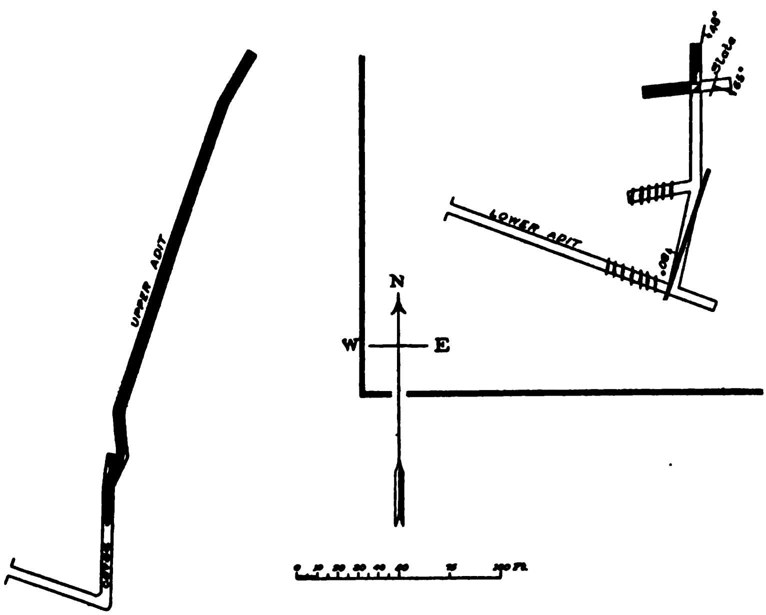
Office: 201 Board of Trade Bldg., Portland, Oregon. Thos. S. Burley, Pres.; Hortense Thurman, Sec.-Treas., both of Portland. Capital stock, $15,-000,000; par value $5.00; $13,818,835 subscribed and issued; $11,688,027.96 paid up. (1916 report).

For description see "Almeda Mine."

ALMEDA MINE (copper-gold) **GALICE DISTRICT** **JOSEPHINE COUNTY**

The Almeda mine is on the north bank of Rogue river in the S. E. ¼ of Sec. 13, T. 34 S., R. 8 W., about 26 miles below Grants Pass, at an elevation of 600 to 1600 feet above sea level, the most important workings being at an altitude of about 750 feet. The mine is reached by a good stage road of 17 miles from Merlin, a station on the Southern Pacific Railroad.

The ore deposit on which the mine is located is especially valuable for its tenor of copper, but it contains also gold, silver, lead and a little zinc. The deposit occupies a zone of faulting along a contact between dacite porphyry and argillite, being confined chiefly to the former. The argillite or slate has been assigned to the Galice formation of the Jurassic period by means of fossils



Alice mine, main adits

(*aucella erringtoni*) found about 100 feet east of the Almeda mine. The contact between this argillite (in places a true slate) and igneous intrusive rocks (including dacite porphyry in places) has been traced by Diller from Briggs creek valley in T. 36 S., R. 8 W., for more than 20 miles to Reuben spur on the north line of T. 33 S., R. 7 W. In general its course is north-northeast and it dips steeply to the east, as the sedimentary formations do in this region. The fault on which the mine is located has not been traced continuously more than about 3000 feet, but it is so prominent it is locally known as the Big Yank lode. It strikes nearly due north and has a steep dip to the east.

The Almeda mine is more fully developed than any other mine in southern Oregon; this is due in part to the fact that it is remarkably well situated for systematic development, being in the narrow but traversable canon of a river which here gives a natural transverse section of the lode to a depth of at least 500 feet. The development, which consists of over 6000 feet of underground work, is therefore largely in the form of drift adits at five different levels. These are supplemented by a vertical shaft reaching a depth of 500 feet, with levels (not fully opened) at each 100 feet. The workings are shown in plan and in longitudinal section in the drawing. They open the deposit for about 1000 feet horizontally and about 800 feet vertically.

Although classified by Diller as quartz porphyry or alaskite, the porphyritic footwall rock of the Almeda mine contains phenocrysts of plagioclase and quartz in a matrix of plagioclase, quartz, epidote, chlorite, magnetite (ilmenite?), and possibly a little orthoclase, but clearly not much. Mineralogically it is therefore a dacite porphyry. The chemical analysis which follows fully confirms the microscopic classification.

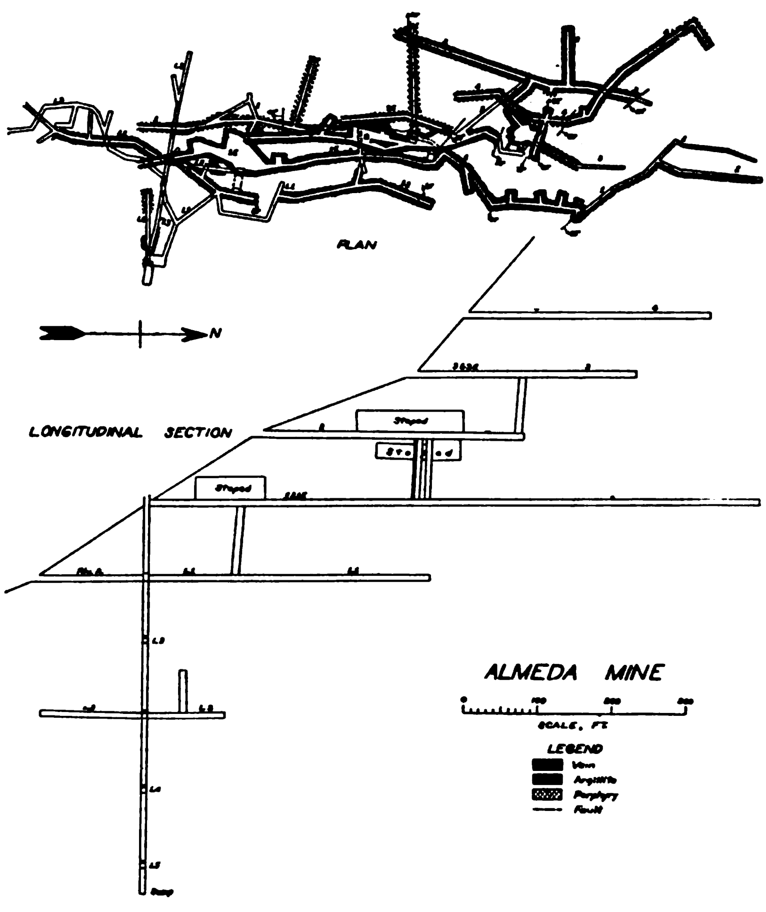
Composition of Dacite Porphyry Footwall from Almeda Mine

(S. W. French, analyst.)

SiO_2	55.92
TiO_2	.75
Al_2O_3	19.66
Fe_2O_3	1.94
FeO	4.76
MgO	5.27
CaO	5.77
Na_2O	3.26
K_2O	.38
H_2O+	2.90
H_2O-	.06
	100.67

Approximate mineral composition	
Quartz	15.6
Orthoclase	2.3
Plagioclase	56.4
Chlorite, Epidote	22.1
Magnetite	2.8
Ilmenite	1.4
	100.6

Adit No. 4 enters in porphyry; at 40 feet from the portal it passes into the vein which here strikes N. 48° E.; the first crosscut to the west terminates in the vein, which here strikes N. 4° E. and dips 86° W.; the crosscut eastward ends in a small porphyry dike in argillite, the dike striking N. 30° W. and dipping 60° N. E.; at about 150 feet from the portal the adit passes through a fault which strikes N. 55° W. and dips 60° N. E.; at about 120 feet farther on the adit again enters the vein with its normal argillite hanging wall; the



Plan and longitudinal section of the Almeda mine

same vein is doubtless continuous to the breast of the adit, as shown in the drawing, although it is not followed all the way by the working.

Adit No. 3 is in vein material on much of its course; 20 feet from the breast it cuts a fault with 2 to 3 feet of soft gouge which strikes N. 36° W. and dips 60° N. E.; the crosscut westward is in vein material and mineralized porphyry all the way; the crosscut eastward passes through 40 feet of porphyry and then enters vein material which grades into a stoped ore body.

Adit No. 3 East passes from argillite to porphyry at about 55 feet from the portal; the contact here strikes N. 20° E.

Adit No. 2 enters in vein material which opens into stoped ground at 140 feet from the portal; 120 feet farther on the argillite hanging wall comes into view beyond a fault which strikes N. 50° W. and dips 55° N. E.; 75 feet beyond the hanging wall is offset about 20 feet eastward by a fault which strikes N. 68° W. and dips 36° N. E.; at the breast the hanging wall of the main vein strikes N. 30° E. and dips 75° eastward.

Adit No. 1 enters in porphyry, passes through low grade ore between 40 and 75 feet from the portal; passes a fault which cuts off the porphyry 195 feet from the portal, the fault striking N. 89° W. and dipping 45° S.; and encounters the main slate hanging wall at about 525 feet from the portal; here the hanging wall strikes N. 15° E. and dips 40° E.; about 120 feet farther on the drift turns to follow a fault, which strikes N. 42° W. and dips 55° N. E., offsetting the hanging wall about 125 feet northwestward as measured along the fault plane. The crosscuts westward from this adit are in altered porphyry, probably somewhat mineralized; the longest one discloses a vertical wall at the breast which strikes N. 4° W. The southernmost crosscut to the east passes through porphyry into low grade ore about 15 feet from the main entry. The next crosscut to the east enters the argillite hanging wall, striking N. 10° E., about 30 feet from the main drift.

Adit No. 1 East passes into ore at 70 feet from the portal by penetrating the argillite hanging wall, which here strikes N. 12° E. and dips 70° E.; 150 feet farther on the entry passes into the hanging wall, from which it emerges into the vein material at about 350 feet from the portal; north of a raise nearby the hanging wall dips only 48° E. It is worthy of note that the lower the level the farther south are the stopes; indeed, the main ore shoot seems to be roughly parallel with the present surface.

Level No. 1 on the river adit is driven in argillite and slate for the most part; at 50 feet from the portal it reaches the hanging wall, which it follows to the breast, except for two stretches of 60 and 120 feet, respectively, which are in the argillite. On this level the hanging wall has an average dip of about 80° E.; near the breast it is locally overturned to a dip of 60° W.; the average strike is about N. 10° E., but it varies from N. 50° E. to N. 30° W. Very little stoping has been done on this level.

When the Almeda mine was visited in September, 1913, the levels below the river adit were inaccessible because they were filled with water. Therefore the following description of these levels is quoted from Diller's report:

On the 300 foot level, within a foot of the contact, the slates, usually dark, are baked light gray, and very hard. They are seamed with calcite, especially on the shearing planes. Rich copper ore was noted near the indurated slates on the 300 foot level, a short distance north of the crosscut from the shaft. The thickness of the principal ore body on the 300 foot level is about 15 feet.

I visited the 500 foot level and followed the crosscut from the shaft westward 96 feet to the end, collecting samples at both ends and at two intermediate points. By the shaft the rock is in some places impregnated with pyrite to such an extent that nearly one-fourth of the mass is pyrite. There is much less pyrite 12 feet from the shaft, and from that point to the western end of the crosscut pyrite, though present, is less conspicuous. The samples taken on the 500 foot level near the shaft and 12 feet west of the shaft were assayed by E. E. Burlingame & Company, who report a gold content of 20 cents a ton in each. One of the samples contained a trace of silver. The rock traversed by the crosscut for 96 feet west from the shaft on the 500 foot level is highly siliceous. The contact of the quartz porphyry with the slates on the 500 foot level appears to me to be at the foot of the shaft. In this view I have been confirmed by a microscopic study of thin sections of the rocks collected along the crosscut. The rocks still retain much of the original structure of the quartz porphyry impregnated with pyrite and are strongly contrasted with samples of the indurated slate found elsewhere in the mine. The absence of a considerable body of ore at the contact by the shaft on the 500 foot level does not necessarily mean that ore does not go down to greater depths, for according to the pitch of the ore shoots the ore should be looked for in the contact along the 500 foot level south of the shaft.

The ore of the Almeda mine has been produced wholly, or almost wholly, by replacement of porphyry. The argillite hanging wall is definite and in many places marked by 6 to 12 inches of fault gouge, but the footwall is quite indefinite, the ore grading into less and less replaced porphyry. The most important ore body is in general next to the argillite, but in places some ore is found in the porphyry, in which case both walls are indefinite, unless one wall has been produced by faulting.

The copper ore near the hanging wall has a gangue of barite with very little quartz and occasional seams of calcite. This ore contains the following minerals: pyrite, chalcopyrite, bornite, chalcocite, sphalerite (pyrrhotite?), galena, malachite, azurite, melaconite (?), native copper, native gold, barite, quartz, calcite, sericite, serpentine (?) and celestite (?). The last mineral seems to be in zones intergrown with barite in certain samples. Mr. Crouch, assayer at the Almeda in 1913, reported a little strontium in some of the ore. A sample from stope 1, adit 2, has barite, calcite, chalcopyrite and pyrite so intergrown as to be probably simultaneous in origin. A sample from adit 1 shows a veinlet of pyrite later than chalcopyrite and barite; another sample from the same adit shows veinlets and cement of later barite, doubtless "secondary." A sample from level 1 or the river adit shows primary intergrown barite, pyrite, sphalerite and galena, which completed crystallization in the order named. A sample of gypsum obtained from Mr. Crouch, the assayer, and said to come from the 300-foot level of the Almeda, is in thin section partly granular to subhedral and partly in long prisms; twinning is present, but not abundant.

The baritic copper ore is found in lenses or shoots lying near the hanging wall and generally 6 to 15 feet thick. But pyrite has penetrated the porphyry to much greater distances, and in some places it contains enough gold to make a low grade ore. Such ore is quite different from the baritic copper ore, being a siliceous pyritic gold-silver ore found west of the former, and more irregular in occurrence. If the whole mass of pyritized porphyry could be mined at a profit the future of the Almeda would be assured, because the pyrite extends in places at least 150 feet into the porphyry, but most of this material is too low grade to work.

According to Mr. H. P. Holdsworth, engineer for the Almeda Company in 1911, average analyses of the two types of Almeda ore are as follows:

AVERAGE ANALYSES OF ORES FROM THE ALMEDA MINE

	Baritic copper ore	Siliceous gold-silver ore
SiO_2	8.8 to 5.1	62.9
Al_2O_3	8.0 to 10.9	5.6
FeO		11.5
CaO	8.0 to trace	2.1
BaO		8.1
$BaSO_4$	47.8 to 28.2	
FeS_2	27.0 to 48.1	
$CuFeS_2$	6.4 to 6.8	
S		8.3

ASSAYS OF ALMEDA ORES

Copper	1.5 to 4.5 per cent	0.3 per cent.
Silver	3.3 to 12.2 ounces per ton...	6.4 ounces per ton.
Gold	0.12 to 0.42 ounces per ton...	0.14 ounces per ton.

The Almeda Consolidated Mines Company, owning the Almeda mine, built a 100-ton matting furnace at the mine in 1908. The first attempts to smelt the ore were not successful, but later results were more satisfactory. According to Mr. Holdsworth:

The furnace is 36 inches by 72 inches at the tuyeres and we averaged a little over 100 tons a day—that is, 100 tons of ore besides the coke and slag. Ran semipyritic smelting ore from 6 to 7 per cent coke. As the iron and barium occur as sulphide and sulphate respectively, there was about 26 per cent sulphur in the charge. Could average about 30 tons a day more when running semipyritic smelting than when running straight coke smelting. The following are typical slags:

COMPOSITION OF SLAGS FROM ALMEDA MATTING FURNACE

	1	2	3	4
SiO_2	30.9	31.8	31.1	38.9
Al_2O_3	10.6	13.5	9.9	4.7
FeO	24.9	24.0	25.3	22.3
CaO	3.1	3.9	4.8	1.3
BaO	30.4	26.9	29.1	32.9

Though the percentage of BaO and alumina is high, they run very well, with seldom a loss of 0.3 per cent copper; usually from 0.15 to 0.2 per cent copper. The ratio of concentration is from 12 to 1 to 20 to 1.

The Almeda mine is equipped with 3 gasoline engines of 175 H. P. and two air compressors having a capacity to run 23 drills, as well as an engine at the shaft to run the hoist.

The mine passed into the hands of Thomas S. Burley, receiver for the Almeda Consolidated Mines Company, on August 23, 1913. The company owns the Rand mine, across the river and south of the Almeda, and a placer mine near the Almeda. At one time it had an option on the Cold Spring claim near the Sugar Pine mine. The receiver opened the Almeda and ran the smelter for 3 weeks, producing 3 carloads of copper matte. He then shut down the furnace to make concentration tests on the ores and to build a concentrating plant.

The total production of the smelter during 1913 is reported to have been 6 carloads of matte, worth about $40,000.

A new company has recently been formed under the name Almeda Mines Company, with Thomas S. Burley as the president. The stockholders are much the same as of the old company.

The new company has given a lease on the mine to Mr. P. B. Wickham, who has been operating it since the summer of 1915. Mr. Wickham is stoping ore from the upper levels of the mine and running the smelter intermittently and shipping his matte to the Tacoma Smelting Company.

ALMEDA MINES COMPANY — GALICE DISTRICT — JOSEPHINE COUNTY

Articles of incorporation filed July, 1916, by Thos. S. Burley and S. C. Spencer, of Portland; Nat P. Ellis, of Waverly, Iowa; C. M. Huddle, of Dayton, Ohio, with office at Grants Pass. Common stock, $3,000,000; preferred stock, $500,000; par value $1.00.

See "Almeda Mine."

ALPS MINING COMPANY — NEVADA

Office: Portland, Oregon. H. W. Rand, 916 E. Taylor St., Portland, Pres.; C. S. Shea, 861 E. Main St., Portland, Sec. Capital stock, $150,000; par value twenty-five cents; capital stock all subscribed, issued and paid up. (1914 report).

This company's properties are located in the Ely mining district, Lincoln county, Nevada.

ALTA MINE (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Diller says:

The Alta mine on Josephine creek, 4 miles west of Kerby, consists of 3 claims. For some years the mine was worked only as a placer, but recently a lode mine was opened in the bluffs bordering the placer and a mill erected to crush the ore. The country rock is serpentine derived from peridotite and cut by a large dike composed of a rock related to dacite porphyry. The dike ranges from 25 to 40 feet in width between serpentine walls and is practically vertical. It strikes N. 40 degrees E. and has been traced by Mr. Wilson about a mile and a half. Many smaller parallel dikes of the same material cut the serpentine of that region, so that the relation of the ore-bearing rock to the serpentine is evident.

The ore is chiefly pyrite, occurring in scattered grains through the rock and more abundantly in small quartz veins, apparently with some chalcopyrite and possibly pyrrhotite. In some places when the rock is pulverized and panned it is found to contain not only pyrite but apparently considerable free gold. As the mine is in the early stage of its development, little is known of the distribution and extent of the disseminated ore. A good sample of the fresh rock with conspicuous blotches and scattered grains of pyritic ore in joints and veinlets of quartz was assayed by E. E. Burlingame and Company of Denver, for the Geological Survey, and it yielded 0.02 ounces in gold per ton. About a dozen sectional samples assayed by local assayers were reported to me by Mr. Wilson and they averaged about $5 in gold per ton.

A "Lane slow-speed Chilean mill" has been erected to crush the ore. The rock is first run through a breaker, and after it issues from the mill is run over plates to Johnson concentrators. The mill is run by a 25-horsepower steam engine and has a capacity of 40 tons in 24 hours. Mr. Wilson reports a satisfactory test run of about 500 tons, made in the fall of 1911, at a cost of 80 cents a ton by water power and $1 a ton by steam. After amalgamation and concentration the tailings are reported to show no trace of gold. The overburden of the mine is gravel, and during the winter the water is used for hydraulicking.

ALTAN MINING COMPANY (Wisconsin corporation) JACKSON COUNTY

This company filed declaration Nov. 20, 1916. Home office, 120 Wisconsin St., Milwaukee, Wis. Local office, Ashland, Oregon. George W. Barrow, Ashland, attorney-in-fact.

ALTON MINE ASHLAND DISTRICT JACKSON COUNTY

For description see "Barron Mine."

AMALGAMATED MINES COMPANY (gold) EAGLE CREEK DIST. BAKER COUNTY

Office: Baker, Oregon. Wm. Deffren, Pres.; W. Burnham, Sec.; G. J. Burnham, Treas., all of Spokane, Wash. Capital stock, $1,000,000; par value $1.00; all subscribed and paid up; $754,824 issued. (1916 report).

Lands: 8 quartz claims on Paddy creek, a tributary of Eagle creek. Considerable work has been done upon lens-like veins in sedimentary rocks.

AMERICAN ALMADEN QUICKSILVER & GOLD MINING COMPANY (mercury) OCHOCO DISTRICT CROOK COUNTY

Office: 100½ Fourth St., Portland, Oregon. W. B. McKinney, Pres.; E. N. Wheeler, Sec.-Treas.; G. W. Tillotson, Howard, Oregon, manager; Capital stock, $1,500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company has 3 claims, the Eldorado, Leroy and White Star, located near Lookout mountain in Sec. 20, T. 14 S., R. 20 E., about 11 miles from Howard, and about 25 miles from Prineville, at an elevation of about 6000 feet. The region is rugged and well timbered.

The country rock is probably andesite, in places considerably altered, in which the cinnabar ore occurs in narrow fissures, the extent and number of which were not determined.

Development work consists of several tunnels. There is a battery of 8 retorts to recover the mercury from the ore taken from the several tunnels.

ANDERSON GROUP CHINA DIGGINGS DISTRICT CURRY COUNTY

Articles of incorporation were filed with the Corporation Commissioner Aug. 25, 1916. Officers: John Hampshire, Pres.; F. F. Ryan, Vice-Pres.; J. G. Wilson, Sec.., Portland, Oregon; R. B. Miller, Treas., Grants Pass. Capital stock, $1,000,000; principal place of business, Portland, Oregon.

AMERICAN EXPLORATION COMPANY

See "Hustis & Anderson" group.

ANHYDREOUS MINES COMPANY

Articles of incorporation were filed with the County Clerk of Multnomah county Aug. 2, 1916. Capital stock, $100,000; the principal place of business is Portland, Oregon. The incorporators are Chas. A. Rice, Ambrose D. Fish and W. E. Rogers.

ANDERSON (G. E.) PROSPECT (gold, etc.) ILLINOIS RIVER DIST. JOSEPHINE CO.

Diller describes this property as follows:

> Mr. G. E. Anderson has recently opened a prospect near Illinois river and the mouth of Rancherie creek in greenstone close to the border of serpentine. The sheared belt of rock, 10 feet in width, carrying a fair grade of ore, runs N. 45° E. and dips 47° SE., approximately parallel with the neighboring contact. Irregular quartz veins occur in about 4 feet of this belt and yield some free gold when mortared and panned. The most prominent ore minerals are pyrite, chalcopyrite, and galena, so that the ore contains copper, lead, and possibly silver, as well as gold. Assays are reported from $1.80 to $180 a ton on picked samples, and the quartz is said to average about $9 a ton.

ANNALULU GOLD MINING COMPANY (gold) CRACKER CREEK DIST. BAKER CO.

Local name, Annalulu mine.

Office: Sumpter, Oregon. J. F. Rand, last Vice-Pres.; A. J. Trimble (deceased), last Sec.; Treas. unknown. Capital stock, $100,000; par value $1.00; amount subscribed, issued and paid up not known. (1914 report).

Six miles by wagon road from Sumpter, a station on Sumpter Valley Railroad (narrow gauge), on branch of Silver creek, in Sec. 6, T. 9 S., R. 37 E. Elevation, 5320. Lands, one patented claim, a fractional claim and millsite.

The North Pole-Columbia lode, according to W. Lindgren (p. 667), continues clearly marked across this property. This property was visited in 1914. The dump indicated that the shaft had been sunk for a few hundred feet, but little ore was to be seen on the dump, and general impressions were discouraging.

Lawrence S. Donaldson, of Minneapolis, Minn., says:

> Company has been inactive for several years. I don't know who the present officers are or where they can be found and cannot ascertain as a stockholder.

ARROWHEAD MINE (gold) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Arrowhead mine, 14 miles south of Grants Pass, near head of Powell creek, is owned by Mr. Wooster, and is at an elevation of about 2900 feet, as measured by barometer. The trail to the mine leaves Powell creek at a small reservoir. An adit extends S. 52° W. 58 paces, and thence S. 35° W. 20 paces to the breast. The last course is on a vein of quartz, which is 4 to 15 inches wide; pyrite occurs in the quartz and also in the greenstone wall rocks.

ARGO GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Argo group of claims is on the west side of Rogue river, about 2 miles below the Almeda mine. It is opened by 3 short adits near the river level, two of which are now caved shut. The other adit extends S. 37° W. about 70 feet and thence S. 57° W. about 20 feet. The country rock is a light colored somewhat schistose "greenstone," which on microscopic examination appears to be a dacite, probably tuffaceous. According to Diller, "Irregular quartz veins, stringers and kidneys occur in a belt about 3½ feet wide. They strike N. 28-35° E. and are generally vertical, but in some places dip 76° N. W." In the workings still open no distinct vein was seen by the writer. The Argo is equipped with a 16-ton rotary ball and tube mill and a water wheel; it has been idle for several years.

This group of claims is now owned by Bigelow brothers.

ASHLAND COAL MINING COMPANY ASHLAND DISTRICT JACKSON COUNTY

Coal on the north side of Emigrant creek has been opened by two incline shafts which are said to reach a depth of about 400 feet. They are now caved and filled with water. Near the surface the shafts dip about 25° in a direction N. 50° E., apparently following the dip of the coal. This outcrop is about 4 miles east of Ashland, and about a quarter mile east of Lithia Springs, which are on the south side of Emigrant creek. This coal is said to be owned by the Ashland Coal Mining Company (dissolved Jan. 3, 1912); it is in Sec. 7, T. 39 N., R. 2 E.. At the bottom of one incline shaft, which was said to be 425 feet deep on an incline of 27°, the following section was reported by E. D. Briggs, of Ashland:

Section at Slope of Ashland Coal Mining Co.

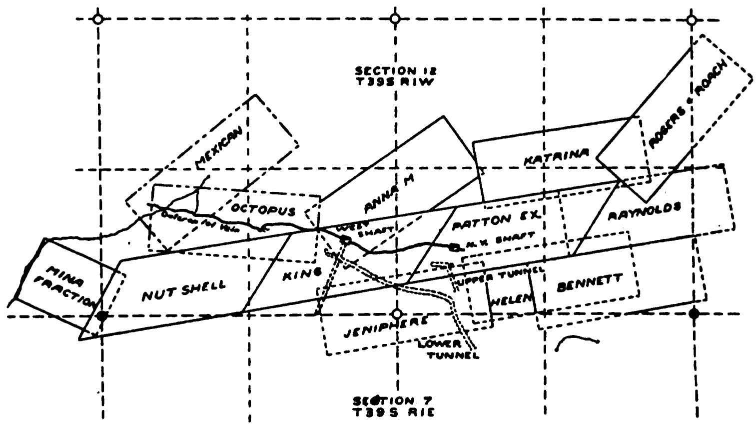
	Feet	Inches
Coal	1	
Coaly shale		3-5
Coal		6
Coaly shale		3-5
Coal		6
Shale with thin seams of coal	8	6
Hard smooth coal		10-12
Coaly shale		2-5
Soft coal		10-12
Section exposed	13 feet.	

The coal at this locality was said to be of a good grade. It was apparently sub-bituminous in character. In a report issued in 1909 J. S. Diller mentions this mine as in active development and states that the slopes opened two coal beds, one 12 feet and the lower 5½ feet thick, separated by 50 feet of slippery shale and shaly sandstone. He says further:

> The coal beds are made up of streaks of good coal locally 6 inches thick, and separated by coaly shale. The coal breaks out in blocks and contains a considerable percentage of sulphur. The disturbing feature at this prospect are irregular masses of old lavas, which appear not only in all the entries, but at various levels on the surface and in bluffs nearby along the creek. Where the coal is in contact with the lava the latter appears to be the older. The abundance and irregularity of these lava masses render the extent of the coal beds a matter of doubt.

ASHLAND MINE (gold) ASHLAND DISTRICT JACKSON COUNTY

The Ashland mine is opened by means of the West shaft, about 900 feet deep, as measured on the incline of about 38°, reaching a vertical depth of about 800 feet beneath the top of the ridge. It is opened further by an adit, crosscutting westward about 500 feet to the vein and drifting on the vein about 1500 feet to the shaft at a depth of 250 feet on the incline. The vein is also reached by the York shaft and an upper adit connected therewith. The chief vein has an average strike of N. 19° E. and a dip of about 40° E. There are two important ore shoots in the vein, one being opened by the York shaft and the other by the West shaft. Both pitch to the south and seem to converge downward. Most of the ore above the adit level has been removed. The vein is regular and persistent, varying in thickness from 2 to 12 feet; the quartz varies in thickness from 0 to 10 feet and occurs in lenses reported to pitch to the south. The vein varies only gently in strike and dip and is not faulted so far as open to inspection. It is in a country rock of coarse tonalite, fine grained diorite, hornblendite and mica schist cut by a few dikes of aplite. The aplite is much more abundant on the hillside east of the mine than it is in the workings.



Ashland mine, showing outcrop and main workings

According to information received from H. V. Winchell of Minneapolis, who examined this mine in 1899, there are several quartz veins on the Ashland ground, only two of which have been developed.

In size the veins vary from a foot to ten or twelve feet in thickness and some of their outcrops can be traced for considerable distances across the Ashland claims. Near the surface and to a depth of one hundred feet or more the veins are oxidized and the sulphides have been removed by leaching. Below this depth, however, the ore is still free-milling, showing that the gold is mechanically associated with the pyrite instead of occurring in such an intimate admixture or combination that the ore is refractory and only to be treated by some chemical process like smelting or cyaniding.

The vein filling is quartz and pyrite with more or less country rock. The walls are very smooth and well defined and there is always a gouge or selvage that makes easy mining or stoping of the ore.

The vein on which the greatest amount of development work and mining has been done varies in thickness from two to twelve feet. The ore is of two grades, shipping ore and milling ore. The shipping ore occurs in somewhat irregular shoots and bunches throughout the mine, and runs from $50 to $200 per ton in gold, averaging about $100. The milling ore carries from $3 to $30 per ton in gold and during the year 1898 averaged about $13 per ton. About 55 per cent of the gold is recovered from the plates, and about 10 per cent is obtained from the concentrates. The last ore milled produced concentrates worth about $75 per ton as compared with an average value of $50 to $60 per ton, indicating increased value with depth.

Two principal ore shoots are known in the mine, although a large portion of the ore outside of these shoots would pay for treatment, and although more or less scattered bodies of shipping ore are encountered everywhere in the vein, suggestive of similar and more continuous as well as larger bodies in depth.

The best defined and most regular ore shoot is that formerly worked through the York shaft and now producing ore in the upper and lower adits. This ore is largely oxidized and is worth from $25 to $40 per ton; the shoot pitches toward the south at an angle which decreases considerably about 200 feet above the lower adit.

Another ore shoot has been worked in the West shaft, and produced shipping and milling ores to the lowest levels reached. This ore was not so much oxidized, but in places it was very rich, some large masses showing free gold and rich sulphdies all over the fractured surfaces.

These two ore shoots seem to converge downwards and there is good reason to believe that they are either upward branches of one large ore body or that they will be found close together forming a large and rich deposit at greater depth.

According to J. P. Burrall, of New York, the ore north of the shaft was regular in quantity, but of rather low grade; south of the shaft the ore contained more quartz and pyrite and was of higher grade. Large bunches of pyrite were sorted out for shipment to a smelter. Near the shaft the ore was irregular both in quantity and value, but evidently grew better in both respects as the work progressed to the south. A mill run made in March, 1899, yielded about $40 a ton on the plates and a concentrate carrying about $325 a ton. At that date the development work was reaching an important ore shoot which pitched to the south. The high grade pyritic sulphide ore contained free gold, recoverable by panning, while low grade ore of similar appearance yielded nothing on panning.

Soon afterward the mine was closed by injunction proceedings brought by owners of adjoining ground, and very little work, aside from the construction of a 10-stamp mill, has been done since.

In 1898 and 1899 the ore from the Ashland mine was treated in a 5-stamp mill operated by water power. It was located at the city of Ashland, about four miles from the mine. The cost of hauling ore from the mine to the mill was between $0.75 and $1.00 per ton. Since then a 10-stamp mill has been erected at the mouth of the West shaft at an elevation of 3350 feet by aneroid. It is equipped with a 6 by 10 Blake crusher, two 5-stamp batteries, Challenge feeders, two 5 by 15 feet amalgamating plates in sections of 7½ feet, and two 6-foot Johnston vanners. The mill has been but slightly used. Both mill and hoist were operated by steam from a horizontal fire-tube boiler, which is still on the ground.

The prospects for making a valuable and important gold mine at the Ashland are very unusually good and it is to be hoped that difficulties in regard to ownership may be adjusted so that development may proceed.

This mine has recently been taken over by Mr. A. W. Bartlett, of Ashland, Oregon, and associates. Mr. Bartlett proposes to mine and mill a large tonnage of ore above the 250-foot level in the old stopes and in the wall rocks, where he claims sufficient mineralization has taken place to allow them to be worked with profit. Mr. Bartlett purchased a part of the mill machinery of the Braden mine and installed it at the Ashland during August and September, 1916.

AXTELL MINE (Moss Rose Group) (gold-silver) ELK RIVER DIST. CURRY COUNTY

In Sec. 8, T. 33 S., R. 14 W. A series of quartz mines in greenstone which strike N. 60° E. and dip 54° N. W., as shown in an open cut, where quartz veins up to 1 foot wide form a mineralized zone over 12 feet wide. Chalcopyrite in fair amounts scattered through quartz and pyrite in greenstone near veins.

BABY MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Baby mine is 9 miles southeast of Hugo on Corn creek, in the N. W. ¼ Sec. 16, T. 35 S., R. 5 W., on the east side of Walker mountain. It is owned by W. A. Sharp, of Grants Pass.

This mine was located in 1897, and is said to have yielded more than $20,000 worth of gold. It is equipped with a 2-stamp mill (formerly 5 stamps), with an 8-foot plate, a crusher, 2 concentrating tables and 2 boilers. It is opened by 2 adits with about 1500 feet of underground work. The main adit is a crosscut for more than 300 feet leading to about 500 feet of drifts. There are several quartz veins in gabbro country rock. The most important vein averages about 4 feet in width, but varies to fissure zones more than 10 feet wide. The vein strikes northwest and dips to the northeast usually at high angles, but locally at much lower angles. Faults are abundant; certain prominent faults strike N. 80° E. with a dip of about 50° W., or strike N. 45° E. and dip 50° S. E. The vein material consists of coarse vein quartz, partly brecciated, with a little calcite and some pyrite. Free gold occurs in the quartz. Sulphide concentrates are said to contain $75 a ton in gold. The gabbro country rock contains abundant labradorite and augite with some chlorite, clinozoisite, sericite and serpentine, and very little chalcopyrite. The mine has been idle for several years.

BACON AND MILLER GROUPS (gold) CHINA DIGGINGS DIST. CURRY COUNTY

These groups were not visited, but Diller describes them together as follows:

Recent strikes of the Higgins mine have greatly invigorated prospecting in that region, and numerous claims have been located near the same horizon to the south on Miller creek and Baby Foot creek, tributaries of the Chetco.

The Miller and Bacon prospects are on the ridge between Miller creek and Baby Foot. At the northern foot of this spur, along Miller creek, a mass of serpentine strikes nearly east and west and cuts the volcanic greenstones which form the body of the ridge. The greenstones are well exposed in the great bluffs overlooking Baby Foot, and are intruded by smaller masses of serpentine, off-shoots of the larger masses which lie at some distances on both sides.

Considerable quartz occurs in irregular veins or bunches in the greenstone, especially near the contact with serpentine, where it is impregnated with chalcopyrite and phyrrhotite. The veins strike in general about N. 60° E. and dip S. E. Their gold content is not evident, though it is said that assays show a considerable amount. The gold at present remains in the decomposed and rotten rock ready to be released by sluicing.

In the Miller Group of ten claims a portion of the contact has been sluiced. A ditch is being opened from Miller creek to the crest of the divide at an elevation of about 2,760 feet, for the purpose of sluicing the available auriferous residual material clinging to the slopes on both sides of the spur.

Although Diller does not mention the fact, it is evident from his map that the Bacon group is on the Miller creek side of the divide, while the Miller group is on the Baby Foot slope, about a mile southwest of the Bacon claims.

BADGER GOLD MINING AND MILLING COMPANY (gold, silver and lead) (California corporation) SUSANVILLE DISTRICT GRANT COUNTY

Local name, Badger mine.

The Susanville Commercial Company owns almost exclusive control of the Badger Gold Mining and Milling Company, the former being one of the F. W. Bradley interests.

The Badger mine is located in Sec. 8, T. 10 S., R. 33 E., on the south side of Elk creek, in the lower part of the present town of Susanville.

The country rock is slate, some of it so siliceous that it might be called quartzite. The vein strikes a little north of east and dips 60 to 70° south. The shaft is down 900 feet below the collar of the shaft and 400 feet below a 1600-foot crosscut driven from Elk creek. It is said that the principal ore shoot is 190 feet long and from 1 to 20 feet wide, with 10 feet of a massive irregular mixture of pyrite, arsenopyrite, zinc blende, galena, chalcopyrite and tetrahedrite, containing high values in silver and gold. It is also stated that both sorting and milling were practiced. Sorted ore was kept above $150 per ton. It is also said that the ore has been only partially stoped between the fifth and seventh levels, and has not been touched between the seventh and ninth.

This vein was discovered in the late '60s, and in the early '70s free gold was extracted in an arrastre from the decomposed croppings, which yielded about $25 per ton. Later on a 10-stamp mill, with concentrators, was built, but there was not a high percentage of extraction.

As a result of litigation, in which the Stockton Mining Company was the complainant, a decree (November, 1905) in the Circuit Court of the United States for the District of Oregon was handed down, which required that the Badger Mining Company, in order to mine on their ore body, which at depth is within the vertical side lines of the Stockton Mining Company's ground, must deposit with the clerk of the court all net proceeds received from the sale of ores, pending litigation to determine the ownership of the ore so mined. Following this order the mine was closed and nothing has been done to reopen the litigation since the date of the order.

BAILEY GULCH MINING AND MILLING COMPANY GALICE DIST. JOSEPHINE CO.

Office: Galice, Oregon. G. S. Smith, Pres.; D. J. Miller, Sec.-Treas., both of Philadelphia, Pa. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1912 report).

For description see "Golden Wedge Mine."

BAISLEY-ELKHORN MINE (gold) ROCK CREEK DISTRICT BAKER COUNTY

This mine is situated on the east end of a low spur from the divide between Pine and Rock creeks, near the head of Elkhorn gulch, a tributary of Pine creek valley, in Sec. 20, T. 8 S., R. 38 E., 18 miles west of Baker. According to Lindgren, it was discovered in 1882 and a mill was erected in 1889. The mine was sold in 1897 to the Eastern Gold Mining Company for $60,000, and, when consolidated later with the adjoining property, the Robbins-Elkhorn, was operated by the United Elkhorn Mines Company. It was closed down in October, 1907, and in September, 1914, was inaccessible. The following description is based upon reports and maps submitted by the present owner, Mr. William Pollman, of Baker, and supplemented by an examination of the surface.

The following statement of production may be incomplete, as there is no record of production from 1901 to 1905:

Prior to Jan. 1, 1898	$342,861.07
1898 to Dec. 1, 1900, 26,095 tons ore (bullion)	84,591.64
3,759 tons concentrates	239,529.84
472 tons shipped @ $45.03 per ton	21,254.04
1905, 20,000 tons crude ore, yielding 3000 tons concentrates	210,000.00
1907, 7,680 tons crude ore, yielding 1280 tons concentrates	38,481.00
1912, (Small production)	?
Total	$936,717.59

The mine was operated through a crosscut tunnel 626 feet long, which meets the vein at a point 265 feet below the outcrop. The shoot above the tunnel was exhausted before 1897 and deeper operations were continued through a shaft on the vein 400 feet deep.

The course of the vein is broadly an arc convex to the southeast, with an average strike over its known extent of N. 42° E.; the dip is nearly vertical.

Lindgren gives the following description of the vein:

The vein matter is confined between two well-defined walls, covered with polished gouge, but within these there are often subordinate fissures. Striations dipping 20° to 40° N.E. were observed on the walls. Sometimes the whole width of the vein is an altered diorite of small assay values. In the pay shoot the width is from 2 to 10 feet, many gradually fading seams running out on the north side. The ore streak on this width is a soft mixture of coarse sulphides with much crushed diorite and occasional streaks of quartz which show comb structure; in one place a 2-foot ore streak was adjoined by 10 inches of white barren quartz * * * On the 180-foot level, 700 feet south of the shaft, the vein which otherwise is entirely contained in diorite, gives sign of splitting up into stringers, and a black fine-grained hornfels appears, which is simply an argillite altered by the heat of the diorite cooling close to it. * * *

The gangue is normal vein quartz with some calcite. In general character the ore is soft and rich in sulphurets, concentrating in the proportion of 7:1. The sulphides, in order of their abundance, are pyrite, black zinc blende, galena, and chalcopyrite, all of which occur in irregular intergrowth with the gangue, the pyrite alone being sometimes crystallized. Ruby silver is occasionally found. The chief values of the ore are in gold which is partly—up to 25 per cent—free amalgamating, occurring in pyrite or intergrown with black zinc blende and calcite in form of pale yellow wires. Some of the brown zinc blende contains 160 ounces silver per ton and no gold, while some of the mentioned black blende contains much gold and no silver. The bullion is 700 to 750 fine. * * * Along with the ore is found some diorite converted to a white mass of sericite, calcite, and with small crystals of pyrite. This metasomatic product as a rule contains no pay.

The last material to be taken from the mine, reported to be from the fourth level in the shaft, shows lenticular masses of gray and milky granular quartz containing disseminated pyrite, blende and chalcopyrite, with which is associated a small amount of pyrrhotite and arsenopyrite. The quartz contains small roughly lenticular aggregates of gray sericite. The associations indicate the replacement by quartz and associated sulphide minerals of the granodiorite which forms the walls. Blocks of granodiorite show, on a small scale, the transition from fresh rock to a zone of sericitic rock along fractures that contain all of the minerals characteristic of the vein. Locally, terminated quartz crystals penetrate lenticular masses of calcite in such a manner as to show that calcite has filled a quartz-lined vug and was probably the last mineral to be deposited.

The vein is reported to be traceable for 1800 feet on the surface and has been explored for 1400 feet on the second level from the shaft. Within this distance two shoots have been found, the Baisley-Elkhorn, 850 feet long, and the Robbins-Elkhorn, 150 feet long. Both appear to have pitched directly down the dip of the vein. Though the former was stoped continuously to the third level 515 feet below the outcrop, the fourth level, 150 feet lower, appears to have found only sporadic masses of ore, which is thought by those who have observed the lower level to be the upper portions of lower shoots of ore. Plans are (1916) under consideration to drive a tunnel about 1 mile long to cut the vein 1500 feet below the outcrop and 625 feet below the lowest level to prospect these supposed shoots.

The ore produced during several periods has shown a wide range in value. Over the period 1898-1900 the extraction from 26,095 tons averaged $12.30 per ton, omitting 472 tons of shipping ore which yielded an average of $45.03 per ton. It would appear that most if not all of this came from the zones between the tunnel and second level in the shaft. The value for 1905 and 1907 was $7 and $5, respectively.

BAKER AND HERRIMAN PROSPECT (gold) BAKER DISTRICT BAKER COUNTY

These men have a small ranch and truck garden on Salmon creek near the Carpenter Hill mine in Sec. 8, T. 9 S., R. 39 E., and have done considerable prospecting along this creek with the hope of finding some of the veins which furnished the gold for the Nelson placers. Their most extensive working is a tunnel 600 feet in length, now partially caved, in greenstone. This tunnel was run to intercept the Young America vein.

BAKER AND MALHEUR OIL COMPANY MALHEUR COUNTY

Office: 614 Chamber of Commerce Bldg., Portland, Oregon. Paul S. Reeder, Pres.; Albert Backus, Sec.; J. W. Heiny, Treas., all of Portland, Oregon. Capital stock, $1,000,000; par value $1.00; $843,455 subscribed, $825,805 issued and paid up. (1913 report). Dissolved by proclamation in January, 1917.

BAKER MINES COMPANY (gold) CORNUCOPIA DISTRICT BAKER COUNTY

Local name: "Last Chance Mine."

Office: Cornucopia, Oregon. R. M. Betts, Pres.; Paul W. Gaebelein, Sec., both of Cornucopia; Jos. B. Thomas, Treas., 132 E. 19th St., New York. Capital stock, $800,000; par value $10; $518,500 capital stock subscribed, issued and paid up. (1916 report).

The following statement is from a previous report published by the Bureau in 1914:

Geology.—The Last Chance is the next vein of importance to the westward and higher up the mountain from the Union-Companion vein. The outcrop at the principal workings is at about 7000 feet, or 1000 feet above the principal outcrop of the Union-Companion vein. Horizontally the Last Chance vein is about 3100 feet from the Union-Companion vein.

The wallrock, in part, is granodiorite, similar to that found at the Union-Companion mine. In other places it is a dense dark green rock that was probably once an argillaceous sediment laid down between the old surface flows.

The striking point of difference between this vein and the others of the district is its location on both sides of an aplite dike that is older than the vein. This aplite dike, locally known as the "Forest dike," is probably the same as found alongside the vein in the Mayflower mine on the other side of the mountain.

Sufficient manganese oxide is present in the surface waters to precipitate on the joints and seams of the dike, black tree-like forms so characteristic of this element. These tree-like forms, which the mineralogist calls dendritic manganese, has caused the prospector to give this dike the apt name of "Forest dike." This dike has a greater amount of dark minerals than ordinarily found in aplite. Basalt dikes also break across both the vein and the aplite dike.

The Vein.—The strike of the vein is N. 20° E. and the dip 45° W. Massive white quartz, through which pyrite with a little chalcopyrite and zincblende are irregularly scattered, makes up the vein. Whether the walls of the vein are of schist, granodiorite or aplite, they are bleached and sericitized, such as is ordinarily found next to any vein made by ascending hot waters.

The stoping width of the Last Chance vein probably averages at least five feet of higher average grade of ore than found so far in the other properties.

It seems probable that the refissuring in the general plane in which the aplite dike had been placed broke the aplite dike in the same way that the Union vein was broken to receive the basalt dike. On the Union-Companion ground the vein was broken to receive a dike. On the Last Chance ground the dike was broken to receive a vein.

Further similarity probably exists in that the refissuring alternated from wall to wall of the dike like the refissuring of the Union-Companion quartz vein. Doubtless at some points it may have loosened the dike along both walls and shattered it in many places. Similarity as to fracturing is pronounced. Here the analogy ceases.

The molten basalt intrusion into the Union-Companion vein cooled rather quickly, but even if it should not have done so, it nevertheless would have had but little effect on the simple quartz of the vein, always slow to alter. Alteration of the walls of the basalt dike are practically negligible. But in the Last Chance vein they are altered, whether it be schist, greenstone, granodiorite or aplite dike. All the rocks except the crosscutting basalt dike are considerably altered next to the vein. The aplite dike especially so, because it was a thin sheet between two walls subjected to compression and movement. This together with its being very fine grained, caused more shattering, therefore more area within it to be subjected to the action of hot ascending waters.

The aplite dike and the Last Chance vein are seen on the surface to be probably several claims in length. The stope lengths are about 300 feet in a development of the vein of not much more than 600 feet with much of the latter distance unfruitful because of a failure to determine the form of a thick irregular basalt dike that cuts the vein. Doubtless when the interrupted vein is found on the other side a good shoot of ore will be discovered. The considerable horizontal length, the good width of the vein, the length of the stopes, the persistence of fair values with frequent bodies of high values, the nature of mineralization of the vein, and the pronounced alteration of the walls all indicate the likelihood of a continuation of shoots of ore to considerable depths.

Mine Development.—We do not possess maps of the mine showing its present development. The following description shows less than the present amount of work done, although it gives a fairly good idea of the development accomplished. This is a description of the work completed up to 1903.

The Last Chance vein is developed by an adit tunnel, driven south on the vein for a length of 690 feet. This tunnel undercuts the vein at a maximum depth below the surface, on its dip of 500 feet. At a point in the tunnel 105 feet from its mouth, a shaft is sunk on the vein to a depth of 265 feet. From this shaft, two levels are run on the vein, at a depth of 100 feet, level drives are run north and south on the vein 270 feet and 180 feet respectively, and at a depth of 200 feet level drives are run on the vein 375 feet and 270 feet respectively. From the north level drives a cross-cut 296 feet is run to the surface, for the purpose of drainage and ventilation.

Since that time this property, until 1914 a part of the Cornucopia Mines, was operated only in a small way by the company or by leasers. These operations were spasmodic and did not extend the development to any great degree. The last work, which was done by leasers milling their ores at the Union-Companion mill, was successful in finding ore of sufficient grade to stand the heavy expense of wagon transportation to the mill. Unfortunately for them, their lease expired November 1, 1913, which came too soon after the finding of the rich ore to get more than a small part of it to the mill to reap the profit for themselves.

The finding of larger and better grades of ore than were already known to exist encouraged certain western and New York persons, largely of the same group already in the Cornucopia Mines Company, to form a strong leasing company to take over the Last Chance vein. This new company, with John M. Baker as general manager, is called the Baker Mines Company. It perfected its organization last winter and arranged for the financing of the development work in the mine, the erection of a surface plant at the mine, an aerial tramway, a water power plant, and a 20-stamp mill with a sand and slime cyanide plant. This work was started early in the spring and late in October they commenced to mill their ore.

They have also acquired claims adjoining them in the Bonanza basin, upon which it is said the development is decidedly encouraging.

Aerial Tramway.—The ore is conveyed to the mill by means of a Bleichert aerial tramway 5500 feet long. The difference in elevation between the loading and discharge terminals is 1675 feet. There are only two intermediate supports for the cable. The upper span has two locked-coil track cables 616 feet long, one is 1⅛ inches in diameter and the other ⅞-inch. The middle span has two similar cables, each 1410 feet long; while the third span has two cables 3210 feet long of 1⅜ inches and 1⅛ inches in diameter, respectively. This span has a clearance of over 500 feet above the bottom of the gulch. The traction rope used is made of special cast steel. This tramway when operated at a speed of 500 feet per minute has a capacity of 15 tons of ore per hour.

Mill Practice and Flowsheet.—The ore is dumped from tram buckets onto grizzlies, the undersize falling into a bin and the oversize passing to a No. 3 Austin gyratory crusher. Twenty stamps are employed in crushing to "so-called" 25-mesh. About 25 per cent of the values are recovered on the plates, which are eight feet in length and have a slope of 2 inches to the foot. After passing through a mercury trap the pulp is treated by a Dorr classifier. The sands are leached in 30-foot vats, the slimes passing to a 30-foot Dorr thickener, and from thence to two 20x16 Dorr agitators. The slime is again thickened in a 20-foot Dorr thickener, diluted and again thickened in a 30-foot Dorr thickener. The reason for the use of two thickeners is because of the necessity of obtaining a large amount of dilution owing to the high value of the slimes. From the last thickener the pulp goes to a 20x16 Dorr agitator used as a stock tank for a Portland filter. The precipitation is with zinc-dust and Merrill zinc presses.

Since the above was written the mine has been producing steadily and profitably. Development has been continued at the mine with a satisfactory increase in proven ore. There has also been substantial additions to and improvements at the surface plants at both mine and mill. Frank S. Baillie, who was the managing engineer of the Columbia mine for so many years, succeeded John M. Baker as manager of the Baker mine on August 1, 1916, where he will doubtless use the same degree of business and enginering skill which kept the Columbia mine in profitable operation for so many years.

BALD MOUNTAIN MINING COMPANY (Maine corp.) (gold)
CRACKER CREEK DISTRICT BAKER COUNTY

Local name, Bald Mountain mine.

This company filed articles of incorporation March, 1916, with a capital stock of $100,000. George N. Putnam, Pres., 35 Congress St., Boston, Mass.; A. D. Sargent, Sec.-Treas., 295 Central St., Lowell, Mass.; Chas, J. Wier, Vice-Pres., 103 Central St., Lowell, Mass.; Chas. A. Johns, Yeon Bldg, Portland, Ore., attorney-in-fact.

The Bald Mountain mine is on the northeast extension of the Ibex vein, in Sec. 3, T. 9 S., R. 36 E., and is said to be similar to it in every way, with the exception that there is a greater proportion of quartz to argillite between the walls. Since the mill was built in 1901 and operated for 4 months, very little has been done upon the property.

In March, 1916, the mine was reported bought and made a part of the Ibex mine. This vein can best be developed and operated from the east side, as a greater depth can be secured by tunnel, and it will also avoid a long grade over the divide.

BALLARD GROUP (copper) HOMESTEAD DISTRICT BAKER COUNTY

These claims are on Ballard creek, about one-half mile west of Snake river from Ballard's landing. The country rock is altered volcanic breccia. The ore minerals are chalcopyrite and its oxidized products, malachite and azurite. Some development work was done upon this group under lease and bond during the season of 1916, but the results have not been announced.

BALTIMORE GOLD MINING COMPANY BOHEMIA DISTRICT LANE COUNTY

Office: Cottage Grove, Oregon. Ed Jenks, Cottage Grove, Pres.; F. J. Hard, Eugene, Sec.-Treas. Capital stock, $2,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report). Company owns 9 claims.

BANFIELD MINE (copper) DREW CREEK DISTRICT DOUGLAS COUNTY

Property consists of 9 claims, located in southern Douglas county, about 35 miles southeast of Riddle and 4 miles south of Drew postoffice, at the head of Drew creek, one of the branches of the south fork of the Umpqua river, in Sec. 34, T. 31 S., R. 2 W. There is a good wagon road to the mine up the South Umpqua by way of Drew. The elevation is 2400 feet.

The property has had a great deal of development work done, several tunnels having been driven aggregating several thousand feet. It is on a schist belt several hundred feet wide. The general direction of shearing movement was north-south and dipping steeply to the east.

The minerals are chalcopyrite and pyrite irregularly distributed through the schist in grains and lens-shaped masses, varying from pea size to an inch or more in thickness, showing by their shape and occurrence that they were formed either previous to or during the movement which produced the schist.

No definite information concerning the average copper content in the workings is available. The occurrence is such as to suggest the advisability of systematically drilling the schist to determine the extent of low grade ore.

BANNER HILL MINING COMPANY **DOUGLAS COUNTY**

Office: 506-7 Stock Exchange Bldg., Portland, Ore. J. C. Ritter, Pres.; W. A. Kuykendall, Sec.; Frank Fisher, Treas., all of Portland, Ore. Capital stock, $50,000; par value $1.00; all subscribed, issued and paid up. (1915 report). Company owns the Banner Hill quartz claims and 6 placer claims.

BANZETTE MINE (gold) **GREENHORN DISTRICT** **BAKER COUNTY**

The Banzette is a little over a mile west of Greenhorn and is in a soft decomposed serpentinoid rock containing vein quartz, a little galena and some chalcopyrite, and some high grade gold ore. This property is idle.

BARR PROPERTY **OPHIR DISTRICT** **CURRY COUNTY**

See "Ink & Barr" property.

BARRON MINE (gold, etc.) **ASHLAND DISTRICT** **JACKSON COUNTY**

The only important deep mine in the Ashland district which is not chiefly valuable for its gold is the Alton or Barron mine, which contains much zinc and some lead, copper and silver. This mine is situated about 3 miles north of Soda Springs on a branch of Emigrant creek, locally known as Sampson creek. It is opened by a crosscut entry extending N. 50° E. about 210 feet to the vein on which drifts are driven both ways, that to the eastward for 235 feet, and that to the westward about 270 feet. The vein material is about 16 feet thick where it is cut by the crosscut, which extends beyond about 80 feet. The vein contains much quartz, fault gouge and sulphides of iron and zinc, with occasional stibnite and realgar. It occupies a fault with a series of volcanic flows on the northeast side and a massive igneous rock (probably auganite) on the southwest or footwall side. The vein strikes S. 55° E. and dips about 80° N. E.; about 30 feet southeast of the crosscut it is cut off at a sharp angle by a vein which strikes S. 25° E. and dips about 80° N. E. The later vein is said to contain stibnite along the footwall and realgar along the hanging wall. The intersection of the two veins seems to pitch steeply to the southeast. A selected sample of ore from this mine is reported to have yielded 44 per cent of zinc, 29 per cent of sulphur, 14 per cent of silica, 5 per cent of lead, 1.5 per cent of copper, 1.4 per cent of iron, 1 per cent of alumina, 0.6 per cent of manganese, 268 ounces of silver, 14.20 ounces of gold, and a trace of antimony. But 60 tons of ore sold for about $530. The minerals observed in this ore include quartz, calcite, sphalerite, pyrite, galena, chalcopyrite, stibnite, realgar, malachite, native gold, wire silver, gypsum and probably pyrargyrite. The tunnel reaches a depth said to be 200 feet; a winze extends 50 feet deeper, and a raise runs to the surface. Near the surface the ore is richer and much thicker, perhaps due to mineralization between the two veins. Very little stoping has been done at this mine.

BATTLE BAR PLACERS **MULE CREEK DISTRICT** **CURRY COUNTY**

Diller describes this property as follows:

> At Battle Bar, on the left bank of Rogue river a little above the mouth of Ditch creek, a terrace 20 to 25 feet above the river is capped by gravel that has been tested by a small placer and said to yield good values. I saw it only across the river, but the deposit appears to be similar to that of Winkle Bar a mile farther down the river.

BEAVER HILL COAL COMPANY (California corporation) (coal) **COOS BAY DISTRICT** **COOS COUNTY**

Local name, Beaver Hill mine.

Office: 870 Market St., San Francisco. W. R. Scott, Pres.; G. L. King, Sec.; W. F. Ingram, Treas., all of San Francisco; A. J. Sherwood, statutory agent, Coquille, Oregon; W. F. Miller, agent, Marshfield, Oregon. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Located at Beaver Hill, about 12 miles south of the town of Marshfield.

This company is controlled by the Southern Pacific Railway, and property is under the management of Mr. L. A. Whereat.

This mine has been a steady producer of coal for many years. The bed at present being mined yields about 5 feet of coal, having two partings of clay material, dividing the coal bed into three seams. The lower seam is about 2 feet thick, the middle seam some 30 inches thick, while the upper seam usually runs about 8 inches and is often left as the roof. The coal bed dips to the southeast nearly 30° at the collar of the shaft, becoming flatter as one goes down, until it is less than 20° at a distance of a little more than 3000 feet down the incline.

Development work of earlier years in this mine was confined to sections within 400 to 500 feet of the surface. Present development work, however, is several hundred feet farther into the ground, the incline shaft having been driven to the limits of the property and the coal mined by a sort of retreating system.

The coal is a good grade of sub-bituminous variety, the analysis of which is as follows:

	Total moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Air drying loss	Heat value BTU
Mine sample	16.10	31.10	39.63	13.17	.81	8.1	9031
Moisture free	....	37.07	47.23	15.70	.97	....	10764
Moisture and ash free	....	43.97	56.03	....	1.15	....	12769

The mine has some good equipment operated by steam power, consisting of an automatic tipple of the latest improved type, screen, sorting table, Sullivan washer and trommel. The plant has a capacity of about 150 tons per day. The company employs about 35 men, with an average production of approximately 1600 tons of coal per month. It produces 3 grades of coal—lump, nut and pea. The pea coal is practically all consumed at the mine for power purposes and represents about 30 per cent of the total output. The mine is also equipped with a ventilating fan of the suction type 16 feet in diameter and 4 feet wide, making 125 revolutions per minute, a large steam hoist and two 100-kilowatt generators for the lighting system.

BEAVIS MAY OIL COMPANY **WASCO COUNTY**

Office: 617 Medical Bldg., Portland, Oregon. Dr. J. B. Keefer, Pres.; Z. N. Trine, Sec.; George A. Beavis, Treas., all of 617 Medical Bldg., Portland, Oregon. Capital stock, $125,000; par value $1.00; all subscribed and paid up; issued, $106,187. (1916 report.) $5576.94 expended in development in 1915.

BEE HIVE MINING COMPANY (gold) **GOLD HILL DISTRICT** **JACKSON COUNTY**

Local name, Bill Nye mine.

Office: Gold Hill, Oregon. George P. Blanchin, 37 Rue Godot de Mauroy, Paris, France, Pres.; Frank C. Bellamy, Gold Hill, Oregon, Sec.; Rene Bordier, Seine, France, Treas. Capital stock, $500,000; par value $1.00; $250,000 subscribed and paid up, none issued. (1916 report).

This company owns 4 claims, the Bill Nye, Bliss, Bliss Extension and Montana, in Sec. 4, T. 37 S., R. 3 W., 3 miles south of Gold Hill on Galls creek, about a mile nearly due south of the Braden mine. It is opened by several adits and a vertical shaft. A considerably anamorphosed impure quartzite is a common country rock; it contains abundant fine grained quartz in patches and layers, and abundant green hornblende and brown biotite with some untwinned interstitial and enclosing plagioclase and a little magnetite; the texture is globulitic to irregular. The vein on which the shaft is located strikes N. 52° E. and is nearly vertical; it contains about 2 feet of quartz. The main adit is about 400 feet long; it is on small veins and stringers near the portal, but crosscuts to the northwest open a somewhat larger vein of quartz which strikes S. 60° E. and dips 80° N. E. The country rock is pyritized and somewhat silicified. In the Bliss adit a vein striking N. 75° E. is cut off about 80 feet from the portal by a fault which strikes N. 30° E. and dips about 40° S. E. Another fault in the same working on a level 80 feet higher produces a horizontal offset of 6 feet to the north, the fault striking N. 14° W. and dipping 55° E., as shown in the illustration.

There is a 5-stamp mill upon the property, but the mine has been idle since August, 1914.

BEESON MINE (coal) ASHLAND DISTRICT JACKSON COUNTY

In Sec. 16, T. 38 S., R. 1 E., a coal seam has been opened by Emmett Beeson, of Talent, by means of a slope or incline shaft following the coal nearly on its dip. This coal outcrops in a ravine at the foot of a sandstone cliff at an elevation of about 2600 feet. Fossil impressions of leaves were collected from shaly sandstone at an elevation of about 3050 feet near the top of the cliff a little south of east of the coal seam. The sandstone strikes about S. 45° E. and dips about 25° N. E. at the place where the fossils are found. The coal seam has a strike of N. 53° W. and a dip of about 16° N. E. The slope opening this coal discloses a fault at 70 feet from the portal, which strikes N. 10° W. and dips about 62° E. The hanging wall of the fault is displaced vertically downward about 6 feet. At about 120 feet from the portal the coal seam is narrowed to about 3 inches by the doming up of the floor; at the breast, about 130 feet from the portal, the coal is again nearly 2 feet thick.

The section at this outcrop follows:

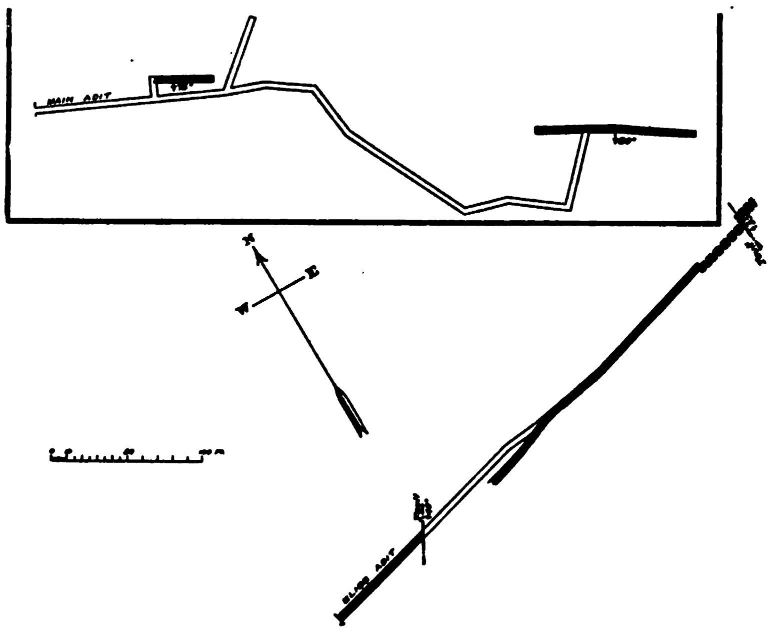
Section at Beeson's Slope in Sec. 16-38-1 E.

	Feet	Inches
Feldspathic sandstone	10	
Shaly sandstone with fossil leaves		6-8
Feldspathic conglomerate sandstone	400	
Covered	5	
Feldspathic conglomerate sandstone	6	
Fine grained sandstone		2-4
Coal		1
Coal and coaly shale	1	3
Coal		3
Fine grained sandstone	8	
Feldspathic conglomeratic sandstone	42	
Coarse quartzose conglomerate	10	
Feldspathic conglomeratic sandstone	20	

According to J. S. Diller, several coal seams have been opened by D. P. Greninger by means of shallow workings about 4 miles north of Ashland. He states that the coal seams increase in thickness and improve in quality to the northeast, although the openings are not sufficiently extensive to determine their value. No lavas nor faults were disclosed by these workings, which furnished a few tons of coal for local use.

There is a coal prospect on W. C. Butler's ranch in T. 38 N., R. 1 E.; it is opened by an adit, now caved, said to be about 200 feet long. The croppings show thin seams of coal in a shale and shaly sandstone. A few impressions of leaves were observed in the shale, but they were too imperfect to be useful in determining the age of the beds.

Summarizing these observations, it appears that coal seams are found more or less continuously from northwest to southeast across the Ashland district. There are several seams of coal, of thicknesses varying from an inch to several feet. The coal improves in quality and quantity down the dip, which is toward the northeast. It is not now in use, but by means of further development it may become a source of fuel for local use and perhaps a source of power through its use in making gas.



Bill Nye mine, main adit and Bliss adit

BELMONT MINE (gold) GREENHORN DISTRICT BAKER COUNTY

A high grade gold vein near Greenhorn, owned by Gilkey and Kershaw, which has attracted much notice during the last 2 years because of its rich pockets.

BENTON GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

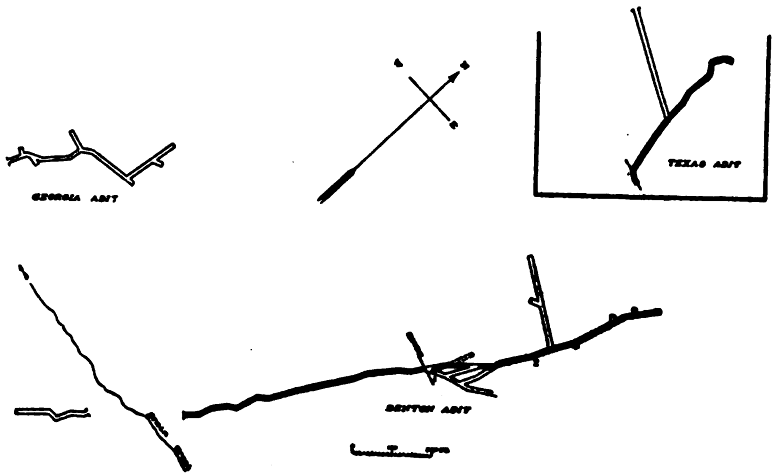
The Benton group consists of 8 claims, situated on Drain creek, a branch of Whiskey creek, in T. 33 S., R. 8 W., near Mount Reuben. There is a good camp of half a dozen buildings, at the mouth of Drain creek, which are still in good repair, although the last work done here was in 1905.

It is now owned by L. A. Lewis, of Portland. It is connected with Glendale, via Reuben Spur, by a good wagon road.

The main adit is a drift following a vein for 600 feet to a fault, which strikes N. 70° W. and dips 85° S.; about 100 feet farther on the adit picks up a vein again, which it follows for about 500 feet. This vein is also opened by an upper adit for about 800 feet. The ore has not been removed. Assays said to have been made by Mr. Bishop, former superintendent of the Greenback mine, are reported as follows:

	Per ton
Upper adit, 40 samples taken.	
Average value of ore from portal to raise 2	$5.32
Average value of ore from raise 2 to breast	4.42
Main Benton adit, 127 samples taken.	
Average value of 34 samples between portal and point 47 feet N. E. of rise 1	2.75
Average value of 43 samples between same point and main crosscut	4.30
Average value of 50 samples between main crosscut and breast	1.80

The Texas adit of the Benton group crosscuts 300 feet to the vein, which is opened by a drift each way; to the south it is cut off by a fault (dipping 50° northerly) about 150 feet from the crosscut entry; to the north it is displaced slightly by another fault about 50 feet from the crosscut. While the latter fault causes little displacement, it twists the hanging wall so much as to locally cause reversal of the dip of the vein; normally this vein dips about 40° east, locally it dips west. The strike of the fault is not shown in the drawing, because it is somewhat indeterminate; in one place it seems to strike N. 47° W. and dip about 60° N. E. Near and for some distance south of this fault the vein has 1 to 3 feet of solid quartz; northward a much smaller vein is



Benton group, chief workings, veins in solid black

exposed. The raise shown in the drawing inclines upward at an angle of 30° and reaches the surface about 100 feet above the adit level. The country rock of this adit is tonalite.

The Georgia adit of the Benton group is quite irregular, as shown in the drawing, and discloses no important vein. Its longest straight course is along a sheared zone about 3 feet wide showing very little quartz.

Tonalite (locally called "gabbro") is present in this region, not only in the Texas adit, but also at the face of the long crosscut (called "Georgia crosscut") from the main Benton adit, where the rock is sheared and contains quartz stringers running in various directions. The minerals present include abundant plagioclase and quartz with some chlorite, epidote, rutile, calcite, sericite and pyrite.

BEN HARRISON MINE (gold and silver) GREENHORN DISTRICT GRANT COUNTY

The Ben Harrison mine is located near the headwaters of Clear creek close to the northwest corner of Sec. 36, T. 9 S., R. 34 E. It is 23 miles by wagon road from Whitney and 28 miles by wagon road from Sumpter. These are stations on the Sumpter Valley, a narrow gauge railroad.

The elevation of the working tunnel is about 6500 feet. The country rock is a medium grained slightly porphyritic "tonalitic" granodiorite. The granodiorite is cut by what are probably granodiorite porphyry dikes. About a mile northeast of the mine on the same branch ridge of the intrusion which extends out toward the Red Boy mine is an exposure of badly altered rock. The roughly parallel attitude of the hornblende crystals and the glassy nature of its feldspars suggest that this rock may have been a flow of dacite, the effusive equivalent of granodiorite. In any case it is genetically connected with the granodiorite intrusion and may have been caused either by a volcanic eruption or else a foundering of the roof of the Greenhorn intrusion, which had stoped its way so close to the then existing surface that a portion of the roof of ancient rocks broke loose and was submerged, permitting the molten rock to flow out.

Aplite dikes abound in the granodiorite and vary in size from an inch or less up to a foot or more in width and some of them, probably the last ones formed, have such a decreased amount of feldspar that they approach quartz veins in composition, but are not mineralized.

About one-half mile south of the Ben Harrison mine and crossing the saddle of this north and south branch of the main ridge is a body of older rocks which at the apex of the ridge is nearly one-half mile wide. This older rock is greenstone and greenstone schist. Its contact with the granodiorite on the north and south sides was not fully observed, but underground in the Ben Harrison mine inclusions of greenstone were noted in the granodiorite, proving that these greenstones are the older rocks.

This greenstone is a very fine grained, badly kaolinized and sericitized rock containing considerable secondary quartz and chlorite. It was probably originally a basalt. The schists are fine grained, consisting chiefly of biotite and apparently secondary quartz with a few garnets. This rock is probably also of igneous origin. This greenstone schist is surrounded on all sides by granodiorite, indicating that it was a downward projecting portion of the roof of older rocks, the main body of which has since been eroded. A great many good sized veins are found exposed in this greenstone, which have been prospected from time to time, the oldest of which is the "Potosi."

The Ben Harrison vein strikes N. 3° E. and dips 67° E. and is lenticular in shape both along its strike and dip. Its minimum width of gouge and altered rock is about 18 inches and its maximum 21½ feet.

The length so far stoped above the 200-foot level is about 400 feet; above the 350 and 500-foot levels the stopes are about 300 feet long. On the 600-foot level the vein has been drifted upon for 350 feet, which at the south face is 12 feet wide and the north face 6 feet wide and averaging 68 inches for the 350 opened up. This is the same average width for the length of the drift as is the 500 stope on that level. The average stoping width for the entire mine so far opened up is 77 inches, and the lowest level, the 600, has good faces of ore both north and south and will likely exceed all other levels in tonnage-feet. Its average value is between 19 and 20 per cent higher than the average value of the ore in the rest of the mine, which averages a little above $10 a ton for the 87,000 tons blocked out on at least three sides above the 500-foot level.

The vein, a brecciated replacement, between the gouge on both walls is made up of fragments of granodiorite up to a foot or so in diameter, surrounded by vein quartz up to six inches wide. The fragments themselves are much silicified and cut by minute reticulate veins. The ferro-magnesian silicate minerals are entirely decomposed and the feldspars largely kaolinized. Calcite, probably derived from the country rock, is present. The same alteration occurs in the wall rocks to a lesser degree, but this alteration of the wall rock is greatest next to the widest part of the vein.

The outcrop of the vein is inconspicuous and is at a narrow portion of the lens, where it is only about two feet wide. At the surface it shows a typical sheared character and mineralization. Quartz, limonite and kermesite, the red oxide of antimony, were observed there.

Several branch and parallel veins, some of which are of considerable economic importance, from which high grade shipping ore is often taken, have been developed during 1915 and 1916. These veins, particularly the one locally called the "split vein," but in reality a continuation of the main vein, are showing up good bodies of milling ore and bid fair to multiply the tonnage available for each level.

The ore minerals are pyrite, stibnite, a little chalcopyrite and sphalerite. The silver sulphides are pyrargyrite and stephanite, with gold of about equal value to the silver in the ore. The gold values in the various parts of the shoot so far opened up remain reasonably constant, but the silver values are quite variable. The good silver ore is in horizontal layers, a streak of lean and a streak of fat, as it were. The silver values vary also greatly between the foot wall and hanging wall. There are many thin lenses of considerable wall area more often on the foot wall, though frequently on the hanging wall and occasionally between walls or else in branch veins into the hanging wall. Sometimes these sulphide sheets are almost pure stibnite with only a moderate silver content, while in other places they consist of quartz and disseminated stephanite, the black brittle sulphide of silver and antimony, in which there is present a small amount of pyrargyrite.

There is also a wide variation in the silver content along the strike of the ore shoot. For instance, upon the lowest level, which is only partially developed, the average gold content north of the shaft compared with that south differs only 14 per cent, while the silver content has fourteen times as much in one as in the other.

This vein was formed by hot waters coming directly from the interior of the intrusion. This hot water, using the fissure as a channel, percolated through the brecciated rock in it, which at the beginning was unaltered. The moderately high temperature ascending water, together with the material in solution, brought directly from deep-seated sources or extracted from the deeper parts of the channel, possessed a vigorous altering effect upon the fragments of granodiorite and the wall rock. They kaolinized the feldspars and the ferro-magnesian silicates were broken down so that now we have the softened badly altered fragments and wall rocks. At the same time that the hot ascending waters were metamorphosing the wall rock and brecciated granodiorite in the vein, it was also depositing the quartz in between the fragments and silicifying their interior, and was also bringing iron, antimony, silver, some copper and zinc, and gold in solution. Lessened temperature and pressure, together with changes in the nature of the solution itself when it reached the upper few thousand feet of the vein, caused a deposition in the vein of the gold and various other metals in their present form as sulphides.

This locality is undoubtedly a glaciated basin. The oxidation in the vein is very shallow and every appearance of the hard silver ore in quartz leads one to conclude that this ore is a primary and not a secondary ore of silver, and therefore the development of this silver-gold ore is not in a zone of secondary enrichment which will, a short distance below the lowest level, become lean in silver values. We conclude, rather, that any changes in the silver content below the 600-foot level will be due to some other factor in ore deposition than to the leaching of silver from the upper part of the vein to deposit it below, forming what is called downward sulphide enrichment.

The mine was equipped with a gyratory crusher, 20 stamps, a tube mill, Richard-Jenney classifiers and Isbell vanners. The concentrates were hauled to Whitney at a cost of $8 per ton when the roads were good, but in the fall and spring the roads are almost impassable for heavy traffic, so that the five or six tons of concentrates produced daily accumulated too rapidly during those periods.

Although the pulp was carefully classified and the product of the first two spigots returned to the tube mill for regrinding, nevertheless the vanners had difficulty in maintaining a 75 per cent extraction. The difficulties in getting the concentrates to the railroad, the high cost of transportation and smelting, together with the loss in the tailings of $2.50 to $3.00 per ton, caused the owners to await the results of a series of tests made by Manager Walter C. Fellows in order to work out an efficient process of extracting the values on the ground.

Cyanide and flotation tests were conducted for about two years before flotation cells of special design were adopted. The cells are reported to get a 90 per cent combined extraction of the gold and silver. There is also a gratifying increase in the value of the concentrates per ton.

The final tests with a 50-ton capacity experimental plant were conducted during the summer of 1916 and the installation completed about December 1, 1916, for a capacity of about 120 tons per day.

BERTHA CLAIM (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Bertha claim (locally known as the "Bertha" pocket), 8 miles southwest of Gold Hill, is in the S. E. 1/4 Sec. 12, T. 37 S., R. 4 W., on the left fork of Foots creek, at an elevation of 1600 feet by barometer. The country rocks here are impure banded and locally schistose quartzites, some limestone, and apparently small intrusions of an andesitic type. The workings are small and now caved.

BERRY'S PROSPECT (iron) COLLIER CREEK DISTRICT CURRY COUNTY

The only iron ore found in this section which can properly be classed as an impregnation deposit occurs on the ridge running easterly from Horse Sign butte between Horse Sign and Collier creeks, in the southwest corner of T. 36 S., R. 11 W. The deposit belongs to Frank Berry, of Agness, and is about 2 miles east of Horse Sign butte, at an elevation of about 3050 feet. The iron ore is magnetite, and it occurs as an impregnation in Myrtle sandstone between two greenstone dikes. The contacts of the sandstone and igneous rocks are not well exposed, so it is impossible to ascertain the width of the impregnated sandstone; but little pits scattered here and there over the surface indicate that it may be as much as 50 to 100 feet wide, and that it runs for some distance down both sides of the ridge. There seems no doubt that a large body of ore could be developed here. The beds appear to strike about N. 20° E., and to dip 51° to the northwest.

The weathered ore looks like a highly jointed brown sandstone, but its great weight at once suggests the presence of metallic material; and the use of a land-lens shows that the pores between the sand grains are completely filled with magnetite. So thoroughly impregnated is the sandstone that an average sample proved to contain 51.45 per cent of iron. Phosphorus, sulphur, titanium, arsenic and copper are entirely absent.

It seems likely that this deposit originated by deposition from solutions developed in the neighboring serpentine during the serpentinization process. Such solutions would normally have led to the formation of one or more masses of the boulder type of iron deposits in the serpentine itself, but accidentally finding their way to the border of the serpentine, they worked outward through the greenstone and impregnated the neighboring sandstone.

Although the iron ore as mined would be of rather low grade, it could readily be concentrated magnetically so as materially to increase its purity. As there is almost unlimited water power at no great distance, this would not be an expensive operation.

The absence of detrimental elements, the apparently large size of the ore body, and the comparative ease with which it could be mined, combine to make this deposit well worthy of a careful investigation, and of exploitation if transportation difficulties can be overcome.

BLACK BEAR CLAIM (gold) ILLINOIS RIVER DIST. JOSEPHINE COUNTY

Concerning this property, Diller says:

> The Black Bear claims, located on the ridge between Hoover Gulch and Fall creek, recently yielded some rich samples of free gold that attracted considerable attention. It is described as a well defined quartz ledge plainly traceable on the surface of the steep mountain slope. The ledge was opened at four different points. It extends northeast and southwest, and where the rich samples were taken it was not less than a foot thick.

BLACK BEAR MINE (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Black Bear mine is on the south fork of Rocky gulch, about 2½ miles northwest of Galice, at an elevation of about 1650 feet, as measured by barometer. It was formerly owned by the Black Bear Mining & Milling Company, but is now controled by the Highland Improvement Company. The main adit is over 700 feet in length and follows a well defined fault for more than 500 feet, as seen in a drawing of the workings. The fault is marked by 12 to 20 inches of soft gouge which strikes about N. 15° E. and dips about 80° E. The ore consists of lenticular bodies of quartz with pyrite and greenstone, which are found on both sides of the fault gouge. No ore has been milled from the main adit, though about 4 tons of rich surface ore was mined from old workings above it. The shorter adit discloses a zone showing scattered quartz near the breast as well as stringers crossing the main course as shown; one is about 2 feet wide and strikes S. 45° E. with a dip of 70° S. W. The country rock is a hard amphibolite, schistose in places, and containing many small quartz stringers or lenses. One to two hundred yards southwest of the Black Bear adits the country rock is dunite (or cortlandite), consisting of granular olivine with patches of tremolite and antigorite and a sprinkling of magnetite. Diller states that at the Black Bear:

> A vertical belt of quartz veinlets and kidneys 2½ feet in width runs nearly north and south. The ore, which is rich in pyrite, with some chalcopyrite, is scattered rather irregularly in the vein belt. Some of the ore is cut by shearing planes, on which the slickensided ore shows decided movement since the ore was depositeed.

BLACK BUTTE QUICKSILVER MINING COMPANY (Washington corporation) (mercury) LANE COUNTY

Local name, Black Butte mine.

Office: New York Block, Seattle, Washington. John N. Powell, Seattle, Pres.; Marion T. Edwards, Seattle, Sec.; W. B. Dennis, Carlton, Oregon, attorney-in-fact and managing agent. Capital stock, $5,000,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company owns 1040 acres of patented land in Sec. 16 and parts of Secs. 9, 8 and 17, T. 23 S., R. 3 W., 17 miles by wagon road south from Cottage Grove, on the coast fork of the Willamette river.

In past years many thousand feet of development work has been done on a low grade cinnabar deposit in a brecciated shear zone in andesite. This mineralized zone in the 100, 200, 300 and 400-foot levels averages about 16 feet in width. The next development lower than the 400-foot level is the 900-foot level. The zone here is shown to be very much wider than on the upper levels. The volume of brecciated material in this level is many times greater than on the upper levels, which is probably the principal reason why the ore is generally lower grade than above. The rock in the shear zone is very much altered and has every appearance of having been leached by uprising hot water solutions.

The company at present employs 30 men. The ore is treated in a 40-ton capacity Scott retort, which has been considerably altered and improved in the past years by Mr. Dennis.

BLACK EAGLE MINING AND MILLING COMPANY (gold-copper) NORTH SANTIAM DISTRICT MARION COUNTY

Local name, Black Eagle mine.

Office: Newberg, Oregon. W. M. Abbott, Pres., Gates, Oregon.; Mrs. Minnie W. Cooper, Sec.-Treas., Newberg, Oregon. Capital stock, $1,000,000; par value $1.00; amount subscribed, $600,000; $353,267 issued and paid up. (1916 report).

The property, consisting of 11 claims, is on the Little North fork of the Santiam river, in Secs. 23, 24 and 25, T. 8 S., R. 4 E., and is 13 miles by wagon road from Gates.

About 1000 feet of development work has been done on the vein on the main level, besides several smaller tunnels and open cuts. The vein contains gold, silver, copper and zinc. The copper in the form of chalcopyrite, malachite and chrysocolla, and the zinc as sphalerite. Considerable manganese and iron oxide is found in different places in the vein, and at one place in the vein is a vertical opening locally called a chimney, and claimed to be more than 100 feet deep, which is more or less circular in cross-section, with its walls lined several inches thick with crystals of calcite and siderite, which locally is thought to be zinc sulphide. This occurrence is somewhat unusual, but is of no importance commercially.

The property is equipped with a sawmill, power plant, bunk houses and a small poorly designed concentrating mill. It is reported locally that the assessment work was not done last year and that the property had been "jumped."

BLACK GOLD CHANNEL MINE (placer) GOLD HILL DIST. JACKSON COUNTY

The Black Gold Channel mine (8 miles southwest of Gold Hill) is on the left fork of Foots creek in Sec. 12, T. 37 S., R. 4 W. It is leased at the present time. In the bank is exposed about 15 feet of unstratified gravels, coarsest below, and containing boulders up to 18 inches in diameter. There is very little fine material; the boulders, which are almost all of greenstone, are subangular to fairly well rounded. The large boulders are handled by a derrick. Two giants are used under a head of several hundred feet. The gravels are forced upward for 15 feet over an elevator, but the sluice takes the material 2½ feet above bed rock. The mine pit of the present workings has an area of 1½ acres. A large area down the stream has already been worked over. The bed rock is slate cut by dikes of greenstone. The strike of the slates is N. 10° E.; distinct joints run about N. 70° W. Numerous small veins are present, and have a general northeast-southwest direction. (Kay—U. S. G. S. Bull. 380, p. 65, 1909.)

BLACK JACK PROPERTY (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Black Jack group is on Quartz creek, not far from the eastern contact of the Peavine serpentine belt. The ore is free milling and between $6000 and $7000 in gold was won from a pocket by hand mortaring.

BLANCO or MADDEN MINE (placer) SIXES RIVER DISTRICT CURRY COUNTY

Diller describes this mine as follows:

The Blanco mine is about midway between Port Orford and Langlois, along the inner border of the coastal plain, at the foot of Madden butte, in the N. E. ¼ Sec. 4, T. 32 S., R. 15 W. When last seen it was operated by Mr. Cyrus Madden with about 500 feet of sluices and 7 burlap tables for catching the fine gold which constitutes about one-half the whole product. Platinum metals occur with the gold at this point and are about one-twentieth as abundant. The section exposed in the mine includes about 8 feet of wind-blown material next to the surface, below which lies from 12 to 20 feet of sand with small, black layers and some gravel. Some of the dark layers are coated by oxide of iron, and one of these is used as a bedrock on which to wash the overlying material. The real bedrock, which lies 10 feet below, is Cretaceous shale, but it is too low for drainage across the plain. The working season usually lasts six months, from November to May, and the mine from 1898 to 1900 yielded over $1100 annually. The beds of sand and gravel of the ancient beach dip gently (10°) westward and over-lap the older rocks at the base of Madden butte. The mine already covers an area of several acres, and there is reason to expect that it will continue profitable farther along the shore, especially at deeper levels, if possible to drain to bedrock.

BLANCHE OR MAY BELLE CLAIM GOLD HILL DISTRICT JACKSON COUNTY

The Blanche or May Belle claim, 2 miles east of Gold Hill, adjoins the Schaffer. It is owned by Guy D. Kinney. An adit follows a quartz vein in tonalite N. 65° W. 250 feet, then N. 75° W. about 100 feet. The vein is narrow; it dips 85° S. and contains quartz with some pyrite and chalcopyrite.

BLOSSOM MINE GOLD HILL DISTRICT JACKSON COUNTY

The Blossom mine, 5 miles north of Gold Hill, is in the northern part of Secs. 19 and 20, T. 35 S., R. 3 W., near the head of the left fork of Sardine creek, at an elevation of about 2400 feet above sea level. An adit on the No

Name claim extends northwestward about 200 feet in an andesitic country rock. The vein strikes N. 37° W. and dips 55° N. E.; it contains some sulphide and very little quartz, being mostly crushed country rock. Near the face of the adit there are two parallel veins. An upper adit (about 85 feet long) opens the same ore body, 75 feet higher up; it is connected with the lower adit by means of a raise on the vein. On the Blossom claim the lower adit extends about 135 feet N. 40° W. as a crosscut, thence drifts on the vein about 110 feet. The deposit strikes N. 75° W. and dips about 80° S.; it consists of a vein about 15 to 20 feet thick, in which one-quarter to one-tenth of the filling is quartz and ore. The country rock is an andesitic "greenstone." The vein minerals include pyrite, chalcopyrite, gold, galena, pyrrhotite (and sphalerite?), with quartz, calcite and sericite. An upper adit about 85 feet long discloses the same deposit with the same position and size. On this level the ore is thoroughly oxidized.

BLUE BIRD MINING COMPANY (gold and silver) BLUE RIVER DIST. LINN COUNTY

Local name, Blue Bird mine.

Office: 67 N. Third St., Portland, Oregon. S. M. Carter, Blue River, Oregon, Pres.; F. W. Brooke, Portland, Sec.; C. Marco, Portland, Treas. Capital stock, $100,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

The property consists of 7 unpatented claims. It is located in about Sec. 28, T. 15 S., R. 4 E., 6 miles from Blue River postoffice, which is 45 miles east of Eugene on McKenzie river. There is a mountain road from this mine to the Lucky Boy mine, and then a fairly good road to the Blue River postoffice. Road from Blue River to Eugene is in good shape. Country is very rugged and plenty of timber is available.

Country rock consists of an andesitic flow-breccia. The deposit is in a brecciated zone, having a N. W.-S. E. strike, dipping nearly vertical, and the width of the brecciated zone is about 24 feet. In some places there are lenses of quartz as much as 6 feet in width. Development work consists of 2 tunnels along the fractured zone. No. 1 is 220 feet long, and No. 2 is 500 feet long. There are several short crosscuts in the brecciated zone in the lower tunnel. Development work is in partly oxidized ore, which contains some iron pyrite. No definite information is available as to values of ore exposed. A careful and systematic sampling of the vein matter exposed would be useful in directing further development work. There is a steam sawmill on the property; also a Denver grinding mill with amalgamating plates.

BLUE BIRD MINE (gold) GRANITE DISTRICT GRANT COUNTY

Within a radius of a mile of the Red Boy mine there has been a great deal of prospecting, principally in the form of long exploratory crosscut tunnels in some of which veins have been found and small amounts of ore extracted. None appear to have maintained production over considerable periods, and many are so far abandoned that assessment work is not kept up.

One of these is the Blue Bird mine, which is developed by a crosscut tunnel 2500 feet long and some short drifts extending under the ridge one-half mile northeast of the Red Boy mill in Sec. 11, T. 9 S., R. 35 E. The tunnel was not accessible in 1914, but Mr. Walter Gleason, of Baker, stated that during 1904 and 1905 about 1500 tons of ore yielding $5000 was taken from a vein near the portal. The material on the dump shows a breccia of unaltered argillite cemented by comb quartz, with minor amounts of pyrite and arsenopyrite.

BLUE LEDGE MINE (copper) UPPER APPLEGATE DIST. SISKIYOU COUNTY, CAL.

The Blue Ledge mine is about 3 miles south of Hutton (formerly called Joe Bar), in the S. E. ¼ Sec. 34, T. 48 N., R. 11 W., at an elevation of about

4000 feet, about 3 miles over the line in California, but the topography is such that all transportation connections are through Jacksonville and Medford, Oregon. It is owned by the estate of Robert S. Towne, 82 Beaver St., New York City.

The copper deposit is opened by a series of adits on the face of a cliff at different elevations; with the winzes and raises this gives a vertical exposure of the ore for about 800 feet, and a horizontal exposure for about 2000 feet. The ore consists of nearly solid pyrite and chalcopyrite, with a little pyrrhotite and rare sphalerite or galena. Microscopically the ore contains also primary tourmaline and a little biotite. The first fissures were cemented by coarse vein quartz; after shearing the second fissures were filled with calcite, chlorite and sulphides. According to numerous assays, the ore contains 3 to 4 per cent copper with about $1.50 to $2.00 in gold and silver. The veins average about 2 feet in thickness; so far as observed the veins are somewhat narrower and lower in grade in the lower levels. The veins strike nearly due north and dip about 65° W.; they are generally parallel with the banding of the sericite schist country rock, but locally cut across it. There are at least three veins which are roughly lenticular in form; one lens succeeds another along the strike, usually with a small offset. The hanging wall is a soft white sericite schist near the vein, but elsewhere it is a mineralized quartzite charged with some muscovite. The footwall is a bluish black hornblende schist. The position of the bedding and rock cleavage seem to indicate that the mine is on the east side of an anticline (overturned to the east), which pitches to the south. Faults are common in the workings, but usually the offset is only 1 to 5 feet, so that there is no difficulty in following the vein. The "pyrite" vein is one of the latest, as it cuts off some faults which offset the "main" vein. Pyrite in big cubes occurs, replacing the wall rocks, especially in the hanging wall.

The Blue Ledge has several thousand tons of ore blocked out. It is equipped with two air compressors and is reached by a good wagon road of very uniform grade from Hutton.

A 1500-foot aerial tram is being installed at this property. In December, 1916, the hauling of ore to the railroad, a distance of 30 miles, was begun.

BLUE RIBBON MINE (gold-silver) GRANITE DISTRICT GRANT COUNTY

About a mile east of the Buffalo-Monitor and on the Crane creek side of the ridge, is the Blue Ribbon prospect, in Sec. 16, T. 8 S., R. 35 E. It is developed by 2 crosscuts and drifts on the vein. This property is also in argillite and greenstone. In the upper crosscut drifting on the vein has opened up two bodies of ore from 2 to 10 feet wide, and in values usually between $10 and $20, with occasional high values. The full stope length has not been developed on this level. Several hundred feet of work has been done in a branching crosscut in a lower tunnel in the search for the vein below, but so far these attempts have been unsuccessful. A few tons of ore were sorted and shipped in 1916.

BIG BUCK or HICKS CLAIM GOLD HILL DISTRICT JACKSON COUNTY

The Big Buck or Hicks claim is 7 miles southwest of Gold Hill, near the center of Sec. 1, T. 37 S., R. 4 W., on the left fork of Foots creek. The workings are on a vertical fissure zone in massive bluish quartzite containing some vein quartz and sulphide of iron.

BIG FOUR PLACER GRANTS PASS DISTRICT JOSEPHINE COUNTY

Pickett creek flows from the west into Rogue river in T. 35 S., R. 7 W., about 10 miles west-northwest of Grants Pass. The Big Four placer mine is about half a mile from the mouth of this creek on a gravel bench overlooking Pickett creek and about 300 feet above Rogue river. According to Diller, the mine is owned by M. J. Merrill, of Portland, Oregon, and embraces about 200 acres, chiefly on a bedrock of slate:

The gravel ranges from 30 to 70 feet in thickness, and is in part clearly stratified. The 14 feet of red earthy sand and clay overburden is said to contain fine gold that can be saved, but the larger pieces are in the bottom gravel. The lower twelve feet of gravel contains well-rounded cobblestones, the largest being 6 inches in diameter. At the bottom a few boulders, generally slate, rest on bedrock, and from 2 to 4 feet of the bottom gravel is partly cemented. The rim rock rises abruptly and slates are much crushed and faulted, forming a terrace on the northwest toward Pickett creek. The old channel is 250 feet in width and 30 feet in depth below the slate-rim terrace, from which the gravel capping has been in part mined away. The water is supplied from Pickett creek at a head of 200 feet, two giants being run for a large portion of the year. The mine has been operated, during the season when water is obtainable, for many years.

BIG HILL COAL MINING COMPANY — **COOS COUNTY**

Office: 1595 E. 13th St., Portland, Oregon. F. O. Weeks, Pres.; J. W. Caldwell, Sec.-Treas., both of Portland. Capital stock, $200,000; par value $1.00; $123,578 subscribed, issued and paid up. (1916 report).

This company controls 480 acres under mining lease.

BILLY BLUE MINE (gold) — **GRANTS PASS DISTRICT** — **JOSEPHINE COUNTY**

The Billie Blue mine, owned by Messrs. Joe Shaska and Wm. Swinden, is located 8 miles southeast of Grants Pass, about 2½ miles up Savage creek from the Pacific Highway. The property is developed by a 65-foot shaft and a few short tunnels and open cuts, exposing in numerous places small quartz lenses in a schist or soapstone. Free gold is found in several places on the property in these development pits and shafts, often plastered upon faces of the country rock. Good prospects were obtained by panning. A 200-foot tunnel is now being driven, which is intended to cut the vein at a depth of 125 feet.

BILLY CREEK MINING COMPANY

Office: Oakridge, Oregon. W. G. Hyland, Oakridge, Oregon, Pres.; Charles McFarland, Sec.-Treas., Eugene, Oregon. Capital stock, $5000; par value $100; all subscribed, issued and paid up. (1916 report).

BIMETALLIC CLAIMS (silver-gold) — **GREENHORN DISTRICT** — **GRANT COUNTY**

This property, now owned by Anthony Mohr, formerly called the Intrinsic, is located in Secs. 6 and 7, T. 10 S., R. 35 E., near the headwaters of Salmon creek, about 2½ miles from the Ben Harrison mine in a straight line and about the same distance from the town of Greenhorn, with which it is connected by wagon road. The elevation of the principal workings is about 7000 feet. It is on the southern slopes of a branch ridge of the main Greenhorn range.

The principal country rock is diorite, a peripheral differentiate of the granodiorite intrusion. Much serpentine and greenstone was observed on the opposite side of Salmon creek. The immediate geology is complex. Large dikes which are neither a true granodiorite-porphyry nor an aplite, but a sort of intermediate which might be called a granodiorite-porphpry aplite, strikes north and south on the east side of the property. They were probably welled up in fissures at a period of time midway between the time when the two types of dikes were being formed elsewhere. After this dike had become solidified, the dike and the adjoining diorite along its western side was shattered in a series of parallel breaks partaking of the nature of a shear zone. This must have been at a period considerably after the time when true aplites were formed elsewhere in the intrusion, because it has been filled with almost pure quartz. The bands or ribbons of quartz are so completely cemented to the intervening dike rock that cross sections with the splendid luster of the quartz in contrast with the creamy but dull color of the dike rock makes a decidedly pleasing appearance.

On the northeastern part of the claims, just beyond the saddle, is a light-colored rock composed almost entirely of calcite impregnated with chalcopyrite and tetrahedrite and containing some secondary feldspar and quartz. This has low values in gold and silver.

The general direction of the veins is E.-W., but these veins are the result of a more or less complex fracturing. The principal workings are in a basin about half way up to the saddle from the creek. There has been a great deal of weathering and decomposition of the rock generally, which may have been due to a centralizing of the fracturing in the basin.

On the side hill west of the development is a large cropping at least 25 feet wide, which appears to be the result of a partial replacement of country rock with quartz, in which there are many veinlets and quartz crystals. Manganese is evident throughout, although in small percentages, and samples taken from this exposure assay about $1 in gold. It could not be determined with the limited amount of development on the surface nearby whether or not this is a harder portion of the same lode seen in the principal workings to the east, which because of its more resistant nature, has not weathered as fast as the country rock or the softer part of the vein.

The underground workings were so poorly ventilated that candles would not give sufficient light to observe very much, but it appears that there is a wide zone of softened badly decomposed rock in which there are lenses of good ore either along the walls or at places between them. How much value, if any, is contained throughout the mass is unknown, but from its appearance it is probably too low grade to mine outside of these lenses. Whether these lenses, which in places are of stoping width, have much vertical or horizontal extent was not ascertained.

On the dump there is quite a tonnage of ore in which there is varying amounts of tetrahedrite, with some pyrite and chalcopyrite. It is said that this ore has been sorted over twice and the first shipment contained between two and three hundred dollars a ton, and that the second sorting brought between one and two hundred dollars, while a third sorting, which has been begun, assays about $75. The main ore dump will naturally average much less than the latter amount.

This deposit is also the product of ascending magmatic waters, but the extremely soft nature of the entire lode would lead one inevitably to question the primary nature of the sulphides present, although tetrahedrite is normally a primary mineral.

The gold values are usually between one and two dollars per ton, and the amount of gold present seems to bear but little relation to the amount of silver present.

BIRCH CREEK MINING PROPERTY (gold) SPANISH GULCH DIST. WHEELER CO.

Richard Coe and J. H. Haggard, Antone, Oregon, owners. Two claims located in Sec. 21, T. 13 S., R. 25 E., in hilly, timbered country, near the head of Birch creek, about 13 miles from Dayville.

The country rock is silicified greenstone and an acid rock, probably alaskite. The presence of the alaskite indicates proximity to an intrusive mass of granitic rock.

There are many irregular small veins and one strong one, which has a width of 12 feet, strikes N. 60° E. and dips 45° N. This vein has over a foot of gouge on the hanging wall, and has been traced on the surface for about 1000 feet along the strike. Vein minerals are galena and sphalerite. Development work consists of several pits, a shaft about 25 feet deep and a crosscut tunnel several hundred feet long, which is being driven but has not yet reached the vein. There are good average values in gold, judging from about 100 assays reported to be from channel samples taken in various openings upon the property.

BONANZA KING (copper) COLLIER CREEK DISTRICT CURRY COUNTY

This group consists of three claims, which are owned by E. G. Hurt, of Agness. They are located about 3 miles east of Saddle mountain, near Collier creek, the eastern boundary of the county. Mr. Hurt purchased one, the Bonanza King, of W. W. Whitton, in 1898, and another, the Bonanza King extension, from R. J. Canfield, in 1912. He located the third, the Spotted Faun, in 1912. Two tunnels, one 60 and the other 48 feet long, were driven on the property, which was also opened up by means of 8 open cuts and shafts. Although work was done as late as 1914, all of the openings have so badly caved as to make it impossible to secure accurate data concerning the deposits in 1915. From what observations it was possible to make, they appeared to be largely of the boulder type, although one or more mineralized shear-zones may also be present. In several cases a little moderately deep development has gone under the ore into seemingly barren serpentine, bearing out the conclusion that most of the deposits are of the boulder type.

The principal ore mineral is undoubtedly chalcocite or copper glance (sulphide of copper), although considerable cuprite (red oxide of copper) and native copper are also present. Magnetite (magnetic oxide of iron) seems to have been invariably associated with the copper ores, and it is claimed that this mineral itself carries copper in every case. This is borne out by the fact that a specimen of seemingly pure magnetite from the Copper King tunnel on the Collier creek group proved to contain 50.05 per cent iron, 2.43 per cent copper, and no sulphur, phosphorous, titanium or arsenic.

Where the copper ores outcrop on the surface, they have been oxidized to malachite (green carbonate of copper) and azurite (blue carbonate of copper). Occasionally a little erythrite (pink arsenate of cobalt) is also present. These substances are said to give place to chalcocite, cuprite and native copper a few feet from the surface in every case. Some of the ore still on the dumps is apparently very rich, and a general sample of such material from a number of points on the Bonanza King group yielded 20 per cent copper, .06 oz. gold, and .12 oz. silver per ton.

A chunk of native copper supposed to have come from this group, which, although only a fragment of the original piece, weighs 3½ pounds. It is coated with malachite and other oxidation products.

BONANZA MINE (gold) GREENHORN DISTRICT BAKER COUNTY

In Sec. 8, T. 10 S., R. 35½ E., and about 4 miles east of Greenhorn and 8 miles by wagon road from Whitney, is the old Bonanza mine, discovered in 1877, and actively operated from 1892 until December, 1904, since which time leasers at different times have mined ore from some of the old workings. The total production was approximately $1,750,000. From the various levels the property is developed to a depth of 1250 feet below the outcrop.

The country rock is argillite, although a little limestone and serpentine are near. The vein strikes about N. 55° W. and is said to be nearly vertical. According to Lindgren, the pay streak averaged only 5 to 6 feet wide, but swelled in places to 40 feet, by the appearance of a vast number of quartz stringers.

BONE OF CONTENTION MINE (gold) LOWER APPLEGATE DIST. JOSEPHINE CO.

The Bone of Contention mine, 15 miles southeast of Grants Pass, is on the line between Secs. 24 and 25, T. 38 S., R. 5 W., on the east side of Williams creek, at an elevation of about 1700 feet, as measured by barometer. It is near the border of an area of tonalite, which extends northward about 2 miles. The tonalite is here in contact with argillite; it is also cut by dikes of aplite.

The mine is equipped with two ore bins, water power obtained from a ditch, and Pelton wheel, a 15-stamp mill with 2 amalgamating plates each 42 by 120 inches, and a concentrating table. The main adit enters S. 77° E., but contains too much water to permit inspection. It is evident from the dump that it leads to several thousand feet of workings. The mine has been idle for several years.

BOULDER CREEK MINING COMPANY CORNUCOPIA DISRICT BAKER COUNTY

See "The Underwood Placers."

BOURNE GOLD MINING COMPANY (gold) CRACKER CREEK DIST. BAKER CO.

Local name: E and E mine.

Office: 705 Chamber of Commerce Bldg., Portland, Oregon. Jonathan Bourne, Jr., Pres.; I. M. Arneson, Sec. Capital stock, $1,000,000; par value twenty cents; all subscribed, issued and paid up. (1916 report).

The lands consist of 2 claims, the Eureka and the Excelsior, upon the North Pole-Columbia lode, and other quartz claims; 7 placer claims, with 2 millsites in the district, all patented. The shaft and surface plant is located about one-quarter mile west of Bourne and about 6 miles north of Sumpter, a station on the Sumpter Valley R. R. (narrow gauge), at an elevation of about 5500 feet.

The general description of the North Pole-Columbia lode, of which the E and E mine is a part, will be found under the "Columbia Gold Mining Company," to which the reader is referred. There has been no change in status of the company since 1914, although representatives of some of the leading development companies have visited the property, having in mind some sort of a consolidation with other companies on the lode, but conditions imposed by the owners have not as yet proved sufficiently attractive.

BOULDER CREEK GOLD MINING COMPANY (gold) OPHIR DIST. CURRY COUNTY

Local name, Star mine, Old Diggings.

Office: 80 60th St., Portland, Oregon. R. D. Hewitt, Pres., Agness, Oregon; John Gardner, Sec.-Treas., Agness, Oregon. Capital stock, $25,000; par value $100; $24,999 subscribed; $21,076 issued and paid up. (1916 report).

At the junction of Boulder creek and the south fork of Lobster creek, in Sec. 25, T. 34 S., R. 13 W., is an extensive bar known as Old Diggings, consisting of 80 acres and 160 acres, under the name of Star mining claims. This company intended to work this property extensively with giants during the winter (1915-16), and, with this end in view, had ordered 1000 feet of piping to communicate with a long ditch constructed by A. W. Wilheit. It is reported they have the following improvements: "4800 feet completed ditch, 1 dam 74x12x8 feet, 1 dam 60x3 feet, sawmill plant with water power, 800-foot pipe giant, blacksmith shop, tools, 3 cabins." $4800 worth of improvements the past year.

BOWDEN CLAIM (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Bowden claim, 4 miles east of Gold Hill, is on the southeast slope of Blackwell hill, near the top of the grade on the road in Sec. 30, T. 36 S., R. 2 W. It has a quartz vein in tonalite, shown by an adit now open about 150 feet, and said to have extended 500 feet, and also by a shaft, where the vein strikes N. 75° E. and dips about 85° N. The shaft is said to be 185 feet deep and to have yielded free gold at 100 feet. The vein was apparently 2 to 3 feet thick where stoped.

Press reports of November, 1916, state that H. H. Leonard, of Gold Hill, is now the sole lease holder and expected to proceed with the unwatering of the shaft and sampling of the workings.

BOWDEN PROSPECT (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Diller says:

Mr. Samuel Bowden, of Grants Pass, has opened a number of claims on the North Fork of Canyon Creek and Lightning Gulch, in greenstone on shear zones, veins of quartz or dikes of dacite porphyry cutting the greenstone, and reddish cherts that are radiolarian and certainly of sedimentary origin. In all these places the greenstone is more or less impregnated with pyrite and in some of them with chalcopyrite. The shear zones and quartz veins run N. 20° E. and dip 40° SE. The greenstone in places is practically a chlorite schist and is then most probably full of pyrite. The reddish chert is closely related to that of the Pocket Knoll region and lies only a short distance beyond the western limit of the great serpentine belt that crosses the North Fork of Canyon creek at the falls, half a mile above its mouth. In the same region the Telluride Gold Mining Company of Seattle has 5 claims. It is reported by Mr. Bowden that several tons of ore were shipped to Tacoma as a test and yielded good returns.

BRADBURY MINE (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Bradbury mine is on the east side of Rogue river about 1¼ miles below the Almeda. It is opened by 3 adits at elevations about 150, 420 and 525 feet above the river. The upper adit enters as a crosscut in schistose country rock extending N. 90° E. 160 feet, where it turns southward to drift about 70 feet on a lead varying from 1 to 50 inches wide, which strikes N. 17° E., and contains 0 to 40 inches of quartz. The middle adit is caved shut at the portal. From the dump it is clear that this adit is several hundred feet long in schistose greenstone, containing a vein of white quartz, carrying a little pyrite and rare free gold. The lower adit extends N. 8° E. about 120 feet in greenstone, containing thin seams and a few bunches of quartzose ore.

BRADEN MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Braden mine is in the S. E. ¼ Sec. 27, T. 36 S., R. 3 W., at an elevation of 1350 feet, about 2 miles south of Gold Hill. It is at present (1913) one of the important mines of Jackson county. It has a 10-stamp mill equipped with a crusher, two 10-foot plates, 4 Johnson vanners, and electric motors, one of 85-horsepower being used to operate an air compressor. According to E. W. Liljegran, of Medford, the mine was located about 30 years ago by B. A. Knott, of Gold Hill, who began development, treating the ores in an arrastre. After several transfers the mine passed to Dr. James Braden, after whom it has since been called. It was sold to C. R. Ray, of Medford, in 1900; seven years later it was leased to the Opp Mining Company; it is now operated by Dr. Ray. In 1907 the mine produced more than $30,000.

There are several quartz veins opened by 6 adits and an incline shaft. The important veins strike about N. 30° E. and dip about 25° S. E. There are four main levels opened by adits at different elevations on the sidehill and connected with one another by raises and winzes. The workings have a total length of more than 3000 feet, but the greatest depth reached is less than 250 feet. The lowest adit (No. 6) has a length of more than 1200 feet, and has yielded considerable high grade ore.

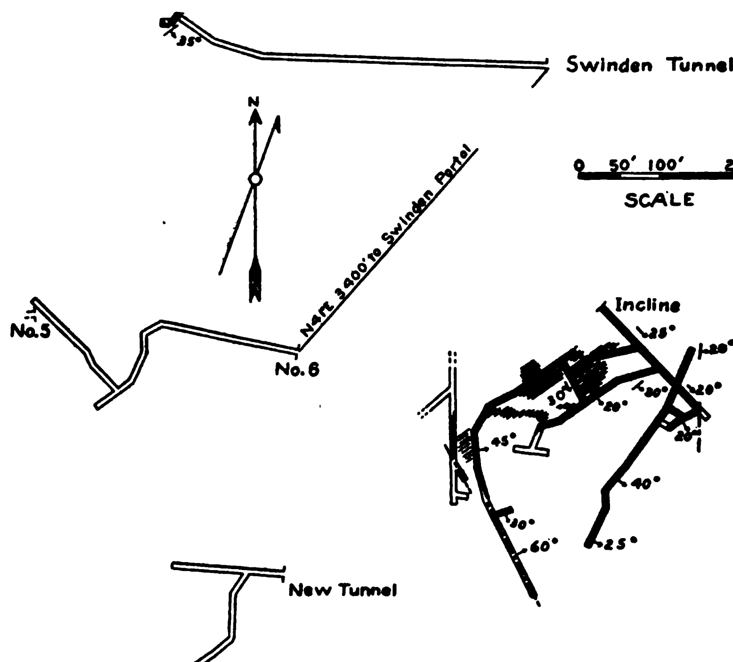
The country rocks of the Braden mine are Paleozoic sediments and interbedded andesites. A rock from the dump of adit No. 2 is plainly banded, some bands being chiefly green hornblende with some quartz, chlorite, zoisite and pyrite, and other bands being chiefly calcite or, rarely, quartz; it is a calcareous hornblende schist. Another sample from the same adit is an amphobolite, containing abundant green hornblende, some pale yellow epidote, some zoisite, some interstitial plagioclase, some garnet, and a little magnetite. But the hanging wall of the vein under the incline shaft is apparently a spessartite, containing abundant hornblende grading from brown to green, abundant plagioclase, some zoisite, calcite, sericite, magnetite and siderite.

The ore is highly quartzose, containing a little calcite and some pyrite, as well as a little arsenopyrite, chalcopyrite, and galena. About 65 per cent of the gold and silver is recovered on the plates and about 25 per cent is saved in concentrates, which are sent to a smelter at Selby or Tacoma. Concentration is about in the ratio 12 to 1; the assay value of the ore is \$8 to \$10 a ton and of the concentrates about \$25 a ton.

According to G. F. Kay:

Most of the production of the mine has come from two shoots nearly 600 feet apart, on the lowest drift of the mine. One of the shoots extended along the vein in this drift for about 55 feet, but in a winze its width increased to about 80 feet, below which it narrowed abruptly. The direction of the shoot was the same as that of the dip of the vein. The other shoot had a length along the strike of the vein of 75 feet; in a winze from it the length increased to 125 feet; at the bottom of the winze, which was run 200 feet below the drift, the ore was low in grade. The direction of this shoot was about S. 50° E. Usually the best ore was found along the footwall of this shoot, although in places the gold and silver were uniformly distributed across the vein, which here had an average width of about 18 inches. The zone of oxidation does not extend farther than about 100 feet below the surface, and in parts of the vein sulphide ores are found at depths considerably less. Along the fault planes the ores show enrichment.

Since the date of Professor Kay's examination of the Braden mine another shoot of ore has been opened on another vein by means of an incline shaft. The vein strikes about N. 55 E. and has an average dip of about 25° S. E., with a thickness of 2 to 5 feet of quartz. In the lowest drift at 190 feet depth on the incline a second vein seems to swing into the main later vein from a direction about N. 10° E. and a dip of about 35° E.; it has been followed back under the incline shaft and shows about 2 feet of quartz. The structure is shown in the illustration. To the southwest the vein seems to be cut off by a



Braden mine, accessible workings

fault which strikes N. 27° W. and dips about 60° N. E. The drawing shows only a small part of the older workings, which were caved so as to be mostly inaccessible when the mine was visited.

The mill was dismantled in 1916 and a good part of the equipment sold to A. W. Bartlett, of Ashland, to be used in equipping the mill at the Ashland mine.

BRANTER MINE (placer) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Branter mine is on Applegate river near the mouth of Keeler creek, and 3 miles east of Applegate, in Sec. 25, T. 38 S., R. 4 W. It is owned by D. H. Mansfield. In the present workings the sands and gravels have a thickness of 30 to 35 feet and show distinct stratification. Many large angular and subangular boulders (chiefly of greenstone) are found at and near the base of the deposit. The bedrock is decomposed greenstone. The mine is equipped for hydraulicking, the water used having a pressure of about 100 feet.

BRAZOS MINES COMPANY (gold) VIRTUE DISTRICT BAKER COUNTY

Local name, Brazos mine.

Office: Baker, Oregon. Al Geiser, Pres.; Mose Fuchs, Sec.; John Thomson, Treas. Capital stock, $25,000; par value $1.00; $15,000 subscribed, issued and paid up. (1916 report).

Two miles north from Pleasant Valley, a station on O.-W. R. & N. Company line; situated in gently rolling sagebrush-covered hills; Sec. 11, T. 10 S., R. 41 E. Elevation 4100 feet; in Burnt river drainage. Wagon road to Pleasant Valley. Lands, three claims—Brazos, Pleasant Valley and Queen Bee.

The development of the Brazos is of recent date, and a 10-stamp mill was erected on it late in 1900. The developments consist of a tunnel with 1,000 feet of drifts, no ore having been stoped at the time of the visit, in August, 1900.

A black argillite, most of it soft and crushed, and without clearly defined bedding planes, forms the country rock. The vein strikes northwesterly and dips 20° to 30° SW. The croppings, which are not conspicuous, rise to 125 feet above tunnel level. The hanging wall is clearly defined by a clay seam, while the foot wall is also well marked. The width averages 3 or 4 feet, the vein matter consisting of soft, black argillite full of little nodules of quartz, rarely forming continuous veins. The appearance suggests that movements on the vein have separated the quartz into isolated lenses. All of these quartz seams and nodules carry gold, some of it being coarse. The pay shoot is claimed to extend for 400 feet along the vein. The ore is probably low grade, but the cost of extraction and treatment, on the other hand, should be very low.

In its northwesterly continuation the Brazos vein changes character, and the vein is exposed on the Pleasant Valley by a 175-foot incline as a normal quartz vein filled with 3 to 4 feet of massive quartz said to assay from $2 to $7 per ton. (Lindgren, p. 726-1901)

The development since 1900 consists of a 600-foot shaft and considerable drifting. Very little is reported to have been done in the last 5 years. None in 1915.

BRIERHILL COAL AND COKE COMPANY WASHINGTON

Office: Portland, Oregon. G. W. Weatherby, 432 E. Salmon St., Portland, Oregon, Pres.; F. A. Bruckman, Sec., and G. W. Weatherby, Treas. Capital stock, $75,000; par value $1.00; $44,400 subscribed, issued and paid up. (1914 report.)

This company's properties are located in Pierce county, Washington.

BRIGHT CARBONATE MINING COMPANY (silver-gold) GREENHORN DISTRICT GRANT COUNTY

Local name, Bright Carbonate mine.

Office: 118 East Webb St., Pendleton, Oregon. George Darveau, Pres.; John Seibert, Sec.-Treas., both of Pendleton. Capital stock, $60,000; par value $1.00; all subscribed, issued and paid up. (1916 report.)

This company owns 3 claims in Sec. 2, T. 10 S., R. 34 E., practically on the backbone of the main Greenhorn range, at an elevation of 7250 feet. The vein is in granodiorite striking northeast, and is developed by drifts and crosscuts. Shipments have been made from this property.

The ore consists of quartz, arsenopyrite, pyrite, zinc blende and a little galena in small veins in country rock, which has been bleached by the development of sericite and calcite stained green with chromium mica. Great widths of the veins are claimed for this property due to the parallel fracturing or shearing of the granodiorite for considerable widths, but these large dimensions are of little economic importance, since the mineralization outside of the principal fracture is nearly always insufficient to warrant mining. The values are in silver and gold. Reported assays from various points range from $5 to $250, more than half of which is in gold, which below the zone of oxidation may be reversed.

BROOKLYN GROUP (copper, gold, silver) HOMESTEAD DIST WALLOWA COUNTY

These claims, owned by A. P. Carnahan, are situated about 12 miles north of Homestead and about ½ mile from the river, both vertically and horizontally. The location of the camp is a picturesque one, situated as it is in an open space on the edge of a heavy forest, with precipitous rocky walls both above and below.

These rocks are quite similar to those at MacDougall's. They consist of amygdaloids, breccias and dense flows cut by granodiorite-porphyry dikes. The amygdules are filled chiefly with calcite, although some contain calcite and epidote, and some quartz and epidote. Volcanic breccia resembling Lake Superior rocks have cementing material of calcite with small amounts of chlorite associated with it. At another point dense greenstones similar to those at the Iron Dyke contain minute grains of iron pyrite.

A fault type of breccia is made up of fragments of dense greenstones with chalcopyrite and calcite as cementing material. It is a fine grained porphyry, in which there is a very finely interwoven groundmass of altered feldspars with sericite, chlorite, kaolin, quartz and epidote as alteration minerals. Judging from these alteration products, the original was probably an andesite. The chalcopyrite is probably due to impregnation and occurs in the fracture planes and also as scattered grains.

Considerably altered granodiorite-porphyry dikes contain resorbed feldspar crystals, which probably indicates that the parent granodiorite is a considerable distance underneath this greenstone cover. Just how far it may be, it is, of course, impossible to say. The presence of this porphyry implies a considerable influence of the granodiorite upon the deposition of ore.

The series of flows have a N.-S. strike and a dip 30° west. There are several N.-S. nearly vertical shear zones. On each side of an E.-W. granodiorite-porphyry dike are quartz veins. There are several other E.-W. veins. These E.-W. veins are fissures, while the N.-S. ones are shear zones of moderate widths, but the mineralization of both types is quite similar. The gangue minerals are chiefly quartz with some calcite and chlorite. Barite is in one of the E.-W. veins. The ore minerals are gold and silver-bearing chalcopyrite and chalcocite. The latter was found with specularite.

It seems probable that a large part of the mineralization is due to ascending currents of water from the underlying granodiorite batholith. The leaching of copper from the shattered greenstone played but a minor part.

Over 400 feet of development work has been done on these claims in crosscuts toward the shear zone and on the E.-W. quartz veins. None of the several crosscuts have arrived at the shear zone lode and no open cuts have been made upon it to demonstrate its value, although it is undoubtedly worth all such work.

Because of a misunderstanding as to the nature of the deposit, crosscuts were started instead of tracing the outcrop into a deep gulch, where a drift upon the zone could have been easily started. This drift would have been in material in which at least double the progress could have been made, besides every bit of work would have given information.

BROOKLYN MINE (gold) WALDO DISTRICT JOSEPHINE COUNTY

The Brooklyn mine, formerly known as the Gold Pick, about 9 miles southeast of Holland, is about three-quarters of a mile, as the crow flies, from the mouth of Bollon creek, at an elevation of about 3500 feet. The main adit is about 300 feet long, entering in a direction west of north; it opens a vein about 12 to 20 inches thick, containing 2 to 12 inches of quartz, which strikes N. 35° W. and dips 55° N. E. This adit is connected by a tramway with a mill on Bollon creek about 600 feet lower. Near the mine Paleozoic argillitic rocks are intruded by amphibolite, diorite and diorite aplite. The ore is white quartz, with very little pyrite; there is more pyrite in the adjoining greenstone. The ore is stoped out above the adit level, but the stopes have a short length horizontally. The ore was apparently of higher grade near the surface.

BUCK GULCH MINE (placer) SUMPTER DISTRICT BAKER COUNTY

This mine is owned by Fred Gowing, A. I. Snyder and associates, of Oakland, California, and located in Buck gulch, a small tributary which drains into McCully fork, a branch of Powder river, about 4 miles by road from Sumpter. The property is located in Sec. 26, T. 9 S., R. 36 E., at an elevation of about 5300 feet.

This placer deposit is an old buried stream channel extending southwest beneath the low range which separates the Powder river drainage from that of the North fork of Burnt river. It is supposed to extend underneath this ridge for about three miles and its maximum depth below the apex of the ridge is about 600 feet. One end of this three-mile remnant of the ancient river system is exposed in Buck gulch and the owners of this mine have driven a 900-foot tunnel through the rim to bedrock to enable them to prospect the gravels thoroughly. Enough of this work has been done in a series of drifts and raises to prove the existence of sufficient yardage of high grade gravel to warrant the bringing of water to the property and the equipping of a good sized plant to wash the gravels. Electric power for the washing plant is being brought from the Sumpter Water and Light Company's plant at Sumpter and a dam is being built across the gulch above the mine to create a reservoir, which will be filled by a 7-mile ditch with water taken from McCully fork.

BUCK GULCH PLACER SUSANVILLE DISTRICT GRANT COUNTY

The Buck Gulch placer is about 3 miles north of Galena and about 1000 feet above the river. This is the small gulch in which coarse nuggets are occasionally found. One which attracted considerable attention was found June 19, 1913, by George Armstrong, the owner of the property. It weighed 80.4 ounces and was valued at $1415.00.

BUCKEYE MINE (copper) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Buckeye mine is owned by an Ohio company. It is about 5 miles northwest of Waters Creek station on Oregon & California Coast Railway, on the east fork of Slate creek, at an elevation of about 2650 feet, as measured by barometer. An adit extends N. 20° W. 65 paces without disclosing any ore or any distinct vein. At 50 paces crosscuts have been run both ways a few feet. A cyclone drill has been used. The ore on the dump contains pyrite, pyrrhotite, chalcopyrite, bornite, malachite and chrysocolla. The country rocks are serpentine, andesite, diorite, and shale grading toward argillite. The shale strikes east of north and dips about 45° S. E. Two adits higher up are said to be 60 and 70 feet long, respectively. The ore is in the andesite near the contact.

BUFFALO GROUP GALICE DISTRICT JOSEPHINE COUNTY

The Buffalo group is at the head of Quartz creek on the slope of Peavine mountain, at an elevation of about 4000 feet. The Chieftain claim, owned by Mr. Wayment, is about 2 miles west of the Oriole mine. According to Diller, a belt of quartzite about 300 feet wide passes through this group; it has serpentine to the west and greenstone to the east of it. On the Dixie claim irregular veins and bunches of quartz carrying pyrite and chalcopyrite strike N. 23° E. and dip 68° N. W.

BUFFALO-MONITOR MINE (silver and gold) GRANITE DISTRICT GRANT COUNTY

The Buffalo-Monitor, situated on the southern slope of the divide between Granite creek and the north fork of the John Day river and about 5 miles from Granite, in Sec. 16, T. 8 S., R. 35½ E., has 2 types of veins, the one narrow and frequently frozen to the walls and of high grade, and the other a broad shear zone about 50 feet wide, of crushed argillite of low value. The narrow high grade veins are between walls of a dense highly siliceous argillite and close to the granodiorite intrusion which was observed in the development of the No. 3 vein, the farthest one in. These small veins are made up of gouge and fragments of argillite cemented together with quartz and hardened by silicification.

The ore minerals are pyrite, galena, tetrahedrite, chalcopyrite, and some stibnite, although occasional bunches high in galena contain gold and silver up to several hundred dollars a ton. Most of the ore shipped contained about $100 in silver and gold in the ratio of 16 to 1 by weight. The widest of all the various lenses was 30 inches; they were rarely more than half that and frequently only a few inches wide. Their stope and pitch length were usually only a few feet.

The Monitor vein, approximately 50 feet wide, made up of crushed argillite with occasional seams of quartz, has been developed by one crosscut and some drifting and other incomplete crosscuts. The channel samples in the one crosscut taken in 5-foot section averages for the full width between $1 and $2.

The property has not produced for 5 years. The total production is said to amount to about $75,000, entirely from the 3 small veins.

This property is under lease to William Narkaus and associates, who in 1916 installed a gasoline-driven compressor and air drills for use in extracting high grade ore from the Buffalo veins.

BULA MINE ASHLAND DISTRICT JACKSON COUNTY

The Bula mine, sometimes called the Lamb mine, because it is now owned by Coachman and Lamb, of Ashland, is situated 4 miles south of Ashland and about half a mile east of Ashland creek, on a ridge, at an elevation of about 3700 feet, as measured by aneroid barometer. It consists of five claims on one or more veins, which are opened by a shaft and two adits about a quarter mile apart, as well as some surface trenches or "pot holes." The southeasterly adit, at which an ore bin has been erected, consists of a crosscut entry about 100 feet long to the vein and a drift extending S. 30° E. about 200 feet. The country rock is tonalite and the vein is an altered zone in a dike and along the contact between the dike and the country rock. The vein contains some quartz and so much "clay" (probably sericite) that it gives trouble by caking about the die in the milling, which has been done in a Lane Chilian mill. The clay is also the probable cause of the poor extraction reported from this ore. The northerly adit consists of a crosscut entry extending southeast 125 feet to a vertical dike, which was followed S. 35° E. 325 feet. As this disclosed no ore and only a little vein material, the tunnel was turned due east to cut another vertical dike disclosed by surface prospecting about 200 feet eastward. This parallel dike has not yet been reached by the tunnel, which now extends about 120 feet from the first dike.

About a mile south of Lamb's house on the east fork of Ashland creek a prospect adit extends S. 60° E. about 45 feet in a slightly porphyritic tonalite, following fissures which contain a little vein quartz, some altered feldspathic material and some fault gouge. About a mile above the forks of Ashland creek on the east branch the coarse tonalite is displaced by an intrusive finer grained aplite with pegmatitic variations. On the south fork of Ashland creek the tonalite is similarly intruded by aplite and pegmatite. (1914 report.)

BULLION MOUNTAIN MINING COMPANY **CALIFORNIA**

Office: Silverton, Oregon. E. S. Porter, Pres.; Marian Palmer, Sec.-Treas., both of Silverton. Capital stock, $1,000,000; par value $100; $7885 subscribed, issued and paid up. (1916 report).

This company's properties are located in Siskiyou county, California.

BUNKER HILL AND SULLIVAN MINING AND CONCENTRATING COMPANY IDAHO

Office: 501 Chamber of Commerce Bldg., Portland, Oregon. F. W. Bradley, San Francisco, Cal., Pres.; George F. Holman, Portland, Sec.; William H. Crocker, San Francisco, Treas. Capital stock, $3,270,000; par value $10; all subscribed, issued and paid up. (1916 report).

This company owns the well known Bunker Hill and Sullivan mine, located at Wardner and Kellogg, Idaho.

BUNKER HILL GROUP (copper-cobalt) COLLIER CREEK DIST. CURRY COUNTY

This group is composed of 6 claims, situated on and to the northwestward of Bunker Hill, and about 1 mile west of Collier butte, and is owned by Mr. Frank Berry. Only a few small pits have been dug on this property, but these are sufficient to show that the deposits are practically identical in character with those in the Collier creek copper region; that is, they are boulder and shear-zone deposits in serpentine. The magnetite associated with the copper ores has, however, crystallized in small but well formed cubes instead of octahedrons, which type of crystallization of magnetite is so unusual as to seem deserving of mention. Another peculiarity of the Bunker Hill outcrops is the relatively large proportion of erythrite (arsenate of cobalt). Whether sulphides of cobalt are present in any quantity in the ores could not be ascertained.

On the northeastern slope of Bunker Hill occurs a dike of dacite-porphyry, through which more or less pyrrhotite (monosulphide of iron) is disseminated. This mineral occurs in both irregular grains and as small tabular hexagonal crystals in miarolitic cavities. Mr. Frank Berry stated that this material has yielded assays for gold, one return being as high as $80 to the ton; but a general sample taken from a number of fragments lying on the surface yielded not a trace of gold.

BURDIC MINE (gold) ASHLAND DISTRICT JACKSON COUNTY

The Burdic mine is near the center of Sec. 13, T. 39 S., R. 1 W., on a hill east of Wagner creek, and about 2½ miles west of Ashland by wagon road. It is owned by Burdic and Grant, of Ashland. The lower adit at an elevation of about 3140 feet follows small fissures and quartz stringers for about 60 feet southeasterly into the hill. About 100 yards to the southeast the upper adit at an elevation of about 3270 feet follows a southeasterly course. The adit enters on a slip showing some fault gouge, but very little vein material; the nearly vertical fissure turns to the south before playing out. The adit continues and turns at a point about 100 feet from the portal to follow for about 150 feet a vein in a diorite dike in tonalite. The vein is narrow, but the dike, which is silicified, chloritized and mineralized, is about 4 to 10 feet thick. The mineralization extends especially into the hanging wall and the foot wall is chloritized. The dike seems to vary from a dark basic diorite to a diorite-aplite or malchite. The water circulation followed a fault gouge about an inch thick. The strike of the vein is N. 80° W. and the dip is about 85° S. Assays of the ore are reported to have been higher at the surface than in the adit below.

BURNT RIVER DREDGING COMPANY WEATHERBY DISTRICT BAKER COUNTY

Local name: probably Pomeroy Dredging Ground.

Office: 506 Oregonian Bldg., Portland, Oregon. O. E. Tisch, Tacoma, Pres.; D. D. Wallace, Portland, Sec.-Treas. Capital stock, $250,000; par value $1.00; $139,125 subscribed; $39,125 issued and paid up. (1916 report).

The following news item was taken from the Portland Oregonian March 4, 1916:

> Baker, Oregon, March 3 (Special). J. H. Callahan of Portland, representing the Burnt River Dredging Company, composed of Portland and Tacoma people, announced while in the city today that the company will install a $15,000 gold dredge on Burnt river the first week in April.
>
> The company has a 680-acre tract eight miles south of Durkee and has control of a stretch of the river for three miles and a half on each side.
>
> Mr. Callahan says the company plans to install a dredge of large size before the end of the year. Prospecting has shown values of 30 cents to $4 a yard.

The location of this ground, as described above, indicates that it is the old Pomeroy dredging ground situated immediately below Weatherby on the O.-W. R. & N., about 14 miles northwest from Huntington.

BUTLER ANTIMONY CLAIMS (antimony-silver) NEW ELDORADO DIST. GRANT CO.

This prospect is in about Sec. 2, T. 10 S., R. 33 E., approximately 4 miles east of Susanville, on the steep west slope of the north branch of Big Boulder creek. These claims were located in 1914.

The country rock is granodiorite. A nearly vertical vein strikes N. 70° W., and is about 12 feet wide where it is opened up in 2 or 3 surface cuts. The vein consists chiefly of quartz, with small included crystals of stibnite, the sulphide of antimony. In places stibnite is abundant in stringers about an inch wide. The vein is of the replacement type, and is reported to have, in the few assays made, about 30 ounces of silver.

BYERS AND HOLLENBECK CLAIMS (placer) SIXES RIVER DIST. CURRY COUNTY

A. G. Byers and G. H. Hollenbeck own two placer claims on the south side of the South fork of Sixes river, which they acquired by location in August, 1915. At the time this examination was made they had just begun work, and had panned about 50 pans of gravel, which averaged one good color per pan.

The gravel bank is an old bench 15 feet above the present water level, and averages about 10 feet in thickness. The best values are said to exist on the bedrock. When interviewed, the owners were planning to sluice the gravel.

CALAPOOIA AND BLUE RIVER MILL AND MINING COMPANY (gold, silver)
BLUE RIVER DISTRICT LANE COUNTY

Office: Brownsville, Oregon. W. B. Blanchard, Pres.; C. E. Stanard, Sec.-Treas., both of Brownsville. Capital stock, $300,000; par value $1.00; $200,000 subscribed, issued and paid up. (1916 report).

The property is in T. 15 S., R. 4 E., and consists of 5 patented claims and 1 claim held by location.

Most of the work is done upon one of the patented claims called the "Poorman," where there is a 600-foot tunnel, which samples from $3.00 to $24.00 per ton. The other claims have been prospected, and all show gold, silver and "base ore."

There is a 2-stamp Tremain mill on the property. There is little activity at present. Information given by W. B. Blanchard.

CALIFORNIA CONSOLIDATED MINES COMPANY

Office: 63 Sixth St., Portland, Oregon. H. W. Manning, Pres.; M. Manning, Sec., both of 63 Sixth St., Portland. Capital stock, $750,000; par value $1.00; $376,040 subscribed, issued and paid up. (1914 report).

This company may be the owner of the California mine, which see.

CALIFORNIA MINE (gold) CABLE COVE DISTRICT BAKER COUNTY

This may be the property of the California Consolidated Mines Company, referred to elsewhere.

The California mine, in Sec. 15, T. 8 S., R 36 E., adjoining the Imperial on the west, is one of the oldest mines in eastern Oregon. It was located in 1873 and at various times up to the building of the mill in 1897 shipments of high grade ore were made assaying from $50 to $500 per ton. In 1897 several carloads were shipped. The 10-stamp concentrating mill was a failure. It is said that a test run upon $25 ore produced concentrates of less value than the crude ore. There has been quite a little development upon the property in several tunnels over a vertical distance of 800 feet, but the mine is not accessible.

The ore, like that at the Imperial mine, consists of heavy sulphides in quartz and calcite in narrow streaks in a 3-foot vein.

CALUMET MINE (gold, etc.) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Concerning this mine Diller says:

The Calumet mine embraces 9 claims, extending from Illinois river at the mouth of Rancherie creek southwest by the forks of the creek for a mile and a half. The country rock is serpentine and tuffaceous greenstone. The fragmental character of the greenstone demonstrates its volcanic origin and also shows that it is intruded by the serpentine. As a result the greenstone at a number of places on or near the contact is more or less richly mineralized with pyrite, pyrrhotite, and some chalcopyrite and galena.

The principal openings of this mine for pyrrhotite and auriferous chalcopyrite are near the mouth and forks of Rancherie creek. They are described in this report under the head of "Copper Mines" because of their relation to the deposit on Fall creek. It is reported, however, that most of the value is in gold.

The greater underground workings of the Calumet mine are in a hill of tuffaceous greenstone nearly surrounded by serpentine about a mile southwest of the forks, higher up the spur than the outcrops of pyrrhotite. On the summit of the hill is a prominent quartz ledge said to carry $4 to $8 a ton in gold. The hill has been tunneled from all sides by nearly 2,000 feet of workings designed to test its ores. Quartz veins are common and run in various directions from N. 40° W. to N. 70° E., centering in the hill. The best quartz veins visible carry chalcopyrite and galena, but the material generally carries free gold. The hill contains a great deal of low-grade ore that might be concentrated, and if the large 500 foot tunnel now far beneath the summit ledge strikes paying ore it might furnish a convenient means of removing a large body of ore.

CAMERON PLACER WALDO DISTRICT JOSEPHINE COUNTY

See "Logan, Simmons & Cameron" mine.

CAMP BIRD CLAIM WALDO DISTRICT JOSEPHINE COUNTY

The Camp Bird claim, owned by Herz and Tibbits, about 11 miles southeast of Holland, is near Bollon lake at the place formerly called Gold Center, at an elevation of about 5300 feet, as measured by barometer. The adit extends S. 70° W. 50 paces in a fine grained auganite containing phenocrysts of labradorite and colorless augite with rare pale brown hornblende in a felsitic matrix of the same minerals with chlorite and a black mineral suggesting ilmenite. At the face of the adit a quartz stringer strikes N. 65° W. and dips about 80° S. W. At the discovery shaft a quartz vein about 6 inches wide strikes west and dips about 75° S.; this shaft is about 300 feet N. 60° W. of the portal of the main adit, and about 120 feet higher.

CAMP CARSON MINE (placer) CAMP CARSON DISTRICT UNION COUNTY

This property is owned by Turner Oliver, of La Grande, Oregon, secured from the Camp Carson Mining and Power Company through liens. It is situated in the southern part of T. 6 S., R. 36 E., and is directly west of North Powder, a distance of 28 miles by wagon road, and about 45 miles by wagon road south from La Grande. The elevation of the property is about 6000 feet.

It consists of 72 claims, but the part of chief interest is that found in the 3 very large pits along the north-south strike of a series of gravel beds, which extend for about 1 mile and dip to the west at an agle of about 25 degrees. The hydraulicking of these separate pits, which have depths of from 10 feet to more than 100 feet, has exposed a series of semi-consolidated beds composed of alternating layers of gravels, granitic sand and soft shales. The inclined bedrock is granite and upon it rests coarse gravels with occasional large boulders and many smaller ones from 6 to 12 inches in diameter. These beds are so persistent in thickness over a long distance along the strike and composed of such large gravel which grade off gradually with no evidence of cross-bedding, so characteristic of river gravels, that it seems likely that these are lake bed deposits of early Tertiary age.

These gravel beds have been worked intermittently by several companies and numerous hydraulic processes with indifferent success. In the largest pit the beds exposed above the granite are from 75 to over 100 feet thick, but which bed or beds carry workable values has not been determined. This information is prerequisite to planning proper methods of mining, and since the chief values are said not to be free, but are contained in sulphides, a method of recovery should be very carefully worked out after extensive sampling had proven that there is sufficient value in the gravels to warrant such experimentation.

CAMP CARSON MINING AND POWER COMPANY CAMP CARSON DIST. UNION CO.

Office: Hoge Bldg., Seattle, Washington. B. F. Walling, Pres.; B. F. Knapp, Sec.-Treas., both of Seattle. Capital stock, $125,000; par value $100; $122,800 subscribed, issued and all paid up. (1916 report).

This company was organized to operate the Camp Carson mine, but the property was afterward sold to Turner Oliver, of La Grande, Oregon, to satisfy the liens upon it. It is now owned by him. The Camp Carson mine is described under that title.

CANYON CREEK CONSOLIDATED GOLD MINES (California corporation) (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Diller says:

The property of the Canyon Creek Consolidated Gold Mines Company embraces 7 claims near the head of the North Fork of Canyon Creek, about 8 miles directly west of Kerby, at an elevation of about 2,900 feet. After a number of prospect openings, more or less promising, were made high up on the slope, a tunnel was run 500 or 600 feet below to find their downward extension. The tunnel is of good size and 300 feet long in greenstone. No important body of ore has yet been reached. A small stringer was cut, yielding $65 in gold and silver to the ton. About 90 feet of rock tunneled is more or less impregnated with pyrite and is said to assay from $2 to $4 a ton. It is proposed to continue the search for the rich ore.

An opening on the creek nearly a mile above the mine exposes a slickensided fault plane striking N. 60° E. and dipping 60° SE.

CANYON MOUNTAIN MINING COMPANY (gold) CANYON DIST. GRANT COUNTY

Local name, Mountain View mine.

Office: Canyon City, Oregon. Jackson Chambers, Pres.; F. S. Slater, Sec.-Treas., both of Canyon City. Capital stock, $1,000,000; par value $1.00; $810,005 subscribed; $876,392 issued and paid up. (1916 report).

This company's property is located 1¼ miles southeast from Canyon City, at an elevation of about 4500 feet, some 1200 feet above the town. The country rock is greenstone and the deposit is in many ways similar to that of the Great Northern mines, elsewhere described. There is a persistent ledge a few feet in width with small stringers roughly parallel approaching the main ledge at an angle of 45 degrees, in which there is frequently found specimens so rich that this company concluded that all the rock could be quarried and milled so as to produce from $3 to $5 per ton in free milling gold. In the fall of 1914 their 10-stamp mill, built during the summer, was operated for a short time, but apparently results were disappointing. The development consists of one tunnel about 500 feet long, which is 300 feet away from the main ledge above referred to. The property has been almost idle since 1914.

CANYONVILLE MINING COMPANY

Articles of incorporation filed December, 1916, with a capital stock of $10,000; par value $1.00. A. E. Sessions, Pres.; George S. Reid, Treas.; Chas. B. Baily, Vice-Pres. and Sec.

CAP MILLER GROUP (copper) HOMESTEAD DISTRICT BAKER COUNTY

This prospect consists of 6 claims and joins the MacDougall group to the south, and has the same type of copper glance deposits, with wide outcrops of promising appearance.

CAPE BLANCO OCEAN BEACH MINE (placer) SIXES RIVER DIST. CURRY COUNTY

The present ocean beach in the vicinity of Cape Blanco is reported to be unusually rich, and there seems no doubt but that large quantities of gold have been extracted from the sand by means of primitive methods. A Sweet gold machine was installed on this beach during the summer of 1915, but while considerable gold and platinum was recovered, it was found impossible to work the sand profitably, as the strong winds which prevail there filled up the cuts as fast as they could be made.

CARDWELL CLAIM (placer) MULE CREEK DISTRICT CURRY COUNTY

W. W. Cardwell, of Roseburg, owns a placer claim on the west fork of the west fork of Mule creek. It can be operated only when water conditions are favorable, as the gold is being recovered from the gravel in the present creek bed. It is reported that it has been quite profitable.

CARLTON GROUP (copper) GALICE DISTRICT JOSEPHINE COUNTY

With reference to this group, Diller says:

The Carlton group, embracing 9 claims, lies on both sides of the South Fork of Galice creek 3 miles southwest of Galice, at an elevation of nearly 1,400 feet. The country rock is slate and greenstone, and their contact corresponds to the position of the Great Yank lode on which the Almeda mine is situated. Two tunnels, aggregating about 250 feet in length, run into the greenstone near the contact. The greenstone in places where sheared is richly impregnated with pyrite and some chalcopyrite. The rock is so richly pyritized that if auriferous it would afford a concentrating ore. An assay made for the Geological Survey by E. E. Burlingame and Company yielded a trace of gold. Some ore bodies are reported on the hillside a short distance south of the tunnels referred to, but the tunnels have not yet reached them.

CARPENTER HILL MINE BAKER DISTRICT BAKER COUNTY

The Carpenter Hill mine is located on Salmon creek in Sec. 8, T. 9 S., R. 39 E., above the old Nelson placers. A tunnel has been driven 1200 feet in greenstone and intercepts many quartz veins, the largest of which is seldom wider than 6 inches. There is a 5-stamp mill on this property, but operations ceased several years ago.

CARTINELL MINE (copper) GOLD HILL DISTRICT JACKSON COUNTY

The Cartinell mine is near the center of Sec. 9, T. 36 S., R. 4 W., less than 2 miles northwest of Woodville, at an elevation of 1250 feet by barometer. An adit extends due northwest about 150 feet and thence N. 55° W. about 50 feet in a fissured zone containing short offsetting lenses of quartz with bunches of chalcopyrite. The vein dips to the northeast at an angle of 50 to 60°; in the weathered zone it contains malachite and azurite. The country rock is andesite, in which the curved cleavages of phenocrysts of pale green hornblende show evidence that the rock has been under considerable differential pressures.

CASCADE COAL MINE JACKSONVILLE DISTRICT JACKSON COUNTY

The largest supply of fuel provided by nature in the Jacksonville district is to be found in the deposits of coal interbedded with Tertiary sediments, probably of Eocene age. There are several seams of coal in the district and some of them have been opened by incline adits or slopes of notable length. Thus, the Cascade coal mine, about 5 miles northeast of Medford, is opened by a double track entry running in N. 87° E., said to be 900 feet long, with a slope at right angles to the adit inclined at an angle of 15 to 18°, and said to be 250 feet on the incline. The workings were nearly full of water when visited in June, 1913. The coal occurs in seams up to 6 inches thick, and is somewhat lenticular or irregular; it is reported to be better with depth. The mine is in Sec. 3, T. 37 S., R. 1 W., at an elevation of 1470 feet, as measured by aneroid barometer. Nearby a small incline has been run N. 40° E., showing a coal-bearing seam about 2 feet thick, which strikes N. 50° W. and dips about 10° N. E. A section near the portal of the west tunnel is given.

Section at Cascade Coal Mine

	Feet	Inches
Sandstone	2+	
Coal		6
Coaly shale	4	6
Coal		2
Coaly shale		2
Coal		2
Coaly shale		4
Coal		3

By sorting, some coal has been obtained from the Cascade mine for local uses. Fossils, said to indicate Eocene age, were obtained from the dump.

CASEY PROSPECT (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

With reference to this property, Diller says:

On the west fork of Rancherie creek, at an elevation of about 3,200 feet and nearly 11 miles in a direct line northwest of Kerby, a group of 6 claims is being actively prospected. The openings are near the contact of greenstone and serpentine, and a soft black deposit rich in pyrite has attracted attention on account of its rapid oxidation and the development of heat when exposed. The material had not been assayed at the time of my examination, but when panned and treated with nitric acid to remove the pyrite it yields numerous colors. The serpentine shows some copper stains, and the decomposed greenstone deeply covering the hill slope is said to pan well in free gold. Assays of the ore by a local assayer are said to indicate a content of $60 a ton. Water is being turned on this property to wash the crushed material at the contact.

CASTEEL MINES COMPANY (placer) DOUGLAS COUNTY

Local name, Casteel mine.

Office: 1500 Vincent Ave., Portland, Oregon. C. N. Johnson, Gaston, Oregon, Pres.; George W. Peterson, 1500 Vincent Ave., Portland, Sec.; Allen W. Smith, Electric Bldg., Portland, Treas. Capital stock, $100,000; par value $1.00; $94,000 subscribed, issued and paid up. (1915 report).

This company owns 160 acres of placer ground in Secs. 14, 15 and 22, T. 28 S., R. 4 W., 12 miles east of Myrtle creek. The company has worked these claims for the last 4 years and has taken out enough gold to pay all expenses, which included such work as ditches and flood dams. The mine is equipped with 2 large giants and 1200 feet of good pipe and all necessary tools for mining. Two men are employed at the mine the year around. Shortage of water is the only drawback. The company plans to build a large ditch 15 miles long, which will take in some 10 or 12 small creeks, and with plenty of rain or snow will be able then to run 7 or 8 months every year. Large bones and tusks of animals and many shells have been washed from the gravels. The mine has always paid well and some large gold nuggets have been taken out in the last 2 years which ranged from $3 to $25 each.

The above information is furnished by J. F. McCormick, a stockholder.

CATTON'S CLAIM GOLD HILL DISTRICT JACKSON COUNTY

See "Coster & Catton's claim."

CENTRAL OREGON MINING COMPANY (mercury) OCHOCO DIST. CROOK COUNTY

Office: 446 E. 58th St., Portland, Oregon. Levi Tillatson, 314 Failing Bldg., Pres.; E. S. Huckaby, 446 E. 58th St., Sec.-Treas. Capital stock, $10,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company has 3 claims on Lookout mountain, the Eldorado, Leroy and White Star.

These names are the same as those of the American Almaden Quicksilver and Gold Mining Company. Three flasks were produced in 1915. The Central Oregon Mining Company is apparently an operating company. There was a small force of men at work in the fall of 1916.

CENTRAL OREGON OIL AND GAS COMPANY (Idaho corporation)

Office: Boise, Idaho. J. C. Turney, Burns, Oregon, Pres.; William R. Litzenberg, Portland, Sec.; C. H. Feldman, Portland, Treas.; G. W. Allen, Portland, attorney-in-fact. Capital stock, $1,500,000; par value $1.00; $1,244,865 subscribed and issued; $320,394 paid up. (1916 report).

CHATTY MINE (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Concerning this mine, Diller says:

The Chatty mine is situated in Days Gulch, nearly 5 miles northwest of Kerby, at an elevation of 3,160 feet. The country rock is greenstone and is much decomposed near its contact with serpentine, where the original owner some years ago found a rich pocket which is reported to have yielded approximately $8,000.

The mine was worked to a depth of 30 feet before it came into the hands of the present owner, who has run a tunnel 110 feet to a fault with a well-defined gouge, but no valuable ore is yet in evidence. The fault runs N. 4° W. and has a steep dip to the west, being approximately parallel to the adjacent contact between the greenstone and serpentine.

This pocket, of small extent, was in oxidized material and its contents were completely removed some years ago. Early prospectors found traces of gold on the surface. Later these traces were followed to a depth of 15 or 20 feet into the oxidized rock, where in the rich pocket the quartz veins were found rusty and black. The quartz in the vicinity is porous, and where compact between the cavities is fairly rich in pyrite. The cavities are lined with quartz crystals, generally coated with limonite like that filling the late fissures in the rock. No free gold was seen with the quartz in any of the cavities, although pocket hunters of the region assert that such quartz is characteristic of pockets. An extension of the pocket has been sought for in all directions, apparently without avail, although the work continues.

CHETCO COPPER COMPANY (copper) CHINA DIGGINGS DIST. CURRY COUNTY

This company's property is located 8 miles west and a little north of Kerby, close to the Josephine county line. It was not visited, but Diller refers to the property as follows:

The same serpentine belt with which the copper deposits are associated on Fall and Rancherie creeks extends southwest by the head of Canyon creek to Chetco river, where a number of similar deposits occur and have been prospected by the Chetco Copper Company and others, by tunnels aggregating more than 250 feet. The ore appears to be mainly chalcopyrite, but Dixon's prospect has furnished some native copper ,and some remarkably beautiful specimens of the bright red oxide of copper, cuprite, in minute cubic crystals. A small amount of ore is said to have been shipped from this locality.

The company was dissolved January 7, 1911.

CHICAGO-VIRTUE MINING AND DEVELOPMENT COMPANY (gold)
VIRTUE DISTRICT BAKER COUNTY

Local name, Chicago-Virtue, formerly the Barry property.

V. P. Dole, Pres., Chicago, Ill.; L. Richey, Sec., Baker; James Meyers, Treas., Baker. (1916 report).

Located about 14 miles to the southeast of Baker in the northern part of Sec. 35, T. 9 S., R. 41 E., on low sagebrush covered hills. The country rock is argillite or greenstone and is much weathered on the surface. The vein is narrow (the maximum width being about 8 inches) and has a strike of about N. 70° E., dip 85° S. It has been traced but a short distance along the strike.

The development work consists of a shaft about 100 feet deep on the vein, with a short drift 40 feet below the surface. There are also several small tunnels and open pits on the property. A 5-stamp mill has been nearly completed.

Very high values were claimed for this vein, but accurate sampling disclosed the fact that although very small bunches of specimen ore might be found, the average value of the quartz was extremely low.

CHISHOLM GROUP (mercury) GOLD HILL DISTRICT JACKSON COUNTY

This group, owned by Dr. W. P. Chisholm, of Rogue River, is located in Secs. 17 and 20, T. 34 S., R. 2 W. Considerable development work has been done on this property and some high grade cinnabar ore has been uncovered. Some retorting was done during the year on ores taken out during the development and several flasks of quicksilver have been sold.

(COLLIN) CHISHOLM (gold and copper) NEW ELDORADO DIST. GRANT COUNTY

This property is located on a shear zone, which is mineralized in places. Pyrite is the chief ore mineral. Pyrrhotite and some chalcopyrite are also present. This zone strikes about N. 60° E., and appears to be somewhat similar to those on the southern slope of the Wallowa range, of which the Poorman is a type, although the shearing and percentage of copper is much less. How much gold and silver per ton is present in this claim was not learned.

CHLORIDE MINE (silver and gold) GREENHORN DISTRICT GRANT COUNTY

This property is located in Sec. 2, T. 10 S., R. 34 E., practically on the backbone of the main Greenhorn range, at an elevation of 7250 feet. The vein is in granodiorite striking northeast, and is developed to some degree by drifts and crosscuts. Shipments have been made from this property.

The ore consists of quartz, arsenopyrite, pyrite, zinc blende, and a little galena in small veins in country rock, which has been bleached by the development of sericite and calcite stained green with chromium mica. Great widths of the veins are claimed for this property, due to the parallel fracturing or shearing of the granodiorite for considerable widths, but these large dimensions are of little economic importance, since the mineralization outside of the principal fracture is nearly always insufficient to warrant mining. The values are in silver and gold. Reported assays from various points range from \$5 to \$250, more than half of which is in gold, which below the zone of oxidation may be reversed.

CHROMITE DEPOSIT COLLIER CREEK DISTRICT CURRY COUNTY

On the top of the ridge above Little Meadow camp, about 2 miles south of Collier butte, are numerous fragments of chromite float. They lie on serpentine not far from its contact with Dothan shales, and are sufficiently large and numerous to indicate the existence of one or more ore bodies of considerable size in that vicinity. A general sample taken from a number of fragments proved on analysis to contain 48.09 per cent chromic oxide, 16.44 per cent iron, 19.78 per cent silica, 8.12 per cent alumina, a trace of titanium, and no magnesium.

CHROMITE MINES CANYON DISTRICT GRANT COUNTY

South and east of Canyon City there are several outcrops of chrome iron ore, but the largest deposit, which was being developed in the late summer of 1916, is located about 4 miles southeast of Canyon City at the head of Quartz gulch and about 17 miles from the railroad at Prairie City. The property belongs to Joe Beggs and Chas. McCorkle, of Canyon City, and has been leased on a royalty basis to the Farrish Company, of San Francisco, with W. C.

Lummis in charge of operations. The deposit outcrops for several hundred feet and the maximum width is at least 30 feet. It is estimated by the owners that this one deposit contains at least 60,000 tons, which can be easily quarried and loaded into wagons for shipment to the iron furnaces in the vicinity of Pittsburgh, Pa., to be used in the manufacture of chrome steel. A wagon road was completed in September to the lower part of the outcrop, and press reports late in September state that the superintendent was busy engaging teams and men, and it was estimated that it would take about 125 horses to haul the ore to the railroad at Prairie City. Press reports late in November state that 60 tons of ore per day were being delivered at Prairie City.

(A. P.) CHURCHILL PROPERTY (gold, etc.) BOHEMIA DIST. LANE COUNTY

Owned by A. P. Churchill. Consists of 11 claims located near the corner of Secs. 23, 24, 25 and 26, T. 23 S., R. 1 E., on President creek, about 3 miles to the south of Bohemia postoffice, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove.

The country rocks are andesite, dacite and volcanic breccia. The main lode strikes N. 60° W., with a dip of 45 to 50° south. The average width is from 3 to 4 feet, and it is said to have been traced on the surface for 1400 feet. The ore minerals are galenite, sphalerite and a small amount of chalcopyrite, and in one cut stibnite is present.

The development work consists of open pits and short tunnels. No definite information of values are available, but good values are said to have been obtained from the oxidized portion of the zone.

CINCINNATI MINING COMPANY BAKER COUNTY

Office: Baker, Oregon. L. G. Lilley, Pres.; C. T. Godwin, Sec.; James H. Nichols, Treas., all of Baker, Oregon. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1913 report).

This company held under contract 13 claims upon Pedro mountain, in Rye Valley mining district, owned by Jack Regan and I. R. McCord, but terms of contract were not fulfilled. Owners are recovering the property. Other assets not known. This information given by treasurer. Dissolved by proclamation in January, 1917.

CINDERELLA MINING COMPANY (gold-silver) BLUE RIVER DIST. LINN COUNTY

Local name, Great Eastern mine.

Office: Halsey, Oregon. W. J. Ribelin, Pres.; H. C. Davis, Sec.-Treas., both of Halsey. Capital stock, $300,000; par value $1.00; $200,000 subscribed, issued and paid up. (1916 report).

Property consists of 7 claims, situated in the southern part of T. 15 S., R. 4 E. Trail about 1 mile to mountain road; 2 miles south to Lucky Boy mine; fairly good road to Blue River postoffice, and from Blue River to Eugene, 45 miles, road is in good shape.

The country rock is andesitic breccia. The deposit consists of a quartz vein about 2 feet wide, having a N. W.-S. E. strike and dipping at a high angle. This vein has been developed by tunnels and raises.

No definite information is available as to the value of ore exposed. A careful and systematic sampling of the vein matter would be very useful in directing further development work.

There is a small 3-stamp mill on the property.

CINNABAR DEPOSITS (mercury) CANYON DISTRICT GRANT COUNTY

About 8 miles north of Mt. Vernon, on what is locally called Cinnabar mountain, is a quartz-calcite vein, which is reported to be traceable for a length of several claims. Its width is said to be 3 to 4 feet and quite regular. Cinnabar, the ore of mercury, is found in places in the vein next to one wall. It was prospected in the early placer days and the best grade was retorted in crude appliances and used by the placer miners of Canyon City and vicinity in catching their gold in the riffles. The deposit was abandoned for many years following the decline of placer operations, but the high price of mercury in 1915-1916 caused them to be relocated and some development has been done by drifting to search for commercial grades of cinnabar.

CLACKAMAS MINING AND MILLING COMPANY (gold) OGLE CREEK DISTRICT CLACKAMAS COUNTY

Office: Oregon City, Oregon. E. H. Carlton, Pres., Canby, Oregon; C. D. Latourette, Sec.; D. C. Latourette, Treas., Oregon City. Capital stock, $1000; par value $10; all subscribed, issued and paid up. (1916 report).

This company owns 3 claims on the north side of Henline mountain at the headwaters of the south fork of Molalla river, in about Sec. 10, T. 8 S., R. 4 E., near the Ogle Mountain mine, reached by a poor wagon road 35 miles east from Silverton. The property can also be reached from Gates on the S. P. railroad by good wagon road for 10 miles northeast to the Silver King mine, then 4 miles by trail over the divide to the north.

The ore deposit at this property is reported to be similar to that of the Ogle Mountain Mining Company's property, and developed by a few short tunnels and open cuts.

CLEVELAND CLAIM ASHLAND DISTRICT JACKSON COUNTY

For description see "Snapshot Claim."

CLEVELAND DEVELOPMENT CO. (gold) MORMON BASIN DIST. MALHEUR CO.

Local name, Cleveland mine.

Office: 408 Buchanan Bldg., Portland, Oregon. Wm. P. Chapman, Pres., 882 Belmont St., Portland; H. G. Patterson, Sec., F. C. Graf, Treas., both of 408 Buchanan Bldg., Portland. Capital stock, $250,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company has 15 claims located near the center of T. 13 S., R. 43 E. about 1 mile south of the Rainbow mine.

Country rock is schistose argillite or greenstone capped by recent lake beds. Development work consists of 2 tunnels and several pits. The lower tunnel (several hundred feet long) was driven first through lake beds then reaching schistose argillite or greenstone and in the summer of 1916 was being driven along a porphyry dike (probably granodiorite) which contained a few quartz seams. This dike but a few feet wide has a strike S. 75° W. and dips steeply to the south. This property has other showings about a mile from the principal workings which were not visited.

CLIFF MINE (gold and tungsten) VIRTUE DISTRICT BAKER COUNTY

This property, owned by Bradbury brothers, is located about 5 miles northeast of Baker, approximately 1 mile north of the Flagstaff mine, at an elevation of about 3600 feet. The property is developed by a shaft to a depth of about 300 feet and was developed as a gold prospect, but in 1916 attention was called to the presence in the ore of scheelite, an ore of tungsten. The property was leased in April, 1916, to F. S. Baillie, former manager of the Columbia mine and at present manager of the Baker Mines Company, who proceeded to prospect the property. Later on W. E. King, of the Rainbow mine, to whom the lease was assigned by Mr. Baillie, opened up the caved shaft so that an inspection and sampling of the lower level could be made. At the time the property was visited the retimbering of the shaft had not been completed, so no underground examination could be made.

CLIMAX MINE (gold) CRACKER CREEK DISTRICT BAKER COUNTY

Situated about ½ mile north of Columbia mine on Fruit creek. Has a small crusher and one stamp on property. Reported not active.

COBALT GROUP (gold-silver-cobalt) ILLINOIS RIVER DIST. JOSEPHINE COUNTY

This group of claims is owned by Frank Berry, of Agness, and is situated at the base of Bald mountain on the east side of the Illinois river. Here is a serpentine hill about 800 feet high, 2 miles long, and two-thirds of a mile wide. It looks like a slide, but as Bald mountain is composed of different material, the serpentine is doubtless in place.

The serpentine is practically free from overburden, and great patches of it are heavily iron-stained at the surface. It has been opened by means of numerous cuts and shafts, and it is claimed that all these openings run into sulphides, principally pyrite, at no great depth. It is stated that independent examinations showed that the ore ran on an average about $10 a ton in gold and silver, and that other elements present, including copper and cobalt, brought the total value to between $15 and $16 a ton. The quantity of ore available is certainly enormous, and if the figures quoted prove correct, it ought to be possible to develop a mine here. It was impossible, because of limited time, to visit more than a few of the openings. From one of these in which many feet of solid pyrite was exposed, a sample was taken which assayed not a trace of gold. Another sample of the porous, iron-stained gossan yielded the same result. From this, it is evident that all the mineral is not gold-bearing, but there are so many exposures and the mineralization has been so extensive that it is not unlikely large bodies of good ore exist elsewhere on the hill.

COEUR D'ALENE DEVELOPMENT COMPANY IDAHO

Office: City Hall, Saratoga, N. Y. E. T. Brackett, Saratoga, N. Y., Pres.; Wm. E. Benton, Saratoga, N. Y., Sec.-Treas. Capital stock, $100,000; par value 10 cents; all subscribed, issued and paid up. (1915 report).

This company's properties are located in Shoshone county, Idaho.

COLE CLAIMS (copper) HOMESTEAD DISTRICT BAKER COUNTY

These claims are located in a branch gulch less than a half mile west of the river from Ballard's landing in Sec. 10 T. 6 S., R. 48 E. The country rock is an altered volcanic breccia containing some chalcopyrite. The chalcopyrite is in fair sized grains and in minute reticulate veins. Much secondary quartz and chlorite are present. A vein about 1 foot wide is being followed with the expectation, after some further work, of reaching one of much greater width, which is said to outcrop upon the hill.

COLD SPRING MINE (copper) GALICE DISTRICT JOSEPHINE COUNTY

With reference to this property Diller says:

> The Cold Spring copper mine lies on the southwest slope of the West Fork of the Galice creek nearly opposite the Sugar Pine. It was lately examined in detail under option by the Almeda Company and half a ton of ore shipped for test. Although I did not see the mine, Mr. Daniel Green informs me that large bodies of copper ore, chiefly chalcopyrite, is in sight, The ore is said to be of good grade, but it has no associated galena, as at Sugar Pine.

COLLIER CREEK COPPER COMPANY COLLIER CREEK DIST. CURRY COUNTY

This property includes a number of claims running from the neighborhood of Horse Sign butte southward, approximately 10 miles south from Agness.

Mr. Frank Berry, of Agness, is either the sole owner of this property or else possesses a controlling interest. Most of the work on the property was done 20 years ago, and the only openings now accessible consist of open cuts and shallow shafts.

The principal mineralized zones on the property are known as the Collier creek vein, the Eagle vein, and the Mohawk vein. Of these, the first is the most persistent, and is exposed in an open cut about 300 yards somewhat east of south of Burt camp over a low divide, as well as elsewhere. This deposit is of the shear-zone type in serpentine, and contains a number of boulder-like masses of iron and copper ores. One hundred feet or less west of the zone, and parallel to it, is a dike of dacite-porphyry, while east of the zone lies comparatively unaltered peridotite. The mineralized zone itself averages about 4 feet wide, and the outcrop consists largely of limonite or limonite-stained serpentine. At many points the gossan is very porous and highly ferruginous, so the zone, which strikes S. 25° W., is easily traceable on the surface. At some points, however, the iron-stain disappears, giving place to a mass of serpentine containing numerous bluish or black veinlets.

Many fragments of good looking copper and iron ore occur in the various dumps along this zone, but most of these have been exposed to the weather so long that a considerable portion of their copper contents has doubtless been leached out. Analyses running as high as 30 per cent copper are said to have been obtained from the freshly mined ore.

The Mohawk vein appears to be an off-shoot of the Collier creek vein. It leaves the latter in the saddle just south of Burt camp, finally disappears under Horse Sign butte, and strikes about N. 10° E. Like the Collier creek vein, the Mohawk is paralleled to the west by a ledge of dacite-porphyry. The two zones are in fact decidedly similar in most respects, but the Mohawk is marked by association with a dark-brown serpentine instead of with the greenish material commonly found in connection with the Collier creek vein.

A fairly fresh sample taken from a small cut on the Mohawk vein was found to consist of magnetite (magnetic oxide of iron), cuprite (red oxide of copper), and malachite (green carbonate of copper); and proved to contain 9.87 per cent copper and traces of gold and silver. Another sample of extremely porous, heavily iron-stained gossan from an outcrop of this vein yielded not a trace of copper, gold or silver.

The Eagle vein, probably an off-shoot of the Collier creek vein, is best exposed just south of the saddle west of Horse Sign butte. A fairly deep shaft at this point exposes a great deal of copper-stained serpentine. The material now on the dump looks low-grade, but the prospect is said to have produced at least one nugget of native copper weighing 26 pounds.

This company was dissolved January 3, 1912.

COLLINS MINE (placer) GOLD BEACH DISTRICT CURRY COUNTY

During the winter of 1914-15, A. M. Collins, of Agness, worked a black sand deposit on ground owned by the Wedderburn Trading Company, about 4 miles north of Wedderburn. He says the deposit is in an old beach about 30 feet above the present water level, and consists of from 12 to 18 inches of nearly pure black sand containing good gold and platinum values, with several feet of lower grade material above, which was separated from the lower streak by 2 to 3 feet of low-grade gray sand. He caught the gold on canvas tables, and, in spite of the fact that he had to pay 30 per cent royalty to the owners of the ground, he succeeded in making good wages throughout the winter.

COLLINS CLAIMS UPPER APPLEGATE DISTRICT JACKSON COUNTY

See "Moses & Collins" claims.

COLUMBIA COAL AND COKE COMPANY WASHINGTON

Office: Corbett Bldg., Portland, Oregon. A. S. Nichols, Pres.; J. K. Kollock, Sec.; H. S. Nichols, Treas., all of Corbett Bldg., Portland, Oregon. Capital stock, $60,000; par value ten cents; all subscribed, issued and paid up. (1916 report).

This company's properties are located in Lewis county, Washington.

COLUMBIA GOLD MINING COMPANY (gold) CRACKER CREEK DIST. BAKER CO.

Local name, Columbia mine.

Office: Sumpter, Oregon. Edward W. Backus, Pres.; Wm. F. Brooks, Sec.; R. L. Horr, Treas., all of Minneapolis, Minn. Capital stock, $150,000; par value $100; all subscribed, issued and paid up. (1916 report).

The lands of this company consist of 2 claims upon the lode and other protective side claims. The mine is in Sec. 32, T. 8 S., R. 37 E., at an elevation of 5500 feet, on Fruit creek, a branch of Silver creek, which flows into Cracker creek, a tributary of Powder river, at Sumpter. The mine is 6 miles north from the Sumpter Valley railroad (narrow gauge) at Sumpter and about 1000 feet above the town, and in a well timbered area, except close in, where it has been used for mine timbers and fuel.

The following description taken from a previous report includes a description of the Golconda mine, the Taber Fraction mine, the E. & E. mine (Bourne Gold Mining Company), the North Pole mine and the South Pole mine. Sections treating of these properties will refer the reader to this description.

The North Pole-Columbia lode, roughly paralleling the Ibex, Bald mountain and Mammoth veins, and approximately a mile and a half southeast of them, is the most extensive gold lode in northeastern Oregon. It can be traced from near McCully fork northeast to Rock creek, a distance of about 6 miles, by its frequent and oftentimes prominent outcrops of brecciated argillite cemented together with quartz. Considerable development has been done upon many claims between McCully fork and Silver creek, among which are the Bunker Hill, Annalulu, Amazon, Mayflower and Mountain Belle, located upon the 2 branches of the vein which splits upon the Golconda property.

These claims just mentioned southwest of the Golconda, although having considerable development upon the lode, which is frequently very wide and highly silicified, have produced practically no ore. They have been either abandoned, patented and lying idle, or else development is confined to the annual assessment work.

The properties which have a record of considerable production beginning with the one farthest southwest, are the Golconda, the Columbia, the Taber Fraction, the Eureka and Excelsior, and the North Pole. The South Pole, upon the same lode and adjoining the North Pole on the northeast, has but a small record of production.

The country rock is the usual black siliceous argillite, sometimes schistose, but more often massive. In addition to the argillite, there is near the vein on the Golconda on its footwall side a body of greenstone, while on the hanging wall side of the Excelsior and North Pole claims is another body of the same rock, which appears to have been an intrusive sheet or sill.

The exposed granodiorite intrusion to the west and north, although at considerably higher elevations, is at no point as much as 2 miles away. The presence of frequent granitic dikes, especially in the vicinity of the northeastern part of the lode, points convincingly to its presence below the surface at much less distances.

These dikes are usually granodiorite porphyries, although near the divide between Silver creek and McCully fork, kersantite lamprophyre was observed. Away from the lodes these dikes are sufficiently fresh to determine their character, but those within the lode have been altered to such an extreme that their original character can only be inferred.

By reference to the section showing the developed portion of the lode attention is called to the fact that the northeast or South Pole claims, which extend over to the Rock creek slope, includes the highest part of the lode, and is in close proximity to the granodiorite intrusion, which is about one-half mile north of the South Pole tunnels. This high ridge has dikes in great profusion. They become less frequent as one goes down the hill toward the

E. and E. shaft, although they are not absent even as far as Golconda ground.

The crosscut on the Yankee Jim claim shows a considerably altered granodiorite-porphyry dike 50 feet wide, with quartz and sheared argillite upon both sides of it.

In tunnels 5 and 3 of the North Pole mine, in the face of the Excelsior adit north on North Pole ground, in the Columbia, and in the Golconda, is found a greenish-white rock, which is probably a porphyry which has suffered extreme alteration and has been impregnated with pyrite. In thin sections of this dike material the feldspars are so badly altered as to be indeterminable. It is simply an aggregate of sericite, kaolin, secondary quartz, feldspar and chlorite. Field evidences, together with the examination of hand specimens and thin sections, indicate that this intrusion, found at various points in the vein over a distance of more than 3 miles, in which the various specimens are strikingly similar, was originally a granodiorite-porphyry. Its extreme alteration indicates that it came into the plane of the vein, although probably not in a continuous sheet, at a time previous to the formation of the vein.

The lode at Silver creek strikes approximately N. 60° E., but changes its strike to the northward until upon the North Pole hill it is N. 30° E. Its dip in Columbia ground is about 60° S. E.; in the Eureka-Excelsior, 70-75°; and in the North Pole, 75-80°.

The lode is easily traced by its croppings of silicified argillite wherever rock in place comes to the surface. The most prominent outcrops are those upon the Golconda, which projects at least 20 feet above the adjoining country rock and upon North Pole ground, where an exposure of quartz is some 300 feet wide.

The width of the lode in the Golconda as determined in the workings is about 175 feet in the upper levels, and about 100 in the lower. In the Columbia it is shown upon the surface to be about 75 feet wide, and averages about 28 feet on the 900-foot level. In the E. and E. the vein is as much as 30 feet wide. In the North Pole, although it has the wide exposure of white quartz above referred to, underground the lode shows from 7 to 40 feet wide, except one crosscut in No. 2 tunnel, which, according to the maps, is in quartz far more than 150 feet, indicating that the large exposure upon the surface above the portal of No. 4 tunnel may extend downward indefinitely in a sort of quartz chimney. The mine maps indicate that development in No. 1 tunnel below and between No. 2 and the surface, has been almost entirely confined to drifting, with but few crosscuts, so that this probability is not demonstrated. The footwall vein on the dike in the Yankee Jim crosscut is about 16 feet wide. A cave prevented the observation of the hanging wall vein in this same crosscut, but it is said to be several feet wide. Although the lower tunnel is 1200 feet long on the South Pole, practically no crosscutting has been done to determine the width of the lode, but it evidently will average more than 10 feet.

The walls of the lode on the North Pole ground are fairly well defined fault planes, especially the footwall. The Columbia is similar to the North Pole, the walls being fairly well defined. The Golconda is between 2 usually well defined walls.

J. T. Pardee, in his description of the faulting and vein structure of the Cracker creek district, states:

> That this wide zone is a normal fault, which has a vertical displacement of at least 400 feet and a horizontal displacement of approximately 1800 feet.

This considerable movement brecciated and pulverized the material between the walls, which in part at least was the location of an intrusive dike of granodiorite-porphyry. Along this dike faulting occurred in a series of movements because it was a plane of weakness ever since the first fracturing that permitted the introduction of the dike. This movement brecciating this argillite zone was probably at about the same time of other vein fracturing in eastern Oregon, or some time in the later stages of the cooling of the Bald mountain intrusion.

This wide brecciated zone made an excellent channel through which the waters driven off from the cooling interior could ascend. These ascending waters, rich in silica, flowing more freely in some places in the zone than in others, deposited variable amounts of quartz from place to place, so that in the lode we have everything from slightly altered argillite to massive quartz. While much of this quartz is the filling between the argillite fragments, still a great deal of it replaced the argillite. This replacement was made so completely in places that only fine specks of carbon remain to indicate that where the quartz now is was once an argillite that contained elemental carbon.

The ascending hot solutions, besides the quartz, carried in solution and deposited with the quartz many different metallic sulphides. Those of much significance were arsenopyrite, pyrite, and to a lesser degree chalcopyrite. These sulphides, in which is practically all of the silver and gold, except in the shallow oxidized parts of the vein, are not disseminated throughout the lode's entire width, but occur in shoots upon one wall or the other, and occasionally at intermediate positions. Most of the massive quartz does not contain to exceed $1 per ton in gold, while much of the less altered argillite is of low grade. The best values are more frequently contained in highly replaced argillite, and often bear a close relation to a gouge streak.

The gold occurs chiefly in fine arsenopyrite. There is also iron pyrite, which is usually of lower grade. The ore is usually in a series of overlapping lenses, which make up the several shoots found in the developed part of the lode. These lenses vary from a mere seam to 25 feet in width. The average width of all the ore stoped in the North Pole mine is a little more than 3½ feet. While figures are not available as to the width of the ore stoped in the E. and E. mine, it probably approximates this figure. The Columbia ore reserves at the present time average 47 inches wide. The Golconda averages are not available, but the maximum width stoped is 25 feet, and doubtless the average for the mine would approximate the figures for the other properties.

With the exception of the Columbia's excellent systematic assay maps, there are none available for this lode. Probably such maps have never been made by the other companies.

It will be observed in the figure that the shoots in the Columbia property have no regular pitch in one direction in the plane of the vein, although they are fairly regular and persist to the lowest limits of development. In the other properties we have only the limits of stoping shown, and these stopes, especially on the North Pole ground, are of such great horizontal length compared with their depth that a pitch cannot be asserted.

The form of the stopes in the sketches and drawings available to the general public has caused many to assume that the shoots so far stoped have been the result of a downward enrichment, but when a few facts are considered it is apparent that little downward sulphide enrichment occurs. The arsenopyrite, which carries the greater part of the gold, is a primary mineral, and is unknown as a secondary constituent of ores enriched by descending sulphate solutions. Very few occurrences of secondary pyrite have been reported from sulphide deposits in western United States, and chalcopyrite in the greater number of its occurrences is clearly primary. The gangue minerals are quartz and calcite.

As already stated, the gold is found in the arsenopyrite, the pyrite containing but low values of that metal. The arsenopyrite and quartz in many places show comb structure, thus indicating successive depositions of these primary minerals from ascending thermal solutions. Frequently whole masses of the first deposited quartz and arsenopyrite have been shattered and recemented by a second deposition of quartz, which contains pyrite. Another phase in the mineralization that often occurs is a further brecciation and the filling of the minute fractures with calcite. Pyrite and arsenopyrite, which are characteristic of the lower vein zone, occur with the calcite. All of these successive mineralizations are the product of ascending hot waters. It would be rather difficult to account for the mineralization of the vein by the process of downward enrichment due to the occurrence of oxides of manganese found in some parts of the lode, which has been used by some as evidence favoring the downward enrichment theory. The presence of calcite occurring as the last phase of mineralization was overlooked, and it is, of course, a well known fact that this mineral will nullify the dissolving action of manganese upon gold.

The fact that in many of the mines the ore has been stoped practically to grass roots would indicate that no lessening of value due to the leaching of the upper portion of the vein has taken place.

A very superficial enrichment of this type of vein may be caused by erosion and the leaching of calcite, which causes a removal of a valueless element, thus leaving a smaller mass of richer ore; and also by a mechanical concentration of the fine gold along channels caused by fracturing and the removal of calcite by solution.

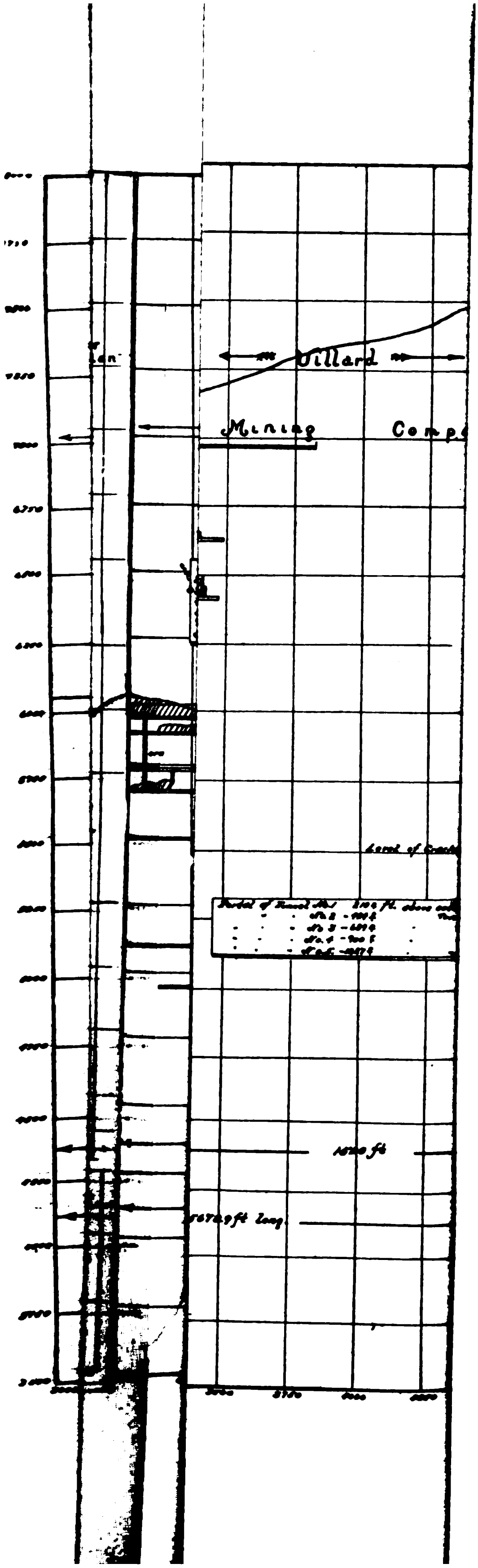
A casual examination of the underground workings, together with an inspection of the plans of the 5 mines located upon the developed portion of this lode, brings out the fact that with the exception of the Columbia, but little systematic crosscutting has been done on the various levels of the several properties.

While the ore shoots are more often located upon or in close proximity to the footwalls, they are not all so located. In the Golconda the lode is very wide and some crosscutting has been done which disclosed shoots upon both walls and an intermediate one cutting diagonally across from the foot to the hanging wall with a dip of 30°. In the Columbia a shoot is found not only on the footwall of the vein, but also on the hanging wall, and in one instance in an intermediate streak. Below the shaft the only shoots found are upon the footwall of the lode. In the E. and E. the shoots are found upon the footwall. In the North Pole they lie occasionally upon the footwall, but more frequently away from it, and occasionally upon the hanging wall. In the South Pole the development is practically confined to the hanging wall.

It will be also noted that there are 2500 feet on the North Pole hill between tunnel No. 5, on the North Pole, and No. 3, on the South Pole, which has had no drifting in the lode. It will also be seen that No. 1 tunnel on North Pole ground, which has no crosscuts, does not extend underneath the full length of the shoot above. Between the E. and E. shaft and the apex of the ridge, and above its 7th level, there is a million square feet of lode without development, above which there has been over a greater part of the distance ore extracted or evidences of it discovered as the result of widely separated prospect holes.

There is a very incomplete development between the walls by means of crosscuts where drifting has been done along the strike. Considerable lengths have not even a single drift, while beneath the known shoots of ore development has not been done in much of the ground to determine whether barren levels occur between bodies of ore, such as is found to occur in the Columbia on the 300-foot level north, where the wall is a carbonaceous argillite.

The percentage of recovery at the North Pole mill from 1895 to 1908, in treating approximately 158,000 tons of ore, averaged $12.22, or approximately 75 per cent. At the E. and E. mill, between 1891 and 1905, the recovery was no more than 63 per cent. The percentage of recovery at the Golconda mine is not available throughout a considerable period of its activity, but to illustrate, the percentage of recovery was 68 per cent from 16,515 tons treated from



Villard
Mining

February 1, 1903, to February 1, 1904. The Columbia secures the highest extraction of any, although the exact figure is not available for publication, but owing to the nature of the milling plant it is necessarily low.

The Golconda, Columbia and E. and E. mines are equipped with 20-stamp mills; the North Pole has a 30-stamp mill. The average daily tonnage capacity for the 20-stamp mills probably was below 50 tons, with a probable present maximum of 2000 tons a month at the Columbia, while the tonnage capacity for the 30-stamp mill did not exceed 65 tons daily throughout any one year.

These small capacities and the consequent high milling costs, in conjunction with the large losses in the tailings, demand a high average grade of ore. The total mining costs cannot very well be kept below $6 per ton, and without efficient management it will exceed that figure. With a 75 per cent extraction an ore averaging $8 is the lowest that can be mined.

The total production from the entire lode, estimated to January 1, 1915, is somewhat in excess of $8,000,000. The smallest production from any one of the properties amounts to more than $400,000. The recovery of $8,000,000 was secured from the several properties, whose combined efficiency from beginning to end does not exceed 67 per cent. The losses, therefor, in the tailings from these mills, was $4,000,000. The lowest acceptable percentage of recovery in present practice is 90 per cent, which signifies that $2,800,000 could have been saved in modern mills. If the present milling practice were continued until the production from this lode were doubled, the losses in excess of a permissible minimum recovery would be more than $1,000,000.

These statements might, at first thought, appear to be a reflection upon the persons who have operated these properties, but it must be borne in mind that their plants, though possible of improvement from time to time, were nevertheless installed before recent development in cyaniding complex ores or concentration by means of flotation had become available.

The improvements in these processes have been accomplished within the last two or three years, while the Golconda, Taber Fraction and E. and E. mines ceased operations 9 years ago, and the North Pole mine 6 years ago, which leaves the Columbia as the only steady producer since the North Pole closed down in 1908.

The Columbia mine is owned by 4 persons, with one of their number, Frank S. Baillie, as manager of the property. Under the efficient management of Mr. Baillie, who has been in charge of the property for 18 years, this company has never delayed a pay day a single day; it was for some time during this period the only steady producing quartz mine in Oregon. The owners naturally feel that a property which has eclipsed all others in the state in steadiness of operation and production, in conservative and successful management, should hesitate to make radical changes in methods which have been and are now successful. They realize that to effect a 90 per cent or more extraction at this mine would require extensive alterations in and additions to the present mill, which would involve the expenditure of considerable sums and would absorb their dividends for some time. The above reasons doubtless have had much to do with the failure of the stockholders to authorize the manager to make such extensive improvements.

A proper consolidation of these properties is an economic necessity for most of them and would be highly beneficial to all. Attempts to consolidate the leading properties have been made by some of the owners, as well as by outside interests, but for one cause or another have been unsuccessful. The usual difficulties have arisen when consolidation of properties is attempted where parties at interest attempt to set prices and make terms each upon his own.

An agreement could be made by the parties at interest to have all their properties examined and valued by a committee of three thoroughly competent engineers, who would report upon ore blocked out upon three or more sides, upon probable and possible ore, upon a new milling plant, and those parts of the surface plant, including water rights and equipment, which would be of value to the consolidation. The new organization would then be in a position to purchase from the individual owners, paying each company for their ore reserves on a basis of the net profits which would be secured in their individual plants.

The ore blocked out on 3 or more sides, although too low grade to mine in separate mills, would nevertheless pay in a consolidated new mill, and should therefore secure to the individual company possessing it some consideration other than stock.

A fair valuation of the separate properties in addition to the reserves and useful equipment, as determined by the committee of engineers, could be paid for in stock of the consolidation.

Aside from the amount of stock issued in payment for the individual properties, a sufficient amount should be placed in the treasury to be sold to meet the obligations to pay for the ore reserves under the terms above given and to supply an adequate sum to develop additional ore reserves and to construct a proper reduction plant when sufficient development work has been done to determine the size of plant which should be installed.

The ore actually blocked out in the Golconda and North Pole mines is small. The actual number of tons and value per ton fairly well blocked out in the E. and E. mine is not available, but a statement from the office of the company states that there is $500,000 worth of ore blocked out. This estimate probably refers to ore which could be treated at a profit in their present plant. There may be a much greater tonnage of ore averaging $5 or $6 which could probably be treated at a profit in the mill of the consolidated company. It is officially stated that there is 100,000 tons of $10 ore blocked out on 3 or more sides in the Columbia mine, and that the conditions with reference to ore on the 900-foot level are identical with those on the 600, 700 and 800-foot levels. No official statement is made as to the tonnage of ore blocked out which would be available in a new mill, but a reference to the sectional elevation of the mine, together with statements from persons not connected with the company, leads one to believe that this tonnage is large.

The North Pole mine is owned by Baring Brothers, of London, and is at present under bond and lease to John C. Lewis, of Portland, Oregon. The Bourne Gold Mining Company, owner of the E. and E. mine, is owned by ex-Senator Jonathan Bourne, Jr., and associates, of Portland, Oregon. The Columbia mine, officially known as the Columbia Gold Mining Company, is owned by Edward W. Backus and two other men, of Minneapolis, Minn., and the fourth owner is Frank S. Baillie, of Sumpter, Oregon, the managing engineer. The Golconda mine is owned by Mr. C. S. Jackson, the well known publisher of the Portland Daily Journal, Portland, Oregon.

The owners of these properties are practically all men of affairs actively engaged in banking, publishing, politics and industry. Their multiplicity of interests causes all but one property to be kept idle. Their chief interest lies not in mining, and their experiences in it were for most of them secured during a period when close valuations upon mining properties were much less common than now, and the experienced engineer, metallurgist and mining geologist, now so prominent in the operation of successful mining companies throughout the world, had then but a small part in operations. A failure to fully realize that experienced technical men can solve their problems of mining and milling keeps some of them from operating their properties themselves, and the experience of some of them during the time when the element of adventure existed to a greater degree than now causes some to over-value their property when considering its sale.

With the exception of a limited amount of development in the last 2 or 3 years at the North Pole mine, the properties other than the Columbia have kept only a watchman. Mine openings are not permanent ones. They have a considerable annual depreciation, and most of them, if left idle for a decade or two, will become nearly a total loss. The only factors which increase the value of known bodies of ore are a reduction in the cost of and an increase in the percentage of extraction. But the idle property, with its rapid depreciation in the value of mine openings and the loss of returns upon capital invested during the period of idleness, will in future vastly exceed any gain from improvement in processes. It is to be hoped that a proper consolidation will be early effected before some of these good properties become an almost total loss.

Since the above was written in December, 1914, O. D. Glover succeeded to the management of the Columbia mine which had been under Mr. F. S. Baillie's management for about 20 years. The company continued operation of the mine and mill as usual until October 15, 1916, when according to press reports the mill closed down; Mr. Glover retired from the management, and only a small crew is to remain at the mine in charge of the foreman.

COLUMBIA MINES COMPANY (placer) GREENBACK DIST. JOSEPHINE COUNTY

Local name, Columbia mine.

Office: 40-54 Front St. N., Portland, Oregon. L. A. Lewis, Portland, Pres.-Treas.; A. M. Compton, Portland, Sec. Capital stock, $20,000; par value $100; all subscribed, issued and paid up. (1916 report).

The Columbia placer is located in Sec. 32, T. 33 S., R. 5 W., and is reached by wagon road 1½ miles north from Placer Oregon. It is supplied with water by two ditches from Grave creek, one giving a head of 100 feet and the other of 600 feet. The deposit occupies the valley of Tom East creek, a tributary of Grave creek, heading near the Greenback mine, and the workings have now nearly reached the Greenback mill. The gravel attains a thickness of 50 feet and is coarsest near the bedrock, which is largely greenstone like the boulders. According to Diller:

The gold is fine and nuggets are rare. Three 5-inch giants are in use and nearly 6 acres are washed over annually. The grade is low and to keep the sluice clear the tailings are washed aside from the end of the sluice by a powerful side stream which piles up the gravel in a prominent heap.

Several other placers have been in operation both above and below the mouth of Tom East creek on Grave creek for at least 30 years, more or less continuously, and it is estimated that the gulch has made an aggregate yield of more than $400,000 in gold.

The property is now under lease by Crook Epperly, of Placer, Oregon.

COLUMBINE CLAIM ASHLAND DISTRICT JACKSON COUNTY

The Columbine claim, about 3 miles southwest of Ashland, and west of Wagner creek, in Sec. 14, T. 39 S., R. 1 W., is owned by R. W. Dunlap. It is opened at an elevation of about 2600 feet by an adit crosscut in diorite running S. 84° W. 85 feet to the vein on which a drift extends N. 36° W. about 100 feet. The vein contains 4 to 6 feet of massive white quartz with some pyrite and a little marcasite and chalcopyrite, and some fault gouge; it dips 55° N. E. The vein seems to contain also a little pyrolusite. The marcasite alters rapidly under atmospheric conditions producing sulphuric acid and iron sulphates, especially melanterite.

COMBINATION MINES COMPANY BOHEMIA DISTRICT LANE COUNTY

Office: Bohemia, Oregon. R. H. Clark, Eureka, California, Pres.-Treas.; W. J. Disch, Milwaukee, Wis., Sec. Capital stock, $450,000; par value $1.00, all subscribed and paid up; $250,000 issued. (1915 report).

COMER MINES COMPANY (gold) QUARTZBURG DISTRICT GRANT COUNTY

Local name: "Present Need Mine."

Office: Board of Trade Building, Portland, Oregon. E. D. Brigham, Chicago, Ill., Pres.; M. M. Wasley, Chicago, Ill., Sec.-Treas. Capital stock, $1,500,000; par value $5.00; $1,100,030 subscribed, issued and paid up. (1913 report).

This company's property is located in Sec. 2, T. 12 S. R. 33 E., 7 miles northeast of Prairie City on Dixie creek. The vein strikes N. 20° E. and dips 70° E. S. E. The width is two to three feet in hard diabase rocks. The ore occupies from four inches to two feet of this width and consists of solid quartz with heavy sulphides in an irregular intergrowth. These sulphides are pyrite, hard and yellow, softer yellowish gray marcasite, a little chalcopyrite, zinc blende and galena. Ore values in gold and silver are about $100 per ton and free gold is almost altogether confined to the oxidized part of the vein. There are two ore shoots each about 70 feet long separated by a barren zone of about the same length. The mine has been developed to the creek level by crosscut and drifts upon the vein but the developed ore is practically exhausted to the creek level.

Dissolved by proclamation, January, 1917.

COMMERCIAL MINING COMPANY (gold)
MORMON BASIN BAKER AND MALHEUR COUNTIES

Local name: "The Rainbow mine."

Office: 214 Chamber of Commerce building, Portland, Oregon. F. P. King, Pres.; H. V. Carpenter, Sec.-Treas., both of Portland. Capital stock, $1,750,000; par value $1.00; $1,666,000 subscribed, issued and paid up. (1916 report).

This is the principal mine of the district and is situated practically on the divide between Dixie creek which flows into Burnt river and Willow creek which empties into the Snake river. This property which consists of 11 claims, is located in the central part of T. 13, S. R. 42 E. and is 28 miles by wagon road west from Huntington and 24 miles southwest from Durkee.

The pay streak in this mine was discovered about 15 years ago and was partially developed and equipped by the present owners who sold the property to the United States Smelting, Mining and Refining Company, who operated the mine for 32 months under the terms of a special contract given them.

Previous to 1911 the mine produced for the Commercial Mining Company $242,000. In the 32 months the property was operated by the U. S. S. M. and R. Company bullion to the value of $1,083,360 was produced from 95,747 tons of ore, an average of $11.40 per ton extracted, the assay value of which was approximately $12.00.

December 1, 1915, the mine reverted to the Commercial Mining Company and has been operated steadily and very profitably ever since.

The geology of the Rainbow mine is comparatively simple, the country rocks are chiefly slate with some granitic intrusives on the hanging wall side and some limestone and greenstones on the foot wall side. The greenstone is an intensely altered rock with an excessive development of scondary hornblende; its original character is difficult to make out.

The vein fissure has a strike of N. 60° E. and in the upper levels a dip of 66° N., while in the lower levels a dip of 54° N. Before the period of vein formation the fissure was filled with a porphyry dike locally known as the "spotted dike." A petrographic description of this rock is as follows:

It is dark brown and has a dense porphyritic texture. There are a few veinlets of quartz and minute reticulate veins of pyrite present. In thin section the predominant phenocrysts are badly formed feldspar crystals which for the most part owe their irregular outlines to resorption, or partial melting after they were formed. In composition the feldspars are of the soda-lime variety and the few that were capable of accurate measurement were found to be andesine. Some show zonal growth to a certain extent, thus indicating a change in the composition of the magma. The ferro-magnesian phenocrysts are hornblende and hypersthene, both occurring in very badly formed crystals, and intergrown with them are small crystals of biotite, some grains of pyrrhotite, and a little magnetite. The groundmass is seen to be made up of very minute feldspar crystals with some quartz. The intergrowth of these minerals is in some places so close that it approaches a micrographic or micropegmatitic texture. The rock has suffered some alteration of the deep-seated type. Many of the feldspar phenocrysts show fracturing and sometimes a development of sericite in these fractures. Other alteration minerals present are: uralitic hornblende, secondary quartz, some actinolite, and a small amount of chlorite.

Judging hastily from the hand specimen alone one might possibly call this rock an andesite. But even then the dull appearance and irregular outlines of the majority of the feldspar phenocrysts are indicative of its intrusive rather than extrusive nature. In thin section the mineral composition at a hasty glance might also appear to be that of an andesite. But, on closer inspection the amount of primary quartz in the groundmass, the microgranitic texture even approaching micrographic in places, and the predominance of feldspar make it clearly evident that this rock is a porphyry genetically related to an intrusive magma that is probably a basic granodiorite or quartz-diorite or perhaps even a diorite in composition. Of course the structural occurrence of this rock is that of an intrusive dike and for this reason unless it were evident that the dike was a feeder to an andesite flow it could not be called an andesite.

The Rainbow vein is not of the fissure type but of the brecciated zone type. The fractured zone varies from a few feet in width in some places to over 50 feet in others. It is made up of fragments of country rock cemented by quartz. The porphyry dike is included in the brecciated zone to a large extent. The foot wall vein of the lode is the best developed and has been the most worked. The hanging wall vein is flat-dipping and branches away from the foot wall or main vein in both strike and dip. The terms "foot-wall" and "hanging wall" in referring to these veins refer only to their positions with reference to the "spotted dike." The vein quartz is fine-grained and contains but a very small amount of arsenopyrite and pyrite in which there is some gold. Some of the free gold in the vein is large enough to be distinctly visible, but for the most part it cannot be seen. A small amount of actinolite and a little chlorite occur with the quartz, and when these minerals are present the gold values are said to be greater. This is noteworthy, as it points toward the precipitating action of the ferro-magnesian silicates.

There has been some movement since ore deposition, as is shown by the gouge and slickensides. The quartz, however, is not fractured to any great extent.

The genesis of this vein is simple, that of ascending thermal solutions from the underlying magma. The presence of the porphyry dike shows that the vein fissure followed this line of weakness.

The mine is worked through a vertical shaft about 400 feet deep. Most of the development has been done on the 200 level, where the vein has been drifted upon for 1700 feet, and much development upon the 3rd and 4th level has also been done, which is being increased every month. Mine and mill are operated by electricity, with power furnished by the Idaho-Oregon Light and Power Company.

The mill has 15 stamps and handles over 100 tons a day. Forty-five per cent of the gold is free milling. The stamps crush to about 12 mesh, from which the pulp goes to a tube mill. From the tube mill it passes over amalgamating plates and then to a Dorr classifier. The sands are returned to the tube mill for regrinding, from which the pulp goes to the Dorr thickener and then to Pachuca tanks. After agitation in cyanide solution the pulp goes to a Kelly filter press, from which the cake is sluiced to the tailing pond and the clear solution going to gold solution tanks. Precipitation is made with zinc dust and a Merrill filter press is used. The mill is very compact and is a model for this type of ore. The recovery is about 97 per cent. In addition to the mill there is a complete assay and experimental laboratory and also furnaces for refining the precipitate and bullion.

COMPTON MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This mine is not far from the North Gem mine, in Sec. 5, T. 10 S., R. 33 E. The vein is in slate and serpentine. An incline 140 feet deep has been sunk on a 4-foot vein of ore, which averages about $15. The shoot is said to be at least 125 feet long. Rich ore is found on the walls from 6 inches to a foot wide. The ore contains some galena and a trace of copper in massive arsenical iron and zinc sulphides. Only the assessment work is done each year.

CONNOR CREEK MINES CONNOR CREEK DISTRICT BAKER COUNTY

Local name, The Connor Creek mine.

Office: Home, Oregon. Clayton Mark, Chicago, Ill., Pres.; J. H. Bagley, Home, Oregon, Sec.-Treas. Capital stock, $100,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

The Connor Creek Mining and Milling Company in the spring of 1915 gave a bond and lease on their 6 patented quartz claims to the above company. The Connor Creek Mines also have 5 placer and 5 quartz claims adjoining.

The present development work consists of opening up some of the upper workings and the No. 4 tunnel. It is the intention to drive this level beyond the last break and so pick up the vein in country which has not been explored. A 10-stamp mill has been built at the portal of the tunnel. There has been a production of $4000 incidental to development work. Press reports of December, 1916, state that bullion valued at $21,000 had been brought in as the result of a short run upon rich ore recently discovered.

For general description of the property, see Connor Creek Mining and Milling Company.

CONNER CREEK MINING AND MILLING COMPANY (gold) CONNOR CREEK DISTRICT BAKER COUNTY

Local name, The Connor Creek mine.

Office: 426 Abington Bldg., Portland, Oregon. T. L. Eliot, Pres.; A. H. McGowan, Sec. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

The Connor Creek mine is situated on Connor creek about 2½ miles northwest of the Snake river. It is one of the oldest mines in Oregon, the vein having been discovered in 1871. The total production is approximately $1,250,000. The immediate country rock is a black slate, which has a general north-northeast strike and dips about 60° west-northwest. The vein strikes about N. 40° W. and dips 70 to 75° southwest. The average width is 3 to 4 feet. The value of the milling ore was from $3 to $10 a ton, but several rich pockets were found in which coarse gold was associated with argentite. So much native mercury was contained in the ore at times that amalgamators had difficulty in maintaining a proper hardness of the plates.

The vein has been developed by 6 tunnels, the shortest of which is about 500 feet in length and the longest 3700 feet. At the present time most of these are caved. The stopes on all levels continue in a northwest direction until a fault is reached. This fault strikes N. 30° E. and dips 45 to 60° S. E.

The vein has been picked up on the other side of this fault, but has not been developed.

In the spring of 1915 J. H. Bagley, Albert Geiser and Isaac Sweet organized a company and were given a bond and lease upon the property. See Connor Creek Mines.

CONQUEST GOLD MINING COMPANY (gold) WEATHERBY DIST. BAKER COUNTY

Local name, Gold Hill mine.

Office: Shoemaker Bldg., Baker, Oregon. Mine office, near Durkee. James A. Panting, Pres.; A. H. Panting, Sec.-Treas. Capital stock, $2,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Four miles northeast of Durkee in Sec. 1, T. 12 S., R. 43 E., and Sec. 6, T. 12 S., R. 44 E., on north slope of Gold Hill, in rolling sagebrush hills—Burnt river drainage. Wagon road to Durkee, O.-W. R & N. station. Lands, 21 quartz claims and 164 acres of placer ground.

The veins upon this property are found both in granodiorite and schist. They are fissure veins, although when cutting schist considerable replacement has occurred. The several veins strike from east-west to 20° S. E., and vary from 2 to 10 feet in width. Several veins have been cut by a long crosscut, but the examination of much of the development was prevented by bad air. High values are reported in some of the veins, the higher values usually in the smaller veins.

There is a 10-stamp mill upon the property, in which some ore has been treated. Some work was done here in 1914 by Mr. Al Geiser, of Baker, in opening up the Spring Gulch, one of the smaller veins, which is nearest to the portal of the tunnel.

Amount of work done in 1914 was $4000. Production was less than $1000. Little is reported to have been done upon the property since 1914.

CONSOLIDATED COPPER MINING AND POWER COMPANY
NORTH SANTIAM DISTRICT MARION COUNTY

Office: Portland, Oregon. Hugh Freeland, Pres., Gates, Oregon; J. H. Colt., Portland, Sec.-Treas. Capital stock, $200,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

It is reported that 67 per cent of the stock in this company is under option to Lotz and Larsen, and that the property consists of the "Minnie E.," the Electric Mining and Smelting Company's claims and the Freeland Consolidated Mining Companys' ground, about 25 claims in all. These are on the Little North fork of the Santiam river at the mouth of Gold creek, in Sec. 19, T. 8 S., R. 5 E.

The property is 14 miles from Gates, one mile of which is trail and 13 miles wagon road.

The country rock is andesite. There are several veins upon the consolidated property, which are from one to several feet wide. There is about ½ mile of drifts and crosscuts, but the work which is being done (1916) is upon the "Minnie E.," on the south side of the river and close to the water's edge, where a drift 210 feet long upon a vein which strikes S.-S. E. and dips E. develops 3 or more feet of chalcopyrite ore, containing 2 to 3 per cent copper and $2.00 in gold. The ore upon that part of the property up Gold creek is said to contain 1 to 14 per cent copper and $2.00 in gold per ton.

CONSOLIDATED LUCKY BOY MINES COMPANY (gold, copper and lead)
BLUE RIVER DISTRICT LANE COUNTY

Local name, Lucky Boy.

Office: 511 Henry Bldg., Portland. D. W. Tilford, Pres.; Cord Sengstake, Sec.-Treas., both of Portland. Amount of capital stock, $1,000,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company in June, 1916, sold one-half interest to Seattle and Canadian capitalists.

Property consists of 13 claims, and is located in Sec. 4, T. 16 S., R. 4 E., about 4 miles from Blue River postoffice, on the McKenzie river, which is 45 miles east of Eugene. The wagon road from the mine to the Blue River postoffice is in fairly good condition, and the road from Blue River to Eugene is in good shape. The country is quite rugged and plenty of timber is available.

The district consists of a series of andesitic flows, interbedded with which are beds of andesitic tuffs and breccias. Small intrusions of granodiorite porphyry are found within a radius of a few miles.

The ore deposits are of the fractured zone type, having a general strike of N. 45 to 50° W. and dipping to the southwest. It is probable that the mineralization was caused by rising solutions in fractured zones from the cooling intrusion of the granodiorite porphyry.

At the Lucky Boy mine the country rock is an andesitic breccia. The lode strikes N. 45° W., with a dip of 80° to the northeast. It has been traced for about 5000 feet, and has a maximum width of 45 feet. The oxidized zone extends to a depth of 150 feet. Below this the chief ore minerals are galena, sphalerite and chalcopyrite. The development work consists of 6 drifts and 1 crosscut tunnel. Considerable ground has been stoped. Mill consists of 40 stamps, 5 Wilfley tables and 5 vanners, and the new interests expect to install a flotation plant.

CONTACT MINING AND MILLING COMPANY (copper, gold, silver)
WALLOWA DISTRICT WALLOWA COUNTY

Local name, Contact mine, or Peacock mine.

Office: Lostine, Oregon. H. J. Martin, Pres., Wallowa, Oregon; O. F. Mays, Sec.-Treas. Capital stock, $1,500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Company owns 10 claims and millsite 16 miles south of Lostine, Oregon, on the east side of Lostine creek, in Sec. 30, T. 3 S., R. 44 E., reached by 8 miles of wagon road and 8 miles of trail from Lostine, a station on the O.-W. R. & N. Company's branch line from La Grande. These groups are on a contact between intrusive granodiorite and limestone and limy schist, about one mile from the stream and about one-half mile above it, at an elevation of about 7000 feet.

The limy schist contact with its contact-metamorphic minerals is not the chief point of interest at this property. Development some time ago practically ceased on the contact and was transferred to a nearly vertical pyroxenite dike 5 to 40 feet wide, which diagonally cuts across the limestone in an E.-W. direction. A few hundred feet of the lower end of this dike was observed and as far as one could see the dike continued to the very mountain top.

The dike rock is dark green in color with a texture nearly dense. In thin sections it is seen to consist of about 75 per cent augite pyroxene, about 15 per cent labradorite, 5 per cent biotite, and 5 per cent quartz. The quartz is probably a secondary mineral. Most of the labradorite feldspar crystals are badly altered.

The dike has been somewhat fractured and in the small fissures the pyrite and pyrrhotite have been deposited, together with some chalcopyrite. Some of the contact-metamorphic minerals, garnet and epidote are in evidence near the borders of the dike for the most part, but sometimes are seen in the adjacent limestone. The pyrite and pyrrhotite appear in greater percentages in the outer portions of the dike. This dike, a basic differentiate of the great intrusion injected in a molten condition into the fissure in the limestone, probably had sufficient heat with the assistance of mineralizers to form the small amount of garnet and epidote present.

Practically no mineralization is seen in the limestone adjoining the dike. In an examination of several open cuts scattered for a considerable distance along this dike the copper minerals appear to be too thinly scattered through the dike to be called ore without values in gold and silver.

The above described property was visited in 1914 in the absence of the owners. The description may include claims called the Peacock group, not belonging to the corporation, but to individuals, some of whom are stockholders in the company.

The "Lostine Reporter" of November 9, 1916, reports that the company has given a lease and bond for 5 years for $65,000 to Ole Twedt, of Seattle, Washington. In their issue of June 8 and July 27, 1916, they state that the "Peacock" group near the "Contact mine" has been bonded to W. M. Montgomery, of Butte, for $35,000, and was being developed under the direction of J. H. Tonkin and crew.

CONUNDRUM GROUP (gold) CORNUCOPIA DISTRICT BAKER COUNTY

This group of claims is situated about 2 miles south of the George W. Smith claims in about Sec. 30, T. 6 S., R. 45 E., in the argillite and greenstone on the south side of Cornucopia mountain. The vein strikes east-west and dips about 50° south. There is only a few inches of quartz in the vein, which is said to be high in gold.

COOK MINE (placer) GOLD HILL DISTRICT JACKSON OUNTY

The Cook mine near Draper about 10 miles southwest of Gold Hill is in the S. ½ Sec. 13, T. 37 S., R. 4 W. The pay gravel is, in places, plainly stratified, and consists mainly of fine gravel and clay. The stream bed has been mined for one-fourth of a mile. The bed rock is made up of greenstone and slates cut by numerous greenstone dikes. It has been greatly sheared and faulted. One fault runs N. 75° W. and dips 31° N.; another runs N. 53° E. and has been traced nearly one-fourth of a mile.

COOPERATIVE COPPER AND GOLD MINING COMPANY (copper) (Arizona corporation) BAKER COUNTY

Office: 425 Seventh Street, Rockford, Illinois. Alfred Larson, Pres.; J. A. Bowman, Sec.; A. T. Bodin, Treas., all of Rockford, Ill. W. S. Bowers, Baker, Ore., Attorney-in-Fact. Capital stock, $1,000,000; par value $1.00; $500,000 subscribed and issued, and paid up. (1916 report).

The properties of this company are located about four miles northeast of North Powder in Sec. 18, T. 6 S., R. 40 E. The company owns 15 claims, two of which are patented. The shaft and buildings are located upon patented ground.

COOS BAY OIL AND GAS COMPANY COOS COUNTY

Office: Marshfield, Oregon. E. A. Anderson, Pres.; R. T. Kaufinon, Sec.; Jno. F. Hall, Treas., all of Marshfield. Capital stock, $25,000; par value $1.00; $13,287 subscribed, $300 paid up. (1913 report).

Dissolved by proclamation, January, 1917.

COPPER BUTTE GROUP EAGLE CREEK DISTRICT BAKER COUNTY

These claims are located on upper Clover creek in Sec. 24, T. 7 S., R. 42 E. The region in which these claims are located is made up of low hills, some of which are capped with basalt and many of which are partially forested. The older rocks are the typical greenstones. Surface alteration has made it difficult to determine their exact character, but many of them are undoubtedly amygdaloidal with calcite filling. One of these flows near Copper Butte, which apparently makes up the horizon of economic interest, has been very badly shattered. In fact the whole flow seems to have been sheared in a very irregular manner. Although it probably can not be called a shear zone, still this shattering serves the same purpose since it permitted easy access for the circulating waters to do their work of deposition.

In many of the joint cracks cuprite and chalcocite have been deposited. Some of the chalcocite stringers are as much as one inch in thickness. Chalcocite is also found disseminated in many places in the shattered greenstone. The exact thickness of this flow which contains chalcocite and cuprite could not be determined. It appears to be flat lying and from 60 to 70 feet thick. The upper part is highly amygdaloidal, while the lower part, as shown in a shallow shaft, is dense in character. The development work has not been of such a nature as to give even an approximate idea of the amount of metal available. A few short tunnels and shallow shafts have been made on the richer stringers. Surface crosscuts and crosscutting raises would best determine how much of the flow contains copper.

This property known under the various names of Gilkeson, Copper Butte, and Copper Queen had at one time a small furnace constructed upon it. The slag rich in copper from this small furnace can still be found nearby. It is reported that about 100 tons of 12 per cent copper was shipped in early days and some copper ore of lower grade is seen upon the dumps. If this is a flat deposit, as before intimated, the development, which was done before the idea of disseminated copper in shattered zones became as well understood, was evidently done in an attempt to determine whether the ore went down or not. Shafts and other development soon reached the dense part of the flow, which proved disappointing, and development ceased.

COPPER EAGLE MINE (copper) GALICE DISTRICT JOSEPHINE COUNTY

The Copper Eagle mine is situated about four miles northwest of Galice on the south side of Pea Vine mountain, and is owned by J. F. Reddy and P. B. Wickham of Grants Pass.

A well defined fissure vein in greenstone 12 to 30 inches wide containing quartz and chalcopyrite is seen in an upper drift for 400 feet along the vein. A tunnel 200 feet long and 120 feet below the drift above mentioned approaches the strike of the vein at an angle of about 25°. A careful survey would determine the change in direction of this lower tunnel to cut the vein in the shortest distance. The vein is said to run 4 to 5 per cent copper and about $2.00 in gold.

COPPER MOUNTAIN MINING COMPANY (copper) WALDO DIST. JOSEPHINE CO.

Local name: "Continental mine."

Office: Grants Pass, Oregon. C. E. Phillips, Pres.; W. R. Nippers, Sec.-Treas., both of Grants Pass. Capital stock, $1,000,000; par value $1.00; $998,400 subscribed, issued and paid up. (1913 report). Dissolved by proclamation in January, 1917.

The Continental mine, property of the Copper Mountain Mining Company, is located one mile southeast of Takilma in the S. E. 1/4 of section 35, T. 40 S., R. 8 W. The workings comprise three adits, one with 180 feet of drift following a very slightly mineralized fissure zone. Some distance north of this is another adit with about 100 feet of work. Some ore observed here was chiefly pyrrhotite with some chalcopyrite. West of this working and at about 100 feet lower elevation a cross cut was being driven to intersect the mineralized zone at greater depth. This was 100 feet long when examined. It is said that some good ore has been hauled to Grants Pass from this property.

COPPER KING NO. 1 (copper-gold) ROCK CREEK DISTRICT COOS COUNTY

One-fourth of a mile west of Mr. John R. Smith's placer ground on Rock creek in the south central part of T. 33 S., R. 12 W. is a thick lens of quartz included within serpentine, and which itself encloses small quantities of the latter. It contains considerable chalcopyrite and the upper portion is seamed with veinlets of malachite and some azurite. A mass of this material measuring about 30 feet long and 20 feet thick is exposed by open cuts. Several prospectors who have examined this deposit consider it a boulder or a large chunk of float which has rolled down from some higher point. There is no doubt, however, that it is in place in the serpentine and represents a "boulder copper deposit" allied to those found farther south in Curry county, but differing notably therefrom in the large quantity of quartz present. This deposit lies about 100 feet east of a big outcrop of dacite-porphyry and may be genetically connected therewith. A general sample taken from all the exposures proved to contain 2.23 per cent copper, .05 oz. gold, and .08 oz. silver. Concentration would doubtless produce a fairly high grade ore.

COPPER QUEEN MINE — GREENBACK DISTRICT — JOESPHINE COUNTY

The Copper Queen mine is situated in the N. E. ¼ of Sec. 15, T. 34 S., R. 6 W. four miles southeast of Leland.

The property is owned by Maloney and Weckler. The ore body has irregular masses of chalcopyrite, pyrrhotite and pyrite between serpentine and greenstone. General occurrence is much the same as ore bodies in the Queen of Bronze and Waldo mines in southwestern Josephine county. Several carloads of copper ore were shipped from this property during the spring and summer of 1916. The property at that time was under lease to P. B. Wickham.

COPPER STAIN (gold-copper) — GALICE DISTRICT — JOSEPHINE COUNTY

The Copper Stain group is not far from the Gold Bug in the Mount Reuben district. It consists of 7 claims owned by Mrs. S. L. Dana, of Springfield, Illinois. The main adit is caved at the portal but may be entered through stopes reaching the surface. The ore is white quartz with some pyrite, and free gold in a few samples. As at the Gold Bug that part of the ore which is stained by copper minerals is said to be richest in gold. The country rock, at least near the vein, seems to be largely serpentine. There has been no work done here for several years. The equipment (now incomplete) consisted of a Tremaine 2-stamp mill with a crusher, a 3 by 10-foot amalgamating plate and a "cannon-ball" amalgamator. Some work is now being done at the property in preparation to operate again.

COPPEROPOLIS MINE (copper-gold) — QUARTZBURG DISTRICT — GRANT COUNTY

These claims are located on the west side of the canyon about a mile above the Standard mine on Dixie creek 7 miles north from Prairie City in Sec. 6, T. 12 S., R. 34 E. The development consists of several cuts and tunnels. An 800-foot tunnel from the creek level taps the lode 300 feet below the croppings. The development of this level shows a large irregular chimney-like body of massive quartz containing tourmaline and chalcopyrite. The total copper-bearing width at the surface is about 40 feet. It can be traced for about 1,000 feet. The ore is largely a replacement of the country rock by quartz, tourmaline and chalcopyrite, but in the rock are richer seams of comb quartz and chalcopyrite. The presence of tourmaline indicates magmatic mineralizers and a high formation temperature. Some 250 tons of ore was milled in a small concentrating mill upon the property, which closed down in 1906.

CORBIN PROPERTY (placer) — SIXES RIVER DISTRICT — CURRY COUNTY

Concerning this property Diller states:

> On the right bank of the Sixes about a mile above the mouth of Dry creek (2 miles above the mouth of Edson creek) nearly opposite Mr. N. C. Divelbliss' mine is a placer operated by Mr. W. O. Corbin, who informed the writer that one winter he saved $11.00 worth of platinum from his washings. He sent 44 ozs. of sand from the mine, which was sieved and washed; it yielded .176 gram of gold, less than one hundredth part as much iridosmine, and no platinum. The relation of the concentrates to the gravel being unknown, the value of the gravel per ton cannot be given.

CORNUCOPIA MINES COMPANY OF NEW YORK (gold)
CORNUCOPIA DISTRICT BAKER COUNTY

Local name: "Union-Companion."

Office: 60 Wall Street, New York. Jos. B. Thomas, 132 E. Nineteenth Street, New York, Pres.; I. W. Hunter, 60 Wall Street, New York, Sec.-Treas.; Robert M. Betts, Cornucopia, Oregon, Gen. Mgr. Capital stock, $500,000; par value $100.00, all subscribed, issued and paid up. (1916 report).

The following is taken from a previous publication of this Bureau:

History.—The gold bearing veins of the Cornucopia district were discovered about 1880. The nearest railroad at that time was the main line at Baker. This distance to railroad transportation, together with the isolation of a snowy mountain camp, caused production to be intermittent for some little time. The strikingly favorable appearance of the veins attracted investors, and early in 1895, although but slightly developed, the Union-Companion claims were sold for $60,000. The purchasers proceeded vigorously with development and installed a 20-stamp mill and chlorination plant to treat the ore. The latter proved to be unsuitable and was abandoned.

The method followed from this time on was by* "the customary method of crushing with light stamps, amalgamating, and concentrating, with a canvas plant for the tailings. The mill was built in 1896 and succeeded in extracting only about 65 per cent of the values. Owing to the fact that the mine is situated 25 miles from a railroad, the hauling, together with smelting charges on the concentrates, combined with the low extraction, made it very difficult to keep the property on a paying basis. It was therefore decided that, if possible, the ore should be treated by cyanidation, thus eliminating outside charges on concentrates and at the same time making a better recovery of the metals contained in the ore. Tests showed that a satisfactory extraction could be obtained by grinding fine, and treating the product by agitation and filtration. Accordingly, in June, 1912, construction on the cyanide plant was started. The crusher, ore bins and stamps of the old mill were left intact, and only such changes were made to the mill buildings as were necessary to accommodate the new machinery." Since the completion of this plant, March 1, 1913, the production has been steady and profitable.

Geology.—The outcrop of the Union-Companion vein is at an altitude of 6100 feet, or 1400 feet above the town of Cornucopia, one and one-half miles away down Fall creek. The outcrop of this vein is traceable, according to Bernard McDonald, for 6800 feet throughout the lengths of the Union, Companion, Red Jacket, and Robert Emmett claims. Its strike is about N. 20° E. and dip 45° W. into the mountain; its maximum width is 20 feet.

The chief country rock is granodiorite, but the vein is near the extremely irregular borders of the intrusion, so that in the plane of the vein the wall rocks alternate continually between the intrusion and the intruded. This older rock in some places on the walls is greenish schist, originally probably a basic sandstone; in other parts of the mine the walls were found to be a part of an old intrusion or flow now altered to greenstone.

One characteristic specimen shows what appears to be a rather irregular contact with the granodiorite, so vague that one might almost say that the assimilation, or melting of it by the intrusion had been arrested when its work had been but partially completed. On the surface granodiorite is in evidence on the Union and Companion claims, while on the Red Jacket and Robert Emmett the older rocks chiefly prevail.

Numerous dikes of granodiorite porphyry are found varying from a few inches to a few feet in width and cutting both the older and the newer rocks. Aplite dikes are less conspicuous here than at points farther up on the mountain.

*Paul W. Gaebelein in the Engineering and Mining Journal of February 28, 1914.

Another rock type is the Tertiary Columbia river basalt in the form of dikes. These dikes are shown on the surface with outcrops in all directions. These reddish-brown weathered outcrops contrast strongly in color with the whitish granodiorite in which they are placed.

The Vein.—The width ordinarily is 2 to 5 feet but it swells in places to a maximum of 20 feet.

"On the whole the vein is remarkably persistent. Hanging and footwalls are sharply marked, inclosing a massive vein of white normal quartz. A ribbon structure by shearing is usually developed in the lower parts of the vein, or at least for a few inches from the footwall."

"The Union-Companion-Red Jacket vein has been developed, at one place in the Union claim, to a maximum depth of 800 feet, while in its northerly extension through the Union, Companion and Red Jacket claims, it has been developed to variable depths averaging 300 feet. This development has revealed the existence of four ore shoots having an average width of three feet and an aggregate length of 1,200 feet along the vein."

"The ore is a hard quartz, containing 3 to 5 per cent pyrite carrying the gold. Silver is present partly as a sulphide, and the proportions of gold to silver by weight are approximately 1-5. There are also present in the ore appreciable quantities of chalcopyrite, arsenopyrite and blende. The ores are variable in value, ranging from $10 to $20 for mill-run grade."

The principal shoot on the Union claim is now down to the 500 level, 100 feet lower than in 1903. The drifting on this level revealed a shoot of ore whose length, width, and grade compare favorably with those above. Of course a vein in which the gold is locked up in sulphides not usually disseminated, but rather in bunches within the massive quartz, must of necessity vary from place to place. Nevertheless when considered in a larger way the precious metal content is quite regular in the stopes from the different levels. Sinking on the vein has been started from the 500-foot level since the camp was visited.

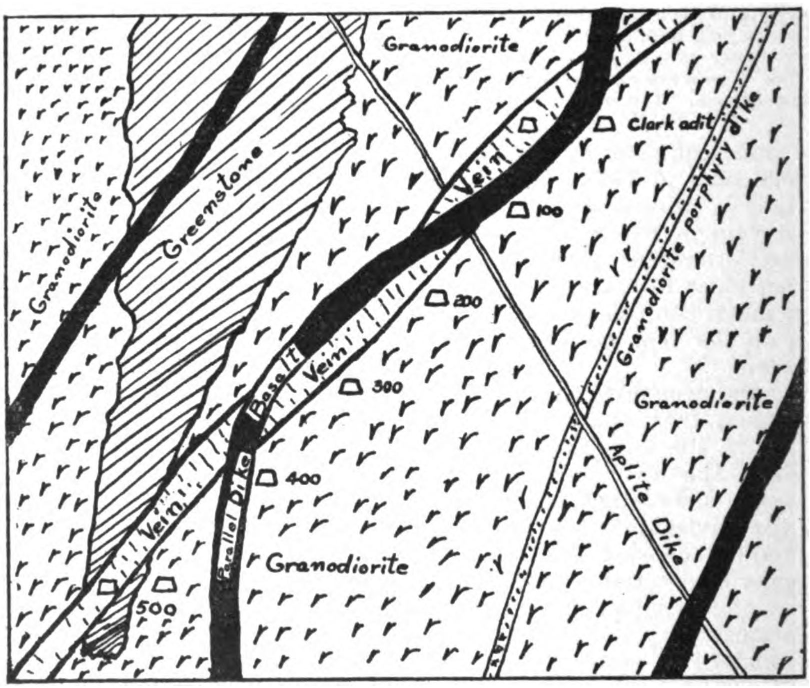
This vein probably represents the final activity of the granodiorite. It would appear from the excess of sulphides on the borders of "greenstone" fragments in the vein that these ferro-magnesian silicate rocks assisted, at least locally, the other agencies in the precipitation or deposition of the metals in the vein. How much of practical value this might prove to be in determining the advisability of developing veins where they cut granodiorite only, would require considerable field examinations, geologic mine mapping and assay maps to determine even if it is determinable.

The Union-Companion operators need be but little concerned on this point because they have on each level a sufficient amount of granodiorite and greenstone to secure whatever favorable influences either one of these wallrocks might provide. The lowest developed level, the 500, has perhaps a greater proportion of greenstone wallrocks than the others, although "granite" is abundant; so that the ore developed for the next lift or two at least should be unaffected by this suggested influence.

Future of the Mine.—It seems reasonable that since the ore has continued for 1000 feet in depth without appreciable diminution in value, it may be expected to continue to a much greater depth. It might even be expected, if the greenstone wallrocks had an appreciable effect in the precipitation of sulphides and, therefore, in the location of at least the richer parts of the ore shoots, that new development below the present lowest level might reveal even better ore there, because of the great amount of greenstone found at depth.

The unbroken continuation of one and the same shoot is not necessarily to be expected. Barren levels occasionally interrupt rich and extensive shoots in any district.

A matter of considerable importance in developing ore bodies in this camp is the large number of basalt dikes found in close proximity to the veins. These dikes are found with strikes in all directions. Whatever the forces were which created these deep-seated fractures now filled with the once molten rock, they must have been very great to overcome the rock's tremendous resistance to rupture. Nature, like armies on the offensive, seeks out the lines of least resistance, so that fracturing will always follow, as much as may be, old breaks or lines of weakness. When the rocks or crust of the earth is being broken at or nearly at right angles (greater than 45°) to a then existing line of weakness, such as a quartz vein, it will break directly across it. This is seen to have occurred in the Union-Companion vein and is shown on the map as the "Cross dike." But should the break approach at less than 45° to the old line of weakness it will turn and break into it, will follow as far as it can the easiest way, to finally break through the other wall and continue on its general course.



Ideal cross-section of Union-Companion vein, country rock and dikes

The latter condition is well shown in the "Parallel" dike on the working plan and in the ideal cross section.

The "Cross dike" passes through the quartz vein and, therefore, was made since the completion of the vein. It can, then, have had no effect upon the vein, except a mechanical one, that is, to cut it in two where it crosses.

In the case of the "Cross dike," no question would arise in the minds of prospectors or operators as to which came first, the vein or the dike. The vein was plainly completed before this crosscutting dike came to cut the vein in two.

Although the "Parallel" dike undoubtedly came since the entire filling of the quartz vein was completed, and at the same time as the "Cross dike," it is less easy to believe that it did succeed the quartz vein. This confusion arises quite naturally:

1. Because this dike is found in the plane of the vein over a large area of its walls.
2. Because the vein is found on both sides of the dike, although ore is but

rarely found locally on both sides except at the outer limits of some of the stopes.

3. Because in the Last Chance vein ore is found on both sides of an aplite dike undoubtedly older than the vein.

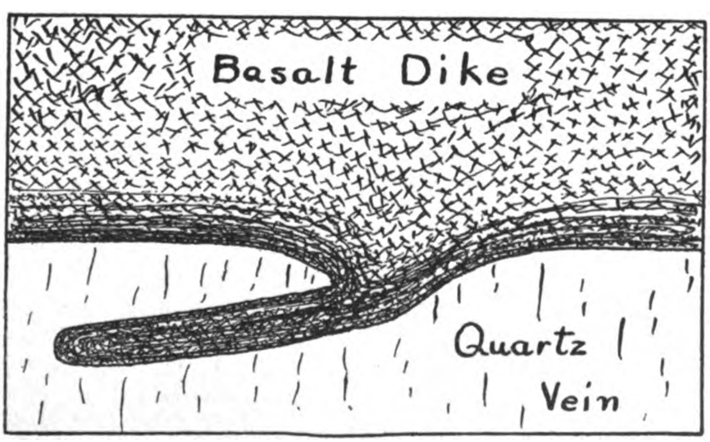
The plane of the vein has a dip into the hill of approximately 45 degrees. The forces which fractured the earth at this point to let in the basalt were applied in such a way that it broke at a steeper angle than the vein fissure previously formed. Approaching the plane of the vein at a rather acute angle, it then had every reason to take advantage of the plane of weakness of the quartz vein to break into and remain in it over a large area.

The dike fracture broke into the vein through the latter's hanging wall above the Clark level and remained in the vein to a point between the third and fourth levels, where it broke through the footwall to continue its natural and steeper dip, so that on the 500-foot level it is some 80 feet away from the vein.

It should cause no surprise that in the fissuring anew in the plane of the quartz vein the break should follow in places the hanging wall, in others the footwall of the vein, breaking diagonally across from one wall to another, and occasionally splitting the quartz vein for considerable areas. The intrusion of the basalt into this fracture left large lenses of ore on both sides of the basalt dike in such forms that the most natural conclusion to be arrived at is that the vein was formed since the dike was formed, that the dike had considerable to do with the vein and its values, and that exploration should follow closely the walls of the dike. Because of this conclusion previous managements followed the dike rather than the vein on its downward course, and for a long time crosscutting in the hanging wall of the dike was not prosecuted. In various parts of the mine evidence is seen of much wasted money spent in the search for ore because of this erroneous theory.

Because of the habit in this camp of following dikes in the search for ore, rather than making the search independently of dikes and on the general course of the vein, it seemed advisable to make the foregoing lengthy statement and to prove its correctness by field study in the following manner:

Intrusions of molten rock naturally solidify quickly next to their cool walls. This chilling comes so quickly that close to the walls it is almost like glass, very dense and fine grained. Here it remains fluid for so little time that crystals have little time to form. As one goes farther toward the middle the cooling is more and more delayed and larger and larger crystals



Tongue of Basalt injected into quartz vein have time to form, so that in a thick dike, while its borders are almost glassy, its interior contains crystals of considerable size.

1. Search was made along the walls of the dike in contact with the vein to find a branching of either one into the other. When this was found, as illustrated in the sketch, the "glassy" borders of the tongue of basalt into the quartz, together with the "glassy" condition of the main wall of basalt nearby, proved that the basalt was intruded into the quartz; that the tongue of the basalt was not a "horse" in the vein and therefore older. This in itself is sufficient proof that the vein is the older.

2. Contacts of the dike with the vein were investigated at various points and it was found that these contacts are invariably chilled contacts and do not show the alteration due to the action of hot circulating waters, evident in all the other wall rocks of the vein. This new or fresh condition of the basalt adjoining the vein is sufficient proof in itself that the vein was formed first.

3. On the Clark level of the Union-Companion mine, it was noted that the "Cross dike," plainly and admittedly of later age than the vein, merged into the "Parallel" dike at their junction in such a way as to prove that they were intruded into these fractures and solidified at the same time. Besides the evidence of the eye at this junction of the two dikes, the microscope revealed in thin sections taken from each dike that they had identically the same mineral composition. This is in itself a sufficient proof that the "Parallel" dike came since the vein was formed.

It is quite evident that both prospector and mine superintendent can make practical use of the conclusion that the basalt or "iron" dikes came since the veins were formed. They should look upon the "iron" dike as a mechanical interruption of the continuance of the vein, which must be broken through or passed over to find the vein beyond. If a dike follows a vein for some distance, when it does leave the vein, rather than worry for fear the values will cease in its absence, they should give thanks.

Cyanide Plant of the Cornucopia Mines Company.—The following excellent description of the crushing and cyaniding methods practiced at the Union-Companion mill is from the pen of their mill superintendent, Paul W. Gaebelein, in an article in the Engineering and Mining Journal of Feb. 28, 1913:

Methods of Crushing and Grinding.—The ore is received directly from the mine cars on three grizzlies set to 1½ in. The undersize falls directly into the ore bin, which has a capacity of 150 tons, and the oversize passes to a 9x15 in. Blake crusher, reducing the ore to 1½-in. size and delivering to the ore bin. The rock is then fed by challenge feeders to 20 950-lb. stamps which make 98 drops per minute through 7-in. Approximately 6 tons of a 0.125% solution of sodium cyanide per ton of ore are fed to the mortars, and the ore is crushed through No. 930 ton-cap screens, which correspond to about 8 mesh. Lime is added at the feeders in sufficient quantity to give the solution a protective alkalinity of 0.7 to 0.8 lb. CaO per ton. The stamp duty is 5.15 tons per stamp. Chrome-steel shoes and cast dies are used, which combination is giving excellent results. The shoes last from 80 to 90 days, while the dies usually last from 40 to 50 days.

At the beginning of operations amalgamation was given a thorough trial extending over a period of several weeks. With finer screens, the results obtained did not justify its continuation, due to the fact that there is but a small amount of free gold in the ore, and that the coarse crushing in cyanide solution made conditions unfavorable to good work. It was therefore discontinued.

The battery product is equally divided between two 4-ft. Callow cones, which remove the coarse sand and feed it direct to the tube mills. Fine grinding is accomplished in two 5x22-ft. tube mills mounted on tires. The advantage of this type of mill over the trunnion type is its lower power consumption. Each mill is driven by a 50-hp., back-geared, General Electric induction motor, which is connected to the tube-mill drive by a spring coupling. The mills make 26 r.p.m. and are lined with 4-in. silex blocks. This lining lasts seven months. Local quartzite is used for pebbles.

Each tube-mill works in closed circuit with a simplex Dorr classifier, the overflow from the Callow cones being joined with the tube-mill discharge and fed to the classifiers. The sand discharge, joined with the underflow of the Callow cones, runs by gravity to the tube-mills, which are equipped with scoops 6 feet in diameter. The only product leaving the crushing and grinding department is the slime overflow of the classifiers.

Each tube-mill is fed with 50 tons per day of material, which has the following screen analysis:

	per cent		per cent
-10 mesh	95.9	- 60 mesh	36.5
-20 mesh	74.2	-100 mesh	26.7
-30 mesh	60.8	-150 mesh	22.9
-40 mesh	50.4	-200 mesh	20.9

This material is first fed to the classifier, which removes the product finer than 200 mesh, returning the remainder to the tube-mill for regrinding. The finished product has the following average analysis:

-100 mesh, 98% -150 mesh, 94% -200 mesh, 86%

As mentioned above, the ore is hard quartz and difficult to grind, and even when ground so that 86% passes 200 mesh, it is still fine sand, and contains practically no colloidal matter or true slime.

Continuous Cyanide Treatment.—The entire product from the crushing and grinding department flows by gravity to a 30x10-ft. Dorr thickener, where it is thickened from a ratio of 6:1 to 2:1 for agitation. The solution overflowing this thickener is used for dilution, as will be described later. The thickened underflow is transferred by a 3-in. air-lift to the agitation tanks.

The three agitators are of the standard Pachuca type, 12 feet in diameter and 36 feet deep. They are operated in series, the pulp receiving about 36 hr. agitation in passing through the three tanks. The solution is brought up to the standard strength of 3 lbs. per ton as it enters the agitation series. Continuous agitation has proven to be efficient and economical in operation, and the Pachuca tank gives satisfaction. Notwithstanding the sandy nature of the pulp and its quick-settling properties, the agitators keep the pulp of a uniform grade throughout the series, and after a year's continuous operation have disclosed no objectionable features. Compressed air at 30 pounds pressure is used, and when necessary, as after a shut-down, high-pressure air from the mine compressors can be furnished for starting.

Tests and experiments on the mill solutions have shown that approximately 35% of the total dissolution of the gold and silver takes place in the mill, while the remaining 65% is dissolved in the agitators. The solution carrying the pulp from the last agitator of the series is consequently relatively high in value. The solution overflowing the 30-ft. thickener is also the lowest grade of the mill solutions. Owing to the fact that the filter plant consists of continuous, revolving drum filters, which are not adapted to the filtration of pulp which is carried in a high-grade solution, it is necessary to reduce, by dilution, the value of the solution which leaves the last agitator with the pulp.

This dilution is accomplished in two 20x10-ft. Dorr thickeners, and the diluting solution is the solution overflowing the 30-ft. thickener. The two 20-ft. thickeners are run in series, and the solution overflowing the 30-ft. thickener, runs into a collecting box from which it is pumped by a 2-in. centrifugal pump and equally divided between the two thickeners. The pulp leaving the last agitator overflows into a 3-in. air-lift which transfers it to the first of the two thickeners. On entering, it is mixed with the diluting solution, which brings the dilution up to approximately 4:1. It is thickened in this tank to 1½:1, and the thickened underflow is transferred by a 3-in. air-lift to the second thickener. The solution overflowing the first thickener is collected in a box, and flows by gravity to the precipitation plant. The pulp entering the second thickener is mixed with diluting solution and thickened to 1 to 1 for filtration, while the solution overflowing is returned to the battery for use in crushing. This dilution reduces the value of the solution, leaving the second thickener to one-third of its original value, which is low enough for filtration. The pulp from the second thickener is carried by a 3-in. air-lift to the filter plant.

The filter plant is composed of two continuous, revolving drum filters. The drums are 14 feet in diameter and 9 feet face. In common with most vacuum filters, their capacity varies with the character of the pulp filtered, and on this sandy material the capacity is great. The entire product of 20 stamps can be handled easily on one machine, and as much as 115 tons have been filtered in 24 hours. The cake is ½ inch thick, and is washed by a series of sprays, which are intended to keep the cake moist on its way to the scraper. The level of the pulp in the tank is kept as low as possible, and the cake receives a thorough air-drying before emerging from the tank. By the combined air-drying and spray-washing, the dissolved loss is kept to a reasonable figure.

A 12x14-in. Buffalo wet vacuum pump furnishes the vacuum for the filters, and discharges the filtered solution into a small collecting tank. The tailings from the filter are removed by the scraper and deposited on a belt conveyor which stacks it on the dump. The great advantage of these filters is in their low maintenance and repair cost, and in the fact that they do not require the services of a special filterman.

Clarifying and Precipitation.—The solution to be precipitated comes from two sources; the solution overflowing the first of the 20-ft. thickeners, and the filtered solution. These solutions flow into a small collecting tank, from which they are pumped by a 3-in. centrifugal pump through a 36-in., 18-frame Merrill clarifying filter. The effluent from the press flows by gravity to four pregnant-solution sumps, each 14 feet in diameter and 6 feet in height. The Merrill system of zinc-dust precipitation is used. The zinc-dust is fed by a screw feeder into an emulsifier, and the resulting emulsion of zinc-dust is fed to the suction line of a 4½x6-in. Buffalo triplex pump. There are in use two 36-in., 18-frame Merrill zinc-dust presses. The triplex pump works against a head of approximately 85 feet when filling the presses. The barren or precipitated solution leaving the presses flows by gravity to the main storage tank, 26 feet in diameter and 6 feet in depth, which is situated in a separate building, and which supplies the small battery feed tanks.

Precipitation results have been satisfactory in spite of the fact that there is considerable copper dissolved from the ore, the precipitate often running 35% copper. The clean-up is made from 3 to 4 times a month. The precipitate is dried in a muffle furnace and melted direct in a No. 125 Donaldson tilting furnace using fuel oil. The resulting bullion varies considerably in grade, depending on the amount of copper in the precipitate, but it usually averages 750 fine in gold and silver.

The extraction obtained is 90% of the gold and from 70% to 80% of the silver, making a total of 87.5% to 89% of the value contained in the ore. Each ton of ore treated consumes 1.40 lbs cyanide, 3 lbs. of lime, 0.90 lb. of zinc-dust. These vary considerably with the different grades of ore, and the figures given above are an average of the consumption over a period of several months' operation, during which period the value of the ore varied from $10 to $16 per ton.

In designing the plant, it was endeavored to make as many of the operations as possible, continuous. The object has been attained in that, since the beginning of operations, the plant has been run by two men on a shift, exclusive of the crusherman. Crushing is done on two shifts only. The batteryman has charge of the stamps and the tube-mills. He attends to all the work incident to the operation of this portion of the plant, and is assisted only in the larger battery repairs. The solution man operates the remainder of the plant. There is no steady attendant in the precipitation room. Melting is done by the assayer, with his assistant. On the day shift there is a repair man with one helper, who keeps up all the necessary repairs.

The plant requires 230 hp. when operating at full capacity. Power is furnished by the company's hydro-electric plant, situated about two miles from the mine. Current is transmitted at 6,600 volts and transformed to 2,200 volts at the mines for use in the motors. The cost of treatment averages $2 per ton, and is subdivided as follows:

	per ton
Labor	$0.65
Supplies	1.03
Power	0.12
Marketing product	0.20
Total	$2.00

Owing to the distance from the railroad, a 25-mile haul, most of which is a rather heavy grade, the freight charges on all supplies are high. The property has been under the management of Robert M. Betts, since the present owners acquired possession, and the mill was designed by Walter L. Reid, of Telluride, Colorado.

Since the above was written in 1914 the property has been producing steadily, although the extremely dry season of 1915 reduced the horsepower available in the company's hydro-electric power plant, located on Pine creek, about one and one-half miles below Cornucopia. Another hydro-electric plant located in Cornucopia was completed in June, 1916. This plant is capable of delivering 300 additional horsepower which, added to the old plant, furnishes ample power for all purposes at mine and mill. Previous to the completion of this additional generating station the lack of power prevented running the mill more than half capacity much of the time for the previous year. In the mine a large triplex pump has also been installed on the sixth level to replace smaller units, which were scarcely able to handle the water during the wet season. A raise connecting the fifth level with the Clark or mill level has been run. This raise was made directly above a winze, which was sunk to develop the sixth level and below. It has been timbered and equipped and is now in use as the main working inclined shaft.

The development of the sixth level in 1915 opened up the shoot on that level, which in width, length and value compared quite favorably with that on the upper levels. Since the new shaft and pump have been in operation, sinking has been continued below the sixth and development begun on the seventh. The results of this development below have not been announced.

The property is now equipped for steady and full operation and in all probability will maintain profitable operation for some years to come.

CORPORAL G MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Corporal G. mine, 5 miles north of Gold Hill, is in the southern part of Sec. 19, T. 35 S., R. 3 W., at an elevation of about 2600 feet above sea level. It is said to have been discovered in 1904 by J. R. McKay, who took out some ore and sold it to Mrs. N. M. Smith, of Gold Hill. It was operated under lease by J. E. Kirk in 1907. It is opened by three adits on the main vein, one above another, on the hillside, and one adit to one side. The adits are about 100 feet long and the vein has been stoped out above the upper adits; the lowest adit was not open to inspection. The vein has a width of 3 to 12 inches and strikes S. 85° W., with a dip of 60° N. The country rock is a micaceous slaty quartzite cut by andesite and spessartite. The ore contains quartz, calcite, pyrite, pyrrhotite and a little chalcopyrite, bornite, sphalerite, galena, and rare free gold. The adit to one side of the main vein opens a parallel stringer on the Volunteer claim; it pinched out at 135 feet.

COSTER AND CATTON'S CLAIM (gold) GOLD HILL DISTRICT JACKSON COUNTY

Coster and Catton's claim, 12 miles southwest of Gold Hill, is in the S. W. ¼ Sec. 21, T. 37 S., R. 4 W., on the right fork of Foots creek, at an elevation of 2550 feet by barometer. A 1 to 2-foot quartz vein here strikes N. 85° E. and dips 70° N. in greenstone. One stamp has been erected in the gulch to be operated by an overshot water wheel, but water is insufficient in summer time. The vein is opened by shallow workings for about 25 feet. About a mile to the northeast near the N. ¼ corner Sec. 22 an intrusion of aplite is visible for 200 feet along the ditch line running around the point.

COUGAR GOLD MINING AND MILLING CO. (gold) (Washington corporation)
GRANITE DISTRICT GRANT COUNTY

Local name, Cougar mine.

Office: 113 Stevens St., Spokane, Wash. David R. Adams, Pres., 1624 Mallon Ave., Spokane; N. Johnson, Sec.-Treas., 113 Stevens St., Spokane; J. W. Larkin, managing agent, 2419 Boone Ave., Spokane. Capital stock, $2,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

About 3 miles north of Granite, a half mile west of the creek, is the Cougar mine, at an elevation of 5200 to 5400 feet. It was discovered in the '90s. The development extends over a vertical distance of 300 feet and consists of short crosscuts to the vein and over 2000 feet of drifting on three levels.

The country rock is a black siliceous and semi-slaty argillite. The strike of the lode is northeast and its dip is 60 to 70° S. E. The underground workings, combined with the surface pits, trace the lode for about 2000 feet. The outcrop on a gently rolling timbered ridge is inconspicuous. The lode is from 2 to 10 feet wide, although in the lower and recent development it appears in one place to be much wider. The walls over a considerable area in the stopes are fairly well defined, although the filling is largely brecciated argillite.

There is very much less quartz than in most of the brecciated zones in argillite in eastern Oregon. Aside from the quartz and shattered argillite, there is a gouge of light color that is said to contain the highest values, which gradually lessen away from it. This would indicate that the ore was deposited by a combination of replacement and quartz filling of the smaller fractures. There are 3 or 4 shoots in the 1200 feet of development on the strike of the vein, whose combined stoping length is more than half that distance. According to reports there is a large tonnage of ore averaging nearly $7 a ton, and a much smaller quantity in one block, which contains nearly twice that value per ton.

A few thousand tons at various times have been stoped and treated in a crude mill upon the property, but there is practically no free gold even at the surface. Cyaniding this ore, which is by no means easy to treat, although the sulphides are nearly all pyrite, has been attempted by incompetents or else the management so interfered with competent metallurgists that they gave up in disgust before a process could be successfully established.

Of the gross value in the tonnage of ore treated, all but a tithe went down the creek. In the last few years work has been confined to development 100 feet below the mill level for 500 feet along the vein.

About April, 1916, this mine was taken over under lease and bond by the United Gold Mining Company, of Spokane, which is described in another place.

COUGAR PROSPECT (gold) QUARTZBURG DISTRICT GRANT COUNTY

This gold prospect is located in Sec. 2, T. 12 S., R. 33 E., on the east side of the west branch of Dixie creek. It is a fissure vein with widths up to 3 feet, and reported to have values in gold and silver up to $450 per ton. George and William Ward, the owners, expected to have a Bryan roller mill installed and driven by water power sometime in November, 1916.

COUNTY LINE MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

For description see "Mount Pitt Mine."

COWBOY MINE (copper) WALDO DISTRICT JOSEPHINE COUNTY

The Cowboy mine is located in the N. E. ¼ of Sec. 11, T. 41 S., R. 8 W., about 3 miles southeast of Takilma. It is controlled by the Tutt estate, Colorado Springs, Colorado. At present it is under option to John Hampshire, of Grants Pass, and the Twohy Brothers, of Portland. This mine is similar to the Queen of Bronze in the character of its ores, their modes of occurrence and associations, which see for description.

COX (C. C.) CLAIM (copper) EAGLE CREEK DISTRICT BAKER COUNTY

C. C. Cox, of Baker, has 2 groups of claims in this region. One group is located about 3 miles south of Sanger on Goose creek, and the other 3 miles still farther south on Sawmill gulch, a tributary of Goose creek. The country rock in both places is a dense greenstone. At the upper claims there are small lenticular veins which contain chalcopyrite. At the lower claims the country rock is cut by small veins of quartz and pyrite. They also contain some epidote and chalcopyrite.

There has been in previous years a great deal of activity in this greenstone area in prospecting for copper.

Development progressed slowly in 1915 and in August, 1916, a reported strike of copper-bearing rock about 30 feet wide was made, and in September it was reported in the press that these claims had been bonded to Spokane parties.

CRACKERJACK CLAIM (copper) ASHLAND DISTRICT JACKSON COUNTY

The Crackerjack claim is about 3 miles southwest from Ashland and about 600 feet southeast of the Pilgrim. It is opened by a crosscut at an elevation of about 3000 feet and by an incline shaft about 75 feet higher up. The vein strikes N. 10° W. and dips 55° S. W. The country rock is a metamorphosed sandy shale, now containing layers of quartz separated by layers of zoisite and some pale green hornblende, with some disseminated calcite and a few isolated crystals of chalcopyrite, films of bornite and rare pyrite.

CRACKER-OREGON MINE (gold) CRACKER CREEK DISTRICT BAKER COUNTY

A vein paralleling the North Pole-Columbia lode, about 1800 feet southeast of it. The principal workings are located in the north end of the town of Bourne.

There is considerable development on a lode of a type similar to the others in the argillites of Cracker creek. It has a 10-stamp mill, with plates and 4 vanners for concentrating, but the property has produced but little and has been idle for some years. One of F. Wallace White's "promotions" and "consolidations."

CRAMER PROSPECT GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Cramer prospect, 4 miles east of Merlin, is on Walker mountain, in Sec. 18, T. 35 S., R. 5 W., at an elevation of about 2350 feet above sea level. It is opened by an adit in greenstone, which extends N. 55° E. 60 paces to a shaft to the surface. There are other minor workings. The main fissure vein strikes N. 55° E. and dips 40° N. W. There is only a little vein material disclosed, and there has been no work done for several years.

CRATER GOLD AND COPPER MINING COMPANY BOHEMIA DIST. LANE COUNTY

Office: Portland, Oregon. Chas. Destel, Pres.-Treas., 180 Burnside St., Portland, Oregon. Capital stock, $1,000,000 (nominal); par value $1.00; amount of capital stock subscribed, none; $689,000 issued and paid up. (1916 report).

Property consists of 12 claims, located in Sec. 15, T. 23 S., R. 1 E., about 1½ miles southwest of Bohemia postoffice, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove.

Development work consists of 101 feet of tunnel, open cuts and 1200 feet of trail work. Assessment work only being done.

CRAWFORD AND FAY CLAIMS (placer) SIXES RIVER DISTRICT CURRY COUNTY

Mr. and Mrs. S. B. Crawford and Emmet Fay are the owners of 4 placer claims on South fork of Sixes river, which they were developing at the time of this investigation. These are the Old High Channel, located in June, 1915, the Dixey, purchased for $500, and the Dixey Extension Nos. 1 and 2, which were located during July, 1915. The first named is an old high river bar, but all the work was being done on the other claims and was confined to sluicing along the creek bed. The owners said they had taken out $20 worth of gold in 3 days' mining, and that most of the values were found directly on the bedrock.

CROWN MINING AND MILLING COMPANY (gold and silver) NORTH SANTIAM DISTRICT MARION COUNTY

Local name, The Crown mine.

Office: Scio, Oregon. Clarence Ingram, Pres.; R. M. Peery, Sec.-Treas., both of Crabtree, Oregon. Capital stock, $100,000; par value $1.00; $62,511.50 subscribed, issued and paid up. (1916 report).

This company owns 7 claims about 12 miles by wagon road northeast of Gates on the Little North fork of the Santiam river, on the north side of Elkhorn mountain in Secs. 32 and 33, T. 8 S., R. 4. E., at an elevation of about 3000 feet.

The principal country rock in this vicinity is andesite, which is widely distributed over the Cascade Range. On this property the andesite has been intruded by a granitic rock, which is a fine grained granodiorite. The outcrop of this granodiorite was only observed at a few points two to three hundred feet southwest from the vein, where the usual aplite dikes were seen to accompany the intrusion.

Fracturing of the andesite and the movement of one block upon another produced the sheared or brecciated zones. In these zones the mineralization has taken place because of the more favorable opportunity for deposition by circulating hot waters. Gold and silver were deposited in these brecciated zones, together with pyrite, chalcopyrite, sphalerite, and a small amount of galenite. Quartz is associated with these sulphides, which was deposited at the same time.

The mineralized brecciated zone on the Crown property is 10 to 12 feet wide, as exposed in a cut some 25 to 30 feet long and 20 feet deep. The company at present is driving a tunnel below this cut, which will, according to plans, cut the vein about 50 feet below the open cut above referred to. The company has also driven a 90-foot development tunnel on another claim about 2000 feet west of the above workings, but only a few small stringers of quartz and sulphides have thus far been exposed, the vein for which it is being driven not having been reached.

CURRY MINING COMPANY (copper) COLLIER CREEK DISTRICT CURRY COUNTY

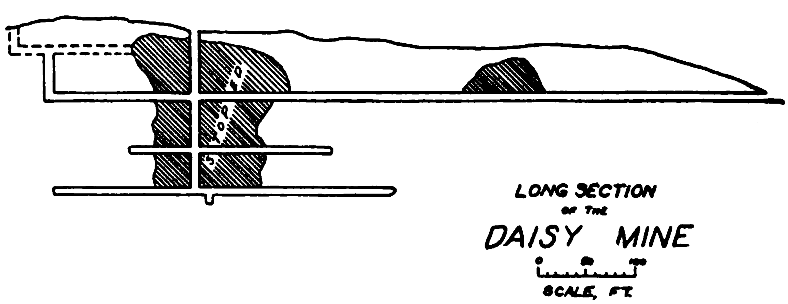
Local name, Bonanza King.

Office: Bandon, Oregon. I. W. W. Crumrine, 410 N. 10th St., Independence, Kan., Pres.-Treas.; John A. Wolf, 906 N. Penn Ave., Independence, Kan., Sec. Capital stock, $1,000,000; par value $1.00; $500,001 subscribed, issued and paid up. (1916 report).

This company owns the Bonanza King copper mine, located about 3½ miles above the mouth of Collier creek, in Curry county. This is probably the same property as that described under the title, "Bonanza King."

DAISY MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Daisy mine, 10 miles east of Hugo, was known at one time as the Hammersley mine, and is still frequently so called. It is just east of the divide between Jack creek and Bummer gulch, at the head of the latter, at an elevation of 3800 feet, as measured by barometer. It is owned by G. R. Smith, of Grants Pass. It was discovered in 1890 and has produced more than $200,000 in gold, according to the owner. It is equipped with a 5-stamp mill, having a 14-foot amalgamating plate and one concentrating table, as well as steam boiler and engine. The workings are shown in the illustration, which



Longitudinal section of Daisy mine

is a section in the plane of the vein based on a similar drawing made by A. H. Gunnell, of Grants Pass, in 1908. A long crosscut adit is now being driven to reach the ore body at considerably greater depth. The vein strikes nearly east and west in andesitic country rock. The main shaft follows the vein on a steep incline. The ore consists of vein quartz, with some calcite and brecciated fragments of argillite, serpentine and quartz cemented by epidote, quartz, calcite and kaolin.

DAISY MINING COMPANY (gold-copper) WALDO DISTRICT JOSEPHINE COUNTY

The property of the Daisy Mining Company is located ½ mile southwest of Takilma. It has 2 adits in the N. E. ¼ of Sec. 34, T. 40 S., R. 8 W. A large fault crosses the lower adit, striking N. 10° W. and dipping 75° to the west. The upper adit is about 45 feet above the lower. The ore observed here is chiefly pyrite with pyrolusite, hematite and serpentine, and traces of bornite and malachite. It is said to carry gold and chalcopyrite in valuable amounts.

DALE PROSPECT (gold) BAKER DISTRICT BAKER COUNTY

Near the center of the west half of Sec. 22, T. 9 S., R. 39 E., west of Washington gulch, more than 400 feet of tunneling has been done along a vein which strikes N. 23° E. and dips 70° W. The vein carries both quartz and calcite, the latter being of very fine grain and possibly of the nature of aragonite rather than calcite. The footwall is distinct and the hanging wall is less so. In one of the branch tunnels there is a very pronounced fault zone striking N. 67° W., and dipping 65° toward the north. About 100 yards southeast of this locality are old openings in much decayed rock, which shows masses of gossan. The largest of these which was seen was about 5 feet in horizontal diameter and 6 feet deep. A little unaltered pyrite was observed in this gossan, which is mainly limonite with small quantities of hematite.

DAN O'SHEA CLAIM CANYON DISTRICT GRANT COUNTY

Described under "Great Northern Mine," since it is owned by same company.

DEEP GRAVEL MINING COMPANY (placer) WALDO DIST. JOSEPHINE COUNTY

Local name, Deep Gravel mine.

Office: Medford, Oregon. W. J. Wimer, Waldo, Oregon, Pres.; A. E. Reams, Medford, Sec.-Treas. Capital stock, $85,000; par value $100; $75,100 subscribed, issued and paid up. (1914 report).

This mine is located 1 mile northwest of Waldo. It embraces about 560 acres in Secs. 20, 22 and 28 of T. 40 S., R. 8 W., the chief workings being in Butcher gulch and its tributaries, about a mile northwest of Waldo. According to Kay:

> The gravels of these gulches are included in a bench which extends from the head of the Butcher gulch to the west fork of the Illinois river. The upper limit of the bench is about 1½ miles from the west fork and about 125 feet higher than the bed of this stream. The most recent workings are in Joe Smith gulch, where an area of more than 10 acres has been mined. At the upper end of these workings the gravels are about 12 feet in thickness; at the lower end they are more than 60 feet, and the bank consists of gravel and sand containing practically no boulders except small ones in the lowest 10 feet. Stratification is well shown. The bed rocks in Joe Smith gulch consist of purplish conglomerates of Cretaceous age, similar to the conglomerates that are being mined in the High Gravel mine.

The pay gravel is washed through a sluice, elevated by hydraulic pressure, and carried through another long sluice, with steel lined riffles.

> A clean-up is made about once a month. The gold is saved by amalgamation and is very fine. The concentrates are sold for their values in platinum, osmium, and iridium. Mr. Wimer stated that the average value of the pay gravels during the years 1903-1907 was about 25 cents to the cubic yard. The water used in the pit and in the elevator is brought by 2 ditches from the east fork of Illinois river. The longer of the 2 ditches is about 4 miles in length.

According to Mr. Wimer, about $130,000 had been expended on the property and about $250,000 taken out of it before 1908. It embraced about 560 acres in Secs. 20, 22 and 28 of T. 40 S., R. 8 W.

DeLUSE MINING AND DREDGING COMPANY (placer) GOLD HILL DISTRICT JACKSON COUNTY

Office: Sutherlin, Oregon. J. F. Luse, Pres.; H. M. MacLean, Sec., both of Sutherlin; A. E. Bamber, Treas., Gold Hill. Capital stock, $10,000; $6900 capital stock paid up. Four persons own the stock. (1914 report).

This company owns 240 acres of placer ground in Sec. 11, T. 36 S., R. 3 W.

DEVILS GATE MINING COMPANY CALIFORNIA

Office: 979 E. 24th St., Portland, Oregon. G. A. Keller, Decatur, Ill., Pres.; Otis E. Wise, 979 E. 24th St., Portland, Sec.-Treas. Capital stock,

$25,000; par value $1.00; $11,933 subscribed, issued and paid up. (1916 report).
This company's properties are located on American river in California.

DIADEM MINE (gold and mercury) GREENHORN DISTRICT BAKER COUNTY

The Diadem is but a short distance from the Banzette and about 1½ miles west of Greenhorn. The country rock is greenstone. The vein strikes E.-W. and has a vertical dip and is of the shattered replacement type. The ore minerals are pyrite and cinnabar. Only a part of the old surface workings was visited.

DICK MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Dick mine is 8 miles east of Hugo, in the N. E. ¼ Sec. 8, T. 35 S., R. 5 W., on the northeast side of Walker mountain, at an elevation of about 2400 feet, as measured by barometer. It belongs to Fetch and Long. An adit has been driven about 200 feet in a westerly direction in quartzite. Gold ore taken out has been run down the hill in a flume to an arrastre.

DIXIE CREEK PLACERS QUARTZBURG DISTRICT GRANT COUNTY

These placers extend from Prairie City north and up Dixie creek for a distance of 4 miles, as well as below the town, in the John Day valley, and cover several hundred acres. Most of the ground was worked in the early placer days and locally the gross production is stated from $600,000 to several millions. The gravel is from 10 to 15 feet deep and the width of the gravel-covered creek bottom is from 300 to 800 feet. In the summers of 1915 and 1916 prospecting was done by means of pits and churn drilling to determine whether it would be advisable to install a dredge upon this ground, but the result of this prospecting has not been announced.

DIXIE MEADOWS MINE (gold) QUARTZBURG DISTRICT GRANT COUNTY

The Dixie Meadows mine is located on the headwaters of Ruby creek in Sec. 23, T. 11 S., R. 33 E., and is owned by L. Vogelstein & Co., of New York. This mine has been quite extensively developed and has a small mill upon the ground. The vein is a large one, much of it decomposed country rock containing considerable gold-bearing pyrite and arsenopyrite.

The ore body, although a large one, is quite spotted and its soft condition makes difficult the extraction of the higher grade bunches. These higher grade bunches are much less in evidence in the lower levels. There is difficulty in concentrating this ore, at least with the present equipment, so as to have a margin above transportation and treatment charges. If the entire body of ore could be treated cheaply upon the ground perhaps this property could be successfully worked. Leasers during the winter of 1913-14 extracted and milled some of the higher grade ore, but ceased operations about the middle of the year. Since then much of the workings have caved and it will take considerable work to reopen the mine.

DIXIE QUEEN MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Dixie Queen mine, 8 miles southwest of Gold Hill, is on the left fork of Foots creek in the N. W. ¼ Sec. 18, T. 37 S., R. 3 W., at an elevation of 1850 feet by barometer. It is opened by 3 adits having a total length of about 450 feet. The lowest extends west about 100 feet and northwest about the same distance, with minor openings. The next tunnel above extends northeast, but is caved at 65 feet from the portal. It is a drift on a vertical quartz vein in a lead 6 to 30 inches wide in a country rock, which is a calcareous argillite. In the upper tunnel a crushed zone dips about 75° N. E.; it has a thickness of nearly a foot.

DOLLY VARDEN (gold) EAGLE CREEK DISTRICT BAKER COUNTY

This property, 8 miles southeast of Sanger and about the same distance north-northeast of Sparta, in Sec. 18, T. 7 S., R. 44 E., is a big outcrop of rusty quartz and silicified shale developed by irregular surface cuts and pits. No regular veins are seen. This group, which has been abandoned for some years, was relocated in 1915 by Chas. Carnahan and B. Martin, who report value per ton of $7 to $8 over a great width.

DON JUAN (gold) GREENHORN DISTRICT BAKER COUNTY

This property is about 1 mile southeast of Greenhorn. It is reported to be in altered greenstone and serpentine with ore vein material of granular dolomite and a little quartz and galena. There is not much activity.

DONNELLY PROSPECT (gold-silver-lead) WALLOWA DISTRICT WALLOWA COUNTY

Located about 1 mile south of Minam lake in about Sec. 31, T. 4 S., R. 44 E., at an elevation of 8500 feet. Small irregular quartz veinlets in a sheared zone 8 to 10 feet wide in granodiorite and an aplite-porphyry dike. Principal quartz stringer is about 6 inches wide containing galena, tetrahedrite, sphalerite and a small amount of chalcopyrite and reported high values of silver and gold.

An adit was started in 1914 to determine whether the smaller veinlets will unite with the larger one at some place below.

DOROTHEA MINE GREENBACK DISTRICT JOSEPHINE COUNTY

Dorothea (Marshall) mine is owned by Mrs. J. F. Reddy who purchased it from Glendale Mining & Milling Co.

The Marshall mine is located on the north side of Coyote creek near the N. W. corner of section 22, T. 33 S., R. 5 W., 5 miles east of the Pacific Highway, the nearest railway station being Leland. It has been opened by several adits and a shaft. A crosscut adit about 500 feet long is wholly in serpentine. A shaft about 100 feet deep exposes a good looking white quartz vein between a serpentine hanging wall and greenstone footwall striking E. and W. and dipping steeply to the N. A shearing movement has taken place since the vein was formed, approximately in the plane of the vein and involving portions of it in the crushed zone. On the footwall the better part of the vein is found which varies from 1 to 4 feet in width. An adit cuts the vein at about 150 feet in depth and from this level considerable stoping has been done. The mill has 5 stamps and a Fairbanks-Morse standard concentrating table driven with steam power.

DOUBLE EAGLE MINING COMPANY (gold) GREENHORN DIST. GRANT COUNTY

Office: The Dalles, Oregon. J. S. Fish, Pres.; T. J. Seufert, Sec.; J. C. Hostetler, Treas., all of The Dalles, Oregon. Capital stock, $1,050,000; par value $1.00; $990,100 subscribed, issued and paid up. (1916 report).

This company owns 7 quartz claims in about Sec. 3, T. 10 S., R. 35 E., about 2 miles north of Greenhorn, Oregon, on the west side of Quartz gulch. Reports of 10 years ago state that there were 500 feet of drifting upon a vein (not described) on an upper level and a 1200-foot crosscut below, which had not reached the vein.

A vein discovered in 1916 is being prospected.

DOUGLAS UMPQUA MINING COMPANY

This company was dissolved January 11, 1916, but reinstated October 27, 1916. Its office is Portland, Oregon.

DREXEL MINING COMPANY

This company was dissolved January 5, 1914, but reinstated November 4, 1916. Its office is Vale, Oregon.

DRY DIGGINGS (placer) **GRANTS PASS DISTRICT** **JOSEPHINE COUNTY**

The placer gravels of Rogue river have been exploited as a source of gold for many years, but work has ceased almost entirely in the Grants Pass district. About 10 years ago the "Dry Diggings" a short distance above the county seat were the scene of considerable activity and a big dam across the river was constructed to aid in the work; after a few years of considerable output work ceased and very little has been done since that time. There are several other placer mines at various points along the river, but none of them has been a large producer. One difficulty in the way of developing important placer mines in this area has been the fact that in many deposits the rich gravel just above bedrock was buried too deeply by later sands and boulders.

DUCOMMUN PROPERTY **WALDO DISTRICT** **JOSEPHINE COUNTY**

See "Elephant or (Ducommun)" property.

EAGLE CREEK PLACERS **EAGLE CREEK DISTRICT** **BAKER COUNTY**

These placers have been worked ever since the late '60s and each season some placer mining is done. All along Eagle Creek there are benches of heavy gravel up to 100 feet above the stream. These benches have been worked to some degree from below the mouth of Paddy creek to a few miles up stream above the mouth of East Eagle creek. Placer mines are found on both upper and lower Paddy creek.

It is reported that the deposits, both bench and stream, near the mouth of Paddy creek and above on Eagle creek, have been sold under lease and bond to the Prince John Placer Mining Company of Grand Junction, Colorado. It is not known whether it is an incorporated company or not.

Press reports of June, 1916, state 30 men were at work constructing a large ditch to carry water for hydraulic purposes.

EAGLE MINE (gold) **GOLD HILL DISTRICT** **JACKSON COUNTY**

The Eagle mine, 3 miles southeast of Gold Hill, adjoins the Millionaire on the west. It is opened by 4 shafts and at least 2 adits, but the workings are not extensive. An adit reveals stringers of quartz in black argillite and andesitic material. The mine is said to have produced some very high grade ore. It is now under lease, but not in operation.

EAGLE MINE (gold) **GRANTS PASS DISTRICT** **JOSEPHINE COUNTY**

The Eagle mine is 6 miles northeast of Merlin on the east side of Walker mountain in the S. W. ¼ Sec. 6, T. 35 S., R. 5 W., at an elevation of 2550 feet as measured by barometer. It is owned by Jim Rush and Herbert Corless of Grants Pass.

The country rocks here include argillite and a sheared pryoxenite or augite diorite rich in dark minerals, as well as some talc schist and black material, probably carbonaceous. The ore is quartzose vein material with very little sulphide. A vein strikes southwest and dips about 40° S. E. The mine has been opened by shafts and adits which are now caved and inaccessible. From the size of dumps it is probable that several hundred feet of underground work was done, but the mine has been idle for several years.

EAST EAGLE MINING & MILLING COMPANY (gold)
EAGLE CREEK DISTRICT **BAKER COUNTY**

Local name, Miller & Lane group.

Office: Baker, Oregon. J. A. Thronson, Pres.; E. S. Platts, Sec.; J. A. Thronson, Treas. Capital stock, $5000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Located about 15 miles north of Sparta or 45 miles northeast of Baker, in N. W. part of T. 6 S., R. 44 E. (Sec. 5 probably), on the west side of the rather steep canyon of East Eagle creek at an elevation of about 5000 feet.

The region is well timbered. Four located claims are owned and 5 claims under bond and lease to the company.

The vein is of the saddle reef type, filling in the top of an anticline with a layer of greenstone below and a bed of argillite above. The axis of the anticline has a north-south direction and pitches to the north. Average width of vein is 4 feet and the average value is said to be $8.50 per ton. Vein has been exposed by about 200 feet of tunnel along the crest of the fold. Cross-cuts and small tunnels have shown that the width of the fold, where occupied by the quartz, is about 100 feet. It is possible that this saddle-reef vein was fed by a fissure, and as the principal breaks in the vicinity strike east-west and dip north, the driving of the tunnel north along the axis of the fold, may bring the best results.

The mine has a good-sized log boarding house, several smaller buildings, a 5-stamp mill run by water power, Wilfley table, assay outfit, etc.

There is another group of claims called the Woodard, about one-half mile west of this property and controlled by the company. Only a small amount of development work has been done on these claims.

ECLIPSE COPPER MINING COMPANY — **UNION COUNTY**

Office: La Grande, Oregon. Julius Fisher, Pres.; Wm. B. Sargent, Sec.-Treas., both of La Grande. Capital stock, $2,500,000; par value 25 cents; $185,000 subscribed, issued and paid up. (1915 report).

EDWARDS AND GARRISON CLAIM (gold) UPPER APPLEGATE DIST. JACKSON CO.

Edwards and Garrison have a prospect about 2 miles from the head of Elliott creek, 30 miles south of Jacksonville and half a mile north of the California line. Small bunches of ore have been obtained from surface workings. The main vein is parallel with the schistosity of the chlorite schist country rock and is 9 to 12 inches thick. It consists largely of pyrite and gouge with only a little quartz; it strikes N. 55° E. and dips 30° N.W. An incline shaft goes down at an angle of 23° about 60 feet N. 60° W. The ore is said to assay about $40 a ton, but some of the gold does not amalgamate readily. A fault striking N.E. cuts the vein but the displacement is only about 1 foot.

ELECTRIC MINING AND SMELTING COMPANY
NORTH SANTIAM DISTRICT — **MARION COUNTY**

Office: 218 Worcester Bldg., Portland. R. M. Russell, Sec. and Treas. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1912 report). Dissolved April 6, 1914.

See "Consolidated Copper Mining and Power Company."

ELECTROLYTIC MINE (copper and gold) — **WALLOWA COUNTY**

Located in Sec. 3, T. 1 S., R. 50 E., on the Oregon side of the Snake river canyon, a few hundred feet from the stream, about 65 miles south of Lewiston, Idaho, and about 7 miles above Dry creek and 2 miles below Sommer's creek. Canyon very steep and rugged; no timber.

The region appears to be made up of altered basic volcanics (greenstones) cut by quartz veins and capped by recent basalt. The old lavas, which are now greenstones, may have originally been andesites. The quartz veins probably came from some cooling intrusive mass at depth, but the intrusion is probably somewhat distant, as the usual offshoots such as porphyry dikes are notably scarce.

Mineralization consists of fissure veins and fracture zones. In both cases it appears to be slight. The main vein is a regular fissure having a strike of N. 10° to 20° W., with a nearly vertical dip and an average width of 8 to 10 inches. A small amount of pyrite is the chief ore mineral. On the western side of this vein there is a fault breccia 4 to 5 feet wide, not mineralized and probably post mineral. The vein has been traced on the surface for several hundred feet and the erosion of the vein and fault breccia has formed a narrow gorge. There is a 600-foot crosscut, which has not reached the vein. It will strike it at a depth of several hundred feet. Although no assays were available, the surface indications are such as would discourage the expenditure of much money in development work.

ELEPHANT or (DUCOMMUN) PROPERTY (copper) WALDO DIST. JOSEPHINE CO.

The Elephant or Ducommun property is located in the S. E. ¼ of Sec. 18, T. 40 S., R. 7 W., 3 miles northeast of Takilma. A 440-foot adit on this property shows some copper ore. The minerals found in the ore are marcasite, pyrite, chalcopyrite, chalcanthite and gypsum.

ELK CREEK GOLD MINING COMPANY (gold) CORNUCOPIA DISTRICT BAKER CO.

Local name, The Robert Emmett.

Office: Union, Oregon. H. C. Susecoind, Pres., Nampa, Idaho; C. E. Davis, Sec.-Treas., Union, Oregon. Capital stock, $50,000; par value $1.00; $28,000 subscribed and paid up; none issued. (1916 report).

Land consists of a quartz claim, the Robert Emmett, located about 1 mile northwest of Cornucopia and about 2 miles by wagon road up heavy grade from same.

Northward from the Red Jacket shoot the vein pinches in the hard schist of the backbone of the ridge, but opens again in the Emmett claim, which has been worked successfully on a moderate scale since 1899. A tramway connects it with a mill built on Elk creek. The elevation is 6,350 feet. The developments consist of a shaft 165 feet deep on the inclined, drained by a tunnel, and of drifts on two levels. The vein is similar to the Union-Companion, though only 1 to 2 feet thick. It contains a shoot of good ore; some of the partly oxidized ore near the surface, 100 feet south of the shaft, contains up to $100 per ton. (Lindgren, p. 744)

For the last few years little work outside from the assessment has been done.

EL SENORA MINING COMPANY (gold) UPPER APPLEGATE DIST. JACKSON CO.

Local name, El Senora.

Office: Applegate, Oregon. A. H. Ruelle, Pres., Seattle, Wash.; E. W. Shattuck, Treas., Applegate, Ore. Capital stock, $500,000; par value $1.00; Stock is entirely subscribed, issued and paid up. (1914 report).

Property consists of 12 located lode claims and 1 placer claim, and is located 3 miles southeast of Applegate in northern part of Sec. 34, T. 38 S., R. 4 W. The workings total about 1000 feet, part of which is caved and closed. The lowest entry was a shaft 130 feet deep and a level said to follow a 4-foot vein of low grade quartz ore for 200 feet. The next entry is an adit which crosscuts N. 60° E. for 80 feet and then drifts S. 45° E. for 70 feet. The vein shows 2 feet of quartz in argillite. Some gold is found also in seams in the country rock. About 100 yards to the southeast the next higher adit follows the vein S. 55° E. for 220 feet. Above this are two short adits and a shaft, where a pocket of ore was removed. The strike of the vein is not constant in all the adits, but it is apparently continuous; in one place it narrows to 1 inch of fault gouge. The company owns a 10-stamp mill, which is on the ground, but not erected. It was obtained from the Oregon Belle mine.

The management states that late development shows a 3½-foot vein that averages about $12 per ton.

ELWILDA OR KRAMER GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Elwilda or Kramer group is now owned by M. C. Page, of Seattle, who is continuing the development of the property. It is about 8 miles by trail from the Almeda mine and consists of 11 claims extending from Rogue river up Whiskey creek. The mill was formerly a rotary 4-stamp Parker mill;

it is now an arrastre run by a Pelton wheel. The group is opened chiefly at two places called the north and south "works." In both places the country rock is greenstone; at the latter it is cut by a dike of quartz monzonite aplite. At the south "works" 2 short adits disclose a quartz vein about 3 feet thick, which is much crushed and faulted. One fault strikes N. 67° E. and dips about 55° S. E. The chief vein strikes nearly east and dips about 60° northward. At the north "works" 2 adits open one or more veins, which vary considerably in strike and dip. The richest portion has a strike of N. 4° E. and a dip varying from 45° W. above the level to 78° W. below in a 40-foot winze. Near the breast a quartz vein strikes N. 20° E. and dips 70° N. W. The gold in the ore from this adit is reported to amount to $5 a ton.

EMERSON PLACER — GRANTS PASS DISTRICT — JOSEPHINE COUNTY

See "Flanagan and Emerson" placer.

EMPIRE GOLD DREDGING AND MINING COMPANY (placer) — CANYON DISTRICT — GRANT COUNTY

Office: 250½ Third St., Portland, Oregon. W. F. Burrell, Pres.; O. L. Kennedy, Sec.-Treas., both of Portland, Oregon. Capital stock, $100,000; par value $100; $72,000 subscribed, issued and paid up. (1916 report).

This company owns the dredging ground in the John Day valley in the immediate vicinity of the town of John Day, and upon Canyon creek, between the towns of John Day and Canyon City. They began the operation of a standard dredge in June, 1916, and the dredge was constructed and floated within the corporation limits of the town of John Day, and is digging up Canyon creek toward Canyon City. Canyon creek and its immediate vicinity is credited by Federal authorities as having produced $15,000,000 in placer gold. Although most of the upper gravels in the stream bed were worked over in the early days, a deposit as rich as was Canyon creek, handled by the methods then in vogue, must of necessity leave values sufficiently high to make dredging profitable. Besides, the failures of the workers of many separate claims to reach and clean to bedrock on account of water difficulties and disposal of gravel, must have left much gold easily recoverable with a modern dredge.

EMPIRE PROSPECT (gold) — CHINA DIGGINGS DISTRICT — CURRY COUNTY

This property lies about a quarter of a mile south of the Golden Dream claim, which is at the head of Slide creek. It is owned by W. G. Cooley and Ben Miller, of Harbor. It was not visited, but the deposit is said to consist of quartz stringers in porphyry (greenstone?). It is said to have been worked for at least 14 years, and was being actively developed during the summer of 1915. It is claimed that at least 2 feet of free milling gold ore averaging $12 a ton is exposed.

EQUITY COPPER AND GOLD MINING COMPANY (gold-copper) — QUARTZBURG DISTRICT — GRANT COUNTY

Local name, The Colorado mine, The Equity mine.

Office: Prairie City, Oregon. W. J. Hughes, Prairie City, Pres.; Mrs. Kate Palmer, Baker, Oregon, Treas.; G. J. Bowman, Baker, Sec. Capital stock, $150,000; par value ten cents; all subscribed, issued and paid up. (1916 report).

This company's property of 6 claims is located in Sec. 2, T. 12 S., R. 33 E., about 7 miles northeast of Prairie City, Oregon, on Dixie creek. The vein on this property is similar in strike, dip, width, values and mineral content to that of the Present Need mine, owned by the Comer Mines Company. The developed ore is practically exhausted to creek level. Production for the year 1915 was $369.95.

ESSEX LEAD AND SILVER MINING COMPANY **IDAHO**

Office: 314 Failing Bldg., Portland, Oregon. George L. Story, Pres.-Treas.; Chas. Hutchins, Sec., both of Portland, Oregon. Capital stock, $200,-000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located in the Beaver mining district, Shoshone county, Idaho.

EUREKA DISTRICT GOLD MINING COMPANY **WASHINGTON**

Office: 705 Chamber of Commerce Bldg., Portland, Oregon. Jonathan Bourne, Pres.; I. M. Arneson, Sec., both of 705 Chamber of Commerce Bldg., Portland, Oregon. Capital stock, $2,500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located in the Eureka Mining District, Ferry County, Washington.

EUREKA MINE (gold) **ILLINOIS RIVER DISTRICT** **JOSEPHINE COUNTY**

With reference to this property Diller says:

The Eureka mine on a branch of Soldier creek, about 12 miles northwest of Kerby, is owned by a company in Eureka, California. The property embraces 6 or more claims and is reached by trail only. There are probably 1,000 feet of underground workings, also air drills, electric lights, and a 10-stamp mill with concentrator and cyaniding plant now idle. The mine was operated more or less irregularly for about 4 years, beginning in 1901, with a Huntington mill. The output, though considerable, is not definitely known.

The country rocks are greenstone and serpentine and the ore occurs in irregular but abundant veins or bunches of quartz on the contact or near it in the adjacent greenstone. The quartz streaked with a dark ore mineral, reputed to be a telluride, is richest and is said to run as high as $500 a ton. Such ore was rare and is not now available. The general average of ore is low, much of it about 40 cents a ton, and would not pay for working. The ribboned veins of quartz strike N. 50° W. and dip 75° NE. The contact has been worked 250 feet in depth and 500 feet in length horizontally.

EUREKA MINING, SMELTING AND POWER COMPANY (copper) (Washington corporation) **WALLOWA COUNTY**

Local name, Eureka mine.

A Washington corporation with offices at Clarkston, Washington. Wm. Struve, Almont, Iowa, Pres.; W. E. Howard, Clarkston, Wash., Sec.-Treas.; C. H. Zurcher, Enterprise, Ore., attorney-in-fact. Capital stock, $2,000,000; par value $1.00; all subscribed and paid up, $838,515 issued. (1915 report).

The property was not visited, but Stevens' Copper Handbook of 1912-13 says: "Lands: 40 claims; patents applied for, but secretary reports (1913) property idle for several years, awaiting railway facilities." This property is located near the Snake river on the Oregon side about Sec. 14, T. 3 N., R. 50 E.

EXCHEQUER MINE (gold) **LOWER APPLEGATE DISTRICT** **JOSEPHINE COUNTY**

The Exchequer mine, 11 miles southeast of Grants Pass and 2 miles north of Provolt, is in Sec. 35, T. 37 S., R. 5 W., on a hill near the Applegate river. The lower adit is about 150 feet long in argillite; the drift is on a small vein which strikes N. 60° W. and dips about 70° N. E. Nearby a vertical shaft said to be 200 feet deep is now caved and full of water. The dump shows pyritized quartz and a vein at least a foot wide. The country rock here is greenstone. The Exchequer mine is owned by W. H. Flanagan, of Grants Pass. It was formerly equipped with a Huntington mill and a concentrator.

FAIRVIEW CLAIM (gold) **GOLD HILL DISTRICT** **JACKSON COUNTY**

The Fairview claim, 5 miles southwest of Gold Hill, owned by Dr. C. R. Ray, of Medford, is in the N. W. ¼ Sec. 5, T. 37 S., R. 3 W., near the top of the ridge between Galls and Foots creeks at an elevation of 2950 feet by barometer. High grade ore is reported near the surface where a narrow vein of quartz with a little calcite, pyrite, and galena strikes N. 50° W. and dips 77° N. E. into the hillside. Very little development has been accomplished here.

FARRELL GROUP (copper) **HOMESTEAD DISTRICT** **BAKER COUNTY**

L. D. Lilley and associates, of Baker, Oregon, secured a bond and lease upon this property, which was formerly owned by Ed. Farrell and sold to eastern people who worked the property for several years, but finally failed to do the annual assessment work and the property was relocated by J. W. Beckham.

This group is situated south of the Iron Dyke and is thought to be upon an extension of the Iron Dyke ledge. The property had a 400-foot crosscut and Mr. Lilley is engaged in continuing this tunnel to crosscut the ledge shown upon the surface and in the shallow workings above.

FAY CLAIM **SIXES RIVER DISTRICT** **CURRY COUNTY**

See "Crawford & Fay Claims."

FIDELITY COPPER COMPANY **IDAHO**

Office: 907 Wilcox Bldg., Portland, Oregon. Joseph M. Healy, Title & Trust Bldg., Portland, Pres.; L. B. Reeder, 907 Wilcox Bldg., Portland, Sec.-Treas. Capital stock, $2,000,000; par value $1.00; $1,866,477 capital stock subscribed and issued; $1,000,000 capital stock paid up by purchase of property. (1916 report).

This company's property, which conssits of 37 claims, is located in the Seven Devils mining district, Adams county, Idaho, directly across Snake river from the MacDougall group and is of similar nature.

FIDELITY GROUP **WALDO DISTRICT** **JOSEPHINE COUNTY**

See "Roseburg and Fidelity" groups.

FIELD MUTUAL MINING COMPANY **IDAHO**

Office: 254 Alder St., Portland, Oregon. Al. W. Field, Pres.; Richard A. Field, Sec.-Treas., both of 254 Alder St., Portland. Capital stock, $100,000; par value 25 cents; $50,000 subscribed, $4650 issued, $2813 paid up. (1916 report).

This company's properties are located in Blaine county, Idaho.

FLAGSTAFF MINE (gold) **VIRTUE DISTRICT** **BAKER COUNTY**

The Flagstaff mine is owned by Boston people, Arthur Murphy having the controlling interest. At present it is under lease and bond by a Seattle syndicate. J. H. Sullivan is in charge of the mine.

It is located about 6 miles northeast of Baker in Sec. 5 T. 9 S., R. 41 E. The country is hilly and barren. The mine is situated on a small hill and the shafthouse forms a conspicuous landmark. There is an excellent wagon road from the mine to Baker.

The particular vicinity is near the contact of intrusive diorite into older greenstones. These rocks are overlain by recent basalt. Although the intrusive is more basic than the usual type, it represents a phase of the main granodiorite batholith. Its dark basic nature makes it hard to distinguish from the invaded greenstones. This difficulty is enhanced by the fact that the contact is somewhat shattered, large blocks of the greenstone being found surrounded by the intrusive. The usual accompaniment of porphyry dikes is present.

Mineralization occurs in distinct quartz fissure veins. One of these, called the Flagstaff vein, upon which the shaft has been sunk, strikes N. 30° E. and dips 60° to the S. E., and is a small persistent fissure with a maximum width of about 18 inches. It has been drifted upon for several hundred feet and much of it has been stoped. The values are said to be in small high grade shoots.

The main vein of the property, which is called "Big Ledge," intersects the Flagstaff vein at a point about 800 feet north of the shaft, has a strike varying from N. 15° W. to N. 35° W. with a dip of 60° to the east. This is a persistent and much larger vein than the Flagstaff vein, having a width of 5 to 8 feet of solid quartz for several hundred feet. The values are said to be evenly distributed and about $16.00 per ton in gold.

There is another vein about 100 feet further north from the shaft called the "White Frost" vein, which has a strike of N. 30° W. and dipping at a high angle to the east. This vein is similar in size and values to the Flagstaff vein.

The development work consists of over 5000 feet of workings. It includes a shaft 760 feet on the Flagstaff vein with several hundred feet of drifts to the north and south at the 260-foot level and the 360-foot level. There is also about 100 feet of drift at the 560-foot level and there is an air raise to the surface from the 360-foot level about 400 feet north of the shaft. The Big Ledge vein is developed by drifts on the 360 and 260-foot levels, with an air raise to the surface near the north face of the 350-foot drift and in the widest part of the Big Ledge on the 360 level there is a winze 85 feet deep and a raise of about the same length.

The 3-compartment incline shaft has been put in excellent shape. There is a 20-stamp mill driven by steam power and a cyanide plant.

FLANAGAN AND EMERSON PLACER GRANTS PASS DIST. JOSEPHINE COUNTY

About 10 miles west and 3 miles north of Grants Pass the Flanagan and Emerson placer mine is located on a gravel terrace on the west side of Rogue river about 30 feet above the water. It is owned by Dr. W. H. Flanagan, of Grants Pass.

According to Diller:

> The mine face exposes 50 feet of fine gravel containing a small amount of sand near the middle and top. On the river side of the mine a portion of the gravel appears to have been washed away and replaced by a later deposit. The slate bedrock is much twisted and faulted. The strike is N. 20° E. and the dip is 45° S. E.

Near this mine to the south in Secs 2 and 11, T. 36 S., R. 7 W., there are extensive deposits of alluvial gravels which have been tested by Clarence H. Mace. He reported 25 cents to $1.60 per cubic yard with a channel 600 to 700 feet wide and the richest streaks on the concave side of the river. Conditions here seem to be favorable for the introduction of dredging. The gold is coarse with rough edges, which indicates that it has not traveled far. For the most part the boulders are small, averaging under 6 inches in diameter, and there is no clay except in part of the overburden. There are places along the present channel where the gravel is only 4 feet thick, and others where it is evidently at least 30 feet, but where the ancient channel is exposed by hydraulic operations it varies from 75 to 150 feet in thickness. Bedrock consists of upturned slate beds.

FLORENCE PROSPECT (zinc) CHETCO (MOUNT EMILY) DIST. CURRY COUNTY

The Florence prospect was located March 4, 1914, and is owned by Charles M. Warren. It is situated just below the crest on the northern slope of Mount Emily. The deposit is along the contact between metamorphosed Dothan sediments and rhyolite. The hornfels resulting from the metamorphosis of the Dothan shale has been crushed, sheared, and silicified at this point, and in the crevices thus formed sphalerite and pyrrhotite have been deposited. The total width of the mineralized zone is about 8 feet; the strike is N. 35° E. and the dip 75° S. W. A sample taken across this mineralized zone proved to contain 3.57 per cent zinc and a trace of gold, while a sample consisting largely of pyrrhotite yielded but a trace of gold. It is certain that this ore would yield a high-grade zinc concentrate, but the only opening on the vein consists of an open cut, and it is decidedly uncertain how extensive the deposit will prove to be. It seems likely, however, that the sulphides will be confined to points along the contact where an unusually great degree of crushing has occurred, and this will tend to give the deposit a "pockety" nature.

An eighth of a mile west of Florence prospect, across a small gulch, is a cliff the face of which is heavily iron-stained and covered with pot-holes. It proved on examination to consist of a brecciated mass of rhyolite containing rounded cavities and seams filled with pyrite and quartz. A sample of the sulphide yielded not a trace of gold, however.

FOREST CREEK MINING COMPANY (placer) JACKSON COUNTY

Office: Henry Bldg., Portland, Oregon. D. W. Dobbins, Pres.; M. A. Brown, Sec.; Adelaide A. Lowden, Treas., all of Portland, Ore. Capital stock, $50,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company owns 40 acres of placer ground in Jackson county. This is a new corporation and very little development work is done upon the property as yet. No production to date.

FORSTER AND THOMAS COPPER CLAIMS EAGLE CREEK DIST. BAKER COUNTY

See "The Sovereign Consolidated Copper Company."

FORTY-NINE DIGGINGS (placer) ASHLAND DISTRICT JACKSON COUNTY

The best known placer mine in the district is called the "Forty-nine diggings." It is about 2½ miles northwest of Ashland at the north end of the ridge between Wagner and Ashland creeks. Here the placer operations have extended at least 20 feet into an old conglomerate bedrock and the same distance into an older bedrock consisting of a series of andesitic flows, now much altered.

Upon weathering the rock becomes lighter colored, and curving lines of iron stain surround and accentuate lenticular or spheroidal forms of more compact material. In places the andesite seems to be amygdaloidal containing cavities filled by later calcite and other material. The flows strike S 60° W. and dip steeply westward and are overlaid by the nearly horizontal conglomerate, probably of Cretaceous age, which strikes S. 40° E. and dips about 70° N. E. This placer has not been in operation for several years.

The following description of the Forty-nine diggings was written by Frank M. Anderson:

The old placer mines near Phoenix, Oregon, were the property of the late E. K. Anderson, who formerly lived near Talent, Jackson county. They form a group lying about the northern end of a ridge of hills which constitute a spur of the Siskiyou mountains. Mining has been done along the eastern and northwestern flanks of this ridge, and gold in small quantities found in all the alluvial gravels of the vicinity. From about 1860 until recent years these mines were worked regularly for a few months during the winter and spring. Until 1895 they yielded generally from 60 to 150 ounces of gold annually, which ranged in value from $16 to $18 an ounce.

The gold was generally accompanied by considerable "black sand" (magnetic iron and other dark minerals) and some grains and nuggets of cinnabar. For the most part the gold was fine, ranging in size from "dust" to "flaxseed" gold, though a few nuggets of gold were found which weighed as much as 3 ounces or even more.

Much of the gold was more or less "rusty" and would not amalgamate freely, so that after all the gold obtainable by this means was removed from the black sand it still had a value of $5 to $8 a ton in gold.

FRASIER MINES (copper, gold and molybdenum) WALLOWA DIST. WALLOWA CO.

Local name, Frasier mine.

Office: 507 Broadway Bldg., Portland, Oregon. F. T. McBride, Pres.; F. R. McBride, Sec., both of Portland. Capital stock, $15,000; par value $10; $7540 subscribed, issued and paid up. (1916 report).

The Frasier mine is on the high ridge which separates the headwaters of the Imnaha from the west fork of the Wallowa. It is in about Sec. 7 T. 5 S., R. 45 E. at about 8000 feet elevation. It is about 18 miles south of Joseph and is reached by 6 miles of wagon road and 12 miles of trail along the west fork of the Wallowa river.

At the Frasier property we have a block of limestone or marble several hundred feet long, occupying the top of a ridge. This limestone outcrop is entirely surrounded by granodiorite and the contact between the two is an irregular ellipse, with its major axis that of the ridge's crest and its greatest vertical distance below the ridge at either side about 200 feet. The contact-metamorphic zone goes all the way round the limestone block, but the northern side of the ridge has the greater amount of mineralization.

The mineralized zone is from 20 to 50 feet wide. The principal gangue minerals are garnet, epidote, calcite and quartz. Much of the garnet and epidote is fine-grained, but when these typical contact-metamorphic minerals had the opportunity, as in vugs and small fissures, they formed into crystals of considerable size. Some of the garnets were found to have a curious zonal structure indicating a change of composition in the outer part of the crystals. Since their exterior is of different composition from their interior which was formed first, the depositing solution must have changed in composition during the slow building up of these crystal forms.

The ore minerals are chalcopyrite, pyrite and molybdenite. Chalcopyrite is found in a zone from six to eight feet wide near the actual plane of the contact in what appears to be altered granodiorite. Chalcopyrite is also found in bunches filling in the spaces between the fairly well formed zonal type of garnet crystals.

Molybdenite, with some chalcopyrite, occurs in the altered granodiorite alongside the chalcopyrite, and appears to be the result of fissuring within the contact-metamorphic zone after the zone had been at least partially formed. It appears likely that the feldspar, biotite or black mica, and the hornblende of the granodiorite had been nearly all replaced by silica; molybdenite afterward completing the replacement of these minerals. This highly siliceous molybdenite vein is from one to two feet wide.

There are also irregular lens-like quartz veins. Small amounts of chalcopyrite and epidote are found, besides the tabular and for the most part badly-formed crystals of molybdenite.

W. Sutton and associates, of Butte, began in 1914 the development of this interesting contact deposit, where considerable surface work had previously been done by Mr. Fraser. A crosscut tunnel 300 to 400 feet long is being driven to get well below the surface, not only to determine the extent and value of the deposit below, but to avoid trouble with snow at the present surface workings.

It is said that there is 20 to 25 cents in gold to each per cent of copper, and that samples contain copper up to moderately high percentages.

FREE AND EASY MINE (gold) WALDO DISTRICT JOSEPHINE COUNTY

Diller says:

> The Siskiyou Sunset Mining and Development Company has a deserted mine, generally known as the Free and Easy, in the large serpentine area 2½ miles west of Kerby. Several tunnels and other openings were made in the serpentine on the south slope of the ridge, but they are now caved in. In the valley, a few hundred feet below the mine, there is a small Huntington mill long unused.

This company was dissolved Jan. 7, 1911.

FREE GOLD CLAIM ELK RIVER DISTRICT CURRY COUNTY

In Sec. 8, T. 33 S., R. 14 W., is the Free Gold Claim, owned by C. W. Curl, near the water's edge a few hundred yards below the mouth of Bald Mountain creek. A dacite dike cuts Colebrook schist near greenstone. Dike strikes S.

10° W. is vertical; 75 feet wide and becomes more siliceous toward its western side where on contact it is practically pure quartz in which free gold was seen occasionally. Chinese worked placer just below dike but not up stream from it.

FREEHOLD MINING SYNDICATE (placer) ILLINOIS RIVER DIST. JOSEPHINE CO.

Office: 506 McKay Bldg., Portland, Oregon. Samuel Weldon, pres.; T. J. Bernard, sec., both of Portland. Capital stock $1,000,000; par value $1.00; all subscribed, issued and paid up. (1914 report).

This company owns five placer claims about 24 miles northwest of Kerby, on Briggs creek, a branch of the Illinois river, 20 miles southwest of Galice. Nothing but assessment work done on this property for some time.

FREELAND CONSOLIDATED MINING COMPANY
NORTH SANTIAM DISTRICT MARION COUNTY

Office: Salem, Oregon. Hugh Freeland, Salem, pres.; W. J. White, Dallas, sec. Capital stock $2,000.000; par value, $1.00; all subscribed, issued and paid up. (1912 report).

Dissolved March 25, 1914.

See "Consolidated Copper Mining and Power Company."

FRENCH DIGGINGS (placer) GRANITE DISTRICT GRANT COUNTY

These placers are located in secs. 20 and 29, T. 7 S., R. 36 E. They are also known as the Currey mine and occupy several hundred acres in a compact area that extends from the summit of the divide at 6,800 feet elevation between North Fork of John Day river and Trail creek down to the latter stream at a point about 6 miles above its mouth and at an elevation of 6,000 feet.

This deposit, which was discovered in the "early days," has been extensively worked and is reported to have produced more than a million dollars' worth of gold. Based upon a minimum yield of 10 cents per cubic yard, a rough estimate of the volume of gravel mined shows that the production has not been less than $387.000. Present operations are confined to the portion of the deposit adjacent to Trail creek, where a small giant is operated by lessees.

Above 6400 feet elevation the deposit represents an undisturbed part of the Tertiary pre-tuff-breccia gravels but below that level they have been disturbed and modified by glacial action, and have assumed the character of glacial drift. In 1914 a 10-foot bank of gravel containing abundant cobbles and boulders was being worked. About 75 per cent of the cobbles and boulders, some of which are decomposed, consist of granodiorite and the remainder of chert and other rocks characteristic of the Tertiary gravel higher up the slope. The matrix is a compact sandy clay.

The gold, which occurs as small, flat, smooth particles worth $17 or more per ounce, is said to be practically confined to a 3-foot layer of indistinctly stratified gravel that rests on the granodiorite bedrock. The deposits are said to be worked at only a moderate profit.

FRY'S PROPERTY COLLIER CREEK DISTRICT CURRY COUNTY

See "Kessler & Frys" property.

GALICE CONSOLIDATED MINES COMPANY GALICE DIST. JOSEPHINE COUNTY

This company operated placer ground along Galice creek a number of years ago, but was dissolved January 14, 1908.

GALLAGHER GROUPS (gold) WEATHERBY DISTRICT BAKER COUNTY

There are few prospects located upon the north side of this mountain, the only ones worthy of mention are the 2 groups owned by Gallagher Brothers, located on upper Manning creek in sec. 2, T. 11 S., R. 44 E. The nearest town is Durkee, which is reached by a good wagon road 12 miles long. The region is moderately hilly. Timber can be obtained from the slopes of the mountain.

The country rock consists of schists, argillites and greenstones all tilted at high angles. Much faulting and shattering has taken place. The gold is contained in quartz lenses of various sizes. The maximum width observed at the old Gallagher property was about 20 inches. Minute impregnations of quartz in argillite also contain gold. Many porphyry dikes were observed in the locality so that it is probable that the granitic intrusion is at no great depth below the surface. This property has been idle for 9 years. It is said to have produced $30,000 within a short time from a small tonnage of ore.

The new Gallagher group about ½ mile northeast of the old group has a crosscut upon it in which is seen a badly altered porphyry dike and many stringers of quartz in the adjoining argillite. A width of some 15 or 20 feet which includes the altered dike and stringers is reported to contain fair values in gold.

GARACHINE OIL COMPANY **PANAMA**

Office: Medford, Oregon. George F. King, pres.; T. W. Miles, sec.; C. I. Hutchison, treas., all of Medford. Capital stock $75,000; par value $100; $60,250 subscribed, issued and paid up. (1913 report).

This company's properties are in Panama.

GATES CLAIMS **WALDO DISTRICT** **JOSEPHINE COUNTY**

See "Tomlinson, Gates and Thomas" claims.

GAUTHIER CLAIMS (gold) **QUARTZBURG DISTRICT** **GRANT COUNTY**

About 3 miles north of the Standard mine in sec. 6, T. 12 S., R. 34 E. F. X. Gauthier is developing an altered volcanic tuff along the side of an intrusion of magnetiferous feldspathic porphyry.

The ore minerals containing gold occur in small veins in what is locally called a dike, but is probably an altered and shattered contact of the porphyry with the fragmental volcanic rock.

GEM CONSOLIDATED GOLD MINING COMPANY (gold) **SPARTA DIST.** **BAKER CO.**

Local name: "Gem Mine."

Office: Baker, Oregon. Mine office: Sparta. E. D. Geiser, pres.; F. E. Geiser, sec.-treas. Capital stock $1,000,000, par value $1.00, all subscribed, issued and paid up. (1916 report).

One mile west of Sparta in sec. 17, T. 8 S., R. 44 E., in rolling hills with sparce timber. Elevation 4000 feet. Wagon road to Baker, 30 miles. Lands, 1 patented claim and 9 located. Normal fissure vein in intrusive soda granite, strike N-NE. Dip 30° E.; developed to depth 500 feet on dip.

With reference to this property Lindgren says:

> The Gem mine, located 2 miles west of Sparta, was worked in early days, a 10-stamp mill being erected in 1873. Two years afterwards the mill was removed to Connor Creek, and the mine was idle for a long time. The vein strikes north-south and its dip is 40° E. The old workings followed the vein to a depth of 100 feet or more on the dip. The new developments consist of a vertical shaft 179 feet deep, with drifts extending 150 to 200 feet from two levels. The vein shows sharply defined foot and hanging walls from 1 to 4 feet apart, between which lie crushed granite and streaks of quartz in some places 2 feet in width. The ore is normal coarse vein quartz, with free gold and a little pyrite and black zinc blende. Near the shaft the vein cuts a dike of granite-porphyry without changing, but on the second level south it is squarely cut off by a basalt dike striking east-west and dipping 50° S., along which some faulting has also taken place. The vein will in all probability be found to continue, as before, beyond the dike.

Only assessment work is done at present. Interior Department ruled (1916) that property is mineral land against agricultural contestant. This contest has held up development. Property equipped with hoist and pumps and small amalgamating and concentrating mill with steam power with wood for fuel available nearby. The mine is operated intermittently and when visited in 1914 and 1916 was filled with water. Total production is not available, 1889-92, $59,000. Vein narrow but rich.

GIBBS PROPERTY (gold) WEATHERBY DISTRICT BAKER COUNTY

Located about 4 miles northeast of Weatherby in about sec. 9, T. 12 S., R. 44 E. Country is hilly and for the most part barren, although timber is at no great distance to the northeast.

The geology of this immediate vicinity presents a contact between granodiorite and black argillite. The mineralization occurs in what might well be termed contact veins, consisting of irregular lenticular masses of quartz varying from a few inches to a foot in width at the contact of the grauitic rock and the argillite. The quartz is now in a crushed condition due perhaps to later movement. Some of these masses are said to go as high as $300 per ton. Their mode of occurrence make the blocking out of the ore costly.

GILBERTSON'S PROPERTY (gold) BOHEMIA DISTRICT LANE COUNTY

O. C. Gilbertson owns a group of claims located in secs. 13 and 14, T. 23 S., R. 1 E. The country rock is andesite. The vein is of the fractured zone type, having a N. 60° W. strike, and dipping to the S. 80°. The brecciated portion of the lode is from 3 to 6 feet wide and the chief mineralized portion about 1 foot. The chief ore minerals are chalcopyrite, galena, pyrite and sphalerite. In the oxidized portion some specular hematite and magnetite were noticed.

Development work consists of a 600 foot crosscut and 400 feet of drifts. The property has not been accurately sampled, but it was said that at a depth of 80 feet the 6 foot width of brecciated material had the value of $11.00 per ton.

GILKESON CLAIMS (copper) EAGLE CREEK DISTRICT BAKER COUNTY

See "Copper Butte Group."

GIRAFFE MINING AND MILLING COMPANY (gold) MORMON BASIN BAKER CO.

Office: Miller, Oregon. Geo. Cartwright, pres.; A. O. Weatherman, sec.; Grace Nichols, treas. Capital stock $150,000; par value $1.00. $75,000 subscribed, issued and paid up. (1916 report).

This company owns 7 claims on the east slope of Clarks creek in sec. 31, T. 12 S., R. 42 E., about 1½ miles north of the Humboldt mine. The ore is a narrow mineralized granodiorite porphyry dike in a country which is largely argillite but also has serpentine and dikes of basalt. A considerable body of lime is a short distance to the north of the property and granodiorite to the east.

On the Giraffe claim No. 1 a drift upon the dike was made from which 200 tons were milled and $7.50 per ton was recovered on the plates. A recent independent sampling of this drift gave an average of $4.20 per ton. About 750 feet north of the above drift, on the Giraffe No. 2, a crosscut tunnel cuts the dike at a depth of 85 feet where the values are about the same as above. A crosscut is being driven on this claim to cut the dike at a depth of 300 feet. This crosscut will be about 500 feet long and it is now about half way in.

This information was furnished by officers of the company.

GLADE CONSOLIDATED GOLD MINING COMPANY, LTD. (Idaho corporation)

Office: Buhl, Idaho. Ira Brackett, Rogerson, Idaho, pres.; Chas. D. Snyder, Buhl, Idaho, sec.-treas.; John C. Bolton, New Bridge, Oregon, attorney-in-fact. Capital stock $50,000; par value $1.00; $47,300 subscribed, issued and paid up. (1916 report).

GLEASON'S PROPERTY (gold) WEATHERBY DISTRICT BAKER COUNTY

Located about 4 miles northeast of Weatherby in about sec. 9, T. 12 S., R. 44 E. There is a fairly good wagon road to the railroad at Weatherby. Country is hilly and for the most part barren, although timber is at no great distance to the northeast.

The country rock is granodiorite, cut by recent tertiary basalt dikes. (On this property there is one 75 feet wide).

The mineralization is in a quartz fissure vein varying from a few inches to a foot or more in width. The strike is north and south and the dip is 80° W. Some siderite occurs in the quartz and this iron carbonate might be mistaken for scheelite.

There has been considerable development work consisting of a cross-cut tunnel, drifts, shallow shafts and some stoping but no information as to values are available. There is a small stamp mill on the property driven by an oil engine.

GLENDALE MINING AND MILLING COMPANY (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

Local name: "Marshall Mine."

Office: Glendale, Oregon. N. Campbell, U. S. Land Office, Portland, Ore., pres.; H. G. Sonnemann, 387½ East Burnside, Portland, sec.-treas. Capital stock $50,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This mine was recently sold to Mrs. J. F. Reddy, of Grants Pass, and now goes by the name of "Dorothea Mine."

GLEN DITCH MINE (placer) GOLD HILL DISTRICT JACKSON COUNTY

The Glen Ditch mine, 15 miles southwest of Gold Hill, is near the head of the right fork of Foots creek. It is owned by Boling Brothers. The stream bed has been followed for some distance, but much good ground remains to be worked. The gravels are about 15 feet thick.

GOLCONDA MINE (gold) CRACKER CREEK DISTRICT BAKER COUNTY

Owned by C. S. Jackson, Portland, Oregon. There has been no activity at this property since 1914. A description of this property on North Pole Columbia lode is found under "Columbia Gold Mining Company," to which the reader is referred.

GOLCONDA MINE (gold) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Golconda mine is 11 miles east of Grants Pass and about 2½ miles northwest of Provolt in sec. 34, T. 37 S., R. 5 W., at an elevation of about 1500 feet. It is equipped with a 3-stamp mill with a plate, now partly dismantled. Two adits were run into the hill, but they are now caved shut. The country rocks are quartzite and argillite cut by intrusions of aplite and tonalite, the main area of the latter being apparently to the south.

GOLCONDA MINE (chromite) WALDO DISTRICT JOSEPHINE COUNTY

The Golconda mine is located in sec. 17, T. 40 S., R. 7 W., 6 miles northeast of Takilma. The property consists of 2 claims held by location. Locators and operators are D. W. Collard and son, G. W. Collard, of Holland, and O. R. Moore of Salem.

The ore body as far as developed seems to be a more or less lens-shaped mass of chromite in serpentine about 33 feet thick with approximately parallel walls, striking N. 15° E. and dipping about 65° E.

The present development of the property consists of a small open cut from which an underhand stope has been made some 40 feet wide, 65° to the east and following the deposit on its dip some 40 or 50 feet.

This property has been an important shipper of chrome iron ore during the past summer, having shipped approximately 2000 tons, which the management states averaged about 40 per cent chromium oxide (CR_2O_3). The ore was hauled from the property about 25 miles to Waters Creek station, the temporary terminus of the California-Oregon Coast Railway. The chromite varies in amount of chromium oxide in different parts of the mass and the management has had some difficulty in mining the material in such a way that the higher grade chromite could be conveniently sorted out. The indications are that a good body of chromite can be proven on this property by more extensive and systematic underground development.

GOLD AND PLATINUM MINES COMPANY (placer) WALDO DIST. JOSEPHINE CO.

Office: Grants Pass, Oregon. I. F. Peck, Pres.; Sec.-Treas. vacant. Capital stock, $1,000,000; par value $1.00; $500,000 subscribed, issued and paid up. (1916 report).

This company was formed in January, 1916, and has 1280 acres of placer association claims on Cave creek, in Josephine county. The development work consists of a dam 80 feet long by 9 feet high, about a 350-foot flume, 400-foot tail race, sluice boxes and camp equipment.

GOLD BEACH METAL COMPANY

Office: Astoria, Oregon. C. G. Palmberg, Pres.; J. M. Anderson, Sec.-Treas., both of Astoria, Oregon. Capital stock, $6000; par value $100; all subscribed, issued and paid up. (1916 report).

GOLD BAR MINE (placer) AGNESS DISTRICT CURRY COUNTY

This property is located at the old postoffice of Illahe, three-quarters of a mile below the present postoffice of the same name. It is on the northwestern side of the Rogue and is owned by T. W. Billings.

Mr. Billings states that the first work on the property was done in 1856, and that the present ditch was started 11 years ago by H. J. Russell, who began to mine 7 years ago. The present owner bought the property from Russell's heirs on October 6, 1911, and it has been worked every winter since then. He says he took out $156 in one month the first year, and that during the second year he cleaned up $300 in gold dust, and stored 7½ tons of sand averaging $272 a ton, which was subsequently washed away. During the third winter Post and G. P. Murch tried to use a Sweet gold machine on the property, but the result was unsatisfactory, as there was so much clay in the gravel that the machine became badly clogged.

That portion of the gravel which has been most extensively mined averages 9 feet thick and is covered with about 4 feet of overburden. It is an old high terrace, and the owner claims that at least 2 other such terraces or channels exist on the property. Several engineers have examined the property, and one named Post claimed that the gravel averages 40 cents per yard in gold. Another named G. P. Murch claimed that it ran only 25 cents per yard. Most of the gold is fairly coarse, and of a flaky nature. The larger pieces are found near bedrock and some of these are worth as much as 25 cents. No attempt to save platinum was made until the winter of 1914-15. During an 80 hours' run made then, a quarter of an ounce of this metal was secured. The bedrock is black Eocene shale, together with some sandstone.

A thousand miner's inches of water is brought to the property in a ditch. This gives 180 feet to 200 feet fall where Mr. Billings has done most of his work, and 100 feet fall to the higher bars.

GOLD BASIN PLACERS CHINA DIGGINGS DISTRICT CURRY COUNTY

Diller describes the deposits here as follows:

About the head of Tin Cup creek, fifteen miles northwest of Kerby, there is a V-shaped remnant of the Klamath peneplain known as Gold Basin on a large mass of granodiorite. The apex of the V points east, and across its southern arm is a broad, shallow valley filled by an old stream bed running approximately N. 20° W. The surface plain of the stream bed is more than 1000 feet in width and 2000 feet in length, and is limited at both ends by deep, rugged canyons. The gravel has a thickness of 110 feet where best exposed on the steep southern slope. Near the bottom the gravel, though somewhat decomposed, is more or less firmly cemented, and this condition exists throughout the mass. It has been tunneled on bed-rock for thirty feet. The material is generally coarse, mostly cobblestones up to boulders 4½ feet in diameter mixed with pebbles and sand. There are no layers of sand to afford definite evidence of stratification. The pebbles are well rounded and are for the most part composed of basic eruptive rocks, greenstone, gabbro, peridotite, and pyroxenite, with some of granite. Though generally greenish, they are in places colored reddish by a surface deposit of oxide of iron. The top portion of the deposit is finer, with some fine gravel capped by a reddish soil. Wherever I saw the pebbles in place the course of the stream was not clearly indicated by their position, though they appeared to be inclined southward, and it is believed that the stream came from that direction. The gravel was tested in 1875 or 1876 by sinking a shaft (now filled with water within twenty feet of the surface) and found to contain very little gold. Most that was found is said to have been in the fine material of the surface.

The only available water is snow water, which is obtainable only in small amounts during a short season. It is gathered by a mile or more of ditch, but reaches the mine with scarcely 15 feet of head, and only a small amount of gravel was mined before work was suspended.

GOLD BUG MINE (gold) GALICE (MT. REUBEN) DIST. JOSEPHINE COUNTY

The Gold Bug mine is on Whiskey creek in T. 33 S., R. 8 W. near Mount Reuben at elevations of 2400 to 2600 feet as measured by aneroid barometer. The old main adit is now completely blocked by fallen timbers at about 350 feet from the portal. The vein contained gold-bearing quartz with some pyrite and chalcopyrite. The vein was only 1 to 2 feet wide where seen, but even this was stoped out, and thicker vein quartz was reported farther in. The country rock of the old main adit is an andesite containing phenocrysts of plagioclase feldspar in a matrix of plagioclase, green biotite, isotropic chloritic material, and a little magnetite and epidote. The illustration is a copy of an old mine map showing a plan and a vertical section of the old workings.

A narrow dike of serpentine may be observed crossing the road within a quarter mile of the mine. Next to the dike the enclosing andesite is considerably altered to epidote, chlorite and quartz. An adit near this outcrop drifts 100 feet on a fissure 1 to 4 feet wide containing 6 inches to 2 feet of quartz striking N. 5° E. and dipping 45° E. The mine is now owned by Romig and Neal. A new incline shaft shows a quartz vein striking N. 35° W and dipping 70° S. W. The vein-filling here is 12 to 14 inches thick and chiefly quartz stained by chrysocolla. A new crosscut adit extends N. 21° E. about 100 feet in andesite. Work was in progress here in the summer of 1913. The mine is connected with the railroad at Reuben Spur by a good mountain road.

GOLD BUG MINING COMPANY GRANITE DISTRICT GRANT COUNTY

Office: Granite, Oregon. N. E. Mighill, Marshalltown, Iowa, Pres.; Chas. Spear, Des Moines, Iowa, Sec.-Treas. Capital stock, $1,500,000; par value $1; $1,200,000 subscribed, issued and paid up. (1913 report).

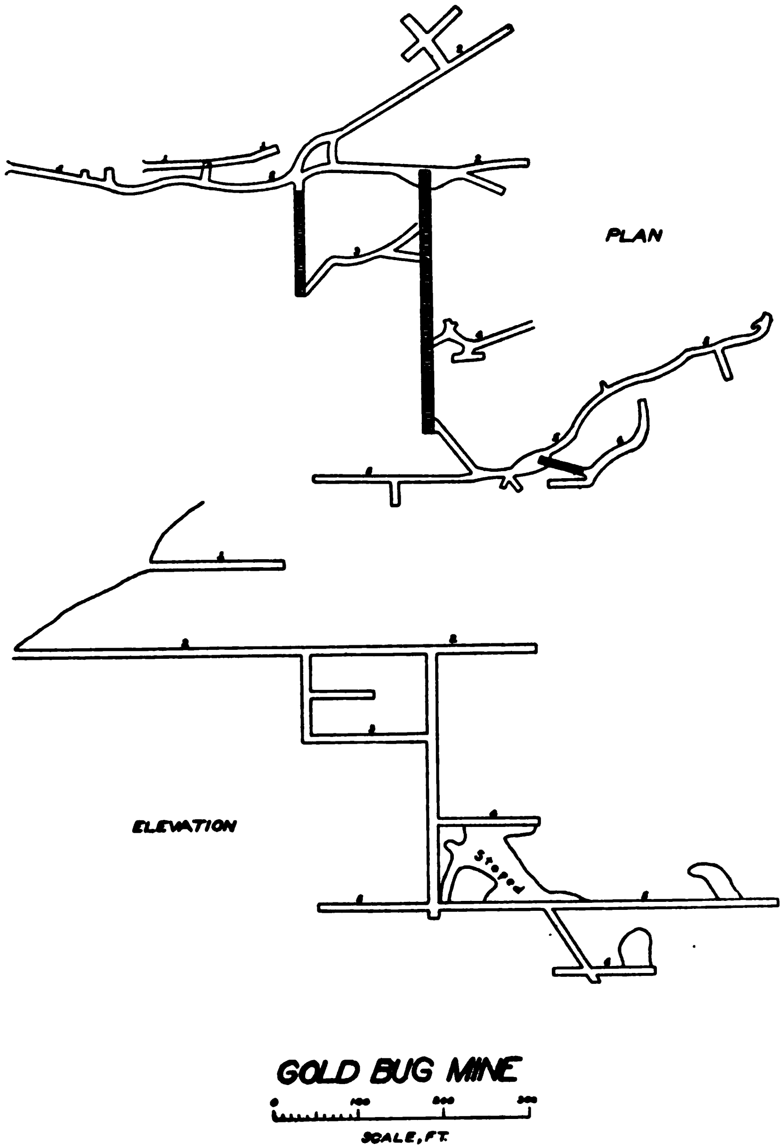
This property is located on Rabbit creek. Property not visited, probably moribund. Dissolved by proclamation in January, 1917.

GOLD COIN PLACER WEATHERBY DISTRICT BAKER COUNTY

This property is located about 2 miles southwest of the Gold Ridge, about ½ mile north of the Rye valley wagon road and 8 miles from Durkee. It is almost at the summit of the ridge that lies between the Rye valley road and the Gold Ridge mine. It occupies the southern side of the hill and reaches an elevation of about 500 feet above the road.

The gold is found in gravel beds belonging to the Tertiary Lake Bed formation. The beds are tilted and somewhat faulted. They consist of pebbles of quartz, flint, greenstone, granite, rhyolite, and volcanic tuff. The pebbles are rounded and vary in size from 3 to 4 inches down to sand. The finer material is usually granular, although some clay is present in places interbedded with the gravels.

There are many other placers in this vicinity, but for the most part they have been worked in a small way.



Plan and elevation of old workings of Gold Bug mine

GOLD COIN MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Gold Coin mine is about half a mile northeast of the Martha mine in Sec. 22, T. 33 S., R. 5 W. and is reached by the wagon road up Coyote creek. It is opened by 3 adits having a total length of about 450 feet; all 3 are in greenstone and serpentine and disclose no well defined vein, but instead numerous bunches and stringers of pyritic ore in calcite and quartz in serpentine. The pyrite also extends into the serpentine irregularly. In places the serpentine is so penetrated by calcite that the rock is properly designated an ophicalcite. This mine is equipped with a 3-stamp mill.

GOLD CREEK MINING AND MILLING COMPANY (gold, etc.)
NORTH SANTIAM DISTRICT MARION COUNTY

Office: Salem, Oregon. Otto Hansen, Pres.; W. I. Staley, Sec. and Treas., both of Salem, Oregon. Capital stock, $3,500,000; par value $1; all subscribed, issued and paid up. (1916 report).

The property is located in Sec. 18, T. 8 S., R. 5 E., about 16 miles northeast of Gates, a station on the Southern Pacific railway. It is on Gold creek, a branch of the Little North Fork of the Santiam, and consists of 17 claims, containing about 340 acres. A wagon road is built to within 3 miles of the property, and there is a good trail from the end of the wagon road. The elevation is between 2200 and 2900 feet.

The sulphide minerals, usually massive, are pyrite, chalcopyrite, galena and sphalerite. The country rock is andesite, and the vein exposed on this property in the upper Wall Street tunnel is well mineralized and from 1 to several feet wide and at the breast is the full width of the wide drift.

Most of the development on the property has been confined to a long crosscut tunnel, which is now in about 1500 feet, it being planned to cut the Wall Street vein with this tunnel at a distance of 2000 feet from the portal at a depth of about 600 feet. It seems unfortunate that so much money has been spent on the long crosscut on this property, when development on the Wall Street vein could have continued the blocking out of ore. The financing of this long crosscut has been difficult, the expense being greater than was at first estimated, and even if it were continued to the point where it is supposed to intersect the Wall Street tunnel, it is possible it would be disappointing, for the reason that the vertical distance is so great below the upper development that it might not be known just when the vein was cut. Numerous veins and stringers of varying sizes are usually found in such crosscuts and if the Wall Street vein should be intersected at a lean or narrow place, uncertainty would result and might be the means of unjustly condemning the property. Improvement and tunnel work to amount of about $4000 was done in 1915.

GOLD DRIFT MINE GRANTS PASS DISTRICT JOSEPHINE COUNTY

For description see "The Oro Fino Mine."

GOLDEN CHARIOT MINING AND MILLING COMPANY (gold)
SUMPTER DISTRICT BAKER COUNTY

Local name, Golden Chariot.

Office: Sumpter, Oregon. Chas. Wiedemann, Newport, Ky., Pres.; Oliver E. Conner, Jr., Sumpter, Sec.-Treas. Capital stock, $350,000; par value $1; $300,000 subscribed, issued and paid up. (1916 report).

This company took over the old Gold Chariot (Tri-State Mining & Milling Co.) prospect, which is located in Sec. 34, T. 9 S., R. 37 E., at an elevation of about 4500 feet and upon gently rolling foothills about 2 miles east of Sumpter.

The property is developed by a single compartment shaft and steam power is used with wood for fuel. The country rock is for the most part a hard blue limestone with here and there a small amount of argillite or argillaceous limestone. The ore is not in a vein, but is in a silicified zone which has a general east and west strike. On the surface this zone is said to be narrow, but upon the 210-foot level where the diamond drilling is being done it is about 6 feet wide. This level is developed by a drift a few feet to the east and about 70 feet to the west. A small amount of ore has been stoped from the west end and a core drill with chilled steel shot as cutters was in operation during the summer of 1916.

Manager Conner continued the core drilling of the ore to depths of 500 feet from the 210-foot level until a sufficient number of drill holes had been made to determine the extent of the ore. November reports state that the winze, which is being sunk from the 200 level, is still in free milling ore of good value.

GOLDEN DREAM CLAIM (gold) CHINA DIGGINGS DISTRICT CURRY COUNTY

See "Higgins Mine."

GOLDEN EAGLE MINING COMPANY (gold) GREENHORN DIST. BAKER CO.

Local name, Golden Eagle mine.

Office: The Dalles, Oregon. J. S. Fish, Pres.; J. C. Hostetler, Sec.-Treas., both of The Dalles. Capital stock, $441,000; par value $1; all subscribed, issued and paid up. (1916 report).

The company's claims are the Golden Eagle, Poorman, Mammoth, Comstock, Yellow Jacket, Danae, Harold and Crow Fractional. Several unique veins are explored by the workings of this mine, which extend under a prominent ridge west of the lower canon of Greenhorn creek, about 2 miles southeast of the town of Greenhorn. The mine has been worked in a small way from time to time, and a total production of $75,000 is reported. The development comprises 3 tunnels and an intermediate drift, aggregating about 2600 feet. The vertical range of exploration is 175 feet, in addition to a shaft (No. 1) 75 feet deep below the lowest tunnel.

The country rock is serpentine derived from peridotite in which there are a number of large blocks of altered gabbro. Evidence elsewhere in the region indicates that the gabbro blocks were caught in the peridotite at the time of its intrusion. Altered gabbro is found only at one place underground. The workings explore a number of non-persistent fissures, three of which are ore-bearing and the others barren. At one place, an ore-bearing fissure terminates against a barren fissure in such a manner as to suggest that the latter is a post-mineral fault. Further consideration leads to the conclusion that all are contemporaneous, though there is other evidence of post-mineral movement. The barren fissures cut the serpentine in an irregular manner, but the three that have yielded ore form a branching system. Of these, No. 2 is the dominant fissure and has been explored almost continuously from the surface to a depth of 200 feet. It trends N. 30° W. to N. 60° W. and dips 40° to 50° N. E. No. 1, a branch of No. 2, dropped into the footwall between the first and second tunnels, though it has not been found below this tunnel. No. 3 is similar, leaving No. 2 below the second tunnel. The most productive shoots have been on No. 1 and No. 2 above the intermediate level and on the No. 3 vein.

The shoot on vein No. 2 has been a quartz lens which attains a maximum width of 3 feet in a winze below No. 3 tunnel. On this level, the quartz contains a small amount of chalcopyrite and one of its oxidation products, chrysocolla. Fifteen tons of this material yielded $22 to the ton in gold. The shoots on the other veins are lenses of coarse, cream-colored dolomite with a little galena that replaces the dolomite along small fractures. Gold, about 850 fine, occurs as films along one wall or fills cleavage cracks in the dolomite adjacent to the walls. Free gold is common in the superficial workings and above the No. 2 tunnel a single sheet of gold measuring 4 inches long, 3 inches wide, and half an inch thick, is reported. One showing considerable galena is usually higher in grade than the average. The shoot on No. 3 vein has been stoped for a distance of 130 feet on No. 3 tunnel level, as well as to a point 65 feet above the level, and in No. 2 shaft to a depth of 20 feet. Within this area, the width has ranged from a maximum of 18 inches to half an inch, the lowest that pays to mine, and the average has been 6 inches. It is estimated that the ore from this shoot yielded $175 to the ton in gold, though the ore from an area 20 by 50 feet below the level yielded $800 to the ton. A portion of the stope above the level, 35 by 65 feet, yielded $35,000 in gold. None of the shoots have been found in the drifts from No. 1 shaft, which is 75 feet deep and now filled with water.

It is reported that the presence of manganese oxide, limonite or chrysocolla indicates ore of good grade. Dendritic films of manganese oxide were observed at a number of places in the lowest tunnel including the extreme limits of work and are common in the upper tunnels. Specimens from the face of the intermediate level show angular fragments of dolomite cemented by chalcedony and stained by numerous dendrites of manganese oxide.

The mine is not accessible below the lower limits of oxidation, but from textural evidence it is highly probable that a portion of the gold of the richer ore has been introduced through superficial enrichment.

GOLDEN GATE MINING COMPANY (gold) (Arizona corporation) GREENHORN DISTRICT GRANT COUNTY

Local name, Golden Gate mine.

Office: 145½ South Main St., Marion, Ohio. M. F. Douce, Pres.; John F. Lust, Treas., both of Marion, Ohio; G. L. Bender, Greenhorn, Oregon, Sec.-Attorney in Fact; Fred L. Daines, Greenhorn, Oregon, Managing Agent. Capital stock, $1,500,000; par value $1; $1,350,000 subscribed, issued and paid up. (1914 report).

The Golden Gate mine, 2 miles north of Greenhorn, has 3 veins upon the property. The Golden Gate and Belcher veins have nearly all of the development. The Golden Gate vein is some 40 feet in width, most of which is quartz. But little work has been done upon this vein in the last 10 years. Judging from the general appearance of the quartz, and from the fact that little has been done upon it in the last five years, the values are probably low.

The country rock next to the Belcher vein is in greenstone and greenstone breccia. The greenstone is a fine-grained greenish-colored rock. Its appearance indicates that originally it was an andesite. The breccia is grayish-green in color and the angular fragments an inch or more in diameter consist of dense, almost purplish-colored, rock. These fragments are probably trachytic in composition. The matrix is a rather indeterminable mass which seems to consist of a more or less granular aggregate, now nearly obscured by the alteration products, chlorite and calcite. It has been badly altered by surface weathering and the oxidation is quite deep.

This vein strikes N.-NE. and dips steeply eastward. The quartz is lenticular, with a maximum width of 3 or 4 feet, diminishing in places to a streak of gouge. There are 2 tunnels upon the vein, the upper some 800 feet long and the lower, together with crosscuts and raises, amounts to some 2400 feet. The shoots said to contain the best ore are found not very far from the mouth of the lower tunnel. The two shoots are about 225 feet and 60 feet long, with a maximum width of 20 inches. Some distance farther in is a third shoot, with much less quartz and about 200 feet long, with a maximum width of about 3½ feet. A 10-stamp mill was erected in 1914 and began to mill the ore from Belcher vein in February, 1915. It was operated for a time, but without much success.

GOLDEN GATE PLACER MINES IDAHO

Office: Pendleton, Oregon. C. E. Penland, Pres.; B. Parlett, Sec.; J. T. Lamberth, Treas., all of Pendleton, Oregon. Capital stock, $75.000; par value $1.00; $59,053 subscribed, issued and paid up. (1916 report).

This company's property is located in Idaho county, Idaho.

GOLDEN GLOW MINING COMPANY IDAHO

Office: 403 Commercial Bldg., Portland, Oregon. Thos. Papworth, 403 Commercial Bldg., Portland, Pres.-Sec.-Treas. Capital stock, $750,000; par value 50 cents; $629,917 subscribed, issued and paid up. (1916 report).

This company's properties are located near Ketchum, Blaine county, Idaho.

GOLDEN RULE CONSOLIDATED MINING AND MILLING CO. (gold)
BOHEMIA DISTRICT LANE COUNTY

Office: Salem, Oregon. William Wechter, Pres.; C. L. Johnson, Salem, Sec. Amount of capital stock, $500,000; par value 5 cents; all subscribed, issued and paid up. (1916 report).

Property consists of 26 claims, located in Sec. 5, T. 23 S., R. 2 E., about 3 miles northeast of Bohemia postoffice, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove. This property is inactive.

GOLDEN STANDARD MINING COMPANY (gold) GOLD HILL DIST. JACKSON CO.

Local name, Kubli mine.

Office: 308 Commercial Block, Portland, Oregon. K. K. Kubli, 84 Fourth St., Portland, Pres.; E. B. Wilson, 308 Commercial Block, Portland, Sec.; E. J. Kubli, Jacksonville, Ore., Treas. Capital stock, $100,000; par value $100; all subscribed and issued; $80,000 paid up. (1914 report).

This company has 81.688 acres of patented land in the Galls creek mining district of Jackson county. The property is known as the Kubli mine and is located in the N. W. ¼ Sec. 5, T. 37 S., R. 3 W., at an elevation of 2700 feet by barometer. A narrow vein, said to have been very rich, is opened for about 200 feet; it is 1 to 18 inches wide, but only 1 to 6 inches in quartz; the vein strikes about east and dips 60° N. The Kubli mill is to the east near the bottom of the hill; it has 2 stamps with triple discharge, a divided plate 4 by 10 feet, and a concentrating table. In the gully nearby there is a small outcrop of tonalite and a border of contact hornblende rock. The composition of this contact phase is given below.

Composition of Contact Rock, Near Kubli Mill, Galls Creek

(S. W. French, analyst)

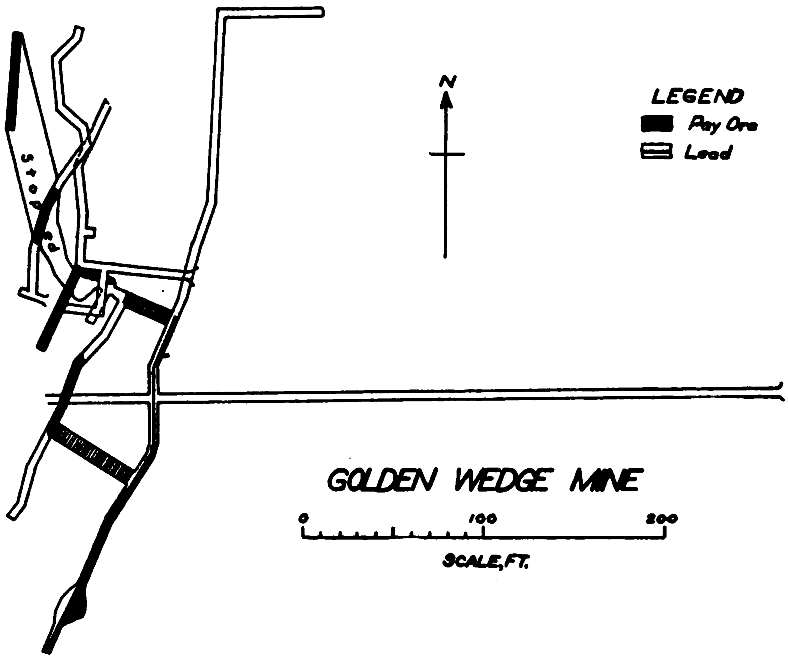
SiO_2	47.42	Approximate mineral composition	
TiO_2	1.01		
Al_2O_3	20.56	Hornblende	57.5
Fe_2O_3	1.19	Plagioclase	42.4
FeO	5.10	(Ab_1An_4)	
MgO	7.08		99.9
CaO	14.04		
Na_2O	1.80		
K_2O	.66		
H_2O+	1.36		
H_2O-	.08		
	100.30		

The mine is not in operation at the present time.

GOLDEN WEDGE MINE (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Golden Wedge mine is about 4 miles northwest of Galice on Bailey gulch. It is said to have been discovered by Mr. Hutchins in 1893. About 1908 the mine passed into the control of the Gold Road Mining & Milling Company, which was reorganized about 1911 as the Bailey Gulch Mining & Milling Company. Diller suggests that the total production of this mine may have reached $50,000 and that future production may result if the Oriole fault is found. The main ore body is opened by about 1200 feet of underground workings, reaching a depth of about 500 feet on the incline. The lode strikes about N 20° E. and dips 50°-60° E. The ore body pitches southward at an angle of about 20°. According to Diller, the "quartz veins and lenses in the sheared greenstone are irregular, as if folded, and many of the quartz lenses or kidneys that have a covering of graphitic material with grains of pyrite are said to average $10 to $20 a ton in gold. Considerable ore has been stoped out of a belt ranging from 16 inches to 5 feet. The graphitic material interferes with handling the ore." The country rock here is a greenstone with intrusions of dacite, containing abundant dark green hornblende with fine granular quartz, sericitized plagioclase, and unusually abundant granular titanite.

An adit near the mill on Bailey gulch is (1913) being extended. It exposes a thick fault gouge, which suggests an important fault. The gouge is grayish



Plan of main workings of Golden Wedge mine

blue when dry and nearly black and soft when wet. It consists chiefly of quartz, siderite, pyrite and sericite, and is therefore finely divided vein material. The hanging wall is serpentine; on the other side the same rock is sheared and mineralized, containing bunches and stringers of quartz. When seen this adit extended southerly about 220 feet; the vein near the breast strikes N. 10° W. and dips 88° E.

The Golden Wedge is equipped with a 10-stamp mill, having two more 2-stamp batteries not in condition to use, and also 7-foot amalgamating plates, a crusher, an air compressor, 2 Pelton wheels, and 12 tanks used as a 25-ton cyanide plant. Power is available only during the wet season.

GOLD HILL AND BOHEMIA MINING COMPANY (placer)
GOLD HILL DISTRICT JACKSON COUNTY

Local name, Red Oak mine, Gold Bank.

Office: 819 Chamber of Commerce Bldg., Portland, Oregon. J. M. Leiter, Pres.; Samuel Weldon, Sec.; I. G. Davidson, Treas., all of Portland, Oregon. Capital stock, $100,000; par value 10 cents; all subscribed, issued and paid up. (1916 report).

This company has 80 acres of patented placer ground 3 miles north of Golden on Sardine creek. There is no activity at the property.

GOLD HILL PLACERS GOLD HILL DISTRICT JACKSON COUNTY

The placer deposits 5 miles southeast of Gold Hill are all closely associated with existing streams, being either in the present stream beds or on terraces not many feet above them. Mining is carried on chiefly during the wet season of winter or early spring. A few of the placers have been equipped with dredges, but hydraulic mining is the prevalent method.

On Kane creek placers have never been extensive, but an electric dredge was under construction in 1908 for use in the S. E. ¼ Sec. 36, T. 36 S., R. 3 W. The capacity was 500 cubic yards in a 10-hour day. The power was obtained from the dam on Rogue river at Ray Gold; the material of the deposit is fine grained clay and gravel with few boulders; the bedrock is an altered slate. Since 1908 very little has been done on this project.

GOLD HILL "POCKET" GOLD HILL DISTRICT JACKSON COUNTY

The Gold Hill "pocket," 2 miles northeast of Gold Hill, is near the top of the hill of that name in the S. W. ¼ N. E. ¼ Sec. 14, T. 36 S., R. 3 W., at an elevation of about 2000 feet. According to E. W. Liljegran, of Medford:

> It was discovered in 1857 on top of the mountain about 2 miles east from the town of Gold Hill. The outcropping rock was so full of gold that it could scarcely be broken by sledging. The crystallized quartz associated with the gold was not honeycombed as it generally is where sulphides have leached out of the rock, leaving sprays of gold in the cavity. The gold in this pocket went down only 15 feet and occurred in a fissure vein, strike about S. 20° E.; dip about 80° E.; with a gash vein cutting the fissure nearly due east and west and dipping vertically. The fissure vein averages fully 5 feet between walls with 1 to 2 feet of gouge on the foot wall, which contains some calcite and quartz mixed with a little sulphide of iron, in spots containing free gold. A mass of micaless granite, about 5 feet wide by possibly 200 feet long, outcrops in the footwall side of the fissure. The country rock is pyroxenite. It is said that this pocket produced at least $700,000.

GOLD HILL QUARTZ MINING COMPANY (gold) GOLD HILL DIST. JACKSON CO.

Office: Medford, Oregon. C. R. Ray, Pres.-Treas.; E. W. Liljegran, Sec., both of Medford. Capital stock, $60,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company's holdings comprise the E. ½ of W. ½ of N. W. ¼ Sec. 14, T. 36 S., R. 3 W., 2 miles southeast of Gold Hill. $500 in improvement in 1915.

GOLD NOTE MINE (gold-copper) GREENBACK DISTRICT JACKSON COUNTY

This mine is located on the Baker creek branch of Grave creek, 17 miles from the railway station at Leland and 9 miles east of Placer. It is owned by E. B. Crouch, of Grants Pass, and associates.

Some 300 feet of development work has been done, exposing oxidized and sulphide ores, which it is claimed run between 4 and 5 per cent copper, with some gold values. It is proposed to treat some of these ores by leaching processes.

GOLD RIDGE MINE WEATHERBY DISTRICT BAKER COUNTY

This mine is situated 4 miles south of Durkee, about in Sec. 9, T. 12 S., R. 43 E. It is an old discovery that has been operated at times for many years, but is now idle, full of water and with adits caved. The total production is said to be $210,000, practically all extracted from 1881 to 1886.

The country rock has a medium grained texture and undoubtedly belongs to the granodiorite clan, but owing to the fact that probably not more than 10 per cent quartz is present, it might better be called a quartz diorite.

According to Lindgren, there are three principal veins, two of them having a strike of N. 51° W. and dipping 65° S. W. A third strikes more nearly east-west and dips south. The veins cross the ridge about 200 feet above the shaft, but their outcrops are inconspicuous and for the most part concealed by wash. The ore above the tunnel had a value of $12-$15 per ton, the largest part of it free-milling.

GOLD RIDGE MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Gold Ridge mine, 4 miles south of Gold Hill, is in the N. E. ¼ Sec. 3, T. 37 S., R. 3 W., on the west slope of Kane creek valley, at an elevation of 2100 feet by barometer. Some oxidized ore has been taken from a 1 to

2-foot fissure, which varies in strike from about north to east in an arc concave to the southeast and dipping steeply northwest. The country rock is schistose and weathered. Nearer the mill an open cut has been made on a 12-inch quartz vein, which strikes N. 63° W. and dips 73° S. W.; the hanging wall is an andesitic rock; the footwall is siliceous and contains a little biotite. The mine is equipped with a 2-stamp mill, having a plate 2½ by 8 feet, run by a 7-horsepower gas engine.

GOLD RIDGE PROSPECTS (gold) ILLINOIS RIVER DISTRICT JOSEPHINE CO.

Concerning these prospects, Diller says:

Pocket Knoll and the divide between Mike and Days gulches, 5 to 7 miles northwest of Kerby, have long been noted for their pockets of free gold. Pocket Knoll is composed of serpentine with a greenstone contact near its western base. From this contact northwest on the divide, to the head of Hoover gulch and beyond, the ancient lavas and tuffs include much reddish and silliceous slates of sedimentary origin. The cherty masses, especially about the head of Hoover and Mike gulches, have recently been prospected. With a small hand outfit consisting of a Simplex rock crusher weighing 150 pounds and a 25-pound muller and plate for pulverizing, T. M. Anderson, of Kerby, is said to have taken much gold out of a number of rich pockets.

There are a number of claims, 4 or more, on the flat divide at the head of Hoover and Mike gulches. The divide is occupied by a belt of more or less cherty slates, about 100 feet in width and covered by a thick layer of rotten rock, bounded on both sides by greenstone with serpentine nearby to the northwest. The greenstone is in places granular, but mostly compact and in general contains much auriferous pyrite. The cherty belt and its quartz veins trend N. 20° E. and dip 50° SE. A tunnel is being run across the belt in the rotten rock to locate the richest portion. A shaft has been sunk 20 feet in this soft rock and gold has been panned from the oxidized material at the bottom. The little swale on the northwest has been sluiced with good returns, and if water were cheaply available it is possible that considerable pay ground could be found.

A short distance northeast of the tunnel mentioned above is the Beauty claim, on which a pocket recently opened is said to have yielded $5000 or more of free gold in quartz. The country rock is compact greenstone lying east of the siliceous slates, and the narrow pay streak, about 10 feet in length and within 2 feet of the surface, runs northwest and southeast perpendicular to the general course of the formations.

GOLD STANDARD MINING COMPANY (gold) JACKSONVILLE DIST. JACKSON CO.

Local name, The Gold Standard mine.

Office: Ashland, Oregon. P. S. Casey, Cle Elum, Wash., Pres.-Treas.; F. G. McWilliams, Ashland, Sec. Capital stock, $82,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company owns the Gold Standard mining claim and the Grass Valley mining claim, consisting of about 30 acres, in Sec. 25, T. 37 S., R. 3 W., 2½ miles west of Jacksonville. This property joins the Opp mine on the northwest and is supposed to be on an extension of the Opp vein.

GOPHER MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Gopher mine, 8 miles east of Hugo, is on the northeast side of Walker mountain, in the S. E. ¼ Sec. 8, T. 35 S., R. 5 W., at an elevation of 2300 feet, as measured by barometer. It is owned by Mr. Dean, of Oakland, Cal. The main level has about 600 feet of crosscuts and drifts, besides raises, winzes and stopes. The vein material is similar to that of the Baby mine and the country rock is also similar. Several veins run in various directions in gabbro. In some places stopes are 7 feet wide. A crushed fault zone strikes N. 20° E. near the breast. The mine has been idle for several years.

GRAND PRIZE HYDRAULIC MINES WALDO DISTRICT JOSEPHINE COUNTY

Office: Holland, Oregon. Thomas Wilson, Holland, Pres.; Sam H. Baker, Grants Pass, Sec.-Treas. Capital stock, $100,000; par value 20 cents; $17,-127.00 subscribed, issued and paid up. (1916 report).

This company is involved in litigation. Its property, about 3 miles east of Holland, is idle.

GRAY EAGLE GROUP (copper) HOMESTEAD DISTRICT BAKER COUNTY

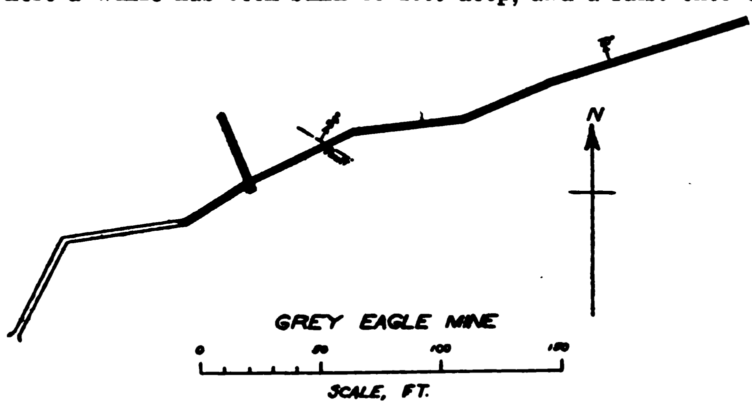
This property is owned by the Gray Eagle Development Company. It joins the Iron Dyke on the east and extends from that property nearly to the townsite of Homestead. It had several men employed in 1916 on the surface and underground and an electrically driven air compressor installed to furnish air for drills, so that a development of the property could more rapidly be prosecuted. Several tons of copper ore on the dump of the principal tunnel had been removed from the mine from ore encountered in crosscutting toward the Iron Dyke ledge, which is believed to continue through this property.

The owners are residents of Halfway, in Pine valley, a town about 20 miles southwest from Homestead.

GRAY EAGLE MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Gray Eagle mine is in the S. E. 1/4 Sec. 29, T. 35 S., R. 3 W., on the east side of Sardine creek, at an elevation of about 1850 feet above sea level, 6 miles northwest of Gold Hill.

The vein is opened by three adits on the hillside; the main adit is nearly 400 feet long, over 300 feet being on the vein, which is chiefly quartz and 9 to 12 feet thick. It strikes about N. 70° E. and dips 70° N. W. Beneath a fault, which strikes N. 60° W. and dips 34° N. E., but produces little offset, the vein is locally 35 feet in width; it is said to carry $22 a ton in gold at this place, where a winze has been sunk 85 feet deep, and a raise extends to the



Gray Eagle, main adit. Vein in solid black

surface. The workings are shown in the figure. The vein is associated with an andesite dike in recrystallized quartzite. The Gray Eagle mine is now owned by Mr. Van Houten, of Gold Hill. It is equipped with an aerial tramway from the main adit to a 10-stamp mill on Sardine creek, which has a 30-horsepower and 10-horsepower gasoline engine, two amalgamating plates, each 4½ by 10 feet, a rock crusher, and two concentrating tables. The mine has been idle since 1911.

GREAT NORTHERN MINE (gold) CANYON DISTRICT GRANT COUNTY

This mine is located about 2 miles southeast of Canyon City on the steep north slope of Canyon mountain, about 1500 feet above the town, at an elevation of 4700 feet. The country is greenstone (gabbro) and diabase-porphyry. A quartz vein 1 to 2 feet thick, north and south strike, dipping 25 degrees west, is upon the property, but it is practically barren, although it contains pyrite and seams of calcite. Another vein on the property 2 feet wide strikes east and west and dips 35 degrees south. This is practically barren also. The valuable gold deposits on this, as well as most other properties on Canyon mountain, are not found in the quartz veins, but rather in quartz-calcite seams, which are quite numerous everywhere. Valuable pockets are occasionally found in quartz seams closely associated with calcite. In 1898 a $30,000 pocket was extracted from one of the seams in a surface cut on this property. Prospecting operations have since been carried on rather extensively underground in search for other pockets with a few successes of much less importance than 1898.

A property of similar nature is the Dan O'Shea claim, in which rich pockets are found from time to time. It is owned by the same persons who possess the Great Northern mine. According to newspaper reports, the owner of these two properties is the Oregon-Utah Mining Company, but it is not known in this office to be a corporation.

GREAT NORTHERN MINE BLUE RIVER DISTRICT LINN COUNTY

This property of 6 claims is owned by L. B. Bartlett, of Portland, and is in the central part of T. 15 S., R. 4 E. The property is 50 miles from Eugene and 5 miles from Blue River, on the McKenzie river, from which it is reached by 4 miles of mountain road and 1 mile of trail.

The country rock is andesite. The lode is developed by several tunnels, raises, etc. An ore shoot is said to be stoped 10 feet wide and 75 feet long, averaging $10 to $12 per ton, with a maximum of $15 per ton.

GREAT WESTERN MINING AND MILLING CO. BLUE RIVER DIST. LANE COUNTY

Office: 350½ Morrison St., Portland, Oregon. L. B. Bartlett, Portland, Pres.; Sarah Whiteside, Portland, Sec.-Treas. Capital stock, $250,000; par value $1.00; $170,000 subscribed, issued and paid up. (1916 report).

The company owns 6 claims, 3 of which have been surveyed for patents.

GREAT WESTERN OIL COMPANY MALHEUR COUNTY

Office: Vale, Oregon. Frank Barrett, Pres.; H. P. Osborn, Sec.; T. W. Davidson, Treas., all of Vale, Oregon. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1913 report).

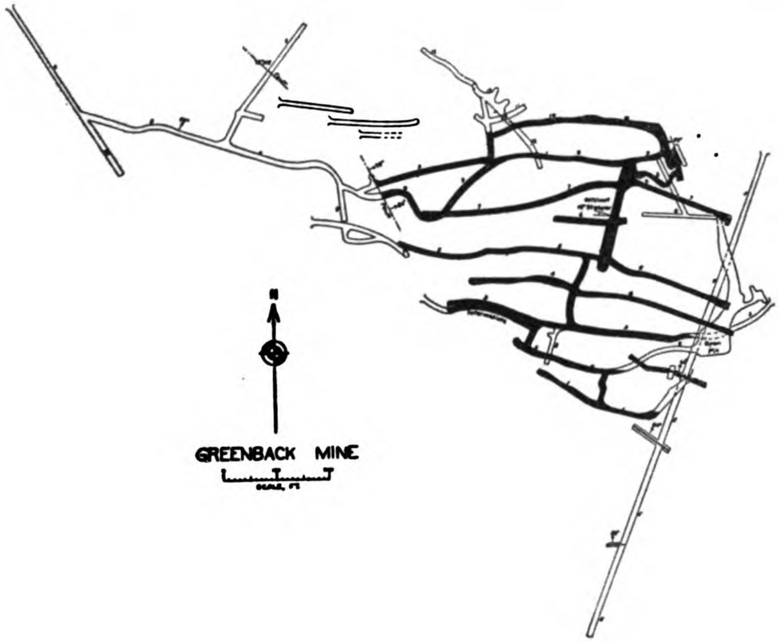
Dissolved by proclamation in January, 1917.

GREENBACK MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Greenback mine is situated near the head of Tom East creek, a tributary of Grave creek, about 1½ miles north of the town of Placer, which is 8 miles from Leland, the nearest railway point, in Sec. 33, T. 33 S., R. 5 W. Its presence has probably had much to do with making Tom East creek the site of one of the most important placer mines in Oregon.

The mine was discovered in 1897 and yielded rich returns from the first. In 1898 it was a producer of some importance, although at that time its ores were treated in an arrastre at Placer. The mine was then sold to the Victor Junior Gold Mining Company, from which it passed in 1902 to the Greenback Gold Mining and Milling Company. It is now owned largely or wholly by R. C. Robinson, of Parish, N. Y. It has the largest milling equipment in southern Oregon, consisting of 40 stamps, operated first by steam and later by electric power, and the following additional machinery: one 12 by 14 air compressor, 3 large Risdon crushers, 8 amalgamating plates each 12 feet long (now removed), 5 Frue vanners and 7 other concentrating tables, several Pelton wheels, 4 cyanide tanks each 4½ by 30 feet, besides solution and sump tanks, and an aerial tramway about 7000 feet long.

The mine is opened on 12 levels, as shown in the accompanying plan. Above the 9th level most of the ore is stoped out to the surface. Below that level it is opened only by a winze, which is full of water, and these lower workings shown in the drawing are taken from a map at the mine. The vein strikes about east and west and varies in dip from about 30 to 60° N. The average dip from the 1st level to the 9th is about 45° N.; it is less above the 5th level, and about 55 to 60° below that level. The vertical depth reached by the 9th level is less than 500 feet. The vein averages about 20 inches in



Greenback mine, workings and ore body; workings on ore in solid black

width, but varies from less than 6 inches to more than 4 feet. The vein filling consists of quartz, calcite and pyrite, with quartz dominant in most places. The average content of the ore mined from the first and second levels was more than $8 per ton, and 75 per cent of this ore was free-milling, according to Captain Buck. The concentrates ran about $75 a ton, and after cyaniding the waste product contained less than $1 to the ton.

The country rock at the Greenback mine is largely greenstone, which is the result of alteration of an andesitic mass. Southeast of the mine serpentine is abundant, while an area of argillite lies to the north. The vein is cut off to the eastward by serpentine, which is apparently later than the mineralization, since the latter is not known to extend into the serpentine, either with or without faulting at the contact. To the westward the main vein is cut off by an important fault which strikes N. 35-40° W. and dips 75-80° N. E. Between these 2 limits, which are about 600 feet apart on the 9th level, the vein is continuous, although exhibiting variations in both strike and dip. Outside of these limits it has nowhere been found. In the stopes on the 6th level there is some indication of a branch vein or stringer going downward into the footwall and diverging also on the strike to the westward, but it has not been explored.

About 80 feet south of the Greenback vein on the 5th level the Irish Girl vein strikes N. 70° W., almost exactly parallel with the former, and dips about 60° N. Where opened it is a vein similar to the Greenback in mineral contents, but only 1 to 3 feet thick and lower in grade. It has been opened only by a drift 75 feet long and a short raise. The long crosscut into the footwall discloses two more veins, which are about parallel, but they are still smaller.

The Greenback mine is at present under lease and bond to Dr. W. L. Baker, of Buffalo, New York, and H. L. Holmes, of Geneva, New York, who are prosecuting some systematic work of rejuvenation of the property, under the efficient management of Mr. Childers, of Montana. They are at present working a force of 30 men.

GREENBACK MINES COMPANY

Filed articles of incorporation in September, 1915. Incorporators, W. S. Farmer, A. C. Hough and Jessie Martin. Capital stock, $2,000,000.

GREEN MINE (placer) JACKSONVILLE DISTRICT JACKSON COUNTY

The Green mine, on Forest creek, adjoining the Sturgis mine on the north, is owned by C. W. Green, of Jacksonville.

GREEN MOUNTAIN COPPER PROSPECT GREEN MOUNTAIN DIST. DOUGLAS CO.

Diller says:

Northeast of Galice the Green Mountain Copper Company has recently opened up a suggestive mass of pyritic ore at an elevation of 3,900 feet on the northwest slope of Green Mountain, 15 miles east of Glendale and about a mile from the country road. The company controls 330 acres of land, part of which is patented.

The country rock is typical greenstone that has been greatly sheared and altered but still preserves its original structure and composition sufficiently to show its diabasic character. The greenstone belt, nearly a mile wide over the summit of Green Mountain, lies between belts of slates and other sedimentary rocks, and is cut off a short distance to the south by serpentine, whose intrusion has influenced the mineralization of the region. The ore impregnates the greenstone and forms lenses. It is usually incased in deep-green chloritic material.

The important copper mineral is chalcopyrite, which is intermingled with a large proportion of pyrrhotite and pyrite. The range of color from bronze to brass-yellow suggests the presence of cubanite, but the ore tested that was free from chalcopyrite gave no trace of copper.

The outcrop lies in the upper drainage of Starveout creek, whose placers have been remarkably productive. At the time of my visit (Sept. 6, 1911) the irregular incline, about 40 feet in length, exposed a body of ore 2½ to 3 feet in thickness, where it disappears beneath the incline. A tunnel is now being run in the hope of finding this ore body at a depth of 200 feet below its outcrop in the incline. The tunnel is already 40 feet in and several hundred feet have yet to be driven. The Pacific Outlook, Dec. 28, 1911, reported that the tunnel was in 140 feet and that a 2-stamp mill had just been completed.

The Green Mountain Copper Company was dissolved by proclamation in January, 1917.

GREEN ROCK MINING COMPANY BOHEMIA DISTRICT LANE COUNTY

Not incorporated. Office: Seattle, Wash. James Miller, Sec.-Treas. Owned by the Miller Bros.

Property is located in T. 23 S., R. 2 E., about 4 miles east of the Champion mine, which is 12 miles southeast of Disston, the terminus of the 20-mile branch railroad from Cottage Grove.

During the summer season of 1916 this company was employing 6 or 7 men, operating a small compressor and a Chilian mill.

GREY EAGLE MINE (copper) WALDO DISTRICT CALIFORNIA

The Grey Eagle mine, a few miles over the line in California, is said to be a very excellent copper property. A third interest in the mine was recently sold to W. P. Thompson, of New York, by John B. Farrish, Fred Dakin, Sr., and Fred Dakin, Jr., on a basis of $500,000. This interest has since been turned over to the Mason Valley Mines Company of Nevada. This company intends to build a railroad to the mine from Waldo, and connect with the California-Oregon Coast Railway Company's line at that point.

GRIFFITH MINE (placer) GRANITE DISTRICT GRANT COUNTY

These placers are in Sec. 16, T. 9 S., R. 36 E.

The Griffith placers are in a high terrace about 3½ miles northwest of the Weaver mine, at an elevation of approximately 5,500 feet, and on the opposite or west slope of the Blue Mountain divide. The portion of the ridge separating the two places is from 200 to 400 feet higher.

Lindgren has described this deposit and records that in 1900 "a hydraulic pit about one acre in extent has been made in the high gravels, and a bank 40 feet high is exposed." The present area of this pit is about the same. Evidently little or no mining has been done since that time. Early in the past season (1909) operations at a point just west of this old pit were commenced, but after a short time they were suspended because of litigation. The gravel here lies unconformably upon fine sediments very similar to those of the Weaver mine and is thickly bedded, striking northwest and dipping 12° N. E.

In its general texture this gravel resembles that of the Weaver mine, and it is likewise affected by normal faults, one of which strikes north, with vertical dip and downthrow of 6 feet on the west.

Considerable "black sand" is said to collect in the sluices, and a sample of it was obtained from G. T. Pinson. Platinum was detected in this sample by D. T. Day, in greater quantity than in the sand from the Weaver mine, amounting to about 1½ ounces per ton. (The present market value of refined platinum is $29 per ounce—in 1914 about $40 per ounce.) In addition, this sample contained a considerable amount of gold amalgam and a few flat particles or "colors" of rusty gold. Both this and the sand from the Weaver mine are by the partial examination made shown to be well worth saving. These occurrences of platinum are interesting as being from new localities, and the metal's close association there with serpentinized rocks is in line with its general occurrence elsewhere.

The extent of this deposit has not yet been definitly determined by prospecting. It seems, as noted by Lindgren, to extend northwestward for a mile or more, and apparently disappears under a basalt flow.

GRIZZLY MOUNTAIN MINING & REDUCTION CO. (gold-silver)
BOHEMIA DIST. LANE COUNTY

Office: Cottage Grove, Oregon. J. C. Klopfinstein, Pres.; George W. McQueen, Sec., both of Cottage Grove. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Property consists of 5 claims located about one-half mile northwest of Grizzly mountain in Sec. 11, T. 23 S., R. 1 E., 1½ miles northeast of Bohemia postoffice, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove. Reported to have an ore body on a porphyry dike 20 feet wide, the vein showing good walls, with 1 foot of high grade ore on the footwall. Minerals are lead and copper sulphides with gold and silver values.

GRUBSTAKE MINE (gold) UPPER APPLEGATE DISTRICT JACKSON COUNTY

This mine is 35 miles south from Jacksonville, in Secs. 9 and 16, T. 41 S., R. 2 W., on the Elliott creek branch of the Applegate. Mr. F. W. Carnahan, of Medford; Frank Edwards, of Watkins, and Walter Garrison, of Myrtle Creek, are the owners.

Three hundred feet of tunnels have been driven on the property, more than 200 of which is a drift on a good-looking quartz vein. The property is equipped with an arrastre, a 32-foot overshot wheel and a small cyanide plant. The mine was in operation in 1916.

GUERIN CLAIM (placer) SIXES RIVER DISTRICT CURRY COUNTY

The only information obtainable concerning this deposit are the statements of Diller that at the time of his investigation "the Guerin brothers were ground sluicing just above the mouth of Butcher gulch, in Sec. 21, T. 32 S., R. 13 W. From one of the Guerin brothers, who works a placer along the South fork of the Sixes, the writer obtained about 5 ounces of concentrates to examine for platinum. Nearly 85 per cent of the concentrates were magnetite, and the remainder was chiefly ilmenite or chromite. Numerous scales of gold were present, but no platinum or iridosmine was found."

HADLEY CLAIMS SIXES RIVER DISTRICT CURRY COUNTY

See "Wallace and Hadley" claims.

HAGELSON PROSPECT BAKER DISTRICT BAKER COUNTY

In the S. W. ¼ of Sec. 22, T. 9 S., R. 39 E., on the northwest side of Washington gulch, are a number of prospect holes and tunnels on veins said to have been located by the "forked-stick method." The country rock is greenstone cut by some diorite dikes. One of the veins is composed largely of platy calcite.

HAMILTON MINING COMPANY **IDAHO**

Office: 307 Benton St., Portland, Oregon. R. E. White, Portland, Pres.; A. N. Hamilton, Milwaukie, Oregon, Sec. Capital stock, $2400; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located on the South fork of Salmon river, Idaho county, Idaho.

HAMMERSLEY MINE (gold) **GRANTS PASS DISTRICT** **JOSEPHINE COUNTY**

For description see "Daisy Mine."

HAMMERSLEY MINE (chrome) **GRANTS PASS DISTRICT** **JOSEPHINE COUNTY**

The Hammersely mine, near the Lucky Queen mine, on Shorthorn creek, is a good-looking chrome prospect.

HAMM GOLD MINING COMPANY (placer) **BAKER COUNTY**

Local names, Big Creek Placers, Cow Creek Placers.

Office: Hereford, Oregon. A. B. Hamm, Pres., Ramer, Tenn; A. M. Howell, Sec.-Treas., Kenton, Tenn. Capital stock, $100,000; par value $1.00; $83,140 subscribed, issued and $83,135 paid up. (1916 report).

About 3 miles east of Hereford, in Sec. 8, T. 12 S., R. 39 E., on Big creek and Cow creek, a branch of Big creek, the latter a tributary of Burnt river, from the north. Elevation about 4000 feet. Wagon road to Baker via Bridgeport postoffice, Auburn creek and Stices gulch. Elevation of pass, 5200. Placers in sagebrush-covered hills near timber line. Lands are Big Creek placer and B. C. O. placer. These placers are located upon andesitic and basaltic lava bedrock; the gold-bearing gravels upon these rocks are from the erosion of the older argillites and intrusive granodiorites, which are found outcropping in somewhat limited areas in the upper drainage of these creeks.

The annual labor performed is about $1000 and production is reported below $1000.

HAMPSON'S CLAIMS **GOLD HILL** **JACKSON COUNTY**

See "McLemore & Hampson's" claims.

HANNIBAL MINING & MILLING COMPANY (gold) **WEATHERBY DIST.** **BAKER CO.**

Local name, Big Lode mine.

Office: Baker, Oregon. J. H. Waugh, Pres.; G. S. Misener, Treas., both of Vancouver, B. C.; M. N. Thompson, Sec., Baker, Oregon. Capital stock, $96,000; par value $1.00; subscribed, $96,000; none issued or paid up. (1913 report).

Located 2 miles northeast of Weatherby, a station on O.-W. R. & N. Co. line, on Chicken creek, a tributary of Burnt river. Lands, 4 quartz claims. Have not been visited, but secretary reported in 1914 that about $20,000 had been expended upon the property. He describes the recent work as "a crosscut tunnel 600 feet tapping the contact, at a depth of 200 feet from surface. We are driving on the contact and it is proving to be a very large body of ore and mineral matter. In this body we find several different ores, some having tested from $3 as high as $40 in gold." In 1915 and 1916 assessment work is about all that has been done.

Dissolved by proclamation in January, 1917.

HANSEN COAL MINE **JACKSONVILLE DISTRICT** **JACKSON COUNTY**

The Hansen coal mine is less than 1 mile north of the Cascade and at an elevation of 1650 feet, as measured by aneroid barometer. The entry is irregular and shows only a little coal; 130 paces from the portal a 2-inch seam of coal strikes N. 30° W. and dips 20° N. E. At 140 paces from the portal a raise to the surface exposed the following section:

Section at Hansen Coal Mine

Surface.	Feet	Inches
Shale	30	
Clay		1-3
Coaly shale		1
Coal, with thin shaly partings		12
Carbonaceous shale		2
Coal		½
Carbonaceous shale		2½
Coal		1
Coaly shale		3
Coal		½
Carbonaceous shale with thin seams of coal..		18
Covered.		

The coal here strikes N. 40° W., and dips 10° N. E.

HARRISON CLAIMS (gold) SIXES RIVER DISTRICT CURRY COUNTY

In Sec. 23, T. 32 S., R. 13 W. on southern slopes of Rusty butte in slaty rock and greenstone. Small irregular veins carrying gold in pyrite, arsenopyrite and galena. Claims are St. Patrick's, Golden Fleece and Mountain Daisy, which may not all belong to Harrison group. Oxidized portion of veins have fine gold and some wire gold.

HARTH AND RYAN MINE GOLD HILL DISTRICT JACKSON COUNTY

The Harth and Ryan mine is in Sec. 33, about 3 miles south of Woodville, at elevations of 2350 to 2600 feet by barometer. It is opened by 4 adits, having a total length of 500 feet, at different elevations on a steep mountain side. The lowest adit discloses 2 crushed zones which strike west and dip toward each other at angles of about 70°; they contain very little quartz. The next adit is the main entry; it extends south and then southeast for 300 feet; about 100 feet from the portal a vein strikes N. 22° E. and dips 45° S. E. At the end of a branch to the southwest a raise discloses a vein striking N. 10° W. and dipping 80° N.; probably the same vein is found at the face of the uppermost adit where it contains 6 to 12 inches of quartz. The country rock at this mine is a "greenstone" containing patches and irregular bands of varying composition, some being chiefly fine granular quartz, others plagioclase, and others hornblende with a few pseudocrysts of the latter mineral.

HASKINS & TRAVERSO CLAIM UPPER APPLEGATE DIST. JACKSON COUNTY

Haskins and Traverso have a prospect in the N. W. ¼ Sec. 6, T. 41 S., R. 2 W. on the north side of Squaw creek at an elevation of 3450 feet by barometer. It is opened by 2 short adits and a 20-foot shaft. The vein is 1 to 3 feet thick, striking N. 71° W. and dipping 60° N. E. in old andesite. The quartz near the surface shows a little copper stain.

HEAVERNE GROUP (copper) WALLOWA DISTRICT WALLOWA COUNTY

These claims are located in Sec. 31, T. 4 S., R. 45 E. on the west fork of the Wallowa river about 13 miles south from Joseph, the railroad terminus from which it is reached by wagon road for 5 miles and indifferent trail for 8 miles. It is about 1½ miles below the Fraser property, and to the east of and near the stream in a limestone-granodiorite contact. The limestone here has approximately an east-west strike, with a high angle of dip to the north. The contact appears to be somewhat irregular and of less width than at the Fraser mine, but considerable epidote and chalcopyrite are visible in the small amount of surface work accomplished. The lesser amount of contact-metamorphism may be due to a steeper angle of dip than found at Frasers.

HECLA CONSOLIDATED MINING COMPANY (lead, zinc, gold and silver)
WALLOWA DISTRICT WALLOWA COUNTY

Local name, Gyllenberg claims (?).

Office: Baker, Oregon. John L. Rand, Pres.; M. Ethel Brooks, Sec.-Treas., both of Baker, Oregon. Capital stock, $1,000,000; par value $1; all subscribed, issued and paid up. (1915 report).

Owns 11 claims in about Sec. 21, T. 3 S., R. 44 E. on the west side of Hurricane creek, about 9 miles from Joseph.

Some 1500 to 2500 feet above and west of the Hurricane trail, and a mile or so beyond the mouth of Fall creek, is a considerable area of banded blue-gray crystalline limestone. Above this limestone is a large exposure of schist which apparently is conformable with the limestone. This high amphitheatric basin built of marble, and walled in by ancient volcanics from pit to gallery, is swept almost clean of loosened stone.

Both limestone and superimposed schists have been cut by numerous dikes. Some of these are light in color, showing in the ground-mass but few crystals of quartz and feldspar. These quartz porphyry dikes since they have neither mica nor hornblende approach aplite in character. In contrast to these acidic dikes are the more interesting lamprophyres. This rock occurs in slightly lens-like dikes parallel to the schistosity of the limestone.

In texture they are very fine-grained, almost dense. These dikes contain about 5 per cent of pyrite, and in thin sections are found to be a lamprophyre, variety kersantite.

Basalt dikes in this region are the youngest dikes of all. A double dike of basalt is well shown. The ore, which is chiefly galena and sphalerite, with a little pyrite, occurs in small lenticular-shaped bodies, less than a foot wide and only a few feet long. The long axes of these lenses are parallel to the schistosity or banding noted above. On each side the limestone is recrystallized and nearly white in color. A little cerussite, lead carbonate, colored green by copper stains, was seen.

HELL GATE MINING AND DEVELOPMENT COMPANY (placer)
GALICE DISTRICT JOSEPHINE COUNTY

The Hell Gate Mining and Development Company (dissolved January 3, 1912,) has done considerable work on a deposit of gravel on the southwest side of Rogue river near the mouth of Hog creek at a level high above the present stream. The resultant excavations are in plain view from the county road across the river. No activity for several years.

HEMLER (GEORGE E.) CLAIMS (gold) CRACKER CREEK DIST. BAKER COUNTY

These 5 claims are about 2 miles north of the Columbia mine on Fruit creek at an elevation of about 7500 feet.

The principal veins are the Gold Nugget and Boise Belle, which are about 150 feet apart, each with strike NE.-SW. and dipping 75° SE. The Gold Nugget vein varies from 5 to 9 feet in width and the Boise Belle vein 4 to 5 feet.

Development consists of several open cuts, but the work is now confined to an adit intended to cut both veins.

The country rock is granodiorite and argillite with vein cutting both. It has a porphyry dike in with the vein and good gouge on foot wall of vein. The widths above given include the dike. The ore is from 3½ to 4 feet wide. Values are from $4 up, but the general average is about $10 per ton. There is plenty of water and timber, a good wagon road to the property and the power line of Eastern Oregon Light and Power Company is only 1 mile away. The above information is from the owner.

HENRYVILLE MINE (coal) **COOS BAY DISTRICT** **COOS COUNTY**

Local name, Smith & Powers mine.

Located about ½ mile west of Henryville and about 6 miles southeast of Marshfield. Owned by the Coos Bay Coal and Fuel Company. The mine has been recently leased by R. M. Jennings and associates, of Portland.

The coal beds have a total thickness of about 5 feet, having 2 partings; the lower parting about 2 feet from the bottom some 6 inches thick, and the upper parting about 8 inches from the roof, leaving the lower and middle seams about 2 feet and 30 inches thick, respectively. The beds dip to the east at varying angles, the upper part of the incline shaft being about 28°, while at the lower part of the incline, 1200 feet down, it is sometimes less than 20°.

The surface equipment of the mine can no doubt be improved with profit as nearly 50 per cent of the product, according to the statement of the former manager, goes into slack and is therefore thrown on the waste dump.

The mine is equipped with a 200 H. P. electric hoist, a Sullivan exhaust fan, electrically driven, 6 feet in diameter and 30 inches wide, making about 200 revolutions per minute.

The mine has a capacity at present of about 100 tons per day.

HEPPNER MINING COMPANY (gold) **NEW ELDORAOD DISTRICT** **GRANT COUNTY**

Local name, Heppner mine.

Office: Heppner, Oregon. D. B. Stalter, Pres., Austin, Oregon; J. O. Hager, Sec.; S. A. Wright, Treas., both of Heppner, Oregon. Capital stock, $1,000,000; par value 10 cents; $97,458.80 capital stock subscribed, issued and paid up. (1916 report).

This company owns 13 claims on the southern slope of Greenhorn range about 6 miles from the Austin-Susanville road and about 18 miles from Austin, the shipping point.

The country rock is a medium-grained granodiorite, cut by granodiorite-porphyry dikes. Considerable surface weathering of the granodiorite has taken place. The remarkable thing here is the fact that one crosses in a distance of a little over 1000 feet a dozen or more veins or lodes consisting largely of quartz, and varying in width from about a foot to 20 feet or more. These veins strike N. 40° E. and dip 50° to 75° E. They are fairly strong fissures, some having been traced for several hundred feet along the strike. These veins are made up of solid quartz, replaced rock, gouge, and in one of the veins considerable pyrite was noted. Gold is free, at least near the surface. Most of the work has been done on the upper and smaller veins, where the ore in places is said to be rich enough to pay to treat in their 2-stamp mill, to which the ore is hauled from the tunnel portals.

It is claimed that on the lowest vein a sample across more than 20 feet assayed $16.20. Two hundred fifty-six feet of tunnel was run in 1915.

HERRIMAN PROSPECT **BAKER DISTRICT** **BAKER COUNTY**

See "Baker and Herriman Prospect."

HICKS CLAIM **GOLD HILL DISTRICT** **JACKSON COUNTY**

See "Big Buck Claim."

HIDDEN TREASURE GOLD MINING COMPANY (gold) **GREENHORN DIST.** **GRANT CO.**

Local name, I. X. L. mine.

Office: Baker, Oregon. Fred T. Kelly, Pres.; N. M. Kelly, Sec. Capital stock, $1,250,000; par value $1.00; $1,250,000 subscribed; $1,090,600 issued and all paid up. (1916 report).

This property of 11 claims is located a short distance east of Greenhorn. There are 2 shafts upon the property and drifting upon the veins has been done in each, but little has been done here recently. Three well-defined veins are said to have been opened up in which there are promising shoots of ore. The workings were not accessible in 1914, but there was some work done upon this property in the fall of 1915.

HIDDEN TREASURE MINING COMPANY (placer) WALDO DIST. JOSEPHINE CO.

Office: 417 Corbett Bldg., Portland, Oregon. George P. Lent, Pres.; Chas. A. Goulding, Sec.; T. M. Wilson, Treas., all of Portland, Oregon. Capital stock, $250,000; par value $1.00; all subscribed, $180,000 issued and all paid up. (1916 report).

This company is involved in litigation. Its property, 3 miles east of Holland, Oregon, is idle.

HIGGINS MINE (gold) CHINA DIGGINGS DISTRICT CURRY COUNTY

This property was not visited, but Diller describes it as follows:

> The Higgins mine, at the head of Slide creek on the Chetco side of the divide, 12 miles on a direct line or 20 miles by trail nearly west of Kerby, has recently attracted much attention. The holdings embrace 10 claims taken up, at least in part, by L. G. Higgins in 1903. They extend northeast and southwest along a contact of greenstone and serpentine. The contact has been sluiced at a number of places and most of the gold has been won in this way. The gold is very fine and flaky. It has not been transported, but was set free by decomposition of the rocks in place along the contact. The gold does not occur in quartz veins, according to Mr. Higgins, but between the folia of the talcose minerals in the shear zone along the contact.
>
> The latest strike of this mine is in the "Golden Dream" at the head of Slide Creek, at an elevation of about 3,500 feet, and has been sluiced by lessees. The ore was rich but not richer than that obtained by Mr. Higgins years ago on the same contact, three-quarters of a mile further southwest. Mr. Higgins has erected a three-stamp mill with a concentrator to mill the contact rock. A 100 foot tunnel, somewhat meandering, has been run along the sheared contact to open it up, but there is no evidence to show the relative value of the rock at and beneath the surface. A short distance west of the mine some slaty rocks outcrop which may be of sedimentary origin, but no gold is reported along this border.
>
> The Higgins mine affords one of the best examples of the general character of the pockety lode-gold deposits in southwestern Oregon.

HIGH GRAVEL MINE (placer) WALDO DISTRICT JOSEPHINE COUNTY

The High Gravel, or Osgood mine, is owned by F. H. Osgood, of Seattle, Washington, and is in Secs. 33 and 34, T. 40 S., R. 8 W., a little less than a mile south of Waldo.

The principal workings are at the head of Allen gulch on both sides of the divide between the east and west forks of Illinois river. Most of the material mined is the conglomerate, determined to be of Cretaceous age by Diller, which forms the bedrock of the other placer mines in the region; it occurs here as a small remnant of a formation once much more widespread. On the west slope the deposits mined extend for about an eighth of a mile along the ridge with an average width of about 100 feet. A strip less than 100 feet wide separates the cuts on the two sides of the hill. In the cut on the east side of the ridge a maximum thickness of about 60 feet is exposed. Mining has been discontinued here. There has been some mining of the recent gravels all along Allen gulch. According to Kay, the conglomerates

> are not strongly cemented and the boulders are rather uniformly distributed throughout the section. Distinct joints are present in the conglomerates and a few small veinlets occur. The bed rock is a fractured, fissured, decomposed, and veined greenstone, which, owing to the presence of iron oxides, has a decidedly purplish tint. These Cretaceous conglomerates are shore deposits, derived from older rocks, similar to those on which they now lie. As stringers carrying values are fairly widespread in these old rocks, some gold is probably present in much of the conglomerate which has been derived from them. But whether or not these values are sufficiently concentrated, as at the High Gravel mine, to be profitably mined can be determined only by prospecting.

HIGHLAND CLAIM GOLD HILL DISTRICT JACKSON COUNTY

The Highland claim, 12 miles southwest of Gold Hill, is in the S. W. ¼ Sec. 22, T. 37 S., R. 4 W., on the right fork of Foots creek, at an elevation of 2600 feet by barometer. It was worked about 20 years ago by Fuller and Bayington; it is now owned by Cook and Swacker. The present workings are confined to the oxidized zone; the old workings were more extensive. The ledge is said to strike N. E. and dip about 35° S. E.; the country rock is a micaceous sandstone.

HIGHLAND DEVELOPMENT COMPANY ROCK CREEK DIST. BAKER COUNTY

Office: Baker, Oregon. S. O. Correll, Pres.; R. R. McGaughey, Sec. Capital stock, $50,000; par value $1.00; $48,948 subscribed, issued and paid up. (1914 report). Dissolved by proclamation in January, 1917.

This company was organized to lease the "Highland Mine" from the Highland Gold Mines Company. Fifty thousand dollars was too low a capitalization for equipping and operating purposes only, without having to meet the payments agreed upon in the lease. When production began the development company was in debt. The receipts from the production were little more than enough to meet operating expenses, but these funds were continually drawn upon to pay old bills of the development company and to meet payments on the bonds of the old company (one of the conditions of the lease), which resulted in continued shortage of funds to meet payrolls and, consequently, the efficiency of labor was low. The management failed to impound tailing from the mill as requested, and finally an injunction was granted by the courts against the company enjoining it from polluting Rock creek and consequently the irrigating ditches drawn therefrom. The mill closed down and liens of creditors both of labor and materials were filed. To determine whether the liens held priority over a mortgage, an action was begun in the courts, which was decided by the Supreme Court in December, 1915, in favor of the liens.

The result of this decision was that the Highland mine soon legally became the property of the creditors, with D. W. French, of Baker, Oregon, as trustee, and the assets of both the Highland Gold Mines Company and the Highland Development Company were extinguished. The mine is reported to have been sold under bond and lease late in August, 1916, to Delbert E. Metzger by the creditors.

For description of property, see "Highland Mine."

HIGHLAND MINE (gold-silver) ROCK CREEK DISTRICT BAKER COUNTY

This mine, which was owned by the Highland Gold Mines Company and operated by the Highland Development Company, is now owned by creditors, who secured the property through labor and material liens. It was leased by them to Delbert E. Metzger in 1916.

The mine buildings and mill are situated in the lower end of Maxwell basin, a mile above the junction of the gulch with Rock creek, in Sec. 19, T. 8 S., R. 38 E. It is reached by wagon road from Haines, the shipping point, a distance of 14 miles and a rise in elevation of 2500 feet.

The property contains 6 claims, the oldest of which was located in 1891. Ore was first discovered in a tunnel near the bottom of the gulch, and though most of the early work was done south of it, the important work which began in 1909 has been confined to tunnels on the north side. A small mill was erected in 1905, but this was replaced by a modern 50-ton plant in 1911, which was run continuously until April, 1914. The immediate cause of the cessation of work is reported to be an injunction issued by a local court restraining the operating company from polluting the waters of Rock creek.

The following statement of production is submitted by the company:

1905	$ 7,781.67a
1909, 330 tons crude ore	25,527.06b
1910, 960 tons crude ore	43,826.00b
1911, 186 tons crude ore	11,129.28b
1912, 1,725 tons concentrates	84,014.50b
1913, 2,678 tons concentrates	111,472.39b
1914, to April 15th, 443.62 tons concentrates	27,801.78b
	$311,552.68

a. probably net. b. gross.

The mine is developed by 6 tunnels with an aggregate length of about 5000 feet. Two tunnels lie south and 3 north of the gulch line. The sixth is a crosscut 625 feet to the vein, with extensive drifts northeast and southwest. These tunnels explore a well defined vein at several levels over a total distance of 3500 feet. In September, 1914, 3 were accessible in part; No. 2 on the north side of the gulch for a distance of 1150 feet, and No. 4 (Highland crosscut or mill level) 240 feet lower, for 1000 feet along the vein.

The Highland vein is the most persistent of the group comprising the Highland, Maxwell, Baisley-Elkhorn and other associated veins. Beginning at the southwest with the Highland vein, which strikes N. 75° E., the Maxwell and Baisley-Elkhorn are successively offset to the east, and the northernmost or Baisley-Elkhorn strikes N. 40° E. Broadly, the dip of each is nearly vertical, though from place to place the stopes show deviations of a few degrees either to the northwest or southeast. Minor fractures, locally ore-bearing, occur nearly parallel to each of the three main veins. At the southwest limit of exploration, the Highland vein, wholly in dense argillite, is about 500 feet from the main granodiorite contact, but farther northeast this distance decreases and the veins successively approach and finally enter the granodiorite. The Baisley-Elkhorn is largely within this rock.

The Highland No. 4 crosscut tunnel starts in a dense gray siliceous argillite which strikes east and dips 60° to the south. This rock contains zones of irregular narrow quartz-filled fractures and is succeeded by a darker argillite, with a few fractures and no quartz veinlets. The rocks forming the walls of the vein range from dark dense carbonaceous argillites to light, coarser siliceous varieties and bedding is rarely determinable near the vein. The character of the vein, as well as the deep narrow furrows on the south wall, inclined at low angles to the northeast, indicate that the vein follows a fault, along which appreciable movement has taken place. The vein material is bounded by well defined walls, from which it breaks freely. Crosscuts locally show a width of as much as 28 feet between the walls, but the more productive portion in few places exceeds 30 inches in width.

The zone of oxidation is very shallow and irregular, probably because the explored portion of the vein crops out within a glaciated area. Films of recently formed hydrous oxide of manganese occur along the walls at a number of places on the lowest drifts.

Four shoots of ore have been found, and though three are fairly defined, the fourth, which has been the source of the richest ore, has been stoped over a very irregular area, and no exact record of its extent has been kept. The most southwestern, or Big Silver shoot, is reported to be 300 feet long, but to contain material of low grade, only a small portion of which was stoped. The next, or Shelton shoot, is 60 feet long and was the source of some ore of shipping grade in the early history of operations. The main shoot, the source of most of the recent production, extends from a shaft near the bottom of the gulch about 1100 feet northeast.

As the shoot has been explored to a depth of only 360 feet, its attitude in the vein is not known with assurance. The Beckwith shoot, 180 feet long, lies farther northeast and the greatest stope length is about 120 feet.

The vein contains several distinct classes of material, each of which locally has been found by assay to warrant mining, though places are known where each contains but little gold and silver, a condition that requires numerous assays, both during development and actual mining, in order that the grade of the product may be maintained. The richest ore shows bunches or short lenses of sulphide minerals in white quartz, locally showing radial structure. The sulphides noted, in order of importance, are fine granular pyrite in which are small patches of dark blende and coarsely crystalline galena, arsenopyrite, chalcopyrite and tetrahedrite. Locally there are small patches of a greenish mica that may be either sericite or fuchsite. This pyritic material here and there is coherent and has definite structure, but most of it is not coherent and a definite structure cannot be recognized in hand specimens. Tests have shown that some of the more coherent material is merely a breccia of the ore minerals cemented by calcium carbonate, and that some of the quartzose portion is a similar quartz breccia. This is one of several features showing that considerable post-mineral movement has taken place in the vein. It is reported that this material from the eastern part of the main shoot contains as much as 2.5 ounces of gold and 15.0 ounces silver per ton, but that very similar material farther west is considerably lower in grade.

Another class of filling is found in the Big Silver shoot and the western portion of the main shoot. Here angular fragments of argillite or masses of pale green mica and pyrite that resemble replaced argillite are embedded in quartz, locally having radial structure. Such material is undoubtedly an argillite breccia more or less replaced by vein minerals and cemented by quartz. This is reported to be low grade.

By far the greater portion of the vein filling is an incoherent mass of crushed argillite, clay, quartz and ore minerals. The argillite is locally fresh but dominantly silicified, and the clay, which ranges in color from light gray to nearly black, appears to have been formed by the alteration as well as attrition of the argillite country rock. The darker varieties of such clays are uniformly low grade, but otherwise the content in gold and silver varies greatly. It is necessary to mine large quantities of this material in order that the richer portions of the vein may be found, as well as to avoid the necessity of holding it in place in the stopes.

With the exception of the quartz-argillite breccia, which usually forms well defined lenses, the other two materials form both definite zones and highly irregular masses, but in each case the limits are walls or slips, along which the materials separate freely.

The ratio of silver to gold in the ore ranges for the most part from 5 to 25 of silver to 1 of gold by weight, but in the concentrates the ratio deviates but little from 9 to 1, being approximately 15 ounces silver and 1.80 ounces gold to the ton. Concentrates containing galena show a higher proportion of gold than the normal pyritic concentrates and indicate an association of gold with that mineral. Thus, a concentrate containing 15.5 per cent lead yielded 5.28 ounces gold and 23.12 ounces silver to the ton. The average recovery from the ore in the present mill has been about 2 ounces silver and .25 ounces gold to the ton. The tailings are reported to contain gold and silver to the extent of $1.80 to $2.20 to the ton in value.

HIGHLAND SURPRISE CONSOLIDATED MINING CO. (Idaho corporation) IDAHO

Office: Kellogg, Idaho. W. W. Papesh, Pres.; W. B. Wadsworth, Sec.-Treas., both of Kellogg, Idaho; C. W. Butler, Independence, Oregon, attorney-in-fact. Capital stock, $1,200,000; par value $1.00; $1,000,000 subscribed, $852,100 issued and paid up. (1914 report).

HILL CLAIMS (copper) HOMESTEAD DISTRICT BAKER COUNTY

South of the MacDougall group, in Secs. 1 and 2, T. 6 S., R. 48 E., are a number of claims on which there is a variety of rocks belonging to the greenstone series. One of them, although locally called "monzonite," undoubtedly is greenstone. Its exact original character was not determined. Although considerable development has been done in this rock, the more favorable parts of this group are those places where the conditions are similar to the MacDougall and Ballard claims, which see for descriptions.

HILLSBORO GOLD MINING COMPANY (placer) EAGLE CREEK DIST. BAKER CO.

Local name, Eagle Creek Junction placer mine.

Office: Hillsboro, Oregon. J. W. Shute, Pres.; A. C. Shute, Sec.-Treas. Capital stock, $6000; par value $1.00; all subscribed, issued and paid up. (1914 report).

This placer mine is situated at the junction of East Eagle creek with Eagle creek, in Sec. 6, T. 7 S., R. 44 E., and considerable development work has been done and equipment installed, but the total production is not available. It is patented ground and little work has been done the last few years.

HOLLENBECK CLAIMS SIXES RIVER DISTRICT CURRY COUNTY

See "Byers & Hollenbeck Claims."

HOMESTAKE MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Homestake mine is in the N. W. ¼ Sec. 16, T. 36 S., R. 4 W., about 1 mile northwest of Woodville, at an elevation of 1600 feet by barometer, and is owned by Dr. C. R. Ray, of Medford.

The main entry extends northeast about 300 feet and thence northwest about 200 feet, crossing numerous small quartz veins and stringers. The country rocks are impure quartzites and argillites. The upper adit strikes a well defined quartz vein about 12 to 18 inches thick, which strikes N. 35° W. and dips 35° N. E. Caved ground prevented learning how far the vein was followed. The mine is equipped with a 5-stamp mill having a concentrator and slime table. The ore contains pyrite and a little galena and sphalerite; telluride of gold is reported in it, but it was not observed.

HOMESTAKE MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

The Homestake mine is on the northern side of Elk creek, a little farther up than the Badger mine. It has a N.-S. vein in serpentine, in which a shoot 4 feet wide and 300 feet long contains $8 free gold near the surface. Zinc-iron sulphides are found but a short distance below the surface.

HOMESTEAD-IRON DYKES MINES COMPANY (New York corporation) HOMESTEAD DISTRICT BAKER COUNTY

Office: 60 Broadway, New York City. David M. Goodrich, Pres.; Charles C. Goodrich, Sec.-Treas., both of New York City; N. D. Simon, 710 Board of Trade Bldg., Portland, Oregon, attorney-in-fact. Capital stock, 1000 shares; no par value; all subscribed, issued and paid up. (1916 report).

This company operates the property of the Iron Dyke Copper Company, which see.

HORSE SHOE PROPERTY WALDO DISTRICT JOSEPHINE COUNTY

The Horse Shoe property is in the N. E. ¼ Sec. 17, T. 40 S., R. 7 W., 4 miles south from Holland. These workings were not examined. The size of the dump indicates several hundred feet of development.

HUMBOLDT CONSOLIDATED GOLD MINES MORMON BASIN DIST. MALHEUR CO.

Office: Baker, Oregon. Fred R. Mellis, Pres.; James A. Howard, Sec.; J. E. Goyer, Treas., all of Baker. Capital stock, $1,200,000; par value $1.00; $1,000,000 subscribed, issued and paid up. (1916 report).

This company formerly owned the Humboldt mine in Mormon Basin, but lost it in 1916 through labor and material liens. The company is now without assets. For description, see Humboldt mine.

HUMBOLDT MINE MORMON BASIN DISTRICT MALHEUR COUNTY

This mine, which was formerly owned and operated by the Humboldt Consolidated Gold Mines Company, is now owned by John Kiernan, of Portland, Oregon. The company lost the mine through labor and material liens. It is now idle and full of water. The pumps were pulled in March, 1916.

The mine is situated in the southwestern part of Mormon Basin, in Malheur county, in the N. W. ¼ of Sec. 20, T. 13 S., R. 42 E. It has 4 levels and was worked by means of a vertical shaft. There is a 20-stamp mill upon the property, which used amalgamation and concentration with Wilfleys and vanners. Considerable percentage of the gold is free milling.

The many movements that have taken place in this immediate vicinity have caused the geology to be confusing. The chief country rock is slate with diorite porphyry in the footwall. In the upper levels trachyte is said to form a large part of the hanging wall. This trachyte was probably a feeder to some of the recent lava flows.

The lode has an east-west strike and a dip of 75° N. in the upper levels, but with a steeper dip below. In some places the lode is as much as 40 feet wide, but the actual quartz veins are rarely more than a few feet thick.

The chief gangue mineral is quartz and much of it is in a sugary condition, due to crushing by later movements. Some calcite is present in the vein. The ore, especially in the upper levels, is free gold, and many fine specimens have been taken from the mine. In the lower levels more sulphides are found. They are chiefly arsenopyrite, pyrite, galena and sphalerite. The galena and sphalerite are said to contain high values in gold.

The Humboldt lode is situated in a zone of weakness, where fracturing and movement have taken place many times. The first break allowed the injection of the diorite porphyry that is found on the footwall. Then came the fracturing that made the opportunity for the hot ascending silica solutions to deposit their burden of quartz and metallic sulphides. Movement took place during the period of vein formation, as is evidenced by the recementing of broken quartz fragments. Considerable post mineral movement has taken place, as is shown by the sugary quartz, the gouge, and the actual faulting of the vein in the lode. The presence of a trachyte dike goes to show further how great a zone of weakness there is here. A certain amount of pressure may still exist as a partial explanation for the bad ground in some parts of the mine, where large sized stulls are crushed in a short period of time. On account of the faulting that has taken place in this mine a careful geological map, combined with an assay map, would have been of considerable value as a guide to development.

HUMDINGER MINE ASHLAND DISTRICT JACKSON COUNTY

The Humdinger mine, owned by C. Halstead, of Talent, on the ridge west of Wagner creek, has been prospected by shallow workings.

HUMDINGER MINE (gold) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Humdinger mine, 12 miles south of Grants Pass, in about Sec. 21, T. 38 S., R. 5 W., and very near the Rising Star mine, is owned by Scroggins and Mascall. The country rock is quartzite and argillite. An adit extends N. 75° W. 40 feet on a small vein of quartz, which dips about 70° N. E. The quartz is high grade gold ore in places. Work in progress in 1913 was near the surface.

HUSTIS AND ANDERSON GROUP (gold) CHINA DIGGINGS DIST. CURRY COUNTY

This property was not visited, but is described by Diller as follows:

The Hustis and Anderson claims are on the northwest slope of the Chetco divide on Miller creek, nearly a mile southwest of the Higgins claims, at an elevation of nearly 2,300 feet. The main contact of serpentine, running N. 20° E., lies just west of the mine which is mainly greenstone. A 100-foot tunnel to the east in greenstone reaches another contact in serpentine.

An old arrastre, now in ruins, gives evidence of milling some years ago. The principal serpentine contact with greenstone extends directly from the Higgins mine to the Hustis and Anderson claims, where it meets another body of serpentine from the east.

HUTCHINSON OIL AND GAS COMPANY MALHEUR COUNTY

Office: Union, Oregon. J. H. Hutchinson, Pres.; N. Schoonover, Sec., both of Union, Oregon. Capital stock, $25,000; par value $1.00; $16,000 subscribed and issued and $1000 paid up. (1916 report).

HYDRAULIC MINES DEVELOPMENT COMPANY (placer) GREEN MOUNTAIN DISTRICT DOUGLAS COUNTY

Office: 1334 Northwestern Bank Bldg., Portland, Oregon. J. C. Williams, 210 Second St., Portland, Pres.-Treas.; W. B. Shirly, 1334 Northwestern Bank Bldg., Portland, Sec. Capital stock, $100,000; par value $10; all subscribed, issued and paid up. (1915 report).

This company owned 19 claims, 380 acres, in Secs. 28, 29 and 32, T. 32 S., R. 4 W., on Starveout creek, 12 miles east of Glendale. Starveout creek is a tributary of upper Cow creek that drains the northwest slope of Green mountain. Several small placers on this creek have been irregularly active for a long time. The company now is out of business. (1916 report).

HYDRAULIC MINING COMPANY (placer) GRANTS PASS DIST. JOSEPHINE CO.

Local name, Cook and Howland mine.

Office: Three Pines, Oregon. G. E. Howland, Pres., Grants Pass, Ore.; Jefferson D. Cook, Sec., Three Pines, Ore. Capital stock, $25,000; par value $100; $18,100 subscribed, issued and paid up. (1914 report).

This company is out of business. Its property, 9 miles east of Hugo and about 4 miles southeast of the Hammersely mine, located on upper Jump-off-Joe creek, in Secs. 24 and 25, T. 34 S., R. 5 W., is now owned by Elizabeth Smith, of Grants Pass, and leased by L. T. Corliss, of Three Pines, Oregon.

The property has only been operated in a small way the past year. Dissolved by proclamation in January, 1917.

HYDRO SIXES MINES COMPANY (placer) SIXES RIVER DISTRICT CURRY COUNTY

Local name, Hydro Sixes mine.

Office: 57 Post St., San Francisco, California. W. J. Bell, Pres.; George W. Root, Sec.; C. J. Pease, Treas., all of San Francisco; C. C. Inman, Bandon, Oregon, Attorney-in-fact. Capital stock, $70,000; par value $1.00; all subscribed, issued and paid up. (1915 report).

This company's property is located between Otter and Elephant Rock creek just below the forks of the Sixes river. This company ever since the autumn rains of 1915 has been washing gravel from the beds of the creeks tributary to the Sixes river and feels highly encouraged at the returns received. In their mining development the company has crossed the beds of 3 different ancient streams all at a considerable elevation above the beds of the present streams. They have water under a 150-foot head taken from Big Otter creek. The company up to January, 1916, had spent $100,000 improving, equipping and getting ready for work. Fifty men were employed during the summer of 1915, cleaning the channel, constructing ditches and building flumes. They expect to spend about as much more to fully equip the property, which consists of about 1200 acres. This information is secured from the Bandon Recorder of January 18, 1916.

IBEX MINE (gold) CRACKER CREEK DIST. GRANT AND BAKER COUNTIES

The vein at the Ibex mine strikes northeast with a steep dip to the southeast, and is located upon the divide between McCully fork and Granite creek in Secs. 3 and 4, T. 9 S., R. 36 E., about 8 miles northwest of Sumpter.

The elevation of the croppings is about 6300 feet, and the lowest and longest tunnel driven in from the western side of the divide is about 500 feet lower. The slopes are well wooded, as are practically all of the argillite areas, and from the croppings a fine view is obtained of Greenhorn mountains and the region to the west.

The vein entirely in argillite is developed by 4 levels, all but 1 of which has been driven from the surface. Most of the development, which totals about 1½ miles, has been done in the last 15 years. Development work upon the vein extends over a distance of about 3000 feet.

This vein, as far as developed, averages about 5 feet, with a maximum width of 25 feet. The vein material for this width was originally crushed and sheared argillite, the result of crumpling and movement of the earth's crust. Into this line of crushing upward flowing solutions deposited quartz between the fragments of argillite and has replaced in variable degrees of completeness much of these fragments with quartz. After the zone had been largely cemented together and much of the argillite fragments silicified another movement in the vein fractured the quartz and silicified argillite which was cemented together again by additional silica brought up from below.

Small amounts of sulphides are found in the quartz and in the argillite fragments. These sulphides consist of pyrite and arsenopyrite. White iron or marcasite and mercurial gray copper, with small amounts of other secondary minerals, are found. The average value of the large amount of ore is said to be so low that high extraction and strict economy would be required for profitable operations. There is a wide variation in the quantity of silver present in various parts of the mine, a variation which bears little relation to the amount of gold contained.

IDA CLAIM (gold-copper) GRANTS PASS DISTRICT JOSEPHINE COUNTY

For description of this property, see "Oregon Gold Mines Company."

IDAHO COPPER MINING COMPANY IDAHO

Office: 610 Spring St., Portland, Oregon. W. J. Patterson, Selling Bldg., Portland, Pres.; James F. Ewing, 610 Spring St., Portland, Sec.-Treas. Capital stock, $20,000; par value 10 cents; all subscribed, issued and paid up. (1916 report).

This company's properties are located in Adams county, Idaho.

IDAHO MINE (placer) GOLD BEACH DISTRICT CURRY COUNTY

This property, which is situated on the present ocean beach, a mile south of Gold Beach, is the one which Mr. W. H. Williamson, of Gold Beach, attempted to work 7 years ago. Although a number of deep pits were dug on this property, they have since been so filled with wind-blown sand that it was impossible to examine the gold-bearing beds. From what was seen, however, it seems certain that these are here covered with many feet of worthless or low grade sand.

IDEAL MINING COMPANY NORTH SANTIAM DISTRICT MARION COUNTY

Office: 569 Spokane Ave., Portland, Oregon. A. B. Crosman, Pres.; Walter Adams, Sec.-Treas., both of Portland. Capital stock, $250,000; par value 25 cents; $145,000 subscribed, issued and paid up. (1916 report).

This company has 9 claims on Gold creek, named as follows: Michigan, Montana, Oregon, Indiana, Kuskogwin, Neukluk, Alma, Buckeye and Colorado. Assessment work only.

IMNAHA MINE (gold) **WALLOWA COUNTY**

This gold mine, also known as the Winchester mine, from S. L. Winchester, one of the men active in its development, is located in Sec. 10, T. 35 S., R. 49 E., about 400 feet from Battle creek, which empties into the Snake river about one mile below the mine. The mine is 25 miles north from Homestead and 40 miles east from Joseph, the railroad terminus, from which a good wagon road goes to within 4 miles of the property.

A tunnel 1000 feet long is now being run. The vein is three and one-half feet wide. There are 4000 feet of tunnels, shafts and crosscuts in the property now. Battle creek is but 400 feet from the property, and the mill is operated by a 50-horsepower Pelton wheel. The buildings are large enough for a plant handling 50 tons each day. The present mill handles 10 tons daily. There is also a sawmill and complete buildings for our employes. The concentrates assay $300 to $500 per ton. We have 50,000 tons of ore blocked out.

The above quotation is from a reported interview with S. L. Winchester in Portland Telegram of February 1, 1916. The property has not been visited.

IMPERIAL MINE (gold-silver) **CABLE COVE DISTRICT** **BAKER COUNTY**

This property of the Imperial Mining and Development Company comprises several claims situated in Cable Cove district, at 6500 to 7700 feet elevation, on a glaciated slope south of the divide between Silver creek and North fork of John Day river, in Sec. 15, T. 8 S., R. 36 E. The property includes the Eagle, Imperial, Winchester and some other veins.

Although the Cable Cove veins were known as early as 1872, it was not until the completion of the overland railroad in 1885 that the district was seriously exploited. During 1900, when Mr. Lindgren made his examination, development "was in progress upon a great number of claims and about 10 carloads of ore were shipped to smelting works."

Soon after 1900 a mill was built, which was supplanted by a new one in 1909, and milling operations continued intermittently up to 1910 on ores from the Imperial, Winchester and Eagle veins. Crude ore was mined and shipped to Salt Lake by F. W. Schofield in 1914. Smelter records were seen showing a production of $50,500 in gold and silver accredited to the Imperial property from 1904 to 1914. The mine was operated in 1915 by C. L. Arzeno and associates, who shipped some crude ore and concentrates, but got into financial difficulties and ceased operations before the year ended.

The intermediate tunnel is a crosscut 500 feet to the Imperial vein and a drift of several hundred feet along the vein. The Imperial tunnel comprises a short crosscut and a long drift on the same vein at a level 152 feet higher. About 550 feet from the mouth of the intermediate tunnel, the vein splits into two branches that diverge at an angle of about 20 degrees. The west branch is supposed to be the Winchester and the east branch the Imperial vein.

The Eagle, although the widest and longest vein, having been traced, it is said, for 2 or 3 miles, because of its lower grade of ore has received but little attention, since it was proven that their mill could not successfully concentrate these ores. The Eagle vein was not examined, but it is said to be as much as 15 feet between the walls. The vein material, largely altered granodiorite, contains streaks of arsenopyrite up to a half foot wide in some places, and in other places as much as 3 feet of $12 ore.

The Imperial vein, usually from 3 to 4 feet wide, although there are places much wider, probably has the greatest alteration of the granodiorite between its walls of any vein in the district. The narrow lenses up to 24 inches wide, with stope and pitch length of usually less than 50 feet, are found usually near the hanging wall. The vein filling is made up of the fragments of granodiorite considerably altered, while considerable widths have been completely altered to a soft white gouge. This is usually close to or surrounding the lenses of ore. This alteration extends often into the wall rock of the vein and is doubtless due to the ascending hot waters which deposited the ore and altered the brecciated vein and the wall rock. The total production probably does not exceed $75,000.

INDEPENDENCE MINE (gold) GRANITE DISTRICT GRANT COUNTY

Four miles north of Granite and in Sec. 20, T. 8 S., R. 35½ E., a mile northeast of the Cougar mine, and on the north slope of the ridge cut by the Cougar vein, lies the Independence mine, also in argillite. The early history of the mine is obscure, though it has been worked within the last few years, and a small production was reported in 1907. The workings comprise two tunnels, an upper 250 feet long, a lower 1020 feet long, and a shaft 210 feet deep, intersecting the second tunnel 440 feet from its portal. A portion of the longer tunnel, wholly in oxidized zone, was accessible in 1914.

The vein is explored for about 1100 feet along the strike N. 50° E., and to a depth of 190 feet below the outcrop. The vein dips 65° S. E. Two shoots, 320 feet and 120 feet long, having average widths of 3 and 2.8 feet, respectively, have been developed. The first of these has been stoped to a height of 60 feet above the tunnel, and is known 100 feet lower in a drift from the shaft. In the accessible workings the vein, which contains only a meagre amount of quartz, is composed of sheared argillite and gouge much stained with limonite. Unoxidized ore from the 100-foot level shows altered argillite breccia cemented by dense dolomite with minor quartz. Locally a breccia of both minerals is cemented by chalcedonic silica. Pyrite and arsenopyrite were observed both in the argillite fragments and in the cement, although tetrahedrite and pyrargyrite appear to be confined to dolomite. Faint stains of proustite occur on fractures. The total content of sulphide minerals does not exceed a few per cent. In the oxidized zone manganese stains are abundant, both on the walls and in the vein mineral.

According to Mr. Walter Gleason, an owner, the average of a number of assays in the oxidized zone of the longer shoot is 2.66 ounces silver and .43 ounces gold per ton, and in the unoxidized ore, 100 feet lower, the average is 9.3 ounces silver and 1.06 ounces gold. These averages indicate a ratio of silver to gold in oxidized ore of 6 to 1, compared with 9 to 1 below, as well as considerable increase in the value of the ore. The associations of the rich silver minerals strongly suggest that this increase in value is to be attributed to downward enrichment, following the weathering and erosion of the superficial portion of the vein. The extent of exploration on the vein, however, does not warrant a statement of the extent to which ore has been enriched by this process.

Several light decomposed dikes, 2 to 4 feet wide, with southeast courses, have been found in both walls. These terminate against the vein and indicate that it fills a fault fissure, although the amount of displacement has not been determined.

The attempt made in a mill on Granite creek to extract the gold and silver from this ore by an adaptation of the cyanide process was unsuccessful.

INGRAM CLAIMS (gold) LOWER APPLEGATE DISTICT JOSEPHINE COUNTY

The Ingram claims, 8 miles southeast of Grants Pass, are on Oscar creek and across the divide on Savage creek. On Oscar creek, in Sec. 14, T. 37 S., R. 5 W., the country rocks are Paleozoic argillites, sandstones and limestone cut by porphyry and serpentine. The limestone near Ingram's cabin strikes

N. 10° E. and dips about 45° E. Ingram's adit No. 1, at an elevation of about 3100 feet, shows some porphyry in its 150 feet of length, but does not reach unoxidized ore. His adit No. 2, at an elevation of about 2900 feet, is about 120 feet in length, the last 20 feet being in a green shaly rock with black indurated talc or gouge in seams, while the adit elsewhere is in andesitic porphyry. Ingram's adit No. 3, at an elevation of about 2300 feet, is only 30 feet long; it discloses gold ore, said to be high grade, but no well defined vein.

INK AND BARR PROPERTY (placer) OPHIR DISTRICT CURRY COUNTY

When this investigation was made, L. G. Ink and Will Barr were working the Old Bonanza claim, now called the Gold Slug, which they purchased from George Curry. They also located on March 10, 1915, 3 other claims along Boulder creek below the Gold Slug, which they called Iron Mountain, Nugget Bar and Lily, making their total holdings a mile in length; $1500 worth of gold is said to have been taken from the Gold Slug claim before the present owners purchased it.

The present owners began work in April, and at the time of the examination were sluicing the loose surface soil on the south side of the creek, in which they were finding gold from grass roots to a depth of about a yard. This gold was coarse, the pieces averaging 25 to 50 cents each, and including nuggets worth $6 to $10 each, and often larger, although the largest they had on hand at the time of the examination was worth something over $2. They state that Curry secured one nugget worth $65 from this claim, and that they found another weighing 4 ounces, 9 pennyweights, for which the mint paid them $93.60. Most of the gold is decidedly worn, but some is so jagged that it could not have come any considerable distance.

One or more old terraces exist on the southern hillside above the present workings, and it seems likely that the gold has slid down from these, although they do not appear to be as rich as is the loose material now being sluiced, of which 250 cubic yards are said to have yielded $100 in gold. The bedrock beneath the present workings is serpentine, but the contact between this material and Myrtle sandstone crosses the Gold Slug claim.

Below the Gold Slug the stream widens and a decided flat has developed. That gold is present here seems well established, but the nature of the ground is such that it must be worked, if at all, on an extensive scale by means of giants. At the time of the examination two men were prospecting on the lower end of the Lilly claim, but had not done sufficient work to indicate the value of the deposit.

Above the Gold Slug claim is the Blue Bell placer, owned by D. Chapin and H. Rowlan; while above this is the Big Nugget claim, located by John R. Hurst during the rush to this district occasioned by the Smith discoveries on Rock creek. Practically no work has been done on these claims, and no further data concerning them were obtainable.

INTERMOUNTAIN CLAIMS (silver-gold) GREENHORN DISTRICT GRANT COUNTY

These claims are located in the northeast corner of T. 10 S., R. 35 E., and about ½ mile north from the Bimetallic claim, elsewhere described, and practically on its extension with the same strike of vein. It is in diorite and greenstone. The ore consists of quartz with tetrahedrite rich in silver, and the pay streak is reported to be as much as three feet wide. This property has shipped ore from time to time. The work is usually performed by leasers. Owing to a combination of circumstances this property was not visited.

IRON DYKE COPPER COMPANY (copper) (Pennsylvania corporation) HOMESTEAD DISTRICT BAKER COUNTY

Local name, Iron Dyke mine.

Office: Erie, Penn. F. F. Curtze, Pres.; F. A. Brevelier, Sec.; A. A.

Claus, Treas., all of Erie, Penn.; A. G. Miles, Homestead, Oregon, attorney-in-fact. Capital stock, $500,000; par value $1.00; $380,000 subscribed, issued and paid up. (1915 report).

Erie Trust Company holds title by trust deed and bond. Worked by Homestead-Iron Dyke Mines Company.

This copper deposit, discovered in 1897, is situated about 2000 feet from the railroad at Homestead. The lower tunnel is about 300 feet above the town. The main croppings are about 375 feet above the lower tunnel and 70 feet below the croppings is the upper tunnel. Down 50 feet farther is an intermediate crosscut, and midway between the latter and the lower tunnel is a fourth crosscut.

The lower tunnel is in some 1300 feet, cutting the ore body about 800 feet in and, passing through it, continues on without discoveries. A zigzag raise connects this tunnel with the three tunnels above. Unfortunately this raise was started a hundred feet beyond the ore in the lower tunnel, and much other development could have been placed to better advantage. The opportunity here to block out the ore and to determine its limits were excellent.

The series of trachytic or perhaps rhyolitic flows here have been so badly altered and silicified that they are now a chloritic indefinite greenstone. Intercallated with the flows is a body of dark brown altered andesite, which may have been an intruded sill.

The greenstone in the hand specimen is in color light green and quite dense. Under the microscope thin sections vary from very fine grained to considerably coarser, but contain very poorly formed silicified feldspars in a ground mass of abundant sericite with some chlorite and a few crystals of secondary quartz. Minute faulted quartz veinlets are revealed throughout this altered greenstone. No thin sections were made of the meta-andesite to determine exactly its present character.

Although the character of some of these flows, due to a variation in their composition and structure, might be much more favorable to concentration than other flows, nevertheless the factor of most importance here is the opportunity for ore concentration through fault planes and shear-zones.

A considerable amount of shearing and faulting has taken place in this immediate vicinity. Several pronounced slips were noted, all having a strike of N. 20° E., and dipping at rather high angles eastward. For a considerable width a shear zone, many feet wide, has the same general direction. The best ore in the lower tunnel is massive chalcopyrite and pyrite, with but little quartz, as a gangue in a lens-shaped body dipping 60° E., with a maximum width of about 6 feet, which is said to extend from the lower to the upper tunnel.

On the west side of the lens in a short crosscut from the lower level the ore seems to be cut off rather sharply by a fault. On either side of this high grade ore, which is said to average 15 to 20 per cent copper, is a much larger body of disseminated pyrite and chalcopyrite in the chloritic greenstone, in which are abundant quartz seams, veinlets and nodules that contain pyrite. There is often a silicification of the rock itself. Statements are made that it contains about $2 in gold, and 6 to 30 ounces in silver, regardless of the per cent of copper present. This deposit, both high and low grade, is in a zone of crushing in which copper-bearing solutions have deposited their contents largely by replacement.

This series of rocks has suffered severely and has become badly altered. This, of course, creates the best conditions for the concentration of metallic minerals whenever opportunity offers, whether it be in great or small fractures, shear zones, or in amygdules. In this particular property a study of thin sections has shown the formation of minute veins which were afterward broken. The field evidence clearly shows the faulting and shearing that have taken place. All of these conditions are favorable to the deposition of copper minerals that have been dissolved from the greenstone series, which practically always contain some copper.

However, as noted before, the presence of such an amount of highly silicified rock and the fact that the gold and silver values are considerable and independent of the copper content, seems to indicate an impregnation of this shear zone from sources connected with the granodiorite. The gold and silver and possibly some of the copper impregnated the shear zone, which at a later time, having been resheared, has permitted a reconcentration of copper from the shear zone along principal planes, assisted by a deposition of copper brought in from the greenstone walls, from which it had been dissolved by circulating waters of moderate depth and temperature.

In 1915 a lease and bond was executed in favor of the Homestead-Iron Dyke Mines Company to Halstead Lindsley, of 60 Broadway, New York, general manager, who placed Emmett Galligan in charge of the property as manager. About August 28, 1915, work was begun at this property, which had had a watchman only for a few years. Shipment to custom smelters of gold and silver-bearing copper ore began almost at once. For the year ending August 28, 1916, 462 50-ton cars of copper ore were shipped, which is said to have averaged more than 6 per cent net copper, besides about $5 in gold and silver per ton. The average shipments of crude ore for the year 1916 have so far been at least 2500 tons monthly.

Commodious and comfortable bunk and boarding houses have been erected, as well as several bungalows for officials and others. A concentrating plant has been erected and started operation about September 25, 1916. This mill has a guaranteed capacity of 125 tons and probably averages at least 150 tons daily. The mill feed, which consists of the ore too low grade to ship crude, goes from the crusher to a ball mill, which reduces it to 60 mesh and concentration is effected by flotation and extraction of 90 per cent. The mine is located about 4½ miles from the Oxbow hydro electric plant and a high line was constructed in 1916 to the mine. Previous to this time the compressor was driven by steam power with coal as fuel. The mine and mill are now operated by electric power. It is said that the shipment of crude ore will be continued, to which the operation of the mill has added a considerable daily tonnage of concentrates.

IRON HILL GROUP (iron) AGNESS DISTRICT CURRY COUNTY

The Iron Hill group includes all the claims on Wake-Up-Riley ridge, about 4 miles southwest of Agness. The deposits exposed are in schist and are so similar in appearance that only 2 were sampled. Each is developed by an open cut, one being about 600 feet south of the other. One deposit is a typical small lens of manganiferous magnetite, which analyzes 28.43 per cent iron, 12.50 per cent manganese, 0.72 per cent phosphorous, and no titanium, arsenic, copper or sulphur. The other was the best-looking deposit examined. An open cut 5 feet wide, 8 feet long and 5 feet deep at the face was entirely in ore, although the manganiferous magnetite is traversed by numerous quartz seams. A sample from this prospect analyzed 22.87 per cent iron, 7.30 per cent manganese and 0.56 per cent phosphorous, and no titanium, arsenic, copper or sulphur.

IRON MASK COPPER COMPANY (copper) SPARTA DISTRICT BAKER COUNTY

Local name, Iron Mask mine.

Office: Baker, Oregon. Mine office: Sparta. F. R. Mellis, Pres.; J. A. Howard, Sec.-Treas. Capital stock, $250,000; par value $1.00; all subscribed, issued and paid up. (1914 report).

All ground, consisting of 22 claims near Sparta butte and extending to

Sawmill gulch, is now in farms. No report last year. No assets. Dissolved by proclamation in January, 1917.

ISIS OIL AND GAS COMPANY

Office: 495 E. 35th St., Portland, Oregon. R. E. Morrell, Pres.; John B. Hibbard, Sec.; O. Rudig, Treas., all of Portland, Oregon. Capital stock, $500,000; par value $1.00; $250,000 capital stock subscribed, $137,634 issued and paid up.

JACKLEY CLAIMS (gold) CORNUCOPIA DISTRICT BAKER COUNTY

The "Jackley" vein is about 1/4 mile west of the Wild Irishman vein, at a little lower elevation. It is about 1 3/4 miles west of the Union-Companion mill. It is a vein of fair width and considerable work is being done upon it by the owner. Fair values are encountered in the drift at times, although the main objective has not yet been reached. The surface beyond shows some displacement of the vein by basalt dikes, which may prove troublesome. Fragments of greenstone in dimensions from a few inches to a few feet are found here in the granodiorite. The granodiorite is more basic, probably due to its melting and assimilation of greenstone. Some of the unmelted fragments actually show recrystallization decreasing toward their interiors. This place is probably near the roof of the intrusion, only a downward projection of the greenstone roof remaining, the rest having been eroded away.

Drifting upon this vein has been continued in 1915 and 1916, with an improvement in the size of the vein and contained values.

JACKSONVILLE MINING AND MILLING COMPANY (placer) JACKSONVILLE DISTRICT JACKSON COUNTY

Office: Jacksonville, Oregon. Mary E. Day, Pres.; Kate Hoffman, Sec.-Treas., both of Jacksonville, Oregon. Capital stock, $10,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company owns 40 acres of placer ground in the S. W. 1/4 Sec. 25, T. 37 S., R. 3 W., 4 miles west of Jacksonville.

JACKSONVILLE PLACER JACKSONVILLE DICTRICT JACKSON COUNTY

The chief placer deposit is along Jackson creek, where one of the early discoveries of gold in Oregon was made in the fall of 1851, and the Jacksonville district, including both forks of the creek and its tributaries, was organized the following year. Both forks were worked as placer from the town up stream for a mile or more; some gravel was worked within the town limits. The bedrock of the placer on the south fork is a rock consisting of very fine quartz, pale brown mica and a black dust resembling magnetite.

JANUARY FIRST MINE (gold) WALDO DISTRICT JOSEPHINE COUNTY

The January First mine, about 3 miles east of Holland, is owned by Harry Siskron, who has operated it successfully on a small scale for several years. It is on the southwest side of Sucker creek, at an elevation of about 2400 feet, a little more than a mile from the "mountain ranch," and about the same distance from California bar. The mine is opened by a crosscut adit extending N. 75° W. about 110 feet to a quartz vein about 18 inches thick, which strikes north and dips 45° W. A drift runs north 30 feet and south 100 feet; at the south breast a 3-inch vein of quartz strikes east and dips 60° N.; here the main vein is nearly pinched out and contains no ore of value. From the drift stoping has been carried up to the surface. The ore is packed on burros to an arrastre on Sucker creek; the tailings are saved and concentrated on a canvas table. A small mill was recently installed on this property.

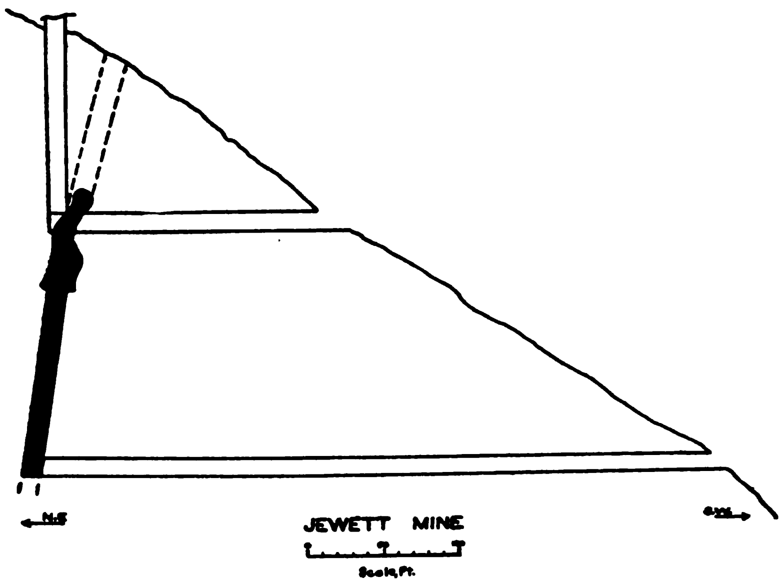
JEWELL & LEWIS (placer) GALICE DISTRICT JOSEPHINE COUNTY

The Jewell & Lewis placer, now known as the Rock Gulch placer, is owned by H. L. Lewis, of Galice, and associates. It is located on Rogue river, about

1 mile below the mouth of Rocky gulch. It was worked by hydraulic methods with water from Rocky gulch, but was inactive in 1913. The gravel forms a bar in the river and also rises to a bench about 15 feet above water level. The gravel has been raised by a steam shovel and then washed by a giant through a revolving screen to remove the coarse material, after which the fine sand passes into the sluice boxes.

JEWETT MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Jewett mine is near the north line of Sec. 34, T. 36 S., R. 5 W., about 4 miles by wagon road from Grants Pass. It was discovered about 1860 by Thomas Jewett, and was recently sold to Claus Schmidt, of Grants Pass. In



Section through the Jewett mine; ore body in solid black

1863 it was provided with an 8-stamp mill, which proved a failure, and was converted into a sawmill. At present it is equipped with a 5-stamp mill, but is not in operation. The accompanying sketch gives a section through the mine and affords an idea of the ore body and the workings.

The country rock is often called greenstone, but much of it is fine grained tonalite, containing abundant plagioclase, quartz and pale green hornblende. Coarse grained tonalite forms a large outcrop on the north side of Baldy mountain, on the south side of which the Jewett mine is situated, and a dike of the same rock is visible at the portal to the main adit. The ore body in general has no definite walls, but occupies a sheared and brecciated zone, which is irregular in thickness and direction. The general direction of the ore body is N. 20 to 55° W., with an average dip of about 75° N. E. The ore has been produced partly by replacement and partly by deposition as a cement of the breccia. The gangue minerals are chiefly quartz and calcite (with the former dominant), with some chlorite and pale brown mica. The ore minerals include native gold, pyrite, sylvanite and pyrrhotite. Considerable ore was mined and milled. In portions of the mine the ore body is more than 8 feet wide. For some years past the mine has not been in operation.

JIM BLAINE MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Jim Blaine mine is located in the N. W. ¼ Sec. 4, T. 34 S., R. 5 W., about half a mile south of the Greenback mine and half a mile northeast of the town of Placer. It is equipped with small stamp mill and concentrator operated by water power, which has proved to be not very efficient in saving the values. It is owned by George Epperly, of Placer, who proposes to ship some of the ore to Tacoma and abandon the mill.

JIM FISK MINE (gold) CORNUCOPIA DISTRICT BAKER COUNTY

The Jim Fisk vein is located but a few hundred feet west of the Mayflower vein and about ¾ mile west from the Union-Companion mill. Where observed there was a very large mass of quartz 20 to 30 feet wide. To both the north and the south this soon narrows down to ordinary widths. No shoot of ore has been encountered. The country rock is granodiorite.

Development was continued in a small way in 1915 and 1916, but the results have not been announced.

JOHNSTON MINE (placer) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Johnston mine, 3 miles northeast from Applegate, in Sec. 11, T. 38 S., R. 4 W., at the junction of the west branch with the main Humbug creek, is owned by W. H. Johnston. The bank averages about 8 feet in thickness and contains considerable clay, in which the main values are found. Boulders of greenstone and granodiorite from 6 inches to more than 8 feet in diameter are present. The bedrock consists of fine grained greenstone, much fractured and veined. The mine is equipped for hydraulicking, the water being brought from Humbug creek. Usually worked only 3 or 4 months of the year with water available.

KALAMAZOO OCEAN BEACH MINE (placer) CURRY COUNTY

Diller states that the time he made his last investigation in this region this mine was reported to be the most productive in Curry county. He says that it is located in the Ophir district near Corwin, which is in Sec. 20, T. 34 S., R. 14 W. This "Ophir district" refers to the territory near Ophir, a town, and not Ophir mining district, near Ophir mountain, in the eastern part of Curry county.

KELLY MINE (gold and silver) ROCK CREEK DISTRICT BAKER COUNTY

This property, owned by D. M. Kelly, of Baker, Oregon, is located on the north side of the West fork of Rock creek, in Sec. 15 or 16, T. 8 S., R. 37 E., at an elevation of about 8000 feet. The vein, which is of the usual Cracker creek type, is in argillite, but the granodiorite contact is only about ¼ mile to the north. The strike of the vein varies between N. 60° E. and N. 85° E. The dip is about 70° N. The ore minerals are zinc blende, pyrite, galena and a copper mineral which may be tetrahedrite. The development work consists of 4 tunnels with a depth from the top of the ridge of about 600 feet for the lowest one. The lower tunnel is about 600 feet long and the others above are about 300 feet each. Most of the development is drifting and exposes ore, which varies from a foot or two up to 10 feet or more wide. The average value of the ore is claimed to be at least $10.

KELSO GOLD MINING AND MILLING COMPANY BOHEMIA DIST. LANE COUNTY

Office: Kelso, Washington. W. P. Ely, Kelso, Washington, Pres.; M. E. Hubbard, Sec.-Treas. Capital stock, $70,000; par value $1.00; all subscribed, issued and paid up. (1913 report). Dissolved by proclamation in January, 1917.

KENT MINE (gold) BAKER DISTRICT BAKER COUNTY

The Kent mine, also called the Stub mine, in the upper part of Washington gulch, has the most development work of any in this area. It is located in Sec. 20, T. 9 S., R. 39 E., and has a small, poorly designed mill, located about 1¼ miles away from the mine.

The country rock is made up of argillite, greenstone and chert. The vein has a N.-N. E. strike and a nearly vertical dip, and widths up to at least 15 feet, made up of quartz and shattered mineralized argillite. While there are places in the vein that are high grade, the average for a large tonnage is low.

The development consists of a tunnel, several hundred feet long, a short winze and some raises.

KERBY QUEEN (or SOWELL) MINE (copper) WALDO DIST. JOSEPHINE COUNTY

This property is now (1916) under option to John Hampshire, of Grants Pass, and Twohy Brothers, of Portland, who are doing some development work with a view to opening up other bodies of copper ores. It is located in the S. E. ¼ of Sec. 17, T. 40 S., R. 7 W. The workings consist of 2 adits; the upper is about 240 feet in length and is mostly in weathered rock. The ore is a mixture of the sulphide and oxide minerals. Ore on the dump shows pyrite and a small amount of marcasite, associated with the chalcopyrite, and pyrrhotite. The ore is said to run $6 in gold in carload lots.

The lower adit is about 700 feet long (August, 1913) and in serpentine all the way. Ore is expected when the limit of the serpentine is reached, estimated to be 60 or 70 feet further.

Twelve or thirteen years ago a 10-ton smelter was installed in connection with this property and operated for 26 days, producing 32 tons of matte carrying copper and gold, to the value of $2000.

On the west end of this property an important deposit of chrome iron ore has been developed by D. W. Collard and son. More than a thousand tons of chrome were mined and shipped during the summer of 1916. For more details, see description of the Golconda mine.

KESSLER AND FRYS' PROPERTY (copper) COLLIER CREEK DIST. CURRY CO.

This prospect, which is owned by William Kessler and John, Walter and Marshall Fry, is on the ridge between North Collier and Lawson creeks, about 10 miles by trail south of Agness, at an elevation, as determined by barometer, of 4200 feet. The country rock here is serpentine, but a dike of quartzite-like dacite-porphyry about 100 feet thick occurs a short distance to the east. Beyond this are a few hundred feet of greenstone, then several hundred feet of Colebrooke schist, followed by a succession of serpentine and peridotite masses down almost to the Illinois river. How far to the west of the claim the serpentine runs is unknown, but it undoubtedly eventually gives place to Colebrooke schist in that direction.

A 50-foot tunnel, which bears S. 34° W., has been run into the serpentine not far from the dacite-porphyry contact. No ore is exposed in this tunnel, and it was doubtless driven with the intention of cutting a mineralized zone nearby. Some copper-stained material occurs in a wash near the tunnel, and big chunks of good ore are said to have been picked up on the flats below, but their exact source is unknown.

KEYSTONE GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Keystone group, belonging to the Akron Gold Mining and Milling Company (dissolved Jan. 11, 1916), is on the south slope of Rogue river nearly opposite the mouth of Whiskey creek. It was not visited by the writer. According to Diller:

> There are two openings far above the river. One of them, 115 feet in length, cuts the ledge at a depth of 100 feet; the other, 160 feet lower, is only partly completed. The country rock is greenstone near its contact with intruded serpentine. The gold occurs in irregular quartz veins or stringers, forming a belt about 3 feet in thickness and approximately parallel to the serpentine contact. The ore appears to be pyrite in fine particles sparsely disseminated through the quartz.

KEYSTONE MINING AND MILLING COMPANY (gold)
QUARTZBURG DISTRICT GRANT COUNTY

Local name, Keystone mine.

Office: 1215 Wilcox Bldg., Portland, Oregon. J. Frank Watson, Pres.; Wm. M. Ladd, Sec.-Treas., both of Portland, Oregon. Capital stock, $50,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company's property is located in Sec. 2, T. 12 S., R. 33 E., about 7 miles northeast of Prairie City, Oregon, on Dixie creek, and about ½ mile above the Present Need mine, the property of the Comer Mines Company. The Keystone vein, with the exception of having much calcite in it, is similar in strike, dip, width, values and mineral content as the Present Need mine. The developed ore is practically exhausted to creek level and there has been little activity at the mine in the last few years.

KNAPPA COAL COMPANY CLATSOP COUNTY

Office: Astoria, Oregon. B. VanDusen, Astoria, Ore., Pres.; J. N. Griffin, 322 Corbett Bldg., Portland, Ore., Sec.; H. G. VanDusen, Astoria, Ore., Treas. Capital stock, $100,000; par value 10 cents; $87,500 subscribed and issued; $62,450 paid up. (1916 report).

This company has 750 acres of land in Secs. 8, 9, 10, 11 and 12, T. 8 N., R. 7 W., in Clatsop county.

KOEHLER ANTIMONY MINE (antimony and gold) VIRTUE DIST. BAKER COUNTY

This property is 4½ miles east of Baker, situated on the opposite and western side of the ridge upon which the Virtue mine is located, and about 3 miles northwest from the latter. It became a producer of high grade antimony ore late in 1915, due to the high price of antimony caused by the European war. The vein is a well-defined one with a maximum width of about 10 feet of vein material containing both gold and stibnite. The stibnite is found scattered throughout the entire width of the vein, but the massive antimony ore is confined to a thickness of about two feet near the hanging wall where locally the lenses are shipped entire. In other places it is cobbed to bring it up to shipping grade. Several car loads containing over 50 per cent antimony were shipped, which were reported to have returned to Dr. A. Koehler, the owner, about $15,000. Much more ore could have been shipped if the owner had hastened the blocking out and stoping of ore while high prices prevailed.

KRAMER GROUP GALICE DISTRICT JOSEPHINE COUNTY

See "Elwilda or Kramer" group.

KRAUSE (J. L.) CLAIMS (gold and copper) NEW ELDORADO DIST. GRANT CO.

This group is located on a shear zone which is mineralized in places. Pyrite is the chief ore mineral. Pyrrhotite and some chalcopyrite are also present. This zone strikes about N. 60° E. and appears to be somewhat similar to those on the southern slope of the Wallowa range, of which the Poorman is a type, although the shearing and percentage of copper is much less. How much gold and silver is present was not learned.

LA BELLEVIEW MINE (gold-silver) GRANITE DISTRICT GRANT COUNTY

This mine is located within the area of highly metamorphosed argillite that lies along the prominent north spur from Bald mountain, in Sec. 8, T. 8 S., R. 36 E., at an elevation of about 7000 feet and about 12 miles north from Granite and 26 miles from Sumpter, the nearest railroad station. It is owned by David Keith and J. T. Bamberger, of Salt Lake, Utah.

The mine workings extend from the top of the ridge southwest, into the ravine forming the north fork of Onion creek. Little work has been done since 1907, and the workings on the vein are now inaccessible. This description is based upon an examination of the surface and notes left by the owner, F. E. Cabell, after his death in 1912. Mrs. Cabell permitted the examination of a collection of specimens taken during the operation of the mine.

Quartz biotite schist, in which persistent laminae of biotite separate quartzose bands one-quarter to an inch wide, forms the walls of the vein. The vein trends N. 50° E. and dips northwest. Two types of ore are recognized. The commonest shows rudely alternating quartzose zones, rich and poor in sulphide minerals, with here and there a lenticular vug. In the richer zones the sulphide minerals, pyrite, arsenopyrite, blende and galena are coarsely crystalline and though dominantly intermixed, are locally in bands. Chalcopyrite and pyrrhotite are sparingly present. In the poorest zones the pyrite is dense and the other sulphides are only sporadically present. The second type of ore shows angular nuclei which may be recognized as mica-schist fragments, more or less replaced by quartz and pyrite, inclosed in masses of quartz crystals, radially arranged. The richer ore shows argentiferous tetrahedrite, probably in primary intergrowth with pyrite and quartz pyrargyrite, possibly proustite, and native silver occur as films along fractures.

According to Mr. Cabell's data, 3 tunnels contain an aggregate of 6000 feet of work on the vein, over a vertical range of about 600 feet. The vein was opened for a distance of 1800 feet in addition to 600 feet explored in the Wide West claim, which adjoins the La Belleview on the southwest. Within this distance 2 shoots were found, the larger of which attained a stope length of 280 feet. The lower portion of this shoot yielded material containing 0.40 ounce gold and 15 ounces silver to the ton.

The total production up to 1911 including ore shipped elsewhere or milled in the mill on Onion creek, amounted to 8000 tons, having a gross value of $200,000. Concentrates averaged 1.20 ounces gold and 55 ounces silver to the ton, and shipping ore was worth $60 to $300 to the ton.

LADD METALS COMPANY **IDAHO**

Office: 302 Concord Bldg., Portland, Oregon. Chas. E. Ladd, Portland, Pres.-Treas.; A. E. Davis, Portland, Sec. Capital stock, $500,000; par value $100; $262,000 subscribed, issued and paid up. (1916 report).

This company's properties are located near Mineral and Landore, Idaho. This corporation is in process of liquidation.

LA GORE GROUP (copper, gold, silver, molybdenite) WALLOWA DIST. WALLOWA CO.

This group is reached by 5 miles of wagon road up Hurricane creek from Joseph, the railroad terminus, and about 2 miles of a zigzag trail up Fall creek, 2500 feet above Hurricane creek. Here the elevated hanging valley has steep walls of badly contorted and faulted schists and marbleized limestones along the irregular granitic border of the intrusion.

The deposit is 4 to 8 feet wide, has a general north-south strike and dips 60° toward the west. Considerable faulting is apparent, but the outcrops of rock in place are so nearly continuous that little difficulty should be experienced in locating these fault blocks. The principal contact-metamorphic minerals are garnet, epidote, quartz, calcite, chalcopyrite, pyrrhotite, and in the most northern claim, molybdenite.

Several cuts and 2 short tunnels constitute the development. The best appearing surface cut has chalcopyrite and pyrrhotite abundantly disseminated in what is probably an altered granodiorite. Here the vein is about 4 feet wide and is said to contain about $9 in gold, $2 in silver and $10 in copper.

LAMB MINE **ASHLAND DISTRICT** **JACKSON COUNTY**

For description see "Bula Mine."

LAMPA COAL MINING COMPANY **COOS COUNTY**

Office: Bandon, Oregon. J. J. O'Neil, Eugene, Pres.; E. B. Caranaugh, Edgewood, Cal., Sec.; T. Jones, Hornbrook, Cal., Treas. Capital stock, $50,-000; par value $1.00; $40,600 subscribed and issued. (1916 report).

This company owns the Lampa coal mine in Coos county, but there is no activity at the mine at present.

LANCE MINE (placer) **GOLD HILL DISTRICT** **JACKSON COUNTY**

The Lance mine, 15 miles southwest of Gold Hill, is on the right fork of Foots creek, in the S. E. ¼ Sec. 22, T. 37 S., R. 4 W. It is owned by the Lance brothers, but is leased at present. The bank has in places a thickness of 20 feet; much of the material is fine. The bedrock consists of lenses of limestone in slates, which are cut by dikes of greenstone. The bed of the stream has been mined for about one-third of a mile, and there is still considerable good ground to be mined.

LANE COUNTY MINING COMPANY **BLUE RIVER DISTRICT** **LANE COUNTY**

Office: Eugene, Oregon. George F. Dorris, Springfield, Pres.; B. F. Dorris, Eugene, Sec.-Treas. Capital stock, $100,000; par value $5.00; all subscribed, issued and paid up. (1915 report).

Company owns 3 patented claims on vein which strikes northwest and southeast.

LAST CHANCE MINE (gold) **CABLE COVE DISTRICT** **GRANT COUNTY**

The Last Chance mine is located in Sec. 14, T. 8 S., R. 36 E., upon a probable northeastern extension of the veins of the Imperial mines. There are several veins on the Last Chance ground, but the one to which attention was directed in 1914 is on the Last Chance claim. The vein is developed for 400 to 500 feet by a drift upon it.

The mineralization in this narrow vein is similar to others in this district. The maximum width of the ore is probably not more than 18 inches, and the greatest stope length of the shoots does not exceed 50 feet. The ore so far opened up, taking into consideration its width and nature, is not sufficiently high grade to pay operating expenses.

LAST CHANCE MINE (gold) **GOLD HILL DISTRICT** **JACKSON COUNTY**

The Last Chance mine, 3 miles south of Gold Hill, on Galls creek, is in the N. E. ¼ Sec. 33, T. 36 S., R. 3 W. Over the divide from the Braden on the slope of Galls creek, at an elevation of 1800 feet by barometer. It is opened by an adit extending about 250 feet nearly due east, which discloses an irregular quartz vein 6 to 30 inches thick. Near the breast the vein strikes N. 74° W. and dips about 15° N. E. The country rock is a fine grained andesite containing some secondary chlorite and calcite. A 2-stamp mill has just been installed, which is equipped with the Perkeypile device to revolve the stamps; it has a 4 by 8-foot plate and electric power.

LAYTON MINE (placer) **UPPER APPLEGATE DISTRICT** **JACKSON COUNTY**

The Layton mine is part of the estate of J. F. Layton, and is under lease and bond by Austin Wilson, of Boston, Mass. It is located 2 miles west of Applegate, in Sec. 20, T. 38 S., R. 4 W. The average thickness of the gravels is about 25 feet and the width is more than 200 feet. The best values are found in an old channel about 15 feet below the level of the present stream bed. The bedrock is greenstone, which in places is distinctly vesicular and greatly fractured and veined. Mr. Layton put in 2 ditches, the upper of which is 21 miles long and the lower 18 miles. Three giants are used under a head of about 300 feet. A considerable area of good ground remains to be washed.

According to a late report, Mr. Wilson is installing considerable additional equipment in order to effect a better saving of values and increase the amount of material handled. This equipment includes 2 Pierce amalgamators and a large winch to use on a derrick to handle the stumps and large boulders. He proposes further to install an electric power plant for both light and power. The mine has been a good payer for years and it is expected that the improvements will be the means of materially increasing its production.

LEMON'S (IRA) PROSPECT (gold) NEW ELDORADO DISTRICT GRANT COUNTY

Between the Heppner mine and Granite Boulder creek are Ira Lemon's claims in granodiorite and greenstone, both considerably altered. A 4-foot lenticular vein strikes N. 20 to 30° E. The ore minerals are pyrite, arsenopyrite and chalcopyrite. The gold content was not learned.

LEWIS & CLARK MINING AND MILLING COMPANY (gold-silver) NORTH SANTIAM DISTRICT MARION COUNTY

Office: Silverton, Oregon. Dr. F. M. Brooks, Oregonian Bldg., Portland, Pres.; Thos. Skaife, Sec., and M. Palmer, Treas., both of Silverton. Capital stock, $100,000; par value 10 cents; $71,000 subscribed, issued and paid up. (1916 report).

Property of 5 claims is situated near the Little North fork of the Santiam, in Sec. 27, T. 8 S., R. 5 E., and about 18 miles northeast of Gates, a station on the Detroit branch of Southern Pacific railway. Reached by good wagon road for the first 13 miles, and the last 5 miles by a good trail from Gates.

The development work amounts to some several hundred feet of tunnel work on 2 levels on the property, exposing veins from 1 to 5 feet wide, which are mineralized shear zones in andesite. The ore contains gold and silver in zinc, copper and iron sulphides. The property has several cabins and a water power plant. A small amount of development work is done each year.

LEWIS PLACER GALICE DISTRICT JOSEPHINE COUNTY

See "Jewell & Lewis" placer.

LIBBY MINE (coal) COOS BAY DISTRICT COOS COUNTY

This mine is 3 miles southwest of Marshfield. The coal bed outcrops on the slope of the hill and is opened and developed by a tunnel. The thickness of the coal beds is between 5 and 6 feet with 2 shale partings—the upper one 9 inches thick and 6 inches from the roof, the lower about 8 inches thick and about 2½ feet from the bottom, leaving 2 coal beds more than 2½ feet thick. The upper 6-inch seam is usually left in the roof.

The coal is of the sub-bituminous variety, the analysis of which is as follows:

	Total Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Air Drying loss	Heat Value B.T.U.
Libby mine, 3 mi. S. W. of Marshfield......	24.90	39.80	27.27	8.03	.75	9.7	8490
Moisture free		53.00	36.31	10.69	1.00		11306
Moisture and ash free.		59.33	40.67		1.12		12659

The mine is working about 13 men at present, and is leased by the Coos Bay Fuel Company, under the management of George Doll.

LIDDY GROUP (gold-silver) CONNOR CREEK DISTRICT BAKER COUNTY

Between 1 and 2 miles south of the Snake River Mining Company's property and about 1 mile north of the Connor Creek mine, in Sec. 34, T. 11 S., R. 41 E., at an elevation of about 3500 feet, is a group of claims owned by J. J. Liddy. The vein in places is several feet wide. It has been subjected to a great deal of movement, which has produced much sugary quartz. On account of this movement and faulting, there is much difficulty in following the vein. The gold values were not learned, but small bunches of tetrahedrite were observed in the vein.

LIKEN'S PROSPECT (gold) GOLD HILL DISTRICT JACKSON COUNTY

Liken's prospect is near the S. W. ¼ Sec. 26, T. 36 S., R. 4 W., about 2 miles south of Woodville, at an elevation of 1850 feet by barometer. A crosscut entry extends southeast about 100 feet and thence a drift follows the vein about 40 feet. In the breast the vein is vertical and contains only 2 to 6 inches of quartz. The dump shows fragments of white vein quartz frozen to the country rock and containing a little pyrite and a metallic mineral which may be a telluride. The country rock is a "greenstone" similar to that at the Harth and Ryan mine.

LILLY M. MINING AND DEVELOPMENT COMPANY ALASKA

Office: Eugene, Oregon. Edgar Grim, Nome, Alaska, Pres.; W. H. Kay, Eugene, Sec.; L. M. Bounds, Eugene, Treas. Capital stock, $20,000; par value $100; all subscribed, issued and paid up. (1913 report). Dissolved by proclamation in January, 1917.

This company's properties are located on Seward Peninsula, Alaska.

LINCOLN MINES COMPANY (lead, gold and silver) QUARTZVILLE DIST. LINN CO.

Local name, Albany mine.

Office: Albany, Oregon. A. M. Hammer, Pres.; J. Deo McClain, Sec.; J. McChesney, Treas., all of Albany. Capital stock, $250,000; par value $25; all subscribed, issued and paid up. (1916 report).

This company has 8 claims in Sec. 23, T. 11 S., R. 4 E., about 23 miles from Gates. The country rock is andesite and the veins are only free milling near the surface.

Lead and zinc sulphides are found but a few feet below the surface. The veins are reported to be shear zones as much as 50 feet wide and to have lenses of heavy sulphides on foot or hanging walls and sulphides distributed through the zone. The values in gold are reported to be of fair grade.

The mine was equipped in 1892 with a 10-stamp mill, amalgamating plates, 4 Frue vanners, sawmill, etc., and produced a few thousand dollars from the plates and about 80 tons of concentrates were accumulated. The Albany Mining and Milling Company, then owning the property, became involved in the panic of 1893 on account of money borrowed and the property eventually passed to the Lincoln Mines Company. The mill is now in ruins.

About $1500 worth of development work has been done on the property during the past summer.

LINDGREEN CLAIMS CORNUCOPIA DISTRICT BAKER COUNTY

See "Steen and Lindgreen" claims.

LISTEN LAKE GOLD MINING COMPANY (gold and copper) GREENHORN DISTRICT BAKER COUNTY

Local name, Listen Lake mine.

Office: Baker, Oregon. F. W. Thomas, Pres.; Fargo, N. D.; C. I. Flynn, Sec., Baker, Ore. Capital stock, $500,000; par value $10; all subscribed, issued and paid up. (1916 report).

This property consists of the Iron Dyke, Copper Dyke, Copper Butte, Copper Sentinel quartz claims and McNamee placers at the head of McNamee gulch, about 4 miles south of Greenhorn and 6 miles north by wagon road from Austin, a station on the Sumpter Valley railroad (narrow gauge). Elevation about 5000 feet. Located in the southeast central part of T. 10 S., R. 35 E.

There is a shaft 120 feet deep. The mine lies within an area of altered gabbro (greenstone), which intrudes the argillite series, and the veins bear some resemblance to the "chloritic subtype" of Lindgren, noted in the Iron Dyke (Homestead) deposit. At the Listen Lake mine a silicified shear zone in the gabbro, reported to attain a width of 50 feet, has been crushed and small amounts of pyrite and chalcopyrite have been introduced along fractures. The material on the dump contains a few per cent of copper and is said to contain a fraction of an ounce of gold to the ton. Water stands within 10 feet of the surface in the shafts and the zone of oxidation is shallow.

LITTLE GEM MINE WALDO DISTRICT JOSEPHINE COUNTY

The Little Gem mine, owned by D. K. Sutherland, is in the S. W. ¼ of Sec. 36, T. 39 S., R. 7 W., about 3 miles east of Holland, on the west side of Sucker creek, at elevations ranging from 2300 to 2900 feet, as measured by barometer. It is opened by several adits having a total length of more than 800 feet. The lower adits are shorter and do not disclose a vein in the greenstone country rock. The upper adits reach a quartz vein, which strikes N. 65° E. and dips about 85° S. E., which seems to finger out downward. The uppermost and longest adit was being reopened and extended in 1913. The country rock here is andesite containing abundant pale green hornblende, lath-shaped oligoclase, some nearly colorless epidote, dirty gray siderite, and greenish chlorite.

LITTLE HILL PROPERTY (gold) WEATHERBY DISTRICT BAKER COUNTY

This property consists of 3 claims owned by Fish and Bowen, of Baker, and McGillery, of Weatherby. It is located about 4 miles northeast of Weatherby in about Sec. 9, T. 12 S., R. 44 E. There is a fairly good wagon road from the property to the railroad at Weatherby. The country is hilly and for the most part barren, although timber is at no great distance to the northeast.

Country rock is granodiorite, which is weathered on the surface, fresh pieces being hard to obtain. The overlying Tertiary lavas are also in evidence in this vicinity, as well as their dike feeders. The quartz vein is of the distinct fissure type, strikes S. E.-N. W. with a nearly vertical dip, and varies in width from 2 inches to 2 feet. The values are said to be well distributed, although in places there are richer streaks of high grade ore. The average value is said to be $130 per ton in free gold.

The development work consists of several tunnels, some of which are inaccessible. There is one drift on the vein about 50 feet below the surface with a short stope to the surface. The present development work consists of sinking a shaft near the vein close to the portal of this tunnel. At a depth of 50 feet the intention is to crosscut a disance of about 10 feet to the vein. There is a small stamp mill on the property driven by an oil engine.

LITTLE MEADOWS PLACER MINING COMPANY (placer) JOSEPHINE COUNTY

Local name, Tennessee Bar.

Office: 31 North First St., Portland, Oregon. F. E. Myers, Pres,; R. F. Myers, Sec.-Treas. Capital stock, $4800; par value $50; all subscribed, issued and paid up. (1916 report).

This company has 2 claims, the "Tennessee Bar," One and Two, on Rogue river, Josephine county.

LITTLE PITTSBURG MINE (gold) ASHLAND DISTRICT JACKSON COUNTY

The Little Pittsburg mine, reached by wagon road via Ashland mine, about 2½ miles west of Ashland, is about 700 feet east of the Ruth on a parallel vein, which strikes N. 3° E. and dips about 70° E. The country rock is like that at the Ruth, but contains some mica. The vein contains some quartz and calcite. An adit said to be 150 feet long is now caved shut at the portal. The vein is also opened by an incline shaft about 50 feet deep and by a few open cuts. The shaft is at an elevation of about 3000 feet.

LOGAN, SIMMONS AND CAMERON MINE (placer)
WALDO DISTRICT JOSEPHINE COUNTY

The placer mine owned by Messrs. Logan, Simmons and Cameron, commonly known as the Logan placer, is under option to George M. Esterly, of Seattle, Wash. The engineer in charge of the investigations is L. A. Levensaler, of Tacoma, Wash. (See Waldo Corporation.)

The oldest workings on this property are in Carroll slough, extending for more than a mile north from near the southwest corner of Sec. 5, T. 40 S., R. 8 W. Several long ditches carry water from the higher portions of the east and west forks of the Illinois river to the placer ground. The water supply permits mining for about 8 months of the year. The placer gold here, which is generally very fine, is accompanied by some platinum, as well as a little osmium and iridium.

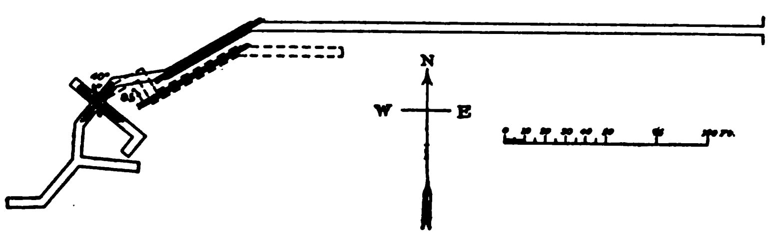
The area mined varies greatly in width, averaging nearly an eighth of a mile. The pit is from 10 to 25 feet in depth and the bedrock is conglomerate and sandstone with some serpentine. Beginning over 25 years ago, mining in this vicinity was carried on for more than 15 years. More recently several acres have been mined on French Flat, where the workings are in the southern part of Sec. 22, T. 40 S., R. 8 W. The material here mined includes a good deal of clay as well as gravel and sand. A hydraulic elevator was used to remove material from the pit, which had a maximum depth of about 15 feet, now largely filled with water. There are only a few boulders visible in the material removed, and most of them are less than 6 inches in diameter. According to Kay, the gravel in Carroll slough averaged about 12½ cents a cubic yard, and the bedrock sediments belong to the Cretaceous period. The bedrock in French Flat is a purplish conglomerate, also Cretaceous, which has been fractured, fissured, and even somewhat veined. There are 3 ditches, the water from one being used in the elevator under a head of 325 feet, that from another being employed in 2 giants, and that from the third being used to clear away the tailings from the end of the sluice at the head of the elevator.

LONG PLACER MINING COMPANY

Articles of incorporation filed in January, 1916, by W. R. Davis, Pres.; W. B. Hart, Vice-Pres., and J. R. Cheathorn, Sec. Capital stock, $250,000.

LONE PINE MINE (gold) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Lone Pine mine, 8 miles east of Applegate, is near the north line of Sec. 15, T. 38 S., R. 3 W., on Forest creek, at an elevation of 2200 to 2600 feet by barometer. It is opened by 3 adits, which are supposed to reach the same ore body. As shown in the illustration, the main entry is a crosscut adit



Lone Pine mine, main adit and one adit above

striking the vein about 250 feet from the portal. The vein strikes S. 60° W. and dips 85° N. W., but it does not seem to be continuous to the southwest, being replaced in that direction by veins of white quartz in slate in various directions. On top of the ridge at an elevation of about 2600 feet shallow workings show a vein striking S. 80° W. and dipping 80° N. in a black argillite. This mine is equipped with a Beers mill having a plate and a jig. It is owned by G. L. Huff, of Gold Hill.

LUCKY BART GROUP (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Lucky Bart group, 7 miles northwest of Gold Hill, includes 11 claims in Secs. 29 and 30, T. 35 S., R. 3 W., at elevations ranging from 2200 to 2900 feet above sea level. The chief claim was discovered about 1890 by Joseph Cox; it is now owned with the others by J. H. Beeman, of Gold Hill. According to the owner, ore has been mined from 5 veins on the group, all of them striking nearly east and west. At one of the adits about a quarter mile west of Sardine creek a vein of quartz 6 to 24 inches thick strikes east and dips about 80° N., thus being roughly parallel with the side hill here, as a "blanket vein." The country rock here is argillite and quartzite. The ore is said to be of high grade in the oxidized part of the vein. According to Kay:

> The veins on the Lucky Bart group have an average width of less than 2 feet; the country rock is metamorphosed sediment, mainly slates and micaceous quartzites. The general strike of these rocks in this vicinity is somewhat east of north; the dip is to the southeast and is usually at fairly high angles. The total amount of ore that has been milled exceeds 14,000 tons, which gave values ranging from $4.80 to $100 a ton of free milling ore. The ore from the Lucky Bart claim carried an average of 3 per cent of sulphides, which ran from 4 to 8 ounces of gold to the ton and a like amount of silver. Nine tons of ore from the deepest workings of this claim were shipped to the Tacoma smelter and gave returns of $130 to the ton. Practically all the ores from the group have been treated at a mill on Sardine creek. At the Yours Truly claim, where work is now being done by J. E. Kirk, the workings consist of an entrance tunnel of 75 feet to the vein, 100 feet of drifting on the vein, and a shaft of 30 feet. The country rock is a mica slate. The vein has an average width of about 1 foot and runs S. 85° W. At the end of the drift there are two veinlets of 8 inches and 4 inches in width and also a small seam. Within the workings there is evidence of considerable faulting; the directions of the fault planes observed were somewhat east of north. Mr. Kirk states that the veins carry more gold adjacent to the fault planes than elsewhere. The ores of the Yours Truly are highly oxidized and carry an average value of more than $30 to the ton.

A small outcrop of "granite" was observed just north of the point where the Lucky Bart vein seems to cross Sardine creek in section 29.

The mine is equipped with a 5-stamp mill on Sardine creek, at an elevation of about 1900 feet above sea level. It has a boiler burning wood, a 2½ H. P. engine, a plate 4 by 11 feet, and a Johnson canvas covered table for concentration.

LUCKY BOY (TINA H.) MINE (gold) MULE CREEK DISTRICT CURRY COUNTY

This property of 2 claims is 2¼ miles from mouth of Mule creek in north-central part of T. 33 S., R. 10 W., on the west side of the west fork of Mule creek, at elevation of 1000 feet. It is owned by Chas. Tucker.

Developed by 2 tunnels (drifts) and raises. The vein varies from a few inches to 3 feet. The strike is N. E.-S. W. and dip 50 to 70° N. W. The ore minerals are free gold and a little chalcopyrite. Production has been about $50,000. Equipped with 2-stamp mill and cyanide plant, operated by water power.

LUCKY DOG MINING COMPANY (placer) JOSEPHINE COUNTY

Local name, Welcome mine.

Office: 506 McKay Bldg., Portland, Oregon. T. J. Bernard, Pres.; Samuel Weldon, Sec., both of Portland, Oregon. Capital stock, $45,000; par value $10; all subscribed, issued and paid up. (1914 report).

Samuel Weldon states:

> The company lost the property because the annual work was not done and the company is not now in existence.

LUCKY FOUR MINING COMPANY IDAHO

Office: Corner E. 73rd and E. Glisan Sts., Portland, Oregon. Chas. Hyle, Pres.; Henry Wingert, Sec.-Treas., both of Portland, Oregon. Capital stock, $50,000; par value 5 cents; $29,285 subscribed, issued and paid up. (1916 report).

This company has 4 lode claims and 1 placer claim in the Summit mining district, Shoshone county, Idaho.

LUCKY JACK MINING COMPANY (gold) ELK CREEK DISTRICT JACKSON COUNTY

Local name, Lucky Jack mine.

Office: Salem, Oregon. W. H. Burghardt, Pres.; Paul M. Sims, Sec.; Salem Bank and Trust Company, Treas., all of Salem. Capital stock, $250,000; par value $5.00; all subscribed, issued and paid up. (1913 report).

This company owns 5 claims 52 miles north of Medford on a branch of Elk creek, 30 miles northeast of Trail, Ore., near the Buzzard mine. This property has several hundred feet of development work.

This corporation is in the hands of the receiver and the property is now idle. Dissolved by proclamation in January, 1917.

LUCKY QUEEN MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Lucky Queen mine, 5 miles east of Hugo, is near the north line of Sec. 31, T. 34 S., R. 5 W., between Jack creek and Shorthorn gulch. It is owned by Rush Bros. A 10-stamp mill was built here in 1886, but it has since been removed. The ore is in quartz veins in argillaceous quartzite. At the face of a crosscut on the lower level the sediments strike N. 40° E. and dip 50° S. E. The auriferous veins strike and dip in about the same directions. On the lower level the main vein is cut off to the northeastward by a fault which strikes N. 70° W. and dips 65° N. E. The vein varies in thickness from about 6 to 30 inches, and the ore is said to average $10 a ton in gold. The mine has been idle for many years, but 2 of the adits are still in good condition.

LUCKY SEVEN MINING COMPANY WALDO DISTRICT JOSEPHINE COUNTY

Office: Grants Pass. Richard Smith, Holland, Oregon, Pres.; Edward H. Richard, Grants Pass, Sec.; Inez Murphy, Grants Pass, Treas. Capital stock, $6000; par value $1000; all subscribed, issued and paid up. (1914 report).

According to information given by the secretary of this company, the prospect was recently abandoned and relocated by 6 individuals. It is located about 10 miles south of Holland near the California line.

A 100-foot crosscut tunnel has been driven during the past year.

LUCKY TOVELL (copper) GREENBACK DISTRICT JACKSON COUNTY

This mine is located in Sec. 28, T. 33 S., R. 4 W., about 16 miles from Leland up Grave creek. This property has only a small amount of development work, which shows small masses of copper sulphide in serpentine somewhat similar in general nature and association with the country rock at the Queen of Bronze in the Waldo district. A small shipment of copper ore was made from this mine in 1915.

LUCKY WARREN PROSPECT (molybdenum)
CHETCO (MOUNT EMILY) DISTRICT CURRY COUNTY

This deposit is owned by Mr. Charles M. Warren, and is situated a short distance south of the crest of Mount Emily. The deposit is similar in nature to that on the Florence claim, but the mineralized streak is narrower, and the interstices between the fragments of hornfels contain molybdenite. A sample across the whole ore body yielded on analysis 3.10 per cent molybdenum.

Another peculiarity of this deposit is the presence of considerable hornblende, which was not seen in the Florence prospect. The mineralized streak is said to yield high gold values when panned, but a sample proved, when assayed, to contain not a trace of gold.

LYTLE MINE (copper) WALDO DISTRICT JOSEPHINE COUNTY

The Lytle mine is located on the east slope of a small spur of Elder peak, in the S. W. ¼ of Sec. 1, T. 41 S., R. 8 W., 2 miles southeast of Takilma. It is controlled by the Tutt estate, Colorado Springs, Colo. At present it is under option to John Hampshire, of Grants Pass, and the Twohy Bros., of Portland. This mine is similar to the Queen of Bronze in the character of its ores, their modes of occurrence and associations, which see for description.

MABLE MINE (copper) WALDO DISTRICT JOSEPHINE COUNTY

The Mable mine, or Copper King, is located on Page creek south of the N. E. corner of Sec. 11, T. 41 S., R. 8 W., 2½ miles southeast of Takilma. It is controlled by the Tutt estate, Colorado Springs, Colo. At present it is under option to John Hampshire, of Grants Pass, and the Twohy Bros., of Portland. This mine is similar to the Queen of Bronze in the character of its ores, their modes of occurrence and associations, which see for description.

MACDOUGALL GROUP (copper) HOMESTEAD DISTRICT BAKER COUNTY, WALLOWA COUNTY

Nineteen of the 40 claims owned by W. B. MacDougall are patented claims. They are located about 5 miles north of Homestead, ½ to a mile from the river and up to 2500 feet above it. The region consists of a greenstone series, which is made up of altered dense porphyritic and amygdaloidal flows with interbedded breccias and tuffs and possibly some intercallated sheets and sills. Considerable shattering has taken place; in fact, the principal mineralization is in brecciation zones. The observed porphyritic and amygdaloidal flows are andesite, while the breccia is made up of the angular fragments of various types of lavas held in a dense groundmass of ferruginous material, in which there has been quite a development of secondary calcite.

The different types under the microscope show that these greenstones have been extensively shattered with the subsequent development of calcite, epidote and quartz in gash veins. Some of these veins contain small amounts of pyrite and chalcopyrite. Occurring in this way, it indicates that these materials are the result of lateral secretion processes.

The principal mineralization is in brecciated steep dipping N.-S. shear zones. Three of these zones were observed and there is said to be four others beyond. Although no surface crosscuts have been made to determine the width, they are said to be from 30 to 200 or more feet wide.

In these shear zones occur various sized stringers of quartz, calcite and chalcopyrite. In some places stringers of chalcocite more than an inch wide are found. These stringers of chalcocite are intimately mixed with a lesser amount of quartz. In some places the country rock on each side of the stringers is impregnated with chalcocite for several inches. At the immediate surface the chalcocite is partially altered to malachite with some azurite, but even there the alteration is quite incomplete and three or four feet below the green and blue colorings of the copper carbonates are nearly absent.

A very important undetermined question is the primary or secondary nature of the chalcocite. If it is primary the same type and degree of mineralization might well be expected to continue far downward in the sheared zones. If it is secondary the chalcocite at shallow depths would cease and much smaller percentages of copper in chalcopyrite mingled with pyrite would be found as the primary ore below the shallow secondary chalcocite.

Some of the chalcocite, as before stated, is intimately mixed with quartz and is apparently a primary mineral. On the other hand, on the surface of one of the upper zones a boulder was broken open, which contained crystals of chalcopyrite, which are being replaced by chalcocite. This boulder has been shattered somewhat and contains chalcopyrite as scattered grains and also associated with quartz and epidote. Some of these grains have been altered to malachite.

In from the portal of the lowest crosscut tunnel 500 feet, but said to be 300 feet away from the first shear zone, is found a rock with a few amygdules filled with calcite and a small amount of chlorite along their borders. This rock is cut by numerous calcite veinlets, some of these containing chlorite and a small amount of chalcopyrite. The calcite in the amygdules is pink, while that in the gash veins is white.

The fracturing came later than the filling of the amygdules, since these veins cut the latter without faulting. In this rock the small amount of chalcopyrite is primary. The chalcopyrite in the boulder mentioned above is primary, but the sooty chalcocite there replacing it is secondary.

When the lower tunnel reaches the shear zones several hundred feet below their outcrops, will it find primary chalcopyrite or primary chalcocite? The evidence would lead one to hope that chalcocite will be found.

The shear zones were probably created at about the same time as the vein forming period elsewhere in eastern Oregon. This was probably after the lateral secretion processes had largely completed their widespread alteration and deposition, as evidenced in the lower 500-foot tunnel. The quartz and chalcocite in these shear zones are apt to be the product of ascending thermal solutions. If this be the case, the chalcocite, in conformity with its appearance and its intimate association with quartz, is probably primary and, therefore, will be the copper mineral to be found at depth within the shear zones.

These claims cover steep to gently rolling hills in which at various points there are many open cuts and pits, numerous short tunnels and three long ones, approximately 200, 300 and 500 feet, respectively. The open cuts have in nearly every case disclosed copper in stringers which have been followed. No open cuts cross the shear zones at points most favorable to expose possible wide disseminations. These could have been made quite cheaply and would have exhibited the width of the shearing, whether the fractures are closely spaced or too widely separated, and whether there might be at some points ore sufficiently rich to ship. After the open crosscuts have been made conclusions could be drawn as to whether the chalcocite is sufficiently disseminated to make low grade ore throughout, or whether there is higher grade but more limited bodies of ore.

If favorable results were secured by the crosscuts, keystone or diamond drilling could be first done at the most favorable points which, if promising, could be followed by systematic arrangement of the drill holes so as to determine the limits of the ore bodies. Should wide zones of low grade primary chalcocite be disclosed, its proximity to the railroad, to water and water power, the favorable climate, and absence of overburden or leached zone requiring stripping, would permit as low grade of ore to be profitably mined as at any of the porphyry coppers now successfully operated.

In 1916 several engineers visited this property to determine whether they should recommend it to their principals for development, but up to late in the year none of them have had the courage to make such recommendations without the nature and value of the deposit having been proven at depth.

In addition to the deposits of copper glance upon this property, there are native copper-bearing outcrops. All of these native copper outcrops are in a certain type of Triassic lavas by the general name greenstone, which in the nature of the rock and in the occurrence of the copper in the rock, are essentially like that of the amygdaloid copper ores of northern Michigan. It is almost impossible to sample the croppings which involve a few acres, so that a statement can be made as to its assay value, but after examining several hundred pieces broken with sledges on the surface, followed by an assay of many representative pieces and sacks of samples, it is thought that it will exceed 1 per cent of copper in value. This outcrop has no underground development.

MADDEN MINE (placer) **SIXES RIVER DISTRICT** **CURRY COUNTY**

See "Blanco Mine."

MAGNOLIA MINE (gold) GRANITE DISTRICT GRANT COUNTY

Comparing the present condition of this mine with the description given by Lindgren in 1900, it appears that the only work since then has been the extension of the lower tunnel about 200 feet. According to reports, the last important work was done in 1904. The tunnels extend northeast along the vein from Lucas gulch, a tributary of Granite creek, about 5 miles north of Granite. A small production is reported.

The vein strikes N. 50° E. and dips 65° southeast, cutting dark siliceous argillite, whose bedding strikes northwest, and dips steeply southwest. Within the explored portion of the vein, 960 feet, there are three stopes, 205, 155 and 25 feet long, respectively. The walls are not continuous between the first two, and as the middle shoot terminates on the southwest against a slip, it is possible that the three shoots are not on the same fissure. Near the face of the tunnel the vein is offset 16 feet to the north along a crushed zone.

Much of the material constituting the vein is soft altered argillite, with a small per cent of pyrite, but there are also lenses of highly silicified argillite breccia. In this material the sulphide minerals, pyrite and arsenopyrite, are confined to the argillite fragments, though marcasite occurs along secondary fractures. The maximum thickness of the longest shoot is 8 feet, but through the greater portion it averages 4 feet.

The ore is reported to be less than $10 per ton, and the saving in previous milling operations has been poor.

The property was reported in 1916 as sold by Boyce and Lachner to the Goddard-Hayes Mines Company, who were expected to begin the development and equipment of the mine some time during the fall.

MAID OF THE MIST MINE (gold) UPPER APPLEGATE DIST. JACKSON COUNTY

The Maid of the Mist mine, reached by wagon road 5 miles south of Applegate, up Thompson creek, is in the south half of Sec. 4, T. 39 S., R. 4 W., on a branch of Thompson creek. The country rock is greenstone, in which there are several auriferous quartz veins, the most important striking east and dipping about 55° S. It is opened by a shaft 200 feet deep and about 500 feet of other workings, now full of water. It has not been in operation for several years. According to Kay:

> The values are irregularly distributed through the quartz, which is fairly free from sulphides. Of the latter, arsenopyrite appears to be more prevalent than pyrite. Calcite is subordinate.

MAMMOTH MINING COMPANY (gold) CRACKER CREEK DIST. BAKER COUNTY

Local name, Mammoth mine.

Office: Board of Trade Bldg., Portland, Oregon. W. W. Wheelock, Pres.; F. J. Newey, Sec., Marquette Bldg., Chicago, Ill. Capital stock, $50,000; par value $100; all subscribed, issued and paid up. (1914 report).

Property consists of Red Fox and Belle of Baker quartz claims, located in Sec. 35, T. 8 S., R. 36 E., at an elevation of 6400 feet, and is reached by wagon road via Cracker creek from Sumpter, a station on the Sumpter Valley railroad (narrow gauge), distance 10 miles.

The Mammoth mine, although upon the McCully fork side of the divide, between that stream and Silver creek, is reached by a branch wagon road from Silver creek. This property, purchased from the Bald Mountain Mining Company by the Mammoth Mining Company a few years ago, was closed down late in 1914, after having been operated by the purchasers largely through a system of leasing since the time of purchase.

The country rock is granodiorite and argillite, but the vein is not a contact vein, since the plane of the vein locally cuts both. There are two shoots of ore upon the property, one upon the Mammoth and the other upon the Belle of Baker claim. Little has been done upon the former for 12 years, the work having been confined largely to the latter since the discovery of rich ore there in 1900. It is here developed by a shaft and four levels. There are two shoots of ore about 50 feet apart, one with a stope length of 150 feet and the other 100 feet. These shoots go down to the 300-foot level, but wedge out above the 400-foot level.

The good ore follows along the foot of a black gouge streak near, but not on the hanging wall of the vein. The hanging and much of the footwall is granodiorite. The vein is from 4 to 30 feet wide. It has been stoped from 2 to 20 feet wide. Assay values range from $2.50 to $10,000 per ton. The large stope averaged $5 to $6 a ton.

The vein material consists of sheared argillite and short silicified lenses, in which much of the argillite has been replaced, alternating with irregularly located streaks of gouge.

The ore minerals, pyrite and arsenopyrite in small percentages make up the concentrates, while rich ore in the vein is usually wire gold associated with roscoelite.

The work in the last 2 or 3 years has been confined to the upper levels, especially in following a narrow streak, in which pockets of high grade ore were occasionally found.

This mine is reported to have been the property of A. Bodelson, who was operating it at the time it closed down late in 1914 on account of financial difficulties; it is said to have passed into the hands of the First National Bank of Sumpter, and from it to the Citizens National Bank of Baker. Not much has been done upon the property since 1914.

MANUEL LOPEZ CLAIMS (copper) WALLOWA DISTRICT WALLOWA COUNTY

Located in about Sec. 18, T. 4 S., R. 45 E., on the west fork of the Wallowa river, about 10 miles south of Joseph, the railroad terminus. There is a wagon road for 5 miles and an indifferent trail for 5 miles. The ore is a contact-metamorphic between limestone and intrusive granodiorite. The contact has a high angle of dip and shows a small amount of mineralization with epidote and chalcopyrite as chief minerals. Development consists of a short adit and a few surface cuts. Property is not active.

MARTHA MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Martha mine is in the S. W. ¼ Sec. 28, T. 33 S., R. 5 W., about 1 mile north of the Greenback mine. It is 2½ miles north of the town of Placer, which is 8 miles west of Leland, the nearest railroad point. It is on the steep western slope of St. Peter mountain overlooking Coyote creek. It is opened by 4 adits at different elevations, having a total length of about 3000 feet. It was opened as a separate mine, but in 1904 it was purchased by the Greenback company and developed more fully by means of electric power from the Greenback mine. In 1906 the Martha was connected with the Greenback mill by means of an aerial tramway. After the Greenback mine was closed the Martha was leased to J. M. Clarke, of Golden, Oregon, who erected a 5-stamp mill on the ground and treated ore previously developed and partly mined. The country rock is greenstone and the ore is similar to that of the Greenback, though not as rich. It occurs in veins and stringers in zones of shearing. In adit 2 the chief vein strikes N. 70° W. and dips at an angle of 55 to 60°; it varies in width from a few inches to about 4 feet with an average of about 2 feet for the first 600 feet; the adit beyond was not accessible; it was said to extend 800 feet. At about 350 feet from the portal a fault which strikes about N. 60° W. causes an offset of about 15 feet toward the north.

This mine is at present owned by R. C. Robinson of Parish, New York.

MARVIN MINE (copper) GALICE DISTRICT JOSEPHINE COUNTY

The Marvine mine is near the top of Peavine mountain at an elevation of 3400 feet, as measured by barometer. A lode 30 feet wide, containing some quartz with chalcopyrite in pyroxenite somewhat altered to chlorite and serpentine, is opened by an adit which extends N. 40° W. about 150 feet. The lode strikes north of east and dips about 45° S.

MASHELL COAL AND COKE COMPANY **WASHINGTON**

Office: Third and Washington Sts., Portland, Oregon. Edward Cookingham, Portland, Pres.; R. S. Howard, Portland, Sec.; Albert Cookingham, Tacoma, Wash., Treas. Capital stock, $100,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company's properties are located in Pierce county, Washington.

MASTODON HYDRAULIC MINING COMPANY **ALASKA**

Office: 503 Platt Bldg., Portland, Oregon. W. G. McPherson, 198 Wilson St., Portland, Pres.; Sanderson Reed, 503 Platt Bldg., Portland, Sec. Capital stock, $100,000; par value $100; all subscribed, issued and paid up. (1916 report).

The properties of this company are situated on Mastodon creek, Alaska, and the postoffice is Miller House.

MATTERN MINE **ASHLAND DISTRICT** **JACKSON COUNTY**

An adit known as the Mattern is near the Ashland mine on the west side of the ridge and about 3 miles by wagon road west of Ashland. The adit extends about 370 feet in a direct line about S. 20° W., all the way on a vein which dips about 40° E. Where observed the east or hanging wall is tonalite and west or footwall is a dark colored diorite.

At the north end of the ridge between Wagner and Ashland creeks and only about a mile northwest of Ashland is another adit called the Mattern. This has a total length of about 325 feet and a general southerly course. At about 50 feet from the portal it reaches the ledge, which strikes nearly north and dips about 40° E. The ledge follows an important fault in which the country rock is much shattered and altered and cemented by calcite and quartz. The wall rock of the ledge is a diorite-aplite or malchite. At about 275 feet from the portal a chute extends upward into a stope and at about 230 feet from the portal an incline winze follows the vein downward; it could not be explored, because it was filled with water.

MAXWELL MINE (gold) **ROCK CREEK DISTRICT** **BAKER COUNTY**

This property adjoins the Highland mine in Sec. 19, T. 8 S., R. 38 E. The workings are indicated by a number of dumps extending over a vertical range of 1200 feet, along a narrow ravine at the head of Maxwell basin, which is formed by the junction of two glacial valleys that head against a prominent northward spur from Elkhorn ridge. The most important operations extended over the period from 1900 to 1905, and though there has been no production since 1905, a little work is reported to have been done as late as 1909. The mine is said to have been sold for $123,000 in 1901.

It is now being operated by Delbert E. Metzger, who keeps a small development force at work in this and the Highland, which he acquired by bond and lease in the summer of 1916. The developments comprise 18 tunnels and short drifts reported to aggregate 6000 feet. The lowest, No. 18, and No. 10, 900 feet higher, were open in 1914, though the sources of ore in the former were not accessible. An aerial tram connects tunnel No. 10 with a mill, now dismantled, in the basin below.

According to J. K. Romig, a former manager, an intermediate tunnel, No. 14, contained the most extensive workings. In this two ore shoots were developed on a vein in argillite, an outer one 250 feet long attaining a maximum width of 4½ feet, and an inner one 80 feet long, with a maximum width of 6 feet. The oxidized zone was extremely shallow. The material now to be found on the dumps of the lower tunnels contains a high per cent of pyrite, arsenopyrite, blende and galena, named in order of abundance. In addition to quartz, the gangue minerals are calcite, siderite and fuchsite. In structure this type of ore resembles that found in the Highland vein, which lies a short distance to the northwest. It is reported that though much of this class of ore contains a fair amount of gold and silver, it is not amenable to treatment by concentration, because of the high proportion of sulphide minerals.

Tunnel No. 10, 290 feet long, and several above it that are now caved, explore a vein different in character, though lying along the extension of the lower group of tunnels. The vein is a breccia zone, in part in granodiorite and in part along its contact with argillite attains a maximum width of 3 feet, and has been stoped over an area 130 feet long by 80 feet high to the outcrop. In contrast with the average strike of about N. 60° E. of the lower Maxwell vein, this vein strikes N. 30° E., and the dip is 80° S. E. The ore occurs as lenses showing angular nuclear masses of fine pyrite, sericite and fuchsite in dense quartz. These nuclei are enveloped in a zone of radial quartz crystals, with here and there a coarse pyrite crystal. If arsenopyrite is present, it was not observed. The vugs between these nuclear masses contain calcite crystals. In addition to the quartzose lenses, the vein contains zones of sericitic gouge. This general structure is characteristic of many veins in the district, but this is the only one seen in granodiorite that showed it. A small amount of manganese oxide occurs in the oxidized ore. Assays as high as $35 a ton in gold are reported, the ratio of silver to gold seldom exceeding 2 to 1 by weight.

MAY BELLE CLAIM GOLD HILL DISTRICT JACKSON COUNTY

For description see "Blanche Claim."

MAYFLOWER GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Mayflower group is on the south fork of Rocky gulch at an elevation of about 2800 feet, about 1½ miles west of the Oriole mine. It is a group of 3 claims located in 1910 and now owned by Robertson and Sutherland. The garnetiferous mica schist here strikes N. 10° E. and locally dips only 35° E. An adit in chloritic serpentine discloses many small lenses and stringers of quartz. Other small openings are on a fault, east of which is a hard banded rock, succeeded westward by 3 feet of radiating light green amphibole, platy serpentine and fault gouge. West of the fault is massive gray talc (?), followed by black chloritic serpentine. The general strike of the rock formations on Peavine mountain is N. 15 to 20° W., with a steep dip to the east. The banded rocks include quartzite, quartz mica schist, fine and coarse amphibole schist and graphitic mica schist. The Mayflower group is equipped with a Chilian quartz mill run by a Pelton wheel. Diller states that:

> The gold is free or is in the pyrite, and chiefly, if not wholly, in the rotten quartz of the greenstone schist adjoining the contact. There is little, if any, gold in the white quartz. A small amount of chalcopyrite is present.

MAYFLOWER MINE (gold) CORNUCOPIA DISTRICT BAKER COUNTY

The mill and cyanide plant is located about ¼ mile south from the Union-Companion mill (see Cornucopia Mines Company), and receives its ores from the mine by an aerial tram from a considerably higher elevation.

This mine is probably located on an extension of the Last Chance vein, but on the south side of the mountain. The vein has the same strike and about the same dip. Its mineralization is similar to the other veins in the region, though the amount of sulphide is somewhat less.

The vein here is smaller than at the Last Chance mine, being at the widest place not over 3 or 4 feet and in many places pinching out entirely. There is evidence in the walls that they have been subjected to a great deal of pressure, but there are no signs here of any great movment. This mine is developed with 2 adit levels and 1 intermediate. A raise in the vein 530 feet to the surface connects the several workings.

The property operated its stamp mill and cyanide plant with steam power. They exhausted their developed ores during the summer months of 1914 and closed down.

It is understood that this property, which had labor and material liens filed against it following the shut-down in 1914, has been purchased by the Queen of the West Mines Company, but the property is inactive.

MAYFLOWER MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This mining prospect, which is on the same side of Elk creek as the Badger mine and not far from it, is inactive.

MAY QUEEN MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The May Queen mine, 5 miles southeast of Grants Pass, is on the east slope of Baldy mountain in Secs. 26 and 27, T. 36 S., R. 5 W., on the west side of Green creek, at an elevation of about 1500 feet, as measured by barometer. It is owned by N. C. Boynton. The country rock is a hard, dense greenstone, in which the vein strikes N. 55° W. and dips 30° N. E. A drift on the vein extends 280 feet to the northwest; about 100 feet from the breast a raise on the vein extends 125 feet to the surface. Some ore was stoped out near the raise. There are no very distinct walls or fault gouge; the vein quartz varies from a mere stringer to a foot in width. At the southern end the vein seems to fork into 2 smaller veins. The mine is equipped with a small 2-stamp mill run by a gasoline engine.

McCARTHY CLAIMS (copper) HOMESTEAD DISTRICT BAKER COUNTY

The McCarthy property, situated about 1 mile north from Homestead, in Sec. 16, T. 6 S., R. 48 E., has chalcopyrite in a vein a few feet wide, but work has been interfered with by a basalt dike, which has discouraged development.

McGEE'S CLAIMS EAGLE CREEK DISTRICT BAKER COUNTY

See "Sheep Rock Mine."

McLEMORE AND HAMPSON'S CLAIMS (gold) GOLD HILL DIST. JACKSON COUNTY

McLemore and Hampson's claims, 7 miles southwest of Gold Hill, are in the S. E. ¼ Sec. 7, T. 37 S., R. 3 W., on the left fork of Foots creek; they report a vein of quartz 6 to 16 inches wide carrying free gold, pyrite, pyrolusite and galena.

McMAHON'S CLAIM (gold) GOLD HILL DISTRICT JACKSON COUNTY

McMahon's claim, about 6 miles southwest of Gold Hill, is in the N. W. ¼ S. W. ¼ Sec. 6, T. 37 S., R. 3 W., on the left fork of Foots creek, at an elevation of 1850 feet by barometer. Here a quartz vein about 18 inches wide strikes N. 55° W. and dips about 40° N. E., the dip increasing somewhat with depth. It is opened by an incline shaft about 75 feet deep, and a drift running S. 55° E. about 50 feet ending in a winze 30 feet deep.

McPHERSON PROSPECT ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

See "Winters and McPherson" prospects.

MEEK'S (ECKIS) MINE (placer) PORT ORFORD DISTRICT CURRY COUNTY

Diller describes this mine as follows:

On the Meeks mine, near Port Orford, Mr. R. G. Eckis has been running an Eccleston Tension Concentrator 24 hours a day for some time. He is using a giant to wash the sand into a sluice box in the bottom of which he has the screen, thus taking the heavy black sand out in an undercurrent. This product is then run over the concentrator. He reports that he is securing 80 per cent of the gold, platinum, and iridosmine, and he says his concentrates run over $8000 a ton total value. One machine handles the undercurrent from 150 cubic yards a day.

Mr. Diller does not say whether the Meek's mine is on the present ocean beach or one of the old high beaches.

MERGER GOLD MINING COMPANY BLUE RIVER DISTRICT LANE COUNTY

Office: 67 N. Third St., Portland. S. M. Carter, Pres., Blue River; F. W. Brooke, Sec.; C. Marco, Treas., both of Portland. Capital stock, $250,000; par value $1.00; all stock subscribed, issued and paid up. (1916 report).

Property consists of 6 claims, located in northern part of Sec. 4, T. 16 S., R. 4 E., about 4½ miles from Blue River, a postoffice 45 miles east of Eugene, on the McKenzie river. The wagon road to the Blue River postoffice from the mine is in fair condition, and the road from Blue River to Eugene is in good shape. The country is rugged and plenty of timber is available.

The country rock is andesite. Deposit is of the brecciated zone type, having N. W.-S. E. strike, dipping at a high angle. It is said to be an extension of the Lucky Boy vein. Development work consists of several tunnels, but the lowest tunnel has not yet reached the vein.

No information in regard to values, etc., was available.

MIDWAY OIL COMPANY

Office: 302 Concord Bldg., Portland, Oregon. Chas. E. Ladd, Pres.; A. E. Davis, Sec., both of Portland, Oregon. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

MILLER GROUP CHINA DIGGINGS DISTRICT CURRY COUNTY

See "Bacon & Miller Groups."

MILLIONAIRE MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Millionaire mine, 4 miles east of Gold Hill, is in S. W. ¼ Sec. 30, T. 36 S., R. 2 W., on nearly level ground, at an elevation of 1730 feet, as measured by aneroid barometer. It is opened by 2 vertical shafts, the deeper one said to be 400 feet deep, with levels opened a short distance each way at each 100 feet. The vein strikes E. and dips about 60° N.; there are 3 veins reported to be nearly parallel, all 4 containing quartz with pyrite and rare galena and chalcopyrite. Two more veins are said to strike north and dip east; these contain calcite, quartz, pyrite and a mineral resembling sylvanite. The country rock consists of dark argillite with bands of andesitic material. The other shaft (called the Johnson) is probably on the same vein; it is 120 feet deep and has a crosscut to the vein at a depth of 30 feet. Here the vein contains 2 to 3 feet of quartz with some fault gouge and a little manganese. It strikes S. 72° E. and dips 85° N., but it is stepped north going down so as to give a smaller apparent dip (about 60°). About 600 feet along the strike of the formation (N. 20° E.) there is a small outcrop of limestone and an old kiln. A fragment of limestone was found on the Johnson shaft dump. The Siskiyou tonalite outcrops about a mile to the northward, and may extend under this region.

The Millionaire mine is owned by the McKeen National Bank, of Terre Haute, Ind. It is equipped with a mill which has never been operated, although substantially complete and in good condition. The mill has 2 Nissen 1500-pound stamps with circular discharge and 2 10-foot amalgamating plates; it has a rock crusher and a Standard concentrating table. The mine has been idle for several years.

MINNEHAHA GOLD HYDRAULIC AND DREDGE COMPANY (placer) GREENBACK DISTRICT JOSEPHINE COUNTY

Office: Portland, Oregon. A. R. Tozier, 365 Morrison St., Portland, Pres.; J. P. Kennedy, 680 Flanders St., Portland, Sec.; J. E. Fallas, 365 Morrison

St., Portland, Treas. Capital stock, $500,000; par value $1.00; $296,000 subscribed and paid up, $204,000 issued. (1913 report.)

This company owns placer claims near Wolf creek in Josephine county. The property has been idle for several years. Dissolved by proclamation in January, 1917.

MOLLIE GIBSON GOLD MINING AND MILLING COMPANY (gold and copper) CABLE COVE DISTRICT GRANT COUNTY

Local name: "Mollie Gibson."

Office: Bourne, Oregon. T. V. Williams, New Castle, Penn., Pres.; Mrs. Jane Evans, Monmouth, Oregon, Sec-Treas. Capital stock, $100,000; par value, $10.00; stock subscribed, $85,290; stock issued, $82,960; stock paid up, $83,280. (1916 report.)

This property of 2 claims is located in the central part of T. 8 S., R. 36 E., on the John Day side of the watershed which separates the drainage of the North Fork of the John Day from Silver creek. It is reached from Sumpter by wagon road up Silver creek a distance of about 15 miles. Development consists of an adit driven upon the vein between three and four hundred feet long, besides raises and surface openings. The ore consists of narrow lenses containing chalcopyrite and gold. The property is not active.

MONITOR MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This prospect is near the Badger mine and is said to contain considerable high grade shipping ore as well as bodies of good milling ore.

MONUMENTAL MINE (gold-silver) GRANITE DISTRICT GRANT COUNTY

This mine is located on the northwestern slope of Bald mountain in Sec. 19, T. 8 S., R. 36 E. about 9 miles by wagon road from Granite. It is one of the oldest producing quartz locations in eastern Oregon having shipped some 14 tons of ore to San Francisco in 1874. Very little work has been done upon the property in the last 20 years.

The outcrop has not been extensively prospected. The developments are 2 crosscut tunnels 215 and 1400 feet long respectively, attaining a maximum depth of about 600 feet below the outcrop. The longer tunnel intersects 6 well-defined parallel veins on which more or less work has been done, and ore has been stoped from three, though the inner or southeastern appears to have been the more important.

The country rock is granodiorite and the principal vein strikes N.-NE. The latter consists of shattered granodiorite in various stages of alteration.

Light-colored gouge and lenses of quartz containing pyrite, arsenopyrite, zinc blende, tetrahedrite and galena, together with some silver minerals in the richer ore, constitute the vein. The shattering and alteration of the granodiorite may be as much as 4 or 5 feet wide, but the lenses of ore have a maximum width of only 18 inches and stope lengths of less than 100 feet.

The production to date is reported to be approximately $100,000. Lindgren states that the gold values increase in depth.

MOON ANCHOR MINES COMPANY (gold) CABLE COVE DIST. GRANT COUNTY

Local name: "Moon Anchor."

Office: 324 Henry Bldg., Portland, Oregon, Mike Zenger, 681 First St., Portland, Pres.; Anthony Mohr, 324 Henry Bldg., Portland, Sec.; Frank Degonda, 232 Front St., Portland, Treas. Capital stock, $100,000; par value $1.00; stock subscribed, issued and paid up $62,235. (1916 report.)

This company is developing a vein of the Cable Cove type, just north of the watershed which separates Silver creek from Bull creek, a tributary of the North Fork of the John Day river. This property of 3 claims was not visited, but press reports late in August, 1916, state that the crosscut which has been driven a few hundred feet to cut the ledge at considerable depth has finally reached the vein and drifting upon it has developed a shoot of ore 120 feet long and 1 to 2 feet wide of supposedly high-grade ore.

MOOD MINE (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Concerning this mine Diller says:

Near the forks of Fiddlers gulch, about 7 miles nearly west of Kerby, are situated the 6 claims of the Mood mine. Like most of the lode mines of that region, this mine is in the vicinity of the western border of the great serpentine belt. It is said that the mine has nearly 2000 feet of underground workings and an old arrastre in which ore was ground that yielded some thousands of dollars. Tunnels are being run to the northeast along a shear zone approximately parallel to the contact. There is a small but distinct gouge, some irregular veins of quartz, and a lense of very hard rock rich in pyrite.

In the same vicinity, but farther west, between the forks and along the main branch of Fiddlers gulch, there are a number of openings that were not seen, among them those of Watson and Andrews. The greenstone is in places full of pyrite, but its value has not been proved.

MORNING MINE (gold) GREENHORN DISTRICT GRANT COUNTY

The Morning mine in Sec. 13, T. 10, R. 34 E., is on the south side of the main Greenhorn ridge a little over 2 miles south of the Morris and about 5 miles by wagon road from the town of Greenhorn. This property and its extensions are in a class by themselves in this region in that they are in a mineralized dike.

The country rock is greenstone of igneous origin, although it is so much altered that its original character is scarcely determinable. Considerable masses of serpentine are in the immediate vicinity. The ore deposit is in an altered N.-S. steep dipping dike. In thin section it is seen to be a confused mass of altered andesine feldspars, many of which are intergrown with quartz forming a micrographic structure.

The alteration minerals present are sericite, secondary feldspar, and secondary quartz. This rock could be called a feldspar porphyry with aplitic tendencies. Its composition shows that it is closely related to the granodiorite. The dike rock is cut by minute quartz veins, many of which show small well-formed crystals. The pyrite, associated with the quartz, has been altered to limonite, as have also the minute grains of pyrite with which the dike rock was impregnated.

Lenticular veins of massive pyrite, approximately parallel to the walls of the dike which in some places are several inches wide, are found on the lowest or working level of the mine and apparently near the upper limits of the sulphide zone. The dike at this point is 30 to 40 feet wide, and is reported by different persons to assay from \$2 to \$5 throughout. Near the surface a stope, several sets wide, called the "ball room" stope, was mined several years ago and undoubtedly was of good grade. Most of the enriched parts have been stoped down to the lowest or mill level.

The leasers in 1914 were mining from various parts of the mine and treating the ore in a small Chilean mill and a home-made arrastre, the latter for regrinding purposes. Amalgamation recovered a few dollars per ton and concentration on revolving canvass tables was being attempted. The massive sulphides are known to be worth from \$20 to \$30 per ton and clean concentrates approximate this value, but crude methods of milling and simple cyanidation will doubtless be unsuccessful in securing a reasonably high extraction.

A complete engineer's examination of this property together with some well directed additional exploration, might demonstrate the presence of a considerable body of ore which although of low grade would nevertheless be profitable to work.

MORRIS MINE (silver-gold) GREENHORN DISTRICT GRANT COUNTY

These claims are about 1½ miles southeast of the Ben Harrison mine in Sec. 1, T. 10 R. 34 E. They have been located at least 20 years and have had considerable sorted silver ore shipped from them from time to time.

The country rock is granodiorite, although argillite and limestone are found in the immediate vicinity. In fact the veins are almost on the contact of the intrusive with the sediments. There are four nearly parallel N.-S. veins with vertical dip which are branch veins of a larger one of moderate width which strikes S. 35° W. The N.-S. veins are narrow, rarely as much as a foot in width, but the wall rock shows considerable alteration.

The minerals found in these small veins are silver sulphides, some tetahedrite, stibnite, pyrite, and arsenopyrite, and at some points silver chloride.

The large vein, 3 or 4 feet wide, seems to consist of quartz, massive pyrite, and arsenopyrite. It is said to have moderate values in gold and silver. It has one drift upon it for a couple of hundred feet.

The ore which has been sorted and shipped at various times since the discovery has all come from the narrow veins. To indicate the proportions of gold and silver the mint of 1891 credits the Morris with a production of $15,000 in silver and $3,400 in gold. During 1913-14 the few shipments made from the property averaged about $50 per ton.

MORRISON SMITH MINING COMPANY

Last report to Corporation Department made in 1913.

MOSES AND COLLINS CLAIMS (gold)
UPPER APPLEGATE DISTRICT JACKSON COUNTY

Moses and Collins have gold prospects in quartz veins in greenstone on Collins mountain in Sec. 35, T. 40 S., R. 4 W., 28 miles southwest of Jacksonville on the Applegate river. Most of the veins are small and rather irregular; one of the largest is 1 to 3 feet thick and contains streaks of pyrolusite. The ore is a surface concentration occurring in rich bunches at or very near the surface.

MOSS ROSE GROUP ELK RIVER DISTRICT CURRY COUNTY

See "Axtell Mine."

MOUNTAIN GEM MINING AND DEVELOPMENT COMPANY
(copper, gold and molybdenite) WALLOWA DISTRICT WALLOWA COUNTY

Local name: "Gem Mine."

Office: Joseph, Oregon. Harry Dawson, Pres.; T. F. Tomkins, Sec.-Treas., both of Joseph, Oregon. Capital stock, $200,000; par value, ten cents; $124,-211.20 subscribed and issued and $123,711.20 paid up. (1916 report.)

The company owns 11 claims on the west fork of Wallowa river in Sec. 31 T. 3 S., R. 45 E., up a side gulch to the west and within 3 miles of Wallowa lake about ½ mile away from the main stream and 10 miles from Joseph by wagon road. The company also has 5 claims 25 miles south of Lostine. The elevation is approximately 6000 feet at the principal contact of the granodiorite with limestone and calcareous schists.

Pegmatite and aplite dikes are present. The aplite dikes for the most part are small ones in the granodiorite, while a pegmatite dike, consisting chiefly of quartz and feldspar, is about 10 feet wide.

The characteristic contact-metamorphic minerals, such as garnet, epidote, quartz, calcite, pyrite, chalcopyrite, molybenite and magnetite are found. The molybdenite is associated with pyrite, with quartz, epidote and calcite as a gangue. The magnetite is associated with quartz, and pyrite with a small amount of epidote.

A short crosscut tunnel has been driven diagonally toward the contact in granodiorite, but has not reached it, but has cut through an irregular bunch of fine-grained pyrite, chalcopyrite, quartz, garnet and epidote about 5 feet wide.

The production in 1915 was 14 tons, valued at $426.40.

MOUNTAIN KING MINE (mercury) GOLD HILL DISTRICT JACKSON COUNTY

The Mountain King mine owned by J. R. Hayes of Detroit is in Sec. 36 (and neighboring secs.) T. 34 S., R. 3 W., 18 miles northeast of Woodville on the Southern Pacific Railway or 12 miles northeast of Gold Hill. The property consists of 800 acres of patented land.

It occurs along a granite-sandstone contact where the granite is in part represented by pegmatite. Native mercury is seen in calcite at an elevation of 2500 feet as measured by aneroid barometer in an open cut near the main adit (No. 1). In the latter there is no well-defined vein but some mineralization along an irregular contact. The ore contains cinnabar, native mercury, pyrite, and a heavy black mineral resembling metacinnabarite. The same contact (with some cinnabar) is visible also at an open cut up the hill N. 70° E. and 140 feet higher than adit 1. In another entry about 100 feet lower than the main adit native mercury is abundant in a much decomposed granite in the floor where the adit forks about 20 feet from the portal. The granite also contains a little cinnabar. The adit extends S. 11° E. 170 feet, the last 90 feet in solid micaceous quartzite; a branch tunnel extends irregularly south about 30° E. 75 feet. Except in the solid quartzite much faulting is in evidence in all directions.

Considerable development has been done on the property during the past summer, all work tending to show larger ore body.

MOUNTAIN LION MINE (gold) LOWER APPLEGATE DIST. JOSEPHINE COUNTY

The Mountain Lion mine is 12 miles southeast of Grants Pass and 1 mile north of Davidson in Sec. 25 T. 37 S., R. 5 W. It is owned by L. L. Jewell, of Grants Pass, and is under bond and lease to C. G. Murphy, of Applegate.

When visited in August, 1913, the main adit was caved and could not be seen; the upper adit (No. 2) is about 500 feet long, with more than 300 feet on the vein which is 4 to 36 inches wide with 0 to 24 inches of quartz and the remainder crushed greenstone. A sample of the country rock contains rare phenocrysts of augite in a matrix of abundant green hornblende (altering to serpentine) and plagioclase, almost wholly sericitized with the production of some secondary calcite and quartz. The main adit is said to be more than 1200 feet long with the ore stoped out above.

The Mountain Lion mine is equipped with a boiler, engine, air compressor, and a 5-stamp mill having 900-pound stamps, a crusher, an 8-foot plate with riffles below, and a concentrator. Adolf Meyer experimented here with a magneto-electric process which is no longer in use. According to Kay,

> The property has been extensively developed, there being about 8000 feet of crosscuts, drifts and other workings. Work has been done on two veins which are in greenstone and slates and which are close to the contact of these rocks within an area of granodiorite. The slates occur as narrow lenses in the greenstones and the best ore of the veins has been obtained near the contacts of the greenstones and the slates. The better-defined vein of the two strikes N. 80° W. and dips 65° S. It averages about 1 foot in width and is faulted at many places. The vein filling consists chiefly of quartz, calcite, and sulphides, the sulphides constituting about 1 per cent of the whole. Owing to the prevalence of faults the vein has been difficult to follow.

The mine has been idle during the last few years.

MOUNTAIN TREASURE MINING COMPANY
GRANTS PASS DISTRICT JOSEPHINE COUNTY

About 1908, the Mountain Treasure Mining Company (dissolved Jan. 1, 1915) put in a 2800-foot pipe line to develop power to open their mine which is in Sec. 34 or 35, T. 34 S., R. 5 W., north of Jump-off Joe creek and 8 miles east of Hugo. Apparently only an overshot wheel was installed, and an arrastre built. The underground development accomplished by the company was not seen by the writer. No work has been done for some years.

MOUNTAIN VIEW MINE (gold-silver) CRACKER CREEK DISTRICT BAKER COUNTY

This mine, situated at the head of Sardine gulch, 2½ miles due north of Bourne, in Sec. 17 T. 8 S., R. 37 E., was not open in 1914. Its period of productive activity extended from 1903 to the end of 1907, when its mill was destroyed by fire. The vein occupies a fissure that strikes northeastward in granodiorite and the severely metamorphosed argillite along its border. According to reports, the mine was profitable during the period of its operation and produced a large sum in gold and silver. It is said that its principal ore shoot was worked over a stope length of 200 feet and pitch length of 300 feet or more, and that at the time the mine closed down ore was exposed for 80 feet along the lowest level. Partial records of the mine's production were seen that show a total of $63,842 in gold and silver. In the crude ore shipped the silver value was comparatively insignificant, the ratio of gold to silver by weight being as 6 to 1.

MOUNT PITT MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Mount Pitt mine, now known as the County Line mine, is owned by G. E. Howland, of Grants Pass. It is located almost on the line between Jackson and Josephine counties in Sec. 31 T. 34 S., R. 4 W. (and in Section 36 adjoining) 10 miles east of Hugo, at an elevation of about 3050 feet, as measured by barometer. It is equipped with a 5-stamp mill with 2 boilers, a 40 H. P. engine, a crusher, a Frue vanner, an 11-foot Pinder concentrator, a 10-foot amalgamating plate, an air compressor, and a cyanide plant. It is opened by about 800 feet of underground work of which more than 500 feet is in the main adit which enters as a crosscut S. 75° E. for 190 feet, and continues as a drift S. about 10° E. some 300 feet. It terminates in a fault or slip containing no ore. The ore consists of pyrite in quartz and calcite forming a vein in plicated argillite associated with serpentine.

MT. BAKER MINING COMPANY WASHINGTON

Office: 4th and Oak Sts., Portland, Oregon. Henry Hahn, Pres.; Leo Friede, Sec., both of 4th and Oak Sts., Portland. Capital stock, $1,000,000; par value, $1.00; $977,300 subscribed, issued and paid up. (1916 report.)

This company's properties are located in Whatcom county, Washington.

MT. REUBEN MINING COMPANY GALICE DISTRICT JOSEPHINE COUNTY

Office: 214 Abington Bldg., Portland, Oregon. H. P. Heninger, Pres.; Ed W. Mueller, Sec.; H. P. Heninger, Treas., all of Portland. Capital stock, $100,000; par value, $10.00; $50,300 subscribed, issued and paid up. (1916 report.)

This company was organized in January, 1916. It has the "Anna," "California," "Virginia," "C. D.," "Albany," fraction of the "Oversight," "Arthur C," and "Utica" claims located on a spur of Mt. Reuben in Josephine county. Some tunneling, sinking shaft and stoping has been done.

MT. SHASTA MINING COMPANY CALIFORNIA

Office: 400 Henry Bldg., Portland, Oregon. H. S. Attix, Pres., Berkeley, Calif.; Theo. Burkhart, 955 Wilton Ave., Portland, Sec.; A. A. Lindsley, 400 Henry Bldg., Portland, Treas. Capital stock, $50,000; par value, $100, all subscribed, issued and paid up. (1916 report.)

This company's properties are located near Shasta, California.

MT. ST. HELENS CONSOLIDATED MINING COMPANY WASHINGTON

Office: 1208 Northwestern Bank Bldg., Portland, Oregon. Thomas Prince, Pres.; Frank M. Bell, 1208 Northwestern Bank Bldg., Portland, Sec. Capital stock, $1,800,000; par value, $1.00; $1,698,444 subscribed, issued and paid up. (1916 report.)

This company's properties are located in Skamania county, Washington.

MULE MOUNTAIN MINES (gold) MULE CREEK DISTRICT CURRY COUNTY

Property consists of 1 placer and 11 lode claims. Owned by G. W. Billings and situated on both sides of Rogue river about 3 miles below the mouth of Mule creek. There are 3 principal veins, Mule mountain, Big Devils Stairs creek, and Keystone veins. The country rock of all the veins is greenstone.

The Mule mountain vein is developed by a 25-foot open cut 12 feet wide an 86-foot shaft and several smaller cuts. The strike of vein is N. 60° E. and dip 60° SE. The vein is made up of about 1 foot of nearly solid quartz and about 2 feet of vein material heavily impregnated with iron. The 3 feet of quartz and iron bearing material is mined and milled in the 2-stamp mill and cyanide plant on the property. This 3 feet of ore is reported to average by sampling about $7.25.

The Big Devils Stairs creek vein is 500 to 600 feet northwest of Mule mountain vein. This Big Devils Stairs creek vein is from 1 to 4 feet wide in the lower workings which splits up in the upper workings to several veins over a width of 4 feet and still higher up they fan out to 15 feet wide with several 1-foot veins and many smaller ones in between. These are quartz iron-stained veins with some pyrite and chalcopyrite. Separate mill runs recovered $26.80 and $18.00. Vein samples over 7 feet 4 inches assayed $13.37; another one over 9 feet 2 inches assayed $13.67, according to reports.

The Keystone vein is a shear zone mineralized from a few feet wide to a maximum width of 20 feet or more. It is similar to Big Devils Stairs creek vein as shown in open cuts and tunnels. Assay values reported to be from $2.50 up to about $100.00.

MUNDY MINE (coal) ASHLAND DISTRICT JACKSON COUNTY

In Sec. 17, T. 38 S., R. 1 E., at an elevation of about 2400 feet, some thin seams of coal have been opened by J. F. Mundy, of Medford. The development work included several drill holes and the results indicate the presence of at least 2 coal seams about 500 feet apart.

In Sec. 16, T. 38 S., R. 1 E., a coal seam has been opened by Emmett Beeson of Talent by means of a slope or incline shaft following the coal nearly on its dip. This coal outcrops in a ravine at the foot of a sandstone cliff at an elevation of about 2600 feet. Fossil impressions of leaves were collected from shaly sandstone at an elevation of about 3050 feet near the top of the cliff a little south of east of the coal seam. The sandstone strikes about S. 45° E. and dips about 25° N. E. at the place where the fossils are found. The coal seam has a strike of N. 53° W. and a dip of about 16° N. E. The slope opening this coal discloses a fault at 70 feet from the portal which strikes N. 10° W. and dips about 62° E. The hanging wall of the fault is displaced vertically downward about 6 feet. At about 120 feet from the portal the coal seam is narrowed to about 3 inches by the doming up of the floor; at the breast, about 130 feet from the portal, the coal is again nearly 2 feet thick.

MUNITALP MINES CORPORATION

Formed in 1914—no report filed. Dissolved by proclamation in January, 1917.

MYER CLAIM UPPER APPLEGATE DISTRICT JACKSON COUNTY

See "Wright & Myer" claims.

NANCY DONALDSON MINING COMPANY (Wyoming corporation) NEVADA

Office: 220 West 19th St., Cheyenne, Wyoming. C. C. Tracy, 170 11th St., Portland, Oregon, Pres.; Walter E. Pratt, Goldfield, Nevada, Sec.-Treas.;

A. J. Anderson, 264½ 4th St., Portland, Attorney-in-Fact. Capital stock, $1,500,000; par value $1.00; $1,035,550 subscribed and issued; $1,500,000 paid up. (1916 report.)

This company has 72.94 acres of patented mineral lands in Goldfield mining district, Nevada. It is located about 8 miles by good wagon road to the northeast of Goldfield. The geology consists of rhyolitic tuff intersected by basalt, andesite and rhyolite dikes. The mineral deposition occurs in or alongside of these dikes, and is increased at the crossings or intersections.

NATIONAL COPPER MINES COMPANY SEVEN DEVILS DIST. IDAHO
WALDO DISTRICT JOSEPHINE COUNTY, OREGON

Local name: "Coad Placer and Gold Bar."

Office: 926 Chamber of Commerce Bldg., Portland, Oregon. L. C. Mackay, Pres., 926 Chamber of Commerce Bldg., Portland; E. H. Hayes, Sec., Portland, Oregon; F. H. Coffey, Portland, Treas. Capital stock, $3,000,000; par value, $1.00; $1,630,318 capital stock issued and paid up. (1916 report.)

This company has 31 copper claims near Cuprum, Seven Devils mining district, Adams county, Idaho, and 2 claims in Josephine county, Oregon, called the Gold Bar mine and Coad placer mine.

The Coad placer now called the National placer is on Sucker creek at the mouth of Grizzly gulch near N. W. corner Sec. 4, T. 41 S., R. 6 W., and the Gold Bar mine is about in Sec. 7 of same Township near top of Bollon peak. These properties are about 37 miles from the railroad at Waters creek station and 12 miles from the wagon road at Holland.

On the placer claim only assessment work is done. At the Gold Bar mine there is a 50-foot shaft and two adits upon a quartz vein which is from 2 to 4 feet wide and of good milling grade. This information was secured from Wm. Trevor.

NAY AUG IDAHO MINES COMPANY IDAHO

Office: 214 Lumber Exchange Bldg., Portland, Oregon. George W. Holcomb, Pres.; Jos. J. Fisher, Sec.-Treas., both of Portland, Oregon. Capital stock, $250,000; par value, $1.00; all subscribed, issued and paid up. (1916 report.)

This company's properties are located in Blaine county, Idaho.

NEIL MINE (gold) ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Diller says:

On the south fork of Fiddlers gulch, at an elevation of nearly 2400 feet, 6 miles west of Kerby, is the mine owned by Neil brothers and recently sold to the Segno-Tomek Gold Mining and Milling Company for $80,000, according to report.

The discovery of the Neil mine was made by a short tunnel that yield, it is said, some remarkably rich dark telluride ore. The discovery tunnel is near the contact of the greenstone and serpentine. It has caved in, water issues from it, and the rich ore reported is inaccessible at the present time.

The Segno-Tomek Company has run a large tunnel N. 68° W. for about 300 feet to a contact and then followed the contact south for nearly 100 feet in an attempt to strike the rich ore several hundred feet beneath the original discovery.

The rocks along the contact are much crushed and for 6 to 12 inches have much sheared material which is decidedly serpentinous. As far as seen it contains little evidence of ore.

NELLIE WRIGHT (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Nellie Wright mine is on the south slope of Blackwell hill about 2 miles east of Gold Hill in the S. W. ¼ Sec. 24, T. 36 S., R. 3 W. A Beers mill to be operated by electric power is under construction; it is provided with plates and a Johnson concentrator. The vein is opened by 2 shafts 50 and 60 feet deep connected by a drift 130 feet long which extends 30 feet beyond one shaft. The ore is chiefly quartz with some pyrite, chalcopyrite, and a dark sulphide resembling galena. The veins strikes about N. 75° W. and dips about 87° N.; it varies in thickness from 1 to 4 feet. The country rock is the Siskiyou tonalite which is here cut by a dyke of andesite, while the vein cuts both the tonalite and the dike.

The property has been operated by Messrs. Haaf and Ray of Gold Hill during the past year and has been sold recently to R. M. Wilson who will proceed with further development.

NELSON PLACERS — BAKER DISTRICT — BAKER COUNTY

The Nelson placers situated at the mouth of Salmon creek in Sec. 8, T. 9 S., R. 39 E., has a reported total production in excess of $400,000. These placers have not been worked for years.

NESBIT GROUP (gold) — GALICE DISTRICT — JOSEPHINE COUNTY

The Nesbit group is about 2 miles west of Galice and at least 2 miles southwest of the Oriole mine at an elevation of about 175 feet above sea level. The group is prospected by three adits, the lowest being a crosscut S. 50° W. about 75 feet showing no vein. The middle adit is a drift extending N. 65° W. about 30 feet in a lode in a talc schist at an elevation of about 1900 feet. The upper adit runs N. 42° W. and at the face discloses the contact between talc scist and a dark bluish rock resembling dunite. The contact is marked by a fault which dips 60° N. W. Diller states that the mountain slopes at the Nesbit are covered by a deep capping of yellowish iron-stained residual material which in places yields free gold. Considerable gold has been won from this residual material by panning. The average of a number of assays is said to be $6.50 a ton, and it seems probable that it would pay well to hydraulic the whole slope.

NEW ELDORADO MINING AND REDUCTION COMPANY (gold)
NEW ELDORADO DISTRICT — GRANT COUNTY

Local name: "Pioneer Mine."

Office: Austin, Oregon. E. B. Reed, Pres.; Edwin H. Saxe, Sec.-Treas. Capital stock, $100,000; par value, $1.00; $50,000 subscribed; $1,749.50 issued. (1916 report.)

The property of this company is located in Sec. 7, T. 10 S., R. 34 E., on the southern slope of the Greenhorn range.

The country rock is granodiorite cut by numerous rather coarse-grained dikes of granodiorite-porphyry. These dikes are so much closer grained than the granodiorite that they remain hard after the granodiorite alongside has become quite soft in the altered zones. This altered zone is the peculiar thing about this property. It strikes N. 35° E., has a vertical dip and a width of something over 200 feet, and has been traced for several hundred feet. It is a soft mass of extremely altered granodiorite, in which the ferromagnesian minerals have been nearly decomposed and the feldspars have been kaolinized.

There is a large number of veins in this zone varying in width from 5 feet down to a few inches. These veins are roughly parallel to the strike of the zone. The larger veins usually consists of bluish quartz; the coloring effect is probably due to minute crystals of stibnite. One vein had a streak of stibuite about 1 inch wide, associated with small amounts of pyrite, and zinc blende. A specimen containing silver sulphide, either stephanite or pyrargyrite, was found at one point. Besides the large veins, there is a number of small veins which cut the rock in every direction. These contain some sulphides of antimony and iron.

This property is said to contain low values throughout the altered zone, but the development work consists almost entirely in drifts along the larger veins, so that there is little chance to sample in cross-cuts in the zone.

The company also owns a group of claims similar in every way to those described under the title (J. L.) Krause.

NICKEL MINES AND SMELTING COMPANY **JEFFERSON COUNTY**

Office: Portland, Oregon. Will H. Bard, 416 Pittock Block, Portland, Pres.; W. J. Maxwell, Portland, Sec.; Clarke C. Foster, Buchanan Bldg., Portland, Treas. Capital stock, $300,000; par value, $1.00; $157,000 subscribed, issued and paid up. (1916 report.)

No information could be obtained concerning the properties of this company except that it has 3 claims in Jefferson county, Oregon.

NIGHT HAWK PROSPECT (gold) **AGNESS DISTRICT** **CURRY COUNTY**

This prospect, which is owned by Frank Fry and C. W. Sinniger, occurs at an elevation of about 1750 feet as determined by the barometer, about 4 miles southeast of Agness on the ridge between the Illinois river and Indigo creek.

The deposit is a sheared and brecciated zone in a very basic greenstone which is partially altered to serpentine at some points. The ore consists principally of pyrite which occurs in kidneys or nodules irregularly distributed throughout the zone. These rounded masses are very hard and solid, and some of them are a foot or more in diameter. Attention was first attracted to the deposit by a bluish-green efflorescence which appears on the surface of the rock in wet weather. No free gold has been found in this prospect, and an assay of one of the nodules of solid pyrite yielded not a trace of that metal.

NOBLE METALS EXTRACTION COMPANY (placer) **COOS COUNTY**

Local name: "Lane Black Sand Mines."

Office: Bandon, Oregon. C. C. McIver, San Francisco, Pres.; W. W. Mendenhall, Bandon, Oregon, Sec.-Treas. Capital stock, $50,000; par value, $1.00; all subscribed, issued and paid up. (1914 report.)

This company has a 10 years lease on what is known as the "Lane Black Sand Mines" consisting of about 100 acres at the head of "The Lagoons" 6 miles north of Bandon. It is an elevated beach mine 160 feet above sea level in Sec. 33, T. 27 S., R. 14 W.

NONE SUCH MINE (gold) **UPPER APPLEGATE DISTRICT** **JACKSON COUNTY**

The None Such mine, 2 miles east of Applegate is half a mile east of Humbug creek and about as far north of Applegate river. It is owned by Longwell and Company, who report that it is opened by a shaft and about 200 feet of workings on a quartz vein. The ore is hauled to the Applegate river and treated in a 3-stamp mill run by water power, which was in operation in September, 1913.

NORLING MINE (gold) **JACKSONVILLE DISTRICT** **JACKSON COUNTY**

The Norling mine is about 4 miles west of Jacksonville and ½ mile southwest of the Yellow King and is owned by Medford Mining and Milling Co.

During June and July, 1913, Mr. Butterly was driving a crosscut adit for the company, his compensation being the right to stope a given area. During development in 1905-1907 the Norling is reported to have produced 120 tons of ore worth $6400. The main adit is at an elevation of 3130 feet as measured by aneroid barometer. For 240 feet it follows a vein which dips 75° S. with minor irregularities. The gold is said to be chiefly in the quartz; the pyrite is even more abundant in the rock adjoining the vein than in the vein itself. Considerable ore has been stoped out above this adit. The vein is 8 to 18 inches wide containing much quartz. The country rock is like that at the Yellow King. A new crosscut adit has been driven S. 13° E. about 215 feet at an elevation of about 3115 feet; it is expected that this entry will strike the vein when driven about 100 feet farther. It intersects one vein at 125 feet from the portal, which strikes N. 65° W. and dips about 65° N. A stringer at 150 feet from the portal strikes N. 83° W. and dips about 65° N., and another at 200 feet from the portal strikes N. 87° W. and dips 70° north. It is reported that further development work was done in 1916, drifting on the main vein.

The mine is equipped with a 5-stamp mill, having plates and vanner, run by engine; it has not been in operation since 1911.

NORTH FAIRVIEW MINING COMPANY (gold) BOHEMIA DIST. LANE COUNTY

Office: 38 E. 6th St., Eugene, Oregon. George W. McQueen, Pres., Cottage Grove, Ore.; Herbert Leigh, Sec., Eugene, Ore.; Darwin Bristow, Treas., Eugene, Ore. Capital stock, $300,000; par value, 10 cents; all subscribed, issued and paid up. (1915 report.)

Property consists of 15 claims located just north of Fairview mountain, in Sec. 11, T. 23 S., R. 1 E., about half a mile from Bohemia post office, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove.

The country rock is andesite. The mineralized fractured zone is said to be 12 feet wide, strikes N. W.-S. E. and dips to the south. It is said to have been traced for more than a mile and opened up with pits, etc.

Development work consists of 2 tunnels, one 300 feet long 100 feet below the outcrop; another 150 feet in length having a depth of 450 feet.

NORTH FAIRVIEW MINE BOHEMIA DISTRICT LANE COUNTY

Consists of 15 claims owned by Alfred S. Walker and George Midgely. See North Fairview Mining Company.

NORTH FORK MINE (placer) GRANITE DISTRICT GRANT COUNTY

These placers are in Secs. 32 and 33, T. 7 S., R. 35½ E. The interesting gravel deposit known as the North Fork or Klopp mine is situated on the south bank of North Fork of John Day river, opposite the mouth of Trail creek. Adjoining it on the east is the placer mine of David West on Onion creek, and to the north across the river are the now idle Dadum placers. All of these mines are situated on parts of the same or similar deposits, and may be conveniently described together.

Mining has evidently been carried on here for many years, the size of the water-supply ditches and of the abandoned portions of flumes and hydraulic equipment showing that some of the former operations were on a large scale. Records of production are lacking but the reports of miners and others familiar with this locality agree that the operations though usually profitable were never richly productive. The volume of gravel worked to date in these mines is roughly estimated to aggregate 6,800,000 cubic yards, which, at a minimum of 5 cents per cubic yard, must have yielded at least $342,000. During the season of 1914 Glenn and Henderson were operating two 4-inch giants at the North Fork mine, and David West a smaller giant on the Onion creek slope.

The gold-bearing material covers about one square mile in a compact area that lies mainly on the south side of the river. The gravel extends from the river's level about 500 feet up the hills on both sides and is shown by the workings to be 60 feet or more deep in places. In this area most of the top layer and a small per cent of the deeper portions have been mined. The few exposures of the bedrock show it to be very irregular and to contain no well-defined channel.

The gravel bed is a compact unassorted mass of sandy clay and rounded to angular cobbles and boulders. In places the latter comprise 30 or more per cent of the whole. Many of them are very large having dimensions in extreme instances as great as 10 feet. The cobbles and boulders are principally of granitic rocks with a sprinkling of schists and a small per cent of lavas. In addition a very few small cobbles of unmetamorphosed argillite are distributed through the mass. Although many of the boulders are firm and fresh looking, some are rusty and thoroughly decomposed. Fine particles of gold are distributed through the mass as deeply as it has been exposed, but accounts agree that the thin top layer is proportionately much richer than the rest. The gold is worth about $14.50 per ounce or is about 700 fine.

This heterogeneous deposit ends about one-fourth of a mile below the mouth of Trail creek, and gold has been recognized in commercial quantities for about three-fourths of a mile above the same point. The same bouldery mass extends up the valley of the North Fork and its main tributaries well into the basins in which they head, but it does not contain gold in commercial quantities.

The deposit is clearly the terminal portion of an old drift sheet laid down by the North Fork glacier. As gold-bearing moraines are very rare and of exceptional occurrence, the presence of gold in this one and its localization at the lower extremity suggest problems of particular interest. Adjoining this glacial deposit on the south is a broad valley known as Crane Flats to which Crane and Onion creeks flow from the vicinities of the La Belleview and Monumental mines. These streams, particularly Crane creek, contain gold-bearing wash that merges into the sheet of gravel covering Crane Flats. This gravel sheet is similar in composition and general characteristics to the terrace gravels of the general region, which are known to be of pre-glacial age. To the northwest across the river along Trout creek there are terraced gravels which are similar in composition and occur at about the same level as those of Crane Flats. Although now separated by the North Fork valley, 200 feet deep, these two deposits are thought to be remnants of one continuous sheet. As is discussed in the following paragraphs it is believed that this ancient gravel sheet is the immediate source of the gold in the morainal deposits of North Fork.

It is observed that all of the various kinds of rock fragments in the North Fork deposits except two, those composed of lava and argillite, can be traced to parent outcrops along the path of the North Fork glacier, and as these exceptions are the most common kinds of rocks in the Crane Flats gravels, the suggestion is had that these gravels supplied the argillite and lava cobbles and the gold as well to the newer deposit.

At the close of the terrace gravel epoch the North Fork is thought to have deepened its valley, separated the Crane Flats and Trout creek gravel sheets, and produced at this point by reconcentration of these gravels a rich placer deposit. Subsequently the glacier descended the valley, plowed up the gravels and incorporated them with its own debris, but failed to render them absolutely unworkable or to sweep them away.

Since the disappearance of the ice, ordinary weathering and erosion have slightly worn down the surface of this deposit enriching its superficial portion by removing barren soil and sand and leaving the gold behind.

NORTH GEM MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This mine is located about 1 mile north of Susanville in Sec. 5, T. 10 S., R. 33 E., about 500 feet above the town. The vein strikes north and south and dips east about 60°. An incline shaft is down about 350 feet from which 4 levels have been driven. The shoot is from 2 to at least 6 feet wide and about 300 feet long. The ore averages about $10 with concentrates $40 to $50. Seventy-five to 100 tons have been milled elsewhere and a few tons shipped crude. Only $3 to $4 is in free gold. The ore is a massive coarse intergrowth of copper, iron and zinc sulphides in quartz gangue. Country rock is argillite. The property was closed down in 1909, but in September, 1916, a carload of crude ore was sorted and shipped to smelters.

NORTH POLE MINE (gold) CRACKER CREEK DISTRICT BAKER COUNTY

Office: Baker, Oregon. Emil Melzer, Attorney-in-Fact for Baring Brothers of London, England.

John C. Lewis, of Portland, Oregon, has had a lease and bond upon the property for about 3 years and has prosecuted development on the 5th level and has run a raise from No. 1 level of the E and E mine to No. 1 level of the North Pole mine. An arrangement with the E and E mine permitted the use of their No. 1 level north for this purpose. Ore below No. 1 can now be hoisted to that level where it can be taken by aerial tram to the mill. The mill has been run for short periods only during the last two years. Very little development has been done this year (1916). For a description of the property, attention is called to the section which treats of the "Columbia Gold Mining Company" where the mines upon the North-Pole-Columbia lode are described.

NORTH SANTIAM MINING COMPANY (gold)
NORTH SANTIAM DISTRICT MARION COUNTY

This company was incorporated in 1908 with a capital stock of $1,000,000, par value of shares $1.00, but it is not listed in the office of the Corporation Department as being in good standing.

According to a prospectus of the company the property consists of 8 claims along the Little North Fork of the Santiam river about 16 miles northeast of Gates. The company reports a vein 6 feet wide which is developed by a 50-foot open cut. No activity at present.

NORTHWESTERN GOLD AND COPPER COMPANY (gold and copper)
SUSANVILLE DISTRICT GRANT COUNTY

Local name: "Chattanooga Mine."

Office: Susanville, Oregon. C. H. Duncan, Sec., Wheeling, W. Va. Capital stock, $1,000,000; par value, $1.00; $680,379 subscribed, issued and paid up. (1916 report.)

This company owns 2 claims. The Chattanooga mine is located in Sec. 5, T. 10 S., R. 33 E., in greenstone and serpentine and not far from the Compton, North and South Gem, and the vein and vein minerals are practically the same. There is a perpendicular shaft down 200 feet and the ledge is reported to be from 1 to 8 feet wide in a shoot at least 75 feet long which is reported to average about $9 a ton.

The great handicap of the companies in this group is that the ore is a massive complex sulphide and that it is located about 25 miles over a poor wagon road from Austin, the nearest shipping point.

OAK MINE (gold and copper) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Oak mine, 6 miles east of Hugo is in the S. W. ¼ of Sec. 4, T. 35 S., R. 5 W., on Jump-off Joe creek, northwest of Walker mountain. This mine is owned by G. A. Baker and George Buell, of Grants Pass, and is equipped with a 20 H. P. gasoline engine and an 8 by 8 air compressor. The main adit enters as a crosscut in greenstone (probably an altered andesite); N. 60° E. about 200 feet from the portal a winze follows the vein down about 50 feet. At the winze solid chalcopyrite ore is visible in the footwall on the main gold-bearing vein which here strikes N. 13° W. and is nearly vertical. At three other points along the drift following the gold-bearing vein small veins of copper ore are visible in the walls. The workings have a total length of about 800 feet. The minerals present in ore of the Oak mine include chalcopyrite, pyrite, pyrrhotite, sphalerite, galena, quartz, and rare malachite and pyrolusite.

One or two veins contain good copper ore.

OGLE MOUNTAIN MINING COMPANY (gold)
OGLE CREEK DISTRICT CLACKAMAS COUNTY

Local name: "Ogle Mountain Mine."

Office: 1003 Main St., Oregon City, Oregon. J. B. Fairclough, Pres.; W. J. Wilson, Sec.-Treas., both of Oregon City. Capital stock, $1,000,000; par value, $1.00; all subscribed, issued and paid up. (1916 report.)

This company's property consists of 22 claims which are located on the north side of Henline mountain at the headwaters of the South Fork of Molalla river in Sec. 9, T. 8 S., R. 4 E., reached by a poor wagon road 35 miles east from Silverton. The property can also be reached from Gates on the S. P. railroad by good wagon road for 10 miles northeast to the Silver King mine, then 4 miles by trail over the divide to the north.

The country rock on this property is very largely andesite and closely related igneous rocks. The ore body as shown by a stope in the upper workings near the surface is a well defined fissure vein with smooth, clear walls and averaging about 5 feet in width. The earlier operations on the property were conifned to the upper workings where 2 tunnels have been driven to connect with the vein and the vein stoped to a depth of approximately 200 feet from the grass roots. Some very good ore is reported to have come from this stope, being largely oxidized material having numerous particles of free gold and wire gold scattered through it. It is claimed by the company that the entire tonnage stoped netted about $5 a ton in free gold.

The development in latter years consists of a long crosscut tunnel 560 feet below the upper workings and 1460 feet long intending to cut the vein exposed above at this depth. Numerous small veins were cut with this long crosscut and an aggregate of several hundred feet of drifting on these different veins has been accomplished. The ores exposed in these veins, according to the report of the management, are usually quite low grade and the principal problem has been to determine which of these veins in the lower crosscut is the same as the more productive vein developed in the upper workings.

The company has been unfortunate in spending several thousand dollars on revising the equipment of the old mill which was ill-arranged and failed in many respects to be a success. The mill was planned and installed by an incompetent engineer who was apparently well recommended to the company. Under his advice the stamps in the old mill were thrown out and the ore fed directly from the crusher to the tube mill, the individual pieces of the ore being about the same size as the grinding pebbles. An attempt was further made to experiment with some untried schemes of agitation in the cyanide plant rather than accept standard successful agitation processes. In numerous other regards the installation was ill-advised, with the result that the experiment was entirely unsuccessful. The failure of the mill to do what was expected of it has been quite discouraging to the stockholders with the result that little activity is now in evidence at the property.

OLD CHANNEL HYDRAULIC MINING CO. GALICE DISTRICT JOSEPHINE COUNTY

The old Channel Hydraulic Mining Company (dissolved January 5, 1914,) controls a large area of "high level" placer deposits near Galice; they form a gravel terrace parallel to Galice creek and Rogue river and more than 2 miles long. The terrace is about 600 feet above the creek and has a thickness of over 100 feet. The bedrock consists chiefly of argillites of the Galice formation. The main ditch from Galice creek is said to supply 5000 miner's inches of water during the rainy season; the giants work under a head of about 350 feet. According to Diller, who gives a detailed description of this deposit with several drawings:

The coarse gravel at the bottom is well rounded and composed largely of greenstone with considerable quartz. Cobblestones as large as 8 inches in diameter are common.

North of Rich gulch boulders are numerous, but on the south side boulders are few, and the gravel is quite firmly cemented. This coarse bottom layer of gravel and boulders is limited to the main channel and contains most of the gold, although some gold is said to be distributed throughout the great thickness of overlying fine gravel and sand. A large body of available gravel lies south of Rich gulch where most of the recent work has been carried on. The bedrock is chiefly slate with some sandstone, but near the western border of the mine north of Rich gulch the slates are cut by dikes and both rocks are affected by a small fault that strikes N. 80° W. and dips 72° S. W.

Other faults are believed to exist in the bedrock of these deposits.

OLD GLORY GOLD MINING COMPANY (copper-gold-silver) GALICE DISTRICT JOSEPHINE COUNTY

Local name, Old Glory mine.

Office: Grants Pass, Ore. C. L. Mangum (deceased) Pres.; William Stock, Sec.-Treas., both of Grants Pass. Capital stock $1,000,000; par value, $1.00; all subscribed, $604,200 issued and paid up. (1916 report.)

This company owns the Old Glory mine on Silver creek, 25 miles due west from Grants Pass, which consists of 4 lode and 2 placer claims, said to show a large lode of low-grade copper ore carrying gold and silver values.

In 1914 the development work consisted of 2 tunnels 40 feet in length exposing a quartz vein which is said to average $10 a ton in gold. The ledges run in a general east and west direction. In 1915 $1200 worth of development was done.

OLIVE CREEK MINING COMPANY (placer) GREENHORN DIST. GRANT COUNTY

Office: Baker, Oregon. Thomas M. Tobin, 9332 South Chicago Ave., Chicago, Ill., Pres., S. A. Tobin, Baker, Sec., Adam J. Weckler, 3446 Broadway, Chicago, Ill., Treas. Capital stock, $1,000,000; par value, $1.00; all subscribed, issued and paid up. (1916 report.)

This company owns the Olive creek and Quartz gulch placers joining the Golden Gate lands, in sections 2, 3, 10 and 11, T. 10 S., R. 35 E.

OPHIR MAYFLOWER MINE (gold) OCHOCO DISTRICT CROOK COUNTY

Owned by A. J. Champion of Howard, W. T. Davenport and E. A. Davenport of Prineville, and Julius McAllister.

Property is located in the Ochoco National Forest in Sec. 30, T. 13 S., R. 20 E. The nearest postoffice is Howard, about 8 miles distant. There is an excellent road through Howard to Prineville, a distance of 26 miles from the mine. The nearest railroad station is Redmond, a distance of 15 miles beyond Prineville. The country is somewhat rugged and is well timbered. The region is made up of a series of andesitic flows interbedded with which are andesitic tuffs and breccias. Mineralization has taken place in rather wide fractured zones in which the country rock is much altered.

On the surface above the workings (after the soil has been stripped), the intensity and width of the mineralization is quite noticeable. At a distance of several hundred feet on the other side of the hill, from the mill and principal development, some placer work is being carried on. Placer deposits seem to be almost of the residual type, in that the gold has not been carried to any great distance. In fact, in many cases short prospect tunnels have been driven in the mineralized bedrock after the soil had been washed off.

The development work consists of a 1400 foot crosscut on the mill level and one a few hundred feet in length about 200 feet above. There are short 100-200 foot drifts running in each direction from the lower crosscut along the fractured zones. Also raises and some ore has been stoped. The ore from one stope having a width from 1 to 6 feet, a vertical length of 250 feet and a horizontal length of 70 feet, was shipped and is said to have averaged $70 per ton. Another shoot called the Ophir shoot 20 feet long, with a maximum thickness of 4 feet is said to average $125 per ton. It has been stoped for 40 feet vertically. A large part of the ground cut by the main adit is said to average about $3 per ton.

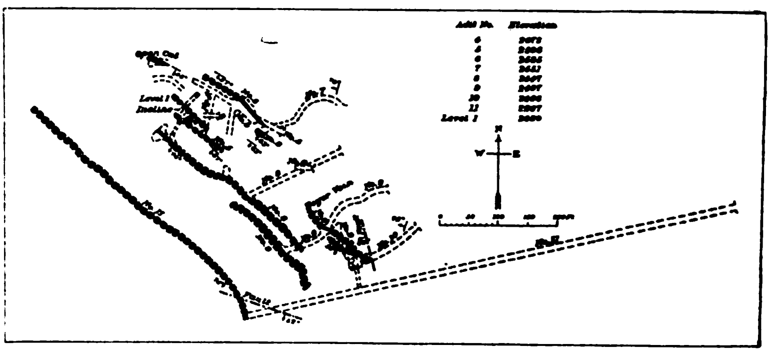
There is a small stamp mill with amalgamating plates and concentrators on the property.

OPHIR MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

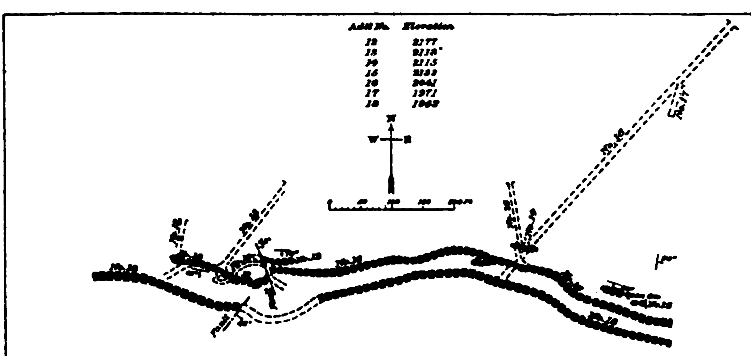
This mining prospect, which is on the same side of Elk creek as the Badger mine and not far from it, is inactive .

OPP MINE (gold) JACKSONVILLE DISTRICT JACKSON COUNTY

The Opp mine was discovered many years ago, but its chief development has taken place within the past 10 years. According to Mr. Beekman, the banker at Jacksonville, the mine produced about $100,000 while controlled by him. Since then it has been operated by a company, by Mr. J. W. Opp, and by lessees. The mine is located in sec. 36, T. 37 S., R. 3 W. about 1½ miles west of Jacksonville at elevations ranging from about 1850 to 2850 feet above sea level. The land held by the mining company includes nine 40-acre plots and 1 mining claim, making a total of 373 acres. It is opened by 18 adits disclosing three main veins. The longest crosscut entry is about 850 feet; another is 550 feet long. The total underground workings amount to about 7000 feet, the distribution of which is shown in the figures. The surface equipment con-



Opp mine, east workings



Opp mine, west workings

sists of about 3600 feet of tram line, a 6-drill Leyner compressor, a 20-stamp mill with concentrator, a 125-ton cyanide plant, and other buildings. The mill has a crusher, a Dorr classifier, 1 Wilfley and 6 Johnson concentrators, 20 stamps and 4 plates.

The adit 10 or Roger vein is apparently the same as the adit 7 vein, although it is not easily seen in adit 8 which it should cross at a point about 60 feet from the portal. At the breast of adit 7 a slip or fault strikes north and dips 50° E.; its effect on the vein is not clear because of lack of development work. The Roger vein strikes N. 60° W. and dips 50-63° S. W. It has a thickness of 3 to 12 feet of which 2 to 4 feet usually contain most of the gold. The hanging wall is well defined, but the vein grades into the footwall, which is replaced or impregnated with ore. The footwall in adit 10 is a dark shaly rock which strikes N. 5° W. and dips about 84° E. Near the portal of adit 7 the footwall shale strikes N. 15° E. and dips about 70° W. This shaly rock is interbedded with quartzite samples of which from the hanging wall of adit 10 consist of fine granular quartz in places, in bands of varying size with more or less yellowish brown iron stain and rare crystals of pyrite; less commonly the stain is chloritic. In some places the ore is brecciated, and the original quartz is coarse and contains very little pyrite, which is found especially in the cementing material of calcite and quartz and also in fragments of carbonaceous shale. This is evidence that the ore was formed not at the time when the veins were first produced, but at a later time when they were fractured and new solutions brought in cementing materials. According to Mr. Opp the pay shoots are usually where the veins are thickest; in other mines when the ore is deposited simultaneously with the gangue this rule is usually reversed, and the condition at this mine is another indication that the gold was introduced after the deposition of the primary quartz of the veins.

The adit 8 vein is the southwest vein in adits 5 and 9 and is also seen in incline shaft 2 and probably in the old surface stopes. On adit 5 level this vein has a thickness of about 4 feet; it strikes about N. 50° W. and dips about 60° S. W. The country rock is a siliceous argillite containing some chlorite and pyrite.

The adit 1 vein is probably the same as the vein near the breast of adit 2; it may be continuous with the adit 8 vein, but there are no workings to prove the connection. In adit 1 the vein strikes N. 57° W. and dips about 75-80° S. W. It has a thickness of 14 feet, 8 or 10 feet of which on the footwall have been stoped out to the surface. The country rock of the vein is an adesite rich in ferromagnesian minerals. A sample from near the portal contains abundant green hornblende, some brown hornblede, some plagioclase, some biotite, titanite, and a little quartz. This andesite is so intimately associated (as an intrusive sill?) with the old Paleozoic sediments that upon weathering it develops a schistosity nearly parallel with the bedding of the latter; near the portal of adit 1 this schistosity strikes N. 10° W. and dips 70° E.

The adit 2 vein (near the portal) has not been traced elsewhere; it strikes N. 65° W. where cut by the adit about 50 feet from the portal. It is possible, but not probable, that this is the same as the Roger vein.

The adit 11 vein is probably the downward continuation of the adit 8 vein, or possibly of the Roger vein. If the former interpretation is correct the Roger vein is probably represented by the small vein about 85 feet east of the main vein. The small vein strikes N. 53° W. and dips about 54° S. W.; it contains about one foot of quartz and 2 or 3 feet of sheared country rock. About 10 feet farther in a shear zone strikes N. 72° W. and dips 54° S. This is visible again where it crosses the drift not far from the crosscut; here it has the same strike and dip and a thickness of about 10 inches, but produces no apparent offset in the main vein. The latter is opened by a drift said to be 500 feet long disclosing a vein varying in thickness from 5 feet to a maximum said to be 25 feet. It strikes about N. 45° W. and dips about 75° S. W. Too much water prevented its inspection.

The adit 18 vein is shown by continuous stoping above that level to extend upward to adits 16, 15, 14, and 13. It varies in strike from N. 70° W. to S. 75° W., averaging nearly west, and dips about 68° S. The vein is continuous on the strike except where cut by a fault, shown clearly in the east drift from adit

13, which strikes N. 20° W. and dips about 65° E. On level 18 a fault block seems to separate the two parts of the vein and the west side of the block is marked by a fault which strikes about N. 38° E. and dips 42° S. E. The vein is largely quartz and averages about 5 feet thick. The value is said to increase where the thickness increases, being about $5.00 a ton in the ore shoots. One ore shoot is about 300 feet long on this level; another is about 150 feet long. The longer one did not reach the surface by 40 or 50 feet in its middle half. After amalgamation ore from this vein concentrates about 40 into 1 and the heavy sulphides are worth about $60 a ton. A rock sample from the crosscut entry (adit 18) contains abundant pale hornblende, some zoisite, calcite, and quartz, with a dark staining material; it is a much altered rock, probably originally a quartzose shale.

Mr. Opp has continued development in a small way during 1916, most of which has been on a new surface showing a few hundred feet south of the mill which he calls the porphyry vein.

The mine as a whole is in good shape and has a large amount of excellent equipment. A considerable additional expenditure is warranted in the further development of ore bodies already exposed in the mine and in arranging the mill to treat the same according to the best milling practice.

OREGON ASBESTOS MINES CANYON DISTRICT GRANT COUNTY

Office: 201 Stock Exchange Bldg., Portland, Ore. Joseph Woerndle, Pres.; E. Sturchler, Ses.; Otto Berg, Treas., all of Portland. Capital stock, $5,000; par value $100; all subscribed, issued and paid up. (1916 report).

This asbestos property is located about 5 miles up Beach creek from Mt. Vernon, in the northeastern part of T. 13 S., R. 30 E. It is about 27 miles from the Sumpter Valley railroad at Prairie City. A great deal of activity was reported on this property in the latter part of 1915 and the first half of 1916. Some $6000 to $7000 was spent in development work on a deposit containing stringers of chrysotile distributed over a width of 300 feet and a length of 2000 feet. A few tons of asbestos was shipped to market but in June, 1916, operations were suspended for a time at least. The quality of the fibre was said to be very fine but was not sufficient to justify the operation of the property.

OREGON BELLE MINE (gold) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Oregon Belle mine, 8 miles by wagon road southwest of Jacksonville, is in the south half of sec. 6, T. 38 S., R. 3 W. near the head of Forest creek at an elevation of about 3000 feet. It is opened by several adits. The country rock is andesite and argillite. The vein is well defined and reaches a thickness of at least 8 feet in some of the stopes; it strikes S. 72° W. and dips 52° N. W.; it is cut off by a fault which strikes N. 64° W. and dips 74° N. E. The rock within and beyond the big fault 20 feet wide crossing the entry about 220 feet from the portal and dipping 75° S. W. is much altered by vein solutions. There are several adits above the main entry but they are caved and closed. One of them has a large dump at an elevation of 3250 feet. The mine was operated several years ago by a stock company. It is now owned by Minnie Ireland of Grants Pass.

OREGON BONANZA MINE (gold) LOWER APPLEGATE DIST. JOSEPHINE COUNTY

The Oregon Bonanza mine, 12 miles south of Grants Pass and 3 miles southwest of Provolt, is in the S. W. ¼ sec. 16, T. 38 S., R. 5 W., south of Powell creek at an elevation of 2100 feet, as measured by barometer. The country rock is greenstone cut by aplite dikes. All the adits are caved and the mine buildings are in ruins. It is at present under option by Edward Layton of Applegate and J. M. Letherow of Grants Pass.

OREGON AND BRITISH COLUMBIA MINING AND DEVELOPING COMPANY
CANADA

Office: 826 Northwestern Bank Bldg., Portland, Oregon. W. J. Peddicord, Hood River, Oregon, Pres.; G. Evert Baker, 826 Northwestern Bank Bldg., Portland, Sec.-Treas. Capital stock $150,000; par value ten cents; $109,149.30 subscribed, issued and paid up. (1916 report).

Own Crown granted lands, Copper Mountain, Princeton, B. C., Canada.

OREGON CHIEF GOLD MINING COMPANY (gold) CABLE COVE DIST. BAKER CO.

Local name: "Oregon Chief Group."

Office: Baker, Oregon. J. T. Donnelly, Nortonia Hotel, Portland, Oregon, Pres.; Thomas Thornton, Sec.-Treas., Baker, Oregon. Capital stock, $1,000,000; par value, $1.00, all subscribed, issued and paid up. (1916 report.)

Eleven miles by wagon road northwest from Sumpter, a station on Sumpter-Valley R. R. (narrow gauge) in Sec. 22, T. 8 S., R. 36 E. Elevation 7000 feet in timbered area at head of Silver creek. Lands, 4 claims located in granodiorite area one mile south from Imperial mine on opposite side of Silver creek. Little work has been done upon the property recently.

OREGON FREEGOLD MINING COMPANY (gold) WEATHERBY DIST. BAKER CO.

Local name, Free Gold Group.

Office: Prairie City, Oregon. W. J. Hughes, Pres.-Treas.; Miss D. E. Hughes, Sec., both of Prairie City, Oregon. Capital stock, $150,000; par value ten cents; $133,478 subscribed, issued and paid up. (1916 report.)

Company owns 11 claims in Lost Basin 6 miles southwest of Durkee, Burnt river drainage, on the eastern slope of Pedro mountain at an elevation of about 4500. The region is made up of argillites and intrusive granodiorite. This is an old prospect but little has been done upon it the last few years. It is in litigation with homesteaders.

OREGON GOLD MINES COMPANY (gold and copper) (Arizona corporation)
GRANTS PASS DISTRICT JOSEPHINE COUNTY

Local name: "Granite Hill Mine."

Office: 1208 West Monroe St., Chicago, Ill. Elmer E. Dick, 736 W. Jackson Blvd., Chicago, Pres.; J. M. O'Grady, 854 Lakeside Place, Chicago, Sec.; Henry F. Comstock, 1262 Carmen Ave., Chicago, Treas.; H. D. Norton, Grants Pass, Oregon, Attorney in Fact. Capital stock, $2,000,000; par value, $1.00; $2,000,000 subscribed and paid up, $1,657,436 issued. (1916 report.)

The Granite Hill mine is in the S. W. ¼ Sec. 29, T. 35 S., R. 5 W. about 9 miles northeast of Grants Pass by wagon road. The mine was bought in 1901 by the American Goldfields Company, and developed extensively between 1902 and 1907 with a resultant production of about $75,000. It was closed early in 1908, and is now owned by the Oregon Gold Mines Company.

The mine is equipped with a 20-stamp mill, having four 10-foot amalgamating plates, 6 Frue vanners installed and 2 more vanners available, a crusher, a 150 H. P. electric motor, and other accessories. The mine has also an air compressor, a steam hoist, and 5 machine drills.

The mine is opened by a vertical shaft said to be 430 feet deep, now filled with water. It is reported to be developed by about 5000 feet of workings on the 2nd level and about 7000 feet on the other levels. The vein is said to attain a width of 12 feet on the 3rd level and 14 feet on the 4th level; it has an average width of about 5 feet, and strikes about east and west and dips about 70° S. The vein filling consists of quartz, chalcopyrite, galena, and pyrite, carrying gold. The sulphides make up less than one percent of the ore and as concentrates they carry from $75 to $100 a ton, and are shipped to the smelter at Selby. The average value of all the ores treated in 1907 was about $5 a ton.

The country rock is a tonalite grading toward granodiorite containing abundant plagioclase and quartz with some orthoclase, and pale green hornblende altering to chlorite. According to Kay this outcrop is part of a narrow tongue which extends southward into the Grants Pass quadrangle from a larger area of tonalite in the Riddles quadrangle. To the east of the tongue is greenstone, to the west is serpentine. At the Granite Hill mine the ores are found in a vein in tonalite; at the neighboring Red Jacket and Ida claims, owned by the same company, they occur in greenstone.

According to C. M. Morphy, former superintendent of the mine, the richest ores were found in 3 shoots each having a length along the vein of about 150 feet and a pitch to the west of south. The zone of oxidation extends to a depth of more than 200 feet from the surface, and the oxidized ores were more valuable than the sulphide ores.

The Red Jacket claim has quartzose ore carrying chalcopyrite, galena and pyrite; alteration produces malachite and chrysocolla. The vein is said to be about 18 inches wide and of high grade in gold. It is reported to strike about northeast and dip about 45° N. W.

The main adit on the Ida claim is at an elevation of 2300 feet as measured by barometer; a quartz vein here strikes N. 65° W. and dips 70° S. W.; the vein is 3 to 30 inches thick and nearly pure quartz; it is cut off at 46 paces from the portal by a fault which strikes N. 25° W. and dips 45° S. W.

OREGON GOLD PROSPECTING AND PROMOTING COMPANY

Office: Chamber of Commerce Building, Portland, Oregon. W. M. Cake, Chamber of Commerce Bldg., Portland, Pres.; O. G. Hughson, 201 Wooster Bldg., Portland, Sec.; J. P. Newell, Spalding Bldg., Portland, Treas. Capital stock, $18,000; par value, $100; $12,000 subscribed, issued and paid up. (1916 report.)

OREGON-IDAHO LEASES

Office: Care W. S. Moore, Yeon Bldg., Portland, Oregon. Wm. W. Elmer, 717 E. Broadway, Portland, Pres.; W. S. Moore, 507 Yeon Bldg., Portland, Sec.-Treas. Capital stock, $20,000; par value, $20.00; $10,020 subscribed, issued and paid up.

This company owns no properties at present. The corporation is kept alive pending settlement of lawsuit in Idaho. (1916 report.)

OREGON-IDAHO INVESTMENT COMPANY **BAKER COUNTY**

A corporation, capitalized for $50,000; par value $100; all subscribed, issued and paid up. James A. Howard, Pres.; Fred R. Mellis, Sec.-Treas.

The company's principal business at the present time is ore buying. A sampling plant is owned by them.

They formerly operated the Sovereign Consolidated Copper Company, Imperial Mining Company and recently the Humbolt Consolidated Gold Mines Company. All these properties are now inactive. They own the "Poorman mine" (prospect) and have recently taken a lease and bond on the Taber Fraction mine.

OREGON KING MINE (gold, etc.) **ASHWOOD DISTRICT** **JEFFERSON COUNTY**

Principal owners, J. B. Cartwright of Portland and J. G. Edwards of Portland. Located in Sec. 30 and 31, T. 9 S., R. 17 E., about 2 miles from Ashwood, which is 25 miles south from Shaniko, the railroad point.

The country rock is andesite and mineralization occurs in a brecciated steep-dipping zone. The width of the lode varies. At 170 feet below the collar of the shaft, it is about 20 feet. The ore bearing minerals are pyrite, galena, sphalerite, a little chalcopyrite, and horn, ruby and native silver. There are lenses of massive sulphide material in the main vein.

The mine is developed by a shaft 640 feet deep with about 450 feet of drifts altogether. A crosscut 400 feet long connects with the shaft 170 feet below the collar. The property is patented and has been idle for several years.

OREGON MANGANESE COMPANY (manganese) GREENBACK DIST. JOSEPHINE CO.

Office: Portland, Oregon. J. H. Haak, 311 Lumbermens Bldg., Portland, Pres.; H. K. Haak, Portland, Vice-Pres.; I. Lowengart, Broadway and Burnside Sts., Portland, Sec.-Treas. Capital stock $20,000.

This company has filed on a number of claims on Coyote creek, 6 miles east of Wolf creek station. Development work has been prosecuted on a showing of manganese ore but December first, 1916, was stopped on account of the winter weather. Further work will be undertaken at this property in the spring.

OREGON MINES CORPORATION BOHEMIA DISTRICT LANE COUNTY

Office: Eugene, Oregon. L. C. Hurd, Pres.; Herbert Leigh, Sec.-Treas., both of Eugene, Oregon. Capital stock, $15,000; par value, $100; all subscribed, issued and paid up. (1916 report.)

Property consisting of 11 mining claims is located near the corner of Secs. 7, 8, 17 and 18, T. 23 S., R. 2 E., about 3 miles from Bohemia post office, which is about 15 miles southeast of Disston, the terminus of a 20-mile branch railroad from Cottage Grove.

OREGON MINING AND POWER COMPANY (placer) DOUGLAS COUNTY

Office: Glendale, Oregon. C. R. Shipman, Glendale, Pres.-Treas.; A. M. LaFayette, 82 Beaver St., New York, Sec. Capital stock, $500,000; par value, $1.00; all subscribed, issued and paid up. (1915 report.)

This company's placer mine has been operated for a great many years up to the last 2 years. It is located 7 miles west of Glendale near Tunnel 7 on the Southern Pacific railroad.

The property consists of 320 acres operated with giants under 350-foot head with flume on 8 inch grade and an 80-foot dump into Cow creek. Gold runs 20 cents or better per yard, about 900 in fineness, which has always sold from $18.25 to $19.25 per ounce.

The property has been practically idle for the last 2 years owing to the unusually cold weather and lack of water.

OREGON-MONTANA MINING, MILLING AND MANUFACTURING COMPANY

Office: Wilcox Building, Portland, Ore. John D. Fletcher, Hood River, Ore., Pres.; H. S. Reed, Portland, Sec.; A. L. Reed, Portland, Treas. Capital stock $20,000; par value $10; all subscribed, issued and paid up. (1916 report).

OREGON NICKEL MINING COMPANY (nickel) RIDDLE DIST. DOUGLAS COUNTY

Incorporated under the laws of California; capital stock, $500,000.

The property is reached by a good wagon road 5 miles west of Riddle station on the Southern Pacific Railway. There are 816 acres patented, un-

In certain parts of Nickel mountain the basic igneous rocks have been

der the management of W. Q. Brown of Riddle.

The rocks in the neghborhood of Nickel mountain are mostly of a basic igneous variety called peridotite by Diller. The nickel ore is a silicate of nickel, genthite, and is found in veins or irregular bodies, probably produced by the action of rising hot waters from some deeper seated magma.

These nickel deposits have been prospected quite extensively and considerable effort has been made to satisfactorily solve the ore treatment problem in order to make the mine commercially successful. No satisfactory solution has yet been reached.

In certain parts of Nickel mountain the basic igneous rocks have been altered to serpentine and considerable bodies of chromic iron ore are found similar to its occurrence in other sections of southwest Oregon. Some of these chromite deposits have been developed somewhat, a few cars being shipped during the past summer by the Oregon Nickel Mining Company to the Illinois Steel Company, which Mr. Brown states average 55 per cent chromic oxide.

OREGON OIL COMPANY

Articles of incorporation filed July, 1916, by G. W. Evans, E. E. Gaucher, A. C. McKinnon and nine others. Office: McMinnville; capital stock $25,000; par value, $1.00.

OREGON PITTSBURG MINING COMPANY (gold) VIRTUE DIST. BAKER COUNTY

Local name: "Norwood Mine."

Office: Baker, Oregon. Alma Williams, Pres.; Melda E. Paulson, Sec.; Anna Williams, V. Pres.-Treas. Capital stock $100,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

Lands consist of 4 quartz claims, Juniper, Wren, Albatross and Magnet. The property is situated in sec. 8, T. 9 S., R. 41 E., about 7 miles by wagon road from Baker and about 2 miles north of the Virtue mine. It is at an elevation of about 3900 feet, in sage brush covered hills on the west side of Virtue flat.

The Norwood mine, near the Virtue, is in similar greenstone, which is more altered. There are several veins, most of them too small to be considered seriously. Quartz and calcite are the vein minerals which in many of the veins has been shattered and slickensides are present as a result of these movements since the vein was formed. The largest vein is an E.-W. steep dipping vein, consisting of quartz, gouge and altered rock. The average width of this vein for 450 feet is about 2 feet. In 1913 a small mill was installed, but no idea of the value of the ore could be obtained and apparntly no systematic sampling has been done recently.

Assessment work upon the 4 claims owned by this company was about all that was done in 1915 and 1916.

OREGON PLACER COMPANY JOSEPHINE COUNTY

Articles of incorporation filed in 1915 by H. K. Owens, John C. Eden, Chas. L. Creelman, with office at Grants Pass. Capital stock $15,000; par value $1.00.

OREGON STRONG LEDGE MINING COMPANY (gold)
LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

Local name: "Michigan Mine."

W. G. Wisner, Pres.; D. C. Hoedemaker, Sec.; F. J. Knight, treas., all of Charlotte, Michigan. Capital stock $1,000,000, par value $1.00; $636,893 subscribed, issued and paid up. (1916 report).

This company owns 80 acres deeded land, 3 lode claims of approximately 60 acres and a placer claim of 20 acres in sec. 16, T. 37 S., R. 5 W. The Michigan mine is about 6 miles south of Grants Pass and about 1½ miles west of Murphy, near the mouth of Board Shanty creek at an elevation of about 1300 feet as measured by barometer. It is equipped with a 64 H. P. engine, a hoist, and an air compressor operated by steam power, as well as a 5-stamp mill having a rock crusher, an 8-foot amalgamating plate, 2 jigs, 3 settling tanks and 1 slimer. The ore has been concentrated 10 into 1, and the concentrates sent to a smelter. The vertical shaft is said to be 130 feet deep with two levels; being full of water it could not be inspected when the mine was visited in August, 1913. The main vein strikes S. 73° E. and dips about 75° N. E.; it is 1 to 3 feet wide and contains pyritized quartz. It has been stoped out for about 100 feet along the surface to a depth of about 60 feet. An adit has been driven N. 38° W. about 45 paces to tap another vein which has not yet been reached. There has been no activity at this property since 1913.

OREGON UTAH MINING COMPANY CANYON DISTRICT GRANT COUNTY

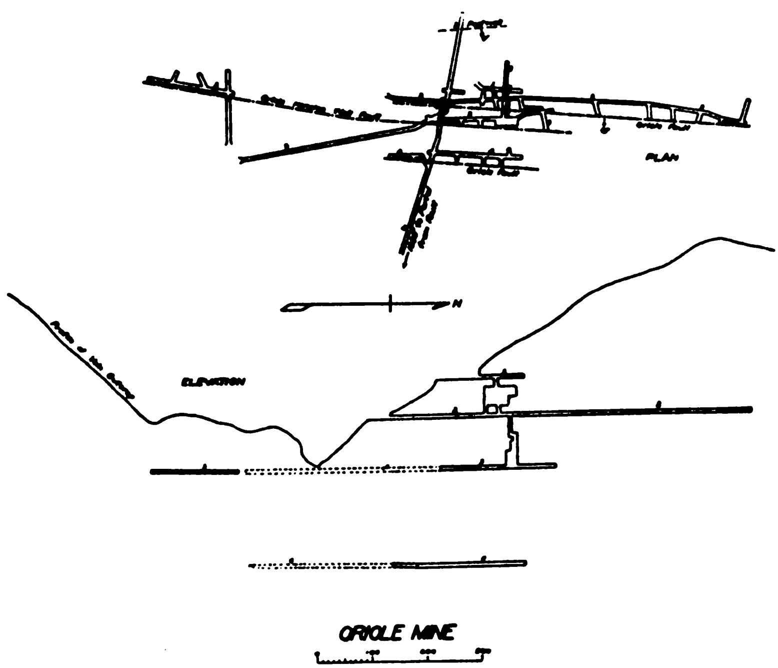
See "Great Northern Mine."

ORIOLE GOLD MINING COMPANY (gold) GALICE DIST. JOSEPHINE COUNTY

Local name: "Oriole Mine."

Office: Dayton, Ohio. Wirt Piper, Grants Pass, Oregon, Pres.; Miss Leah L. Russell, Dayton, Ohio, Sec.-Treas. Capital stock, $1,000,000; par value 10 cents; $650,000 subscribed; $525,000 issued and $520,000 paid up. (1916 report).

The Oriole mine is about 2 miles northwest of Galice on Rocky gulch at an elevation of about 1100 to 1400 feet above sea level and 300 to 600 feet above Galice. The Oriole Gold Mining Company, which was organized in 1909, owns 9 claims, 8 of which are arranged in 2 tiers with common end lines extending about 3000 feet north and south and 2400 feet east and west. The illustration shows a plan and section of the workings as prepared in 1911 by F. A. Jones, who had charge of the development. As shown in the section



Plan and elevation, main workings Oriole mine

the vein is opened on 4 levels to a maximum depth of about 500 feet below the outcrop and 325 feet between levels. The total length of underground workings on the four levels is more than 3200 feet.

The company has installed a power plant consisting of a Pelton wheel under a head of 350 feet; sufficient water is available, at least in the wet season, to run a 12x12 air compressor for two drills and a 7½ kilowatt D. C. generator at 115 volts. Stamp mill machinery was on the ground, but not yet installed in 1913. It included a jaw crusher, 10 stamps of 1000 pounds each, two plates, and 2 vanners.

The Oriole workings disclose a fault marked by 6 to 12 inches of soft bluish-gray to dark green gouge and continuous with little variation in strike and dip for considerable distances. The average strike of the fault is N. 5° E.; the walls vary locally to N. 7° W. and N. 12° E.; the average dip is about 75° E. and the variations are usually between 65° and 80°. The fault is on the contact between greenstone and a rhyodacite porphyry, showing evidence of brecciation, apparently due to flowage while cooling. In thin section the rock shows phenocrysts of quartz and of more or less broken orthoclase and plagioclase, partly altered to zoisite and epidote, in a finely granular party banded matrix of quartz, feldspar, sericite, and biotite.

It is more siliceous than an average quartz latite or rhyodacite and too high in soda and too low in potassa for a granite. But the alkali ratio combined with the microscopic study make it clear that the rock must be considered a silicified rhyodacite.

The greenstone near the vein is much sheared and chloritized. The ore is a milky to grayish quartz which occurs in lenses near the fault in the greenstone footwall, and carries a little pyrite and chalcopyrite. The ore is said to average $15 to $20 a ton.

The property has been in litigation for several years. It is reported that it was placed in the hands of a receiver in March, 1916, and that all indebtedness has been paid. It is expected that further operations at the property will be started soon.

ORNAMENT GOLD AND SILVER MINING COMPANY (gold, etc.) GREENHORN DISTRICT GRANT COUNTY

Local name: "Ornament Mine."

Office: 215 North 24th St., Portland, Oregon. H. H. Stephenson, Pres.; Bertha E. Martin, Sec.; Sadie A. Stephenson, Treas., all of Portland, Oregon. Capital stock, $25,000; par value, $1.00; all subscribed, issued and paid up. (1915 report.)

This company owns 4 quartz claims in the upper drainage basin of Granite Boulder creek about 7 miles above the mouth of Granite Boulder creek, in Sec. 11, T. 10 S., R. 34 E., on the east side of the creek. There is no road up this creek from the Thomas ranch on the Middle fork, but these claims are reached by a wagon road from Greenhorn, a distance of about 7 miles.

The vein is located near a contact, where granodiorite forms the footwall and argillite and limestone the hanging wall. It is a fault contact for only a part of the vein. Quartz is the gangue and the ore minerals are arsenopyrite, pyrite, zinc blende, chalcopyrite, galena and tetrahedrite. It contains moderate values in silver and gold. The maximum width is about 3 feet. The property is developed by 3 long drifts upon the vein. Small shipments have been made from the property, but the values per ton are too low to ship the crude ore.

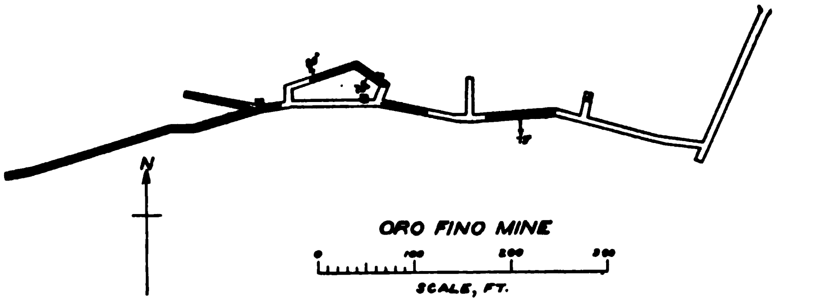
ORO FINO MINE (gold) GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Oro Fino mine, 9 miles southeast of Hugo, is in the southeast corner of sec. 3, T. 35 S., R. 5 W., south of Jump-off-Joe creek, at an elevation of about 2800 feet, as measured by barometer. It is owned by Saul Stone of Grants Pass and Seymour Bell of Portland.

It has recently been renamed the Gold Drift mine; it is equipped with a 5-stamp mill having a 10-foot amalgamating plate, a concentrating table, and suitable boiler and eigine. It is only half a mile southwest of a ridge of "granite" which is probably part of the tongue of tonalite extending southward to the Granite Hill mine.

The main adit of the Oro Fino leads to about 1300 feet of crosscuts and drifts, nearly 1000 feet being on one or more veins which are persistent and fairly regular in their course. The country rock is a greenstone, which seems to be an altered andesite, containing abundant small crystals of hornblende.

some plagioclase phenocrysts, some epidote, little pyrite, quartz and chlorite. The workings on the main level are shown in the figure. The vein filling con-



Main adit Oro Fino mine. Main vein in solid black

sists of quartz which has been broken in many places wth later introduction of calcite and pyrite. The iron sulphide is also found commonly scattered through the country rock, especially in fragments of the latter, which are in or near the veins. Work was in progress at the Oro Fino in 1913, but for the most part it was in shallow workings some distance from the main adit.

OSCAR CREEK CONSOLIDATED MINING COMPANY (placer) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

Local name: "Jewell & Moore Group."

Office: First National Bank Bldg., Grants Pass, Oregon. Charles Burkhalter, Pres.-Treas.; Alva H. Gunnell, Sec., both of Grants Pass, Oregon. Capital stock $250,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company has the Jewell and Moore group of 5 placer claims, 3 being patented; the Swinded claim, unpatented; Carson group of 2 claims, unpatented; together with 92 additional acres of patented right of way and dump grounds located in Secs. 14, 15, 22 and 21, T. 37 S., R. 5 W., 2 miles east of Murphy and about 10 miles south of Grants Pass.

The equipment on this property consists of 2 giants, 1100 feet of pipe, 300 feet of flume and 3 miles of ditches. The water supply is sufficient for operations about 4 months in the year. It is said that the property has produced more than $40,000 to date.

OSGOOD MINE (placer) WALDO DISTRICT JOSEPHINE COUNTY

For description see "High Gravel Mine."

PADDY CREEK MINE (gold) EAGLE CREEK DISTRICT BAKER COUNTY

This property is located on Paddy creek in Sec. 15, T. 7 S., R. 44 E. A gold quartz property with crusher, 10 stamps and amalgamating plates. Has a small production from occasional operation of mill. Several hundred feet of development has been done in opening up lens-like veins in sedimentary rocks.

PANTHER CREEK MINING COMPANY JOSEPHINE COUNTY

Office: Grants Pass, Oregon. Louis F. Kramer, Pres.; Henry W. Snyder, Sec.-Treas., both of Reading, Pa. Capital stock, $250,000; par value, $1.00; $150,000 subscribed, issued and paid up. (1916 report.)

PARADISE MINE (gold) MULE CREEK DISTRICT CURRY COUNTY

Owned by G. W. Billings and others. It is near line between T. 32 and 33 S. in R. 10 W. on west side of the southern peak of Saddle mountain near the top and about 6 miles by trail from the mouth of Mule creek at Rogue river. Elevation 3200 feet.

Property developed by drifts about 300 feet long on a broken faulted vein in greenstone which strikes N. 85° west and dips 60 to 70° southwest and is from a few inches to 4 or 5 feet wide consisting of much quartz and vein material with some cross-faulting of vein. Values stated as averaging $10 per ton in gold with some high grade bunches.

PARKERVILLE DIGGINGS GREENHORN DISTRICT BAKER COUNTY

See "Winterville and Parkerville Diggings" for description.

PARK MINING COMPANY

Office: Salem, Oregon. John E. Steen, Pres.; W. Y. Richardson, Sec.-Treas. Capital stock, $25,000; par value $1.00; $16,791 subscribed; $4806.85 issued and paid up. (1916 report.)

This company was organized in March, 1916. It owns no property as yet.

PAYMASTER MINING AND MILLING COMPANY (lead, gold and silver) QUARTZVILLE DISTRICT LINN COUNTY

Local name, Paymaster mine.

Office: 399 East Forty-seventh St. N., Portland, Oregon. H. L. Cox, Pres.; Frank Converse, Sec., both of Portland. Capital stock, $1,000,000; par value $1.00; $594,013 subscribed, issued and paid up. (1913 report).

Property located in Secs. 1 and 2, 11 and 12, T. 12 S., R. 4 E., 28 miles southeast of Gates. An old wagon road leads to within 3 miles of the property. It is reported by the managament that a 130-foot drift has been driven upon a vein in which 14 inches will run from 75 to 90 per cent galena and the entire vein will average as much as $25 per ton in lead, gold and silver. Dissolved by proclamation in January, 1917.

PAYNE'S MINE (placer) GREENBACK DISTRICT JOSEPHINE COUNTY

Payne's placer mine is near Foley gulch in S. W. ¼ Sec. 19, T. 33 S., R. 5 W., about 3 miles east of the Pacific highway on Coyote creek and about 5 miles from the station of Wolf creek. According to Diller:

> The mine stretches up from the creek level to the terrace nearly 100 feet above. Coyote creek has but little fall, and the Ruble elevator has been used to advantage. The greenstone pebbles are completely rotten; those of slate are not so thoroughly decomposed.

An underlying dark gray gravel is fresh and unaltered.

PEACOCK MINE (copper, gold, silver) WALLOWA DISTRICT WALLOWA COUNTY

For location and description see "Contact Mining and Milling Company."

PEARCE MINE (placer) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Pearce mine, 4 miles southwest from Jacksonville, is on the east fork of Forest creek in Sec. 11, T. 38 S., R. 3 W. It is at present leased by Floyd Pearce, of Jacksonville.

The gravels have an average thickness of about 12 feet, but in places they have been 45 feet thick. In the lowest 6 feet of the deposit there are many large undecomposd boulders, but above this zone the material is gravel and sand not very strongly cemented. The best values are at and near the bottom. Some of the ground has run as high as $7000 to the acre. The bed rock is greenstone, the slope of which is not more than 2 feet in 100 feet. The mine is equipped for hydraulicking, 3 giants being used. The pressure of the water is only about 85 feet. The property consists of 240 acres, a large part of which remains to be worked.

PEARL MINING COMPANY (gold) ELK CREEK DISTRICT JACKSON COUNTY

Local name, Buzzard mine.

Office: Central Point, Oregon. W. C. Leever, Pres.; J. W. Merritt, Central Point, Ore., Sec.-Treas. Capital stock, $4400; par value $20; stock entirely subscribed, issued and paid up. (1916 report).

Property is located on one of the branches of Elk creek, reached by good wagon road, 27 miles northeast from Trail. Property consists of 10 quartz claims held by location. Located in Secs. 20, 21 and 29, T. 31 S., R. 2 E. The property is at present leased and managed by Paul Wright, of Trail, Oregon.

Ore deposit is in a shear zone in andesite. Vein material is largely gouge with stringers of sulphides running through the gouge at different places. The values are closely associated with the sulphides, pyrite, sphalerite and galenite, the small stringers of sulphides often running as high as $400 to the ton in gold. The plan adopted thus far has been entirely hand sorting, hand jigging and sacking and shipping direct.

Some of the newest work on the property done by Mr. Wright is a drift on a stringer of sulphides on the opposite side of the hill from the old workings. This drift has proceeded about 150 feet and agrees in strike and dip with the main vein. Mr. Wright calculates that by continuing this drift 700 feet farther he will cut the main vein at a depth of 300 feet.

The property is equipped with an old mill, consisting of a jaw crusher, a small Huntington mill and a Frue vanner.

Total production of the property is not available but 4 tons were sacked and shipped during the past summer, giving smelter returns of more than $2100.

After further development of the property Mr. Wright proposes to determine the proper mill equipment which will make the best recovery. It seems probable that the entire gouge vein, which averages about 3 feet wide, will be sufficiently high grade for milling.

The ore body has a strike of N. 40° W. About 3000 feet of work has been done to date on the property and the deepest work is only 170 feet on the vein. Vein is reached by a 1600-foot crosscut tunnel and is stoped in some places to the surface.

PERKEYPILE MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Perkeypile mine 6 miles southwest of Gold Hill is in the S. W. ¼ Sec. 5, T. 37 S., R. 3 W., near the top of the ridge between Galls and Foots creeks. A crosscut strikes the vein at 90 feet and a drift follows it about 300 feet. The vein strikes S. 60° E. and dips 72° S. W.

PHILIPS OR VANGUARD PROPERTY (gold) JOSEPHINE COUNTY

Concerning this property Diller says:

> The Philips property, known also as the Vanguard, is on the north slope of Days gulch near Pocket Knoll. Several openings have been made in the hillside and an 80-foot tunnel run in greenstone not far from its contact with cherty slates. Some sulphide ores carrying copper and gold were obtained, although no considerable bodies were visible at the time of my examination. The tunnel is to be extended 500 feet farther into the hill. A small and very crude arrastre on the creek is said to have been used to grind some of the pocket ore from the ridge near the knoll.

PHOENIX MINE (gold) GREENHORN DISTRICT BAKER COUNTY

This mine is located about 1 mile southeast of Greenhorn. The ore consists of coarse granular dolomite with a little quartz and galena. It contains abundant high-grade gold intergrown as small grains with the carbonate. The mine has an 80-foot shaft, 1000 feet of development. A pay shoot 30 feet long, 4 feet wide and containing about $36 per ton was found but did not hold out in depth. The above statement is taken from W. Lindgren's "Gold Belt of the Blue Mountains of Oregon."

PILGRIM CLAIM (gold) ASHLAND DISTRICT JACKSON COUNTY

The Pilgrim claim, about 3 miles southwest from Ashland, is on the ridge west of Wagner creek, at an elevation of about 3000 feet, in Sec. 14, T.

39 S., R. 1 W. It is now owned by C. Halstead, of Talent. It is opened by an adit drift extending N. 10° E. about 170 feet on a vein containing about 3 feet of quartz in a quartz schist. The vein dips 62° W. At 50 feet from the portal a raise extends upward about 30 feet on the vein to the surface. The country rock has well defined bands, marking sedimentary layers, now much contorted, but in general crossing the adit at a large angle and dipping steeply. A small sample examined microscopically proves to be a fine, even grained quartzite with seams of siderite and disseminated muscovite.

PINE FLAT MINE (copper) AGNESS DISTRICT CURRY COUNTY

The Pine Flat mine is located in the south central part of T. 35 S., R. 32 W., in the Pine Flat copper district, which is situated about 4 miles southwesterly from Agness on the ridge which farther to the south is known as Wake-Up-Riley ridge, and is composed largely of Colebrooke schist.

The copper occurs as thin seams and stains of malachite in jointed and sheared serpentine, near and below the dacite-porphyry. The latter strikes N. 80° E. and dips 32° S. E. Two short tunnels have been driven along the serpentine-dacite-porphyry contact, and several open cuts have also been made along the same horizon.

The whole occurrence bears a strong resemblance to the shear-zone deposits in the Collier creek district. Whether any high grade or was found is unknown. A general sample of the ore on various dumps yielded 9.87 per cent of copper and traces of gold and silver.

PLATINA y ORO MINING COMPANY

Articles of incorporation filed December, 1916, by Cordie K. Cadman, Chas. K. Cadman and A. Clinton Vestal, with a capital stock of $50,000; par value $10. Office at Marshfield, Oregon.

PLATINUM, IRIDUM AND GOLD COMPANY (placer) JACKSON COUNTY

Office: Bandon, Oregon. P. Langdell, Gold Hill, Pres.; J. N. Watt, 621 J St., Sacramento, Cal., Sec.-Treas. Capital stock, $500,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company had 4 placer mining claims of 20 acres each, or 80 acres, besides 320 acres adjoining these claims of patented land in Sec. 2, T. 32 S., R. 15 W.

Over $1000 worth of development work was done on these claims in 1914. The above lands were disposed of in the spring of 1916. The company now has the Crescent No. 4 and No. 5 lode claims in Jackson county.

PITTSBURG DEVELOPMENT COMPANY

This company filed articles of incorporation in 1915. Incorporators: James B. Kerr, Harrison Allen, Omer C. Spencer. Capital stock, $16,000; par value $1.00. Office, Portland, Oregon.

POCAHONTAS MINING AND IRRIGATION COMPANY

Office: Baker, Oregon. C. W. Kelly, Pres.; M. E. Roberts, Sec.-Treas. Capital stock, $2500; par value $10; all subscribed, issued and paid up. (1916 report).

POOLER'S PROPERTY (gold) BLUE RIVER DISTRICT LINN COUNTY

This property, owned by E. O. Pooler, consists of 1 claim located in Sec. 29, T. 15 S., R. 4 E., about ½ mile of trail to connect with mountain road to Lucky Boy mine. Fairly good wagon road to Blue River postoffice. Road from Blue River to Eugene is in good shape. Country is very rugged and plenty of timber is available.

The country rock is andesite. The deposit is of the brecciated zone type with a N. W.-S. E. strike. The property is developed by short prospect tunnels and open pits. An 8-foot width is said to assay from $8.20 to $13.40 per ton. Some specimen ore has been taken from this prospect, showing wire gold imbedded in quartz crystals. The quartz has the appearance of being formed in small vugs.

It is reported that during the present summer of 1916 more development work has been done, including the installation of a small stamp mill.

POORMAN GROUP (copper) EAGLE CREEK DISTRICT BAKER COUNTY

This property is owned by the Oregon-Idaho Investment Company of Baker, Oregon. The claims are situated in Secs. 32 and 33, T. 7 S., R. 43 E., between Balm and Goose creeks, on a small stream known as Slide creek, which flows through the property into Balm creek.

The topography represents a partially eroded basaltic plateau and is characterized by small streams whose branches head in comparatively short gulches. In this immediate vicinity the basalt caps only the higher ridges and is not of great thickness.

The country rock is for the most part a dense altered greenstone, somewhat brecciated and cut by quartz-calcite gash veins. In some parts it is very siliceous, which may be due to the more acidic composition of the original rock or, as is more probable, to secondary silicification. On account of the obscuring effect of alteration, not much can be said about the original character of these rocks. It is probable, however, that they were trachytes and andesites. For instance, one specimen taken from the outcrop shows a light-colored dense rock cut by veins of pyrite. In thin section it is seen that the groundmass is a confused indeterminable mass of alteration minerals consisting chiefly of chlorite and sericite. Apparently the rock before alteration had a texture approaching closely that of a glass. It can also be seen in the thin section that pyrite is associated with quartz in the veinlets.

The mineralization is in a shear zone having a strike of about N. 65° W., a dip of from 40° to 60° to the south and is from 150 to 300 feet in width. On the surface the red stain of iron oxide is very noticeable, and occasionally there are stringers of hematite from 1 to 2 inches in thickness. Pyrite was found on and near the surface associated with quartz in small veins. At a depth of one to two hundred feet chalcopyrite is the chief ore mineral. Many large sized blocks that have been taken from the development drift and crosscuts have had enough chalcopyrite in veinlets to contain 7 per cent copper.

These richer portions may, in fact, be considered as a type of quartz vein. This is well illustrated by a specimen from a silicified zone. The rock is intensely silicified and appears to have suffered a brecciation since the silicification, as is shown by the fact that the cavities are partially filled with minute quartz crystals intermingled with chalcopyrite. In thin section it is seen that the main mass consists of interlocking quartz grains impregnated with chalcopyrite, and also cut by veinlets of chalcopyrite. In these veins some chlorite is associated with the chalcopyrite.

It seems probable that this brecciated zone in the old greenstones made an excellent opportunity for the replacing action of hot ascending silica solutions, which carried their metallic content, although a certain portion may have been leached from the greenstones. The excess of silica and the presence of gold would indicate other sources besides that of andesitic or basaltic lava.

After the silicification and impregnation of pyrite and chalcopyrite, the zone was fractured again and probably a further concentration of the copper took place by circulating or perhaps even descending waters.

The specimens clearly show a brecciation after the silicification, and it is not unreasonable to suppose that where this frcturing is most pronounced there might be found deposits of richer ore.

Development in 1915 was done by the Baker Mines Company under lease and bond, but no new discoveries are reported.

PORPHYRY MILL CLAIMS (gold) SUSANVILLE DISTRICT GRANT COUNTY

These claims are on the north side of Elk creek, about midway between Susanville and Galena. They cover an area to the east of Quartz gulch and north of Elk creek, over what is known as "Porphyry hill." This hill is made up of slate cut by several light-colored, much altered dikes. The dikes have a general E.-W. strike and dip N. into the hill at high angles. Three dikes were noted from 30 to 40 feet wide.

In thin sections these dikes are seen to consist of larger grains of quartz, imbedded in a much finer grained ground mass consisting of quartz, feldspar and sericite. These larger grains are curious in that they do not have a true crystal outline, but appear to be made up of broken fragments. The ground mass is undoubtedly of igneous origin, although some of the quartz and the sericite is secondary.

These dikes are probably quartz porphyries, which after consolidation were shattered at depth. The formation of secondary quartz in the ground mass has obliterated the evidence of shattering, but the large quartz crystals show it in a striking manner. The intergrowth of quartz and feldspar indicates that this porphyry has aplitic tendencies.

Although there has been but little development, ore has been shipped or milled at various times. Shipments of a few tons each have been made that reported gross values from $80 to $100 per ton. Ore was treated in an arrastre with returns of $3162 from 150 tons. This ore came from the slate adjoining the porphyry. At another time from porphyry $1600 from 80 tons was received; at another time in a Huntington mill 44 tons returned $7 per ton; later 8¾ tons produced $237; some 80 odd tons milled from a dump returned $125; and from another claim 31 tons were arrastred, producing $5 per ton; and on still another claim a 9-foot channel sample assayed $4.10.

All the above statements concerning these porphyry deposits were furnished by J. C. Haskell, one of the owners. Channel samples taken by the writer in a tunnel crosscutting a massive and hard part of one of the dikes averaged $1.80 a ton for 15 feet. It is stated that in the principal workings at the bottom of a winze a rich streak of ore is made up of sulphides similar to those in other parts of the district.

Prospecting in 1916 upon this hill by Haskell and Reiter has disclosed additional stringers of high grade gold ore.

PORTLAND GROUP (gold) WALDO DISTRICT JOSEPHINE COUNTY

The Portland group is located 1½ miles southeast of Holland, and owned by V. C. McKinney, of Holland, Oregon; W. V. Lewis, of Portland, and R. M. Lewis, of Idaho.

The ore deposit is found in a quartz vein which varies in thickness from 4 inches to more than 3 feet.

Development work consists of a shaft 115 feet deep, at the bottom of which is a drift 50 feet each way. There is an adit driven on the vein 350 feet long at about the same elevation as the bottom of the shaft. Considerable stoping has been done from the adit level, the ore body averaging about 2½ feet wide, from which, according to the manager, $3 to $4 of gold is saved per ton.

The property has a small Gibson mill of about 20 tons capacity.

PORTOMA MINING COMPANY IDAHO

Office: 213 Board of Trade Bldg., Portland, Oregon. D. C. O'Reilly, Pres.; F. A. Knapp, Sec.-Treas., both of Portland. Capital stock, $100,000; par value 5 cents; $53,000 subscribed, issued and paid up. (1916 report).

This company's properties are in Shoshone county, Idaho.

POWDER RIVER GOLD DREDGING COMPANY (California corporation)
SUMPTER DISTRICT BAKER COUNTY

Office: 433 California St., San Francisco, Cal. W. P. Hammon, Pres.; A. E. Boynton, Sec.-Treas., both of San Francisco; S. O. Correll, attorney-in-fact, Baker, Oregon. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

The most important placer mining operation in the state is that of the Powder River Dredging Company, located near Sumpter, Oregon. The total holdings of this company is about 1500 acres, of which about 700 acres is to be dredged. This 700 acres of commercial gravel extends from a point a short distance north of Sumpter to McEwen, a total distance of about 5 miles.

The commercial gravel is in a meandering channel from 300 to 2000 feet wide, and averaging about 1000 feet, and occupies only a part of the valley floor. The average depth of the gravel is 18 to 20 feet. The bedrock is a soft decomposed rock, which dredgermen call "clay webfoot." Nearly all of the gold is on bedrock, and the condition of the gravel and bedrock is such as to be called quite hard digging. This fact will be better understood when it is known that the manganese steel bucket lips last only 5 months, while in California practice they last about 18 months.

The two dredges are of the standard type and were constructed by the Yuba Construction Company, of Marysville, Cal. On dredge No. 1 the 65 buckets have a capacity of 9 cubic feet each, and on No. 2 dredge 7½ cubic feet each, and the dredges will dig to a maximum depth of 30 feet. The 2 dredges have an actual capacity of about 10,000 cubic yards daily. The dredges have wood hulls, which, according to California experience, have an average life of 10 to 12 years. They have no amalgamating plates. They are equipped with Hungarian riffles, which have a slope of 1¼ inches to each foot of length.

The power is furnished by the Eastern Oregon Light and Power Company. The horsepower required is naturally variable. The consumption averages about 750 H. P. in 7 motors for each dredge.

The clean-up is made weekly, and the high extraction, estimated at 95 per cent, is made upon easily washed gravels, which contain but little clay. The gold is medium coarse. The particles average larger than those in the California dredging field. The largest nugget secured is ⅝x⅜-inch, while perforations in the revolving screen are ¾-inch. It is evident that no nuggets of gold are lost in the oversize. The average fineness of the gold is 785. The total cost per yard is approximately 3½ cents, which is higher than California practice, due largely to the more difficult digging.

Between 100 to 105 acres were dredged from February 1, 1913, to October 8, 1914, a period of about 20 months, or about 60 acres annually. This was done with dredge No. 1.

The company secured in November, 1914, some additional ground, for which negotiations had been in progress for some time. Since this purchase has been effected they began in the spring of 1915 the digging of a pit to install another dredge to work the ground upstream from the point where the present dredge began to dredge the channel downstream toward McEwen. This boat was completed in October, 1915, and has been operated steadily ever since, with gratifying results.

PRINCE EXTENSION MINING COMPANY NEVADA

Office: 803 Williams Ave., Portland, Oregon. C. B. Garrison, Pres.; W. W. Zallars, Sec.; W. G. Gregory, Treas., all of 512 Board of Trade Bldg., Portland. Capital stock, $1,000,000; par value $1.00; $720,000 capital stock subscribed, issued and paid up. (1916 report).

This company's properties are located in Lincoln county, Nevada.

PRINCE JOHN PLACER MINING COMPANY EAGLE CREEK DIST. BAKER CO.

This company is incorporated under the laws of Colorado. For description see "Eagle Creek Placers."

PSYCHE MINE (gold GREENHORN DISTRICT GRANT COUNTY

The Psyche mine is about 2 miles west of Greenhorn in the western part of T. 10 S., R. 35 E. It is owned by J. D. Dixon, of Baker, Oregon. It is in serpentine with some altered dolomite. A fine-grained, light-colored sericitized porphyry was also noticed. Considerable development has been done upon this property and a stamp mill was erected, but was removed in 1914. Only the old badly weathered surface workings were visited. At these points the true nature of the mineralization is not very apparent.

It was opened by a 130-foot shaft, a crosscut 300 feet long, drifts and a raise to the shaft level. It has been idle for a few years. It was reported late in December, 1916, as sold to a new company of Baker persons, who expect to do extensive development.

QUEEN ANNE MINE UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Queen Anne mine, 10 miles southeast of Applegate, is in the N. E. ¼ Sec. 3, T. 39 S., R. 2 W., on Deming creek, near the Sterling placer mine, at an elevation of 2750 feet by barometer. It is owned by W. H. Simmons, who has a mill at the mine consisting of a boiler, engine and 3-stamp battery of 250-lb stamps. It is opened by an adit extending 75 feet N. 20° E. along the bedding of the schistose argillites, which contain some pyrite, but no vein quartz. To the northwest there are 3 shafts, the deepest following a quartz vein for 40 feet. The 4-foot quartz vein strikes N. 45° W. and dips 80° N. E.

QUEEN MINE (gold-copper) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Queen gold and copper mine is about 4 miles northwest of Waters Creek station, on California-Oregon Coast railway, on the divide between Water and Limpey creeks, the former being a tributary of Slate creek. The country rocks are reported to be greenstones, argillites and serpentine by Diller, who says further:

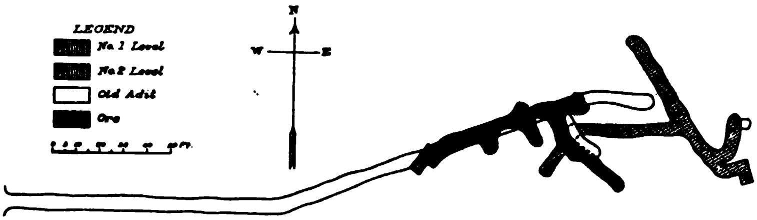
> A small placer at the head of one of the forks of Water creek near the contact between greenstone and serpentine yielded $3000 in gold some years ago and started prospecting to find its source. A number of tunnels and crosscuts aggregating over 800 feet of underground workings have been run in the greenstone. An interesting breccia of greenstone, cemented by quartz and about 12 feet in thickness, is exposed by the tunnel on the Limpey creek side of the divide and may be locally mineralized. Outcrops of this breccia were seen as far west as Slate creek, 2 miles below the Buckeye mine.

QUEEN OF BRONZE MINE (copper) WALDO DISTRICT JOSEPHINE COUNTY

The Queen of Bronze mine is located in the N. W. ¼ of Sec. 36, T. 40 S., R. 8 W., about a mile east of Takilma and 2½ miles east and south of Waldo. The land consists of 320 acres patented. The mine was formerly the property of the Takilma Smelting Company, owned by Messrs. Tutt, Hull and McNeil, of Colorado Springs, Colo. Early in 1916 it was sold to John Hampshire, of Grants Pass, Twohy Brothers, of Portland, and associates, and Roy Clarke became manager.

The mine is about 42 miles from Grants Pass, over a well constructed wagon road, with some heavy grades, which add to the difficulty of transportation. Heavy rains in fall and winter make the road almost impassable. At present the railroad point is Waters Creek station on the California-Oregon Coast railroad, a distance of 27 miles.

The company has a 100-ton smelter located near the north ¼ corner of Sec. 35, T. 40 S., R. 8 W., which is at the foot of the slope on which the mine is located, and about ½ mile west of the workings. The limestone for the



Chief workings of the Queen of Bronze mine at Takilma, Oregon.

smelter was hauled from the quarry in the N. W. ¼ of Sec. 25, T. 40 S., R. 8 W., a distance of about 1½ miles, while coke, as well as all machinery and other equipment, had to be hauled from Grants Pass. The fuel supply was uncertain and in 1907 the works were compelled to import Japanese coke packed in 100-pound bags. The ore was trammed from the mine to bins and hauled to the smelter, a distance of about a mile by the road. The smelter has a 125-ton water-jacket blast furnace operated semi-pyritically, making matte, when in blast averaging 45 per cent copper, 2.5 ounces silver and $2.50 gold per ton, that is shipped to the Tacoma smelter for conversion.

The equipment of the mine included several boilers, an air compressor, hoist and machine drills. A large amount of development work has been done on the property and mining has been prosecuted by means of tunnels, shafts and open cuts. Large surface ore bodies have been mined by the so-called glory hole method, in which the ore is mined by overhead stoping clear to the surface, passed down a chute and removed through a tunnel below.

Below the open cuts 2 long adits have been driven. The ore from these glory holes was removed through the upper adit. The lower is about 225 feet below the level of the outcrop and is about 1100 feet long.

The ore is massive chalcopyrite, pyrrhotite and some pyrite, together with their oxidation products, such as malachite, azurite, cuprite, chrysocolla and tenorite. Much has been written concerning the occurrence and origin of the copper ores in the Waldo region. Whatever has been the origin of the original ore bodies, whether from magmatic segregation, from solutions related to the cooling of an intrusive magma or from lateral secretion, a more important factor has since been very prominently in evidence; namely, a very marked faulting or shearing movement, which has taken place involving the entire ore body in the fault zone, thus brecciating a wide zone of material, having for one wall the serpentine on the northwest and a less altered basic igneous rock on the southeast. In between these walls is now found a brecciated zone of variable width, in which individual pieces of the brecciated material are often chunks or bodies of massive copper and iron sulphides.

As development of the mine proceeds it is more clearly shown that between these chunks, masses or lenses of sulphides there is no relation one with the other. Their sides strike and dip in every angle or direction and in almost every case are surrounded by mashed or squeezed serpentine.

Winchell describes and identifies numerous more or less basic igneous types of associated rocks, such as andesite, auganite, diorite, augitite, pyroxenite and serpentine. The chemical or mineralogical relation of all of these is not widely different and could be conceived as closely related textural or mineralogical variations of the same magma. According to the observations of the writer, the mashed, altered and squeezed black colored materials in both the Queen of Bronze and Waldo mines, generally known as serpentine, are formed from any or all of the above named list of rocks, which are described in detail by Winchell.

The history of the development of both the Queen of Bronze and the Waldo mines up to date shows that the ore bodies are discovered most unexpectedly and are not in accord with any logical scheme by following veins or stringers, as is the case in most quartz mines. On the other hand, it is evident that any sort of working theory which provides active underground development in this brecciated zone produces at times good results.

If the writer's analysis of the commercially important geological factors is correct, it would seem that the territory in which these ore masses may be found may be quite extensive both in width and depth. A system of drilling could well be inaugurated to prospect this brecciated zone, in which large and small masses of copper sulphide ores are inclosed.

It is said that up to 1910 more than $150,000 has been spent on the properties, including the building of the smelter, and also that more than 20,000 tons of ore have been smelted, the average content of which has been about 8½ per cent copper, $3 gold, and the silver usually below 20 cents.

Some good sized ore bodies have been developed during the recent months and several thousand tons have been hauled to the railroad at Water's Creek, some 27 miles from the mine, and shipped to the Tacoma smelter.

QUEEN OF THE WEST MINES COMPANY (gold) (West Virginia corporation)
CORNUCOPIA DISTRICT BAKER COUNTY

Local name, Queen of the West mine.

Office: 209 Pillsbury Bldg., Minneapolis, Minnesota. A. Y. Bayne, Pres.; Lewis W. Campbell, Sec.; H. U. Maurer, Treas., all of Minneapolis; Richard Amidon, Cornucopia, Oregon, Attorney-in-fact. Capital stock, $1,000,000; par value $1.00; $993,466 subscribed, issued and paid up. (1916 report).

Located to the westward on the opposite side of Bonanza basin from the Last Chance in the almost inaccessible cliffs of the mountain is the Queen of the West vein. Picturesque indeed is the position of its mine buildings; its boarding house is on a narrow cliff where material thrown from its windows falls downward for hundreds of feet. A steady nerve and a sure foot are needed on the trail from the mill to the mine and to explore the cliffs above. With snow on the ground it is impossible, and unless they brave the snowslides of the Bonanza basin trail, miners must remain at the mine for some four or five months in winter.

Nearly all of the country rock is granodiorite, similar to that at the Union-Companion mine. There are a few fragments of schist in the vicinity of the vein which are remnants of the old roof.

The vein has the usual strike of N. 20° E. and a dip near the surface of about 45° but at depth this decreases to about 30°. The average width of the vein near the surface is between three and four feet, but generally speaking it decreases in width with the decrease in dip.

The gangue minerals are quartz and calcite containing pyrite, chalcopyrite, galena, and sphalerite in bunches. It is said that the zinc, lead, and copper minerals carry most of the gold values. In many places the vein shows included fragments of altered granodiorite, and the granodiorite on each side of the vein for about 2 feet is badly altered and impregnated with pyrite which is said to contain some values in gold and silver. This vein can be traced for a long distance, reported to be as much as 3000 feet.

Future development plans are to crosscut from the lower tunnel a few hundred feet beyond the Queen of the West vein, to cut the Red Cross vein whose principal outcrop is some 1500 feet above the lower tunnel. The Red Cross vein is similar to the other veins, but little is known with reference to ore shoots therein.

During the past 2 years (1915, 1916) some development work has been done, and it is said that good ore has been discovered. A new 2-buckel Leschen tram 3300 feet long has been erected. The 10-stamp concentrating mill has been remodeled and enlarged and a complete cyanide plant installed. The general method used is to separate the sulphides with tables and following the tables Dorr classifiers dividing the tailing into sands and slimes; the sands going to leaching vats and the slimes mixed with the concentrates which have previously been ground fine in short tube mills are treated in Pachuca tanks. The mill is well equipped with all accessory apparatus and there are many hydraulic motors installed in order to separately drive different parts of the mill.

This mill is reported to have begun operation late in November, 1916.

RAMSEY MINE (gold) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Ramsey mine is near the Buckeye and Queen mines in the Slate creek region; the ore at the Ramsey carries gold with little or no copper; the mine is located on the west fork of Slate creek about 6 miles northwest of Wonder and 1½ miles above the forks at an elevation of about 2800 feet, as measured by barometer. The workings are shallow and disclose no regular vein. The ore is due to surface enrichment, and much of it has been treated by placer sluicing methods. The mine is owned by W. H. Ramsey who has an arrastre in which some ore has been treated on the creek just below the workings. According to Diller:

> In the upper tunnel the fault contact of the serpentine overlying the greenstone is well exposed, striking N. 25° W. and dipping 62° N. E. That is, however, in a bend of the contact, for the general trend of the contact of serpentine and greenstone is N. 30° E. and the dip is 40° S. E. Some distance west of the contact toward the creek another tunnel has been run into crushed greenstone, and the iron-stained rock has been reported by local assayers to contain a small percentage of tungsten. A sample selected by Mr. Ramsey and myself to test this matter was sent to the laboratory of the Geological Survey where it was tested by R. C. Wells and found to contain no tungsten, but a small fraction of 1 per cent of vanadium.

RED BIRD MINE (gold) GREENHORN DISTRICT BAKER COUNTY

This property owned by Abel and Petty is located near the town of Greenhorn. The shoot uncovered in 1915 is reported to be about 80 feet long and from 6 to 14 inches wide and of high grade free gold ore, which is said to have averaged $500 to $800 gold from a few tons which have been milled.

RED BOY MINES COMPANY (West Virginia corporation) GRANITE DISTRICT GRANT COUNTY

Office: Fremont, Nebraska. Ray Nye, Pres.; E. L. Hoppe, Sec., both of Fremont, Neb. F. A. Harmon, Baker, Ore., Treas.; John Thomsen, Baker, Ore., Attorney-in-fact. Capital stock, $1,400,000; par value $1.00; $1,000,000 subscribed, issued and paid up. (1916 report).

The assets of this company, commonly known as the Red Boy mine, were sold at sheriff's sale in Canyon City in January, 1916, for $34,500 to satisfy a trust mortgage securing a bond issue of $137,900. The property was bid in for the bondholders who in June, 1916, reorganized the company and filed articles of incorporation as the Red Boy Mining and Development Company, capitalized at $250,000, under which title a description of the mine is given.

RED BOY MINING AND DEVELOPMENT COMPANY (gold)
GRANITE DISTRICT GRANT COUNTY

Local name, Red Boy mine.

Office: Baker, Oregon. Ray Nye, Pres.; Arthur F. Winter, Jr., Sec.; Paul Colson, Treas., all of Fremont, Neb.; F. A. Harmon, Baker, Vice-Pres. Capital stock, $250,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company is the reorganized Red Boy Mines Company. The total production of this mine is between $800,000 and $1,000,000; it is one of the best known mines of eastern Oregon. Its activity at the present time is confined to prospecting in certain parts of the mine and to re-cyaniding some of the low-grade concentrates.

The country rock is a slaty siliceous to calcareous black argillite, originally a mud deposit in quiet waters on the floor of an inland sea. Since the time of its deposition this mud, which aggregated hundreds of feet in thickness, became cemented into a rock that was afterwards subjected to pressure, making it somewhat laminated. Since the elevation is 4600 feet at the mine they have been upliftd since deposition about a mile. The bending, squeezing, slipping or faulting has tilted them to the westward 15 to 20 degrees from the horizontal.

The granodiorite intrusion which now makes up the main ridge of the Greenhorn range, has a northward spur on which is the Ben Harrison mine, about a mile from the main range. This same spur extends northward on the west side of the Red Boy mine. From this spur, as in practically all the other districts, dikes ranging from granodiorite porphyry to "quartz aplite" have filled fissures in the adjoining argillite.

The dikes in the underground workings of the Red Boy mine are very badly altered, but a microscopic examination of some of the fresher pieces shows that they are felsites of aplitic tendencies. These dikes, which near the veins are quite narrow, were injected into the fissures in a molten condition from below at some time well along in the dike-forming period. The upward flow had no crystals formed in it previous to the somewhat sudden ascension of the molten material, which because it was injected in narrow, sheet-like form between cold walls, congealed so quickly that only small or incipient crystals of quartz and feldspar had time to form.

A further shifting and movement occurred and the planes in which the dikes were located were fractured again because they were planes of weakness. This fracturing and movement involved both dike and adjoining argillite, but the latter was fractured to a much greater degree. This fracturing from one to several feet wide permitted the ascension of solutions from the concealed intrusion from which were deposited the quartz, the sulphides, and the silver and gold. These ascending solutions must have brought the gold and silver from the igneous intrusion, although it may have secured some quartz by leaching from the walls on its upward journey. The shattered dikes and the adjoining argillite which make up the irregular walls of the veins both contain disseminated pyrite. These are undoubtedly deposits from ascending hot waters, which were especially active in their alteration of the aplitic dikes.

The quartz in the veins fills in and surrounds the sheeted and brecciated argillite. In some places white quartz and dark argillite are in roughly parallel bands when the vein is observed in cross section; at other places the appearance is more that of fragments of argillite of all shapes held in a white quartz matrix.

The characteristics of the vein itself are well stated by Lindgren:

> In their general character the veins are similar to those of Cracker creek, though they are not so wide. They consist of a crushed fault zone in argillite, from 3 to 15 feet wide, in which the broken rock is cemented by a great number of quartz seams.

The footwall of the Monarch is usually smooth and sharply defined, while the hanging is less well marked, a definite wall being often entirely absent. The width between walls varies from 5 to 7 feet. The vein matter is a black, crushed slate, and sometimes, also, masses or bunches of soft porphyry, both containing finely divided pyrite. The vein matter is traversed by a number of small quartz seams, rarely over 4 inches wide. Most of the seams are on the footwall side and produce a banded appearance of the vein. The best pay is contained in the 2 feet on the footwall, though the whole width is mined. In a few places on the Monarch vein bunches of 5 to 6 feet of solid quartz were found. The seams usually show clearly defined comb structure, the crystals projecting from both sides of the seams, meeting in a median line. There is no evidence of surface oxidation of the Monarch on this level.

The Red Boy vein averages from 3 to 6 feet in width and is in general structure similar to the Monarch, though the quartz is apt to form somewhat heavier bodies. It also contains more clay than the Monarch vein.

The value of the ore appears to be entirely contained in the quartz seams and consists chiefly in free gold alloyed with much silver, the bullion being from 515 to 525 fine. The quartz contains a small amount of sulphides, pyrite with very little chalcopyrite, and arsenopyrite. . . . . . Metallic silver and copper have also been found on the Monarch vein, inclosed in white massive quartz, and thus probably primary. The 5 per cent sulphurets contained in the ore are low grade, from $5 to $20 per ton, and probably are largely contained in the slate milled with the quartz.

It is believed that a careful reading of the above will bring out the following facts:

1. That the best channel was along the foot wall which lessened toward the hanging wall.
2. That the best pay is contained in 2 feet on the foot wall, although the vein is from 5 to 7 feet wide. The values lessen, generally speaking, from foot toward hanging.
3. That the quartz seams are banded with free crystal faces in the middle of the bands, indicating that they were formed from ascending hot solutions. Quartz formed in the cold is chalcedonic.
4. That the value of the ore appears to be largely contained in the quartz seams, chiefly in free gold and silver.
5. That the sulphides found disseminated in the dike and in the argillite, although taken from near the surface, are undoubtedly primary and are of low grade because of their method of deposition outside of the channel.

All of the facts indicate that the ore in the Red Boy mine is primary, notwithstanding the fact that the vein so far developed below the 200-foot level is too low-grade to mine. The ore shoots of good grade above that level are not the result of downward sulphide enrichment, although a superficial examination of the mine maps might cause one inclined to overemphasize the effects of secondary enrichment to draw such an inference because the stoped length of 800 feet is so much greater than its 300 feet of pitch length.

Primary ore deposition is a physico-chemical process which involves many variable factors. Lessening temperature and pressure, different wall rocks from horizon to horizon, mingling of different solutions by the joining of ascending flows of water and the great variableness in the velocity of the ascending waters passing through open fissures, filtering through brecciated fragments or stagnating next to impervious layers of gouge, all combine to influence ore deposition or to prevent it in any given place, to give it with a lavish hand or sparingly or not at all.

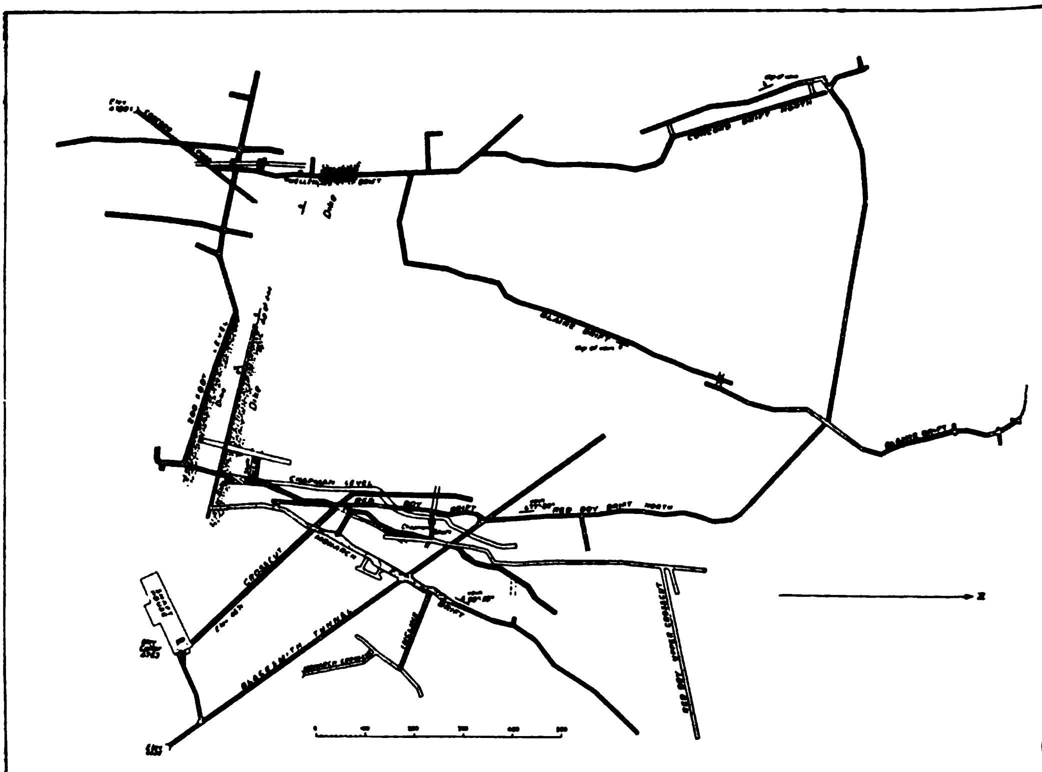
A careful examination of the mine map shows that the N.-S. Red Boy vein dips steeply west and the Monarch vein, with a medium dip also west, joins the Red Boy vein at a horizontal angle of about 30°. The difference in dip of the 2 veins would cause their junction to pitch to the N.-NE. The maps shows this to be the case.

The value of the ore was said to have been maintained, at least as far as the 200 level, but the development from the 200 to the Chapman level and from that level to a lower one, failed to develop ore. It is said that upon the lower level the Red Boy vein was not recognized. This would eliminate from consideration all development except approximately 300 feet on the Chapman level which, judging from its position, is on the Monarch vein.

The excessive amount of water made mining so difficult and expensive which, combined with the low values encountered along this distance, caused further drifting north on the Monarch vein to be abandoned. It will be noted further that crosscutting on those lower levels is practically absent. The development below the stopes is so limited and insufficient that one cannot state that the vertical limits of the stopes is the vertical limit of the ore.

Ore might not be found by new development upon the Chapman level. It might be absent upon the Chapman level and be present upon lower ones, or there might be little or no ore outside of that already stoped, due to the effects of one or more of the causes enumerated above, which affect the deposition of ore from ascending solutions in a great variety of ways. All possible shapes of primary ore shoots are apt to be found.

In any of the above statements it should be remembered that there probably was some mechanical concentration of gold at or near the surface due to the removal of the valueless part of the vein.



Plan of the Red Boy mine

A fault zone appears in the Red Boy mine cutting across the Red Boy and Monarch veins in the position marked on the map and labeled "dike." This fault zone is in a great many respects quite similar to the Red Boy and Monarch veins, but differs from them in its greater width between the hanging and foot walls. On the 200-foot level this zone must be more than 100 feet wide. This shearing was along an old line of weakness which contained one of the intrusive dikes. This dike, only a few feet wide, was involved in the shearing and faulting and blocks of this igneous rock are found in the crushed mass showing little or no shattering, doubtless due to its greater ability to resist crushing than the adjoining slate. Whether this particular fracturing occurred at the same time as that which permitted the formation of the Red Boy and Monarch veins was not determined, but some evidences point to its having been later.

A large amount of clay along the south wall of this broad zone of crushing is indicative of the amount of movement that occurred, which may or may not have been a compensating one.

Red Boy hill has many dikes and veins and upon many of the latter considerable development work has been done in the past, the results of which are not available at this time, but considerable ore has been extracted from some of them. Perhaps a detailed and thorough examination of the surface and underground workings made by a thorough-going engineer might disclose evidences of additional ore bodies.

RED JACKET CLAIM (gold-copper) GRANTS PASS DIST. JOSEPHINE COUNTY

For description of this property see "Oregon Gold Mines Company."

RED MOUNTAIN PROSPECT (gold) CORNUCOPIA DISTRICT BAKER COUNTY

This prospect is located about ½ mile northwest from the Queen of the West mill in Sec. 21, T. 6 S., R. 45 E.

The eastern end of Red mountain can be seen on the way to Norway basin and to the Queen of the West mill. The rest of it is well observed from the apex of the ridge on the George W. Smith claims where, looking north one can see Twin lakes far below the contact of the ligher colored granodiorite with the darker schist of Red mountain above. Nearly all of this eminence (9500 feet) is bare of vegetation. The rock, of reddish brown color, is almost as solid at the surface as below. Loosened by the action of ice and snow loose rock is not permitted long to remain upon its forbidding walls.

Although not examined much except at the contact with the "granite," Red mountain appears to have been once a sediment, but due to the regional disturbances occurring before that which permitted the granitic intrusion, it is now a schist. The granodiorite is clearly seen to have intruded into the schists, because along its border are found innumerable inclusions of angular fragments of schist within it. Both porphyry and aplite dikes cut the granite and the schist.

The Red mountain vein is situated close to the contact with granodiorite and roughly parallel to it. The outcrop of the principal shoot has an elevation of about 7200 feet, but the vein can be seen for a considerable distance to much higher elevations. It is not a contact vein, although locally so considered. The contact of the "granite" with the schist does not appear to be mineralized, although there are effects which appear in the character of the granodiorite. The roughly parallel attitude of the larger biotite mica crystals gives an appearance of gneissic texture. Many of the large quartz grains are cracked and wavy, evidencing contact stresses.

The vein has a strike of N. 80° E., a dip of 50° N. and a maximum width of five feet, but pinches to small dimensions within a few hundred feet. It is seen to cut granite, schist and the granite-porphyry and aplite dikes as well, showing that the vein is later than all of these. It is of the simple quartz type, showing banding in places together with white sericite mica. Iron pyrite, also the green stains of copper are seen in the vein material found near the collar of the shaft. This incline sunk on the vein for about 100 feet is now partially caved. A crosscut (several hundred feet long) at an elevation of 6600 feet, is being driven to cut the vein, but has not yet reached it. It is still in the granodiorite, although it would appear from the nature of the rock near the face of this crosscut that the tunnel is approaching the contact and perhaps the vein. (1914 report.)

RED RIVER GOLD MINING & MILLING COMPANY
MULE CREEK DISTRICT **CURRY COUNTY**

Office: Indianapolis, Indiana. Albert Izor, Pres.; Thos. F. Harrington, Sec.; Chas. Lilly, Treas., all of Indianapolis, Ind.; Jonathan Brown, Agent, Marial, Ore. Capital stock, $1,000,000; par value $1.00; $933,800 subscribed, issued and paid up. (1910 report).

This property is reported to be in the possession of Geo. M. Cheney, of Indianapolis, Indiana, and W. H. Corwin, of Marial, Oregon, the sole active bondholders. The former owns most of the bonds and the latter has an option upon the property and is developing it. There are 10 quartz and 10 placer claims. The quartz claims are on Mule Mountain north of Rogue river and west of Mule creek and the placers are on these streams nearby.

There is about 250 feet of tunnels besides open cuts upon the quartz claims on a shear zone in greenstone consisting of many small quartz stringers over a width varying from 10 to 50 feet and averaging 20 feet wide. The value for the full width is said to be about $3 in gold. The placer claims are on both banks of Rogue river as well as on lower Mule creek. The bedrock is slate and is about 20 feet above the river. The deposit consists of about 30 feet of fairly coarse gravel covered over with 35 feet of fine material. Water is brought to the penstock by a 4-foot flume 3½ miles long which cost $80,000. From 4 to 8 6-inch giants are used according to season and are operated under 180 feet head. It is said that the gravel averages about 9 cents per cubic yard.

REEDER MINE (gold) **ASHLAND DISTRICT** **JACKSON COUNTY**

The Reeder mine, about 4 miles south of Ashland, is on the ridge about half a mile northwest of the forks of Ashland creek. It is opened by a lower adit at an elevation (determined by aneroid barometer) of 2900, a second at 3040, and a third at 3320 feet above sea level. The lower adit is a drift 350 feet long on the vein which here strikes N. 45° W. to N. 51° W. and dips about 80° N. E. This vein consists of numerous small fissures and shear zones, somewhat discontinuous, filled with quartz and green siliceous and chloritic material. The country rock of all the openings is tonalite. The second adit is a drift about 180 feet long on the same vein. One wall seems to be a large aplite dike with pegmatitic phases having a very irregular contact with the tonalite. The vein in this working is more clearly defined and averages about 4 feet in thickness. The third adit is about 300 yards northwest of the others on the northeasterly instead of the southeasterly slope of the hill. It consists of a crosscut entry running S. 50° W. for 70 feet to the vein, on which drifts run in both directions, one being S. 48° E. for 40 feet, and one N. 50° W. for 150 feet; the latter is terminated by a raise inclined at an angle of 37° reaching the surface. In this adit fault gouge is conspicuous with a small amount of white vein quartz. Narrow veins of sheared feldspar are characteristic of that portion of the ore which is said to be especially rich. The vein is about 4 feet thick in this adit.

RETALLAC MINING COMPANY **IDAHO**

Office: 695 Multnomah St., Portland, Oregon. Fenton Merrill, 1633 Boyleston Ave., Seattle, Wash., Pres.; C. A. Bell, Portland, Vice-Pres.; Paul DeHaas, Portland, Sec.-Ttreas. Capital stock, $5000; par value $1.00; all subscribed, issued and paid up. (1916 report.)

This company's properties are located in Idaho county, Idaho.

REVENUE POCKET (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Revenue "pocket," 5 miles south of Gold Hill on Kane creek, is near the center of Sec. 11, T. 37 S., R. 3 W., nearly at the top of the ridge at an elevation of 2570 feet as measured by barometer. It is about 100 feet east of an outcrop of limestone interbedded with argillite which strikes N. 10° E. and dips 70° E. This "pocket" was worked out years ago; it is said to have produced $100,000. At present the vein is being explored by Butler and Higinbotham; the vein is opened for about 35 feet and shows about 2 feet of quartz.

REYNOLDS MINE (nickel) WALDO DISTRICT JOSEPHINE COUNTY

Diller says:

A prospect near Rough and Ready creek, about 12 miles northwest of Waldo, with 850 feet of tunnels, lies in the midst of the great serpentine area and has attracted the attention of prospectors for copper. I was unable to visit the prospect, but Mr. Reynolds kindly sent me at my request a series of samples to illustrate the ores of his prospect. The material is much altered and weathered serpentine, stained green by carbonate of copper, together with delicate pinkish or bluish gray tints, suggesting the presence of cobalt. Some pyrrhotite seems to be present, but it is evident that the samples are so altered that they afford an unreliable basis for judging the ores. Both nickel and cobalt have been reported in these ores. Tests by Chase Palmer in the chemcial laboratory of the Geological Survey showed the presence of 0.29 per cent nickel, but no cobalt was found.

RICHARDSON CLAIMS (gold) GREENHORN DISTRICT GRANT COUNTY

These claims are located just north of the Morning mine and on what appears to be the continuation of the same dike or else upon a similar one. The light-colored altered porphyry dike here is 5 or 6 feet wide, but has associated with it a 2-foot quartz vein. The values are said to be about the same as the average at the Morning mine.

RICHMOND GOLD MINING COMPANY (gold) GALICE DIST. JOSEPHINE COUNTY

Local name, Richmond group.

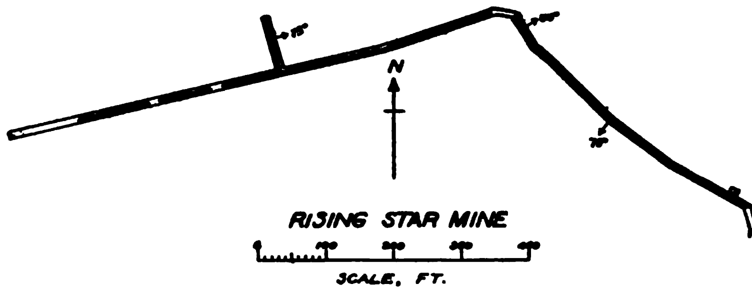
Office: Salem, Oregon. B. F. Rowland, Portland, Pres.; Edward Friday, Galice, Sec.-Treas. Capital stock, $1,000,000; par value 10 cents; $725,618 subscribed and paid up, $25,618.50 issued. (1916 report).

The property of this company is known as the Richmond or Friday group and is located 3 miles northwest of Galice. Concerning it Diller says:

The Richmond group, north of the Oriole, embraces 12 claims in the head of Rocky Gulch and laps over into the head of Deer Lick, a branch of Bailey creek. Seven tunnels, aggregating 600 feet or more, have been run in various directions into the sheared greenstone, exposing some quartz kidneys and veins with but little visible ore. Most of the gold was found with quartz near the summit on both sides of the divide. A ball mill and an old arrastre, both in ruins, were once in operation. The Oriole fault and lode enter the Richmond group, but farther north, near divide, are not so well marked, though quartz veins are more numerous, some striking west of north toward the Golden Wedge, whereas others run east of north toward the Arago. The only work in progress in July, 1911, was on the Deer Lick slope, where an 18-inch rusty quartz vein appears, which is said to assay $15 to $20 a ton.

RISING STAR MINE (gold) LOWER APPLEGATE DISTRICT JOSEPHINE COUNTY

The Rising Star mine, 12 miles south of Grants Pass, is in the northern part of Sec. 21, T. 38 S., R. 5 W., about half a mile southwest of the Oregon Bonanza, at an elevation of about 2200 feet, as measured by barometer. The mine is owned by Mr. St. John who has kept the main adit open. The latter is about 1500 feet long as shown in the sketch. The first part of the adit, going northwest, discloses a vein striking northeast and dipping about 75° S. W. which contains quartz varying from 0 to 48 inches thick. The thicker portions have been stoped out. In the second part of the adit, running southwest, only quartz stringers are found, and even these are less abundant near the face. The country rocks here include diorite and hornblende schist. The Rising Star mine was formerly equipped with an air compressor, a 5-stamp mill with a concentrator, and other machinery, now removed. In 1900 it was owned and operated by the Champion Gold Mining Company. Very little work has been done recently.



Main adit of the Rising Star mine near Powell Creek, Oregon. Main vein in solid black.

RIVERTON MINE (coal) COOS BAY DISTRICT COOS COUNTY

Located at Riverton, Oregon, 18 miles southwest of Marshfield and 12 miles northeast of Bandon.

Owned by the Riverton Fuel Company, W. S. Hall, president and manager. This company has taken over the property of the Riverton Coal and Development Company and also Kay brothers' property, and is beginning development on a considerable scale. The new company began operations in September, 1916, and is now working 30 men.

The coal beds have a total thickness of 4½ feet with 2 small partings 2 or 3 inches thick.

This mine is the only one in this district which is located on water transportation, all the coal being shipped by boat on the Coquille river. Preparations are being made for improved bunkers on the river near Coquille whereby transfer can be conveniently made from the boat to the railroad.

ROBERTS GROUP (gold) GREENHORN DISTRICT BAKER COUNTY

This group, about 2 miles southwest of Greenhorn, is in greenstone. The vein strikes about N. 70° W. and dips nearly vertical. The actual width of the vein was not determined, but the silicified replacement of the brecciated vein is of moderate width. Some of the material shows high gold values in the pan. Development work consists of open cuts, a crosscut and a drift which has not gone far enough to get underneath the croppings exposed in the open cuts.

ROBERT EMMETT COMPANY BAKER COUNTY

Office: Baker, Oregon. W. D. Pierce, Pres.; R. D. Carter, Sec.-Treas., both of Baker. Capital stock, $5000; par value $100; all subscribed, issued and paid up. (1916 report).

ROBINSON CLAIMS SIXES RIVER DISTRICT CURRY COUNTY

See "Smith and Robinson" claims.

ROCK CREEK CLAIMS (placer) ROCK CREEK DISTRICT COOS COUNTY

This property, which is owned by Mr. John R. Smith, is situated in Coos county on upper Rock creek, a tributary of Coquille river.

Mr. Smith reached the property in October, 1914, and claims to own by right of re-location 4 placer and 8 lode claims. His title has been disputed by former owners.

He has made and installed 500 feet of sluice boxes, and has done a great deal of additional productive work. He states that 3 men, working with pick and shovel and often contending with 9 feet of snow, took out $3500 worth of gold in 2½ months during the fall of 1914. He says that he left the property on January 18, 1915, and freely showed the gold he had recovered. This caused two men to go to the property during his absence and to work thereon without permission from him.

Mr. Smith further claims that he recovered $2000 worth of gold after his return to the property in the spring of 1915. At the time of this investigation, he was putting in ditches and laying plans to mine the ground on a large scale. He says that the gold is coarse and unworn, and is very pure, averaging about $19.50 an ounce in value. He has found that it hugs the bedrock closely.

This property has been worked more or less since the spring of 1915, but as far as can be learned has not yielded according to expectations.

ROCK GULCH PLACER — GALICE DISTRICT — JOSEPHINE COUNTY

See "Jewell and Lewis."

ROGERS GROUP (copper) — HOMESTEAD DISTRICT — BAKER COUNTY

This group, upon which considerable development was in progress in 1916, is situated about 3 miles below Homestead and in close proximity to the river and about 1000 feet above it at the outcrop. The outcrop is easily observed, since it is decidedly red in color and several feet wide. The development consists in driving crosscuts a few hundred feet to determine the nature of the deposit which has such a pronounced gossan.

It was feared that the tunnel, which was being driven at the time the property was visited in August, 1916, would crosscut the deposit too high above the water table to determine whether or not commercial copper ore would be found at depth.

ROSEBURG AND FIDELITY GROUPS (gold) — WALDO DIST. — JOSEPHINE COUNTY

Concerning these claims Diller says:

> The Roseburg group of six claims and the Fidelity group of four claims lie about the head of Tennessee Gulch, 3 miles southwest of Kerby, at an elevation of nearly 2,500 feet. These claims cluster about the southwest end of an area of granular greenstone surrounded by serpentine whose relations were not fully determined.
>
> Portions of Tennessee Gulch have afforded rich placers. Claims were taken up and a little arrastre built 40 years ago near the head of the gulch. Two tunnels have been run, one N. 70° E. and the other N. 70° W. near the contact of the greenstone and serpentine. The cellular quartz veins containing free gold are in the greenstone and are approximately parallel to the irregular contact, ranging from N. 50° to 80° E., with nearly vertical dip. Pyrite is the most abundant ore. No distinct trace of copper minerals was observed.
>
> A large tunnel is being run at a considerably lower level. It is already in 170 feet in greenstone and nearing the supposed horizon of the veins which appear at the surface.

ROSSLAND AND DEER PARK MINING COMPANY — ALASKA

Office: 270½ Washington St., Portland, Oregon. D. Solis Cohen, Pres.; S. W. King, Sec.; W. C. Wortman, Treas., all of Portland, Oregon. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company owns 4 mining claims on Gravina Island, Alaska.

ROYAL DUKE MINING COMPANY — LAKE COUNTY

Articles of incorporation filed September, 1916, by A. N. Bennett, I. L. Wakefield, C. N. Barrett. Capital stock, $5500; par value $1.00. Office, Lakeview, Oregon.

ROYAL WHITE MINE (gold) — GREENHORN DISTRICT — GRANT COUNTY

This mine is located about 1 mile north of Greenhorn and is owned by George R. Wiegand, of Greenhorn. It is situated 2000 feet northeast of the Belcher tunnel, on the north end of the ridge overlooking Quartz gulch.

It is of particular interest, because intricate faulting is shown and the abundance of manganese oxides suggests that superficial enrichment has taken place.

The principal development is a tunnel, which attains a maximum depth of 95 feet below the outcrop. The country rock is dense gray, thin-bedded chert, intricately fractured and locally plicated. The bedding trends east and the dominant dip is north, a structure which appears to antedate the fracture followed by the vein.

The vein fills a well defined fracture, which strikes N. 40° E. and dips steeply west, and is composed of chert breccia cemented by dense cream-colored chalcedony, which in vugs is covered with a film of minute quartz crystals. No sulphide minerals have been noted in the vein, though iron and manganese oxides are common throughout the explorations. Two portions of the vein, which range in width from 1 to 3 feet, have been worked; a northern 160 feet long, and a southern 30 feet long. The northern end of the longer shoot abuts against a crushed zone 5 feet wide and from this a 2-ton boulder is reported to have yielded $400 in gold. On the southern end of this shoot, the hanging wall bends over and merges with a fracture trending northwest in such a manner as to indicate that it has been dragged during a post-mineral fault movement. This portion has been explored to the surface, and has yielded several hundred tons of sorted ore containing $25 to $28 a ton in gold. It is estimated that 1400 tons of material remaining in the stopes contain $7 to $9 a ton in gold.

The second shoot abuts on the south against an east-west fault and has also been stoped to the surface. Its northern limit has not been explored.

Manganese oxide forms films on fractures throughout the workings, but locally occurs as lenses parallel to the bedding of the chert. In the first crosscut east, and near its intersection with the main drift, there are three lenses parallel to the bedding of the chert, which attain a maximum thickness of 10 inches. Though these may have been lenses of argillite containing more manganese than elsewhere, the relations indicate that much of the manganese in them is secondary. The character of unoxidized ore is not known, but it is possible that a portion of the gold in the vein is secondary and of superficial origin.

A small production has been reported over the period 1904 to 1910.

ROY MINING COMPANY (gold-silver) ASHWOOD DISTRICT JEFFERSON COUNTY

Local name, Roy mine.

Office: Pendleton, Oregon. E. P. Marshall, Pres., Pendleton, Oregon; W. J. Furnish, Portland, Sec.-Treas. Capital stock, $20,000; par value $1.00; $12,648 subscribed, issued and paid up. (1916 report).

This company owns 145.72 acres of patented land in Secs. 30 and 31, T. 9 S., R. 17 E., adjoining the Oregon King mine in Jefferson county. No activity at the property at present. The ore carries silver, gold and copper with silver predominating.

RUBY MINE (silver and gold) GREENHORN DISTRICT GRANT COUNTY

This property is located in Sec. 2, T. 10 S., R. 34 E., practically on the backbone of the main Greenhorn range, at an elevation of 7250 feet. The vein is in granodiorite striking northeast and is developed to some degree by drifts and crosscuts. Shipments have been made from this property.

The ore consists of quartz, arsenopyrite, pyrite, zinc blende, and a little galena in small veins in country rock, which has been bleached by the development of sericite and calcite stained green with chromium mica. Great widths of the veins are claimed for this property, due to the parallel fracturing or shearing of the granodiorite for considerable widths, but these large dimensions are of little economic importance, since the mineralization outside of the principal fracture is nearly always insufficient to warrant mining.

The values are in silver and gold. Reported assays from various points range from $5 to $250, more than half of which is in gold, which below the zone of oxidation may be reversed.

RUTH MINE — ASHLAND DISTRICT — JACKSON COUNTY

The Ruth mine, reached by wagon road, about 2½ miles west of Ashland, is about 500 feet east of Wagner creek, in Sec. 13, T. 39 S., R. 1 W., at an elevation of 2750 feet, as measured by aneroid barometer. The Ruth adit extends from the portal S. 2° E. 90 feet, then S. 5° E. 40 feet, and finally S. 2° E. 20 feet to the breast. At the portal the adit is in the footwall; at 60 to 80 feet from the portal it is in the vein; beyond that it follows a branch or stringer of the vein into the hanging wall. The vein strikes nearly due south and dips about 80° E. It consists of quartz and calcite with some gold and pyrolusite in hornblende rock. Tonalite is abundant in the hills nearby, but was not seen in the adit. The Ruth mine belongs to J. A. Kane, of Talent.

RYAN MINE — GOLD HILL DISTRICT — JACKSON COUNTY

See "Harth and Ryan" mine.

SALMON MOUNTAIN COARSE GOLD MINING COMPANY — COOS COUNTY

Office: Myrtle Point, Oregon. C. C. Carter, Pres.; Orvil Dodge, Sec.; E. A. Dodge, Treas., all of Myrtle Point. Capital stock, $500,000; par value $1.00; $275,000 subscribed, issued and paid up. (1914 report).

This company owns 15 claims known as the Salmon Mountain group. It is not known whether or not these 15 claims include the property described under the head of "Salmon Mountain Mine." Dissolved by proclamation in January, 1917.

SALMON MOUNTAIN MINE (gold) — COOS COUNTY

In the Port Orford folio Diller describes this property as follows:

The Salmon Mountain mine, on the north slope of Salmon Mountain, at an elevation of 2,100 feet, is hydraulic, using water with nearly 200 feet head, brought across the divide from the upper part of Johnson creek. The cut is about 50 feet deep, the same in width, and 500 feet long, with a range of 200 feet in height. It is in rather fragmental material of igneous origin, except at the lower end, where Eocene shales and sandstones occur. Although closed at the present time, it has been worked during the rainy season at intervals for a number of years. When running under good head the mine paid $75 to $100 a day and the gold is said to be rather uniformly distributed through the whole mass. This fragmental material of volcanic origin forms a bench with small depressions on the steep slope of Salmon Mountain, and appears to be due to a slide.

The rock is dark, often purplish or greenish, sometimes brecciated, much fractured, and easily goes to pieces. Although much altered, it retains traces of its ophitic structure which connects it with the basalts. Near the upper limit of its exposure, above the bulkhead it, is more solid and is associated with a rock rich in glaucophane, with sandstones and indurated shales bounding it on both sides.

The gold of the mine appears to be derived from small quartz veins, such as have been prospected in the immediate vicinity. Its intimate association with this igneous rock is exceptional and unlike anything else seen in the region. The branch of Salmon Creek which heads near the mine contains much of the same sort of debris in its bed and yields a small amount of gold annually to several miners.

A short distance southwest of the Salmon Mountain placer mine a quartz mine was opened by several tunnels running in a southerly direction into the hill. One of these showed a 2 inch quartz vein, with smaller veinlets, containing besides some pyrite occasional visible traces of free gold. Veins of this sort are found in the pebbles of Cretaceous sandstone which occur in the adjacent Eocene conglomerate, so that the formation of the veins belongs near the close of the Cretaceous.

SAMPSON CLAIMS (gold) — CRACKER CREEK DISTRICT — BAKER COUNTY

East of the Cracker-Oregon mine and of the usual Cracker creek type.

Nothing has been done recently at this property. A part of F. Wallace White's "consolidations."

SAND GULCH MINING COMPANY SPANISH GULCH DIST. WHEELER COUNTY

Office: Antone, Oregon. A. C. New, Pres.; N. E. New, Sec.; J. E. Derr, Treas., all of Antone, Oregon. Capital stock, $10,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

SANFORD PLACER MINES COMPANY (placer) (Washington corporation) DOUGLAS COUNTY

Office: North Yakima, Washington. Fred C. Belohlar, Georgian Hotel, Seattle, Wash., Pres.; P. B. Holdridge, North Yakima, Wash., Sec.-Treas.; A. E. Wheeler, Eden, Ore., attorney-in-fact; Chas. L. Lull, managing agent, Eden, Ore. Capital stock, $50,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's property is 12 miles west of West Fork station on West Fork creek.

SANGER GOLD MINES COMPANY (gold) EAGLE CREEK DIST. BAKER COUNTY

Local name, The Sanger mine.

Office: Baker, Oregon. F. W. Paine, Pres., Walla Walla, Wash.; J. K. Romig, Sec.-Treas., Baker, Ore. Capital stock, $2,000,000; par value, $1.00; $1,295,146 subscribed and issued; $2,000,000 paid up. (1916 report).

The Sanger mines of about 600 acres of quartz and placer claims are located in the northern part of T. 6 and 7 S., R. 43 E., on the western side of Eagle creek, in a quartz and placer mining area which has a record of considerable production. There has been little activity outside of small placer mining operations since 1900.

The ore deposits are several miles distant from the granitic outcrops of both the Wallowa range and the Sparta district, and may have been due to the intrusive influence of either or both. Because they are located in argillite and far to the north of Sparta they have for convenience been grouped with those others which were the undoubted product of the Wallowa intrusion.

The following description of the deposits and the production from the placer mines of Sanger is taken from the work of Waldemar Lindgren, frequently quoted in this report:

> The vicinity constituted the old placer camp of Hog'em, and from the gulches leading up to the mine the sum of $500,000 is reported to have been extracted. The principal vein, called the Summit lode, was discovered in 1870, and actively worked during the following years. In 1874 the production was $60,000 from ore containing $16 per ton. Just how much was produced up to 1887 cannot be ascertained, but it is not probable that the amount was very great. In 1887 a 10-stamp mill was built, and in 1889 the production began to increase rapidly. During the four years 1889-1892 the Mint reports give a total of $813,000 for this mine. Work was discontinued in 1897 and the mine was idle until December, 1900, when preparations were made to reopen it. It is commonly given as $1,500,000, and this figure is very likely approximately correct.
>
> The developments consist of several tunnels and an incline shaft 400 feet deep. Unfortunately there was no opportunity to examine the deposit, so that the information available is scanty.
>
> The country rock is a black clay slate, containing pyrite near the veins. The latter are well-defined quartz veins, with clay selvage, and dipping at gentle angles. To judge from available specimens, the ore is a normal coarsely crystalline vein quartz, with a little gray calcite. It contains about 3 per cent sulphurets, consisting of pyrite, chalcopyrite, brown zinc blende, and a little galena, together with free gold. On the whole, it has considerable similarity to the ores of many California gold-quartz veins. The principal vein is said to contain three pay shoots. The upper stopes were worked for a horizontal distance of 600 feet, 50 to 100 feet below the surface. The average width of the vein was here 15 inches, and the ore yielded $20 to $25 per ton. Below the zone of surface oxidation the vein was from 2 to 4 feet wide and the ore yielded $12 per ton. If these figures are reliable it may mean that the oxidized vein has been leached and compressed to smaller volume; while the absolute amount of gold remained the same the tenor appeared to be increased by this process.

Development work during the summer of 1916 consisted in making a few open cuts and running some short tunnels in the attempt to pick up the extension of some of the veins. The geologic conditions in this vicinity are such as to make prospecting rather difficult. The older slates have been severely fractured, cut by porphyry dikes and quartz veins, then followed a period of erosion, after which came the later basaltic lava flows. During the period of erosion fragments would naturally break away from the quartz veins and become scattered in the overlying soil. The outpourings of basalt have in a way sealed this material and so caused it to remain in its original condition, or perhaps may have consolidated or altered it to a certain extent. Therefore fragmental quartz might be mistaken for a vein outcrop. Another misleading factor is that both the older rocks and soils may be so altered that they resemble each other. In only one case in the recent development work was a vein observed and that was a very narrow one in the older shales a few inches in width, which had not been traced along its strike.

SANLINORE MINES AND POWER COMPANY

Office: 702 Spalding Bldg., Portland, Oregon. Z. H. Greenough, Pres.; Joseph H. Johnston, Sec.-Treas. Capital stock, \$50,000; par value 10 cents; all subscribed and paid up; \$25,075 issued. (1914 report). Dissolved by proclamation in January, 1917.

SARAH-BELLE MINING COMPANY — JOSEPHINE COUNTY

Office: Kelso, Washington. R. W. Welch, Pres.; W. P. Ely (deceased), Sec., both of Kelso, Wash. Capital stock, \$100,000; par value \$1.00; all subscribed, issued and paid up. (1913 report).

Properties near Golden, Oregon. Dissolved by proclamation in January, 1917.

SCANDINAVIAN-AMERICAN COMPANY — GALICE DIST. — JOSEPHINE COUNTY

This company installed a dredge to work gravels about 2 miles below the Almeda mine on Rogue river, but it was evidently not successful, as it has not been in operation for several years. It is reported that this company is defunct.

SCHAFFER CLAIM — GOLD HILL DISTRICT — JACKSON COUNTY

The Schaffer claim is northwest of the Nellie Wright, 2 miles east of Gold Hill. An adit 150 feet long discloses a vertical quartz vein 4 feet wide near the portal, but lost at the breast; the vein strikes N. 65° W. in tonalite.

SCHEELITE PROPERTY (tungsten) — WEATHERBY DISTRICT — BAKER COUNTY

Property consists of 5 claims owned by E. D. Morin, Adam Kolb and George Morin, of Baker, Oregon. Located 4 miles from Weatherby on Chicken creek, in about Sec. 9, T. 12 S., R. 44 E. There is a fairly good wagon road from the property to the railroad at Weatherby. The region is hilly and for the most part barren, although timber is at no great distance to the northeast.

Country rock is granodiorite and weathering has taken place, so that no fresh rock outcrops. Scheelite occurs in small quartz veins. The principal one is said to be from 2 to 14 inches wide. It strikes N. 40° W. and dips 45 to 55° to the south.

Development work consists of a prospect drift and short shaft. The shaft, which is sunk in the bed of Chicken creek, is filled with water.

No accurate sampling has been done, so that no information could be obtained in regard to the tungsten content of the veins, which also contain gold, as there has been, and still is, some placer mining in the immediate vicinity.

SCHOLL'S (LOUIS) PROSPECT (gold and copper) WALLOWA COUNTY

Located in Sec. 3, T. 1 S., R. 50 E., about 3 miles southwest of Temperance creek (Brockman's ranch). The Snake river canyon is quite rugged here and the prospect is about 1700 feet above the river at an elevation of about 3200 feet. The region is excellent for grazing and there is some timber on the property and more above.

The region is composed of older sediments, altered volcanics (greenstones) intruded by acid porphyry, while the presence of contact-metamorphic minerals seems to indicate that the main mass of the intrusive is at no very great depth. These rocks are overlain by loosely consolidated gravels, which in turn are overlain by basalt.

There are many outcrops highly mineralized with magnetite, epidote and quartz, and some of these may be as much as 100 feet in width. They appear to strike N. 80° E. and have nearly a vertical dip. Where limestone occurs a certain amount of replacement is evident.

Development work consists of 2 short tunnels. In one a 4-foot ledge of pyrite has been exposed and also masses of magnetite intergrown with chalcopyrite and pyrite. It was not possible to determine the shape or size of these deposits and no assay values were available. However, it would seem that this place is worth prospecting, and if a railroad is built along the Snake river these deposits may become of economic importance.

SHULZ AND AINSWORTH CLAIMS (placer) OPHIR DISTRICT CURRY COUNTY

At the time of the investigation in 1915, R. Schulz and C. Ainsworth were prospecting on the Great Falls and Tender Foot claims below the Ink and Barr placer on Boulder creek. They were doing work under an option from Dan Rowlan, the owner.

In the lower end of this property the bedrock is smooth serpentine, and runs down to a V, so that little gold has been caught there, and they had saved almost nothing during the month while they had been at work. A short distance above their present location, however, there is a flat, toward which they were working, and where they expected to find gold.

The press in 1916 report the finding of much coarse gold upon Boulder creek, either upon these claims or near them.

SCHWARTZFADER (WILLIAM) CLAIM (gold)
UPPER APPLEGATE DIST. JACKSON COUNTY

William Schwartzfader has a claim east of the famous Steamboat pocket, which has bunches of auriferous quartz in andesite, at an elevation of 3100 feet by barometer. The veins contain a little calcite and pyrite. The ore is treated in Scheerer's 4-stamp mill, located at the Steamboat pocket. So far as seen this ore is the product of surface enrichment.

SEVEN-THIRTY MINE (copper) GALICE DISTRICT JOSEPHINE COUNTY

The Seven-thirty mine is about 2 miles northwest of the Almeda mine and 1 mile west of Rogue river. It is said to have produced good ore, but has been closed for some years. It is now under option by H. B. Wickham, of Galice.

SEVENTY-THREE CINNABAR GROUP (mercury) GOLD HILL DIST. JACKSON CO.

R. H. Spencer, together with his associates, of Portland, Oregon, are now developing a group of claims adjoining the Mountain King, in Sec. 1, T. 35 S., R. 3 W., known as the No. 73 Cinnabar group, which is reported to be a very promising property.

SHEEP ROCK MINE (gold) EAGLE CREEK DISTRICT BAKER COUNTY

Two miles above the mouth of East Eagle creek in Sec. 30, T. 6 S., R. 44 E., is the McGee property commonly known as the Sheep Rock mine. The rocks in this locality are sandstones and volcanic breccias somewhat tilted. Upon the Sheep Rock claim there is a dike of altered igneous rock 30 to 40 feet wide, which strikes N. 40° W. and dips 50° S. W. There is auriferous quartz on both sides of this dike. The veins are from 10 to 18 inches wide and contain from $1 to $3 in gold besides carrying some pyrite and chalcopyrite. The principal veins on this property have a strike from N. 30° to 60° E. and a dip of from 27° to 37° N. W. These veins have gouge and show slickensides on both walls.

According to an engineer's report upon this property from which the above statements are taken, some of these latter veins have widths of 20 to 40 inches and values secured by panning of from $1.40 to $16.80. Considerable development work has been done in previous years but not much has been done recently.

SHERWOOD OIL COMPANY — **CLACKAMAS COUNTY**

Office: Sherwood, Oregon. M. C. Young, Pres.; J. E. Morback, Sec.-Treas., both of Sherwood, Oregon. Capital stock, $25,000; par value $1.00; $18,792.50 subscribed, issued and paid up. (1916 report).

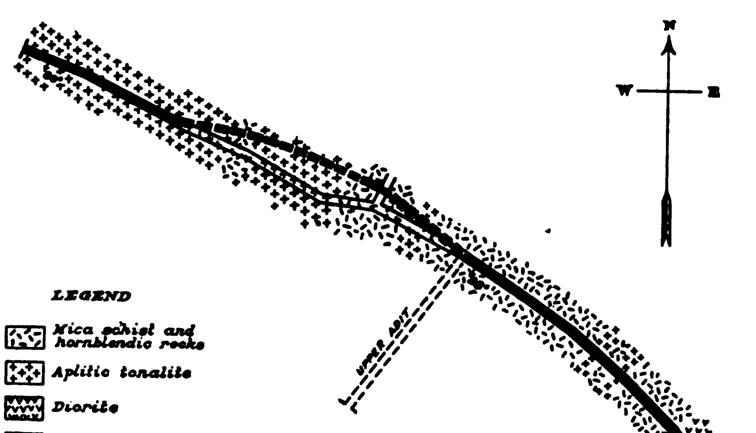
The location of its properties is about 5 miles south of Sherwood, Oregon.

SHORTY HOPE MINING AND MILLING OMPANY (gold)
ASHLAND DISTRICT — **JACKSON COUNTY**

Local name, Shorty Hope.

Office: Ashland, Oregon. H. S. Sanford, Pres., Ashland, Ore.; M. J. Goldner, Treas., Long Island City, N. Y.; T. W. Sanford, Asst. Sec., Ashland, Ore. Capital stock, $1,000,000; par value $1.00; $784,498 subscribed, issued and paid up. (1914 report).

The Shorty Hope mine is in Sec. 12, T. 39 S., R. 1 W., about 4 miles up Wagner creek from Talent and about a mile west of the Ashland mine. The long lower adit of the mine is at an elevation, determined by aneroid barometer, of 2450 feet; it is 1480 feet long and is said to reach a maximum depth of 160 feet; it follows a vein containing shoots of quartz some of which contains some pyrite and a very little chalcopyrite and galena. The vein varies from 3 to 10 feet in thickness; it strikes about N. 55° W. and dips nearly vertically. At 800 feet from the portal a vertical shaft leads to an upper tunnel level communicating with the surface through a crosscut adit 80 feet long. On the upper level drifts are opened on the vein in both



Shorty Hope mine, main adit and upper adit.

directions and some stoping has been done. The country rocks are tonalite, diorite, plagiaplite, and biotite hornblende contact rock. Some ore has been obtained from these workings, but the chief efforts of the owners were directed not to removing but to opening up the ore. The mine is equipped with a mill well located on a hillside of enough slope to permit ore to pass through without being elevated. The ore passes over grizzly bars 1½ inches apart to a 5 by 8-inch Dodge crusher placed over a bin from which it is fed by Challenge feeders to 10 stamps of about 1000 pounds weight each. The discharge is through a slotted metal screen of about 20 mesh to silvered amalgamating plates, one being 4 by 11 feet, and the other 4 feet wide and in three steps of 4, 4 and 3 feet respectively. From the plates the ore goes to two Frue vanners, 6 feet wide, which yield a high grade concentrate containing some galena. The mill was operated by water power, but has been used very little.

Other adits nearby give additional data concerning the veins in this region. One opening at an elevation of 2750 feet extends N. 30° W. about 90 feet following a zone of crushed rock about 3 feet thick with some vein quartz. The wall rock is a spotted diorite grading into a dark biotite hornblende rock. A second adit extends S. 24° E. about 120 feet at an elevation of about 2800 feet on the Hope claim; it is supposed to be on the southeast extension of the Shorty Hope vein. The vein here is small; the wall rock is diorite, with a little pegmatite near the portal.

SIERRA NEVADA CONSOLIDATED MINING COMPANY **IDAHO**

Office: McKinley Ave., Kellogg, Idaho. S. A. Easton, Pres.; C. W. Simmons, Sec.-Treas., both of Kellogg, Idaho. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located in Shoshone County, Idaho.

SILENT FRIEND MINE (gold) **GREENBACK DISTRICT** **JOSEPHINE COUNTY**

The Silent Friend mine is located in Sec. 15, T. 33 S., R. 5 W., on the north slope of Post Mountain at the head of Wolf creek, 9 miles east of Wolf Creek station on the Southern Pacific railroad. It is owned by John Scribner, of Wolf Creek, Oregon.

According to Kay:

> The chief development has been by 2 adits. The lower of these is 320 feet in length and crosscuts several stringers. The upper is 75 feet in length, and has an upraise to the surface. The country rock is greenstone, which is strongly chloritized adjacent to the veins. The ores are found in veinlets and stringers which run in various directions, but the majority of them have a general trend between southwest and west. The filling consists of quartz, calcite, pyrite, arsenopyrite, and, locally, chalcopyrite. Some specimens of ore, which were found to consist largely of calcite, chlorite, and arsenopyrite, showed considerable free gold visible to the unaided eye.

Mr. Scribner states that from the oxidized material on the surface overlying a network of small stringers he has taken gold to the value of more than $7000.

SILVER KING MINING COMPANY (gold, silver, lead and zinc)
NORTH SANTIAM DISTRICT **MARION COUNTY**

Local name, Silver King mine.

Office: Albany, Oregon. J. J. Langmack, Pres., Gerlinger Bldg., Portland.; Wm. S. Risley, Sec.-Treas., of Albany. Capital stock, $500,000; par value $1.00; $303,412.75 subscribed, issued and paid up. (1916 report).

Property located 10 miles northeast of Gates, a station on the Southern Pacific railway, and reached by good wagon road. About 3 miles from Elkhorn postoffice. Property consists of 12 mining claims, totaling about 240 acres.

A small quartz vein in andesite is exposed by a shaft reported to be 80 feet deep, nearly full of water at the time it was visited. The vein as exposed on the surface is 15 to 18 inches wide, containing considerable sulphide minerals, such as pyrite, galenite and sphalerite.

The greater amount of development of the property, however, is on the more or less mineralized shear zone several hundred feet up the mountain to the north, and known as the Queen of the West. It has a general strike N. 60° W. and dips about 60° S. W., and is well exposed in the bed of Henline creek, which is described as follows by C. W. Riddell in an engineer's report and printed in the company's prospectus:

At the outcropping the mineralized area extends 130 feet in width, with 26 inches of well mineralized quartz on the foot wall and 36 inches on the hanging wall. The intervening distance between the walls is filled with crushed and highly kaolinized country rock, with quartz stringers through it, all showing mineralization, but not opened up sufficiently for sampling. The development comprises two drifts, one on each side of Henline creek. The one on the east side being driven on the hanging wall 70 feet into the mountain, giving a vertical depth of approximately 60 feet. The showing in this tunnel is along the quartz vein on the hanging wall, and disclosed movement after the formation of the vein and the mineral deposition. The values have largely been leached by descending waters. The drift on the west side of Henline creek cuts through a portion of the kaolinized country rock to the hanging wall, which it then follows for about 65 feet. This does not reach below the oxidized zone, and shows that the mineral values have been leached.

The sulphide minerals are pyrite, galena and sphalerite. The channel sampling done by C. W. Riddell in the west drift was over an average width of 36 inches for 10 samples which averaged $1.20 in gold, 15.3 ounces of silver not discarding 2 high assays, from 3 to 4 per cent of lead and about the same of zinc in the samples which were assayed for zinc.

The work recently has been confined to driving a crosscut to the Queen of the West vein, the portal of which is at the foot of a cliff about 600 feet below the drifts above referred to and about 1000 feet from the point where it is expected the vein will be cut. This crosscut is in now about 100 feet.

SIMMONS PLACER — **WALDO DISTRICT** — **JOSEPHINE COUNTY**

See "Logan, Simmons and Cameron" mine.

SIMMONS PROSPECT (gold) — **CORNUCOPIA DISTRICT** — **BAKER COUNTY**

Simmons mountain is a long ridge between the east and west forks of Pine creek. It is on the northern or right hand side of the west fork, while "Granite" or "Cornucopia" mountain as it is locally known, is on the south or left hand side. This mountain, although of lesser elevation than the "granites" to the south, has extremely precipitous slopes, particularly the southwest portion. Readings taken with a clinometer near the principal outcrop of the Simmons' vein to the stream 2000 feet below gave a slope in excess of 40°.

This mountain is made up chiefly of a series of flows in which dense volcanics are interbedded with amygdaloids. Because of their alteration and their present color these rocks can well be called greenstones, although meta-basalt might be considered a more scientific name. The apparent strike of this series of flows is north and south and the dip is 40° to the E., judging by the parallel elongation of the amygdules or calcite-filled cavities seen in the lower tunnel.

The principal vein of the Simmons group has a strike 25° to 30° N. W. It has a flat dip to the east rarely exceeding 30° and more often much less. The principal vein has been traced on the west and north sides of the mountain for more than 2000 feet. It is, however, where exposed, for the most part too small to make ore unless of high grade. A great deal of work has been done on the croppings so that its width at almost all points can be easily seen and measured. The exposed part of the vein of workable size, unless some of the narrow portions should have very rich ore of which we have no information, is about 350 feet long, the maximum width a little more than 4 feet, the minimum 18 inches; the average width would not exceed 3 feet for this distance, perhaps a little less. The vein consists chiefly of quartz with small amounts of feldspar. Probably less than 1 per cent of the sulphide minerals, chalcopyrite and galena, are present in thin streaks near the center of the vein.

The development consists of the surface work before mentioned, short inclines sunk on the vein and two short crosscuts to the vein, besides the principal crosscut. Outside of the principal crosscut and the surface work, the development gives little information as to the nature of the main shoot below the surface. The inclines for some strange reason were sunk at the ends of shoots rather than in them where the best of the lens was exposed. The main crosscut also started towards and did cut the vein at a point outside of the principal shoot. In drifting to reach the shoot, although evidently mistaking a branch shattering of the foot wall for the vein, it was luckily encountered near the edge of the shoot. Drifting, at the time the property was visited in 1914, had progressed less than 100 feet upon the quartz lens. This development is nearly all the underground development of value. The width of the lens over this distance underground seems to be about the same as that directly above it on the surface.

This group is one of the oldest in the district and has been examined by several engineers with a view to purchase. Although not in possession of any of their reports or assay results, I am confident that the principal shoot contains considerable ore of milling grade.

In 1915 the property was under lease and bond to the Baker Mines Company. Drifting was continued on the vein. It was reported locally that the shoot of ore in the drift was found to equal the outcrop in size and value. However, the company decided to give up the lease and it is now reported that the owners have made a working arrangement with George W. Smith, who has been driving a crosscut to reach the ore upon the opposite side of the apex of the mountain from where the shoot of ore, discussed in previous paragraphs, is located. Some difficulty in holding the ground has delayed the work of crosscutting so that the objective point has not been reached.

SIPE (JAMES B.) MINING COMPANY (gold) CRACKER CREEK DIST. BAKER CO.

Local name, Buckeye mine.

Office: 516 Federal St., Pittsburgh, Pa. James B. Sipe, Pres.; Chas. F. Knapp, Sec.-Treas., both of Pittsburgh. Capital stock, $500,000; par value $1.00; all subscribed, issued and paid up. (1912 report. Dissolved January 5, 1914).

On the divide between Rock creek and the head of East Crack creek, about 2 miles northeast of Bourne, is the Buckeye mine, the property of the Sipe Gold Mining Company. Most of the development of this property has been accomplished in the last 10 years. There is about two-thirds of a mile of drifts and raises upon the property, most of which is on the Cracker creek side of the divide. The strike of the main vein is N. 60° E. and the dip is approximately 70° S. E. Besides the main vein there are narrow branch fissures containing limited quartz lenses in which are frequently found excellent specimens of coarse free gold. In the 2 tunnels on the Cracker creek side the vein averages about 4 feet wide, and is said to have a good grade of ore for a considerable part of the developed distance.

The tunnel next below, or No. 3, about 300 feet below the one above, followed a branch fissure for at least 1000 feet before crosscutting back to the main ledge, which was finally encountered late in 1914. Development in 1915-1916 was continued upon No. 3 level.

SIXES BEACH PLACER **SIXES RIVER DISTRICT** **CURRY COUNTY**

Diller describes this mine as follows:

The Sixes mine is located about 2½ miles south of Denmark, near the line between Secs. 27 and 34, T. 31 S., R. 15 W., and is operated by Mr. W. P. Butler of Lakeport, Cal. Like the Blanco mine, it lies along the eastern border of the coastal plains, at an altitude of nearly 200 feet above sea level. The mine covers about an acre and has a depth below the surface of about 12 feet, exposing along the eastern border the following section:

Section of the Sixes mine, 2½ miles south of Denmark.

	Feet
Surface material, wind-blown sand and soil	5
Gray sand with boulders	2
Black sand with boulders	2½

The whole 9½ feet of material is more or less distinctly stratified and dips gently westward, away from the shore, which is formed of crushed sandstone and shale of Cretaceous age. This bedrock series is well exposed in the eastern portion of the mine and contains rock oyster borings. The decomposed fine sediments yield tough bluish clay, which on the surface for 6 inches or so is stained reddish and becomes more granular, affording a good bedrock for mining. The gravel is washed into pool and raised 15 feet by a hydraulic elevator to get drainage for sluicing and tables. Much of the gold is fine and is associated with platinum metals in sufficient quantities to make the saving of them a matter of some importance.

The lack of adequate water supply and good drainage renders mining so expensive as to retard the development of hydraulic mining along this promising old beach. It would seem to be an encouraging locality to test by a modern dredge.

SIXES MINING COMPANY (placer) (Utah corporation)
SIXES RIVER DISTRICT **CURRY COUNTY**

Local name, Divelbiss property.

Office: 743 West Third St., Salt Lake City, Utah, and 625 Market St., San Francisco, California. L. R. Eccles, Ogden, Utah, Pres.; C. B. Edington, Salt Lake City, Utah, Sec.; John Pingree, Salt Lake City, Utah, Treas.; A. H. Thomas, Denmark, Ore., Attorney-in-fact; W. A. Bechtel, San Francisco, Cal., Managing Agent. Capital stock $1,125,000; par value $5.00; $789,500 subscribed, issued and paid up. (1916 report).

This company has an option on a number of claims originally owned and worked by the Divelbiss family. They first gave an option on the property to C. Inman who transferred his interest to the Sixes Mining Company, and now has no interest in the property. Diller describes the claims owned and once operated by N. C. Divelbiss as follows:

The most extensive (of the placer mines then being operated below the forks of the Sixes), operated by N. C. Divelbiss, is on the left bank in the sharp bend two miles above the mouth of Edson creek, and covers a large part of an acre. The gravel bank, worked by water under pressure, is fifty feet high and rests on Cretaceous sedimentary rocks. Farther west, near the mouth of Edson creek, on the right bank, is an upper terrace of large extent which has been mined on the edge, but with scarcely sufficient success to warrant the fluming necessary to supply the water that is needed to do the work satisfactorily.

Diller also states as follows relative to the platinum content of this ground:

In order to get a clew to the source of the platinum (in the beach placers), if possible, concentrates are obtained from the placer mines at several points along the Sixes. Ascending the river, the first was obtained from Mr. N. C. Divelbiss's mine on the left bank of the stream about three-quarters of a mile above the mouth of Dry creek. The sample submitted contained the concentrates from a clean-up after removing the gold. It weighed about 22.87 grams, of which 5.78 grams (about 25 per cent) were separated by the magnet. Platinum scales were found rather abundant, and non-magnetic, so they remained in the non-magnetic portion. The scales generally were very small, but one well-rounded by attrition weighed .03 grain. The scales are generally malleable and sectile and of steel gray color, distinguishable from the nearly tin-white and almost brittle scales of iridosmine, which are about one-third as abundant as those of platinum. In the estimates given below the platinum and iridosmine are counted together. The residue was passed through a series of sieves ranging in size from 60 to 100 mesh per inch, separating it into six lots which were then panned out. Nearly all the platinum was caught in the 60, 80 and 100 mesh. The total yield was .384 gram—about .0168 per cent of the total sample examined. A ton of such sand containing the same proportion would have about $7,500 worth of platinum alone. This material is highly concentrated, and there is no means of determining how many cubic yards of original gravel it represents, so that the value of the platinum per ton of gravel is unknown. Besides magnetite, the other minerals are chiefly chromite and ilmenite, with much zircon, epidote, and garnet and a trace of cinnabar.

Another sample of concentrates from the same mine, weighing 60 ounces, contained platinum at the rate of about $17.00 a ton, and the gold was about seven times as abundant as the platinum, but in this case as in the first the amount of gravel represented by these concentrates is unknown.

In order to get an idea of the relative values contained in the gravel of the mine, the concentrates from two pans of gravel next the bed rock were obtained from Mr. N. C. Divelbiss. They contained 32½c in gold, but no platinum was found. Two pans of gravel from 25 feet above the bed rock contained 3c in gold and no platinum.

Mr. W. A. Bechtel, of San Francisco, the general manager of the Sixes Mining Company, very kindly furnished the following information about the work being done, under date of May 26, 1916:

Location: The Sixes Mining Company is operating on the Sixes river in Curry county, Oregon, about 11 miles from Port Orford and 70 miles south of Marshfield, on what is known as the Divelbiss property, approximately 300 acres.

Water Rights: The water rights of both the Little and Big Edson creeks have been obtained and their waters are being confined by a dam on the Big Edson, and will be used in mining operations on this property.

Flume: The Sixes Mining Company has constructed a very substantial 3'x4' flume, 4½ miles in length, from the above mentioned reservoir. This gives a fall of sixteen feet to the mile, and delivers water into the penstock with a 296' head, measured from bed rock. We avoided construction of ditches on account of the porosity of the soil; in fact, from the very nature and ruggedness of the country traversed by the flume, we decided it would be more economical to build a flume and thus avoid the loss of water which generally occurs in ditch lines, to say nothing of the annoyance and loss of time.

Channels: We have three distinct channels traversing this property, but the magnitude of these is not clearly defined as much of the surface is covered by a heavy growth of timber. The first channel, the present bed of the Sixes river, varies in width and depth. We expect to sample and prospect this channel methodically this coming season in an endeavor to determine the value of the gravel. Mining here will be done with dredges, which will be operated by electric power developed by the same water as is now being used in washing on the second channel. The second channel is now being washed with water taken from Edson creek as before mentioned. We have found this channel to be 100' wide from rim rock to back wall, with a depth of 55 feet of gravel and a layer of well packed sand about two feet thick and 25 feet above bed rock. We have encountered no heavy boulders, and found it possible to handle this material very satisfactorily. We have found excellent values in the first six feet of blue gravel on the bed rock, with profitable values to the grass roots. The third channel lies above the second channel, but its extent has not been fully ascertained. It has been prospected, however, and seems to carry very good values. In fact, uninterested people maintain that this channel carries better values than eitner of the other two.

Operations: We have been operating for the past thirty days using one giant with a 6-inch nozzle. This supplies our present sluice flume with as much material as it will carry with best results. This "run" is in the nature of an experiment to determine the best methods to be employed to save the values existing in our grounds.

Gold, Platinum and Black Sands: We find that our property contains much black sand and platinum; and our earlier prospecting indicates that at least 10% of the values are in platinum. The black sands have received much attention and study from everybody who has tried to work in this district, since it has been found difficult to extract the gold and platinum contained therein. We have devised a method for doing this which, if it proves successful, will be given to the mining world in general, for we realise that the extraction of the values in this material has been a stumblnig block to the success of many mining companies. The gold in our property runs better than $18.00 per ounce, as determined by many assayers' reports. It is what is known as fine gold, nothing of nugget size having yet been found. The largest grains are about the size of a kernel of rice and are usually considerably flattened. The superintendent of our property is of the opinion that he will catch most of the gold in the first three or four riffles. We are, however, using undercurrents for additional production.

SMITH AND ROBINSON CLAIMS (placer) SIXES RIVER DIST. CURRY COUNTY

M. A. Smith and J. B. Robinson own 3 claims at the mouth of Rusty creek in Sec. 27, T. 32 S., R. 12 W., where it flows into the south fork of Sixes river. These are the Big Nugget, located in 1915, and the Big Foot and Nut Wood, located the previons year. The owners were ground-sluicing in the bed of Rusty creek, and they claimed to have recovered $14.60 in gold at the date the examination was made.

SMITH (GEORGE W.) CLAIMS (gold) CORNUCOPIA DISTRICT BAKER COUNTY

These claims are situated about 1 mile north of the Jackley claims near the northern end of Granite mountain and at the head of Little Eagle creek in Sec. 19, T. 6 S., R. 45 E. The elevation of the shallow workings is from 9000 to 9500 feet. The latter elevation is that of the mountain ridge.

The country rock is granodiorite with the exception of the basalt dikes. In contrast to the north side of the mountain this side has a long and rather even slope and is deeply weathered. Float is rarely seen and vein croppings are buried under the sand and rock fragments. Veins are traced here only by the discoloration of the surface due to iron stains.

On the lower slopes development by open cuts and short tunnels has not exposed large veins in place, but on the apex of the ridge a pit has exposed a somewhat brecciated quartz vein with altered walls striking N. 80° E. and dipping 60° N.

It will be noted that this vein has a different course than the other veins on the mountain. It has fairly parallel walls and in the pit shows a width 9½ feet with reported fair values in gold. This shallow pit is sunk along the side of a thick basalt dike that cuts the vein. Many dikes are seen on this part of the mountain and doubtless will frequently interrupt development.

The mountain has no prominent ridges upon which mine buildings could be erected and protected from snowslides. Prospecting cannot be prosecuted here for more than three and one-half months of the year. Snows on the flat come early and stay late and attain a maximum depth of at least 15 feet. Development if done in this short season can practically all be done on the vein but when the time comes to prepare for production and the erection of upper terminals of an aerial tramway, a working tunnel will have to be driven from some protected point to the vein to avoid the possible destruction of the mine structures by avalanches.

Assessment work was done in 1915, and in 1916 F. X. Gauthier secured a one-half interest under working conditions and is doing his development work upon ore with reported good results.

SNAKE RIVER MINES COMPANY (gold) CONNOR CREEK DIST. BAKER COUNTY

Local name, The Schist Property, formerly the Runner claims.

The property of this company is located in Sec. 33, T. 11 S., R. 45 E., about 3 miles by wagon road from the railroad (19 miles north of Huntington). This part of the canyon is quite rugged and the hills are covered with bunchgrass and sagebrush. The property is about 1600 feet above the river, which has an elevation of about 1900 feet above sea level.

The country rocks are limestone, limestone schist, quartz sericite schist, and argillite. The limestone is blue in color and has a finely crystalline texture; in some places it is brecciated and recemented with calcite. The schist is bluish in color and quite dense. In thin section it is seen to be very fine grained and to consist chiefly of elongated quartz grains with fine parallel bands of sericite. No true bedding planes were noted in the rocks, but the general strike of the schistosity is N. 72° E., dip 61° W. There are some small specks of hematite in the schist that have probably been derived from pyrite, which was probably an original constituent of the schist.

There are several fine grained porphyry or aplitic dikes that cut the above rocks parallel to the schistosity, although, of course, their crosscutting nature is quite apparent in places. Some of the smaller dike stringers are badly altered and have the appearance of clay seams.

On this property the schist is cut in many places by quartz veins a few inches wide, from which branch minute reticulate veins impregnate the body of the schist. Samples taken of the country rock all show the presence of gold. It is probable that this metal is contained in the minute stringers, while the unaltered schist is barren. The quartz and gold were deposited in the shattered schist from ascending solutions coming from the underlying cooling magma. In this case apparently the values have been disseminated widely through the schist. The limits of the gold-bearing schist have not been determined in 2 crosscuts which are being driven upon the property.

This property is being developed by several hundred feet of tunnels and drifts. In general the values vary from 40c to $3, with a few as high as $7 and $14 per ton. From a glance at the assay map (July, 1916) it appears that (excluding the high assays) an average value of $1.75 per ton is attained.

A test mill of 75 tons per day capacity has been built, which crushes with Chilian mills and cyanides the slimes.

The climate, topography and transportation facilities are favorable for all-the-year-round operations.

SNAKE RIVER MINING AND MILLING COMPANY (copper) HOMESTEAD DISTRICT BAKER COUNTY

Local name, Koger Group.

Office: R. D. No. 2, box 218A, Pasadena, California. J. H. Schneider, Pres.-Treas.; Mrs. J. H. Schneider, Sec. Capital stock, $300,000; par value $1.00; $219,105 subscribed, issued and paid up. (1916 report).

This company has many claims located in the basin northwest of the Iron Dike, about 1 mile from Homestead, in Secs. 8, 9, 16 and 17, T. 6 S., R. 40 E. The same types of dense greenstones are found here, which have scattered through them small amounts of pyrite. In contrast with the Iron Dike, this property has but a slight amount of faulting and no shearing.

SNAPSHOT CLAIM (gold) ASHLAND DISTRICT JACKSON COUNTY

The Snapshot claim, formerly called the Cleveland, is located on Wagner creek, near the north side of Sec. 23, T. 39 S., R. 1 W., at an elevation of about 3000 feet, and about 1 mile southwest from the Ashland mine. It is now owned by R. W. Dunlap, of Ashland. It is opened by an adit about 50 feet long running N. 31° W. in tonalite on a quartz vein varying in thickness from 1 to 4 feet. A branch vein or stringer joins the main vein at 20 feet from the portal. The latter strikes N. 20° W. and dips about 56° E.-N. E., while the former has a strike of N. 20° W. and a dip of 66° E.-N. E., and carries quartz and pyrrhotite. The tonalite adjoining the vein is much mineralized in some places. Another adit on the same claim was not visited.

SNOW CREEK MINING COMPANY (gold and copper) GREENHORN DIST. BAKER CO.

Local name, Snow Creek mine.

Office: 2104 Court St., Baker, Oregon. Henry B. Smith, Bay City, Mich., Pres.; Chas. H. McColloch, Baker, Sec.; Robt. J. Davison, Bath, N. Y., Treas. Capital stock, $200,000; par value $1.00; $132,000 subscribed, issued and paid up. (1915 report).

In Sec. 16, T. 10 S., R. 35 E., at the head of Snow creek, is the Snow Creek mine. This mine has a 10-stamp mill and 3 vanners, an 80 H. P. steam plant, and is developed by a vertical shaft 225 feet deep and 1315 feet of drifts, which disclose a fair sized shoot 300 feet long. It has been under water for a few years.

SORBECK PROSPECT BAKER DISTRICT BAKER COUNTY

On the west side of the tributary to Washington gulch near the center of Sec. 27, T. 9 S., R. 39 E., a considerable amount of work has been done in a branching tunnel which cuts various types of rocks—limestone, chert, greenstone, and a black tuffaceous rock. The latter carries a small amount of pyrite, which tarnishes to a bright yellow, indicating probably a small copper content. Several small fault zones with clay gouge occur in these workings and one small vein of quartz was noted. A detailed study of this prospect, which contains in all over 1200 feet of tunnel working, was not made.

SORDY'S (HARRY) CLAIM GALICE DISTRICT JOSEPHINE COUNTY

Harry Sordy's claim is about half a mile north of the Oriole, at an elevation of 3000 feet, as measured by barometer. It is N. 31° W. of Galice at least 2 miles. The vein is opened by an adit and several shorter workings. The former is about 150 feet long, and the vein, in small lenses, strikes N. 40° E. and dips 55° northwest. The country rocks are serpentine and greenstone. This claim was formerly owned by John Carlson.

SOUTH GEM MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This claim is on the same vein as the North Gem and lies immediately south of it. It has a shaft 100 feet deep, with about the same width of vein as at the North Gem, to which the reader is referred.

SOUTH POLE CONSOLIDATED GOLD MINES COMPANY
CRACKER CREEK DISTRICT BAKER COUNTY

Out of business.

SOUTH POLE MINE (gold) CRACKER CREEK DISTRICT BAKER COUNTY

See "Columbia Gold Mining Company" for description.

SOVEREIGN CONSOLIDATED COPPER COMPANY (copper)
EAGLE CREEK DISTRICT BAKER COUNTY

Local name, Sovereign mine.

Office: Baker, Oregon. J. A. Howard, Pres.; K. O. McEwen, Sec.; John Arthur, Treas. Capital stock, $2,000,000; par value $1.00; all subscribed, issued and paid up. (1913 report).

Six miles west of Sparta, in Sec. 23, T. 7 S., R. 43 E., in timbered area. Elevation 4000 feet. Wagon road to Baker, 25 miles. Lands, 3 claims. Dormant.

The country rock is a dense greenstone, in places slightly brecciated and cut by small irregular quartz veins, which contain small amounts of galena, zinc blende and chalcopyrite.

Company organized to develop the Sovereign mine, but the results were so discouraging that work ceased a few years ago. Property now being developed by H. C. Thomas and H. W. Forster.

SOWELL MINE WALDO DISTRICT JOSEPHINE COUNTY

See "Kerby Queen (or Sowell)" mine.

SPAULDING MINE (placer) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Spaulding mine, 7 miles by wagon road southwest from Jacksonville, is on Forest creek, in Sec. 4, T. 38 S., R. 3 W., and is owned by John Davies, of Jacksonville.

The maximum thickness of the deposit in the present workings is more than 40 feet, but the average thickness does not exceed 25 feet. The lowest 10 feet consists of gravels containing boulders; the upper part of the deposit is hardpan. Even in the lower part there are but few boulders, and these are usually less than 1 foot in diameter. They are rounded or subangular and are usually of greenstone, although some are of granodiorite. The mine is equipped for hydraulicking.

SPENCE MINE (gold) WALDO DISTRICT JOSEPHINE COUNTY

The Spence property is in Sec. 19, T. 40 S., R. 7 W., 2½ miles east of Takilma. The size of the dump at the main adit indicates 500 feet to 700 feet of workings. It could not be entered because of a cave near the portal. The ore on the dump is chiefly pyrite. A 60-foot tunnel in the vicinity is a crosscut and does not show any ore. Another tunnel not examined is said to be 200 feet long and shows somewhat better ore than that on the dump of the long tunnel.

SPOKANE GROUP (gold) GALICE DISTRICT JOSEPHINE COUNTY

The Spokane group is near the head of Rich gulch, at an elevation of about 2200 feet, as measured by barometer. An adit extends N. 10° W. about 190 feet in a serpentinous rock, containing irregular kidneys and stringers of pyritiferous quartz, associated with a fault marked by soft gouge. The foot-wall of the lode is a garnetiferous mica schist. The group is owned by Robertson and Sutherland.

STANDARD MINE (gold, copper, cobalt) QUARTZBURG DIST. GRANT COUNTY

On the east fork of Dixie creek, less than a mile above the junction, in Sec. 12, T. 12 S., R. 33 E., is the Standard copper mine, located on the east side of the creek, and for some few hundred feet above.

The country rock is made up of a series of old volcanic flows. In many places these have an amygdaloidal texture, in which calcite is the chief filling material. Dark, finely granular dense flows are also present, made up of much andesine feldspar, and considerable uralitic hornblende, with some sericite and chlorite, which probably makes it an altered uralite andesite.

On top of the ridge, above the mine workings, is a fine-grained, light-colored altered dike about 50 feet wide, which has a ground mass of badly formed intergrowth of quartz and feldspar. Its mineral composition indicates the parent granodiorite below. Its texture indicates it to be a granodiorite porphyry grading into aplite.

There are several developed veins on the property. These veins strike approximately N. 70° E. The most important are the Juniper and Standard veins. The Juniper vein is steep dipping and has a maximum width of about 2½ feet, and is of the replacement type with quartz and calcite as gangue minerals in with the altered country rock in the vein. The ore minerals are chalcopyrite, pyrrhotite, pyrite and some smaltite. These sulphides occur in small lenses with chalcopyrite as the chief sulphide. It is said to carry $3 in gold per ton. It has been developed by 120 feet of tunnel and has been traced by means of prospect pits for about 1000 feet.

The Standard vein has a dip of a little over 50° S. and in widths up to 10 feet. The mineralization of this vein is similar to that in the Juniper. It is said that lenses of sulphide 100x50x5 feet have been stoped. It is developed by three tunnels about 100 feet apart, 700, 1200 and 1300 feet long, respectively, all of which are connected by raises.

The Willie Boy vein, farther to the eastward, contains a small rich stringer of the usual minerals, but besides the massive cobalt di-arsenide, smaltite, there are small crystals of safflorite scattered through chlorite. Safflorite is identical in composition with smaltite, but crystallizes in the orthorhombic instead of the isometric system.

It is probable that these veins were formed by hot ascending solutions which were the last action of the intrusive mass at depth. The veins are of the replacement type, and the influence of the wall rock was probably an important factor. The mineralization is unique in that cobalt minerals are present. Although the region is somewhat weathered, it is doubtful if there is much secondary enrichment.

These veins have been practically worked out to the level of the creek. Large croppings of a lode into which these small veins lead appears to be many feet wide, but no development was observed upon them. These wide N.-S. croppings of quartz and partially replaced country rock contain bunches of chalcopyrite within a foot or two of the surface.

A great deal of money has been expended upon this property, which closed down in 1907, after operating the mill for 6 months. Development work was started again in the spring of 1914 by new owners and was continued in 1915 and 1916.

STAR GOLD MINING COMPANY (gold) ASHLAND DISTRICT JACKSON COUNTY

Office: Oswego, Oregon. J. W. Bickner, Pres.; H. B. Bickner, Sec.-Treas., both of Oswego. Capital stock, $500,000; par value $1.00; all subscribed and paid up; $340,150 issued. (1916 report).

This company owns 14 claims about 5 miles west of Ashland, in the Wagner creek district. The company has done only a limited amount of development work to date. They expect to proceed with this work the next year on an extensive scale, so as to bring the property to a paying basis.

STAR MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Star mine is in the S. E. ¼ Sec. 7, T. 34 S., R. 5 W., about half a mile south of Placer. It was opened by two shafts about 250 feet apart, but as the workings are full of water no examination was possible. From the dumps and trenches the vein evidently strikes about east and west in a greenstone country rock, while the ore is gold-bearing quartz.

STARR (McKINLEY) GROUP (copper) GOLD BEACH DISTRICT CURRY COUNTY

This group is located about 7 miles south of east from Gold Beach at an elevation of 3950 feet, as determined by the barometer. It was originally located as the McKinley group by Col. I. E. Munsey about 1893. He held possession of the property until he died in 1912. The property was re-located in 1915 by Charles Starr, Harriet Starr, R. G. Starr and J. R. Stannard, all of Gold Beach, who now hold 15 claims. It is reported that Col. Munsey was offered $60,000 for the property, but that he considered it worth $6,000,000, and would not consider the lower figure.

As previously stated, the country rock is serpentine, but at least one lens of Colebrooke schist exists in the vicinity, and some greenstone occurs west of the property. The main mass of Colebrooke schist lies not far to the east.

On the Starr No. 2 claim, above the trail, a cross-cut tunnel 275 feet long has been driven N. 60° E. No ore is shown in this opening. It was undoubtedly put in for the purpose of cutting at depth the deposits outcropping above the mouth of the tunnel.

The first cut above the tunnel measures about 15 by 10 by 6 feet. The deposit is a shear-zone in serpentine and shows considerable copper carbonate or iron-stain in the cracks. A general sample from the dump yielded 8.18 per cent copper and no gold.

North of the last mentioned opening is an open cut 30 or more feet long, 15 feet wide, and 12 feet deep. In this is exposed about 12 feet of sheared serpentine stained in the same way as is the deposit described in the last paragraph. A sample carefully cut from across the whole mass yielded 3.17 per cent copper, 1.61 oz. gold, and .27 oz. of silver per ton. A little chalcopyrite (copper-iron sulphide) was present in this ore, and the amount would doubtless increase at greater depth. The high proportion of gold is an unexpected feature which may lead to interesting developments.

Above the cut just mentioned is the large open cut or pit, 40 feet in diameter. In this occurs a highly iron-stained, porous gossan to a depth of about 5 feet. Then comes massive sulphide ore for a foot or two; while beneath this is limonite-stained serpentine. The sulphide ore consists of chalcopyrite and pyrrhotite (monosulphide of iron), which latter has a peculiar fibrous appearance. A sample of the gossan proved to contain no gold, as was also true in the case of the limonite-stained serpentine below the sulphide. The sulphide ore yielded 5.1 per cent copper, but no gold or nickel.

A tunnel has been driven directly beneath the open pit just described. It runs S. 45° E. for 20 feet, then gradually curves to the southward for 55 feet so as to bring the breast directly below the pit and at a depth of no more than 10 or 15 feet beneath the material there exposed. Near the mouth this tunnel cuts a copper-stained sheared zone from which considerable ore has been taken. A conical pile of this material, 4 feet high and 12 feet in diameter, was sampled and proved to contain 1.04 per cent copper and no gold. It is but fair to state, however, that this ore gave evidence of considerable leaching and it is not unlikely that the grade was considerably higher when it was mined. This material, as well as one or more copper-stained shear-zones, are exposed in a trench 250 feet long north of the tunnel and open pit.

The open pit and tunnel described in the preceding paragraph are of especial interest as here we seem to have pretty conclusive proof of the boulder-like nature of the deposit of copper ore. No one can doubt for a moment that the material is in place, and yet, within a depth of a few feet, an ore running better than 5 per cent copper gives place to fresh, unstained serpentine.

About 100 feet east of south of the big pit is an open cut in which some slightly oxidized magnetite is exposed. This material is of the lodestone variety. That is, it is itself a magnet and will pick up small particles of iron or steel. Analysis proves it to be the highest grade iron ore found on the trip, since it contains 60.13 per cent iron, .36 per cent phosphorous, and no sulphur, arsenic, or titanium.

Numerous other openings exist on this property, and several others were visited, but they appeared so similar to those already described that they were not sampled. Enough time was spent in examining the deposits to prove their essential similarity to those in the Collier creek region, both the boulder and shear-zone types being represented. The principal points of difference are the relative scarcity of magnetite, and a substitution of chalcopyrite and pyrrhotite for chalcocite, cuprite, and native copper. It may be that the scarcity of magnetite is due to differences in climatic conditions, since the greater rainfall in the vicinity of the McKinley group may have hastened the decomposition of any magnetite that once existed there.

STEAM BEER MINE (placer) GREENBACK DISTRICT JOSEPHINE COUNTY

Diller reports that:

the Steam Beer placer, near Leland, owned by H. K. Miller, has continued in full operation for a number of years. The ditch is about 9 miles in length and supplies a head of 200 feet. The gravel terrace is 50 feet above Grave creek, which affords excellent dumping ground. The mine exposes 25 feet of gravel, generally coarse below, and made up largely of greenstone with scarcely any quartz. The bed rock is slate.

STEAMBOAT POCKET (gold) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Steamboat pocket, 2 miles west of Steamboat, was mined out before 1869; it is said to have produced $350,000, which came from a shallow surface working in andesite. Scheerer has explored the andesite under the Steamboat pocket by several adits, two entering from the south and one from the north side of the hill. The upper adit is at an elevation of about 3000 feet in Sec. 20, T. 40 S., R. 4 W., entering N. 10° E. and opening into several crosscuts and drifts following small veins and fractures. A little stoping has been done chiefly on two veins. The country rock is andesite which is faulted in several directions like a system of joints on a large scale. One vein containing 18 inches of quartz strikes N. and dips 45° W. Another with 10 inches of quartz (on which the pocket was located) strikes N. 10° W. and dips 45° E. Another with 5 inches of quartz strikes N. 80° W. and dips 75° N. Another with the same thickness of quartz strikes N. 45° and dips

55° N. E. Still another with 3 inches of quartz strikes N. 55° E. and dips 75° N. W. The adit from the north extends S. 70° E. into the other workings. At the present face of the main adit there is a pyritized shear zone.

STEAR PROPERTY AGNESS DISTRICT CURRY COUNTY

See "Stephens and Stear" property.

STEEN AND LINDGREEN CLAIMS (gold) CORNUCOPIA DIST. BAKER COUNTY

These claims are in Norway basin, which is some 3 miles from Cornucopia, on the headwaters of the west fork of Pine creek. A trail goes up on the more gentle slopes to the north of Simmons mountain and drops down some 300 to 400 feet into Norway basin.

The country rock is greenstone varying from dense to amygdaloidal and from fine-grained to porphyritic. It is made up of a series of flows similar in every way to those of Simmons mountain.

The situation of the outcrop of the vein is on the floor of the basin, but it is somewhat concealed because of loose rock and freshly made soil. The vein has a N. and S. strike and dips 65° to the E. It is developed by an adit upon the vein 750 feet long which reaches a maximum depth of 200 feet. The vein is of the shear zone type and varies in width from a streak of gouge up to 16 feet. Three ore shoots have been found; the first runs 100 feet in from the portal; the second begins 80 feet beyond the first and continues to the face; while they expect to be well into the third before the season closes. This third shoot is the main objective of the owners, because of the good values found at the surface.

In 1915 and 1916 drifting was continued which opened up good widths of medium and low grade ore, but owing to the death of Mr. Lindgreen the third or principal shoot was not developed.

STELLA COAL MINING COMPANY WASHINGTON

Office: 426 Lumber Exchange Bldg., Portland, Oregon. M. J. Lynch, 427 Lumber Exchange Bldg., Portland, Pres.; J. P. McInery, The Dalles, Oregon, Sec.; L. Shanhan, 144 Third St., Portland, Treas. Capital stock, $25,000; par value $10; capital stock all subscribed and paid up, none issued. (1916 report). Properties located near Stella, Washington.

STEPHENS AND STEAR PROPERTY (gold) AGNESS DISTRICT CURRY COUNTY

This property, which is owned by Mr. Stephens and Charles Stear, is situated about 3000 feet north of the Night Hawk about 4 miles southeast of Agness. It has been developed by means of a tunnel which is said to be over 300 feet long, but was locked at the time the examination was made. The dump is of such size as to indicate that considerable development work has been done. From material on the dump, it seems probable that the deposit consists of relatively narrow white quartz stringers through a sheared or brecciated zone, which is said to be more than 20 feet wide in some places. The country rock is mostly greenstone, but there is some serpentine on the dump, and it is evident that both rocks are penetrated by the workings. There is so much wash on the surface that the relationship of these could not be determined. Some calcite and a little pectolite and red hematite are present on the dump, but it is evident that these are not common. The quartz is said to occasionally show free gold, and it is also claimed that gold can be panned from it at many points. It is reported that this property was last worked in the spring of 1915.

STERLING GOLD QUARTZ MINING AND MILLING COMPANY
UPPER APPLEGATE DISTRICT JACKSON COUNTY

Office: Medford, Oregon. W. H. Canon, Pres.; J. L. Denner, Sec., and G. L. Davis, Treas., all of Medford, Oregon. Capital stock, $1,000,000; par value $1.00; capital stock subscribed, $702,995; amount issued, $636,095; $9114.50 paid up. (1912 report. Dissolved January 11, 1916).

The Sterling Gold Quartz Mining and Milling Company has developed a group of claims in Secs. 28, 29 and 32, T. 38 S., R. 2 W., at an elevation of about 2800 feet by barometer. The lower adit is about 240 feet long following a vertical quartz vein 1 foot or less in thickness associated with fissuring filled by calcite and sulphides. The middle adit is about 60 feet long following quartz stringers which strike S. 70° E. and dip about 50° N. E. The upper adit is about 400 feet long; it enters as a crosscut, and then drifts on crushed zones in the country rock, one of which strikes N. 15° W. and is nearly vertical. Seams of calcite, quartz, and some pyrite run in all directions. The main crushed zone strikes N. 45° W. and dips about 80° S. W. Some stoping has been done irregularly in this zone. No work has been done for the last few years.

STERLING MINE (placer) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Sterling placer mine is on Sterling creek, from 1 to 4 miles above its mouth, at Buncom, on Little Applegate river, and is owned by R. S. Bullis, of Medford. The present workings are on the south line of Sec. 33, T. 38 S., R. 2 W., at an elevation of about 2300 feet. A large electric power pump has recently been installed, by means of which pressure at the nozzle has been increased to the equivalent of a head of about 200 feet. The gravel is so thoroughly cemented that much of it must be broken with powder before using the giants. The deposit is 20 to 40 feet thick and about 400 feet wide. Drifts have been run on bedrock ahead of the giants about 100 feet. The gravel contains boulders of andesite and some quartz. According to G. F. Kay:

> The values are found across a width of nearly 200 feet. In these gravels the tusks and jaws of a mammoth, as well as other mammalian bones, have been found. The bed rock at the mine is greenstone, in which are patches of slaty tuffs, whose strike is N. 8° E. and dip is about 60° W. The slope of the bed rock is about 2 feet in 100 feet. The length of the working season varies from 6 to 9 months. The value of the gravels was about 40 cents to the cubic yard. The total production of the mine is said to exceed $3,000,000.

STERLING MINING COMPANY UPPER APPLEGATE DIST. JACKSON COUNTY

Dissolved by proclamation in January, 1917.

**STEVENSON MINING COMPANY (gold)
GREENHORN DISTRICT GRANT AND BAKER COUNTIES**

Local name, Spero mine.

Office: Greenhorn, Oregon. Stephen Little, Pres.; Edward G. Stevenson, Sec. Capital stock, $1,000,000; par value $10; all subscribed, issued and paid up. (1915 report).

This company owns 7 claims a short distance east of Greenhorn at the old town of Robinsonville. The country rock is serpentine. The vein strikes N. 30° E. and is 10 to 15 feet wide, and comprised of massive white quartz. The property has only the assessment work done upon it each year.

STOCKTON MINE (gold) SUSANVILLE DISTRICT GRANT COUNTY

This property has had considerable prospecting done upon it, but in recent years has been idle. It has been in litigation with the Badger Gold Mining and Milling Company, which see.

STUB MINE BAKER DISTRICT BAKER COUNTY

For description see "Kent Mine."

STURGIS MINE (placer) UPPER AGGLEGATE DISTRICT JACKSON COUNTY

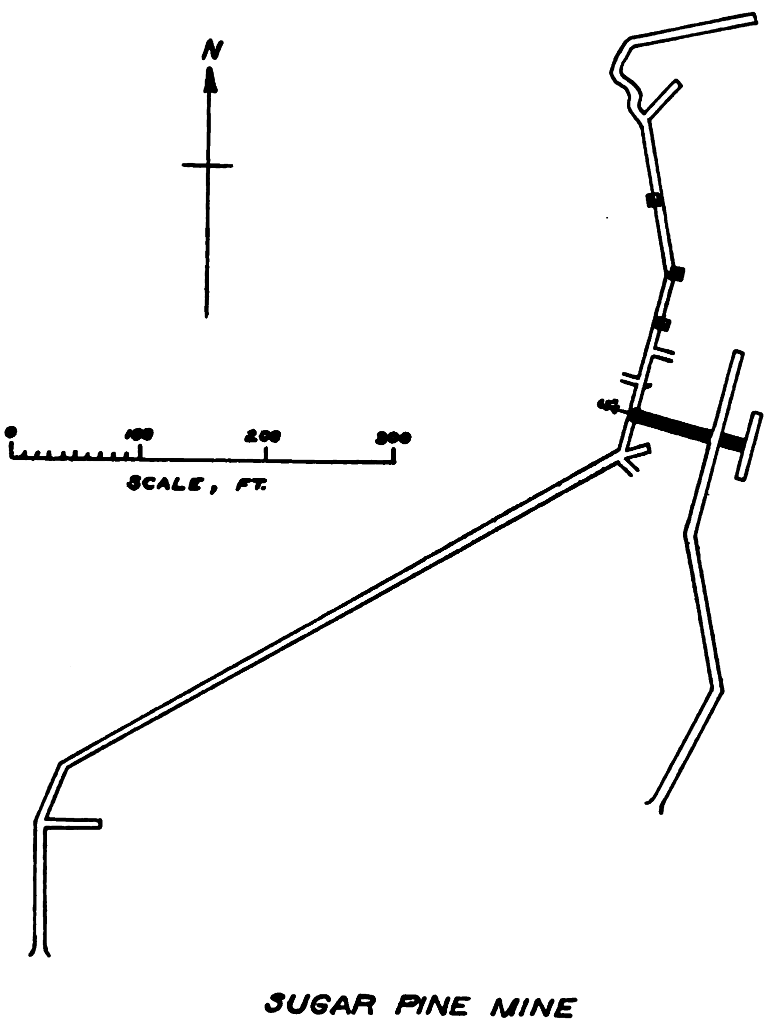
The Sturgis mine is 4 miles southwest from Jacksonville on Forest creek, in Sec. 10, T. 38 S., R. 3 W. It was formerly the property of the Sterling

Mining Company, but is now owned by Vance Mining Company, of Eureka, Cal., and leased by Lou Stone. The property contains about 900 acres.

The deposit has an average thickness of about 30 feet. In the lowest 10 feet are gravels and sand containing rounded and subangular boulders, which are chiefly of greenstone, although some are of granodiorite. The bedrock is greenstone much fractured and veined; in places it is very slaty, the strike being N. 30° E. and the dip 48° S. E. The mine is equipped with giants, and a derrick is used for handling the boulders. About 1 acre a year is mined.

SUGAR PINE MINE (gold) **GALICE DISTRICT** **JOSEPHINE COUNTY**

The Sugar Pine mine was one of the earliest quartz mines discovered in the Galice district. It is said to have been opened by Cassidy and Draper in 1860 and worked by Green brothers from about 1875 to 1887, when it was sold to the Sugar Pine Mining and Milling Company. It is now owned by Mrs. Mollie Belding, of Grants Pass.



Main workings, Sugar Pine mine

It is on the north fork of Galice creek, about 2½ miles southwest of Galice. It is opened by nearly 3000 feet of underground workings. At the lower adit at an elevation of about 1700 feet the vein seems to be a narrow dike intrusive in amphibole schist. This entry has a length of about 1100 feet, of which about half is following one or more veins. The main lode is 1 to 5 feet in width and contains many stringers and lenses of quartz; it strikes about north and dips 65 to 70° W. The workings are shown as platted from a rapid Brunton compass survey in the illustration. In one place on the upper adit level, 150 feet above the lower, the lode is widened to about 5 feet and crossed diagonally by quartz veins. The ore consists of quartz, often adhering solidly to greenstone, and carrying a little pyrite, chalcopyrite and galena. The ore from a rich shoot mined out by the Green brothers is said to have yielded more than $25,000 when treated in an arrastre. A 10-stamp mill, erected in 1908, was run a few months and later moved to the Oriole mine.

SUGAR PINE MINING AND MILLING COMPANY GALICE DIST. JOSEPHINE CO.

Articles of incorporation filed in 1914. No report made to State Corporation Commissioner. Dissolved by proclamation in January, 1917.

See "Sugar Pine Mine."

SULLIVAN EXTENSION MINING COMPANY IDAHO

Office: 501 Chamber of Commerce Bldg., Portland, Oregon. J. W. P. McFall, Portland, Pres.; George F. Holman, Portland, Sec. Capital stock, $1,000,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's properties are located in Idaho.

SUMMIT MINING COMPANY (placer) WEATHERBY DISTRICT BAKER COUNTY

Local name, Summit mine.

Office: 317 Board of Trade Bldg., Portland, Oregon. H. A. Moore, Pres.; Laura Moore, Sec.-Treas. Capital stock, $9000; par value $100; all subscribed, issued and paid up. (1916 report).

This company has the Summit placer mine, located in Lost Basin, Baker county, which is close to Pedro mountain in T. 12 S., R. 42 E.

SUMPTER SMELTER SUMPTER DISTRICT BAKER COUNTY

Formerly the property of the Northwestern Smelting and Refining Company, but has recently (1916) been sold for taxes to J. A. Gyllenberg. It has been idle for several years.

SUNNYSIDE COAL MINE JACKSONVILLE DISRICT JACKSON COUNTY

The Sunnyside coal mine is in Sec. 36, T. 37 S., R. 1 W., about 5 miles east-southeast of Medford. Two entries have been made; the entry to the northwest is an incline equipped with a boiler and steam hoist. It was not inspected, being full of water. The other is horizontal and accessible; it is at an elevation of 1970 feet, as measured by aneroid barometer, and extends S. 34° E. about 650 feet. In places the roof has caved, but the entry is nowhere caved shut. Nearly the entire length of this adit the coal bed extends from the floor to the roof without showing its entire thickness, which was found to be about 12 feet at one point where caving permitted measurement. At the face of the adit the coal seam is 8 feet 3 inches thick, and in a branch passage to the south it is 15 feet thick. The quantity of coal in the seam varies remarkably, so that a section at one point may show much more coal than at another. The maximum amount of coal in the seam is about 75 per cent and the minimum in the main entry is about 30 to 40 per cent. The coal bed has a strike of N. 72° W. and a dip of 13° N. E. The coal is brittle and slacks to small fragments upon exposure to the weather.

About 130 feet from the face of the adit, branch tunnels leave the main entry on both sides. Those extending to the northeast follow down the dip of the coal and are therefore full of water and inaccessible. On the other side one branch extends S. 84° W. about 500 feet; from this laterals extend northward to a parallel tunnel and other workings, whose extent was not determined. Following the main branch to the west, the coal seams in the coal-bearing bed become thinner and the shale bands thicker until at the face the bed contains only a little pure coal.

There are several faults disclosed in these workings, but they are not important, as the displacement is only 1 to 4 feet.

J. S. Diller, of the U. S. Geological Survey, described explorations for coal, probably at this mine, in 1909, as follows:

The coal 6 miles east of Medford lies along the steeper slope, which rises from the edge of the valley, 600 feet above the town, to the bold front of the Cascade range. Some years ago the Southern Pacific Company prospected a coal bed at this point, and the size of the dump indicates that the trial drifts must have been about 100 feet in length. Since then R. P. Little has discovered a number of other coal beds a short distance farther up on the same hillside and opened two of them by slopes, tunnels, and drifts, aggregating nearly 900 feet in length. Drainage is effected by a lateral tunnel into an adjacent ravine. Considerable coal has been hauled to Medford and sold at $8 per ton.

The principal bed prospected is about 12 feet thick, and the striking feature at the entrance of the gentle slope is the large number of clay and sand partings with very little coal between them. The partings weathering whitish are strongly contrasted with the darker bands. As the slope is descended along the bed there appears a decided increase in the quantity and improvement in the quality of the coal toward the northeast. The bands of black lustrous coal, generally not over 6 to 8 inches thick, locally swell to more than a foot and furnish the source of supply for the local demand. The intermediate shaly coal and coaly shale is abundant and requires much picking to obtain satisfactory results. Several faults striking N. 40° E. and dipping 26° to 42° S. E. have been encountered in the tunnels. The direction of movement and the amount of displacement could not be definitely determined. No lavas were seen in the mine, but they appear higher up, covering the whole succession of coal beds. The decided improvement in the coal down the dip suggested that as the most favorable direction in which to prospect.

Since the examination on which the foregoing statement is based was made, the Pacific Coal Company has purchased this mine and has developed the openings to the northeast along the dip of the coal bed for more than 1000 feet. The prediction that the coal would be found of better quality and in larger quantity has been confirmed. A few small faults have been encountered, but these are all of the normal type and easily overcome. The mine is now (1907) producing coal and supplies the local market. The development of this mine has greatly stimulated prospecting in other parts of the field.

J. A. Holmes of the Geological Survey collected a sample of coal at this locality last summer (1907) and has kindly furnished the following results of an analysis in the laboratory of the Survey fuel-testing plant.

Analysis of Coal Obtained Near Medford, Oregon.
(F. M. Stanton, chemist in charge)

	As received	Air dried
Laboratory No.	5346	5346
Loss of moisture on air drying	....	2.00
Moisture	11.30	9.49
Volatile matter	23.39	23.87
Fixed carbon	31.89	32.54
Ash	33.42	34.10
Sulphur	1.16	1.18
Calories	4,183	4,268
British thermal units	7,529	7,683

The sample taken is a complete section of the coal bed exposed and represents what has to be removed in working the coal. It contains not only the good coal but all the shaly partings. The high percentage of ash indicates that the bed contains much that would have to be thrown away in mining. The ash is about four times as great as that of the bed mined at Libby in the Coos Bay region.

SUNNYSIDE MINING AND MILLING COMPANY (gold-copper)
NORTH SANTIAM DISTRICT **MARION COUNTY**

Office: 569 Spokane Ave., Portland, Oregon. A. B. Crossman, Pres., Lewis Bldg., Portland; Walter Adams, Sec.-Treas., 569 Spokane Ave., Portland. Capital stock, $1,000,000; par value $1.00; $580,000 subscribed, issued and paid up. (1915 report).

Property is located 16 miles northeast of Gates, by good wagon road 13 miles, and trail 3 miles. There are 9 claims.

This property joins the Gold Creek Mining and Milling Company's grounds and development work so far completed indicates similar vein and mineral conditions as found at that property. Only one opening was visited, which is a drift upon a vein where massive zinc, iron, lead and copper sulphides a foot or two wide were seen at the face.

Assessment work is done each year.

SURPRISE MINING COMPANY (placer) WALDO DISTRICT JOSEPHINE COUNTY

Office: 619 Henry Bldg., Portland, Oregon. H. Taylor Hill, Pres.; T. I. Loughlin, Sec.; M. E. Freeman, Treas., all of Portland. Capital stock, $18,-000; par value $1.00; all subscribed and issued and paid up. (1916 report).

This company owns 7 placer claims or approximately 140 acres on the east fork of Althouse creek, 5 miles east of Takilma. In the fall of 1916 operations were in progress putting the mine in shape for winter operations. It is understood that some concentrating machinery for saving the fine gold is being installed.

SUSAN D MINE (gold) VIRTUE DISTRICT BAKER COUNTY

Formerly the White Swan mine, William Schlutting, principal owner, located about 3 miles southeast of the Virtue, in Sec. 25, T. 9 S., R. 41 E., and has been practically idle since 1903. The mine was worked successfully in the '80s and was idle from 1897 to about 1900, when it came into the possession of Letson Balliet, who operated this and other properties with a brass band and other similar features until 1903, when the Federal Government stopped his operations. Previous to his time the production was estimated to have been not less than $200,000.

The country rock here, in contrast to the diorite at the Flagstaff and the greenstone at the Virtue, is a black soft argillite with a few well defined diorite dikes which are off-shoots from the intrusion below. The vein strikes northwesterly and is nearly vertical. The quartz is white and massive like that of the Virtue, with a small amount of sulphides and calcite. It is developed by a shaft about 300 feet deep and several drifts upon the vein. There are many small veins in the vicinity of the Susan D, and in some of these chimneys of coarse gold have been found, although none of large amounts.

SUSANVILLE PLACERS SUSANVILLE DISTRICT GRANT COUNTY

The placer mines near Susanville were discovered in 1864 and have been worked practically every season since then. Those of Elk creek have been worked over more than once and the last time by Chinese who ceased operations in 1915. The territory of chief interest is in the valley of Middle Fork of the John Day river from the mouth of Elk creek down stream for 4 or 5 miles. This has been held under option for some time by Emil Melzer and associates of Baker, Oregon, who, in 1914 and following, sank pits and did some churn drilling. The valley here is quite broad varying from several hundred feet up to a half mile or more and the possible dredging ground involves several hundred acres. Values are reported to be in sufficient amount to make dredging profitable.

SUTHERLIN QUICKSILVER MINING, REFINING AND DEVELOPMENT COMPANY (mercury) DOUGLAS COUNTY

Local name, Bonanza mine.

This company was incorporated September, 1916, with a capital stock of $6000. Incorporators are L. S. Griswold, W. T. S. Hoyt and John E. Meister.

The company's property was formerly called the Bonanza mine and is located 8 miles east of Sutherlin in Douglas county on Foster creek. It is under the management of L. S. Griswold.

The ore deposit is a low grade cinnabar ore disseminating through brecciated or shear zones in andesite.

The company is installing a small mill and retort and it is proposed to concentrate the ores before retorting.

SWACKER FLAT MINE (placer) GOLD HILL DISTRICT JACKSON COUNTY

At the Swacker Flat placer mine, 8 miles southwest of Gold Hill on the left fork of Foots creek in the N. E. ¼ Sec. 12, T. 37 S., R. 4 W., there is a fault which is later than the formation of the placer gravel. The fault strikes N 40° W. and dips about 65° N. E. The vertical displacement is at least 10 feet. The region is being carefully tested for placer gold in the gravels.

SWASTIKA MINING COMPANY (placer) (Maine corporation) GRANTS PASS DISTRICT JOSEPHINE COUNTY

Local name, Swastika mine.

Office: 19 Congress St., Boston, Mass. Bernard C. Pratt, 53 State St., Boston, Mass., Pres.; Fred C. Cox, Malden, Mass., Sec.-Treas.; E. A. Rathbone, Grants Pass Ore., attorney in fact. Capital stock, $200,000; par value $1.00; all subscribed, issued and paid up. (1914 report. Out of business).

This company has been exploiting a low gravel bank in the forks where Jack creek flows into Jump-off-Joe, 4 miles east of Hugo, known as the Swastika placer mine. It was operated for several years before 1910; since then very little has been done, aside from work on a small scale by lessees. During the operation of the mine by the company two 18-inch pipes were used, one under a head of 150 feet and the other of about 75 feet. According to Diller:

> The gravel is 15 to 30 feet deep and is composed of greenstone pebbles. It is coarsest below, the largest boulders being 2 feet in diameter. In many places the whole mass is rotten, so that many of the boulders go to pieces under the stream from the giant. The bedrock in the Swastika mine and throughout the slopes of Jack creek is greenstone.

This mine at present is under lease to Messrs. Mackey and Ward, of Hugo, Oregon.

SYKES CREEK MINING COMPANY (placer) JACKSONVILLE DIST. JACKSON CO.

Office: Seattle, Washington. I. J. Merrill, Pres., 1019 Post St., Seattle. The secretary and treasurer of this company traded their interests and no new ones had been elected at the time this report was made. Capital stock, $30,000; par value $1.00; $18,325 subscribed, issued and paid up. (1915 report).

This company owns 80 acres of placer ground 10 miles up Evans creek from Rogue river in Sec. 1, T. 35 S., R. 4 W. There is no activity at the property.

SYLVANITE (gold-silver-tungsten) GOLD HILL DISTRICT JACKSON COUNTY

The Sylvanite mine is in Sec. 2, T. 36 S., R. 3 W., about 3 miles northeast of Gold Hill. It is owned by E. T. Simons. The vein strikes N. 22° E. and dips about 65° E. and the country rocks have the same attitude; they are argillite partly altered to chlorite and serpentine. The vein contains quartz carrying some pyrite. The workings, now badly caved, are reported to consist of a drift 1200 feet long at an elevation of 1360 feet by barometer and a crosscut to the vein at an elevation of 1650 feet, with a shaft to the lower level. According to W. A. Marvin, who was in charge of the mine at one time, the ore contained no telluride, but a little galena and much pyrite in quartz; the fault gouge contained about $3 worth of gold and silver per ton; high grade gold occurred in "boulders" not in place at depths from 80 to 160 feet; sulphide ore began to appear at about 160 feet depth and was 5 feet wide at 225 feet depth; the hanging wall was a slate and the footwall a limestone.

Considerable interest has been attached to this property since the discovery in March, 1916, of tungsten along with the gold ores in the form of scheelite. The mineral occurs in small stringers with quartz. Samples have been taken from these quartz ledges which run as high as 40 per cent tungstic acid, but it is claimed by the management that the vein as a whole runs less than 2 per cent. The veins carrying the best grade of tungsten have been developed to a small extent and the tungsten resources of the mine have not yet been determined.

The property is under lease and bond to Stone and Avena, of Denver, Colorado, who are doing some further development work.

TABER FRACTION (gold) CRACKER CREEK DISTRICT BAKER COUNTY

The Taber Fraction, 346 feet long, is on the North Pole-Columbia lode between the Columbia Gold Mining Company's ground and that of the Bourne Gold Mining Company. For a general description of the lode see Columbia Gold Mining Company on another page. Total production estimated at $475,000. No production since 1905, when the Columbia Gold Mines Company ceased to operate it under a lease.

A lease and bond upon this property was given to James A. Howard, of the Oregon-Idaho Investment Company, of Baker, Oregon, in the fall of 1916 and permission was secured from the E. and E. mine (Bourne Gold Mining Company) to use tunnels of the latter in working the property.

TAKILMA SMELTING COMPANY (Colorado corporation) WALDO DISTRICT JOSEPHINE COUNTY

Office: 301 Mining Exchange Bldg., Colorado Springs, Colorado. Charles L. Tutt, Pres.; William Tutt, Sec.; J. A. Hull, Treas., all of Colorado Springs; C. E. Tucker, Takilma, Oregon, attorney in fact. (1916 report).

TALENT COAL COMPANY ASHLAND DISTRICT JACKSON COUNTY

Office: Talent, Oregon. Emmett Beeson, Pres.; E. B. Adamson, Sec.; Louis Brown, Treas., all of Talent. Capital stock, $10,000; par value $10; $5040 subscribed, issued and paid up. (1916 report).

The company owns 320 acres in Sec. 16, T. 38 S., R. 1 E. A coal seam has been opened by Emmett Beeson, of Talent, by means of a slope or incline shaft following the coal nearly on its dip. This coal outcrops in a ravine at the foot of a sandstone cliff at an elevation of about 2600 feet. Fossil impressions of leaves were collected from shaly sandstone at an elevation of about 3050 feet near the top of the cliff a little south of east of the coal seam. The sandstone strikes about S. 45° E. and dips about 25° N. E. at the place where the fossils are found. The coal seam has a strike of N. 53° W. and a dip of about 16° N. E. The slope opening this coal discloses a fault at 70 feet from the portal which strikes N. 10° W. and dips about 62° E. The hanging wall of the fault is displaced vertically downward about 6 feet. At about 120 feet from the portal the coal seam is narrowed to about 3 inches by the doming up of the floor; at the breast, about 130 feet from the portal, the coal is again nearly 2 feet thick.

The section at this outcrop follows:

Section at Beeson's Slope in Sec. 16, T. 38 S., R. 1 E.

	Feet	Inches
Feldspathic sandstone	10	
Shaly sandstone with fossil leaves		6-8
Feldspathic conglomeratic sandstone	400	
Covered	5	
Feldspathic conglomeratic sandstone	6	
Fine grained sandstone		2-4
Coal		1
Coal and coaly shale	1	3
Fine grained sandstone	8	
Feldspathic conglomeratic sandstone	42	
Coarse quartzose conglomerate	10	
Feldspathic conglomeratic sandstone	20	

TEMPEST MINE (gold-silver) GREENSHORN DISTRICT GRANT COUNTY

This property consists of 3 claims located in about Sec. 2, T. 10 S., R. 34 E., on the west side of and close to Granite Boulder creek at an elevation of 6500 feet. The development here consists of several short tunnels from which quite a little ore has been shipped. There is said to be five veins cropping in granodiorite which strike N. 35° E. and dip nearly vertical, but only one was examined. This one is up to 4 feet in width and consists of altered sericitic kaolinized rock in which there are small stringers of quartz with arsenopyrite, pyrite, and zinc blende, a little gold, but with the chief values in silver.

Very little work has been done on this property in the last few years, but the press of October, 1916 announces that this property, owned by Millard Bennett and E. E. Bennett, had been sold to Florence N. Doty, of Denver, for a price of $50,000.

TEN SPOT CLAIM GRANTS PASS DISTRICT JOSEPHINE COUNTY

The Ten Spot claim, 5 miles southeast of Grants Pass, is near the north side of Sec. 27, T. 36 S., R. 5 W., on Baldy mountain. It is owned by G. E. Everson and R. E. McDaniels, of Creswell, Oregon. The country rock is decomposed or "rotten" tonalite, locally called granite. The vein is not now exposed, but is said to be a small quartz vein which has been prospected by surface pits and a shaft 30 feet deep all in "rotten granite." The vein seems to strike N. 58° E. A crosscut adit is being driven by contract; it extends 140 feet S. 40° E. in "rotten granite," so soft as to be dug with pick and shovel and to require careful lagging to hold the ground. The vein has not yet been reached by the crosscut.

TEPUSTETE IRON COMPANY MEXICO

Office: 1215 Wilcox Bldg., Portland, Oregon. Theo B. Wilcox, Pres.; J. Frank Watson, Sec., both of Portland, Oregon. Capital stock, $100,000; par value $100; all subscribed, issued and paid up. (1916 report).

This company's properties are located in San Ysidrio, Lower California, Mexico.

TEXAS OREGON POWER AND PLACER MINING COMPANY
GALICE DISTRICT JOSEPHINE COUNTY

Office: Merlin, Oregon. John M. Fenn, Pres.; John McM. Byers, Sec., both of Merlin. Capital stock, $130,000; par value $1.00; $129,900 subscribed, issued and paid up. (1915 report).

This company has 204.3 acres of placer ground 10 miles northwest of Merlin at the mouth of Taylor creek, near Galice.

THOMAS CLAIMS WALDO DISTRICT JOSEPHINE COUNTY

See "Tomlinson, Gates and Thomas" claims.

THOMAS COPPER CLAIM EAGLE CREEK DISTRICT BAKER COUNTY

See "Forster & Thomas" copper claims.

THOMPSON MINE (copper) COOS COUNTY

Diller says:

> Mention should be made of the copper ore that has been found in a mineralized belt nearly 25 miles to the northeast in the vicinity of Mount Bolivar, the most prominent peak in the greenstone belt that is shown near the northwest corner of the map. The greenstone of this belt is impregnated at a number of places by pyrite, chalcopyrite, and bornite, and contains numerous veins of quartz and calcite. The most important copper prospect noted in this region is on the west fork of Cow creek at the locality known as the Thompson mine. It has been exploited by several tunnels and inclines and yielded at least 50 tons of ore, chiefly chalcopyrite, and bornite. The works were closed at the time of my examination, but the occurrence of so much ore on the dumps apparently shows the existence of ore bodies of considerable size. This prospect, although only 17 miles from the main line

of the Southern Pacific railroad at West Fork and all down grade, is reached by trail only. Numerous prospects have been opened in this mineralized belt between Mount Bolivar and Rogue river, but none of greater promise than that already noted has yet been found.

THREE LODES MINING COMPANY GALICE DIST. JOSEPHINE COUNTY

Office: Medford, Oregon. C. E. Wickstrum, Rogue River, Oregon, Pres.; N. L. Townsend, Medford, Sec.; George Lindley, Medford, Treas. Capital stock, $350,000; par value 35 cents; all subscribed, issued and paid up. (1916 report).

This company owns the Three Lodes group of 9 claims and has bonded the Golden Pheasant group of 9 claims. These claims are located about 2 miles west of Galice on a contact between greenstone and serpentine.

This property has been exploited at various times during the past several years as a tin, tungsten and platinum property. Lately it is supposed to be a molybdenum property.

TIN PAN MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Tin Pan mine, 5 miles southwest of Gold Hill, is in the S. W. ¼ sec. 31, T. 36 S., R. 3 W. on the ridge between Galls and Foots creeks. It was located many years ago; in 1908 it was owned by the Pacific American Gold Mining Company and prospected by more than 1200 feet of drifts, shafts, and other workings on the vein without finding any large body of good ore. At that time the mine was equipped with a 10-stamp mill (since removed) having a Blake crusher and two concentrating tables. The country rock on top of the ridge west of the mine is an andesite porphyry containing abundant much altered phenocrysts of plagioclase, and bunches of green hornblende or brown biotite as well as some magnetite, epidote and siderite in a fine granular groundmass. In 1913 the workings were badly caved and inspection was impossible. It was relocated in July, 1913, by M. L. Hall. According to G. F. Kay:

> The country rock in which the ores occur are slates, limestones, and greenstones, the greenstones apparently being intrusive in the sedimentary rocks although some of them may be volcanic. The sedimentary rocks strike about N. 13° E. The strike of the vein is between northeast and east and the dip is nearly vertical. The vein varies in width from less than 18 inches to more than 6 feet of solid quartz between definite walls, which are in general but slightly altered. In places there is a gouge from 1 to 3 inches in width. This material is clay-like, but it contains carbonates and sulphides. Most of the gold content of the vein is in the sulphides, which run about $60 to the ton. The sulphides are pyrite and galena which together constitute less than 2 per cent of the ores. Some faulting has occurred. The zone of oxidation reaches a depth of more than 100 feet.

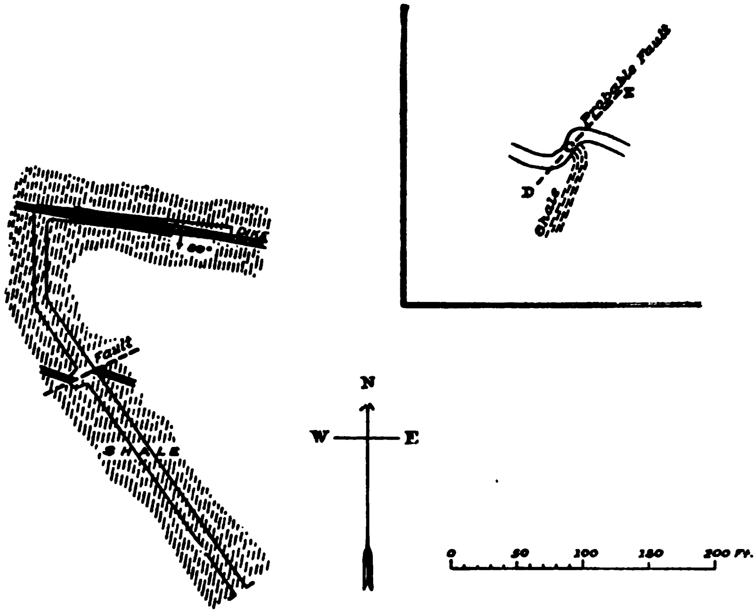
TOMLINSON, GATES AND THOMAS CLAIMS (copper) WALDO DISTRIST JOSEPHINE COUNTY

The copper prospect belonging to Tomlinson, Gates and Thomas, 12 miles southeast of Holland, is on top of the ridge east of Grizzly gulch, at an elevation of about 4850 feet as measured by barometer.

At the upper shaft the vein strikes N. 60° W. and dips about 75° S. W. It is about 18 inches wide, but the adjoining ground contains quartz and some copper minerals to a width of about 4 feet. The copper occurs in chalcopyrite, bornite, chalcocite, chrysocolla, and malachite. Pyrite is also abundant.

TOWN MINE (gold) JACKSONVILLE DISTRICT JACKSON COUNTY

The Town mine near Jacksonville, is on a ridge about 800 feet west of the reservoir on Jackson creek at an elevation of 2200 feet as determined by aneroid barometer. It is owned by J. G. Rinehart. A bunch of rich gold ore known as the Johnson pocket and reported to have yielded $30,000, was taken from a shallow cut in a quartz vein in micaceous shales near the top of the ridge. The old partly filled opening marking the site of the pocket is curved like a circumflex as shown in the drawing. At the point C the shaly layers are curved, probably as a result of faulting in a direction DE, which seems to have offset the vein about 16 feet. A crosscut adit was driven from a point about 300 feet down the hillside to the southeast to cut the veins under the pocket. It was run N. 35° 265 feet, and then north 70 feet and easterly about



Town mine, main adit and surface workings

150 feet as shown in the drawing. At 200 feet from the portal a mass of quartz was cut in the northeast wall, but as it did not continue across the adit it was not recognized as the vein, and the adit was continued. More recent work at this point discloses a narrow band of quartz in an apparent fault leading southerly to more quartz which is probably the faulted continuation of the main vein, the offset being similar to that observed on the surface. The vein strikes north of west and has a nearly vertical dip. The extension of the adit opened a second nearly parallel vein which pinched out to the east, the tunnel then following a dike along the south side of which the vein was formed. The country rock is a shaly argillite which strikes N. 10° E. and dips 80° E. A dike present in the adit consists largely of hornblende and is a mafic diorite or a spessartite.

About 600 feet to the north on the northeast slope of the ridge at about the same elevation another adit runs S. 15° W. nearly 200 feet. At 185 feet from the portal it cuts a 2-foot vein of quartz which strikes S. 85° W. and dips steeply to the north. A drift of 20 feet to the west on the vein shows no important change in character. This is apparently below a shallow pit on the surface, about 120 feet higher, made in taking out the "Bowden" pocket which is reported to have yielded $60,000.

Beside the reservoir on Jackson creek another vein called the Reservoir ledge has been worked. The vein in this ledge is 1 to 3 feet wide and strikes N. 85° W. with a dip of about 85° N. It is opened only on the surface.

There has been no activity at this mine for several years.

TRAVERSO CLAIM UPPER APPLEGATE DISTRICT JACKSON COUNTY

See "Haskins and Traverso" claim.

TREASURY GROUP (gold, etc.) GALICE DISTRICT JOSEPHINE COUNTY

The Treasury group, about 4½ miles northwest of Galice, is noteworthy because its ore contains not only quartz and pyrite, but also chalcopyrite, malachite, and sphalerite.

TREASURE MINE (gold) BLUE RIVER DISTRICT LINN COUNTY

Property consist of 5 patented claims, located in the southern part of T. 15 S., R. 4 E. Five miles of fair wagon road to Blue River post-office, and a good road from Blue River to Eugene, a distance of 45 miles.

Country rock is andesite. Deposit is of the brecciated zone type, having a maximum width of 45 feet. Strike N. 45° W. dipping 80° to the southwest.

Developed by 2 tunnels, the upper one 500 feet long, the lower one 1800 feet long. The length of the ore shoot is said to be 270 feet. Mill consists of 12 stamps and amalgamating plates.

TRI METAL MINING COMPANY JOSEPHINE COUNTY

Filed articles of incorporation 1916. Joe R. Smith, C. McDougal, James White and M. Norden, incorporators. Capital stock $10,000. Office: Grants Pass, Ore.

TROUT CREEK MINING AND MILLING COMPANY (gold-silver-lead and zinc) HARNEY DISTRICT HARNEY COUNTY

Local name: "Bullion Quartz Mine."

Office: Canyon City, Ore. O. J. Darst, Burns, Ore., Pres.; F. S. Slater, Prairie City, Ore., Sec.-Treas. Capital stock $100,000; par value $1.00; all subscribed, issued and paid up. (1916 report).

This company's property is the Bullion Quartz claim in Sec. 4, T. 21 S., R. 32 E., 13 miles north and 8 miles east of Burns, on the stage road from Burns to Canyon City via Harney City and about 12 miles north of the latter on the headwaters of Trout creek, a branch of the Silvies river, which flows southward emptying into Malheur lake. The country rock is reported to be granite cut by large porphyry dikes. This property has not been visited but according to reports much work is done every year. In 1914, 100 feet of tunnel and 40 feet of a two compartment shaft, besides the construction of buildings was accomplished.

It is reported that the vein has been opened up at three places and that it is a strong ledge as much as 14 feet wide with assay values from $4.00 to $500 per ton. The railroad having been completed to Crane, Ore., 22 miles from the mine, the company will take out ore during the winter of 1916 for shipment to Salt Lake smelters.

TRUST BUSTER MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Trust Buster mine 5 miles northeast of Gold Hill is a few hundred feet south of the N. W. corner of Sec. 36, T. 35 S., R. 3 W. at an elevation of 1700 feet by barometer. It is equipped with a Beers mill having a crusher, a plate, a concentrating table, and a 15 H. P. gas engine. An adit shows several quartz veins in tonalite; the junction of two veins gives a small shoot of ore which has been mined out to the surface, and about 20 feet below the adit level. The workings are too shallow to show sulphide ore. The main vein strikes N. 50° W. and dips 46° S. W. The mine was leased by the Pacific Coast Mining Company about 4 years ago.

TYEE BAR PLACER MINE GALICE DISTRICT JOSEPHINE COUNTY

The Tyee Bar placer mine is on the south bank of Rogue river about a mile below Whiskey creek. It was worked years ago and reopened in 1911. The bedrock is argillite.

UMPQUA COPPER COMPANY (copper) DOUGLAS COUNTY

Local name, Rowley Group.

Office: Grants Pass, Oregon. J. F. Reddy, Pres., Grants Pass, Oregon;

Alva H. Gunnell, Sec.-Treas., Grants Pass, Oregon. Amount of capital stock, $375,000; par value, 25 cents; $362,884.50 issued. (1916 report.)

Property consists of 14 claims known as the "Rowley Group" in Sec. 4, T. 32 S., R. 2 W. 20 miles northwest of train in southern Douglas county and 30 miles in an air line north of Medford.

The ore bodies are found in a zone where shearing and compression has produced schist many hundreds of feet wide. Small sulphide lens-shaped masses of chalcopyrite and pyrite are found rather widely but irregularly distributed throughout the schist. These occurrences of sulphide which range in size from wheat grains to lenses an inch or more in thickness, together with a small amount of quartz associated with them are squeezed and drawn out in the planes or laminations of the schist, showing that they were formed either previous to, or during the movement which produced the schist. In the better looking areas which are 100 feet or more wide, they are found a few inches to a foot apart, with nearly barren material between. Under these conditions the principal problem in the development of the property will be to determine the volume of this schist which is sufficiently mineralized to make low grade copper ore bodies.

It seems probable that the property could be prospected to advantage by sinking a large number of drill holes over the more promising areas.

Considerable development work by tunnels and open cuts has been done. In some of these cuts and tunnels which are usually driven nearly at right angles to the general strike of the schist, samples have been taken which give some promise of rather large low grade copper deposits.

Near the footwall side of this wide schist zone is found a massive sulphide vein which is traced by iron stained capping for several hundred feet, and opened by 2 short tunnels near the bed of the creek. This vein is parallel to the schist and consists of nearly pure pyrite as much as 15 feet wide which is said to carry sufficient values in copper and gold to make it a low grade ore.

UMPQUA ZINC MINING COMPANY — DOUGLAS COUNTY

Office: 511 Corbett Bldg., Portland, Oregon. Jennie B. VanHorn, Pres.; J. T. VanHorn, Sec.-Treas. Capital stock, $10,000; par value, $1.00; all subscribed and issued; $8000 paid up. (1916 report.)

This company has 2 quartz claims in Douglas county.

UNDERWOOD PLACERS — CORNUCOPIA DISTRICT — BAKER COUNTY

Placer deposits in the Cornucopia region are of rather limited extent, although further investigations may reveal new workable ground. The only placers now being worked are situated about two miles below the town of Cornucopia, on Pine creek, near the mouth of Boulder creek. They are known as the "Underwood" placers, and are now operated under the name of the Boulder Creek Mining Company, Charles Campbell, superintendent. It is a bench boulder gravel deposit with the bed-rock several feet above the present stream, and the "pay" in an old channel of Pine creek. The gold, which is usually quite coarse, is nearly all found close to bed-rock, or within a few feet of it. The bed-rock is covered by a deep overburden, composed largely of heavy boulders, some up to 6 or 7 tons. Previous to the sale to the present owners this property was worked by drifting, and the returns are said to have been about $25 a day per man after the "pay" channel was struck.

The new owners have equipped the property with flumes, pipe, giants and derricks operated by water power, and have proceeded to hydraulic the ground. It would seem to a casual observer that the place where they began to hydraulic the ground was ill-advised. Apparently it should have been begun farther down the stream so that boulders and wash could have been placed on worked ground rather than to have begun apparently in the middle of the deposit. It would seem that there would be a greater profit to continue with the working of the mine by means of drifting, because of the coarse deep overburden of low value.

The quantity of overburden and the great number of very large boulders together with equipment insufficient to handle them caused a shut down of the property in 1914. The property was not operated in 1915 and 1916.

UNION LEADER MINING COMPANY **DOUGLAS COUNTY**

Office: Glendale, Oregon. F. G. Bowersox, Salem, Pres.; B. L. Darby, Glendale, Sec.; W. H. Darby, Salem, Treas. Capital stock, $150,000; par value, $25.00; $76,500 subscribed, issued and paid up. (1916 report.)

This company owns 97.74 acres of mining lands with improvements 12 miles east of Glendale at the head of Cow creek in the S. E. ¼ Sec 36, T. 32 S., R. 5 W.

UNITED COPPER COMPANY (copper) (Washington corporation)
GREENBACK DISTRICT **JACKSON COUNTY**

Local name, Copper King mine.

Office: 95 Union St., Seattle, Wash. S. S. Fluhart, 2600 First St., Seattle, Pres.; B. E. Fluhart, Leland, Oregon, Sec. and Attorney-in-Fact; Dr. R. N. Leezer, 95 Union St., Seattle, Treas. Capital stock, $1,000,000.

The property of this company, the Copper King mine, is located at the head of the Slate creek branch of Grave creek about 18 miles east of Leland.

The ore deposit is a well defined fissure vein in andesite. The development in September, 1916, had exposed by surface cuts a well defined quartz vein with chalcopyrite which is said by the manager to run between 4 and 5 per cent copper and two dollars in gold. This company is erecting a mill on the property with which they will concentrate these sulphides to smaller bulk and haul to the railroad at Leland.

UNITED COPPER-GOLD MINES COMPANY (copper-gold-silver)
ILLINOIS RIVER DISTRICT **JOSEPHINE COUNTY**

Office: Room 4 Murphy Block, Salem, Oregon. W. S. Low, Pres.; Daniel Webster, Sec.; C. E. Lebold, Treas., all of Salem, Oregon. Capital stock, $500,000; par value, $1.00; $219,654 subscribed, issued and paid up. (1916 report.)

This company owned property on Pickett creek near Merlin which has been sold. It now owns 12 claims in Illinois district about 12 miles northwest of Selma, on Fall creek, one-half mile above its junction with the Illinois, at an elevation of about 1400 feet.

The copper ore of this locality has attracted attention many years. Early in the sixties of the last century a small smelting furnace was located at the mouth of Rancherie creek. The matte was packed out about 30 miles across the mountains to the coast. Another small furnace was built on Fall creek in 1894, but was not a commercial success, owing to the difficulties of transportation. In 1899, several hundred tons of ore was packed out to Selma, hauled to Grants Pass and shipped to Tacoma, where it is said to have been smelted at a profit. The mine has now been idle for several years.

The geology is described by Diller as follows:

The country rocks of the deposit are greenstone and serpentine. The greenstone is an ancient volcanic mass, a mixture of lava flows and tuffs of Mesozoic age that are greatly altered. Its fragmental character, though not a prominent feature, may be clearly seen on close examination of the clean exposure near the mouth of Fall creek, where the rock is made up of many lapilli. The serpentine is an altered saxonite, evidently of later eruption than the greenstone with which it is in contact.

The ore minerals are chalcopyrite and pyrrhotite, generally more or less intermingled, and either may be most abundant. Malachite is rare. In some places the pyrrhotite appears as small streaks in the chalcopyrite. The ore bodies removed were in the serpentine near its contact with the greenstone. It is possible that some ore occurred in the greenstone, but the greater portion, if not all of it, appears to belong to the serpentine. The ore bodies were comparatively small and were in irregular bunches, not in distinct veins. The pyrrhotite was tested for nickel by R. C. Wells in the chemical laboratory of the Geological Survey. A mere trace of nickel was found, possibly 0.001 per cent.

The following statement is made by the management: There is 1000 feet of development work, including a 500-foot tunnel, and a 200-foot crosscut, exposing 1000 tons of ore. A dark gossan sometimes stained with copper is underlain at 15 feet in depth by ore carrying 18 per cent copper and 5 to 10 ounces silver and upwards of $1 in gold.

UNITED GOLD MINING COMPANY (gold) (Washington corporation) GRANITE DISTRICT GRANT COUNTY

Local name, Cougar mine.

Office: 505 Hyde Block, Spokane, Wash. Arthur B. Lee, Pres.; Chester C. Robbins, Sec.-Treas., both of Spokane; Jno. L. Rand, Baker, Attorney-in-Fact; Elmer C. Brain, Granite, agent. Capital stock, $1,000,000; par value, $1.00; all subscribed and paid up; $568,050 issued. (1916 report.)

This company acquired the Cougar mine under bond and lease from the Cougar Gold Mining and Milling Company about April, 1916. The new company proceeded to make cyanide tests of the ore and remodel the old mill equipping it for all-slime cyanidation. A long pipe line was also installed to provide water for power and milling purposes. It will have a pulverizing and dissolving capacity of 125 tons provided by a crusher and 2 rolls, two 5-foot tube mills of short length, standard Pachuca agitation tanks and standard accessory apparatus. Steam will serve for power purposes until water power installation is completed. The mine is less than 1 mile from the transmission line of the Eastern Oregon Light and Power Company.

UTAH QUICKSILVER COMPANY (mercury) GOLD HILL DIST. JACKSON COUNTY

Incorporated about August 1, 1916. Incorporators, Alex Nibley, Edwin Jones and W. Y. Cannon of Salt Lake City, with a capital stock of $50,000.

The property contains 35 claims near the Chisholm group.

The ore deposit consists of cinnabar in shear zone in andesite, the cinnabar being found over a wide territory in this section but usually quite low grade. The chief showing is on the Rainier claim where cinnabar deposits along with pyrite outcrops in an andesite fault breccia. The vein strikes N. 70° W. and contains black quartz 12 to 15 inches wide with a well defined wall.

The development work at this point consists of an open cut 12 to 15 feet deep exposing a vein some 20 feet in length. The vein is opened up in 2 or 3 other points thus tracing it for 3 or 4 hundred feet. The property is at present under option to Boston people.

VALLEY VIEW PROSPECT CORNUCOPIA DISTRICT BAKER COUNTY

See "Wild Irishman prospect."

VANGUARD PROPERTY JOSEPHINE COUNTY

See "Philips or Vanguard" property.

VESUVIUS MINES COMPANY (gold) BOHEMIA DISTRICT LANE COUNTY

Local name: "The Vesuvius Mine."

Office: Eugene, Oregon. Mine office: Bohemia, Oregon. E. M. Johnson, Pres.; F. J. Hard, Sec.-Treas. Capital stock, $6,000,000; par value, $1.00; all subscribed, issued and paid up. (1916.)

Located in Sec. 11, T. 23 S., R. 1 E., about 15 miles southeast of Disston which is the terminus of a 20-mile branch railroad from Cottage Grove.

The Vesuvius mine is the principal holding of the Vesuvius Mines Company, although the company has 50 quartz claims in all. It comprises 16 lode claims located on the western and southern slopes of Fairview mountain, and the western slope of Bohemia mountain. The post office and principal store of the district is on the ground of the company.

The geology is comparatively simple, consisting of andesite flows interbedded with some andesitic tuffs. The andesite in some cases is somewhat altered, as calcite-filled amygdules have been noticed. The ore occurs in a mineralized fractured zone in the andesite. This zone strikes N. 60° W. Near the surface as shown in the upper workings, considerable oxidation has taken place and the rock is badly altered. At depth the principal ore minerals are galena, chalcopyrite, pyrite and sphalerite. The development work consists of 3 tunnels. The lowest is about 1200 feet below the outcrop and is driven along the fracture for a distance of 2000 feet. In places the mineralization is 3 to 4 feet in width and 25 to 50 feet in length. Then for long stretches the fractures contain but a small amount of quartz, and in many places the fracturing becomes very slight.

The main working tunnel is about 800 feet above the lowest and is about 2000 feet upon the vein. The vein material is oxidized but in respect to the quartz it is similar to that of the lower tunnel. There are several raises from this level and in a drift 76 feet above it, there is a lens of quartz about 3 feet wide. There is also a similar lens in a raise 40 feet above this drift. There is another tunnel on the vein 300 feet above the working tunnel and 100 feet below the outcrop.

In a prospectus made by the company, assays of \$7.50, \$20.64, and \$17.80 per ton on widths of from 18 inches to 3 feet are given. It is also stated that a profit was made on ore running only \$5.00 a ton, \$3.20 of which was free and caught by amalgamation, the other values saved by concentration.

There is a 10-stamp mill, amalgamating plates and tables which is driven by steam power, also a light plant, sawmill, etc., on the property.

Besides the Vesuvius mine, the Vesvius Mining Company owns the following groups of mining claims: The Oregon-Colorado, The Utopian, and the Riverside.

Of these, the Oregon-Colorado has the most development work. The country rock is an andesitic breccia and an andesitic tuff. The development work consists of a tunnel 2000 feet along the fissure at a depth of about 900 feet below the outcrop.

Conditions are similar to the Vesuvius, fractured zones having a N. 60° W. strike and the chief ore minerals consisting of chalcopyrite, galenite, sphalerite and pyrite.

VICTOR MINE (gold) GALICE DISTRICT JOSEPHINE COUNTY

With reference to this property Diller says:

The Victor mine is about 7 miles from Galice on the West Fork of Galice creek. When in the region in 1911 I was unable to visit it, but Mr. C. L. Barlow, of Galice, informs me that the owners struck a rich vein and took out about \$2,500 in a month with a hand mortar. In 1912, 5 men were still at work and were averaging more than \$4 to the man a day.

VICTORIA MINING COMPANY DURANGO, MEXICO

Office: Grants Pass, Oregon. A. Oldoerp, Little Rock California, Pres.; Louis F. Kraemer, Reading, Pa., Sec.-Treas. Capital stock, \$10,000; par value, \$100; capital stock all subscribed, issued and paid up. (1916 report.)

This company's properties are located in Durango, Mexico.

VINCENT CREEK GOLD AND COPPER COMPANY (copper and gold) GREENHORN DISTRICT GRANT COUNTY

Office: Austin, Oregon. Burton Miller, Prairie City, Pres.; Nellie Miller, Prairie City, Sec.-Treas. Capital stock, \$200,000; par value, \$1.00; \$100,002 subscribed and paid up; \$100,858 issued. (1916 report.)

This property consisting of 6 claims is located on Vincent creek 5 miles northwest of Austin. The country rock is greenstone and the ore is chalcopyrite and its oxidation products. The property was not visited but judging by the description given it is similar in ore occurrence to that of the Listen Lake mine elsewhere described.

VIRGINIA MINE (gold) GREENHORN DISTRICT GRANT COUNTY

This property is located in Sec. 10, T. 10 S., R. 35 E., about ½ mile east of Greenhorn. It has a shaft about 200 feet deep in coarse, partly crushed gabbro (greenstone). A $20,000 pocket was taken from this property in the 90's but the prospecting done since then has failed to find another. It is not active.

VIRTUE MINES DEVELOPMENT COMPANY (gold) VIRTUE DIST. BAKER CO.

Local name, Virtue mine.

Office: Baker, Oregon. J. K. Romig, Pres.; M. Boswell, Sec.-Treas. Capital stock, $1,500,000; par value, $1.00; $1,475,845 subscribed and paid up; $1,384,-075 issued. (1916 report.)

Lands consist of Virtue Consolidated Group of 16 quartz claims and the Borman and Virginia placers, in all about 400 acres situated in T. 9 S., R. 41 E.

Lindgren says.

As this mine is one of the earliest and largest producers in the whole region described it may be desirable to outline its interesting history more fully. It is 7 miles nearly due east from Baker City in an air line, and is situated in the foothills of the dry and barren ridges which partially fill the big bend of Powder river. The drainage around it is to the northeast into the lower part of the river; its elevation is 3,800 feet.

The discovery dates from 1862, and was due to the tracing up of rich placers filling the gulches below it. For ten years after its discovery it was known as the Rucker or Union mine. A great deal of work was done in early days, as shown by Raymond's report of 1870. From 1871 to 1878 it was worked nearly continuously, largely by Brown and Virtue. In 1878 it was sold to Grayson and Co., of San Francisco, and up to 1884 was worked in a more or less satisfactory manner. From 1884 to 1893 the mine was idle, but in the latter year work was resumed and continued with excellent results until 1898, when, after a short period of idleness, it was sold to the Consolidated Virtue Mine Company, of Montreal, Canada, also owners of the adjoining Collateral mine. After a short period of work in the upper parts of the mine, it was again closed on August 1, 1899. When visited the mine was, unfortunately, shut down. The property is equipped with a 20-stamp mill.

The production up to 1878 was $1,250,000. From 1878 to 1884 $200,000 is the estimated amount. From 1893 to 1898 the production was $739,000, the maximum being reached in 1896 with $259,000 and the minimum in 1898 with $13,100. The total production is thus $2,189,000.

The earlier developments consisted of three tunnel levels, the lowest of which is 300 feet below the croppings. From the lowest tunnel a vertical shaft was sunk 800 feet deep, and at each 100 feet crosscuts were made to the vein. The levels extend from 200 to 400 feet north and 800 to 900 feet south from the shaft.

The country rock is a greenstone of very fine grain and dull greenish-gray color, some of it having a serpentinoid appearance. It is an old volcanic tuff or breccia, probably of the same age as the slates of the White Swan or the gabbro and diorites of Flagstaff. Much of it is so altered that its original character can be recognized only with difficulty. It has no slaty structure.

The vein strikes northwest and dips 45° to 80° S. W., its width varying from 6 inches to 12 feet, being on an average 14 inches. Southeasterly it may be traced into the adjoining Virginia mine.

The ore is a white, normal, coarse vein quartz with some drusy cavities. It contains free gold, which often is very coarse and shows imperfect crystallization; it is unusually pure, reaching a fineness of 940. The quartz contains an extremely small amount of sulphurets, consisting of a little pyrite and chalcopyrite. Occasionally the quartz is banded by shearing, and this is considered the best rock. The country rock near the veins contains seams of calcite and pyrite, but ordinarily carries no value. The richest ore occurred near the surface. In 1870 the average yield was $20 per ton; in 1873, $40 per ton was reported; in 1875, $24 per ton. From 1893 to 1898 the ore averaged $15 or $16 per ton. Still richer chimneys were occasionally found in the main ore shoot.

* * * * * * From the seventh level up, the ore was stoped for the full distance of the drifts, the ore shoot being practically 1,200 feet long. According to the earlier data in Raymond's report of 1870, the upper part of the shoot above the lowest tunnel level was much shorter. Mr. Grayson stated that "no stoping was done between the eighth and the seventh level, as the ledge matter was broken up and carried but slight values." The mine was then abandoned, and since that time it has never been unwatered.

An interesting feature is that the water in the shaft is very abundant and stands a short distance below the collar, that is, a couple of hundred feet above the level of the valley. Moreover, it is warm or tepid, so that it must represent an ascending column of the underground circulation. The high temperature was a serious obstacle to the working of the mine.

As may be expected, there are a great number of claims and prospects near the Virtue mine, but none of these have as yet proved important producers. The southeasterly extension of the Virtue has been worked by means of a shaft in the Virginia. Adjoining on the southwest is the Collateral, a vein said to be similar in character to the Virtue, and accessible by crosscuts from the lower levels of the Virtue workings.

The company now controls about 1 mile along the series of veins. Eight of these veins have been located but the larger part of the production came from the Virtue vein, the most northeasterly.

The property is equipped with crusher, 20 stamps, 5 vanners and 4 cyanide tanks with hoists, boilers, engines, motors, etc. Motive power was, until recently, steam but is equipped to be driven by electricity secured from the Eagle River Power Company with which it is connected by high line. We are not certain that the mine has been unwatered since 1899, but some ore has been extracted since then (1906-7) from mine above mill or drainage level and some $1500 from ore on the dump. The production since 1900 has been only a few thousand dollars in all. The press from February to July, 1916, made frequent reference to a lease and bond having been given to George W. Field and Company, of Boston, the reported terms of the lease were 17½ per cent royalty the first two years and 20 per cent the second two years upon the gross receipts with privilege to purchase for $400,000. Financial difficulties were encounteerd in connection with the Eagle River Power Company, an allied company, so that aside from the repair of the mill little has been done to date by the leasing company.

WAGNER CLAIM (placer) SIXES RIVER DISTRICT CURRY COUNTY

Diller says that at the time of his examination the Wagner claim, about a mile below the mouth of Butcher gulch in Sec. 20, T. 32 S., R. 13 W., was being worked by Mr. J. L. Searle and others from the state of Washington.

"The whole stream was dammed to a height of about 5 feet and 2 lines of sluice boxes were suspended on numerous logs felled across the stream. A steam pump and 9 men were employed."

WAGNER (G. P.) CLAIM UPPER APPLEGATE DISTRICT JACKSON COUNTY

G. P. Wagner has several claims about a mile west of Steamboat in Sec. 20, T. 40 S., R. 4 W., where he is removing ore brought to its present position by surface waters. In Rich gulch, which was mined by placer methods years ago, small quartz veins are known in the bed rock; one of them is nearly vertical and strikes N. 55° E. They are said to produce high grade ore.

WALDO CORPORATION (Washington corporation) JOSEPHINE COUNTY

Office: Seattle, Wash. D. E. Skinner, 1621 L. C. Smith Bldg., Seattle, Pres.; Louis Levensaler, Union Club, Seattle, Vice-Pres.; L. B. Stedman, Holler Bldg., Seattle, Sec.-Treas. Capital stock, $100,000; par value, $100. George M. Esterly, Seattle, general manager. (A recent corporation.)

WALDO MINE (copper) WALDO DISTRICT JOSEPHINE COUNTY

The Waldo mine is located in Sec. 36, T. 40 S., R. 8 W., near the west quarter corner. This mine was operated by the Waldo Smelting and Mining Company but is now owned by DeWitt VanOstrand, of Phillips, Wisconsin; Dr. J. F. Reddy and Alva H. Gunnell, both of Grants Pass, Oregon.

A mill of 50-ton capacity is being installed to concentrate some of the lower grade ore found in the mine as well as the several thousand tons on the dump. This mine has shipped several hundred tons of ore during the past summer which was hauled from the mine by wagon 27 miles to Waters creek station and shipped from there to the Tacoma smelter.

The ore is a massive chalcopyrite associated with pyrrhotite and pyrite together with their oxidized products. These massive sulphides are found in different sized masses separated from each other and apparently having no relation to each other any more than individual pieces in any fault breccia have a relationship, one with the other. Whatever has been the origin of the ore and whatever may have been the shapes, dimensions of the shoots, and structure, a very marked shearing movement has taken place involving the original ore body shattering it and scattering the separate blocks through a brecciated or crushed rock zone, a large part of which zone is serpentine. It is found that there is no relation in strike and dip between the ore masses found in this brecciated zone. Serpentine is usually the wall rock although sometimes diorite or an andesite locally known as "vein rock" may be found on the wall of some of the masses. This is probably due to the fact that sometimes a single mass in this large brecciated zone may be made up of both country rock and massive sulphide, has been able to preserve its identity and has not suffered the punishment common to some of its neighbors.

If the above analysis of the main geological factors which have affected commercial mining conditions at this property are correct these unrelated masses of sulphides may be found at greater or less intervals, both laterally and vertically in this fault zone and it would seem to the writer that a system of prospecting this territory in a large way by drilling might be inaugurated with profit.

WALDO SMELTING AND MINING COMPANY (Colorado corporation)
WALDO DISTRICT JOSEPHINE COUNTY

Office: Colorado Springs, Colorado. Spencer Penrose, 301 Mining Exchange Bldg., Colorado Springs, Colorado, Pres.; Charles L. Tutt, Colorado Springs, Sec.; J. A. Hull, Colorado Springs, Treas.; C. E. Tucker, Takilma, Oregon, Attorney-in-Fact. Capital stock, $3,000,000; par value, $100; all subscribed, issued and paid up. (1916 report.)

For a description of the mine formerly owned by this company see Waldo mine.

WALL (P. L.) CLAIMS SIXES RIVER DISTRICT CURRY COUNTY

In Sec. 21, T. 32 S., R. 13 W. Discovered May 1, 1915. In August, 1915, a 20-foot open cut exposed a 1 to 4 foot rusty quartz seam.

WALLACE AND HADLEY CLAIMS (placer) **SIXES RIVER DIST. CURRY COUNTY**

Tom L. Wallace and Oliver C. Hadley own 2 placer claims on the south fork of Sixes river known as the South Fork Nos. 1 and 2, the re-location of which was recorded January 1, 1915. This property was originally called Thompson Flat. They began work in March and had 160 feet of pipe on the claim when the examination was made. The first gravel was washed in May, and it is claimed that $165 worth of gold was taken out during the spring of 1915. It is said that the values are confined to within about one foot of the bedrock, with the greatest proportion of the gold directly on the bedrock, and that no clay is present to interfere with the saving of the gold. Very little platinum is found in this ground, and no attempt to save it has been made.

WALLA WALLA GROUP (copper, gold and molybdenum)
WALLOWA DISTRICT WALLOWA COUNTY

This property is at Aneroid lake in Sec. 34, T. 4 S., R. 45 E., at an elevation of about 7000 feet. It is about 13 miles south of Joseph, the railroad terminus near the head of the east fork of the Wallowa river. For 6 miles out of Joseph is a good wagon road, while the remaining 7 miles is by trail.

It is a contact-metamorphic deposit between intrusive granodiorite and limestone.

Development work has been done in 2 places on the contact between the limestone and the granodiorite. One is in the abrupt walls just above the lake, and the other is along the contact some few hundred feet to the northwest.

At the latter place a tunnel, about 100 feet long, is driven near the contact in the altered granodiorite, but attains less than 50 feet in depth. The mineralized zone is about 20 feet wide, although the granodiorite is altered to a greater width. Typical contact-metamorphic minerals, such as garnet and epidote are found, and the recrystallized limestone contains some quartz. Sometimes the garnet and epidote crystals are very small, but frequently are as much as three-fourths of an inch in diameter. The altered granodiorite is impregnated with chalcopyrite in spots, and small indistinct veins of molybdenite also occur.

A better place to observe this contact is on the abrupt walls above the lake, where it is exposed for several hundred feet with widths up to 50 feet.

The mineralization is similar to the one just described, but considerable chalcocite is present. This high-grade copper mineral is disseminated along the contact zone for some 200 feet and for considerable widths. It is found both in the altered granodiorite and in the recrystallized limestone, although more of it is seen in the latter. The intergrowth of garnet, epidote, and quartz is usually fine-graned. Besides chalcocite, small amounts of molybdenite and chalcopyrite are present. A lamprophyre dike cuts the contact along the sides of which chalcocite is much increased within the contact zone. The dike itself contains considerable disseminated pyrite. It looks as if the intrusion of this dike or the action following it had aided in the dissemination of chalcocite.

This contact with its metamorphic zone has been developed but little, and much of this could have been done to greater advantage. The crosscut started some distance below the contact in the loose rock and has not yet reached it. The outcrop is so situated that it would not be very hard to develop it with open cuts.

It is reported that developments of 1915 or 1916 made a very satisfactory showing of copper ore by crosscutting the contact in close proximity to the lamprophyre dike.

WALLOWA COUNTY MINING AND DEVELOPMENT COMPANY (copper-gold)
WALLOWA DISTRICT WALLOWA COUNTY

Local name, Williams mine.

Office: Enterprise, Oregon. Jesse Walker, Pres.; J. A. Burleigh, Enterprise, Sec.; George W. Williams, Wallowa, Treas. Capital stock, $200,000; par value, $1.00; all subscribed, issued and paid up. (1916 report.)

This company owns 14 claims on Lick creek, Wallowa country, Oregon, in about Sec. 3, T. 5 S., R. 46 E., 9 miles east and 13 miles south of Joseph, the railroad terminus from which the mine is reached by a 25-mile wagon road.

It is reported to be a quartz vein containing a small percentage of gold-bearing chalcopyrite. The nature of the country rock is not reported.

WATERMAN PROPERTY (gold) SPANISH GULCH DISTRICT WHEELER COUNTY

The property is owned by E. O. Waterman. Located in about Sec. 12, T. 13 S., R. 24 E., about 2 miles southeast of Antone.

The country rocks are greenstone, limestone and argillite cut by aplite dikes. The deposit is a distinct regular quartz fissure vein, having a strike of N. 60° E. and dipping 45° S., with an average width of 2 feet, and a maximum width of 5 feet.

Development consists of a shaft about 125 feet deep on the vein. No assays are available. Near this property there is evidence of chromite deposits.

WATKINS COAL COMPANY **WASHINGTON**

Office: Third and Washington Sts., Portland, Oregon. Edward Cookingham, Ladd and Tilton Bank, Portland, Pres.; R. S. Howard, Portland, Sec.; Albert Cookingham, Tacoma, Washington, Treas. Capital stock, $25,000; par value, $100; $12,800 subscribed, issued and paid up. (1916 report.)

This company's properties are located in Lewis county, Washington.

WAY CLAIMS (placer) **SIXES RIVER DISTRICT** **CURRY COUNTY**

At the time of this investigation, Mr. C. W. Way was working 3 placer claims, the Rainbow, Robert Harrison fraction, and the Nugget Patch, acquired by purchase in 1912. These have been worked by hydraulicking from the time they were purchased. The property is equipped with 800 feet of flume and 600 feet of pipe. It is claimed that $700 worth of gold has been taken out of this ground, and that the values are confined largely to a point in the gravel just above the bedrock.

Mr. Mitchell gives the location of this property as being just below the Wallace and Hadley claims on the south fork of Sixes river.

WEAVER MINE (placer) **SUMPTER DISTRICT** **BAKER COUNTY**

This placer mine is in Secs. 26-27, T. 9 S., R. 36 E. and 4 miles by wagon road west from Sumpter.

The following extracts are quoted from a report by Pardee:

The Weaver mine is situated near the head of the north prong of Buck gulch, in a gravel terrace hanging upon the north slope some 200 feet above the bed of the ravine. Its elevation above sea is 5,550 feet. It extends as an ill-defined bench, having a course approximately east and west, 1,000 feet or more, its western termination not being exposed. In its eastern portion pits 50 to 90 feet wide and aggregating 450 feet in length have been made, exposing a bank 40 feet high. These openings have apparently reached not more than halfway across the deposit. In part the gravel rests unconformably upon loosely consolidated fine sands and silt, which in turn rests upon a bed rock of cherty shale and basic igneous intrusive rocks. The gravel consists of smooth rounded cobbles of an average diameter less than 12 inches, in an abundant sandy matrix that is very loosely "cemented" . . .

Gold is distributed throughout the gravel, but is found in greater quantity in the lower layers. It occurs mainly as small half-rounded grains of pin-head size and dust, with occasionally a small nugget. Its fineness is reported as 900 to 940. . . . .

The Weaver property is equipped with a small hydraulic plant and supplied with water through a ditch about 6 miles long that diverts the flow of Grays gulch, a tributary of McCullys Fork. Water in sufficient amount for mining purposes is had only during part of the spring and summer.

This mine has been operated profitably during the past nine years, but a statement of its output and the average yield of the gravel is not available for publication. The sluices here yield a considerable amount of "black sand," a sample of which was examined in the Survey laboratory. A few specks of platinum were detected in it by D. T. Day. It contained in addition a globule of gold amalgam and a few small flattened particles or "colors" of rusty gold.

South and southeast of the Weaver mine, on the opposite slope of Buck gulch, and on the divide between it and Mosquito gulch, fragmentary patches of gravels are poorly exposed at elevations of 5,500 to 5,600 feet. They greatly resemble the gravel of the Weaver mine and are thought to belong to the same stream system. On the divide mentioned they are apparently overlain by andesitic tuff.

WESTERN CONSOLIDATED MINES COMPANY **CALIFORNIA**

Office: 701 Spalding Bldg., Portland, Oregon. A. N. Wills, Pres.; M. B. Bozworth, Sec.-Treas., both of Portland. Capital stock, $50,000; par value, ten cents; $50,000 subscribed and paid up; $5,316.50 issued. (1914 report.)

Dissolved by proclamation in January, 1917.

This company has abandoned its property which was located in California on the East Fork of the Illinois river between the Preston Peak group of mines and the Takilma property, about 8 miles from Waldo, Oregon.

WESTERN METAL MINES COMPANY

Filed articles of incorporation in March, 1916.

L. E. Crouch, E. O'Keane, A. E. Gibhardt, of Portland, incorporators. Capital stock, $100,000.

WEST COAST MINES COMPANY (gold) BOHEMIA DISTRICT LANE COUNTY

Local names, Champion mine, Musick mine, Helena mine.

Office: 210 Chamber of Commerce Bldg., Portland, Oregon. W. J. Zimmerman, Pres.; W. M. Cake, Sec., both of Portland. Capital stock, $1,500,000; par value, $1.00; amount subscribed, $890,000, issued and paid up. (1916 report.)

This property is now under lease to H. C. Mahon, of Portland. W. W. Elmer is manager. The entire property consists of 47 claims, including 3 mines, local names of which are Champion, Musick and Helena. Of these, the Champion is the largest. It is located in Sec. 13, T. 23 S., R. 1 E., about 12 miles southeast of Disston which is the terminus of a 20-mile branch railroad from Cottage Grove.

The wagon road from Disston to the Champion mine is in good condition and could easily be put in first class shape. The country is rugged and plenty of timber is available.

The region is made up of a series of andesitic flows which are for the most part dark in color and finely crystalline. There is no evidence of intrusive rock in this immediate vicinity but nearby regions show intrusions of granodiorite porphyry into the andesites. The mineralization was probably caused by heated solutions rising from a deep seated intrusion, and it is found in highly altered and mineralized fractured zones. As a rule these zones have a N. W.-S. E. direction with a nearly vertical dip. Oxidation has taken place to about 200 feet below the surface. Below this the chief ore minerals are pyrite, galenite, and a little chalcopyrite and sphalerite. At a still greater depth, the pyrite diminishes, and chalcopyrite, sphalerite and galena become the principal ores.

In the Champion mine, the main lode has an average width of 3 feet with a maximum width of 8 feet of brecciated material cemented with quartz. Sometimes there are masses of quartz as much as 4 feet thick. The strike is about N. 60° W. Dip nearly vertical. The lode has been traced for 2000 feet on the surface. The ore shoots in the lode dip to the southeast and in many cases there are lens-like stringers of pure galena sometimes a foot in width, crossing the lode. As might be expected the values are very irregular. It is said that an ore shoot which runs from $35 to $50 per ton in the richer portions will rarely go below $10 to $7 per ton in the low grade portions. However, if it is $7 in the richer part, it might not be possible to mine the low grade portions at a profit.

The Champion mine has many hundreds of feet of workings. At present the No. 9 crosscut tunnel to the No. 9 level is the main adit, although the No. 12 crosscut adit is being driven to the lode.

Previous production of the Champion mine is reported to be $1,700,000. The ore cars as they come from No. 9 tunnel are taken down a cableway 3000 feet long to the mill about 1000 feet below. Mill consists of 20 stamps and concentrators operated by electric power derived from a power house which is located 8 miles down the creek.

The Musick mine is located near Bohemia mountain about 1 mile to the southwest of the Champion. The geology is quite similar. Main lode has a width from 5 to 15 feet and has been traced on the surface for 5000 feet. The ore shoots probably dip to the southeast. Oxidized zone extends to a depth of 200 feet from the surface, although some sulphides are present along the first 100 feet of depth. Below this, there is not much oxidation and the sulphides do not seem to change with greater depth. The principal minerals are galena, sphalerite and chalcopyrite.

Development work consists of tunnels, raises, etc., and much ground has been stoped. The reported production is $180,000.

The ore from the Musick mine has been trammed in cars to one of the upper levels of the Champion, dropped to the No. 9 level in that mine, and then to the mill.

The Helena mine is located about 1 mile to the northwest of the Champion in Sec. 7, T. 23 S., R. 2 E. At the time of the examination it was practically inaccessible. However, the mineral occurrence as judged from specimens on the dump is similar to the other mines in this vicinity. Production of the Helena is said to be $150,000, and practically all of this was taken from an oxidized zone near the surface.

WEST (DAVID) PLACERS GRANITE DISTRICT GRANT COUNTY

For description see "North Fork mine."

WEST SHORE OIL COMPANY COOS COUNTY

Office: Bandon, Oregon. O. A. Trowbridge, Pres.; C. R. Wade, Sec.; A. McNair, Treas., all of Bandon. Capital stock, $50,000; par value, $1.00; $23,571 subscribed, issued and paid up.

The property of this company is located 18 miles southeast of Bandon, Oregon, and is held under a lease. The lease covers 640 acres and runs for 20 years and is perpetual, if or so long as oil is obtained in paying quantities in well when completed. (1916 report.)

WEST SIDE GOLD AND SILVER MINING COMPANY (gold and silver)
GREENHORN DISTRICT GRANT AND BAKER COUNTIES

Local name, West Side mine.

Office: Yamhill, Oregon. J. A. Simmons, Pres.; Richard Baird, Sec.; W. G. Busbee, Treas., all of Yamhill. Capital stock, $10,000; par value, one cent; $8,143.07 subscribed, issued and paid up. (1916 report.)

This company owns 4 patented quartz claims adjoining Greenhorn City on the west.

In this vicinity most of the geology is difficult to make out, since the rocks are so badly altered and weathered and because so much folding and faulting has taken place. They are made up of a complex of greenstones, argillites, serpentines, and near the West Side vein and in a few other places there are beds of dolomite. A "dolomite" bed is cut by the West Side vein.

This steep dipping N. S. vein is in the form of narrow broken lenses and consists chiefly of quartz, with some dolomite and calcite. The ore minerals are galena, pyrite, gold and silver. Some time after the vein had been formed shearing took place involving a width of possibly 20 feet or more. The shearing and movement was approximately parallel to and inclusive of this lenticular vein. Since the shearing was quite pronounced with a considerable movement, perhaps involving oscillations, it has obscured and mixed the blocks of ore with the wall rocks in the shattered zone so that it is somewhat difficult to follow the ore.

Since the shearing of the vein about the only mineralization which has taken place is a deposition of chalcedonic quartz. A few carloads of ore were shipped from this mine in 1914 from which the returns were between $50 and $75 a ton. The West Side is developed by shafts about 40 feet deep, and a tunnel upon the general strike of the vein 300 to 400 feet long.

WHITE ELEPHANT PROSPECT (gold) CORNUCOPIA DISTRICT BAKER COUNTY

The White Elephant, west of the Jim Fiske and about 1 mile west of the Union Companion mill, is a well-defined quartz vein 4 to 5 feet wide in granodiorite, having a strike N. 20° E. and dip 45° W. It is said that this vein contains fair values in gold.

Development was continued in a small way in 1915 and 1916, but the results have not been announced.

WHITE HORSE MINING COMPANY (placer) GOLD HILL DIST. JACKSON CO.

Office: 1124 Board of Trade Bldg., Portland, Oregon. I. G. Davidson, Pres.; J. F. Booctin, Sec.; J. M. Leiter, Treas., all of Portland. Capital stock, $100,000; par value, $5.00; all subscribed, issued and paid up. (1916 report.)

This company owns placer ground 3 miles northeast of Gold Hill in Sec. 3, T. 36 S., R. 3 W. There is no activity at the property.

WHITED MINING COMPANY (gold) BAKER COUNTY

Local name, Whited property.

This company filed articles of incorporation in November, 1916, with a capital stock of $15,000; par value, $1.00; Alfred Whited, Pres.; Grace A. Whited, Sec.-Treas., both of Unity, Oregon.

This property is located 5½ miles south of Unity on the steep, well timbered western slope of Bull Run creek. This group of 8 claims is owned by Alfred Whited and Joe Wahn and operated by C. J. Johnson and Edward Elge.

The vein is near the border of an intrusive granodiorite into greenstone with the usual complex dikes. The principal ore shoot following the hanging wall of one of these porphyry dikes has a strike of N. 45° E. and dips 80° N. W. The width of the mineralized zone is 4 feet. There is but little quartz evident in the vein. The greenstone on the hanging wall of the dike is much serpentinized.

The development work consists of 2 crosscut tunnels and drifts upon the vein in each. In the lower and principal crosscut there is a 40-foot winze and a drift north 35 feet where a small amount of ore has been stoped. The ore is a gold ore but the other minerals are copper and iron which have been largely oxidized in the workings so far developed. There is a 10-stamp mill upon the property operated by water power. This mill has amalgamating plates and Wilfley tables. It was in operation in September, 1916, when a visit was made to the property.

WHITNEY MINE (gold) GOLD HILL DISTRICT JACKSON COUNTY

The Whitney mine 2 miles east of Gold Hill is in the N. E. ¼ S. W. ¼ Sec. 13, T. 36 S., R. 3 W. in a coarse subsiliceous rock not far west of the tonalite border. The main entry at an elevation of 1375 feet, is a crosscut for 130 feet; at 10 feet from the portal a vein said to have produced high grade ore strikes N. 50° W. and dips 60° S. W. At 70 feet from the portal a drift follows vein No. 1 for 290 feet; this vein contains 2 to 5 feet of soft material with stringers of quartz; it strikes N. 67° W. and dips 55° to 75° S. W. At the breast of the crosscut a raise follows vein No. 2 which has a 3-foot vein-filling like the preceding and is about parallel with it. In these workings small stringers of aplite are common generally standing about vertical and trending north. In another adit only 20 feet vertically higher, the No. 2 vein is found to be in a granitic dike while the No. 1 vein is on the granite contact about 30 feet distant. At this level the latter is a shear zone carrying a little quartz. Several smaller veins have been explored for short distances. One of them contains some chalcopyrite in places. At the intersections of these veins with the larger ones good ore has been found. A subsiliceous rock containing considerable magnetite is associated with these veins and not found elsewhere on the hill. It appears to be a contact phase rather than a separate intrusion. In thin section it is found to consist of coarse augite and magnetite with a little olivine and brown hornblende.

WHITNEY PLACER GREENHORN DISTRICT BAKER COUNTY

In the southern part of T. 10 S., R. 36 E. and extending almost across it is the Whitney valley with Burnt river flowing through it. The headwaters of Burnt river rise in the Greenhorn range and many placer diggings such as Winterville and Parkerville are drained by it. The gravels of Whitney valley were prospected by test pits and churn drilling in the fall of 1915 and the spring of 1916. The depth to bedrock was found to be from 7 to 20 feet and some of the test pits are known to be of good grade for dredging purposes, but whether or not there is sufficient acreage of gold-bearing gravels to warrant the installation of a dredge has not been announced.

WILD IRISHMAN PROSPECT (gold) CORNUCOPIA DISTRICT BAKER COUNTY

The Wild Irishman vein, now called the Valley View is located about ½ mile west of the White Elephant and about 1½ miles west of the Union Companion mill. It cuts across the southeastern end of Granite mountain at an elevation of about 9000 feet. The vein has a maximum width of 6 to 8 feet and can be seen from the apex of the mountain to continue clear across Bonanza basin and up the other side. It is probably a continuation of the Red Cross vein. Some of the quartz in the vein shows well-formed crystals. The strike is N. 20° E. and the dip 50° to 60° W.

Work upon this vein was prosecuted in the summer seasons of 1915 and 1916 and it is reported that shoots of ore of fair size and good quality have been encountered.

WILLIAMS AND ADYLOTT MINE (gold)
ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Concerning this mine Diller says:

A number of claims on Hoover gulch, about 8 miles directly northwest of Kerby, are owned by Williams and Adylott. The claims were seen from a distance only. The country rock is mainly greenstone and greenstone tuffs, which are well exposed in the bluffs about the head of the gulch, but there is an intruded mass of serpentine also in the neighborhood and possibly, too, some cherty slates and quartzites related to those at the head of Hoover gulch.

A shaft has been sunk 40 feet in rock that is said to contain gold all the way down. The residual material has been piped off and $500 cleaned up, though much of the gold is reported to have been lost.

WILLOW CREEK PLACER MALHEUR COUNTY

About 3 miles east and down stream from Ironside post office near the eastern side of T. 14 S., R. 39 E. is the placer ground owned by Ben Matthiessen and C. M. Ford. Bed rock is about 20 feet from the surface and the upper half or two-thirds is soil and clay and nearly all the gold is close to bedrock. The ground is flat and Willow creek flows through it so that the earth and gravel must be elevated to be washed and disposed of and water also must be kept out. To accomplish this, a 10 H. P. gas engine and a 4-inch centrifugal pump was installed which elevates the earth, water, gravel and mud, after it has been ground-sluiced in the sump. Nearly all the gold is coarse, ranging in size from that of a pin head to a maximum of $14 and is reported to run about 75 cents per cubic yard.

WILSON BASIN MINING AND DEVELOPMENT COMPANY

Out of business.

WINKLE BAR (placer) MULE CREEK DISTRICT CURRY COUNTY

Diller describes this property as follows:

Nearly a mile below the mouth of Ditch creek and 26 miles below Galice, on the right bank of Rogue river, is a large terrace known as Winkle bar. It contains perhaps 30 acres. The slate bed-rock terrace rises about fifteen feet above low water in the river, and is capped by 20 to 30 feet of gravel which is generally coarse, half of it consisting of boulders over 5 inches in diameter. A small placer operated here some years ago and a test shaft encourages the Winkle Bar Developing Company to plan for larger operations. Ditch creek, with a few miles of ditch, will supply water with a head of 120 feet. The gold is fine and will require special precaution for its recovery.

WINTERS AND McPHERSON PROSPECTS (gold)
ILLINOIS RIVER DISTRICT JOSEPHINE COUNTY

Concerning these prospects Diller says:

Lightning gulch is a tributary of Canyon creek west of the serpentine belt and traverses essentially the same horizon as the north fork. The greenstones are greatly sheared and cut in some places by dikes related to dacite porphyry. Near by are banded siliceous rocks which resemble quartzites and probably, like the cherts of the North Fork of Canyon creek, belong to sedimentary masses.

Near the mouth of Lightning gulch, J. A. Winters has run a number of prospect tunnels into black slates or along their contacts with greenstone. The rocks at this place are much disturbed by slides, and although they may in some places average several dollars a ton, the source of the gold is difficult to trace. Some of the gold, however, appears to be in the slates, whose bronze slickensides are due to shearing movements after the deposition of the ore.

Some distance up Lightning gulch Eugene McPherson has a mine tunnel 200 feet in length that follows the contact between greenstone and banded quartzite. The greenstone is greatly altered and the contact is very irregular. A small quantity of rich telluride ore is reported to have been stoped from this tunnel. I was unable to obtain a sample of the ore at the mine, but a small fragment was given me by Mr. Bowden, who assured me that it came from the McPherson tunnel. Mr. Bowden also gave me a sample from his own prospect farther northwest, on Lightning gulch. Both samples reacted strongly for tellurium, giving a decided purple solution when boiled in concentrated sulphuric acid.

WINTERVILLE AND PARKERVILLE DIGGINGS GREENHORN DIST. BAKER CO.

The now deserted camps of Winterville and Parkerville are situated a mile east and a mile south, respectively, of Geiser. At these points deposits of Tertiary pre-tuff-breccia gravels have been mined by hydraulic methods. The total production is unknown but has been estimated, on the basis of 50 cents per cubic yard for the volume of gravel worked, at a minimum of $145,000. Of late years activity has been confined to the Winterville diggings which have intermittently produced small amounts.

The Winterville deposit is situated on the slopes adjoining Bennett creek in Sec. 16, T. 10 S., R. 35½ E. The work at present is being done entirely on the gravels west of the stream, those east of it having been worked out a long time ago. In 1900, when visited by Lindgren, the Winterville mine was being operated on a larger scale than at present, and but little can be added to the following description quoted from his report.

The gravels washed at present are found about the level of the creek (Bennett creek) and on its western side. The area which thus far has been hydraulicked comprises about 3 acres, the banks being from 15 to 20 feet high. The bed rock is a serpentined greenstone of uneven surface. A north-south fault in the bed rock has been exposed 100 feet long and showing a scarp 30 feet high which dips 60° E. The pay gravel, resting on the bed rock, is from 3 to 10 feet thick, not very coarse, and sometimes cemented. It contains pebbles of serpentine, quartzite, slate, and quartz. Above this rest 15 feet of clayey beds with small strata of coaly material. Above this follows 2 feet of hard cemented gravel, covered by andesitic tuffs and breccia. The gold, found chiefly on the bed rock, is extremely coarse, the pieces ranging from 0.05 ounces up to 15 ounces in weight, but at the same time very well washed. Most of the nuggets have an oblong flat shape. The fineness averages 900. This interesting deposit was clearly formed before the time of the Neocene andesitic eruptions and must be of Eocene or early Neocene age.

Since Mr. Lindgren's examination the pit west of Bennett creek has been worked back a distance of 1000 feet or more and two other faultscarps have been exposed. One forms a wall 20 feet high that strikes N. 60° W. dips 65° N. E. and crosses near the middle of the pit. The other forms the present south boundary of the workings. It presents a curved wall 40 feet high that varies in trend from eastwest to sonthwest and dips steeply northward. In addition, other small displacements are shown, the net result of all being a rapid elevation of the bedrock southward and westward, although it dips in these directions.

The Parkerville mine in Sec. 18, T. 10 S., R. 35½ E. had been idle for some time, and therefore the gravel banks were not so well exposed at the time of the examination as those at Winterville. Enough was seen, however, to make certain that the two deposits are identical in character and composition. The bedrock here is cut by faults that dip in the same direction as those of the bedrock at Winterville and cause displacements in the same manner. The two mines are undoubtedly situated upon portions of the same gravel channel.

The intervening space of about a mile and a half comprises a divide 300 feet high composed of tuff-breccias. If the buried channel remains level or nearly so between the exposed portions it is too deeply buried to allow of any other method of working than by drifting. It is probable, however, that step faults, similar to those observed in the two pits that have been excavated exist in the lands between. If this is true the gravel bed, to some extent at least, ascends the hill from Winterville by steps and descends to Parkerville due to its dip slope.

West of Parkerville this erratic deposit is fully 40 feet thick and dips beneath the tuff-breccias at an angle of 12°; it is not known to appear at the surface farther west.

WOLF CREEK MINING AND DEVELOPMENT COMPANY (placer) GREENBACK DISTRICT JOSEPHINE COUNTY

Office: 702 Spalding Bldg., Portland, Oregon. A. N. Wills, Pres.; M. B. Bozworth, Sec.-Treas., both of Portland. Capital stock, $1,000,000; par value, $1.00; $15,806 subscribed, issued and paid up. (1916 report.)

This company owns 80 acres of placer ground on Wolf creek in Josephine county. The property has been idle for several years.

WOODARD GROUP EAGLE CREEK DISTRICT BAKER COUNTY

See "East Eagle Mining and Milling Company."

WOODROW PROSPECT (gold) EAGLE CREEK DISTRICT BAKER COUNTY

Owned by Mike Woodard, of Baker, Oregon. Located about 13 miles from Sparta and 43 miles northeast of Baker, in the northwest part of T. 6 S., R. 44 E. on the west side of the rather steep canyon of East Eagle creek at an elevation of about 5300 feet. There is but little timber in the immediate vicinity although there is plenty at no great distance.

The country rock is a rather coarse grained volcanic breccia, somewhat altered so that now it has a light greenish color. The quartz vein occupies a narrow but persistent fissure. It is quite regular in width, averaging 18 to 24 inches with strike N. 30° W. dip 50° W. There is a later basalt dike 50 feet wide on the hanging wall. On the surface the vein has been traced for 500 feet by means of small cuts and it is said that every cut pans well. It has been developed by a 100-foot drift having a maximum depth of 50 feet and by a 25-foot winze sunk on the vein about 20 feet from the portal of the tunnel. No assays are available, but samples panned by Mr. Woodard appeared to run about $50 per ton.

WRAY (CHAS.) CLAIMS (gold and copper) NEW ELDOADO DIST. GRANT COUNTY

This property is located on a shear zone which is mineralized in plates Pyrite is the chief ore mineral. Pyrrhotite and some chalcopyrite are also present. This zone strikes about N. 60° E. and appears to be somewhat similar to those on the southern slope of the Wallowa range of which the Poorman is a type, although the shearing and percentage of copper is much less. How much gold and silver is present in this copper claim was not learned.

WRIGHT MINE (gold) UPPER APPLEGATE DISTRICT JACKSON COUNTY

The Wright mine 2 miles east of Applegate is near the south line of Sec. 14, T. 38 S., R. 4 W. near Humbug creek. It is opened by two adits, the upper running 80 feet north in decomposed "granite" to dense hard greenstone while the lower runs 150 feet north and thence 20 feet west; it enters in decomposed "granite" which becomes harder as the contact is approached. At the turn, and beyond, the adit is in hard greenstone with quartz here and there apparently produced by replacement. No well defined vein is visible. The ore consists of mineralized greenstone containing free gold, galena, and sphalerite.

WRIGHT AND MYER CLAIM (gold) UPPER APPLEGATE DIST. JACKSON COUNTY

Wright and Myer have a mine 3 miles northwest of Steamboat in the S. W. 1/4 Sec. 17, T. 40 S., R. 4 W. at an elevation of about 3200 feet as measured by barometer. An adit crosscuts 30 feet to a vein which is followed 70 feet N. 60° W. The vein contains a little chalcopyrite and is said to average $28 in gold per ton. Pyrite disseminated in the andesite wall rock is said to carry $16 a ton in gold and very little copper. The vein plays out upward but the surface workings are on a vein dipping 50° N. E. while the lower vein dips 75° S. W. Adjoining claims have ore containing arsenopyrite, pyrrhotite, and chalcopyrite in quartz. Wright and Myer have a 2-stamp mill with an 8-foot plate and one jig operated by a gasoline engine.

YELLOWHORN MINE (gold) GREENBACK DISTRICT JOSEPHINE COUNTY

The Yellowhorn mine is in the S. W. 1/4 Sec. 4, T. 34 S., R. 5 W. about a mile south of the Greenback mine and 1/2 mile northeast of Placer, Oregon. It is owned by Mr. Clemens, of Placer. It is opened by an adit about 800 feet long in greenstone which follows a vein for 650 feet. The vein varies in thickness from 6 inches to 4 feet with an average of about 10 inches, and is in a rock which contains many stringers. The vein filling is chiefly white quartz with some calcite, pyrrhotite, chalcopyrite, pyrite, and galena. A thin section shows that the calcite is of later origin than the quartz. Pyrite is more abundant in the wall rocks near the vein than in the vein itself. The vein strikes nearly east and west.

YELLOW KING MINE (gold) JACKSONVILLE DISTRICT JACKSON COUNTY

The Yellow King mine, 4 miles northwest of Jacksonville, on Jackson creek is owned by the Medford Mining and Milling Company; in Sec. 26, T 37 S., R. 3 W. at an elevation of 2800 feet, as measured by aneroid barometer. A crosscut adit extends N. 17° E. about 240 feet; at the face drifts run about 20 feet in a 3-foot vein with quartz seams and some sulphides. The country rock is a dark massive andesitic rock; all the vein matter is hard and impervious. At 197 feet from the portal the adit cuts a vein marked by much fault gouge and very wet; the walls are well defined, but there is little quartz and less pyrite in this vein, which strikes S. 83° E. and dips 77° S. At a shaft on the hillside to the south at an elevation of about 2900 feet free gold is visible in iron-stained quartz.

YELLOWSTONE MINING COMPANY (gold) BAKER DISTRICT BAKER COUNTY

The Yellowstone Mining Company's (dissolved Jan. 11, 1916) property in McCord gulch, in Sec. 7, T. 9 S., R. 39 E. is in slate and black limestone cut by many kinds of dikes. The 2 principal veins upon this property are the Old Soldier and Tom Paine. The former is 3 feet in width and is developed by 2 tunnels, one of which is about 60 feet and the other some 600 feet long. The Tom Paine vein varies in width from a few inches to several feet as seen in several hundred feet of development.

Along Washington gulch there are many prospects, but for the most part the veins are small and the mineralization and shattering are but slight.

YOUNG AMERICA PROSPECT (gold) BAKER DISTRICT BAKER COUNTY

The Young American prospect, situated about ¼ mile up the creek from Carpenter Hill mine in Sec. 8, T. 9 S., R. 39 E. is also in greenstone, and the development is upon a massive quartz vein which has a maximum width of 5 feet.

ZENITH MINING COMPANY GRANITE DISTRICT GRANT COUNTY

Office: 321 American Bank Bldg., Tampa, Florida. Henry Leiman, Pres.; A. B. Filogamo, Sec., both of Tampa, Fla., and Emmett Callahan, Assst. Sec., Portland, Oregon. Capital stock, $1,000,000, par value, $1.00; all subscribed, $664,445 issued and paid up. (1914 report.)

The property consists of the Zenith, Putman, and Chance quartz lode mining claims near Granite, Baker county, Oregon. The property was not identified in the field.

THE MINING DISTRICTS OF OREGON

GEOLOGY AND NATURAL FEATURES

Oregon possesses deposits of a great number of the useful minerals. On account of its vast size, however, (having an area of over 95,000 square miles) in comparison with its population (which is about 700,000) much less is known of them, and fewer have been made use of than is true of the mineral resources of most of the neighboring states.

Ores of the precious metals have been mined in the various mountainous sections of eastern Oregon since 1861 and in the southwest counties of the state for the past sixty-five years. The main streams in these sections have also furnished from year to year a varying production of placer gold. Gold has been taken from the beach sands along the coast for years and a small amount of platinum and its associates of the rarer metals is produced annually, Although it was a secondary product of gold and silver ores before that date Oregon began its regular shipments of copper in 1905.

Oregon supplies its own needs in building stone, clays and the common clay products, and possesses an abundance of raw materials for making lime and Portland cement. It has inexhaustible supplies of sand and gravel which are suitable and being used for many purposes. Coal has been mined for years in the vicinity of Coos bay, Coos county, and lignites and sub-bituminous coals are known to exist in various other parts of the state. Large deposits of gypsum along its eastern edge are being worked and the products shipped into neighboring states. Various other non-metallic minerals exist in the state of which there has been but little or no production to date, for economic reasons, or because of the lack of a thorough knowledge concerning them.

Oregon is similar in many ways to its sister coast states. Cutting across it from north to south are the two main ranges of mountains, the Cascades and the Coast range, both of which continue into Washington on the north and California to the south. The Cascade mountains form the "backbone" of the state, dividing it into two parts commonly referred to as Eastern or Central Oregon and Western Oregon. The portion east of the Cascades is about twice as large as that to the west. The Coast range of mountains parallels the coast line very closely for its entire length.

In eastern Oregon, there are a number of scattered lesser mountain ranges rising from a more or less level elevated plain, besides the main area of the Blue mountains, which consists of several ranges and occupies most of the northeast counties of the state. It is in these rugged mountains of eastern Oregon that the most active mining operations are being carried on at the present time and where the opportunities for discovery and development are as good as the state affords.

Along Oregon's northern border the picturseque Columbia river runs for 300 miles, itself a transportation highway the value of which the state of Oregon is just beginning to fully realize. Between the Cascade and the Coast range, and extending from the Columbia southward for nearly 200 miles, lies the celebrated Willamette valley, traversed its entire length by the Willamette river. In places the floor of this valley is 25 miles wide and this with the contiguous foot-hills comprise over three million acres of productive farm lands.

The Willamette valley is separated from the Umpqua river valley to the south by a cross range of mountains that connects the Cascades and the Coast range. A similar range lies between the Umpqua and the great Rogue river country still farther to the south. These two rivers drain westward into the Pacific, and within their broad valleys are thousands of acres of the most productive farm lands in the state. Lying against the California border is the great Siskiyou uplift, which, again, connects the Cascades and the Coast range and separates Oregon territory from the Shasta region in California.

Outside of mountainous areas, much of eastern Oregon consists of rolling uplands suitable for wheat growing and the raising of live stock. It will thus be noted that Oregon possesses a great diversity of land surface, and a corresponding variety of industries besides its mining interests.

Main trunk lines of railroad now reach practically all parts of the state as will be seen by a glance at the map. The Southern Pacific railway, with its many feeders, traverses the state from north to south, passing through the most productive portions of western Oregon and in California, connecting also with both water and rail lines at Portland practically at the north border of the state. The Oregon Electric railway operates lines throughout the length of the Willamette valley. Coast points are reached through passes in the Coast range and by means of coastwise boats between San Francisco, Portland and Seattle. Practically throughout its 300 mile course as the north boundary of the state, the Columbia river is paralleled by two trans-continental railway lines, the S. P. & S. railroad or "North Bank" on the Washington side and the O.-W. R. & N. railroad on the Oregon side of the river; both of which enter the city of Portland. The main Portland-Ogden line of the O.-W. R. & N. cuts across and taps the most important mining, farming and stock-raising sections of northeastern Oregon; while branch lines from both of these roads reach far south into the interior and central districts of eastern Oregon.

The mineral deposits of economic importance are found prevailingly in the more hilly portions of the state, the non-metallic principally in the foothills bordering the river valleys, and the metals chiefly in the more rugged and higher part of the mountain ranges. It is found that workable deposits of the metal-bearing ores are associated quite generally with igneous rocks, that is, either with rocks of volcanic origin, or the more crystalline rocks such as granites and granodiorites that have pushed their way towards the surface and cooled from the molten or liquid condition. On the other hand, the common building stones, clays, and other non-metallic materials are obtained mostly from the sedimentary beds, from rocks that have been deposited in water and have been later more or less consolidated.

Examination of the different sections into which the state is divided by its natural physical features shows that the Cascade range is composed almost entirely of volcanic lavas of varying character that have been violently ejected or have flowed from a large number of volcanic vents that formerly existed along the crest of the range. The position of these vents or openings is represented today by the scores of craters and sharp peaks scattered throughout its entire length across the state. Mt. Hood, the highest of these, rises to an altitude of over 11,000 feet, while Mts. Jefferson, North, Middle and South Sister, Thielsen and McLoughlin, reach upwards of 9000 feet above sea level. From these old volcanic openings molten lavas flowed down both slopes of the range and showers of dust and ash were scattered over large stretches of contiguous country. Pre-existing sedimentary and other rocks were thus largely covered up, or broken through by the force of intrusions of the molten rock from below.

Along the west slopes of the Cascades, therefore, we find a variety of rocks, including ancient and recent lavas, volcanic tuffs and conglomerates, and shales, sandstones, etc. In places, masses of partly or wholly crystalline rocks appear that have been intruded into or have welled up beneath the overlying beds. It is in association with the last type of rocks that most of the ore deposits are found. The east slopes of the Cascades and the adjacent country are more generally covered with surface lava flows through which the streams have only here and there cut sufficiently deep to expose these earlier rocks.

The Coast range of mountains is composed largely of beds of such rocks as shales, sandstones and quartzites, limestones and conglomerates. These are tipped up or folded and broken through by many dikes of basaltic lava and in places covered or interbedded with both ancient and the more recent lava flows. The Coast mountains have not been at all thoroughly prospected for ores of the metals, although coal, iron ore, stone, an abundance of useful clays are found, besides the scattered gold and platinum-bearing sands along the beaches and some of the streams that flow from their slopes into the Pacific ocean.

The principal mountain ranges of eastern Oregon are made up largely of igneous rocks of both recent volcanic and ancient deep-seated origin. Many of the prominent peaks have cappings of lava resting upon deeply eroded portions of an old granitic or granodioritic mass that has apparently pushed up from below. Others show outcroppings of sedimentary beds, sandstones, slates and marbles, that have been folded, or broken and tilted at various angles, and very greatly modified from their original condition. There are also other evidences of greater movement and disturbance of the rocks here than in most other sections of the state. Some of the ranges seem to have been produced by up and down slipping along vast breaks that often extend for many miles. Such "faulting" has assisted in the upbuilding of the Blue mountains proper, of the Wallowa range, Steen mountains and many others in eastern Oregon. Vigorous geologic disturbances of the kind mentioned, where they involve rocks of igneous types that originate at or extend to great depths in the earth, very frequently give rise to conditions that are favorable to mineralization and the formation of ore bodies. That such conditions formerly existed in our eastern Oregon mountain regions in a pronounced degree is proved by the occurrence there of the most extensive and richest bodies of workable ores of the common metals to be found anywhere in the state.

THE METALS

The total production of all metals in Oregon to date is estimated at 140 million dollars; 105 million from eastern Oregon and 35 million from the western part of the state. The production for 1915 was $2,003,509 from 65 placer and 30 quartz mines. Metal output for 1916 estimated at $4,000,000.

Western Oregon.—The state of Oregon contains several metal-bearing areas, widely scattered in different regions. More than half of its coast is fringed with a belt of auriferous sands which sometimes are rich in fine gold. A second mining field, the chief producing one of western Oregon, is situated in the southwestern part of the state and includes Jackson, Josephine, Douglas, Coos and Curry counties. It may be considered as the northern extension of the gold and copper belt of California. A third region in western Oregon is that on the western slope of the great Cascade range in the Bohemia, Blue River, Quartzville, North Santiam and Ogle Creek districts—from the Siskiyous on the south almost to the base of Mt. Hood near the Columbia river on the north.

The earliest discoveries of gold in Oregon were made in Jackson and Josephine counties, where placer gold was found as early as 1852. In the same year the Jacksonville district was organized, following the discovery of placer gold on a tributary of Jackson creek. That fall gold was found on Josephine creek and in the spring of 1853 a great rush followed to Althouse creek, where the bed of the stream was found to be uniformly rich. From Sailor Diggings, a famous placer region, a 15-mile ditch was paid for with one year's production. In the two or three following years practically every part of southern Oregon was prospected and many productive districts were organized. After the most accessible gravel deposits were taken up and largely exhausted, placer miners turned to bench deposits and drift mining wherever such deposits could be worked by water under considerable pressure. Hydraulic mining was used in southern Oregon as early as 1856 and has been employed almost continuously ever since.

Soon after the discovery of gold-bearing gravels, quartz veins were located. In 1859 gold quartz was found at Gold Hill so rich that $400,000 is said to have been taken out the next year. A similar rich deposit at Steamboat, found at about the same date, yielded $350,000 in a short time. The quick exhaustion of the many rich strikes gave the region a reputation of being a "pocket" country, besides causing prospectors to search for them rather than to develop ore. It is a region where many bonanzas have been found, but recently developments indicate that it also contains large bodies of lower grade ores of gold and copper.

Early in the '60s an 8-stamp mill was installed near Grants Pass, and many plants of similar nature have been erected since that date, the largest of which, the Greenback mill, has 40 stamps.

The total production of all metals to date is estimated at 35 millions, about 5 of which came from the mines of the Cascade Range. The average production for the last 5 years is $200,000, but the 1916 production of all metals will be more than twice that sum.

Eastern Oregon.—East of the Cascades (besides the most productive one, the Blue mountain region) are several widely scattered districts. Pueblo mountain district is in southern Harney county, and the Harney district in the northern part of the county, 125 miles away. The High Grade district of southern Lake county, 80 miles west of Pueblo mountain, is near the California line; the Howard district in northeastern Crook county, and the Ashwood district in the new county of Jefferson. Spanish Gulch is in southeastern Wheeler county. The above scattered districts have a record of but a small production.

The most important mining region in eastern Oregon, and in the entire state, is that of the Blue mountains, which is situated in the northeastern part of the state and extends westward for 130 miles from the Idaho line. This important region comprises 30 mining districts. Its total production to date is at least three-fourths that of the entire state.

The first gold discovery in eastern Oregon was at Griffin gulch, a few miles southeast of Baker, in the fall of 1861. In 1862 the large placer mines of Auburn, nearby, were discovered, and the following year Auburn camp had a population of 5000. By 1864 nearly all of the mining districts of eastern Oregon were known. Supplies were brought in from The Dalles, 300 miles away. Because of the difficulty of access and cost of transportation of supplies, gravels which did not yield $8 per day for each man were not considered.

In 1863 the Auburn canal was completed. The next year the Rye valley ditch was constructed, and 9 years later Sparta ditch was completed, as was the Eldorado ditch, with its total length of over 100 miles, to supply water to the Malheur diggings. But by this time the principal hydraulic placer deposits were largely exhausted and a gradual decline in production began which has continued nearly to the present day. The introduction of standard gold dredges has caused an increase in placer production in the last two years, which is to be further increased by additional dredges.

The Virtue quartz mine was discovered soon after the discovery of placer gold. Quartz mines were worked at Susanville and at Mormon Basin as early as 1865 and 1868. One of the first mills was built at Susanville in 1869. Connor creek and Cable Cove were worked, but the shipment of ore on horseback for several hundred miles caused development to be slow. Real activity in quartz mining followed the construction of a transcontinental railroad in 1885, and the development of the many camps was thereafter placed on a more permanent and productive basis.

Speculation was rife from 1899 to 1903, and much money was unwisely spent. Eastern Oregon has just recovered from the injurious effects of this "boom," and since the greater number of producing properties are in good hands, we have a steady production from most of them, which is being increased by the addition of other producers to the list.

The production of the Blue mountain region previous to 1880 is very imperfectly known. Since that time the total annual production has been compiled by the federal government. Taking into account the best information obtainable, the total production of all metals for this area from 1861 to the end of 1916 is estimated at $105,000,000. This estimate is based on that of Waldemar Lindgren up to 1899, to which has been added the production since that time.

Production previous to 1904 was for some years above the million-dollar mark, but beginning with that year there was a decreasing annual production to 1911, the low-water mark, when $463,439 was produced. Since 1911 there has been a marked increase in production, so that in 1915, the last year for which complete figures are available, the production from the 6 counties, for all metals, was $1,859,033. Since the phenomenal production of the earlier placer days this amount has been approached but once when, in the year 1891, the gold and silver production was $1,849,131.

Every one of the producing counties in this region enlarged their output in 1915, both placer and quartz mines increasing their production. It is estimated that the production for 1916 was almost twice that of 1915.

Copper.—Copper usually occurs in Oregon closely associated with gold and silver. Some of the more distinctly copper ores are found in the Homestead district on the Snake river, where it occurs as chalcocite and chalcopyrite in shear zones in greenstones. Another important area is the copper belt in the lower Powder river valley, where chalcopyrite, chalcocite and cuprite are found disseminated through the shattered and sheared greenstone.

Some good copper prospects are found in the Wallowa district, where they are mainly chalcopyrite in a contact deposit between granodiorite and limestone.

Another important distrist is the Waldo, some 20 miles southwest of Grants Pass. Here it occurs as chalcopyrite. The production from this district to date has amounted to approximately three million pounds, in spite of the long haul. The copper properties in this section will receive considerable impetus in their development on the completion of the California and Oregon Coast railroad, which is being built from Grants Pass to Crescent City, California.

Other districts where copper ores are found are the Imnaha and Quartzburg in eastern Oregon, the North and South Umpqua in Douglas county and the Coast Range mountains in Curry and Josephine counties.

The total production of copper to December 31, 1915, as given by the United States Geological Survey, is 3,768,469 pounds. The mine production for 1915 is reported to be 451,172 pounds, while the smelter production is reported as being 797,471 pounds. It is estimated that the smelter production of copper from Oregon ores in 1916 will exceed the total production for all previous years.

Other Metals.—There are no mines in Oregon at the present time which are operated primarily for the production of lead. It is a common constituent of the base ores of gold and silver and in greater or less quantities occurs in several districts in both eastern and western Oregon, especially in Lane and Baker counties.

The production of lead in 1915 was 62,957 pounds. This production came from six counties of the state, Lane county producing the greatest amount, although Baker also had a considerable production.

The mountains of southwestern Oregon and northern California have long been known as the principal source of platinum in the United States. Although the output of platinum from Oregon is small, averaging only 98 ounces for each of the last six years, the high value of the metal makes the occurrence important.

Peridotite and serpentine derived from it are generally considered to be the native rocks of platinum and the abundance of serpentine in southwestern Oregon may account for the occurrence of it there, although platinum has not yet been found in place.

The production is secured chiefly from beach placer mines and associated with black sands.

Quicksilver is widely distributed in southwestern Oregon and traces of its ore, cinnabar, can be found in concentrates of nearly all of the placer mines. At a few points there has been extensive prospecting, but the total annual production of the state never exceeded a few hundred flasks. These deposits are irregular and though large are of low grade.

The first localities developed are northeast of Oakland. Developments are carried on farther north, especially on the Coast fork of the Willamette in Lane county, where a small production was attained within the last few years, though the mine has since been closed. More than 12,000 feet of workings have been opened up at the Black Butte mines, which has proved up an ore body from 7 to 20 feet wide and showing persistence both in length and depth. The cinnabar is also disseminated in small quantities through the country rock which, therefore, represents a very large deposit of low grade ore. The production for 1916 is estimated at 300 flasks.

A deposit of nickel ore in which the nickel is present as the green silicate, genthite, occurs a few miles west of Riddle on Nickel mountain. Peridotite partly changed to serpentine has resulted in the formation of a body of nickel ore sufficiently large to suggest the possibility of successful mining. The Oregon Nickel Mines Company has prospected it quite extensively, but as yet no attempt has been made to work it.

Molybdenum has been found in a few localities in the state, the most noted of which is in the contact deposits in the Wallowa district previously referred to under copper. The metal occurs as molybdenite, the sulphide of molybdenum, and is associated with such minerals as chalcopyrite, pyrite, magnetite, quartz, calcite, garnet and epidote.

Antimony is found in numerous sections of the state, usually in the form of stibnite, the sulphide of antimony. Promising prospects are found in the Upper Applegate district, Jackson county, near Watkins, and on Forest creek, in the same district. These ores are said to contain good values in gold and silver.

Stibnite is also found on Big Boulder creek four miles east from Susanville, in Grant county.

The most important property in the state is the Koehler mine, which see for details.

Chromite is ordinarily found in the vicinity of serpentine areas. Quite extensive areas of serpentine are found in the southwestern Oregon counties, also in Wheeler, Grant and Baker counties. In all of these localities chromite has been found, but the chief places of importance are those near Canyon City in Grant county, and in the Waldo district in Josephine county. The property near Canyon City is described under the heading, "Chromite Mines." and that in the Waldo district under the title, "Golconda Mine," to which the reader is referred.

COAL

Oregon is well supplied with coal, there being numerous fields located in various parts of the state, the most important of which is the Coos Bay field, in the southwestern part of the state, named from the fact that it entirely surrounds that body of water. The Coos Bay region is the only one that has recorded a steady production. This field has been operated continuously during the past 35 years and has produced about two and one-fourth million tons of coal. The production reached the maximum in 1904, when it amounted to 111,540 tons. The output in 1915 was 39,231 tons, valued at $111,240.

The coal in this section is sub-bituminous and its average analysis is about as follows:

Moisture	9.5%
Volatile matter	43.5%
Fixed carbon	36.5%
Ash	7. %
Sulphur	1.2%

The production in this region has been materially reduced in the past few years on account of the cheap fuel oil from California.

Another locality which gives promise is the Eden Ridge field in the southeastern part of Coos county. This field has been sufficiently prospected to demonstrate the existence of two veins of coal, one 7 feet and one 10 feet thick, being in quality the highest grade yet found in the state. A railroad has been surveyed into the district and is already constructed to a point 10 miles distant.

Other coal fields have been prospected in different parts of the state, the chief localities being the Upper Nehalem in Columbia county, the Lower Nehalem in Clatsop and Tillamook counties, the Yaquina field in Lincoln county, the Eckley and Shasta Costa in Curry county, the Rogue Valley field in Jackson county, and the John Day field in Wheeler, Gilliam, Morrow and Grant counties.

BAKER COUNTY

BAKER DISTRICT (Pocahontas, Auburn, Minersville)

The several districts which formerly had the name of Auburn, Pocahontas and Minersville have been in recent years described under the name of Baker. It is located upon the southeastern end of the Elkhorn range. The flanks of this range here are 4 to 5 miles wide and present narrow gradual sloping ridges separated by deeply incised gulches; on the east it sinks below Powder River valley, which is 3500 feet above the sea, while its western base is covered by the gravels of Sumpter valley, at an elevation of 4000 feet. The foot of the south end of the range is flooded by basaltic lavas up to 4500 feet and Powder river flows around the district in a semicircle.

The streams which drain this district are the several branches of Salmon creek, extending up into Hibbard, Rouen, Dutch and Washington gulches, which flow north into Powder river; Griffin and Elk creeks, which flow eastward; and Poker creek, flowing south into Powder river, drains French and Blue Canyon gulches in the old Auburn diggings.

Heavy timber covers the middle slopes of the range, while the upper ridges and peaks are often bare and rocky. South and east of Auburn the rolling foothills are covered by lava and gravel and sagebrush.

Elevations in the district range from about 3500 at the Nelson placer up to approximately 5300 at the Auburn ditch (30 miles long), which was constructed in 1863 to furnish water for the various gulches.

The rocks are slate, argillite and some limestone, together with interbedded greenstone, some of which are old lava flows. That the main granodiorite intrusion outcropping over wide areas farther north extends underneath this district is made evident by numerous dikes of granodiorite porphyry.

The first gold discovery in eastern Oregon was made at Griffin gulch in the fall of 1861. In 1862 the large placer mines of Auburn were discovered and the following year Auburn camp had a population of 5000.

The veins range from stringers to wide massive quartz veins. In Auburn the veins are small, in which occasionally rich pockets have been found. Most of the larger veins in other parts of the district have been too low grade to work. At the present time both placer and quartz production is practically negligible.

CABLE COVE DISTRICT

The county line between Baker and Grant counties follows the watershed which separates the Powder river drainage from that of the North fork of the John Day. The Cable Cove mining district is on both sides of this divide and therefore is in both Grant and Baker counties.

Cable Cove proper is on the Baker county side at the head of Silver creek, about 10 miles northwest from the railroad at Sumpter, and is reached by a good wagon road up Cracker and Silver creeks. Near Cable Cove the road emerges from the thick timber in the bottom of the valley and the head of the creek appears as a wide amphitheatre with steep slopes sparsely timbered. To the west the ridge of Bald mountain rises with bare light gray glaciated outcrops. Eastward a number of sharp and high granite peaks meet the eye as a continuation of the Elkhorn range. Looking north and west from the divide, wide glaciated mountain ridges and valleys are seen.

This district proper extends about 3 miles in the direction of the ridge and a mile or two down on each side of it. The elevation at the camp is about 7000 feet, while the higher points are about 700 feet above. Bald mountain, about 2 miles southwest from the camp, has an elevation of 8330 feet.

Although of moderate elevation, a great deal of snow falls in the various basins, of which Cable Cove is a type. Snow is apt to cover the ground for about 6 months, but the roads are well protected from winds, so that it is not difficult to maintain them throughout the winter.

The geology of all of the veins is simple, since the country rock is entirely the intrusive granodiorite, and aside from aplite only a few dikes are seen. Glaciation caused these basins to have their present form. The veins are normal fissure veins, the result of an extensive system of parallel shearing planes. The vein matter consists largely of granodiorite crushed and chloritized, and close to the ore lenses in the more important veins, which are usually on the hanging wall side, the granodiorite is largely altered to sericite and kaolin. These high grade lenses are rarely more than a foot in width and consist of a small quantity of quartz and calcite gangue, the remainder being heavy sulphides. In a few places concentrating ore of lower grade is found up to a few feet in width alongside the higher grade lenses. The ore minerals are arsenopyrite, galena, chalcopyrite, pyrite and zinc blende, with gold and silver. The slopes of the divides are dotted with dumps and prospect holes upon the closely spaced parallel veins which cut across the district in a N. E.-S. W. direction.

Work was extremely active in this camp about 1900, a period of great activity in mining everywhere in eastern Oregon. Ore was discovered in the district in 1872, but not until 1885, when the transcontinental railroad was completed, did the district become active. One mill was erected previous to 1900, and others have been built since, but only a small mill was in operation in 1914.

The Imperial mine in 1915 and 1916 has been producing intermittently and the concentrating mill has been run occasionally.

CONNOR CREEK DISTRICT

Connor Creek district is a name applied to the territory along the Snake river between the mouth of Burnt river and the mouth of Powder river. In the central part of the district is Connor creek, which flows into Snake river about 14 miles north of Huntington. Connor creek, heading near Lookout mountain, is a small watercourse, a gulch rather than a creek. The grade is steep and its canyon deep and narrow, branching into 2 forks near Connor Creek mine, 2½ miles up from the river.

The elevations are from 2000 to 4500 feet. The canyon slopes are covered with sagebrush; timber is found to the west of the district on Lookout mountain. The weather along the Snake river canyon is mild in winter and hot in summer.

The eastern border of the intrusive granitic rock of Lookout mountain is about 6 miles from Snake river. The intrusion failed to rise to as great elevations as in most of the regions elsewhere, consequently erosion has not yet removed the older rocks. In Connor Creek district it exists, nevertheless, at greater or less distances below the surface. The sediments and flows which make up the crust of the earth here were crumpled and folded at the same time as those in the adjoining regions. Accompanying and following closely upon this activity came the molten rock underneath it. Granodiorite porphyry and aplite dikes which are off-shots of the intrusion outcrop frequently. The country rocks are limestone and schist. No true bedding of the limestone was noted, but the schistosity strikes N. 70° E. and dips from 80° N. to vertical. The limestone is blue in color and has a finely crystalline texture. In some places it is brecciated and recemented with calcite. Where the pressure of the mountain building forces was strong enough the limestone has been changed into a limestone schist. The schist found in this locality is bluish and quite dense. In thin section it is seen to be very fine grained and to consist chiefly of elongated quartz grains with fine parallel bands of sericite. Most of the ore deposits in the district are simple quartz veins, but the recent development is upon gold disseminated in schist, a more particular description of which is found under Snake River Mines Company.

Upon the several small streams which flow into the Snake river there have been placer mines since early days. Those on Connor creek have been the most productive. It naturally has derived considerable coarse gold from the Connor creek vein. The whole creek below the mine has been worked over twice and parts of it are worked at the present time. The total production of the placer gold for this locality is about $125,000.

CORNUCOPIA DISTRICT

The Cornucopia district is small in area. The mines and prospects are all within 4 miles of the town of Cornucopia, situated on the upper reaches of Pine creek, in the Wallowa range. It is 25 miles from the railroad town of Robinette, on the Snake river branch of the O.-W. R. & N., 33 miles north and down the river from the main line at Huntington. A good wagon road from Robinette to the camp leaves the Snake river at about 1,900 feet elevation at the mouth of Powder river which it also shortly leaves to mount on even grades to the divide between this stream and Pine creek at 3060 feet.

From here one drops by easy grades 400 feet into the delightful Pine valley and the thriving town of Halfway. A 2 per cent grade carries us up beyond Carson, where begins a steady 1,200-foot rise along Pine creek to our destination, 6 miles beyond. This part of the journey is through a fairly dense forest and within sight and sound of a good-sized mountain stream. This passage is from the hot sagebrush hills along the Snake, through a fertile agricultural valley dotted still with pines, into a region of deep canyons and precipitous slopes. Except in winter, regular auto, as well as the daily wagon mail stages, take the traveler in by way of Robinette or directly in from Baker some 65 miles by road to the southwest.

From the time one leaves the watershed between Powder river and Pine creek, until well on his way from Carson to the camp, he passes over ordinary Columbia river basalt. One then begins to see greenstones and similar rocks, while in the steam beds bowlders evidence the fact that Pine creek has its sources in granitic areas.

The town of Cornucopia is situated at the eastern limit of a granitic outcrop approximately 250 square miles in extent. Its outline is quite irregular. Its greatest dimension is southeast to northwest, a distance of about 30 miles.

Surrounding this granitic area are found limestones, greenstones and schists. To the south and east these surrounding rocks are generally much lower in height. To the north and west many of their higher points rival the "granite" in the steepness of their slopes and in the loftiness of their elevations. Surrounding all is the Columbia river basalt, which covers so much of the area of Washington, Idaho and Oregon.

The producing veins are all situated on "Granite" mountain two or three miles to the north and east of the town of Cornucopia, and at elevations of 1000 to 3000 feet above it.

There are many prospects on both slopes of this mountain as well as the ones on Red mountain, Simmons mountain, in Norway basin and those to the east and south of town. There are also the placers on Pine creek. There are several parallel veins on Granite mountain which strike a few degrees east of north and usually dip 45° westward.

This district has been a steady and profitable producer of gold and silver since the completion of a well-devised cyanide plant at the Union-Companion mine the first of March, 1913. The success of this company induced the Baker Mines company to build a somewhat similar plant to treat ore from the Last Chance vein, which began the operation of its 20 stamps and cyanide plant the latter part of October, 1914.

Gold was discovered about 1880. And soon afterwards production began in the intermittent way usual with new, isolated mountain mining camps.

According to Bernard MacDonald's report upon the property, the Union-Companion, Red Jacket and Last Chance claims produced $1,008,000 previous to 1903. Estimating the years 1906, 1908 and 1916, and taking the official figures of Charles G. Yale, of the United States Geological Survey for the other years since 1903, the entire production to January 1, 1917, for the district is in excess of $4,000,000. The production for 1916 is estimated to be more than $750,000.

The deposits are normal white quartz veins in granodiorite, schist and greenstone. The principal values are in gold which, except near the surface, is but little amenable to amalgamation. Amalgamation and table concentration recovered but 65 per cent of the gross value, which is largely locked up in iron and other sulphides occurring in irregular bunches within the white quartz body of the vein. Fine grinding, 80 per cent through 200 mesh screen, and cyaniding recovers 90 per cent. The ores so far mined have a gross value well above $10 per ton.

CRACKER CREEK DISTRICT (includes Ibex or Bald Mountain district)

The Cracker creek district is north of the Sumpter district and extends from the divide which separates Powder river drainage from that of the John Day to the north and east. It includes all of the drainage area of the Powder river north of the Sumpter district with the exception of the small area of the Cable Cove district in Baker county. Granite district joins it on the west and the Cable Cove, Rock creek (Elkhorn) districts on the north and east.

Bourne, 6 miles directly north of Sumpter, with which it is connected by a good wagon road, is the only town in the district. Branch roads extend to the various mines on Cracker, Fruit and Silver creeks. The Ibex and Bald Mountain mines, in what has sometimes been called the Ibex district, are reached by wagon road directly up McCully fork from Sumpter, a maximum distance of 9 miles.

The lowest elevation in the district is about 5000 feet and all of the mining plants are located above that altitude. Timber is plentiful except in the higher altitudes. The maximum important elevations are from 5500 to 8000 feet. Deep snow prevails in winter but operations are nevertheless maintained throughout the year.

The district northeast to southwest is about 10 miles long, and most of it is in some variety of argillite, although occasional bodies of greenstone are seen. The argillite and the greenstone are the oldest rocks in the district. Practically all of the important veins outcrop in argillite but they are not far from the irregular southern border of granodiorite which extends indefinitely northward. This is the westward extension of the contact mentioned in the description of the Rock creek district, and also in the description of the Granite district to the west. The reader is referred to the description of the Ibex, Mammoth, Golconda, Columbia, E. and E., North Pole, Mountain View and Buckeye mines for more detailed information concerning the vein system of the district. The total production approximates $9,000,000.

EAGLE CREEK DISTRICT (including Paradise (Paddy Creek), Copper Butte and Sanger Districts)

This district includes practically all of the drainage of Eagle creek, together with the territory south and west of Sanger which slopes towards lower Powder river and is drained by Balm and Goose creeks.

The elevation varies from 3500 feet on Lower Balm and Goose creeks to 8000 on East Eagle creek. Practically all of the district is covered with timber, only occasional small areas are barren.

Much of the area south of the Wallowa range and north of lower Powder river is covered by recent lava flows. Those areas not so ocvered are, with the exception of the small area of granite upon which the town of Sparta is located, made up of old sediments and old lavas and volcanics. The steep slopes and high ridges which form the upper drainage area of Eagle creek are made up of various sediments and old volcanic flows and breccias in considerable complexity. The lower foothills from near Sparta west to North Powder, where they are not covered by Columbia basalt, are seen to be made up almost entirely of greenstones.

Eagle creek is an important stream with several branches that head far back into the Wallowa range. Upon these several branches which reach even to the western limits of the Cornucopia mining district are many quartz veins and placer deposits. There has been some activity in the development of quartz veins in the last year or two and the placers, although not as active as formerly, are worked in a small way.

Much limestone is found in the upper drainage area of Eagle creek. This limestone and the other sediments which are largely calcareous appear to have once covered much of this region but now only remnants remain which have escaped erosion. These limestones, sandstones and argillites have frequently been made schistose and crystallized by the mountain building forces which created the Wallowa range.

It appears probable that in this locality as elsewhere in the Wallowa region these sediments were laid down upon a wide belt of old lavas and breccias. Volcanic breccia is also frequently interbedded with them. These breccias and old flows have been generally altered and nearest to the Wallowa granodiorite intrusion have been compressed and altered into dark green amphibolitic schist.

The two branches of Eagle creek which have received most attention in quartz and placer mining are East Eagle and Paddy creeks.

On Paddy creek considerable work has been done, most of which has been upon lens-like veins in sedimentary rocks. Although there is a mill upon one of the properties the production from occasional runs is small.

The placer mines of Eagle creek have been worked ever since the late '60s, and each summer some placer mining is done. All along Eagle creek there are benches of heavy gravel up to 100 feet above the stream. These benches have been worked to some degree from below the mouth of Paddy creek to a few miles upstream beyond the mouth of East Eagle creek. Placer mines are also found both on upper and lower Paddy creek.

The Sanger mines are located in the northern part of T. 7 S., R. 43 E., on the western side of Eagle creek in a quartz and placer mining area which has a record of considerable production. There has been little activity outside of small placer mining operations since 1900.

The ore deposits are several miles distant from the granitic outcrops of both the Wallowa range and the Sparta district, and may have been due to the intrusive influence of either or both. Because they are located in argillite and far to the north of Sparta they have for convenience been grouped with those others which were the undoubted product of the Wallowa intrusion.

There are three large exposures of greenstone in the drainage area of lower Powder valley, only one of which is of much importance as a mining territory. One is west of North Powder, another is nearly surrounded by the most northerly bend of Powder river and is commonly known as Farley hills. No description of either of these greenstone areas will be attempted.

The third and at present important area extends from Medical Springs south and east some 20 miles. This greenstone belt makes up much of the middle drainage area of the various creeks which flow southward from the Wallowa range into Powder river, of which Goose and Balm creeks are the most important streams in relation to the prospects of this region. As examples of the two types of copper deposits found in this area, two prospects which are apparently the leading ones are described elsewhere under the name of "Gilkeson claims" and "Poorman group."

The reader is referred to the index of properties located in this district for details of the ore deposits.

HOMESTEAD DISTRICT (Iron Dyke)

Four miles down the river from Pine creek and Copperfield is Homestead, the terminus of the Snake river branch of the O.-W. R. & N. Co.'s line, 58 miles north of Huntington. Five miles below Homestead the east and west county line between Baker and Wallowa counties cuts across the Homestead district. A wagon road extends 7 miles farther down the stream. A trail continues along the river 4 or 5 miles farther, and from there on the canyon is impassable. For 125 miles northward, as far as Asotin, a few miles above Lewiston, Snake river flows through one of the most remarkable canyons in the United States.

The older rocks emerge from below the basalt between Copperfield and Homestead where in the basin west of Homestead, the contact is a thousand feet or more above the Snake; at Ballards it is about two thousand feet; at Spring creek, 7 miles from Homestead, a little less; and at Squaw creek, 12 miles away, considerably more.

Basalt and the river and inaccessibility make this mining district's limits. This ragged edge of the older rocks elsewhere covered by the red blankets of recent flows, is for the most part made up of greenstones. This greenstone series, the oldest rocks of the district, consist of amygdaloidal, porphyritic and dense flows with interbedded breccia, tuffs, sandstones, and conglomerates. The igneous flows make up by far the larger part of the series. Smaller streaks of sandstone and conglomerate are imbedded in the flows.

The general direction of the strike is N.-S., but the dip varies in both angle and direction. Microscopic examination of many thin sections reveals the fact that the original character of these rocks is much obscured by their pronounced alteration. This much is evident, that before their alteration the flows ranged from ordinary basalt to rhyolite, from basic to acidic flows, in which are roughly bedded masses of volcanic tuffs, breccias and occasionally thin beds of sandstone and conglomerate. These older rocks are old lavas erupted during the Triassic period. They are the same kind of rocks, of the same age and are the product of the same disturbances and rupturing of the earth's crust that caused the outpouring of the streams of molten lavas which are now the greenstones exposed at Cornucopia, at Joseph, on the southern slopes of the Wallowa range, and doubtless concealed under vastly greater areas by the great outpourings of recent basalt, the Columbia river lavas. The imbedded sandstones and conglomerates show that at intervals this region was submerged to receive for a short time a deposition of coarse and finer sediments, but the lifting out of the water or the coming of the next flow was too soon to permit anything but thin beds of these sediments to be laid down.

Following the last flow much of this as well as a vast region to the north and west was submerged for a considerable length of time, and during this time of submergence limestones in the deeper portions and muddy sediments in the shallower parts were laid down in considerable thicknesses.

About eight miles north of Homestead and continuing for about three miles, limestone lies conformably on the flows and is folded with them. This limestone has a thickness of 300 to 500 feet. It is probable that it at one time covered much of the greenstones in this vicinity. In many places the flows are badly contorted, so much so that the rock has become banded. This folding which followed the deposition of the limestone and included both it and the series of flows beneath it, was doubtless the result of the same forces which preceded and accompanied the great intrusion of granodiorite that makes up the main body of the Wallowa range. The effects of these movements are not as pronounced here as in much of the regions farther west. It is farther away from the greatest folding and is also farther from the great intrusion which nevertheless came in under this region as well. If the northwest and southeast folding had extended in full effect to this region erosion would have removed lava, limestone, and greenstone here as well and have left exposed the granodiorite. This did not occur, but nevertheless underneath this region there exists the concealed granodiorite intrusion. Numerous dikes of granodiorite-porphyry extending upward from the mass below cut the greenstones of Snake river.

Another effect of these movements was the development of a large number of shear zones where often the country rock has been made schistose. The strike of this schistosity is about N.-S. and it dips usually at a high angle.

The shearing, fissuring, faulting, and brecciation of the greenstone gave ample opportunity for lateral and ascending waters to do their work of alteration and mineralization, the activity of which was much intensified by the after-effects of the deep-seated granodiorite intrusion. In some places the former and in others the latter type of solution appears to have been the chief factor in ore deposition.

The deposition of native copper and the mineralization between greenstone and limestone is probably due to lateral secretion. The quartz veins at Carnahans in all probability are due largely to ascending solutions, while deposition in shear zones, as for instance, at MacDougal's property and at the

Iron Dyke, may be due to a combination of lateral secretion and impregnation from sources below.

After the vein formation there was a period of erosion, after which came the enormous outpourings of basalt. When these had ceased another period of erosion began which continuing to the present time has permitted the Snake river to cut its deep channel down even into the older rocks.

The discovery of and activity in this district has taken place within the last 20 years. Copper indications at the surface are evident to some degree almost everywhere in the exposed greenstones. Much of this territory is held by location, besides many claims are patented.

This district is opposite the Seven Devils district in Idaho, and the chief producing property is the Iron Dyke which is estimated to have produced in 1916, in excess of 3,000,000 pounds of copper.

MORMON BASIN DISTRICT (Including Rye Valley and Malheur Districts)

This district extends from Rye valley, Upper Dixie creek, westward to Malheur city. It thus takes in both slopes of the divide between upper Dixie creek and Willow creek. Since this divide is the county line between Baker and Malheur counties the district is in both counties. The Mormon Basin region proper is close to the divide. The Rainbow, the most important mine in the district, is in both Baker and Malheur counties. It is a true basin in shape with many small gulches draining towards the central part where they unite with Mormon Basin creek, which makes its exit through a small canyon in the southern rim. The elevation of the floor of the basin is about 4700 feet and it is probable that the maximum relief is about 1000 feet.

The steep sloping hills are covered with sagebrush and the higher elevations with sparse timber. There is a small precipitation. In winter the snowfall is not heavy enough to be of any great inconvenience. The railroad points are Durkee, 22 miles away, and Huntington, 25 miles distant.

The geologic history of this immediate vicinity is similar to many other regions of eastern Oregon, but with certain phases somewhat accentuated. The oldest rocks, which are also the predominant ones, are a series consisting chiefly of what were originally mudstones, sandstones, and siliceous and calcareous sediments. Interbedded with these may have been some lava flows or perhaps the basic igneous rock was intrusive into sediments in the form of sheets and sills.

This series was then subjected to severe mountain building forces which folded and faulted the rocks and altered the shales, sandstones, siliceous and calcareous rocks into slates, quartzites, cherts and marbleized limestones. By these same forces the basic igneous rocks were altered until they now consist of secondary hornblende, serpentine, and other green-colored minerals, so that they are now called greenstones.

Just at the close of this period of mountain building which contorted, fractured, and changed the series into rocks very much as they are at present, there came a granitic intrusion. The largest batholithic mass now exposed by erosion is that of Pedro mountain to the northeast. A stock of considerable size occurs west-southwest of the basin and can be seen along the road to the town of Malheur. Generally speaking the rock is a granodiorite of medium granular texture and consists of andesine feldspar with quartz, hornblende, and biotite and small amounts of magnetite. There are of course local variations in its composition due to magmatic differentiation. Increase of quartz bringing it nearer a granite, the decrease of quartz making it a quartz-diorite while the absence of quartz makes it a diorite.

Accompanying the intrusion in its closing phases were the characteristic dikes of porphyry and aplite. The first mentioned type are of peculiar interest in this region on account of the well known "spotted" dike of the

Rainbow mine. This particular rock is described under the description of that mine.

The heat of the intrusion as well as the emanations from it contributed further to the metamorphism of the overlying rock. During the cooling of the magma the region was under stress and the resulting fissures were filled with molten material which upon solidifying formed the dikes that have just been mentionel. Later when much of the magma had solidified the fissures which were formed at this time were filled with ascending silica solutions. These solutions deposited their quartz in the veins, and the precious metals and other minerals also. In this particular region movement took place during vein deposition as is shown by cemented vein breccia in many of the veins.

The mineralization of the veins in Mormon Basin varies. In some a large percentage of the gold is free; in others it is contained in sulphides which are chiefly arsenopyrite, and pyrite with minor amounts of sphalterite and galena.

After the veins were formed there was a period of erosion. Then came the outpourings of Tertiary lavas and the formation of lake beds during the same age. Both acid and basic lavas are to be found in this vicinity. The former which were probably earlier are represented by rhyolites and trachytes. In the Humbolt mine there is a dike of altered rock that was probably a feeder to one of these later flows.

Lake beds were formed in the lower part of the basin and probably have a thickness of a hundred feet or more. In places they are interbedded with altered trachytic flows. The lake beds vary in character from coarse gravel to clay. It is probable that the placers of today were at least partly formed by the reconcentration of gold bearing Tertiary gravel beds by present day streams.

The basic lavas are represented by basalt as in other parts of the eastern Oregon region. They are probably somewhat later than the lake beds. Basalt is found on many of the ridges.

Since the Tertiary series of lake beds and lava flows were laid down considerable movement has taken place, as is shown by the tilting and faulting of them.

Recent erosion has taken away much of the Tertiary covering. The present day placers have been formed by the wearing away of auriferous veins and the consequent deposition of the gold in the stream channels and also by the reconcentration of gold-bearing gravels of the lake bed formation.

This region is a particularly difficult one to prospect as is evident by the many abandoned tunnels. The cause of this difficulty is the close resemblance in places of the lake beds to the older altered rocks. Fragments of gold-bearing quartz in the coarser deposits of the lake beds entice the prospector to drive underneath ore at the surface which is not in place. The amount of wash or mantle rock is often such as to hide the true character of the bedrock. In some parts of the Basin faulting and shattering is particularly prevalent and here even when a true vein is found care must be taken to find it beyond the fault.

Willow creek is one of the largest tributaries of Snake river and enters it a short distance above Huntington. A bare ridge, 1000 to 2000 feet high separates Burnt river and Willow creek. On the slopes of this ridge and from 6 to 12 miles west of Rye valley are a number of well known old placer camps—Clarks creek and Bridgeport on Burnt river and Mormon basin, Amelia, Malheur and Eldorado on the Willow creek side. The operations have largely ceased in most of these camps.

The Rye valley placers were discovered shortly after 1862 and have been worked up to the present time with a total production of more than $1,000,000. Water is available for only a few months in the year.

Dixie creek has been placered for 3 miles above the town but the high gravel bars have produced by far the most gold. Years ago it was proposed to dredge the stream bed but a depth of 90 feet has discouraged the attempt although borings are said to show an average value of 30 cents a yard.

A number of quartz veins have been found near Malheur but as yet none of them have become steady producers. The Red, White and Blue vein near Malheur has been developed by a shaft and has produced at times. It is said to be a vein 2 feet wide contained in a clay slate which is cut by diorite dikes.

A number of quartz veins containing silver have been found on Pedro mountain and attracted attention 40 years ago. The veins were rich in silver. But little has been done upon them in the last few years.

The production of the Mormon basin district from its placer mines is not known, although the amount is quite large. The production from quartz mines is confined almost to the last 9 years. The total production for the 9 years is approximately $2,250,000.

ROCK CREEK (Elkhorn) DISTRICT

This district includes all of the drainage of Rock creek as well as that of upper Pine creek. It has formerly been considered as two districts, that of Rock creek and Elkhorn. The principal mine on Pine creek is the Baisley-Elkhorn, reached by wagon road up that creek. All the rest of the district is reached by wagon road from Haines up Rock creek.

The elevations range from about 5500 to 8500 feet and deep snows prevail in winter. The timber is plentiful on the middle elevations, but the higher points and ridges are practically bare.

The mines of both Rock creek and Pine creek are in close proximity to the contact between the granodiorite intrusion and the older rocks which are mostly argillite. This argillite is much altered due to contact metamorphism. Dikes of granodiorite porphyry and aplite cut the older rocks frequently. Near the contact the granodiorite intrusion shades off into diorite. Rock and Pine creeks and the many basins in their drainage areas show the profound effects of glaciation. The basin in which are the Highland and Maxwell mines is a hanging valley.

The veins of this district contain chiefly gold in an ore rich in sulphides. About one-fourth of the gold is amenable to amalgamation. Pyrite and zinc blende with some chalcopyrite are the principal minerals. The strike of the vein system is north-east to south-west.

SPARTA DISTRICT

The Sparta mining district is located in T. 8 S., R. 44 E. Sparta, the only post office in the district, is 30 miles from Baker on the main wagon road to Richland, the chief town in Eagle valley. This township is between lower Eagle creek and Powder river, and with the exception of its northern border is a granitic area surrounded by recent basalts. Doubtless it was once entirely covered by the Columbia river basalt since Sparta butte, close to the town of Sparta, is an uneroded remnant of basalt. The Sparta region, no larger than 30 square miles, is a granitic stock which was intruded into the older greenstones and sediments. These older greenstones and sediments which covered this granitic stock at the time were eroded from its top. Afterwards when the great flows of Columbia river basalt spread over wide expanses in eastern Oregon they covered the Sparta region also, and erosion, with the exception of the northern border, has not fully uncovered all of the intrusion which had been uncovered previous to the first flow of this late basalt.

This intrusion is a light-colored rock of very coarse-grained texture, and consists chiefly of feldspar and quartz. The rock, in thin section, is seen to be composed chiefly of albite feldspar, which sometimes shows zonal growth with the central portion of the feldspar crystals more basic than the outerparts. This rock is a soda granite and the much larger quartz grains and the more basic portions of the feldspars suggest that it is a more acidic phase of the intrusion which elsewhere in eastern Oregon is almost altogether the more basic granodiorite. Besides the granite there are outcrops of porphyry in the vicinity.

In the granitic area adjacent to Sparta we have normal fissure veins formed by the deposition of quartz coming from the cooling mass below. The same type of vein is found cutting the greenstones, but the more distant they are from the intrusive the less extensive is their mineralization.

Lindgren states:

A long, heavily timbered ridge follows the western side of Eagle creek for a long distance toward Powder river. The Sparta mining district occupies the southern end of this ridge, where the rounded hills, here scantily forested, gently slope toward the arid foothills of Powder river. The elevation of Sparta is 4200 feet. The normal granite which forms the country rock is deeply decomposed and the gulches are filled with gravel. It was found at an early date that these gulches, draining in all directions from the central hill, were auriferous, but on account of lack of water little could be done until in 1873, the Sparta ditch was completed, with a capacity of 3000 miner's inches and a length of 22 miles. This canal takes its water from the west fork of Eagle creek and carries it down on the long ridge to Sparta. Great activity followed its completion, but in a few years the output rapidly diminished. According to the mint reports the placers produced $35,000 in 1882, $30,000 in 1889, $4,500 in 1890, $3,100 in 1891, $85,000 in 1892.

The gulch placers of Sparta in most cases led up to well-defined quartz veins. Many of these were known in early days and gold was extracted by hand mortars, arrastres, and small mills. These operations were not continued, however, and the production from the veins gradually fell off; from $60,000 for Union county in 1880, the output was reduced to $7,300 in 1885, $15,000 in 1886, and $15,000 in 1887; but in 1889 there was a most remarkable change, the output in that year rising to $576,000. Most of this, of course, came from the Sanger mine (Eagle district) and the Cornucopia (district), but a large proportion was contributed by the quartz mines of Sparta. For the four years (1889-1892) from which complete returns are available, the following productions are compiled:

Little Pittsburg	$111,000
Windsor	72,000
Union Tunnel Company	91,000
Gold Ridge Company	124,000
Free Thinker	65,000
Arkansas Belle	83,000
Magpie	19,500
New Gem	59,000
Del Monte	27,500
Buffalo	25,000

As the workings deepened the country rock became harder and the general conditions more unfavorable, so that of late years the production has again been declining, and in 1900 only one mine, the Gem, was worked on a larger scale. Though the veins are narrow they are rich, and it is more than probable that thorough prospecting will develop many good mines in the vicinity. The prevalent strike of the veins is north-south or northeast-south-west; the dip is to the east or southeast. The country rock is throughout a granite, in which the biotite is usually converted to chlorite. The ore is free-milling quartz, with some sulphurets.

There is very little activity in mining in this district at the present time. Some work is being done at the Gem mine. A small amount of placer mining is also carried on. The surface of the granite is badly weathered and the shafts and various tunnels and open cuts have nearly all caved in so that there is little to be observed.

SUMPTER DISTRICT

The Sumpter district includes the Powder river drainage from an east-west line about 3 miles north of Sumpter, down to and including Deer creek which flows into the Powder river about 9 miles below Sumpter. It thus takes in practically all of Sumpter valley. A short distance below the mouth of Deer creek the Powder river enters a narrow canyon in which it flows for about 12 miles. The Sumpter valley, which is above the canyon, is at an elevation of from 4000 to 4500 feet and is an alluvial bottom flanked by broad gently sloping forested benches. Beyond these the snowy summits of the Elkhorn range rise abruptly eastward, while to the west a well-timbered ridge of moderate elevation separates the valley from Burnt river drainage. A little above Sumpter the Powder river ceases and is made up of branches of Cracker creek, McCully fork and several other smaller creeks, all heading among the high ridges leading to Elkhorn range or Mt. Baldy.

Argillites in great variety outcrop over most of this area. Although the main branches of the streams rise in granodiorite areas, the only outcrops of granodiorite within the district are of small extent: one on the divide between Sumpter and Granite, about half of which is in Baker county, a very small outcrop at the head of Lake creek, a branch of Deer creek, and several small irregular outcrops on the divide between Powder river and Burnt river on the south side of Sumpter valley below the town. Some small outcrops of limestone as well as occasional bodies of greenstone are found within the argillite areas, and granodiorite porphyry and aplite dikes occur in the vicinity of the granodiorite, since the latter is an intrusive into the argillite.

The general course of Powder river was evidently laid out before the outpouring of the basalt which covers much of the territory to the south of the district. It is evident that these basaltic flows dammed the river to a height of 4600 to 4700 feet and that this barrier created Sumpter valley. Coarse gravels at once began to accumulate filling the valley to an elevation of 4600 feet; and these ancient gravels can now be seen on the older rocks for a maximum width of nearly 6 miles and a length of about 15 miles. As the lava barrier was gradually cut through the gravels were left in terraces in the valley. At the present time the stream has cut down 700 feet below the top of the lava flows.

There is a small area of lava still remaining upon the divide between Buck gulch and Burnt river valley. Underneath this lava flow is a buried stream channel. This buried 3-mile remnant of a former drainage system apparently forked a short distance above Sumpter. The destruction of most of this stream probably contributed more gold to the placer mines than the errosion of veins by the present drainage system.

Workable placer grounds do not extend very far up Cracker creek from Sumpter since most of the area to the north formerly had glaciers in it. To the west there was much placer mining in former days, particularly at the Weaver mine and on benches above and below the town of Sumpter. The greatest area of course is below the town where on the valley floor the dredges are working a field 300 to 2000 feet wide and 5 miles long. Several of the smaller creeks which empty into Deer creek contain placer gold.

About the only active quartz mine is that of the Golden Chariot Mining Company, elsewhere described.

VIRTUE DISTRICT

The Virtue district, one of the oldest in Eastern Oregon, is situated about 7 miles directly east of Baker and is about 12 miles in length from north to south and varies in width from 3 to 6 miles. It occupies the southern part of T. 8 S., practically all of T. 9 S., and the northern part of T. 10 S., all in R. 41 E.

It covers a region of low arid hills rising in the great bend of Powder river. The elevation ranges from 3400 to 5000 feet. The hills rise rather abruptly from Baker valley and slope gently eastward toward the lower Powder river valley. Most of the drainage is toward the latter. Within these hills is Virtue flat, a sage-covered depression extending 8 miles east and west and 2 miles north and south. The water supply is very scant, the only stream being Ruckle creek in the extreme eastern part of the district. Good wagon roads from Baker City reach every part of the district.

The geology is similar in the main essentials to that of the other mining sections of eastern Oregon, in that the ore deposits are the result of an intrusion into older flows and sediments. Obscured as it is by the covering of hillside wash, basalt, and lake beds laid down since the time of the intrusion and only partially removed, makes field investigation difficult.

The intrusion exposed over but a limited area in the northern part of the district is a greenish-gray diorite, grading into gabbro. This diorite is probably a local development of a granodiorite intrusion. By this we mean that the intrusion in stoping its way into the older greenstones and argillites has incorporated so much of these older rocks that its acidic nature has been so modified on this upper part as to become sufficiently basic to be called a diorite. Erosion has exposed nothing but the diorite, but there are many things which evidence that underneath this modified exterior it will shade into granodiorite at depth.

The argillites and greenstones into which the intrusion came have been much mashed and altered by regional metamorphism, doubtless both before and during the time of the intrusion. Of the older rocks greenstones predominate in the northern part of the district, while argillites are the chief older rocks in the southern part. They doubtless continue underneath their basalt covering many miles to the south and west. Thin basalt flows are found on the tops of the elevations and on much of the hillsides. In Virtue Flat lake bed materials to considerable depths exist.

At different times during this period the intrusion was fractured and its roof of sediments and flows as well. Into these fractures was injected the dikes which grade from basic to acidic, the latter from granodiorite-porphyry to aplite. After the dikes had been formed, later fractures were filled with gold-bearing quartz deposited in them by hot ascending waters coming from the intrusion itself. Since the intrusion apparently is a stock or roughly circular, it is to be expected that there would be no parallel vein system. The quartz veins strike in many directions and individual veins are not traceable for long distances. Most of the deposits are normal, simple quartz veins containing very small amounts of sulphides and the free gold is coarse and contains but little silver. Very rich pockets were frequently found. The total production of the district is about two and one-half millions.

WEATHERBY (Gold Hill) DISTRICT

The Weatherby district includes the drainage of Burnt river from Durkee station south to the Snake river, with the exception of upper Dixie creek where the old Rye Valley district, now grouped with the Mormon Basin district, is located. Burnt river emerges into an open valley near Durkee, turning at the same time to a southeasterly direction, which it maintains until near its junction with the Snake. A few miles below Durkee a canyon again begins and continues down to Huntington, with a depth of from 2000 to 2500 feet. Above Weatherby a number of smaller tributaries join the river, all heading up toward Lookout mountain (elevation 6900 feet), the highest point in the divide between Burnt and Powder rivers and a well known landmark visible from all directions. The elevation of the river at Durkee is about 2650 feet, descending to 2117 at Huntington. The grass-covered slopes rise steeply from the narrow flats along the river, and are forested only along the highest portions of the Lookout ridge. During the rainy season Burnt river carries a considerable amount of water, but so much is taken out in ditches for mining and agricultural purposes that it is almost dry at times during August and September near Huntington. Dixie creek, heading some 12 miles westward on Pedro mountain, is the only tributary of note entering Burnt river from the western side.

Burnt river canyon, in the region here described, is cut in older rocks—slates, limestones and diorites. The great sedimentary series is, as far as can be seen, conformable with the Huntington and Snake river series. It consists almost exclusively of fissile clay-slates and strata or lenses of gray limestone. It is only toward Unity and Pleasant Valley that greenstones and greenstone tuffs appear, probably as formerly intercallated flows. The strike is very constantly N. 70 to 80° E., and the dip usually at very steep angles toward the north. The most prominent stratum of limestone crosses Cave creek south of Burnt river canyon, and continues with well marked croppings several hundred feet wide to the foothills of Durkee valley. The age of this series is not known, no fossils of any kind having been found in the limestone masses or in the slates. Occasionally greenstone-schists are interbedded with the clay-slates.

Large masses of granitic rocks are intruded into this sedimentary series on a line from Lookout mountain to Malheur, a line also followed by the gold deposits. The most easterly of these masses occupies Lookout mountain and the summit of the ridge. A smaller area of granodiorite begins on Gold Hill, a few miles southeast of Durkee, and probably continues down as far as Sisley creek. The third and largest area contains quartz-diorite and diorite along the margins, but granodiorite and possibly also granite in the center. This is the area of Pedro mountain on the west side of Burnt river, extended for about 10 miles southwest and northeast, with a maximum breadth of 6 miles. The intrusive character of these rocks is proved by dikes of similar material in the slates and by contact metamorphism of the latter. As far as observed, these granitic rocks show no schistosity.

The Neocene formations are developed extensively only in Durkee valley and in the foothills 5 or 6 miles north and northeast of the railroad station.

Auriferous veins and placers accompany the series of intrusive granitic rocks from Lookout mountain to Malheur. In contrast to the strongly developed vein system of the Sumpter region, these veins are not very persistent. They cannot be traced for long distances, nor are strike and dip constant. On the whole, this belt is more noted for its placers than for veins, from which fact it might be inferred that the gold is scattered in many small fissures rather than concentrated in prominent vein systems.

Several prospects are located north of Lookout mountain, but has not as yet attained prominence. On Chicken creek, near Weatherby, are several veins which have been worked in a small way for many years. Practically all of the streams which flow into Burnt river are gold-bearing and have been worked since the early days. A few placers are now worked each year. The most celebrated are the diggings of Sisley and Chicken creeks. The gravel bed of Burnt river is gold-bearing and low bars have been worked with considerable success below Durkee.

Between Durkee and the mouth of the lower canyon good dredging ground is thought to exist. At Weatherby the canyon widens to 700 feet. A dredge was operated for a short time about 20 years ago, but it ceased operations because it was not heavy enough to do the work.

CLACKAMAS COUNTY

OGLE CREEK DISTRICT

The Ogle Creek district lies on the western slope of the Cascade range in the southeastern part of Clackamas county, and occupies the area drained by Ogle creek, one of the headwater branches of the Molalla river.

The region is reached by a poor wagon road from Silverton, on a branch of the Southern Pacific railroad, some 35 miles west. The district can be more easily reached from Gates by wagon road 12 miles to Elkhorn postoffice, and then by trail 5 miles over the divide between the Little North fork of the Santiam and the Molalla.

It is a region of rugged topography, varying in altitude about 2000 feet, the higher points having an elevation of about 3500 feet. The annual precipitation of the district is about 50 inches, a large part of which falls in the winter months as snow, and stays on the ground for several weeks. The hills are heavily forested, due to the mild, humid climate, and the region lies within the Oregon National forest.

The rocks of the district are almost entirely Cascades andesitic lavas, which make up a large part of the Cascade range. The ore deposits are in silicified and mineralized fracture zones cutting through the andesites, varying from 1 to 8 or 10 feet in width. The most important ore minerals are pyrite, chalcopyrite, sphalerite and galenite. Near the surface these vein minerals are oxidized and are found as free gold in iron-stained vein material. Some beautiful specimens of wire gold have been procured from veins in this district. The best developed mine of this area is the Ogle Mountain, which has been on the producing list at different times during the past ten or fifteen years.

COOS COUNTY

COOS BAY DISTRICT

The Coos Bay district is located in the west central part of Coos county, and is the most important productive coal field in the state. The coal field, as described in the publications of the United States Geological Survey, is in general elliptical in outline, 30 miles in length north and south, and 12 miles in greatest breadth, having an area of approximately 250 square miles, included in townships 24 to 29 south, ranges 12 to 14 west. The south end of the coal field is drained by the Coquille river, while the larger part of the area in the north end of the district is drained by the Coos river and its tributaries.

The altitude varies from 500 to 800 feet above sea level. The climate of the district is mild, the rainfall being rather heavy, averaging 65 to 70 inches annually. The precipitation is largely in the winter months and is confined almost entirely to rain.

The principal towns of the district are Marshfield and North Bend, both located on Coos Bay. Other towns are Coquille, Myrtle Point, Riverton, Beaver Hill and Bandon.

The district is well supplied with transportation, Coos Bay furnishing good harbor facilities for coastwise shipping trade. Early in 1916 the Southern Pacific railway completed its line to North Bend and Marshfield, connecting with the main line at Eugene. This furnishes the first railway communication with points outside of the county which this district has enjoyed.

The rocks of the district are largely sandstones and shales, closely associated with the coal beds. In the hills farther to the east are found numerous flows and intrusives of basalt. Mining in the district is confined largely to coal, which occurs in beds 3 to 5 feet thick. The sedimentary rocks in which the coal beds are found have been gently folded and for this reason the coal beds are found at times outcropping on the surface and again many hundreds of feet below the surface, having a usual dip of from 20 to 40 degrees. The quality of the coal in this section is fairly long flaming, having 10 to 15 per cent of ash, and has been determined by the United States Geological Survey as sub-bituminous.

ROCK CREEK DISTRICT

Rock Creek district is in the extreme southern portion of Coos county, being contiguous to the Ophir district of Curry county, and occupies the area drained by Rock creek, a tributary of Coquille river. The elevation varies from 1200 to 3000 feet. The climate is mild. There is a rather heavy rainfall, and considerable snow in the winter months.

The region is heavily forested and is within the Siskiyou National forest. Excellent forest maps covering this area and showing trails, general drainage and other useful information can be had by applying to the forest supervisor, Grants Pass, Oregon, or to United States Forest Service, Portland, Oregon. This region is also covered by the topographic sheet of the Port Orford quadrangle, published by the United States Geological Survey, and same can be had by applying to the Superintendent of Public Documents, Washington, D. C.

There are no wagon roads in the district. It can be reached by trail from the Rogue river at Agness or from the end of the Smith-Powers logging road from the north. According to Diller, the predominating rocks are sandstones and shales with some basic igneous rocks, probably intrusive into the sedimentaries, and which have been altered in numerous places to serpentine.

There has been considerable interest for a number of years in quartz and placer mining in this section, as well as farther to the north in the Salmon mountain country. Good prospects for gold, as well as copper and chromic iron ore, have been reported from this section.

CURRY COUNTY

AGNESS DISTRICT

The Agness district is in the east central part of Curry county in the vicinity of the town of Agness, which is situated on the Rogue river, about 20 miles from the coast. The district occupies an area drained by the Rogue river, being bounded on the west by the divide between Rogue river and Lobster creek, on the north by the Coos-Curry county line, on the east by Mule creek district, and on the south by Collier creek district.

The elevation of the district varies from about 120 feet at Agness to more than 3500 feet in some of the higher points in the district. The climate is mild, the usual summer temperatures being between 60 and 70 degrees. The temperatures in the winter are usually above freezing, but in the higher altitudes being sometimes below zero. The annual rainfall is above 65 inches. In the lower altitudes the snow rarely stays on the ground long, but in the higher altitudes it may accumulate for a few weeks.

The district is heavily forested, being within the Siskiyou National forest. Excellent forest maps covering this property and showing trails, the general drainage, and other useful information, can be had by applying to the Forest Supervisor, Grants Pass, Oregon, or to the United States Forest Service, Portland, Oregon. The district is also partly covered by the topographic sheet, Port Orford Quadrangle, published by the U. S. Geological Survey, and same can be had upon application to the Superintendent of Public Documents, Washington, D. C.

The only means of transportation to the district is by trails, there being a good trail on either side of the Rogue river from Gold Beach to Agness.

The rocks are predominantly sandstones, shales and conglomerates, except in the southwestern portion, where considerable quantities of mica schist are found, together with some basalts. Locally other basic intrusives and serpentines are also found.

CHETCO (Mt. Emily) DISTRICT

The Mt. Emily district is situated in the southwest corner of Curry county, Mt. Emily being the most important topographic feature of the district, and occupies the area in the neighborhood of the mountain, drained by the tributaries of Chetco river and Wheeler creek.

The elevation varies from less than 100 feet at the river to nearly 3000 feet at the summit of Mt. Emily.

The climate is mild, the usual summer temperatures being between 60 and 70 degrees. The temperatures in the winter are usually above freezing, but in the higher altitudes being sometimes considerably below freezing temperatures. The annual rainfall is 60 to 70 inches. In the lower altitudes the snow rarely stays on the ground long, but in the higher altitudes it may accumulate for a few weeks.

Brookings and Harbor, 6 miles to the southwest, at the mouth of Chetco river, are the nearest towns. The district is heavily forested, being within the Siskiyou National forest. Excellent forest maps and showing trails, the general drainage and other useful information can be had by applying to the Forest Supervisor, Grants Pass, Oregon, or to the United States Forest Service, Portland, Oregon.

Sedimentary rocks in this district are predominantly shales, slates and fine grained sandstones, into which rhyolites have been intruded in the neighborhood of Mt. Emily. In certain areas around the mountain, a rock which seemed to be syenite porphyry was noticed, which is probably closely related to the intrusion, and in other places dikes of basalt are found. There is considerable evidence of mineralization around this rhyolite intrusion, a number of comparatively rare minerals being found, such as molybdenite, cobalt and nickel minerals.

CHINA DIGGINGS DISTRICT

The China Diggings district is located in the southeast part of Curry county. It occupies the headwaters of the Chetco river in the nieghborhood of Gold Basin butte, Red mountain and Whetstone butte, the eastern boundary of the district being the Curry-Josephine county line.

The district has a mild climate, the usual daytime temperature in the summer being from 60 to 80 degrees, while in the winter it rarely gets colder than 10 degrees above zero. The rainfall is between 65 and 70 inches annually. In the lower altitudes snow rarely stays long on the ground, while in the highest altitudes, 3 or 4 feet may remain for several weeks. The altitude varies from 1500 to 2000 feet, the highest elevation being 4000 feet.

The area is well forested, being within the Siskiyou National forest. Excellent forest maps covering this property and showing trails, the general drainage and other useful information, can be had by applying to the Forest Supervisor, Grants Pass, Oregon, or to the United States Forest Service, Portland, Oregon.

Transportation is entirely confined to trails, being most readily accessible from Illinois river in Josephine county.

The rocks in this district comprise several varieties of greenstone and a great deal of serpentine, outcropping in several bands with a general north-south trend. Gold ores in this area are usually found in the greenstone in the neighborhood of the serpentine contacts.

COLLIER CREEK DISTRICT

Collier Creek district is situated in the east central portion of Curry county and includes the area drained by Collier, Lawson and Horsesign creeks, its eastern boundary being Josephine county. The elevation varies some 2000 feet in the district, the highest elevation being above 4000 feet.

The climate is mild, the usual day time temperature being from 60 to 85 degrees, and in the winter varies from freezing temperatures to 10 degrees above zero. The total rainfall of the district is about 40 inches. The snowfall is small in the lower altitudes, while in the higher altitudes it attains at times a depth of 3 or 4 feet for several weeks.

Transportation is entirely confined to trails. The district can be reached by way of Agness from the north or by trail down the Illinois river from Kerby and Waldo in Josephine county.

The region is well forested and is within the Siskiyou National forest. Excellent forest maps covering this property and showing trails, the general drainage, and other useful information, can be had by applying to the Forest Supervisor, Grants Pass, Oregon, or the United States Forest Service, Portland, Oregon.

There is a great variety of rocks found in this district, the most important being argillites, slates and sandstones, known as the "Myrtle formation," which occurs mostly in the lower drainage area of Lawson and Horsesign creeks. In the upper headwaters of Lawson creek are found considerable areas of mica schists, known as the "Colebrook formation," while in the headwaters of Collier creek are found other sandstones and shales which go by the name of "Dothan formation." In the neighborhood of Horsesign butte and the headwaters of Horsesign creek are found a series of basic igneous rocks and the alteration products such as serpentine. Most of the ore deposits are in or near serpentine, many of them having a close association with intrusive igneous dikes, which are found to be dacite porphyry. The deposits in the serpentine are lens-shaped masses of varying sizes similar to those found in the Waldo district in the Queen of Bronze and Waldo mines. A considerable amount of development work has been done in this area, some massive copper ores having been packed out in earlier days.

ELK RIVER DISTRICT

Elk River district is in the northern part of Curry county, and occupies the area drained by the Elk river, being immediately south of the Sixes River district. The elevation varies from slightly above sea level at the river to approximately 2500 feet at the highest points in the district.

The annual rainfall is heavy, being usually above 65 inches. Snow rarely stays on the ground long in the district. There are no wagon roads except those at the mouth of the river near the coast, and trails are the only means of communication. The district is well forested and lies within the Siskiyou National forest. Excellent forest maps covering this property and showing trails, the general drainage, and other useful information, can be had by applying to the Forest Supervisor, Grants Pass, Oregon, or the United States Forest Service, Portland, Oregon. The district is also covered by the Port Orford topographic sheet published by the United States Geological Survey. Copies of the same may be had upon application to the Superintendent of Public Documents, Washington, D. C.

Both placer and quartz prospects are found in the district. Men who have prospects in gravels along the river claim that rich bars exist at several points. The rocks are predominantly sandstones, shales and conglomerates in what is known as the "Myrtle formation." Most of the mining activity is, however, in an area of altered andesites and other porphyries known locally as greenstones. This area occurs at the mouth of Bald Mountain creek and for a few miles above.

GOLD BEACH DISTRICT

The Gold Beach district is located near the mouth of the Rogue river and occupies the old beaches both north and south of Gold Beach for a distance of 5 or 6 miles.

The elevation of the district is only slightly above sea level, the climate therefore being extremely mild. The annual rainfall of this section is about 65 to 70 inches. Snow rarely stays long on the ground in this section.

The principal towns are Gold Beach and Wedderburn, one on each side of the Rogue river at its mouth. Transportation in the district is confined to small coastwise vessels, which occasionally stop at Gold Beach and Wedderburn. A fair wagon road connects with points north and south along the coast.

The rocks of the district are entirely sandstones, shales and conglomerates close to the coast line, while the older contiguous rocks further inland are mostly of the basic igneous type and serpentine. Mining is confined largely to the placer deposits of the present beach lines and older elevated beaches near the coast. The sands making up these old beach deposits are in many places largely black sands, the black minerals being magnetite, ilmenite and chromite, all of which are very resistant to weathering and which have come from the weathering and erosion of rocks distributed over the wide drainage area of the Rogue and other rivers. Considerable values in platinum and gold are found in different places in these black sands, which have been mined in a small way with varying success in different parts of this district, as well as at other points on the Coos and Curry coast.

MULE CREEK DISTRICT

Mule Creek district is located in the extreme east central portion of Curry county, and occupies the area drained by Mule creek and its tributaries, which flow into the Rogue river at a point about 40 miles above its mouth. The district is bounded on the north by Coos and Douglas counties, on the southeast by Josephine county, and on the southwest by the Rogue river.

The elevation varies from a few hundred feet at Rogue river to more than 3500 feet at the highest points. The climate is mild, the daytime temperatures in the summer varying from 60 to 80 degrees, and in the winter from above freezing to 10 degrees above zero. The annual rainfall is about 50 inches. In the lower altitudes snow rarely accumulates to any great depth in the winter, while in the higher altitudes it may reach 3 or 4 feet and stay on for a few weeks.

There are no wagon roads, transportation being confined entirely to trails. The district can be reached by good trails up the Rogue river from Agness or by trail down the Rogue river from the Galice district in Josephine county.

In the district are found sandstones, shales and conglomerates, characteristic of a large area along the Rogue river, more especially in the southeastern portion, while in the northern portion in the neighborhood of Diamond and Saddle peaks and Mt. Boliver, are found large areas of greenstone, which are altered porphyries, such as andesite. Serpentine areas are found in numerous places near the contact between the greenstone and the sediments. The ore minerals of the district are largely copper and iron sulphides carrying values in gold and silver.

OPHIR DISTRICT

The Ophir district is located in the north central portion of Curry county and occupies the area drained by Boulder creek, which has its headwaters at Ophir mountain on the Coos-Curry boundary line.

There are no wagon roads in the district, being reached by trail either from the mouth of Rogue river or from Agness, about 10 miles southeast.

The rocks are largely sandstones, shales and conglomerates, into which have been intruded basic igneous rocks, sometimes altered to serpentine. Considerable areas of greenstone are found in the district. In past years there has been considerable prospecting both in placer and quartz mining.

PORT ORFORD DISTRICT

The Port Orford district is located in the northwestern portion of Curry county near the coast, including the area in the vicinity of Port Orford.

Transportation is confined to small coastwise vessels, which stop at Port

Orford, and to wagon road which runs north and south near the coast line. This road connects with Denmark, Bandon and Marshfield to the north.

The mining in this district is entirely beach placers, from which gold and platinum are recovered with variable success. Considerable progress is being made in this kind of placer mining in numerous places along the coast of Coos and Curry counties, and it is hoped that a satisfactory solution for the recovery of these metals may soon be worked out on a large scale.

SIXES RIVER DISTRICT

Sixes River district is located in the northern part of Curry county and occupies the area drained by the Sixes river. The elevation of the district varies from sea level at the mouth of the river to about 3000 feet at the highest points.

The climate is mild. The annual rainfall is from 65 to 70 inches. Snow rarely stays long on the ground in the lower altitudes, while in the higher parts it may accumulate to a depth of 3 or 4 feet for a few weeks.

The wagon roads are confined to areas contiguous to the coast. Trails are the only means of transportation in the main part of the district. The coast wagon road connects with points farther north in Coos county, such as Bandon and Marshfield.

The rocks are predominantly shales, sandstones and conglomerates of the Dothan and Myrtle formations, but are often intruded with basic igneous rocks, which are altered in numerous places to serpentine. A considerable area of greenstone is found in the headwaters of the Sixes river near Rusty butte and Salmon mountain. A considerable area of basalt is found in the north central part of the district. There has been more mining activity in this district than in any part of Curry county. Placer mining has been carried on more or less for more than 30 years, and in later years leading to considerable activity in quartz mining.

CROOK COUNTY

BEAR CREEK BUTTE DISTRICT

The Bear Creek Butte district is in Crook county, 30 miles southeast of Redmond, a railway station near the Deschutes river. This district is about 20 miles south of the Howard mining district and is south of Crooked river, on the headwaters of Bear creek, which eventually flows into Crooked river at Prineville.

It is reported that fair values in gold and silver are found in wide deposits in porphyry. This district has not been visited, but it is thought that this porphyry may be andesite similar to that in the Howard and Trout creek districts farther north. In the spring of 1916 there was renewed interest in this district.

OCHOCO (Howard-Bolivar) DISTRICT

This district, located on Ochoco creek, is in the northern part of Crook county about 30 miles northeast of Prineville and about 45 miles from the railroad at Redmond, although it is expected that a local line will connect Prineville with the main line in a short time.

The district is well watered and well timbered. The country rock is practically all some variety of andesite and the important mineralization is in wide brecciated zones in this rock.

A small production of placer gold is made each year. The chief mine of interest is the Ophir Mayflower, elsewhere described. The distance of this district from the railroad and the baseness of the ore have had much to do with the failure to successfully operate the properties.

REDMOND DISTRICT

During the latter part of 1914 and in 1915 there was much interest taken in the black sand area of the Deschutes and Crooked rivers in Crook county. A great many claims were staked by various persons and one or more experimental mills erected to test out these deposits. Much publicity was given to the matter in 1915, but not much activity was reported in 1916.

The sands are associated with thick beds of light colored volcanic tuffs and some gravel. The area on Crooked river and the Deschutes river is apparently an old lake bed deposit, of unknown extent, which was entirely covered by lava flows since the lake beds were formed. The basic lavas may be seen overlying the tuff and sands for many miles in the canyon of the Deschutes river.

DOUGLAS COUNTY

DREW CREEK DISTRICT

Drew Creek district is situated in the southern part of Douglas county in the headwaters of the south Umpqua river, and includes the area drained by Drew creek, the most important mines being 4 to 6 miles south of Drew postoffice. The district can be reached by wagon road from Canyonville, up the south fork of the Umpqua, a distance of 25 miles, or from Gold Hill or Medford by way of Trail and Trail creek.

The elevation of the district varies from about 1500 to 3000 feet. The climate is mild. The annual rainfall is about 30 inches. Three or four feet of snow are not uncommon for a few weeks in the winter.

The district is well forested and is located in the Umpqua National forest. Forest maps can be had by applying to the United States Forest Service, Portland, Oregon.

The rocks of the district are largely Cascades andesitic lavas, which make up a large part of the Cascade range; also mica schists, in which most of the mining development of the district has been done. The ores are copper sulphides carrying some gold and silver, and cinnabar has been reported from this district.

GREEN MOUNTAIN DISTRICT

The Green Mountain district is located in southern Douglas county near the Jackson county line, about 20 miles east of Glendale, at the head of Starveout creek. A fair wagon road is built to a nearby point, most of the district being reached only by trail. The elevation of the summit of Green mountain is about 4800 feet.

The country rocks in the district are a much sheared and altered greenstone, which makes up most of the mountain. Some slates and other sedimentary rocks are found. The ores are usually found in the greenstone, the minerals being chalcopyrite, pyrite and pyrrhotite.

RIDDLE DISTRICT

The Riddle district is situated in the south central part of Douglas county, and as used in this report is the area in the vicinity of the town of Riddle, situated on the main line of the Southern Pacific railroad, and including the country lying farther west in the neighborhood of Nickel mountain.

The elevation of the district varies from about 600 feet at the Southern Pacific railroad at Riddle to more than 3500 feet at the summit of Nickel mountain.

The annual rainfall is above 30 inches. The daytime temperature in the summer ranges from 75 to 100 degrees, while in the winter the temperature varies from somewhat above freezing to nearly zero.

There is a good wagon road from the town of Riddle to the top of Nickel mountain, 5 miles to the west.

The rocks of the district are largely of the basic igneous type altered to serpentine in numerous places. Sedimentary rocks, such as sandstone, shales and conglomerates are also found. The principal activity in mining is on Nickel mountain, where considerable bodies of nickel silicate ores have been developed. No production of nickel has been reported as yet from the district, but some shipments of chromic iron ore have been made during the summer of 1916.

GRANT COUNTY

CANYON DISTRICT

The celebrated placer mines of Canyon are situated in the upper drainage basin of the South fork of the John Day river. The valley here widens to a broad depression, about 18 miles from east to west, and from 4 to 8 miles from north to south. In contrast to the narrow and heavily timbered valleys of the North and Middle forks, there is a bare expanse of gravelly pasture land with strips of alluvial soils along the river from a quarter mile to 1 mile wide. The elevation at John Day is 3000 feet; at Prairie, 3500. The climate is fairly mild and dry, the water supply ample; in consequence the valley was settled soon after the discovery of the placers, and has for 35 years supported a prosperous community of cattlemen and farmers. North of the river the hills rise gradually and culminate in a timbered ridge forming the divide between the Middle and South forks of John Day river. The eastern end of the valley is surrounded by dark forested mountains rising to about 6500 to 7000 feet. At the very head of the valley there is, however, an unexpectedly low pass (elevation about 4500 feet), through which a wagon road leads over to the Malheur river basin. South of the valley the picturesque Strawberry range rises abruptly, with serrated peaks, culminating in Strawberry butte, having an elevation of about 8600 feet. Toward Canyon the sharp ridges are a little lower, but still attain 8000 feet. The range presents a steep, but not very regular slope, with numerous salients and deeply incised canyons. Hot springs are found on Reynolds creek in the uppermost part of the valley.

The older pre-Miocene diabases, slates and serpentines at the north side of the valley have been described under the hading "Quartzburg District." In general there is a marked similarity of geologic structure between the Greenhorn mountains, Dixie butte and the Strawberry range. All of them are built up of diorites, diabases and serpentines, inclosing smaller masses of sedimentary rocks, usually clay-slate. Canyon peak, the bold salient from the main range which rises back of Canyon, consists of coarse gabbro or gabbro-diabase containing irregular masses of dark green finer grained diabase or diabase porphyry. This hill is celebrated for its rich pocket veins, and most of the placer gold in the vicinity is probably derived from its veinlets.

The placers of Canyon are justly celebrated as the most important and productive deposits of the kind in Oregon. They were discovered in 1862, and in less than a year many thousand miners were at work on the gravel bars of the creek and in the gulches of the surrounding hills. During the first few years the production was very great, but exact figures will probably never be known. Estimates are made varying from \$3,000,000 to \$5,000,000 a year. In 1865 the product was estimated at \$22,000 a week (Raymond's report, 1870), or about \$1,000,000 a year. In 1870 it had already fallen to \$300,000 a year. In the following year the production was still further reduced, but remained for a long time about \$100,000. From that time on the production has gradually decreased to only a thousand or two each year until 1916, when a dredge began operation near the town of John Day.

GRANITE DISTRICT (Including Red Boy and Crane Creek Districts)

The Granite district includes all of the area drained by that creek except the upper parts of Olive and Clear creeks, which rise near Greenhorn and extend as far west as the Ben Harrison mine. It also takes in the drainage of the North fork of the John Day as far west as the mouth of Crane creek, with the exception of that small part of the Cable Cove district which extends over into Grant county, and that part of the Cracker Creek district which extends across the divide into Grant county in the vicinity of the Ibex mine. It thus includes scattered placers of the North fork of the John Day, the territory on Crane creek which has sometimes been called the Crane Creek district, such scattered properties as the Monumental and La Belleview on the slopes of Bald mountain, the Granite district proper and the Red Boy district.

Granite is the only town in the district. It is 14 miles from the railroad at Sumpter and is reached by a good wagon road over the divide, which is about 2000 feet above Sumpter. This town is 4500 feet above sea level. The area is well timbered and wagon roads penetrate to all of the important localities. Deep snows prevail in winter.

The southern part of the district, including the old Red Boy district, is argillite and related sedimentary rocks. The argillite continues north along the west side of the Bald mountain outcrop of granodiorite, and to the north is seen in most of the drainage area of the North fork of the John Day where it is not covered with recent gravels or later lavas. Granodiorite, aside from that of Bald mountain, continues north on the eastern side of the district to the northern limits of Grant county. A smaller outcrop is also seen in the southeastern part of the district upon the divide between Granite and Sumpter districts. With the exception of the Monumental mine, practically all of the quartz mines are found in the argillites. These are well represented by the Red Boy and the Cougar mines, to which the reader is referrd for details.

Placer mines are scattered quite generously over the district from north to south and much placer gold has been recovered in the past. Although the hydraulic placer mines are not yet exhausted, the chief possibilities for the future are in certain dredging areas of Granite and Crane creeks.

GREENHORN DISTRICT (Including Bonanza and Alamo Districts)

This district includes the eastern half of the Greenhorn range. Its western limit is practically defined by Granite Boulder creek, which flows south into the Middle fork of the John Day and the South fork of Desolation creek, a part of the drainage of the North fork of the John Day. The eastern part of the district takes in the headwaters of the North fork of Burnt river. The extremely irregular line which separates Baker from Grant county crosses this district.

Although a not rugged spur of the Blue mountains, the Greenhorn range is rather high and somewhat irregular. Vinegar hill, the highest point of the range, is about 8200 feet. The range extends from near Whitney to a few miles west of Susanville, a total distance of at least 30 miles.

Most of the territory is heavily timbered and only portions of the higher ridges are bare. It is well watered by many fair sized swiftly flowing creeks on both sides of the range.

The railroad shipping points in the district are Sumpter, Whitney, Tipton and Austin, stations on the Sumpter Valley railway. Wagon roads extend up most of the creeks to the important mines and prospects. Greenhorn is the only postoffice in the district.

The entire Greenhorn range is surrounded by post-mineral lava flows. Within this border of lava are greenstones, argillites and lesser amounts of serpentine, and in the heart of the district is found the granodiorite which makes up the backbone of the range and was intruded into the older rocks. The older rocks on the northern side of the ridge and as far around as Greenhorn City, including those of Bonanza, Winterville and Parkerville, are practically all argillites, while the south side of the range as far around as

Greenhorn City is largely greenstone. From the Morning mine to Greenhorn City there are frequent exposures of serpentine. In the large exposure of granodiorite are seen the usual granodiorite porphyry and aplite dikes. Naturally the older surrounding rocks, underneath which is the concealed intrusion, exhibit many of these offshoots from the mass.

After the aplite dikes, which were the last molten product of the intrusion, came another fracturing of both the intrusion and the older surrounding and covering rocks in which ascending solutions from the interior of the magma filled the veins and altered and replaced the wall rocks. These hot solutions deposited quartz and in many of them both precious and base metals in various mineral forms. Their considerable variety will be noted in the description of some of the mines and prospects. The ores of this mountain range are gold and silver, with copper and lead ores of minor importance. Some of the gold ores are free milling, but usually they are not. Cutting across the middle portion of the range is a belt in which there is much silver in antimonial sulphides. The mine which has produced the most is the Red Boy. The mine which has the most ore blocked out is the Ben Harrison.

In the upper drainage basin of Granite Boulder creek there are several silver-gold prospects. With the exception of that near the Ornament the country rock is granodiorite.

On the opposite side of the Greenhorn range from Granite Boulder creek and near or within two miles of the main ridge are several silver-gold properties, of which the most important mine is the Ben Harrison, and the most important prospects are the Morris, Bimetallic and Intermountain groups. In the Ben Harrison the gold and silver values are about equal, while in the others silver is of chief importance.

In the vicinity of the Morning mine the properties are in a class by themselves, since they are mineralized dikes.

Mining in the region on the eastern side of the Greenhorn intrusion and in the older rocks into which it came can be placed roughly in two groups. This area is exposed to view because of the erosion of recent basalt, which probably once covered it entirely. The region around the Bonanza mine is in argillite, while those in the vicinity of Greenhorn are practically all in the greenstone series. The latter group extends from near the Morning mine through the town of Greenhorn and old Robinsonville to Quartz creek, two miles north of Greenhorn. There is an exceedingly large number of veins which are usually small, but are frequently productive of rich ore.

In the neighborhood of Vincent creek there are areas of greenstone in which both fissure veins and disseminated deposits of gold-bearing copper ores are found.

The creeks which drain into Burnt river and those in the eastern end of the district which drain into Granite creek have been extensively mined for placer gold. Those of Winterville, Parkerville and McNamee gulch are especially noteworthy.

NEW ELDORADO DISTRICT

Between Elk and Granite Boulder creeks the mountain streams flowing south into the Middle fork are Coyote, Big Boulder, Horse and Beaver creeks, of which Big Boulder, with its several branches, is the largest. Between the Middle fork of John Day river and the ridge above and largely in the drainage of Big Boulder creek is the New Eldorado camp.

The nearest postoffice and railroad station is Austin, from which the main wagon road to Susanville is followed for about 10 miles to the Thomas ranch. A mountain road extends from here for about 5 miles to the Heppner mine in the central part of the district. The middle and lower elevations are well timbered.

The prospects are in both granodiorite and greenstone. The ore deposits in the granodiorite are in both narrow fissure veins and wider replacement types. Some of the gold ores are free, at least near the surface. Other veins are more complex and contain mostly silver and antimony. In the greenstone area there are several properties in which obscure shear-zones are mineralized in places. Pyrite is the chief ore mineral, with some pyrrhotite and chalcopyrite.

QUARTZBURG DISTRICT

Prairie City, a terminus of the Sumpter Valley railroad, is on the John Day river near the mouth of Dixie creek. The Quartzburg district includes all of the drainage of Dixie creek and a small territory across the divide at the head of Ruby creek, which drains into the Middle fork of the John Day where the Dixie Meadow mine is located. The principal mines and prospects of this district are situated about 6 miles north of Prairie City and close to the branches of Dixie creek. A series made up of meta-andesites, some of which are amygdaloidal and some porphyritic, with altered tuffs and serpentines, and argillites make up the older rocks. Most of the flows are so chloritized as to warrant their being called greenstones. Veinlets and the amygdule filling evidence the alteration of the rock.

An intrusion into the greenstone, which is apparently a fine grained granodiorite, is exposed to some extent west of the camp. Its presence underneath the mining camp is made known by the numerous porphyritic dikes, which all have granodiorite tendencies. Many of these dikes are said to contain low values in gold. After the intrusion there was another period of shearing and fissuring, which furnished channels for hot ascending solutions that filled the fissures and shear zones with quartz containing gold, silver, copper and other sulphides.

In the shear zones on the eastern part of the camp there was much replacement of the shattered country rock. From this time on the geologic history is similar to the rest of eastern Oregon, in that flows of Columbia river lava were succeeded by the erosion which created the present topography.

The Dixie creek placer mines were discovered in 1862, and soon after that date the quartz veins on the west fork were found and have been worked intermittently at least since 1880. Lindgren states that the production to 1900 is not believed to have exceeded $100,000, and the production since that time has been considerably less.

On the east fork of Dixie creek the country rock is made up of a series of old volcanic flows, where veins containing copper ores are found.

No change of Lindgren's report of 1900, which is quoted below, is to be noted. Locally the gross production from the Dixie placers is reported from $600,000 to $6,000,000. Probably the lesser amount approximates the truth. The depth of the gravel and the condition of the bedrock was not learned, but if these were proven suitable it might pay to install a dredge.

The Dixie creek placer mines were discovered about 1862, and were reported rich, though no data as to production are at hand. Raymond's report for 1870 contains the statement that at that time there were 100 white men and 200 Chinamen employed, and that the fine, scaly gold was 860 fine. In 1873 the creek is reported as turned over to Chinese labor. In 1882 two small hydraulic plants were in operation, producing $30,000 (Mint report). At the present time very little placer mining is done.

The placers consist of the gravels accumulated in the present creek to a depth of 10 to 15 feet. The workings extend upstream from Prairie for 5 miles, or to the entrance of the diorite canyon, where the grade becomes very steep. The width of the gravel-covered river bottom is from 300 to 800 feet, the whole of which has been worked.

SUSANVILLE DISTRICT

The Susanville district is about 22 miles down the Middle fork of the John Day river from Austin, a station on the Sumpter Valley railroad. A good wagon road could be built rather easily in place of the present one, which in 3 or 4 places deliberately leaves water grade to swing around over rocky ridges to return after some circling to the stream again. Not only is the distance longer, but the ascent and descent of rocky ridges makes it a disagreeable and expensive haulage road.

Galena, just below the mouth of Elk creek, and Susanville, about a mile up Elk creek from its junction with the Middle fork of the John Day, are the two postoffices. The district is well timbered, especially in the central part on the middle elevations.

The quartz prospects and mines of the Susanville district are confined to a belt extending northeast from Galena. This belt is less than 2 miles wide and less than 4 miles long. It has a great many prospects and mines. They are in slate, serpentine and porphyry, and a few are in greenstone. Most of the veins strike in an E.-W. direction, but most of those in the serpentine are N.-S. ledges.

HARNEY COUNTY

HARNEY (Trout Creek-Idol City) DISTRICT

Trout creek is a branch of Silvies river, which flows south into Malheur lake. This stream is an important one, which rises on the south side of the range south of the John Day valley. Its headwaters rise directly south of Canyon City. Until the railroad was extended from Vale up Malheur river, Harney district was more than 100 miles from the railroad. It is now between 20 and 30 miles from Crane, the present terminus of this line. The principal part of the district is in T. 20 and 21 S., R. 32 E.

Placer deposits were found in Trout creek in 1891 and approximately $50,000 has been produced. The placer gold seems to have been derived from wide bodies of porphyry. This porphyry belt is about 4 miles long and 1½ miles wide extending from southwest to northeast. Ledges have been found which carry from $3 to $36 in gold and one to 80 ounces in silver. The principal country rock is granite. The ore, with the exception of the shallow oxidized portions of the veins, is base and could not be sent to the smelters because of the long wagon haul. It is the intention of the owners of the Trout Creek Mining and Milling Company, the active property in the district, to ship ore in 1917, now that the railroad has been completed as far as Crane. This district has not been visited and the statements above are from the press and private sources of information.

PUEBLO MOUNTAIN (Denio) DISTRICT

With the exception of the area to be described, practically all of the southern half of Malheur county is covered by basalt, rhyolite and associates tuffs. The exception is Pueblo mountain and area which extends from beyond the Nevada line north for about 10 miles. This mountain rises abruptly a short distance west of Denio, Oregon, a postoffice about 110 miles north of Winnemucca, Nevada, the nearest railway station. It is composed of rock that belongs to an older series than do the lavas to the north. It is apparently made up of andesite porphyry, micaceous schists and granitic rocks, which have been more or less extensively affected by mineralizing agents.

Some prospecting has been done and good specimens of carbonate ores of copper, as well as native copper, have been found, but the distance from the railroad is so great as to discourage prospecting and development of the copper ores.

JACKSON COUNTY

ASHLAND DISTRICT

The Ashland mining district is situated near the town of that name about 12 miles north of the California boundary in Jackson county, Oregon. The most important mines in the district are on the ridge a few miles west of Ashland, but other mines of note are situated farther west on Wagner creek, to the south of Ashland creek, and to the east-southeast on Sampson creek. The district varies in elevation from about 1900 to over 4000 feet above sea level. It occupies the valley of Bear creek, a tributary of Rogue river, and as used in this report, the west boundary will be Anderson creek, and the divide between Bear creek and the Little Applegate river; the north boundary the north line of T. 38 S.; the east boundary the east side of R. 2 E., and the south boundary the Siskiyou divide.

The annual rainfall of the district is about 30 inches. There is considerable snowfall in the higher elevations, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer is between 75 and 90 degrees while in the winter it varies from above freezing to 10 degrees above zero.

The southern portion of the district is well forested; in the northern part the forests are scant. This district is in part in the Crater National Forest.

The main line of the Southern Pacific railway runs through the district and the principal towns are Ashland, in the central, and Talent, in the western part.

The earliest mining in the Ashland district was probably done in 1858; it was in that year that the mining district called Forty-nine Diggings was organized. For about two decades the chief mining activity was in the placer deposits, but the interest gradually shifted to underground mines, and as early as 1880 several of these had been discovered and opened in a small way. About 1890 the Ashland mine was worked more actively and during 1892-1899 its output was about $150,000. About the same time the Shorty Hope and Mattern mines were productive. During the following decade development work continued more or less regularly at the Shorty Hope mine on Wagner creek, but the production of the district decreased considerably. The quartz mines are usually well-defined fissure veins with quartz as the principal gangue material, the most important values being gold.

The town of Ashland is located on the border of the intrusive igneous mass which forms the heart of the Siskiyou mountains. To the north and east of Ashland, Bear creek valley is eroded in Cretaceous and Tertiary sediments which lie in beds dipping to the northeast away from the igneous intrusion. To the south and west of Ashland the central part of the mountains is formed of a coarse-grained rock which solidified from fusion while a great mass of fused rock material was at considerable depth below the surface. On the east side of Bear creek valley the mountains are formed of nearly horizontal layers of volcanic rocks which took their present position by flowing over the surface as great floods of lava.

The oldest rocks of the Ashland district are those found along Wagner creek (especially in the ridge to the west), which consist of amphibolites and hornblende and quartz mica schists probably produced by the effects upon sedimentary formations of the intrusion of the (once) hot and liquid rock mass composing the mountains to the east. These rocks may be correlated with the Salmon and Abrams formations of Hershey, which he assigns tentatively to the Precambrian. East of Wagner creek are sandstones and argillites with some limestone lenses, which are probably of Paleozoic age.

The next younger series of rocks consists of the great intrusive mass in its various phases. This rock is chiefly tonalite or quartz diorite, that is, it is a coarse-grained igneous rock composed of sodic plagioclase feldspar, quartz, and hornblende or biotite or both. The plagioclase feldspar is accompanied in some parts of the mass by orthoclase feldspar; the rock is then called a granodiorite. In other places the plagioclase is largely replaced by orthoclase and the rock is a true granite. Commercially all these rock types pass as granite, and one kind is just as good as any other for use as a building or ornamental stone. Associated with these massive igneous rocks and probably from the same source there are numerous dikes of fine-grained igneous rocks of the same general composition as the former, but containing a larger proportion of light colored minerals. They are called aplites in general, some varieties present in this region being tonalite-aplite, plagiaplite, and diorite-aplite or malchite. Near the borders of the igneous intrusion it is less siliceous in some places and contains no quartz; it is then a diorite.

After the intrusion of these igneous rocks there was a long period of erosion during which the surface was gradually lowered hundreds and perhaps thousands of feet, just as it is being slowly worn away today. The materials removed by erosion were carried away by the streams and deposited in quiet water at some distance. For a long time the region of deposition included the area now occupied by Bear creek valley. At the beginning of this time the rocks formed were conglomerates, which were succeeded by sandstones, in large part containing abundant fragments of feldspars and called feldpathic sandstone or arkose. Some of these rocks contain fossils which give silent testimony that they were formed in Cretaceous times. Later the material deposited included finer sands and even clays. At one time the region was swampy or controlled by other conditions favorable to the development of luxuriant vegetation, which accumulated under water (without weathering) and gradually formed thick beds of peat which finally turned into coal. Near the close of this period of deposition the formation of ordinary sediments was interrupted one or more times by volcanic activity in the mountains to the east, which produced great quantities of volcanic ash that was brought by winds (and water) into beds resembling the finer sedimentary rocks derived from erosion. Fossil leaves found in the coal and in the adjoining rocks show that these deposits were formed in the Tertiary period.

At the close of this period the sedimentary beds were somewhat tilted by elevation of the Siskiyou range or depression of the Cascades so that they dipped at an angle of 10° to 25° toward the northeast. At about the same time the great lava flows from the volcanic vents of the Cascade range covered the sediments which then filled the present site of Bear creek valley, and flowed westward to the slopes of the Siskiyou mountains. These lavas are commonly called basalts, but for the most part they are auganites, andesites, and rhyolites, that is, they contain more silica and alkalies and less iron and magnesia and lime than do the basalts. All of these rocks furnish excellent road materials. In some places the rhyolite has been much altered to a clay which may be of value.

After the cessation of volcanic activity there followed a long period of erosion during which the lava flows were slowly worn away. Along the margin of the flows they were somewhat less compact and were therefore removed a little more rapidly. Thus Bear creek valley originated, and was gradually deepened and widened to its present size, not only cutting through the lavas but also through about a thousand feet of the underlying sedimentary rocks. As an incident of this erosion there are shallow temporary deposits of river gravel and silt of recent formation in various places near water level in the valley. These stream deposits are the most recent formations in the region; indeed, they are still in process of deposition more or less irregularly.

This district has large deposits of excellent granite for building stone in numerous places on the northern slope of Ashland mountain. (For description see Vol. I, No. 2, Mineral Resources of Oregon.)

The Ashland district has the greatest variety and quantity of mineral waters of any section of the state. The city of Ashland has very extensively developed certain springs in the neighborhood, the mineral waters being piped into the city for several miles where it is made available for public use in a most attractive city park. (For a more detailed description of the mineral springs in this district see Vol. I, No. 5, Mineral Resources of Oregon.)

ELK CREEK DISTRICT

Elk creek district is in the northeastern part of Jackson county, and occupies the area drained by Elk creek, a tributary of the Rogue river. The north and west boundary of the district is the Douglas-Jackson county line; the east boundary, the divide between Elk creek and Mill creek; and the south, the Rogue river.

The climate is mild, the usual daytime temperature in summer being from 60 to 85 degrees and in the winter from freezing to 10 above zero. The total rainfall of the district is about 40 inches. The snowfall is small in the lower altitudes, while in the higher altitudes it attains at times a depth of 3 or 4 feet for a few months. The elevation of the district varies from about 2000 feet to over 5000 feet.

It is a heavily forested area and is within the Crater National Forest. Some excellent forest maps showing trails, roads and general drainage can be had by application to the U. S. Forest Service, Beck Bldg., Portland, Oregon. This district is covered by the topographic map known as the "Ashland Sheet," published by the United States Geological Survey, and same can be had by application to the Superintendent of Public Documents, Washington, D. C.

Medford is the nearest railway point, some 40 miles distant. The district is served by the Medford-Crater Lake auto road as far as the mouth of Elk creek, 2½ miles east of Trail postoffice. Here the Elk creek road leaves the Crater Lake road and continues in a northeasterly direction for about 25 miles to the mines.

The only mine in the district from which production has been reported is the Buzzard, operated by the Pearl Mining Company. Some high grade sulphide ores have been shipped from this property.

The geology of the district observed hastily seems to be quite simple, and consists of a series of flat-lying Cascades andesite flows. Vertical fissuring has taken place locally, producing fractured zones, which furnished opportunity for the mineralizing waters to place ore deposits in their crushed or brecciated portions. Some of the highest grade sphalerite known in the state has been produced from this mine, often running as high as $500 per ton in gold.

GOLD HILL DISTRICT

In this report the Gold Hill district includes the whole Rogue river valley from Central Point and Table Rock westward to Josephine county. It is limited on the south by the divide between Rogue and Applegate rivers and includes tributaries of Rogue river from the south, namely, Kane, Galls, and Foots creeks, and from the north, namely, Sams, Sardine, Wards, and Evans creeks. There are many placer and auriferous quartz mines in the district and other mineral resources of various kinds. There are no large cities in the area, but the town of Gold Hill, on the Southern Pacific railroad, is headquarters for the most active part of the region. Near Central Point and Table Rock the Rogue river occupies a wide valley; only a few miles to the west it enters a narrow valley from which it does not emerge until it reaches Josephine county. The Gold Hill district is a mountainous region cut by one narrow east-west valley and its tributaries from the north and south. The elevation varies from less than 1000 feet at the mouths of Evans and Savage creeks to nearly 4000 feet on top of Fielder mountain, and similar elevations both north and south of Rogue river. The Southern Pacific railroad runs through the district east and west, following Rogue river. The district is well served with wagon roads and trails by which any section can be easily reached.

The annual rainfall of the district is about 30 inches. There is considerable snowfall in the higher portions, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer is between 75 and 90 degrees, while in the winter it varies from above freezing to 10 degrees above zero.

The Gold Hill district, as the name is here used, includes half a dozen areas which were at one time organized as mining districts. Thus, the Foots creek district was formed in 1853; the placer gold here was unusually coarse. The Evans creek and Pleasant creek districts were organized in 1856, but the rich pocket from which the town of Gold Hill takes its name was not discovered until January, 1859. It is said that $400,000 was taken out the first year. During the seventies placer mining continued somewhat less actively, about half the miners being Chinese. In 1884 placers on Galls creek were notably successful, while gold bearing gravels on Foots creek were profitable throughout the decade. During the nineties the output of the placers decreased, but work continued on many creeks of the region. During the first decade of the twentieth century placer mining continued on Foots, Galls, Sams, Sardine, and Pleasant creeks, one dredge being used on Foots creek, a 7-mile ditch constructed on Sams creek, and other improvements made in the district. On the whole, the production of the placer mines has been maintained for a long time, but is slowly decreasing, and no large auriferous vein deposits have yet been developed to adequately take their place, although several have been opened near the surface during the last ten years. Thus, the Millionaire mine about 3 miles southeast of Gold Hill was opened by a vertical shaft to a depth reported to be 400 feet, the Bill Nye mine about 3 miles south of Gold Hill was opened by several adits, and considerable work was done on the Tinpan, the Lucky Bart, and other mines. These and other mines were more or less productive at various times during recent years.

A great variety of minerals is produced in this district. In the northern part, near the headwaters of Evans creek, there is considerable development of quicksilver in progress. There is a good tungsten prospect about 3½ miles north of Gold Hill, and gold quartz mines and prospects are well distributed.

The Gold Hill district is a region occupied chiefly by old Paleozoic sediments interbedded with sills or flows of andesite and greenstone. Everywhere the sedimentary rocks strike northerly, usually about N. 15° E. and dip eastward at angles ranging from 65° to nearly 90°. Diller has shown that Jurassic beds near Waldo have been overturned so that the oldest strata now overlie the younger formations. It seems probable to the writer that the Paleozoic sediments are also overturned, and that limestones found on Kane creek are probably of early Paleozoic age, and fossils found in limestone lenses on this creek indicate that they are not Devonian; the writer would suggest that they are Silurian rather than Carboniferous in age. Fossils found in limestone lenses on Cheney creek and south of Waldo were considered as probably Devonian in age by E. M. Kindle of the U. S. Geological Survey in 1909; others collected by the writer on Cheney creek in 1913 were considered by the paleontologists of the U. S. Geological Survey to belong probably to the Carboniferous. Accordingly the Paleozoic sediments west of Kane creek in the Gold Hill district are referred to the Devonian or Carboniferous or to both periods.

Long after the formation of these Paleozoic sedimentary rocks the region was intruded from below by a mass of molten igneous rock; at about the same time and perhaps by the same agency the bedded rocks were closely folded and overthrust to the westward. The intrusive rock solidified beneath a considerable thickness of sediments or other rocks, which has since been removed in some places. Thus, the igneous mass is now exposed to view in the mountains at the head of Kane creek, and extends thence northeastward nearly to Central Point and thence northwestward past Tolo and Ray Gold to the west side of Blackwell Hill; the same rock outcrops in the N. E. ¼ of Sec. 35, T. 35 S., R. 3 W., on the west side of Sams valley; a similar rock of aplitic texture outcrops near the south line of section 15, T. 37 S., R. 4 W., on the right fork of Foots creek, and it seems probable to the writer that it underlies at considerable depth a large part (or all) of the Gold Hill district.

This igneous intrustion and intense folding seems to have elevated the region enough to cause a new cycle of erosion and the formation of coarse sediments which could not be transported far by ordinary agencies. Therefore conglomerates were produced, and these were succeeded by feldspathic sandstones during part of Cretaceous time. Rocks produced in this way are now found between Evans creek and the headwaters of Sams and Sneider creeks; similar rocks are doubtless covered by later lava flows near the Table Rocks. Along Evans creek from the "Meadows" northward these Cretaceous sandstones are overlain by a considerable thickness of Tertiary sandstones which contain some thin beds of coal.

The latest rock formations in the district consist of stream deposits some of which are very valuable on account of the gold they contain. They are formed along all the streams of the district, but are not abundant along Rogue river in this region because the latter is here in a narrow rock-cut portion of its course to the sea.

This district is one of the most important in Southern Oregon in the quantity and quality of its limestone deposits. The Beaver Hill Portland Cement Company has completed a large plant at Gold Hill which began operations in the summer of 1916. The district has good road materials of several kinds including granite, limestone and basaltic lavas. (For more detailed description of limestone, building stone and road materials, see Mineral Resources of Oregon, Vol. I, Nos. 2, 5 and 7.)

JACKSONVILLE DISTRICT

For the purposes of this report the Jacksonville or Medford district is bounded to the southeast by the Ashland district, and includes all of Bear creek valley between Phoenix and Central Point; to the southwest it extends to the divide between Bear creek and Little Applegate river; to the northeast it is limited by Antelope creek. The most important mines in the area are near Jacksonville, and that town has been a mining center for five decades. It is still the county seat, but Medford, only four miles away on the main line of the Southern Pacific railroad, has grown so rapidly that Jacksonville commercially is only a suburb of the larger city. There is a branch railroad connecting Jacksonville with the Southern Pacific railroad at Medford. The district varies in elevation from about 1400 feet above sea level near Medford to approximately 4400 feet on a spur of Grizzly mountain, about 3 miles west of the Sunnyside coal mine.

In later years there has been considerable development in quartz mining. The veins are well-defined, having quartz as the principal gangue material, the most important values being gold.

The annual rainfall of the district is about 30 inches. There is considerable snowfall in the more elevated portions, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer is betwen 75 and 90 degrees, while in the winter it varies from above freezing to 10 degrees above zero.

A large part of the area of the district is a rich farming section, only a small portion of the higher elevations being forested.

Gold was discovered near the present site of Jacksonville in the fall of 1851 and mining in the region began as early as 1852, in which year the district was organized as a result of the first infux of miners from California. Jacksonville was for a time the seat of a county government which extended nominally from the Pacific ocean to the Rocky mountains and actually exercised legal authority from the ocean to the interior of Oregon. The placer mines on both forks of Jackson creek were the object of the first mining operations, and furnished large returns for several years. As early as 1870 the industry became less profitable and gradully passed into the hands of Chinese.

Two quartz mills were erected during the 60's; the Hopkins mill on the left fork of Jackson creek was not successful, and as early as 1869 it had been converted into a sawmill. The Occidental mill on the right fork of Jackson creek cost $10,000; it was equipped with 10 stamps, 2 rotary pans, and 40 horse power, and had a crushing capacity of 20 tons a day.

The geology of the Jacksonville district is in some respects more complicated than that of the Ashland region. As in the latter, the chief valley (Bear creek) is occupied by Cretaceous and Tertiary sedimentary rocks, overridden on the northeast by lava flows, but the mountains to the southwest are formed by much altered Paleozoic sediments and old andesitic rocks. The great igneous mass forming Mount Ashland has its counterpart only in an area of granitic rock in the hills west of Central Point extending from the forks of Jackson creek northeast nearly to Central Point and thence northwest to Tolo and Ray Gold in the Gold Hill district.

The geological history of the Jacksonville district is very similar to that of the Ashland area. The oldest rocks of the region are highly altered Paleozoic sediments in the mountains south of Medford; they are closely associated with old andesitic rocks. Near Jacksonville these sediments consist chiefly of shales which strike N. 10°-20° E. and dip 75°-90° W. These formations were intruded by a granitic mass which occupies a huge irregular dike-like area extending northeastward from the forks of Jackson creek. After a long period of erosion had uncovered and partly removed these rocks the deposition of Cretaceous conglomerates occurred, covering much of this district with a layer of which only fragments now remain. According to paleontologists of the U. S. Geological Survey fossils collected by the writer from this conglomerate include specimens of *Trigonia leana* Gabb, *Modiola siskiyouensis* Gabb and *Dentalium,* which show that the rock belongs to the basal beds of the Chico formation of the Cretaceous. A thin nearly horizontal layer of this conglomerate is still left at points along Jackson creek; it is reported on top of the ridge west of Jacksonville. The whole of Bear creek valley was apparently a region of deposition (with one interruption) from the time of the Chico at least to the close of the Eocene. The formation of the basal conglomerate was followed by the gradual deposition of at least 500 feet of feldspathic sandstones containing some conglomerates, and also some beds of coal. These rocks occupy the whole of Bear creek valley and form the lower cliffs on the northeast side. Fossil plants collected by the writer at the Cascade and Sunnyside coal mines and also from a shaly sandstone about half a mile easterly and 500 feet higher than Beeson's coal mine include, according to F. H. Knowlton of the U. S. Geological Survey, samples of laurel, poplar, fig-tree, linden, brake, and fern (*Laurus similis?* Kn, *Populus Zaddachi?* Heer, *Ficus* sp. cf. *sordida* Lesq., *Grewia* sp. cf. G. *celastroides* Ward, *Pteris* sp.? and *Anemia* sp.?) which "appear to indicate reference to the Eocene."

After the deposition of these sedimentary rocks they were covered by great lava flows from volcanoes in the Cascade range. The lavas consist of auganite, andesite, basalt, and rhyolite; they covered the whole of Bear creek valley to a depth of hundreds if not thousands of feet, but they probably did not extend far beyond the divide south of Jacksonville. Erosion has now removed them from the valley except for the remnants forming the tops of Upper and Lower Table Rocks. The same cycle of erosion has also removed much of the sedimentary rocks which were covered by the lavas, thus forming Bear creek valley.

The latest rock formations in the district are the shallow stream gravels which may shift repeatedly as the years pass, but under favorable conditions may be more permanent and of greater thickness and importance.

This district has an abundance of granite and sandstone for building purposes, and andesites and granites for road materials, all of which have been developed to some extent within the past few years. (For more detailed description see Mineral Resources of Oregon, Vol. I, No. 2.)

UPPER APPLEGATE DISTRICT

In this report the Upper Applegate district includes all that part of Jackson county which is drained by the Applegate river. On the north and east it extends to the divide between Rogue and Applegate rivers, on the south it is limited by the California state line, and on the west by the Josephine county line. As thus limited the district is a large one, being some 25 miles north and south on the west side and the same distance east and west on the south side, and includes such old district names as Steamboat, Sterling creek, Thompson creek, Ferris gulch, Humbug creek, Sterling peak, Squaw creek and Buncom. The district has no railways, but stages run from Grants Pass by way of Murphy and Provolt to Applegate and Steamboat, and also from Jacksonville by way of Ruch up the Applegate river to Watkins and Hutton. The region is very mountainous, varying in elevation from about 1200 feet where Applegate river enters Josephine county to 3000 to 5000 feet everywhere except along the water courses and to 7377 feet at the summit of Sterling peak, about 20 miles south of Medford. The largest valley lands are near Ruch and Applegate, where some very rich farming land is under cultivation. Elsewhere the region is used as a stock range, or for timber or mining.

The annual rainfall of the district is about 40 inches. There is considerable snowfall in more elevated parts, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The usual daytime temperature in summer is between 75 and 90 degrees, while in the winter it varies from above freezing to 10 degrees above zero.

The Upper Applegate district was organized by placer miners in 1853, but at that time it included only the region within a few miles of the mouth of Forest creek. The Sterling district was organized the following year; it included the region of the creek of the same name. Soon afterward the Buncom district was established to serve the placer miners along the lower part of Little Applegate river. Before 1865 the rich gold ore at Steamboat was discovered and removed. As early as 1870 much of the placer ground had passed into the possession of Chinese, who were content with small returns and continued for at least ten years reworking the gravels left after the first work of the white men. In 1882 Beck and Epperson were using hydraulic methods near Steamboat and finding coarse gold. The same year Berryman and Hansen ran drifts in consolidated gravels near Applegate. J. T. Layton was operating a placer mine on Ferris gulch as early as 1884; in 1886 he had a ditch 23 miles long with a giant operated under a head of 300 feet. The Sterling placer mine had a ditch of the same length with a head of 250 feet and 2 giants operating all the year. During the next five years the Layton and Sterling placers were the most important mines in the district. In 1891 the Sturgis placer on Forest creek became the leading producer, but in 1895 the Layton was again the leader, and in 1901 the Pearse placer on a branch of Forest creek near Jacksonville was very active. In 1903 the Sterling mine was again the most successful while the Sturgis and Pearse were active.

Numerous placer mines in this district continue to be important contributors to the placer production in southern Oregon. Interest in quartz mining is increasing but has not yet reached a stage of steady production.

The oldest rocks in the Upper Applegate district are probably the hornblende and mica schists in the ridge north of Elliott creek and on Dutchman's (Sterling) peak and Red mountain. They are intruded by andesitic and serpentinized dikes and also modified by intrusions of tonalite. These schists may be correlated with the Salmon and Abrams formations of Hershey, who has considered the mica schist to be the older, and has tentatively placed both groups in the Precambrian. The mica schist is well shown on the road from Hutton to the Blue Ledge mine, where a graphitic layer with minor folds is exposed at an elevation of about 3800 feet. The hornblende schist, or Salmon group, is well displayed on Red mountain where it is intruded by basic dikes and considerably recrystallized, in places developing a bladed actinolite rock. About a mile and a half north of Red mountain on 7-mile ridge an amphibole schist contains bands of fine grained quartz and some epidote. On the eastern peak of Red mountain some of the serpentine seems to be an alteration product from amphibolite.

Both the Salmon and Abrams formations apparently conform in strike and dip with the Paleozoic rocks. A study of the relation of the bedding and cleavage in a banded slate at the Blue Ledge mine seems to indicate that the series is overturned.

The Upper Applegate district is occupied in large part by old Paleozoic sedimentary rocks with interbedded sills or flows of andesitic character. In places these bedded rocks are penetrated by dikes of dark igneous rocks and also by larger irregular masses of tonalite. The sediments in general strike about N. 20° E. and dip at a high angle to the eastward. As elsewhere shown for this entire region they have perhaps been overturned so that the oldest beds now lie above the younger. On this basis the oldest Paleozoic rocks are the argillites and sandstones containing limestone lenses near Watkins and on Little Applegate river and its tributaries. They have been intruded by andesitic and serpentinized dikes, and are in places highly altered. They are also modified by intrusions of tonalite. Serpentine, derived in part from dunite, is abundant on Red mountain, which obtained its name from the color of the thoroughly oxidized soils derived from it and similar highly ferruginous rocks. The serpentine is cut by seams, some of which are occupied by chlorite and others by talc. It is also marked in some places by long conspicuous needles of actinolite. On the eastern peak some of the serpentine is derived from the alteration of amphibolite.

The Siskiyou tonalite batholith extends southward to Siskiyou gap between mount Ashland and Red mountain. Smaller tonalite intrusive masses outcrop near the batholith, as on Dutchman's peak, and less than 2 miles to the southwest on Elliott creek ridge north of Silver fork. Tonalite was also observed in masses of various sizes at other places in the district; the largest mass noted was on both sides of Applegate river at Watkins and for about a mile to the southwest; the same mass may be continuous with an outcrop in Sec. 32, T. 40 S., R. 3 W. between Squaw creek and French gulch. Other masses were observed in Secs. 26 and 35, T. 40 S., R. 4 W. West of Grouse creek, in Sec. 34, T. 40 S., R. 3 W. along Lyman creek, and in Secs. 29 and 31,

T. 40 S., R. 2 W. north of Squaw creek, as well as in Secs. 7, 8 and 18, T. 40 S., R. 2 W. north of Beaver creek and in Secs 18 and 19, T. 40 S., R. 2 W. west of Glade creek. Finally, outcrops of tonalite were observed in Secs. 10, 15 and 27, T. 38 S., R. 4 W. north and south of Applegate, and a mass noted in Sec. 24, T. 38 S., R. 5 W. probably extends eastward at least to the slopes of Ferris gulch. The wide distribution of the tonalite makes it reasonable to believe that the Siskiyou batholith underlies a large part or all of the district, a deduction of much importance in considering the probable source of the ore deposits.

Deposits of Mesozoic and Tertiary age are unknown in the Upper Applegate district although Cretaceous conglomerates are reported on the border of the region on the ridge west of Jacksonville, and it may well be that such rocks once covered a much larger area.

Pleistocene and Recent stream gravels and silts are not abundant in the district because most of the gradients are too steep and the valleys too narrow to permit their accumulation, but such deposits are found along the Applegate river and some of its tributaries, and in some places they have proved of value as a source of placer gold.

There are numerous good deposits of granite and sandstone for building purposes in this district, but these are not developed on account of being so far from transportation. The greenstones and argillite found in large quantities in different parts of the district have been used as road material with good results. An abundance of limestone of good quality is found on Steamboat creek and Elliott creek in the southern part of the district, and also on the Little Applegate river in the eastern part of the district. (For a more detailed description of these deposits see Mineral Resources of Oregon, Vol. I, Nos. 5 and 7.)

A deposit of antimony ore is known near Watkins and another reported on Forest creek. A small shipment was made from the former during the past summer, but owing to transportation difficulties, has not as yet proven a success.

JEFFERSON COUNTY

ASHWOOD (Trout Creek) DISTRICT

Trout creek is a branch of the Deschutes river, whose source is on the opposite side of the range from that of Ochoco creek, mentioned in the description of the Ochoco or Howard mining district. This district is in the immediate vicinity of Ashwood, about 25 miles directly south of Shaniko, a terminus of one of the branches of the O.-W. R. & N. Co.

The nearest timber is about 15 miles south on the headwaters of Trout creek. In the vicinity of Ashwood the country is covered with sagebrush and the hills are rolling with frequent deeply incised canyons.

The ore deposits are in mineralized shear-zones in andesite and vary from narrow to widths as great as 20 feet. The ores are gold and silver, contained in pyrite, galena, chalcopyrite and sphalerite.

JOSEPHINE COUNTY

GALICE DISTRICT

As the name is used in this report, the Galice district includes the whole northwest corner of Josephine county; that is, it is the area (within the county) drained by Rogue river that lies north and west of the mouth of Jump-Off Joe creek and also west of the Southern Pacific railroad, and bounded on the southwest by the divide between the Rogue river and the Illinois river.

The Galice district, as thus defined, includes areas which have been known under various names in the past, especially Galice, Mt. Reuben, Merlin, Glendale and Rogue river. Except for a few placer deposits, the mines of the district are confined to T. 33, 34 and 35 in R. 8 W. of the Willamette meridian. The region is mountainous, and yet the topographic features are dominated by a high-level peneplain deeply dissected by the canon of Rogue river and less deeply cut by the numerous tributaries of that stream. The old peneplain is too much dissected to be recognized by any large level surfaces, but it is inferred from the accordance of summit levels on both sides of Rogue river and the uniformity of sky-line in other parts of the district. Elevations in the area vary from about 600 feet along Rogue river to the level of the peneplain (somewhat above 3000 feet) and to higher altitudes on more or less isolated peaks of 4000 feet or more.

It is a well forested region, being a part of the Siskiyou National Forest. The district is served by a good wagon road from Merlin, 15 miles from Galice postoffice and 18 miles from the Almeda mine. Some other short wagon roads are found in different parts of the district as branches of this main trunk line and good trails furnish communication with all parts of the region.

The annual rainfall is about 40 inches. There is considerable snowfall in the higher parts, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer is between 75 and 90 degrees, while in the winter it varies from above freezing to 10 degrees above zero.

Placer mining on Galice creek began about 1854 and has continued more or less steadily ever since, although with irregularly diminishing activity. During the '50s the work was directed especially to the most accessible and richest deposits. On account of the partial exhaustion of such gravel beds, there was some decrease in activity during the '60s. In the next decade some of the slightly less accessible deposits were opened by means of ditches and flumes, some of them of considerable length. By 1880 the small placers were chiefly in the hands of Chinese, who reworked and extended old workings with some profit. In 1883 Galice creek district made an output estimated at $8000. In 1886 quartz mines increased in activity in this area. In the '90s the quartz mines of the Mt. Reuben district became prominent, and in 1897 the principal quartz mining in southern Oregon was in this district. In 1898 the Gold Bug mine had a 5-stamp mill which was yielding good returns, while the Golden Wedge mine put its ore through an arrastre. These mines continued active during the next five years. In 1905 the Almeda mine was already in course of development and in 1908 a 100-ton matting furnace was built at the mine. In 1907 the Oriole was the scene of some activity, which has continued with minor interruptions to the present time. In 1908, 3000 feet of underground development work was done at the Almeda and three quartz mines in the district produced $23,580 worth of metals. In 1910 the producing mines included the Oriole, Gold Road, Nesbit and Sugar Pine, the last one using a 10-stamp mill. In 1912 the Almeda smelter was operated for thirty days, and the following year it was in operation about the same length of time.

During 1915 and 1916 the Almeda mine has been operated in a small way most of the time.

The geology of the Galice district is relatively simple. Aside from small deposits of stream gravels the rocks of the area are either Jurassic sediments or igneous intrusives (possibly with some extrusives). The general strike of the sediments and also of the contact between the sediments and the igneous rocks is about N. 20° E.; the sediments dip steeply to the eastward, but are overturned according to Diller, so that the strata to the west are younger than those near Galice. He has designated the Jurassic sediments at Galice by the name of that town, while those west of Whiskey creek he calls the Dothan formation.

The oldest rocks of the district therefore belong to the Galice formation a conclusion which is supported by a report of a study by paleontologists of the U. S. Geological Survey of fossils collected at the Almeda mine by the writer. Director Smith of the Survey writes that these fossils all belong to the species *Aucella erringtoni* (Gabb), "which indicates Jurassic age and probably the Galice formation." The Galice formation consists of argillites slates and thin bedded argillaceous sandstones. In the region where the county road crosses Rogue river (in T. 35 N., R. 7 W.), and elsewhere it is intruded by greenstones of various kinds. Igneous rocks between the Almeda mine and Tyee bar also separate the Galice formation from the Dothan formation which occupies the whole northwest third of the Galice district, according to Diller. The Galice and Dothan formations are strikingly similar, if not identical, lithologically, and the reasons for separating them from one another are not apparent.

Near the footbridge across Rogue river between Grave and Whiskey creeks the cliff along which the river trail runs is composed of very light colored quartzose rocks with distinct and numerous parting planes resembling bedding. Here the cleavages strike N. 35° E. and dip about 60° S. E. About a mile up stream (south) a similar siliceous fine grained banded rock strikes N. 10° E. and dips very steeply eastward. With these exceptions Rogue river cuts through serpentine and various andesites and porphyries (more or less altered and locally called greenstone) between the Almeda and the Kramer or Elwilda mines. This mass of "greenstones" has been penetrated by intrusions of basic igneous rocks, now altered to serpentine, and also by dikes and more irregular masses of more siliceous igneous rocks. All of these rocks have been sheared and altered as a result of later earth movements, some of which were part of great mountain building processes. This shearing produced many fissures later filled by vein materials, which include ores in many places.

After this complex of Jurassic sediments and igneous intrusives took approximately its present position erosion and sedimentation began to modify its surface. Before the present gorges were cut out streams flowed over the surface in positions differing somewhat from their present courses. Here and there these streams deposited gravels which have not since been removed by erosion and form the "high level" placer deposits. Later the eroding power of the streams seems to have been increased, perhaps by uplift of the region, and they cut their present gorges and deposited gravels here and there along them, not only at their present levels, but also at higher levels within their existing narrow valleys. All of these gravels have been more or less useful as placer deposits.

GRANTS PASS DISTRICT

As the name is used in this report the Grants Pass district embraces the area in Josephine county south and east of the mouth of Jump-off Joe creek which is drained by the Rogue river, exclusive of the Applegate river. It is limited to the northwest by the Greenback and Galice districts, to the east by the county line and the Gold Hill districts, to the south by the Lower Applegate district. It includes districts which have been known by the following names: Jump-off Joe creek, Winona, Merlin, Louse creek, Rogue river, Dry Diggings, Pickett creek and Grants Pass. The district is about 18 miles long east and west and averages 12 miles wide north and south. The city of Grants Pass gives its name to the district, being not only its commercial headquarters and railroad shipping point, but also the county seat and chief mining center of southern Oregon. The district is mountainous, ranging in elevation from about 800 feet above sea level at the mouth of Jump-off Joe creek to peaks reaching altitudes above 3000 and even 4000 feet. The highest point in the district is the top of Elk mountain about 1½ miles southeast of the Oro Fino mine and 7 miles northeast of Grants Pass. But the area between the county seat and the mouth of Applegate river on the south and the station named Hugo on the north, which forms a triangle cutting the Grants Pass district in two parts as a wedge, driven northward, would do, is distinctly gentler in relief, presenting the aspect of a hilly region with wide and gently sloping valleys.

There is a large amount of rich farming land in the district and the higher elevations are well forested. The annual rainfall of the district is about 25 inches. It is common to have 3 or 4 feet of snow in the higher elevations, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. In summer the day time temperature is about 75 to 90 degrees. In winter it rarely gets below 10 degrees above zero.

Mining began in southern Oregon in 1852, but during the first years the industry was apparently wholly outside of the Grants Pass district. Mining began on Josephine creek, west of Kerby, and spread to the Waldo and Lower Applegate districts, and even to the Galice district, before there is any record of work closer to Grants Pass. Finally the placer miners spread to Pickett and Jump-off Joe creeks. But the mining industry did not become important in the Grants Pass district until the placer gravels were largely exhausted and attention was directed to the quartz vein deposits. An 8-stamp mill was built at the Jewett mine in 1863; failure to make a success here seems to have delayed mining development in the region at least a decade. The Lucky Queen mine north of Walker mountain was equipped with a 10-stamp mill in 1886; the Fidelity mine made a small output in 1889; the Hammersley or Daisy mine on Bummer gulch was discovered in 1890, and the Baby mine on Walker mountain seven years later. The W. H. Flanagan mine on Pickett creek produced $18,500 in gold in 1891. In 1898 the Jewett mine was an important producer, using its own mill, while the Baby mine sent its ores to a smelter. The Granite Hill mine was purchased by the American Goldfields Company in 1901, and three years later the Hammersley and Granite Hill were important producers. In 1902 extensive plans were made to construct a big dam across Rogue river about 3 miles above Grants Pass, in order to develop on a large scale the Golden Drift or Dry Diggings placer mine. In 1906 the latter was developed to a depth of 400 feet and equipped with a 20-stamp mill. In 1908 the Mountain Treasure put in a 2800-foot pipe line to develop water power for mining and milling purposes. In 1909 the Swastika hydraulic placer mine near Winona produced about $10,000 in gold. In 1911 three placer mines were productive in the Jump-off Joe district, namely the Swastika, the Sexton, and the Cook and Howland. Most of the output of the Grants Pass district during recent years came from placer and deep mines along Jump-off Joe creek.

The oldest rocks of the Grants Pass district are in the eastern part, where the Paleozoic sediments of the Gold Hill district extend across the county line westward into Josephine county. In this region they consist of argillites and some argillaceous sandstones. The Galice formation (of the Jurassic period) is the name given by Diller to the argillites and thin-bedded sandstones occupying the eastern part of range 7 west, north and south of the mouth of Jump-off Joe creek. A rudely triangular area forming about the middle third of the Grants Pass district from the county seat and the mouth of Applegate river on the south to the station named Hugo on the north is occupied by a large outcrop of tonalite. An outlier of this tonalite is one of the country rocks of the Granite Hill mine; here it grades over toward granodiorite. On Walker mountain at the Gopher and Baby mines a gabbro is found which may be another phase of the tonalite. The rock at this place is in large masses distinctly schistose; in thin section it is clear that the tonalite has been sheared, even the feldspar showing curvature in its cleavages and twinning. It contains abundant plagioclase and quartz, some green amphibole and brown biotite, with a little magnetite and titanite. Alteration products are not important;

they include some sericite, epidote and kaolin. The gabbro on Walker mountain contains abundant labradorite and augite, with some chlorite, clinozoisite, sericite, and serpentine.

Less than half a mile down Bummer gulch from the Daisy or Hammersley mine the country rock is a micaceous arkose consisting of fine granular poorly rounded quartz, with some grains of plagioclase and orthoclase cemented by reddish brown biotite, or, elsewhere, by nearly colorless mica, probably muscovite. These quartzose sediments are associated here with volcanic rhyolitic breccias, containing fragments of quartzite, rhyolite, plagioclase, quartz, sericite, magnetite and volcanic dust.

At the Eagle mine on Walker mountain the country rock is argillitic, containing very fine grained quartz, pale brown mica, magnetite, and an opaque groundmass suggesting carbonaceous material.

The sedimentary rocks of the eastern part of the Grants Pass district are intimately associated with andesites at many places. These andesitic rocks seem to be interbedded with the argillites and sandstones, and probably occur both as sills and as flows. Both the argillites and the andesites are so much altered that it is difficult to distinguish them in the field. At the Mt. Pitt mine there is also some serpentine. In a few places the sediments are also associated with some rhyolite, often rhyolite breccia, whose intrusive or extrusive character has not been fully determined, though the available evidence favors the latter mode of formation.

The sedimentary rocks are not known to contain any limestone in the Grants Pass district.

The only rocks in the district younger than the Galice and Dothan formations of the Jurassic are the gravels of the various streams. These are of recent origin and belong to the present cycle of erosion. They are of some importance as sources of placer gold along Jump-off Joe and Louse creeks; the more extensive gravels of Rogue river near Grants Pass have also yielded gold, but not in proportion to their extent.

This district has some excellent deposits of granite and trap rocks of various kinds for building stone and road materials. (For further description see Mineral Resources of Oregon, Vol. 1, No. 5.)

GREENBACK DISTRICT

The Greenback district occupies the northeast corner of Josephine county and includes the area east of the Southern Pacific railroad, which is drained by Grave, Coyote and Wolf creeks. Parts of this district have in the past been known by the following names: Wolf creek, Grave creek, Coyote creek and Leland districts. Leland is the most accessible railroad station for points on Grave creek and Wolf creek station serves the rest of the district. The little town of Placer, 8 miles east of Leland station, on Grave creek, is in about the center of the district. The Hammersley mine is just outside of the district, being south of the divide between Grave and Jump-off Joe creeks. The whole region is very mountainous, varying in elevation from 1000 feet at the confluence of Wolf and Grave creeks to altitudes commonly reaching 3000 feet and attaining 4000 in a few places, such as a peak about a mile west of the Hammersley mine and another about a mile northeast of the Greenback mine. But the highest point in the district is on the eastern border at Onion Springs mountain, whose summit reaches an altitude of 5274 feet above sea level. The mountains are well covered with timber; the only arable land of consequence is along Grave creek.

The annual rainfall of the district is about 35 inches. There is considerable snowfall in the higher portions, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer time is between 75 and 90 degrees, while in the winter it varies from somewhat above freezing to 10 degrees above zero.

So far as the published records show, Grave creek was not one of the regions early worked by the placer miners and the date of the discovery of gold in the region is unknown. But the auriferous gravel deposits of Grave and Wolf creeks were probably discovered as early as 1860 and it is known that the Grave creek placers alone produced $20,000 in gold in 1883. During the rest of that decade there was a variable but continuous output from Grave and Wolf creeks. In 1895 there were small mines near Leland and Grave and others somewhat more important on Coyote and Wolf creeks, including one placer and two gold-bearing quartz vein mines. As early as 1898 the Greenback mine was a producer of some importance, although at that time its ores were treated in an arrastre. In 1900 the Greenback was owned by the Victor Junior Gold Mining Company and its development was more rapid. In 1902 and 1903 a 40-stamp mill was built at the Greenback, as well as a 100-ton cyanide plant. In 1904 it was excelled in production by only one mine in Oregon. About the same time the Martha mine was productive. The Lewis placer near Leland and the Columbia placer on Grave creek were operated in 1905, while the Greenback continued its large production. The latter was closed in August, 1906, and was idle for the next three years. In 1910 it was again a large producer, but soon after it closed and has not since then reopened. In 1912 the production came almost entirely from 10 placers on Grave creek and 4 placers on Wolf creek.

In 1916 activity was again resumed in the Greenback mine under new management, while the Dorothea and Jim Blain are also on the list of producers. The quartz mines of this section have their principal values in gold.

The Greenback district is occupied largely by rocks, which are either shales (or argillites) or igneous masses. The argillites are probably of Jurassic age, according to Diller, and are assigned to the Galice formation. The various types of igneous rocks range in age from Paleozoic to Cretaceous, according to Kay. The andesites are probably Paleozoic, or Jurassic, while serpentine intrudes Jurassic sediments and certain coarse grained plutonic rocks are referred to the Lower Cretaceous.

A sample of greenstone from the face of the crosscut into the hanging wall on the 9th level of the Greenback mine contains rounded crystals of quartz and phenocrysts of plagioclase, partly altered to sericite and epidote in a fine matrix of granular feldspar, quartz, sericite (or talc), fine needles of hornblende and titanite. It shows very distinct banding or flow structure and contains some later vein quartz and calcite.

A sample of greenstone from the face of a crosscut into the footwall from the 9th level of the Greenback mine contains abundant lath-shaped plagioclase, a little orthoclase, and some hornblende altering to chlorite, as well as much epidote and veinlets of calcite, siderite, epidote and pyrite.

A sample of greenstone from the breast of the long crosscut into the footwall from the 5th level of the Greenback mine contains abundant augite altering to green hornblende and chlorite, abundant labradorite, and some calcite and leucoxene. It is a coarse grained auganite.

A sample of rock largely altered to serpentine taken from a point near the breast of the main drift on the 9th level of the Greenback mine is too much altered to permit identification of the primary minerals; it contains abundant secondary calcite, some nearly colorless serpentine, some feldspar (which may be secondary adularia, as it shows only simple twinning), some isotropic chloritic material, and some kaolin.

In general the greenstone at the Greenback mine is of an andesitic type with variations to auganite and to dacite. A later intrusion of serpentine was originally a more basic rock than andesite. Another intrusion forming a dike on top of the Greenback ridge in the N. W. ¼ Sec. 4, T. 34 N., R. 5 W., is an aplite or micrographic granite consisting chiefly of a graphic intergrowth of quartz and orthoclase with some plagioclase and quartz, and also a little zoisite, chlorite, epidote, titanite and magnetite.

ILLINOIS RIVER DISTRICT

The Illinois River district, as used in this report, includes the area in Josephine county north and west of Kerby, which is drained by the Illinois river and its tributaries. As thus defined, it is bounded on the west and northwest by Curry county; on the east and northeast by the Galice, Grants Pass and Lower Applegate districts, and on the south by the Waldo district.

The district has a mild climate, characteristic of the Rogue river valley, the usual daytime temperature in the summer being from 60 to 80 degrees, while in the winter it rarely gets colder than 10 degrees above zero. The rainfall is approximately 40 inches annually. In the lower altitudes snow rarely stays long on the ground, while in the highest altitudes 3 or 4 feet may remain for several weeks. The altitude varies from 1000 feet at the river to above 5000 feet in numerous peaks of the district.

Lack of transportation is a serious problem. The California and Oregon Coast railway will soon pass through Selma and Kerby, on the south boundary of the district. Wagon roads have thus far penetrated only a few miles from these towns, and all transportation is therefore confined to trails.

The area is quite densely forested and is included in the Siskiyou National forest. Excellent forest maps showing trails and general drainage can be had by applying to the Forest Supervisor at Grants Pass or the United States Forest Service, Portland, Oregon. A considerable portion of this district is covered by the Kerby topographic sheet, published by the United States Geological Survey, a copy of which may be had by application to the Superintendent of Public Documents, Washington, D. C.

The rocks of the district are fine grained sedimentaries, serpentine and greenstone. The sediments are found in the northwestern portion of the district and are composed of argillite, slates and clay-sandstones, called Dothan formation by Diller. These sediments have a general northeast strike and usually dip steeply to the southeast. The central part of the district is largely serpentine formed from the alteration of basic igneous rocks, also altered andesite and other porphyries locally called greenstone. The contacts between the greenstone, serpentine and sedimentaries have also a general strike northeast. All of these rocks have been sheared and altered as a result of later earth movements, some of which were a part of great mountain building processes. This movement produced many fissures, which were later filled by vein materials that include ores in many places. After this complex of sediments and igneous intrusives and extrusives took approximately its present position, erosion and sedimentation have materially modified its surface. Before the present gorges were cut out, streams flowed over the surface in positions differing somewhat from their present courses. Here and there streams deposited gravels which have not since been entirely removed by erosion, and form high-level placer deposits. These high-level gravels, as well as the present stream gravels, are fruitful of many placer deposits of the district.

LOWER APPLEGATE DISTRICT

In this report the Lower Applegate district includes all the territory in Josephine county which is drained by the Applegate river and its northward and southward flowing tributaries. It is limited on the north by the Grants Pass district of the Rogue river valley, on the east by the county line and the Upper Applegate district, on the south by the Waldo district, and on the west by the divide between the Rogue and Illinois rivers. It includes areas which have been called districts of the following names: Applegate, Davidson or Missouri Flat, Murphy, Oscar creek, Powell creek, Slate creek, Williamsburg or Williams creek. The district is of irregular shape, but has a maxium length of about 20 miles east and west, and only slightly less north and south. In the region of Cheney creek and westward it is only 6 miles across, north and south. The district is very mountainous, but contains the northward sloping valley of Williams creek and the northwestward flowing Applegate river. The highest point in the district north of the river is at the top of Grants Pass peak, which is 3835 feet above sea level, but Mungers butte, south of the river, rises to more than 5200 feet, and several other peaks exceed 4500 feet in altitude. Williams creek valley varies from 1150 to 1650 feet in altitude, while the Applegate valley is between 900 and 1200 feet above sea level.

The annual rainfall of the district is about 35 inches. There is considerable snowfall in the higher elevations, while in the lower altitudes the snow rarely stays on the ground more than a few weeks. The ordinary daytime temperature in summer is between 75 and 90 degrees, while in the winter it varies from somewhat above freezing to 10 degrees above zero.

The district is served by the California and Oregon Coast railroad, which is projected from Grants Pass to Crescent City, California. The line has been completed and is in operation as far as Waters Creek station, 15 miles from Grants Pass. The district is also served by a good wagon road from Grants Pass through Waters Creek station to the Waldo district; also by good wagon road from Grants Pass to Murphy and up the Applegate and Williams creek. The section is well forested and is included in the Siskiyou National forest.

Mining began in the Lower Applegate district very soon after the discovery of gold on Josephine creek in 1852. The first mining in the district was probably in the gravels of Williams creek. But veins were discovered in Slate creek valley about 1860, and their exploration continued during that decade. However, the chief mining in the district continued to be confined to the placers all through the '70s. The Horsehead placer mine was the next important one on Williams creek in 1882; the following year it produced $3000 in gold. The Watts placer near Murphy was also productive at about this time, while the Josephine mine on Slate creek was sold for $3740 in 1882. The Mountain Lion mine near Davidson was discovered in 1889, and its development, with some output, continued during the next decade. Powell creek placers and the Rising Star quartz mine were productive in 1900. The next year the Savage and Mellen placer on Missouri Flat near Davidson was active and the Sunshine and Combination mines in the same region were developed soon afterward. In 1910 the Mountain Lion mine had 2000 feet of underground work and was equipped with a 5-stamp mill having electrolytic chlorination and amalgamation. Placer mining has continued on Williams creek, Oscar creek and elsewhere up to the present, but there is now very little activity in the deep mines of the district.

The rocks of the Lower Applegate district include argillites, sandstones, quartzites, limestones, marbles, greenstones, serpentine and tonalite, as well as alluvial deposits. The oldest rocks are Paleozoic sediments, including argillites, sandstones, limestones and some interbedded greenstones. The next younger series consists of argillites and sandstones of Jurassic age. The great tonalite intrusion probably came at the close of the Jurassic period; the only later rocks are the recent alluvial deposits.

Structurally, the Paleozoic and Jurassic sedimentary rocks have been tilted till they dip at high angles, and the Jurassic beds have even been overturned, according to Diller, so that while they dip eastward the overlying beds to the east are actually the oldest of the series. It seems probable to the writer that the Paleozoic rocks are also overturned so that the rocks at the eastern border of the district are the oldest rocks in the area. They consist of argillites, sandstones and interbedded andesitic greenstones, which may be provisionally assigned to the Silurian period. The next younger rocks are found at present underlying these to the westward; they include argillites, sandstones and lenses of limestone. These lenses contain some fossils by means of which the enclosing rocks on Powell and Oscar creeks have been referred to the Devonian by Diller. A similar series of rocks on Cheney creek, still farther west, has been referred provisionally to the same period (Devonian) by Diller, but it seems possible that it represents the Carboniferous, as fossils from this locality collected by the writer in 1913 are reported by the paleontologists of the U. S. Geological Survey to be "poorly preserved crinoid stems which indicate Paleozoic and probably Carboniferous age." In this region shales and argillites are abundant, and there are some greenstones.

The youngest consolidated sedimentary rocks are the argillites and sandstones in the Galice formation of the Jurassic period, which are found on Slate creek in the extreme western part of the Lower Applegate district. They are intimately associated with greenstones, which upon careful study are found to be andesite and diorite; some serpentine, derived from peridotite, is found in the same area.

If any rocks of the Cretaceous or Tertiary periods were deposited in this region they have been removed by later erosion so completely that no trace of them is now known. The latest rocks of the district are the unconsolidated gravels deposited by existing streams along their courses. These have been the scene of placer mining since the first days of gold mining in the state.

This district has abundant deposits of granite and marble; also some of the best and most extensive deposits of limestone in southern Oregon will be found in this section, in the neighborhood of Cheney creek and Williams creek. (For further details of these resources see Vol. 1, Nos. 5 and 7, Mineral Resources of Oregon.) Some good prospects of chromic iron ores are known in the serpentine areas of Slate creek.

WALDO DISTRICT

The Waldo district is in the southwest corner of Josephine county including all the area south of Kerby drained by the Illinois river and its tributaries. As thus defined, the district is bounded on the east by the Lower Applegate district; on the north by the Illinois river district; on the west by Curry county, and on the south by the California line. It includes districts described heretofore under the following names: Sucker creek, Browntown, Althouse creek, Holland, Sailor Diggings, Takilma, Bollon creek, and Indian creek. The Waldo district is about 25 miles long east and west and about 15 miles wide north and south. It is a region of rugged mountains except on the western border where the Illinois river valley is relatively remarkably flat. The valley varies in elevation from 1400 to 1700 feet while the mountains reach elevations ranging from 4000 feet to considerably more than 6000 feet. In the eastern two-thirds of the district among the mountains the valleys are narrow and deep, though not like canyons.

The climate of the district is quite equable, the daytime temperature in the summer usually ranging from 60 to 80 degrees, and in the winter from above freezing to 10 degrees above zero.

The area is forested, especially in the higher elevations, being in the Siskiyou National Forest. The valleys contain a considerable area of excellent agricultural land. The principal towns are Kerby, Waldo, Takilma and Holland, which are reached by a good auto and wagon road from Grants Pass, 35 to 45 miles distant. The California and Oregon Coast railway, which is planned to connect Grants Pass with the harbor at Crescent City, will pass through the heart of this district. Fifteen miles of this road has already been completed from Grants Pass, the present terminus being Waters Creek station. The company plans to have this road completed as far as Waldo within the next year. This railroad will not only furnish transportation for the Waldo district, but will afford a natural outlet for the mining transportation in other sections south and west from Waldo in California, where it is known that there are copper resources.

Mining began in the Waldo district in the spring of 1853 when a placer miners' "stampede" to Althouse creek occurred. At about the same time sailors are said to have abandoned a ship on the coast and traveled overland to the "Sailor Diggings" near Waldo where a ditch costing $75,000 is reported to have paid for itself in one year. The gravels on Sucker creek were extensively mined from 1854 to 1860, though the results were not very satisfactory. In the latter year the Waldo copper mine was discovered by Mr. Hawes, and quartz veins on Althouse creek were opened soon afterward. The early work at the Waldo mine gave poor returns on account of the extremely high cost of transportation and materials. Work in the gravel of Scott's gulch near Waldo began in 1861 and continued for about 35 years. The Waldo Hydraulic Mining Company began work in 1877, and the ground is not yet exhausted. Simmons brothers opened the Deep Gravel mine more than 40 years ago; in 1878 Wimer and Sons bought a half interest, and in 1888 they secured the remaining half of the property. The Deep Gravel Mining Company became the owner in 1900, and later sold to the Waldo Consolidated Gold Mining Company. The chief mining activity in the district has been in the placers ever since mining began, these gravel deposits are still productive and give promise of continuing to yield for many years. In recent years the development of lode mining has progressed steadily. During the past year there has been a marked development in copper mining in this district, the important producers being the Queen of Bronze and Waldo mines. Chrome iron ore properties also have been important producers during the past year.

The Waldo district is occupied chiefly by old sedimentary rocks including argillites, quartzites, and limestones, and by dark colored subsiliceous igneous rocks, including andesite, serpentine, auganite, pyroxenite, etc. Smaller areas of other rocks are known, such as Cretaceous gravels and sands.

The oldest rocks known in the district are the Paleozoic argillites and limestones which occupy much of the mountainous portion, not only that drained westward to the Illinois river, but also that drained eastward to the Applegate river. In general, these rocks strike east of north and dip steeply eastward. They are interbedded with andesitic greenstones in many places. It has been suggested elsewhere in this report that they are overturned so that the oldest beds of the series are on the eastern border lying above the younger beds to the westward. The whole of the Paleozoic series lies above the still younger Galice formation of the Jurassic period near Waldo and Kerby; according to Diller the overlying position of the Paleozoic rocks is due to faulting in this locality. Andesites and basic igneous rocks largely altered to serpentine are associated with the argillites of the Galice formation.

Nowhere in the Waldo district are any intrusions of tonalite known, although some may exist in the mountainous portions which were seen only along a single rapid traverse.

Near Waldo there is still a small area of Cretaceous gravels and conglomerate, which has served as a source of placer gold. It lies unconformably above the Jurassic argillites; the latter are steeply inclined to the east while the Cretaceous gravels are nearly flat. On the basis of fossils these have been referred to the Horsetown formation of the Lower Cretaceous, or Comanchean. It is probable that these gravels were formerly much more widespread in this region than they are at present.

The youngest rocks in the Waldo district are the alluvial gravels still in process of formation by existing streams. In the mountainous portion of the district they are confined to very narrow strips along the water courses, but in the Illinois river valley near Waldo they are somewhat more extensive.

The mineral resources of the Waldo district include copper, gold, silver, chromium, manganese and limestone. The gold and silver deposits occur both as placer and metalliferous quartz veins. Placer deposits have been worked successfully for 60 years and are still far from exhaustion. The development of quartz mining for gold and silver is not extensive in this section, although greater interest is shown in this kind of mining the last few years.

Chromite, the only important ore of chromium, occurs in quite pure masses in numerous sections of this district. It is usually closely associated with serpentine and the deposits found are more or less lens-shaped, varying in size from a few tons to thousands of tons. Several of these deposits in the district have been developed during the past year and approximately 2000 tons shipped to iron smelters in Chicago and Pennsylvania. There are numerous deposits of limestone in this district—one near Takilma on Elder creek, another 3 miles southeast of Kerby, and others in the eastern part of the district in the neighborhood of the Oregon caves. (For a more detailed description see Bulletin Nos. 5 and 7, Vol. I, Mineral Resources of Oregon.)

LAKE COUNTY

NEW PINE CREEK (Highgrade) DISTRICT and COYOTE HILL (Lost Cabin) DISTRICT

Nearly all the surface of Lake county is covered with either basaltic lavas or by lake and stream deposits. The few exceptions are: the locality south of Lakeview, east of New Pine creek station on the N. C. and O. railway, whose terminus is Lakeview, Oregon, the Coyote hills in T. 35 S., R. 23 E., Rabbit hills about 6 miles north of Coyote hills, Juniper mountain and Gray's butte near Alkali lake, Wagontire mountain north of Alkali lake and Horse mountain northwest of Alkali lake.

With the exception of Wagontire and Horse mountains, each one of these localities is much less than a township in extent. These outcrops, the most important of which are mentioned above, are older acidic effusives determined to be almost altogether andesites. The one or two areas which are known to contain gold and silver are those of New Pine creek and Coyote hills. Neither of these places have been visited and no reports by others are available. Such values as have been found are reported to be in oxidized ores in andesitic breccias. New Pine creek, or Highgrade district as it is sometimes called, is nearly all in Modoc county, California. Much prospecting has been done and one or more properties equipped with small plants working upon comparatively narrow veins of ore on which the returns in 1915 are nearly $25 per ton for the few hundred tons treated. The Coyote hills, or what is sometimes known as Lost Cabin gold mining district, was brought to the notice of mining men in August, 1906, by the Loftus brothers. Nothing is known as to the developments in the last few years.

The soda works at Alkali lake have been equipped and are producing. Some development of the nitrate deposits of Wagontire mountain has been accomplished in 1916.

LANE COUNTY

BLUE RIVER DISTRICT

The Blue River district lies on the western slope of the Cascade range about 45 miles east of Eugene, and occupied the area drained by Blue river, a tributary of the McKenzie. The district therefore occupies a portion of the two counties Lane and Linn. The elevation of the district ranges from 1000 feet to nearly 4000 feet.

It has the characteristically mild climate of western Oregon, the annual rainfall being between 40 and 50 inches, most of which falls in the winter time. Snow usually covers the hills in this district for several weeks. The district is well forested being in the Cascade National Forest.

The nearest railroad station is Springfield on the Southern Pacific railroad. A good wagon road connects Springfield with Blue River postoffice on the McKenzie river at the southern border of the district. Trails are the only means of transportation in the district proper.

The rocks of this area are Cascades andesitic lavas and tuffs which make up the larger bulk of the Cascade Range. The ore deposits in the district are in silicified and mineralized fracture zones, more or less vertical in these andesites. The important ore minerals are pyrite, chalcopyrite, sphalerite and galenite. The veins strike north 60° to 80° W. and dip steeply to the southwest, being approximately parallel to those of the Bohemia region farther south. Considerable mining activity has been evidenced here for a number of years. Many properties have been worked. The district as a whole has not yet reached a steadily producing stage.

BOHEMIA DISTRICT

The Bohemia district is situated in the southern part of Lane county and lies on the crest of the Calapooya mountains, which forms the divide between the Willamette and the Umpqua rivers. The region is 30 miles southeast of Cottage Grove on the Southern Pacific railroad and may be reached by a branch railroad running to Disston, 12 miles from Cottage Grove, from which a good wagon road is built to the Champion mine in the heart of the district. There is also a good wagon road up Sharp's creek to Bohemia postoffice from a point a few miles below Disston.

The topography of the district is very rugged, the elevation varying from about 2000 feet in the bottom of the stream canyons to more than 6000 feet on some of the prominent peaks in the district. The hills are heavily forested due to the mild humid climate. The precipitation is about 50 inches annually, a large part of which falls in the winter time as snow that accumulates many feet deep for several weeks in the higher altitudes. The district is in the Umpqua National Forest.

The rocks of the district are Cascades andesitic lavas and tuffs which make up a large part of the Cascade Range. The ore deposits of the district are in silicified and mineralized fracture zones, cutting through these andesite lavas, having a general strike N. 60° to 80° W and dipping steeply to the S. W. The ore bodies vary from 1 to 10 feet in width, the principal ore minerals being pyrite, chalcopyrite, sphalerite and galena. The best developed mines of the district are the Champion, Musick and Bohemia. Mining activity has been in evidence in this district for more than 50 years, the most noted development taking place some 15 or 20 years ago. Considerable production has been reported from the district, which has been estimated at between $300,000 and $400,000, mostly in free gold. Owing to the difficulties in transportation, concentrates cannot be shipped with profit which run less than about $25 a ton.

QUARTZVILLE DISTRICT

The Quartzville district lies on the western slope of the Cascade Range in the northeastern part of Linn county, and occupies the area drained by the Quartzville branch and the headwaters of the middle fork of the Santiam river.

The district is reached from Gates, a station on a branch of the Southern Pacific railroad, some 20 miles to the northwest. A wagon road was constructed from Gates to the district years ago but is not now passable. The district can also be reached up the middle fork of the Santiam from Foster, where there is a fair wagon road for 12 or 15 miles.

The topography of the district is quite rugged, the elevation varying from about 1000 to more than 3000 feet. Owing to the mild and humid climate, the district is densely forested and lies within the Oregon National Forest.

The geology of the district is comparatively simple, the rocks being almost entirely flat-lying Cascades andesitic lavas and tuffs. In common with many of the other districts on the western slope of the Cascade Range, the ore deposits are in silicified and mineralized fracture zones cutting nearly vertically through these andesitic lavas. The minerals near the surface in these veins are largely free gold in iron-stained quartz and country rock. Some very excellent specimens of wire gold have been found in this section. Deeper down these minerals change to sulphides which are usually pyrite, chalcopyrite, sphalerite and galenite. The district has been a small producer for many years, one of the most persistent small producers being a property owned by Bob Monroe, who has been operating for a number of years, recovering gold from the oxidized portion of these veins with a small stamp mill.

LINN COUNTY

BLUE RIVER DISTRICT

See Blue River district, Lane county.

MALHEUR COUNTY

MORMON BASIN DISTRICT

See Mormon Basin district, Baker county.

MARION COUNTY

NORTH SANTIAM DISTRICT

The North Santiam district is situated on the western slope of the Cascade Range in the northern part of Marion county and occupies the area drained by the Little North Fork of the Santiam river. The district is reached by a fair wagon road from Gates, a station on a branch of the Southern Pacific railroad, some 12 miles to the southwest.

The topography is quite rugged, the elevation varying from less than 1000 feet to 3500 feet in the highest points. The climate is mild and humid, the daytime temperatures in summer varying from 60 to 80 degrees, and in the winter rarely going as low as zero. Snowfall is rather heavy and it is common for the snow to remain for several weeks in the winter.

The district is well forested and lies within the Oregon National Forest. Elk Horn postoffice is situated in the southwestern part.

The rocks of the district are almost entirely Cascades andesitic lavas and tuffs, which constitute a large volume of the Cascade Range. The ore deposits are in silicified and mineralized fracture zones cutting through the lavas and tuffs. These fracture zone veins vary from 1 to 6 or 8 feet in width, the principal ores being pyrite, chalcopyrite, sphalerite and galenite. Near the surface these minerals oxidize and the values are usually found as free gold in iron-stained quartz and country rock.

UNION COUNTY

CAMP CARSON DISTRICT

The Camp Carson district, near the headwaters of the Grande Ronde river, is reached by wagon road up that stream from La Grande, a distance of 45 miles, or from North Powder over a high pass, a distance of 28 miles. The elevation of the principal property, the Camp Carson mine, is about 6000 feet. This is a placer mine. In past years several quartz properties have been developed in the upper Grande Ronde, but all of these have been practically abandoned or are idle.

This district, which is a well-timbered one, is north of the Granite and Rock creek districts and is on the northwestern extension of the Elkhorn range. Practically all of this wide area is granite except on much of the lower elevation where gravels or semi-consolidated sediments prevail. The deposit of chief interest, the Camp Carson mine, apparently must have been deposited by a drainage system entirely different from that of today. The gravels which were deposited in horizontal beds have since been tilted to an angle of more than 20 degrees. An interesting feature is that the gravels rest upon the granite which indicates that the granite was also involved in the tilting movement.

Production has been comparatively small and operations have been unsuccessful, apparently because of the cemented or semi-consolidated nature of the deposits, and because only a part of the values contained have been recovered by the standard methods now in use.

WALLOWA COUNTY

WALLOWA DISTRICT

The mineral deposits of chief interest in the Wallowa district, although but a few miles from Cornucopia, are best approached from the north because high passes lie between. The branch line from La Grande runs down the Grande Ronde river a little east of north, most of the way through a productive agricultural valley. When it reaches the junction of the Wallowa river with the Grande Ronde it turns southeast and up the former through narrow defiles to enter soon, delightful Wallowa valley. The road and the river are at the foot of steep mountains on the right, while to the left stretching out in the distance is the valley and the slowly ascending hills.

Near the head of the valley at Joseph our railway journey ends. Located on wash from the terminal moraine at the lower end of Wallowa lake, only a mile away, the town is almost within the shadow of lofty mountains having no intervening foothills.

The district includes all of the drainage of the Wallowa river, south of Wallowa and including Lostine creek. On horseback from Joseph one travels up the east fork of Wallowa river, up the west fork and up Hurricane creek, each a separate journey, because no trails have been dug as yet along the barren ridges which separate these mountain streams. Above Joseph and the lake, out of the first pass to the left, flows the east fork of Wallowa river, and close to the right the west fork issues. Across the town one sees the way up Hurricane creek, while beyond the farthest mountain to the right the Lostine flows.

Wallowa lake is about 5 miles long, a mile wide, and in places is said to be 400 feet deep. It is the product of an immense flow of ice, which, coming down the forks of the Wallowa from the south, spread out as it emerged to be destroyed as it advanced, by the valley's warmer air. Its burden of stone brought down for tens of thousands of years built up the high ridges on the sides of the present lake and dammed it up at its foot. A warmer climate afterwards prevailing, the glacier melted away and Wallowa lake is there to take its place. Only incipient glaciers are found on the northern slopes of the higher peaks far back in the mountains to indicate how great a change has occurred. This is the greatest of all these glacial lakes, but throughout all the region smaller ones are there to fill the places where the streams of ice with tools of stone carved out great basins in the solid rock.

The region which we are to enter is on the northern side of the same intrusion seen at Cornucopia. Here its roof of sediments is all but gone, and on its irregular sides schists and limestones expose their complex borders. Here and there on the broad expanse of the intrusion large isolated blocks of the ancient roof still remain. Water and ice has removed all but these and, laboring on, has scored deep valleys in the younger rock.

Where limestone is in roof or wall at the contact, copper and gold appear. In basic dikes copper and gold are also found, and where these products of the great intrusion cut the contacts, increased copper sulphides next to the dikes are found.

Along these contacts and in the basic dikes called lamprophyres, are the chief economic deposits. There has been but little development in the Wallowa region, and with the exception of test shipments it has no production.

WHEELER COUNTY

SPANISH GULCH DISTRICT

This district is located in the southeastern corner of Wheeler county in T. 13 S., R. 25 E. Placer deposits have been worked since the first discovery of gold in Eastern Oregon, but the quartz ledges, some of which are quite wide, have not been developed or equipped for production. The district is located on Rock and Birch creeks, which flow north into the John Day river. The nearest store and postoffice is Antone, about 5 miles from the central part of the district. The active area is small and close to the main highway, or is reached by short branches therefrom, the greatest not over 4 miles long. Antone is about 60 miles west of Prairie City, the western terminus of the Sumpter Valley railroad, a narrow gauge line 80 miles from Baker. Antone is about 75 miles south from Condon, a branch line of the O.-W. R. & N. It is also about 60 miles southeast from Shaniko, on another branch of the O.-W. R. & N. With each of these railroad stations the district is connected by good wagon roads; that to Prairie City is entirely a water grade. The higher elevations in the district are well timbered. The lower half is covered with sagebrush.

Most of Wheeler county is covered by recent lavas. Spanish Gulch is a comparatively small area of the older rocks, which is probably entirely surrounded by these lavas. These older rocks are greenstones, argillites and serpentine which have been intruded by granodiorite porphyry and a complexity of dikes. Many of the veins are almost altogether massive quartz, while in others the vein material is highly altered and silicified country rock. The other minerals are pyrite, chalcopyrite and galena, containing gold and silver. In the vicinity of the serpentine areas chromite outcrops are found. The distance of this district from the railroad and from other mining camps has much to do with retarding what is apparently a promising field.

Index of mines, mining companies and prospects arranged alphabetically by counties and districts

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DOUGLAS COUNTY

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MARION COUNTY

UNION COUNTY

WALLOWA COUNTY

WASCO COUNTY

WHEELER COUNTY

UNCLASSIFIED

OREGON CORPORATIONS WHOSE PROPERTIES ARE WITHOUT THE STATE

VOLUME 3 NUMBER 1

MARCH, 1920

THE MINERAL RESOURCES OF OREGON

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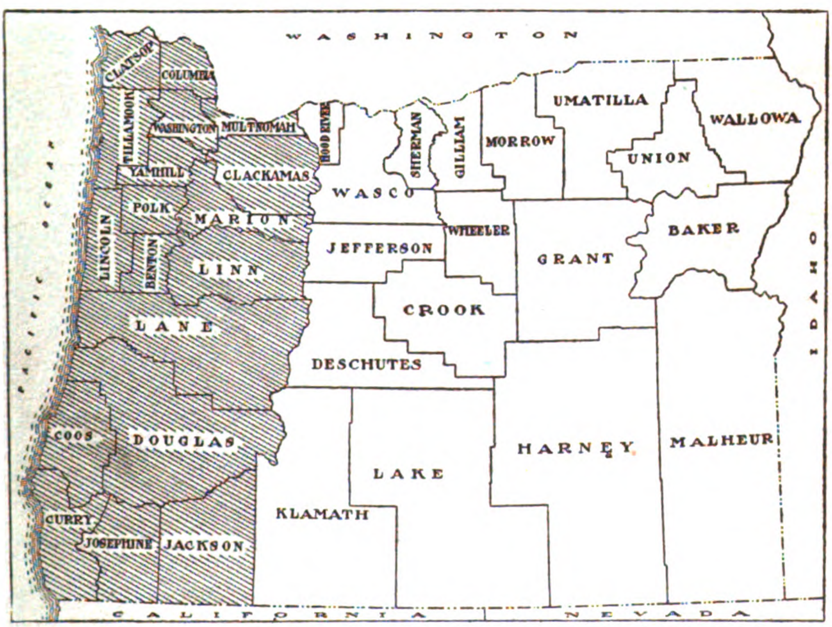

Sketch map of Oregon. Shaded portion covered in the oil and gas investigation.

REPORT ON

Investigation of Oil and Gas Possibilities of Western Oregon

By HARRISON and EATON, Consulting Petroleum Geologists

Forty Pages Six Illustrations

STATE OF OREGON

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BUREAU OF MINES AND GEOLOGY

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417 OREGON BUILDING, PORTLAND, OREGON

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Ira A. Williams, Geologist
G. E. Stowell, Assistant Mining Engineer

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ILLUSTRATIONS

FOREWORD

It has been a matter of common knowledge among geologists for many years that western Oregon is largely made up of rock formations of similar geologic age to those of the great oil producing districts of southern California. Early in 1919 the Oregon Bureau of Mines and Geology planned as one of its important projects for the year the geologic examination of all the sedimentary areas of western Oregon to determine whether in any sections conditions are favorable to the occurrence of commercial quantities of oil and gas.

It was especially desired that the quality of the investigation be the same as that demanded by any of the big oil producing companies. Harrison and Eaton, Consulting Petroleum Geologists, of Denver, Colorado, and Fort Worth, Texas, was employed to make the investigation. This firm was selected after careful inquiry into the experience records of many prominent oil geologists of the country. The inquiry showed that the members of this firm are men of unquestioned integrity who are held in high regard by those prominent in their own profession, as well as by leading oil producing companies of the country. The Bureau was fortunate in securing the services of men who have proved themselves so eminently successful as oil geologists in the commercial industry.

Close touch with the progress of the work was maintained throughout the season and it is my belief that the actual geologic conditions in the field were correctly interpreted, and that the conclusions reached are logically founded upon these conditions. Particular effort was made to render available all the geologic information accumulated by the Bureau during past years, as well as all possible data from other sources, for the purpose of this investigation. I regard the report in its entirety as a faithful presentation of fact followed by logical conclusions.

HENRY M. PARKS, Director.

VOLUME 3 MARCH, 1920 NUMBER 1

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of All Her Minerals

PUBLISHED AT PORTLAND BY
THE OREGON BUREAU OF MINES AND GEOLOGY
HENRY M. PARKS, Director

REPORT ON INVESTIGATION OF OIL AND GAS POSSIBILITIES OF WESTERN OREGON

By HARRISON AND EATON, Consulting Petroleum Geologists

Following is our report on the investigation of oil and gas possibilities in Western Oregon, conducted during the field season of 1919 in accordance with our contract with the Oregon Bureau of Mines and Geology.

Mr. Clarence B. Osborne, one of our geologists, was placed in active charge of the field work for the Oregon Bureau and the compilation of the data and preparation of this report have been largely entrusted to him. Mr. Osborne was assisted throughout the work by Ewart G. Sinclair and during part of the work by Dr. Warren D. Smith of the University of Oregon. These geologists are all graduates of American universities and their combined experience includes commercial investigations for oil in the fields of California, Texas, Wyoming, Oklahoma, Philippine Islands, South America, Canada, Cuba and China. Mr. Frank Kelsey was employed as field assistant during most of the work and rendered valuable and efficient service.

Upon the completion of the gathering of the field data, one of the members of the firm of Harrison and Eaton, Arthur Eaton, reviewed the work in the field, visiting the localities where sections had been measured and examining all of the regions that had furnished geologic information of importance in this investigation.

ACKNOWLEDGMENTS

Throughout the investigation, the geologists received most hearty and helpful assistance from the people in all parts of the State where work was carried on. It would not be possible to list the names of all

who have assisted the field men with helpful advice and information as to exposures of rock, road conditions and supposed oil indications, but mention should be made of the assistance given by Mr. W. D. Dement and Mr. Windgate of Astoria, Mr. Herbert Nunn, State Highway Engineer, Mr. Pyle of Lacomb, Mr. Spencer of Bandon, Arthur Noah of the Libby Mine, Mr. Anderson of Nehalem, Mr. Lane of Manzanita, Mr. Barlow of Warrenton, Dr. Goucher of McMinnville, Roderick Macleay of Portland, F. W. Strake of Waldport, George W. Neilson of Medford, and Dr. Earl L. Packard and Hubert Schenck of the University of Oregon. Acknowledgment should also be made of the geologic assistance in the office and field rendered by Director Henry M. Parks, Ira A. Williams, Geologist, and Arthur M. Swartley, Consulting Mining Engineer, of the Bureau of Mines and Geology.

AREA EXAMINED

The area under investigation included all of Oregon north of the California line and west of the Cascades mountain range.

During the past twenty years there has been from time to time a number of small oil "booms" in western Oregon and, all told, a considerable sum of money spent in actually trying out some of the regions by drilling. The desire that the people of Oregon have more definite knowledge as to the oil possibilities, based on a connected and general study of the geology of the state, led the Oregon Bureau of Mines and Geology to have such an investigation made that any future expenditures of money in oil prospecting in western Oregon might be spent in regions offering some promise, if such regions could be found to exist.

TOPOGRAPHY

On Plate 1 is shown a relief map of the state. The vertical scale of this map is approximately five times the horizontal scale, and for this reason, the land surface seems more rugged than is actually the case. In traveling throughout western Oregon, one is impressed with the fact that the topography is fairly old or well developed erosionally. The two important features are the Coast and Cascade ranges of mountains. From the California line to about the north line of Douglas county, there is a widening of both the Coast Range and the Cascade Range, making that part of western Oregon seem almost all made up of low ranges of hills and mountains with no great valleys or basins. As we go north of Douglas county, we find the main ranges are separated by the broad Willamette valley.

The drainage of western Oregon is interesting in that the great Rogue, Umpqua, Siuslaw, Yaquina, and Trask rivers with their sources east of the Coast Range cut their way through that range to empty into the Pacific Ocean. These rivers are now tide-flooded for a distance of from 10 to 30 miles up-stream, their deep channels having been cut at a time when this portion of the Pacific Coast was at a higher elevation than now.

This matured topography has made the gathering of geologic data difficult, because when stream erosion becomes slow there is more and more time for all rock surfaces to decay and become soil covered and thereby hide the geologic evidence. Where the new highways have been cut across the Coast Range, many good exposures are seen. During the low water in summer the larger rivers expose in their channels much of the rock that makes up the Coast Range. The wave-cut cliffs along the Pacific Coast also display the geology along much of the coast and very valuable data have been gathered from these rocky points.

VEGETATION

The equable climate and the very heavy annual rainfall have made the greater part of western Oregon almost a jungle of forests and dense brush and vines. This is especially true in the Coast Range mountains. Here the undergrowth is often impassable except along the main highways and trails. The brush, vines, low clinging shrubs, and moss cover with a dense blanket much of the underlying geology. This vegetation really presents a very expensive difficulty to be met where any careful detailed geologic survey is to be made in western Oregon. Once away from the graded roads on the west slope of the Coast Range, a geologist might spend days fighting his way through the vegetation to obtain enough data to accurately map the surface geology of one square mile of territory.

GEOLOGY

The careless observer traveling through western Oregon might easily get the impression that the geology of the entire area is a mixture of different kinds of shales, sandstones and volcanic rocks in a sort of hodge-podge, having no definite relation. But the same traveler would, upon making a more careful study of the region, find that the state is built up of a series of layers of rocks and these layers, like the pages of a book, each tells its story of what was happening throughout Oregon at the time that layer was being deposited.

The story or geologic history of Oregon would be more easily read if the layers of rock had all remained smooth and flat as when deposited, but due to great movements and strains of the earth's surface, these pages of history have been badly wrinkled by folding. They have been torn by big fault movements and some pages removed by erosion, so that today the pages have to be pieced together in order that we may read what has happened during each big geologic measure of time in the past.

Period	Formation	Type Locality	California Equivalent	Lithology	Thickness	Typical Fossils
Recent	Terrace	Bandon coast		Sands, clays, gravels, marine sands, black magnetic beach sands, varicolored sands.	25'-50'	
Pleistocene				Loose sands and gravels and shell beds.	100'-300'	Saxidomus giganteus Paphia staminea.
Pliocene	Coos	Fossil Point Coos Bay	Merced	Conglomerate.	30'	Mixed fauna of living Pliocene and Miocene.
	Empire	Coos Bay Empire		Sandstone. Light and colored shales.	400'-500'	Pecten coosensis. Chione securis, etc.
Miocene		Newport	?	Tuffaceous sandstones and shales.	500'-800'	Pecten propetulus. Cardium coosensis. Arca devincta. Desmostylus hesporus. Desmatophoca oregonensis.
Oligocene	Acila Shales (Astoria Shales?)	Newport (May include part of Astoria Shales.)	San Lorenzo?	Dense dark-gray shales, very fine-grained.	2100'	Acila Shumardi. Acila gettysburgensis. Fish scales. Agasoma gravidum.
	Yaquina	Yaquina	?	Lower 1000' coarse-grained sandstone buff-colored with a slight showing of coal in lower part. Upper 1300' fine-grained, bluish colored, quite micaceous.	2300'	Acila thracia. Aturia angustata. Phaecoides, Spisula.
	Toledo	Toledo	?	Tuffaceous sandstones and shales, green-gray in color when fresh.	3000'	Not found.
Eocene	Coaledo	Coaledo, Coos Bay	Ione	Thinly bedded sandstones and shales of fresh and brackish water deposition with number of coal beds near top.	4000'	Ostreas, Modiolus, Mytilus. Brackish and fresh water fossils in beds near coal measures.
	Tyee	Tyee Mountain	Tejon	Rather porous sandstone generally heavily bedded with thin separations of muddy gray shale. The sandstone is bluish-gray in color and very micaceous.	2500' Roseburg. 5000'+ Florence. 4000'+ Newport.	Generally lacking in fossils. Sandstone and shale often carry small fragments of carbonized wood. Venericardia planicosta found in Tyee.
				Basal conglomerate largely made up of Cretaceous and metamorphic pebbles 2000'. About 3000' of dark muddy sandstones and brown shale beds overlie the conglomerate.	5000'	Turritella uvasana.
Cretaceous	Not found in Oregon	Chico, California	Chico			
	Upper Myrtle Lower Myrtle	Myrtle Cr., Ore. Myrtle Cr., Ore.	Horsetown Knoxville	Conglomerate, sandstone and sandy shales.	10,000'	Aucella crassicollis. Aucella piochii.
Pre-Cretaceous Metamorphics	Curry Co.	Curry Co.	Metamorphics	Schists, cherts quartsite and slaty shales.	5000'	Radiolaria.

Investigation of Western Oregon.

Abundance of Life	Structure	Igneous Activity	Remarks
Relatively scarce.	Weakly cemented deposits, little disturbed.	None.	
Life abundant.	Gentle dips.	None.	
Rich in fossils.	Firmly cemented and little disturbed.	Post-Empire intrusives and flows.	Most of western Oregon was above sea level and was heavily eroded.
Mollusca, abundant in sandy strata.	Gently folded.	Tuffaceous deposits.	
Life not very abundant.	Coastal deposits. Monoclinal dipping to west 10°-20°.	Basaltic intrusions and flows and tuffaceous deposits.	Coastal deposits are dense and not of good character as petroleum reservoir.
Very rich in organic animal life.	Open gentle plunging anticlines and monoclinal in west coastal region. Gentle west dips.	?	Acila shales near Newport give petroleum odor when freshly fractured. Astoria formation seems to be of same horizon as Acila shales but only near Newport were these shales found to be favorable as possible source of petroleum.
Abundant molluscan life in some horizons.	In coastal regions monoclinal dips to west.	?	Not of satisfactory character as source of petroleum products.
Quite barren of evidence of life.	Same as Yaquina.	Pyroclastic.	Very unsatisfactory as a possible source of petroleum products.
Some horizons rich in brackish water fossils. Plant remains from which coal was formed.	Large gentle folds in Coos Bay region with some faulting and igneous intrusions.	Probably the main intrusive masses such as Mary's Peak, Granite Mt. and other Coast Range volcanic peaks were formed during Coaledo or early Oligocene time.	Lacking in evidence of being a possible source of petroleum products.
Quite barren of life.	Folded and faulted and cut by volcanic intrusions.	Basaltic intrusions and pyroclastics near crest of Coast Range mountains.	The Tyee of Florence and east of Newport doubtless includes the same horizon as the Coaledo of Coos Bay. Not favorable as source of petroleum.
All but a few horizons are barren of evidence of life.	Folded and faulted.	Basaltic intrusions.	Contains nothing to produce commercial quantities of petroleum products.
			During Chico period, western Oregon was above sea level and subject to heavy erosion.
Lacking in much evidence of life except plant remains.	Folded, faulted and somewhat altered by dynamic action.	Granodiorite, batholiths, serpentine, etc.	Not of favorable character as possible source of oil and is badly folded and faulted.
Highly metamorphosed.	Altered by excessive dynamic action.		Too badly changed by dynamic action to be of any value as producer of oil.

The lover of geology could spend a lifetime in the Coast Range and Cascades, always finding new bits of information to add to the geologic history. This investigation, however, was made for a very practical purpose and neither time nor funds would permit a study of many of the very interesting problems of a purely geologic nature. The aim was to find if western Oregon offered possibilities as a producer of petroleum or gas in commercial quantities and the study of the geology was largely controlled by this problem. For this reason, fossils were collected only where they were needed in furnishing additional help to correlate the different horizons.

The beds making up the different geologic ages were studied as to their being a possible source or container of oil. The measurements of thickness of beds were made to determine how deep wells would have to be drilled to pass through from one period of deposition to the next.

The Cascade Range of mountains is made up largely of igneous flows, intrusions and interbedded tuffaceous sediments. Although interesting geologically, this great thickness of igneous rocks has no petroleum possibilities. For this reason no attempt has been made in this report to consider the detailed geology of this range, though the outline map herewith covers to its summit line.

The Table of Stratigraphy accompanying this report (pages 6-7) has been prepared to summarize the principal geologic events that have taken place in western Oregon. In the preparation of this table, most of the works of previous Oregon geologic investigations have been studied and made use of insofar as they were of importance to this report. The compiling of this information and the preparation of this table are largely the work of Dr. Warren D. Smith of the University of Oregon.

A study of this table will show that since Jurassic time western Oregon has been subjected to long periods of subsidence below the level of the ocean and during these periods great thicknesses of marine sandstones and shales were deposited. These today are the great layers of rocks of which western Oregon is composed.

These beds have been uplifted into a few big major folds, one of which with axis in a general north and south direction follows the Coast Range region, although the crest of this fold does not conform to the top of the ridge nor can it be said to have any very great effect in having produced the present topography or relief of this part of the state. East of this upward fold is a great synclinal trough in which the strata dip to the eastward beneath the Willamette valley, and so far as observed, the inclination is continued beneath the west slopes of the Cascade Range. These major folds are gentle in slope but there is much minor folding in the strata which is more noticeable due to steeper dips and sharper folding.

PRE-CRETACEOUS

The geologic history of western Oregon is of interest in this investigation only back to the beginning of the Cretaceous age. The rocks laid down before Cretaceous time in Oregon have all been so badly altered by earth movements that they are now almost completely metamorphosed to mica schists, slates with highly-developed cleavage, and cherts, the more basic igneous rocks having altered to serpentine. This alteration is so great that the Pre-Cretaceous, even if it ever were a source of petroleum, could not today be regarded with any hopes of its being a source of a commercial producer of oil in western Oregon.

A well anywhere in western Oregon, if it could be drilled deep enough, would eventually reach Pre-Cretaceous rock. So we might regard the Pre-Cretaceous as the bedrock or floor upon which the sediments since that time have been deposited. This Pre-Cretaceous floor is found exposed in Jackson, Josephine, Curry, southern Coos and Douglas counties. As one goes north, this bedrock is covered by an increasing thickness of younger deposits of conglomerates, sandstones, shales, lava flows and intrusions. When the north end of the state is reached, if one were to drill to find this bedrock, the hole would probably have to go to a depth of more than three miles below the surface.

CRETACEOUS

Before the beginning of the Cretaceous deposition and extending into the early part of the Cretaceous age, there were great movements in the earth's crust in the lands bordering the Pacific. There were extensive intrusions of granodiorite that played their part in the mountain-making of southwestern Oregon.

From the geologic evidence all of the northern and central parts of western Oregon during Cretaceous time lay below sea-level, and the land area included only a small part of southern Coos and Douglas counties and the counties south of this line. All of the north was covered by the Pacific Ocean. The great lava flows cover and hide so completely the Cretaceous of the Cascades and of eastern Oregon that it is a question as to how far east one would have to go to find what part of eastern Oregon was above sea-level during the Cretaceous period. Identified Cretaceous sediments are found as far east as the John Day valley.

The Cretaceous of western Oregon as found exposed in the southwestern counties, is made up of conglomerates, shales and sandstones, lenses of limestone and many igneous intrusions. These beds have been subjected to sharp folding and such extreme stresses and strains that their material is greatly altered and as a possible source or retainer of petroleum products offer nothing encouraging. This feature of the Cretaceous will be treated in more detail in the discussion of Economic

Geology. These conglomerates and sandstones were found to be largely made up of the erosional material of the older metamorphic rocks.

As far as the Cretaceous could be studied from exposures in the southern counties of western Oregon, it marks a depth below which it would be useless to drill in the hope of producing oil or gas. For this reason, it was discarded early in the investigation and time was not spent in attempting to make a measurement of its thickness or in any detailed description of the different exposures. As it now exists in southwestern Oregon, it is an erosional remnant, and a great amount of time would be necessary to piece together the lower Cretaceous deposition, while much of the upper portion would still be missing as it has been removed by the long erosional period at the end of the Cretaceous and before the beginning of Tertiary deposition.

The fossil life found in the Cretaceous of western Oregon indicates that the lower part would correspond to the Knoxville of California, a period of rather cold climatic conditions. The upper Cretaceous of Oregon is richer in fossil life of a more tropical nature and has been classed with the Horsetown of California. These warmer water conditions continued throughout the remainder of the Cretaceous, and in relation to higher beds part of the upper Cretaceous beds of Oregon are correlated with the Chico of California.

TERTIARY

At the close of the Cretaceous, and extending into the early Eocene in western Oregon, there was an elevation of the surface and a long period of erosion during which period much of the upper layers of Cretaceous sediments were carried away. It was during this time that the Cretaceous of Oregon was badly faulted and subjected to heavy stresses and strains which resulted in the sharp folding and alteration of the deposits as now seen in the exposed Cretaceous of southwestern Oregon. The Tertiary will be treated under the three great main divisions—Eocene, Oligocene, and Miocene.

Eocene

As has been stated, during the early Tertiary western Oregon stood as a land surface, but during the latter part of the Eocene it was once more submerged and subjected to a building up of sedimentary beds. The whole of the north and central parts of western Oregon were once more below sea-level. The shoreline was near the south end of Coos and Douglas counties, with a long extension or bay extending almost to the southern end of Jackson county.

The Eocene of western Oregon has as its equivalent in California the Tejon and Ione sediments. While it represents only the last part of the Eocene age, it makes up a very formidable thickness of the sedimentary rocks of western Oregon and where complete would measure more than ten thousand feet thick. It has been separated into a number of divisions by the different geologists who have worked in Oregon. In this investigation three divisions were helpful in the work in the Eocene, the lowest called the Umpqua; over this the Tyee; and the highest part of the Eocene, the Coaledo.

The Umpqua: The surface exposures of the Umpqua are found in Douglas and Coos counties overlying the Cretaceous, the type locality being along the Umpqua river east of Roseburg where this formation was named by Joseph S. Diller of the United States Geological Survey.

The lowest part of the Umpqua consists of a great thickness of conglomerate, made up largely of pebbles of Cretaceous or Pre-Cretaceous material. In the section measured from Roseburg to the coast (see plate II) the conglomerate was in places 2000 feet thick. There were beds of coarse sandstone in the upper parts of the conglomerate. Overlying these were dark muddy sandstone and brown shale beds having a thickness of from 1000 to 3000 feet, the total thickness of the Umpqua being in some places as much as 5000 feet. As a whole the Umpqua is rather barren of fossil life. A foot or two of sandstone or shale will at times be found very rich in fossil remains and then there will be hundreds of feet of thickness seemingly devoid of fossils.

Tyee: This formation was given its name by Joseph S. Diller in the Roseburg folio (No. 49) of the United States Geological Survey, the type locality being Tyee mountain in Douglas county. The Tyee is exposed over a larger area in western Oregon than any of the rocks of the other geologic divisions. It makes up the greater part of the surface exposures of the Eocene shown in Section A-A, Plate 2, Section B-B, Plate 3, and Section C-C, Plate 4.

The Tyee is predominantly a sandstone member and the character of deposition would seem to indicate that it was laid down in a slowly receding shallow sea throughout the entire region west of the Willamette and north of the Umpqua river. The sandstone is, when fresh, blue-gray to green-gray in color and very micaceous, the small flakes of white muscovite mica being very characteristic of the Tyee. The sandstone is usually quite massive with thin separations of micaceous muddy-gray shale carrying tiny fragments of carbonized wood. Much of the sandstone also carries small fragments of carbon. In the lower and also upper part of the Tyee, the sandstone is more thinly bedded with numerous thin interbedded shale layers.

In the measured Section A-A, Plate 2, the Tyee is about 2000 feet thick. In section B-B, Plate 3, more than 5000 feet of Tyee was measured and neither the top nor bottom of it was found in that section. In section C-C, Plate 4, over 4000 feet of Tyee was measured and this did not include the entire thickness. The Tyee has been classed largely on lithologic characteristics and in Sections B-B and C-C, it is possible that the measured thickness includes some sandy phases of the underlying Umpqua and the overlying Coaledo.

The Tyee is almost devoid of fossil life except for the small showing of wood fragments. The *Venericardia planicosta* has been found in the Tyee near the town of Monroe.

Coaledo: The top member of the Eocene has been named by J. S. Diller in the Coos Bay Folio (No. 73), United States Geological Survey, the Coaledo, after the town of Coaledo, Coos county. During this period of the Eocene, the larger part of western Oregon was above sea-level with the coast region one of extensive swampy areas where peat bogs were formed. The Coaledo consists of a series of fresh, brackish and marine beds of sandstone and muddy shale. In the Coos Bay region are a number of coal seams and some of these are thick enough to pay to mine although the coal is not of high grade.

The greatest thickness of the Coaledo is approximately 4000 feet in the Coos Bay region. The Coaledo has undoubtedly been included as Tyee in the measured sections north of Coos Bay, as it is much like the Tyee except for the coal measures, and these coal beds are rather local in extent as they were formed in relatively small basins. Throughout the whole of the Coaledo, there is a scarcity of fossil life, but in some of the brackish and marine beds there are quite abundant remains of oysters, Mytiluses, etc.

Oligocene

Following the Eocene period, the deposits of Oligocene sandstones and shales were laid down covering western Oregon as far south as Eugene. Possibly the shoreline was still farther south, and subsequent erosion has removed the evidence of the extreme southern limit of the Oligocene deposits. As the south half of Western Oregon was doubtless a land surface during most of Oligocene time, it is from Lane county north that the Oligocene is of importance and in the north coastal counties where the greatest thickness now exists.

For convenience, the Oligocene has been divided into three periods—Toledo, Yaquina and Acila shales.

Toledo: This is the lowest member of the Oligocene and its name was taken from the type locality three miles south of Toledo in Lincoln county. This division is made up of tuffaceous sandstone and shales. They are green-gray on the unweathered surfaces, but in the weathered portions vary in color from white to yellow to red. The sandstone is rather thinly bedded and sandy shale makes up the greater part of this series.

From three miles south of Toledo to Oysterville, there is a total thickness of 2800 feet of the Toledo sandstone and shales. These may not all be of Oligocene age but possibly transitional between the Eocene and Oligocene. There is a lack of fossil life in the Toledo and the tuffaceous character of the deposition may account for the scarcity of life during that period.

Yaquina: Overlying the Toledo is the Yaquina sandstone. The lower half of this division is coarse-grained, buff-colored sandstone interbedded with carbonaceous shale. Some of the lowest shale members occasionally carry thin seams of soft coal and one of these about six inches thick has been prospected near Toledo.

Above the coarse sandstone is a micaceous blue-gray sandstone, heavy-bedded, very fine-grained and quite fossiliferous. Here are found many Oligocene fossils, *Aturia angustata, Acila thracia* Phaecoides, Spisula, etc.

The Yaquina division measures 2300 feet thick, of which the lower part of coarse-grained sandstone is 1000 feet.

Acila Shales: This name has been given to the upper member of the Oligocene as found in the section from Yaquina to Newport, *Acila shumardi* being found quite generally throughout this section. It is a very dark blackish-gray shale and even where weathered is dull gray in color. It is fine-grained and when freshly fractured gives a pronounced petroleum odor. In the section measured from Yaquina to Newport, this Acila shale is 2100 feet thick. A part of this same member is found along the coast north of Newport in the vicinity of Jump-off Joe Rock and here 800 feet of thickness is exposed.

This shale was named from the fossil Acila shells that are found in it, the *Acila shumardi* being used as the type fossil. In the Newport region the shale contains innumerable shall shiny brown fish scales and throughout its entire thickness gives evidence of having been deposited during a period rich in marine life.

In the Oligocene in many of the northwestern counties of Oregon, in the vicinity of Tillamook, Astoria, Clatskanie, Buxton and Willamina, the upper member or Acila shale has been found, but in only the Newport region was this shale petroliferous in odor and in no other places was it of the favorable nature found at Newport.

Astoria Shales: The shales in the town of Astoria have been studied by a number of geologists and this occurrence has been given as a type locality for upper Oligocene of Oregon. The division of Acila shales used in this report possibly could be properly called Astoria shales.

There is a total thickness of more than 7000 feet of Oligocene in the Newport Section C-C, Plate 4, and nearly this much Oligocene was found in the Section D-D, Plate 5.

Miocene

Following the Oligocene, and with slight unconformity, we find in the coastal region of Tillamook, Lincoln and Clatsop counties, the sandstones and shales of the Miocene period. A good section can be seen just west of Newport along the coast. The Miocene found in Coos county west of Marshfield shows a marked unconformity with the underlying Eocene, for here the entire Oligocene series is missing.

The Miocene found in the Newport region is a dense sandy shale, tuffaceous in character. In the weathered surfaces it is yellow to gray-brown, and in the unweathered olive-gray to bluish-gray in color. Marine vertebrates have been found in these beds and large fossil pectens, the *Pecten propetulus* being a marker for these beds.

About the middle of the Miocene period of the Tertiary world-wide deformation of the earth's crust occurred. The Alps, Himalayas and Andes were largely formed during this time interval and in Oregon, uplift of the Cascade Range possibly began. This was also a period of basaltic intrusions and flows in Oregon. The present deposits of Miocene in Oregon doubtless represent only remnants since during the Pliocene much of the Miocene was eroded. The total thickness of Miocene now found in western Oregon would measure less than 1000 feet and a thickness of from 500 to 800 feet would mark its importance on the total of the Tertiary.

Pliocene

The period of the Pliocene is one in which most of western Oregon was well above sea-level and most of the Pliocene deposits are fresh-water sandstones, clays, shales and gravel beds. Along the coast there are some Pliocene beds of marine origin. There is no great thickness of either the Pliocene or Pleistocene deposits in Oregon west of the Cascade Range of mountains, and in this investigation they are of very little importance. The greatest thickness of the combined Pleistocene and Pliocene would not exceed 800 feet and where found, the thickness is rarely over 400 feet. These formations are interesting in their marked unconformity with the older formations.

SUMMARY OF GEOLOGIC HISTORY

The rocks that existed before Cretaceous time in western Oregon are so completely metamorphosed that they mark a limit below which it would be useless to expect to find any petroleum products. These metamorphic rocks make the bedrock upon which the younger rocks have been laid down.

The metamorphic bedrock is exposed without covering in the extreme southern counties of western Oregon. As we go north, the Cretaceous conglomerates, sandstones and shales are found covering the metamorphics. Still farther north, there is a layer of Eocene sandstones, conglomerates and shales. On top of the Eocene still farther north, is a covering of thousands of feet of sandstone and shales of the Oligocene, and in the northernmost and north-coastal counties are a few hundred feet of Miocene sandstones and shales lying on top of the Oligocene.

On top of this is a relatively thin covering of Pliocene and Pleistocene sandstones, clays and gravels over part of the central valley section and over much of the coastal region.

Attention should be called to the fact that great igneous or volcanic activity occurred during the Cretaceous, Eocene, Oligocene, Miocene and Pliocene periods. This is very important because thereby the entire western part of Oregon has been broken and cut by innumerable dikes and igneous intrusions.

RELIEF MAP AND SECTIONS OF WESTERN OREGON

Four east and west sections were surveyed to show the major geologic structures and to measure the thickness of the different geologic divisions. As can readily be understood each of these sections includes geologic data obtained over a rather wide strip of country north and south of the section lines and surveyed from the Cascade mountain range to the Pacific Ocean.

These data were compiled for each of the main surveys and from these was prepared a general section along an east and west line. These generalized sections have attempted to give only the main geologic structure and must be understood to show only these main features. In order to make the sections more readable to those to whom geologic sections may not be readily understood, a relief map of western Oregon was cut and the sections fitted to the topography along such lines. The relief map of Oregon has the vertical scale about five times the horizontal scale in order to make the relief more apparent. In fitting the geologic sections to these two different scales it was found necessary to take into account the exaggeration in the vertical scale in preparing the sections. This has made the sections rather hypothetical and they should be considered as giving only the big important features of the geology.

In the surveying of these sections the field data for section A-A, Plate 2, and Section C-C, Plate 4, are the work of Ewart G. Sinclair and Dr. Warren D. Smith; Herbert Schench assisted in the survey of Section A-A. Section B-B, Plate 3, and Section D-D, Plate 5, were surveyed by Clarence B. Osborne, assisted by Frank Kelsey.

ECONOMIC GEOLOGY

In any geologic investigation to locate areas in which oil or gas can be developed in commercial quantities, there should be an understanding of the geologic data that are generally accepted as having proven of vital importance in the study of oil fields throughout the world. For this reason, a brief statement will be given on the known sources of oil and gas, the types of geologic structures that have been found to be necessary for the concentration of commercial quantities of these products, the types of porous rocks that have been found to be satisfactory reservoirs for the oil or gas, and the other conditions that are of importance in retaining the oil in such reservoirs.

SOURCES OF OIL

Petroleum geologists, after a study of the oil fields of the world, are generally agreed that the great bulk of petroleum commercially produced had as its origin organic matter from animal or plant or a combination of animal and plant remains. This organic material has been deposited in and with some dense fine-grained material such as silt or lime that today we find as shale or limestone. Geologic evidence seems to indicate that for petroleum products such deposition has always taken place under marine or saline water conditions. The deposits of shales of fresh water origin do not seem to have been satisfactory as a source of oil.

In this discussion petroleum products will be used as a term including not only crude oil but also petroleum gas. This does not include marsh gas.

Sandstones or conglomerates or other coarse-grained deposits, although often rich in fossil shell remains have not been found to be a satisfactory source of oil. It may be that at the time of deposition the coarse porous nature of the material allowed the organic remains to be removed mechanically or into solution in the overlying water, and thus most of the decomposed organic material necessary to the formation of petroleum would be taken away; whereas the fine-grained shales or lime or other dense material may in a purely mechanical way have sealed in place each particle of organic material, so that later when the whole mass of shale or limestone was subjected to certain geologic action, these organic materials would be changed into petroleum products.

In order that commercial quantities of petroleum be formed it is necessary that there be a satisfactory source. Since living matter is the original source of petroleum the geologic conditions at the time of deposition must have been such that an abundance of live matter existed. The greatest variety and quantity of life exists on the earth during tropical, moist conditions.

Regions that are either cold or arid are not productive of abundant life. Regions subjected to frequent depositions of volcanic dust, even though tropical, are regions in which there is frequent destruction of life. Long periods of uniform conditions are important in producing abundant life over any large area.

The study of geologic history shows that the different regions of the earth have been subjected to very extreme changes of climate and this too is destructive to the building up of abundant life. An area that has marine or saline sedimentary beds of shale, limestone or similar fine-

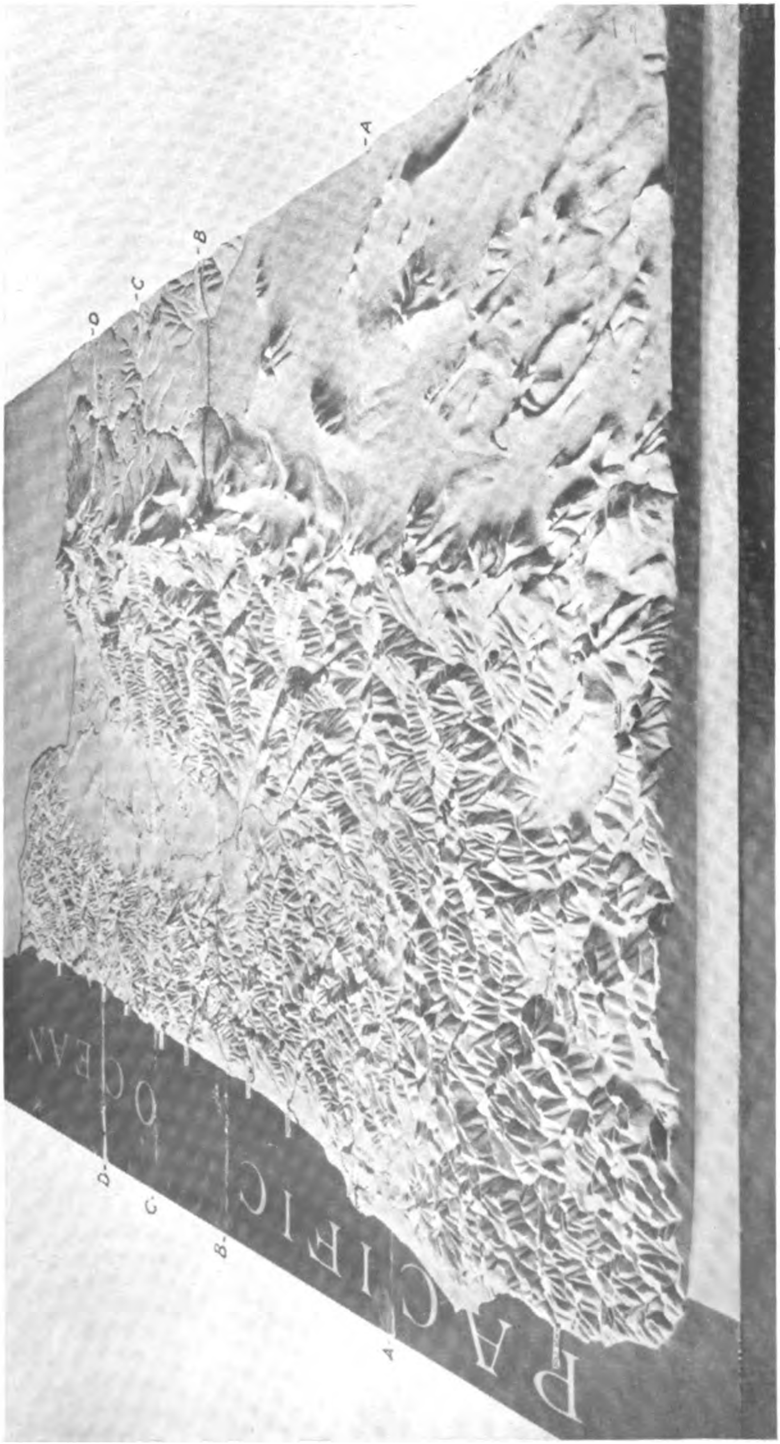


Plate 1. Relief map of Western Oregon showing location of geologic cross-sections which follow.

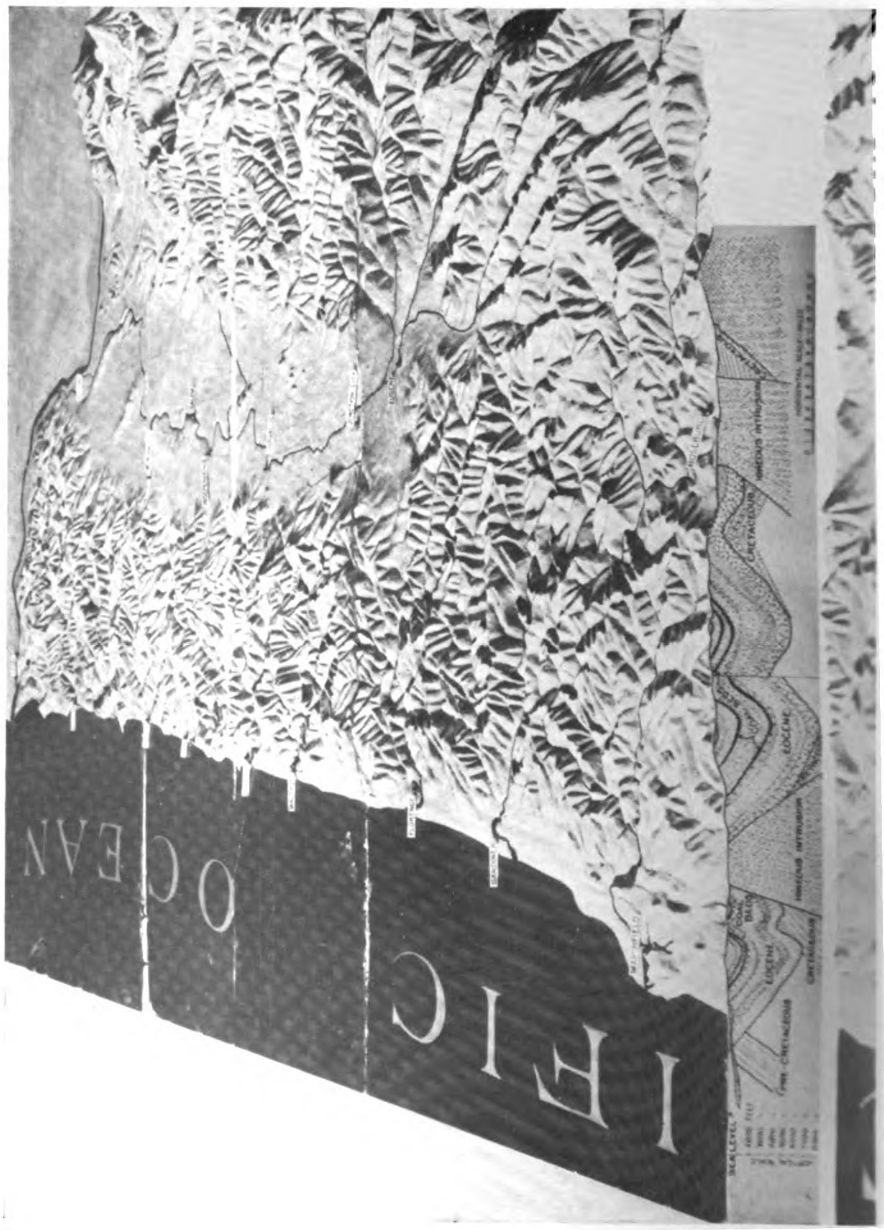


Plate 2 General Geologic Section A A

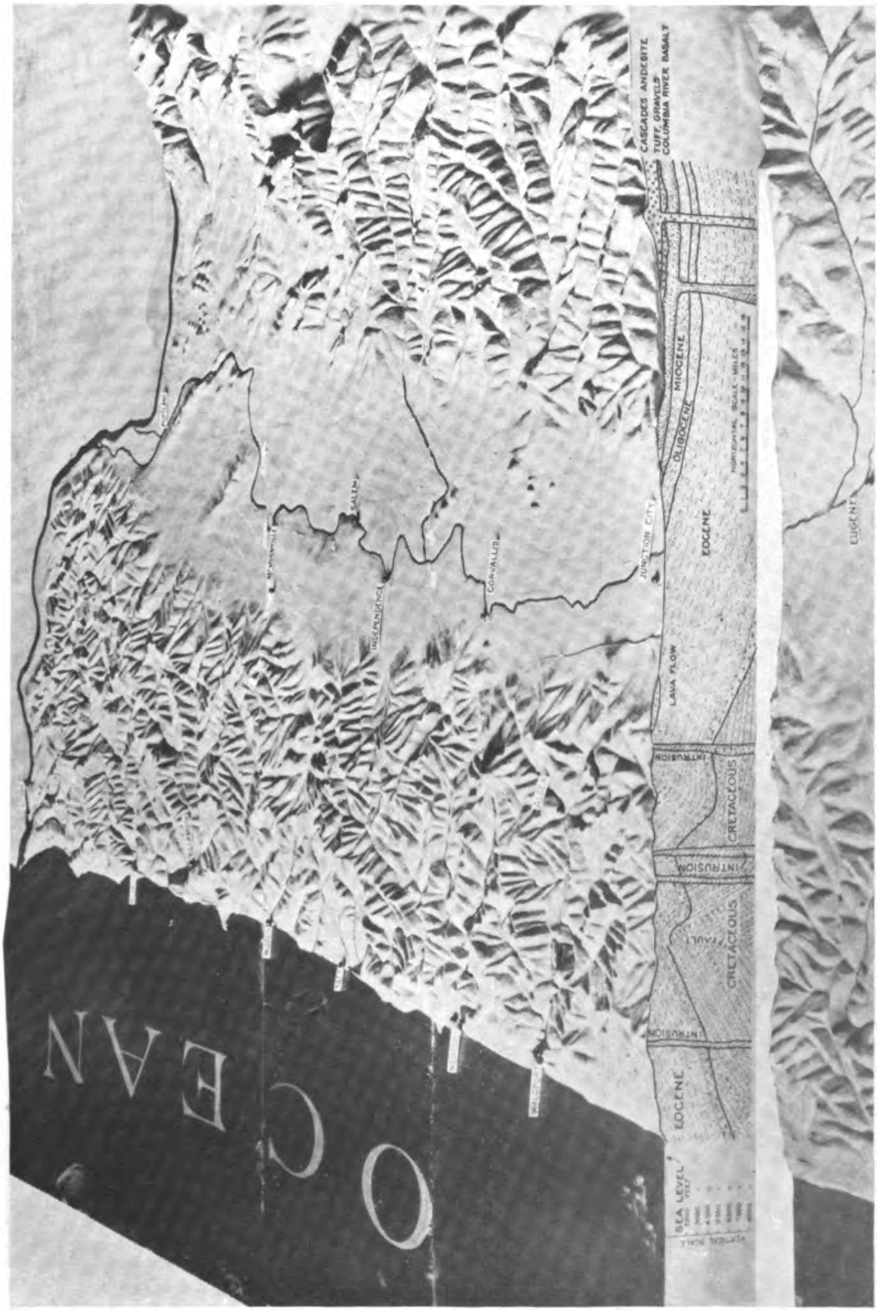


Plate 3. General Geologic Section B-B (Siuslaw Valley-Eugene)

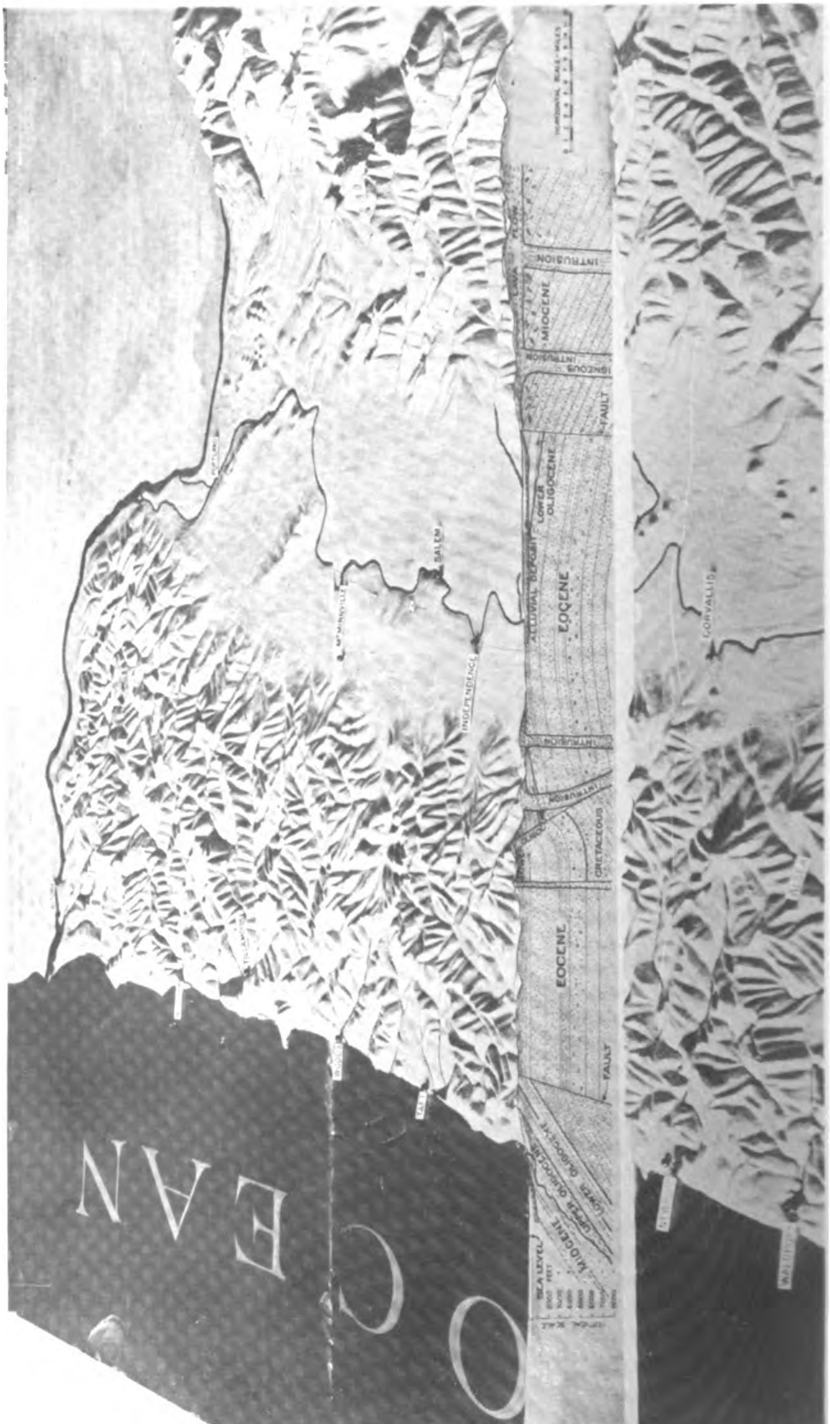
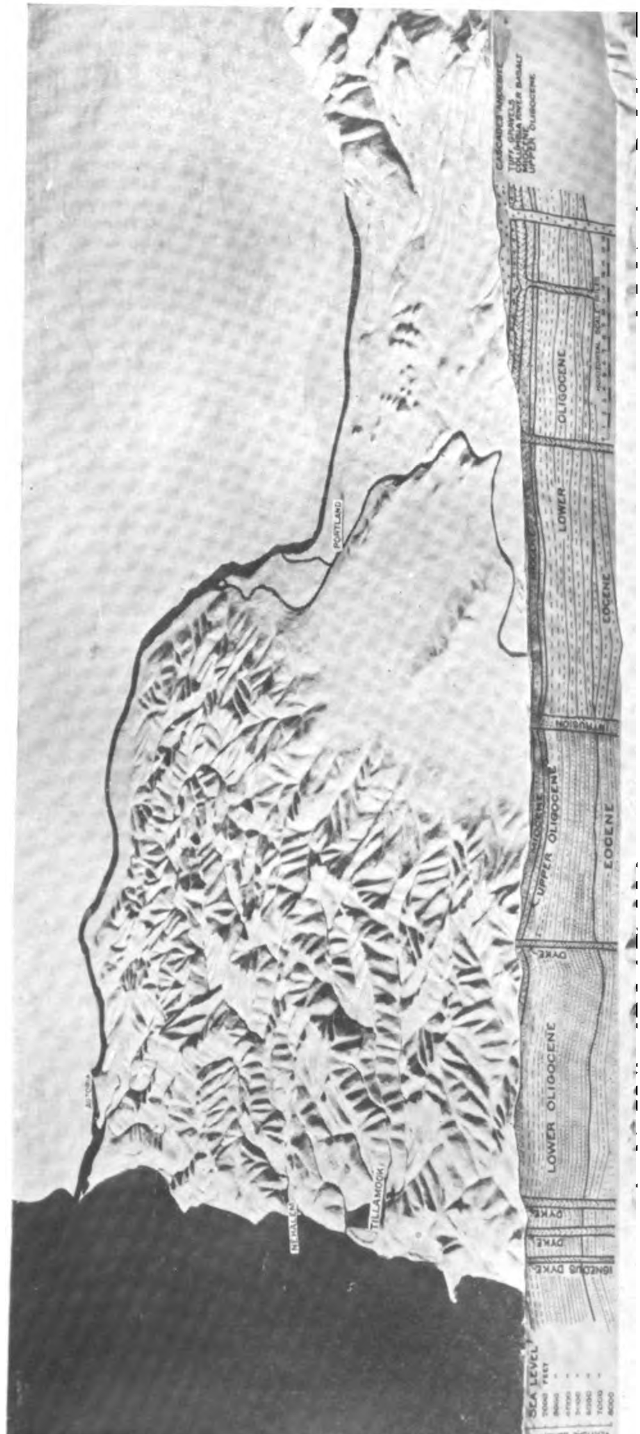


Plate 4. General Geologic section C-C (Yaquina Bay-Santiam River)


ASTORIA
PORTLAND
NEHALEM
TILLAMOOK
LOWER OLIGOCENE
EOCENE
UPPER OLIGOCENE
MIOCENE
DYKE
IGNEOUS DYKE
LOWER
OLIGOCENE
SEA LEVEL

grained sediments rich in organic remains from which petroleum products can be obtained, will be a possible productive petroleum area if other necessary conditions are also satisfactory.

Fine-grained sandstone might be, if very rich in life, a source of petroleum products, but coarse sandstones or conglomerates or breccias cannot be regarded as being at all favorable as a source of such products. Metamorphic rocks even though they were originally sedimentary and rich in organic life, must be eliminated as being a possible source of oil since the geologic action sufficient to produce the metamorphism would have driven off all petroleum products if any had ever been present. A region of entirely igneous rocks cannot be regarded as a possible source of petroleum (except in some theory of inorganic chemical reaction to produce the petroleum hydrocarbons). There is no satisfactory evidence that nature has ever produced oil in commercial quantities by chemical combinations of inorganic material.

PETROLEUM RESERVOIRS

If organic matter in shale or limestone were to ever remain in the condition in which it was deposited there would be no deposits of crude oil or gas, but stresses and strains in the crust of the earth seem to produce a change in the organic remains, making of them hydrocarbons of petroleum. There are great bodies of shale in Colorado, Utah and Montana that carry a high amount of organic remains and yet they show no trace of oil until subjected to either great straining movements or high temperature by which the organic remains become petroleum hydrocarbons. If a region has material that can be a source of petroleum it must also have adjacent to this source a porous member, either sandstone, conglomerate, shattered shale, a highly-creviced limestone or rock carrying openings or caverns in which the oil can be held and from which it can be removed when such porous material is tapped by a well or other opening.

It is generally believed that petroleum products if found commercially will be in porous material generally overlying the organic shale or other sedimentary source of the petroleum. Evidence would indicate that petroleum products, being lighter than water, are forced up through porous rocks on top of the water and would, if not interrupted, finally be forced out on the surface of the earth or up to the top of the underground water. If there is, however, an impervious bed of shale or limestone or dense sandstone or other dense material, then the oil will be trapped when such layer is reached and it will rise no higher.

If the beds or rocks that are the source of this oil, the porous reservoir bed, and the impervious capping all lie in a horizontal position, then any well sunk through the cap layer would find no great accumulation of petroleum products. But if these beds had all been folded and there was sufficient water, rock or gas pressure to force the oil into the highest parts of the folds, then along the crests of these folds, called anticlines, there would be a concentration of the oil from both slopes or sides of each anticline. If instead of a simple fold, there had been a dome, then the petroleum products would accumulate from all sides of this dome and be found concentrated in the reservoir space at the top of the dome and under the impervious cap. Anticlinal folds or domes with slopes extending over large areas are most favorable for a great accumulation of petroleum. Sharp folds with limited drainage area are at best only small producers unless the beds in which the oil originates are extremely thick.

It can be easily understood that if the crest of the anticline is tilted there is a chance that the oil will be forced by pressure to higher points along the crest of the anticline to where the impervious cap-rock may be exposed and cut away at the surface of the earth so that it would no longer hold back the petroleum. In a region of light oils this would result in the area draining itself of its petroleum and the oil would be lost. In the oil fields of California and in other regions where asphaltic oil is produced the cutting of the caprock has resulted in the escape of large quantities of oil, but the evaporation of the lighter oil products eventually leaves the opening from the porous reservoir clogged with asphalt, and other heavier parts of the oil, so that the outlet is finally cut off. Such an anticline may still be productive of oil on being drilled down the plunge of the anticline below the outcropping beds and where they are still under sufficient cover.

If the caprock at the crest of an anticline or dome is broken by faults, then the oil will probably migrate to higher beds and unless it is again trapped by a higher impervious layer, will be lost.

If igneous material is intruded into a series of folded sediments where an accumulation of oil has already occurred, it will probably either disturb the beds so that the oil can escape or the heat action may be sufficient to burn out the oil. In certain fields, however, it has been found that where the intrusions took place prior to the oil accumulation, the intruded material in the form of dikes or sills sealed the beds so that avenues for the escape of the oil were cut off and pools of oil have accumulated in the formations adjacent to these igneous masses.

SUMMARY OF GEOLOGIC CONDITIONS FAVORABLE FOR COMMERCIAL DEPOSITS OF PETROLEUM

First. If any region is to be productive of petroleum it must have beds that could be a source of petroleum.

Second. The petroleum products must be found in beds porous enough to hold the oil and yet when tapped by a well there must be chance for the oil to flow to the well.

Third. The porous reservoir beds must be overlain by beds of dense impervious material so as to prevent the further upward movement of the petroleum.

Fourth. There must be a folding of the beds containing the oil, and of the impervious caprock bed, so that the petroleum of a considerable area can be concentrated in the top of domes or anticlinal folds.

Fifth. For lighter oils a geologic structure of the general shape of a dome is necessary in order that the impervious caprock will retain the oil at the top of the dome and prevent any further movment of it. Asphaltic oils can work up the crest of a plunging anticline which has been cut by erosion and by evaporation seal the porous reservoir bed so that part of the oil is still retained in the crest of the anticline in that portion where the productive horizons have not been eroded.

Sixth. One other requirement might be added, namely, that the porous reservoir containing the petroleum products must be within possible drilling distance from the earth's surface.

DISCUSSION OF PETROLEUM POSSIBILITIES

Having in mind the points that are of importance in deciding the possibilities of developing petroleum products in any area, we will now review the information obtained in this investigation of the geology of western Oregon.

PRE-CRETACEOUS

As has already been stated, there is a bedrock floor of Pre-Cretaceous metamorphic rocks underlying all of the rocks deposited since the beginning of Cretaceous time. This bedrock floor is exposed in the extreme southwestern counties of Oregon and from there north is covered in general by an ever-increasing thickness of younger deposits. Because of its highly metamorphosed condition it cannot be regarded as being a possible source or producer of petroleum products.

CRETACEOUS AS A POSSIBLE PRODUCER

The only Cretaceous found in western Oregon is in Jackson, Josephine, Curry and southern Coos and Douglas counties. This Cretaceous has been subjected to such extreme folding and faulting that even if it carried good sources of petroleum originally it would be of doubtful productive value. Upon careful examination of the better looking shale of the Cretaceous, and after tests of these shales, they were discarded as offering nothing favorable as a productive petroleum horizon. As has been stated, the Cretaceous beds are sharply folded and faulted, and if they carried shales that could produce even small quantities of petroleum products, there would be oil indications in the form of either live seeps or petroleum residues. There is no evidence that the Cretaceous of western Oregon has ever been productive of petroleum products.

In southwestern Humboldt county in California, there are a number of seeps of light oil that are believed to be of Cretaceous or Pre-Cretaceous origin. These seeps were examined but the occurrence offered no hope of Cretaceous or Pre-Cretaceous petroleum products in western Oregon. This region of seeps in Humboldt county is faulted and badly folded in much the same way as are the Cretaceous beds in western Oregon. If oil exists in the Cretaceous of western Oregon there should be many oil seeps but none are found.

These light oil seeps in Humboldt county have caused the drilling of a number of wells in that region but to date it has been found that the rocks are too badly faulted and folded to allow the accumulation of oil in commercial quantities.

Chester W. Washburne, in his "Reconnaissance of the Geology and Oil Prospects of Northwestern Oregon," United States Geological Survey Bull. 590, page 53, in discussing Clatsop County says,—"As the surface rocks of this region are generally saturated with circulating ground water that reaches the surface in the rainy season, it is not unreasonable to think that the water has washed out all of the free oil of the rock that can be removed by water displacement." This statement has produced in the minds of the people interested in oil development in Oregon an idea that the heavy rainfall of Oregon is ample reason for there being no live light oil seeps throughout the entire western part of the state. The live light oil seeps in Humboldt county are in a region having an annual rainfall of over one hundred inches and with all of this water the seeps continue very active throughout the entire year.

At the end of the Cretaceous period in western Oregon the entire region was raised above sea-level and in addition to the extreme earth movements that folded and faulted the beds, there was a long period of erosion that removed all but the lower part of the Cretaceous in southwestern Oregon. It is possible that farther north more of the Cretaceous beds were left uneroded, but all of the Cretaceous in the northern and central counties is covered so deeply by later deposits that even if there were a possible favorable horizon in such upper-Cretaceous it would still be beyond the reach of the drill. There is no evidence that the Cretaceous which is within reach of the drill in northern Coos and Douglas counties is any more favorable than that exposed on the surface in the southern part of these counties.

EOCENE

Overlying the Cretaceous are the Eocene deposits which have been divided into three divisions, the Umpqua, the Tyee, and the Coaledo. The lowest member, the Umpqua, is made up of from 1000 to 2000 feet of conglomerate beds in Coos and Douglas counties where the lower Eocene is exposed. Over this is from 200 to 1000 feet of sandy shale containing wood fragments. Nothing was found in the Umpqua that could be regarded as favorable for a source of petroleum products. Tests made of the best of this shale did not show a trace of oil and none of it was found to be at all favorable in carrying any great amount of organic remains.

The Tyee overlies the Umpqua and is essentially a sandstone member with occasional thin muddy shale beds between the heavier sandstone layers. The Tyee generally is a thick, rather lifeless, sandstone that makes up much of the central part of the Coast Range from Coos to Tillamook county. In Coos county it measured 2000 feet thick between the top of the Umpqua and the bottom of the overlying Coaledo. North of Coos county, in Lane county, over 5000 feet of Tyee was found, and in Lincoln county over 4000 feet, and neither of these measurements gave the complete thickness of this member. The shale beds in the Tyee are lacking in evidence of organic remains that could be regarded as being a source of petroleum.

Traces of Oil Near Town of Florence

In one locality traces of oil have been found in the Tyee in Lane county near Florence, Oregon, on the Johnson ranch, which is located on the east side of the North Fork of the Siuslaw river about six miles from the town of Florence. The oil was found filling some of the cavities of a vesicular volcanic sill or dike which is exposed on the hillside about a quarter of a mile back of the ranch house. At two places this intrusive rock has been exposed by short open cuts. Traces of clear yellow thick oil are found filling tiny spaces and cracks in this volcanic rock.

This volcanic rock has been intruded so as to lie immediately above a dark bed of shale about four feet in thickness. Where exposed it is in contact with the shale. At the ranch we were told of one oil-filled cavity the size of a walnut being found, but at the time of the visit of the writer only a few pieces of the igneous rock could be located that contained any oil and this was in cavities not larger than grains of wheat.

While no fossils could be discovered in the underlying shale bed it is possible that it is the source of the small amount of oil, and that the oil has been forced from the shale through cracks in the igneous rock to fill such cavities as could be reached. No trace of oil could be found in the sandstone that is above the igneous intrusion nor other evidence of oil in any of the other formations in this vicinity. These traces of petroleum are of interest in showing that material has existed in the Tyee here that could under favorable conditions produce a trace of real oil but there are no indications that oil has ever been produced by the rocks in this region in quantities sufficient to make it of commercial value.

As has been stated, the Tyee is very largely made up of porous sandstone throughout and even if the occasional thin shale beds were all possible sources of oil, it is doubtful if enough oil would be produced in any part of the Tyee to be of commercial importance. But a careful study of the Tyee in many exposed sections throughout western Oregon has shown that the shales are not of a satisfactory character to produce any oil and the small traces found on the Johnson ranch cannot be regarded as being an indication that commercial quantities of petroleum will be found in this formation.

Overlying the Tyee in western Coos County, is the Coaledo and this marks the upper part of the Eocene period. In this region, there is 4000 feet of Coaledo made up of fresh water sandstones and shales with occasional brackish water shale beds. In the upper part of the Coaledo are a number of coal beds. A study of the beds of shale and sandstone, and tests of the more favorable looking shales failed to show any part of the Coaledo that could be regarded as a source of petroleum in commercial amounts, as none of the samples gave even a trace of oil. The sandstone members of the Coaledo, even when the structure is favorable for oil concentration, contained no evidence of ever having been the container of oil. The subject of oil seeps will be taken up later but it should be noted that in Coos county there are a number of folds which are so cut that there should be live seeps if any part of the Coaledo is productive of oil. But nowhere in the Coaledo was it possible to find petroleum seeps or signs of petroleum residue. As the pitch coal of Coos county has been the cause of attempts to develop oil in this region, an investigation was made of the occurrence of this material.

The "Pitch Coal" of Coos County

In the coal beds of the Coos Bay region the miners have occasionally found small seams and narrow veins of what they call "pitch coal." These usually occur at or near broken or faulted areas in the coal beds. This "pitch coal" is a dull resinous brown to brownish-black in color; when powdered it has a very resinous feeling, and when lighted with a match burns like a tar or pitch product.

It was described by J. S. Diller when he made the examination of the Coos Bay coal field and samples were at that time thoroughly analyzed by W. C. Day.* Mr. Day in his report says:

"Briefly stated, my conclusions are that the pitch coal is a variety of asphaltum, and that it has not been formed from the coal alone with which it is associated, although vegetable material similar to that which yields coal may have formed some of the original material which, by a process of distillation, was converted into the pitch coal."

Because this "pitch coal" does contain some material which seems to be a variety of asphaltum, it has been given considerable attention as

* Day, W. C., 19th Annual Report, U. S. Geol. Survey, Part III, pp. 270-376, 1899. Results of tests given.

furnishing a slight indication of asphaltic oil for this region. In the present examination, the Libby mine was visited but at the time of examination, July, 1919, the miners were unable to find any "pitch coal." The miners all seemed quite familiar with "pitch coal" although they stated that it was not of common occurrence and when found it was usually at or near faulted places in the coal beds. The "pitch coal" at times had been found making up a small part of the main coal bed and at other times in the well-defined seams cutting through the coal bed. These seams of pitch coal had been known to extend into the caprock above the coal bed but none of the miners ever found the seams going below the coal into the underlying sedimentary beds.

If the "pitch coal" should be seriously regarded as indicating a possible supply of asphaltic oil underlying this coal region, then the seams in which it is found should cut through the beds underlying the coal and show a connection with such an underlying source. Nowhere could the writer find evidence that this pitch coal came from any source but the coal beds proper or by combination with the coal and the beds lying immediately under the coal.

In the examination of this region it was found that the coal beds at times lie just above beds containing marine or brackish water fossils, and it seems possible that with faulting these fossil beds might have been the source of small amounts of asphaltic material that could have united with distillation tar products from the coal and thus have produced the small veins of "pitch coal." During this examination only one vein of pitch coal was seen and this was in the Knight coal vein at Riverton. Samples of this and samples from the Libby mine are, in all physical tests, tar distillation products rather than asphaltic.

An examination of a thickness of more than 10,000 feet of sediments underlying the coal through to the metamorphic beds certainly shows no shales of a satisfactory character to be a source of oil in commercial quantities, and there is no indication that any of these underlying beds have ever produced or contained oil in commercial amounts.

From all of the evidence obtained and from tests made in this investigation it can be stated that the "pitch coal" is in part, if not almost entirely, a product of the coal veins themselves and if it does contain some variety of asphaltum this asphaltum has been derived from organic remains in beds very closely associated with the coal beds. The sedimentary beds below the coal give no indication of having contained asphaltic oil or of ever having been the source of oil in commercial quantities.

The Eocene sedimentaries of conglomerate, sandstone and shales with a total thickness of more than 9000 feet are exposed as the surface rock in most of Coos, Douglas, Benton, Lane, Lincoln and part of Polk counties. In the exposures in southern Coos and Douglas counties, most of the Eocene has been removed by erosion and the thickness overlying the Cretaceous varies from nothing to the total of more than 9000 feet. In Yamhill, Tillamook, Washington, Columbia and Clatsop counties, the 9000 feet of Eocene is generally covered by from nothing to more than 10,000 feet of the younger beds of shales, sandstone and conglomerates.

The entire Eocene offers no evidence that is favorable for the production of petroleum in commercial quantities. Wells sunk in it in Coos county have found traces of inflammable gas but there is enough vegetable organic matter throughout the shales and sandstones of the Eocene to produce the small amounts of gas encountered in these wells.

OLIGOCENE

As already stated, the south half of western Oregon was above sea-level during the Oligocene period, and it is only north of an east and west line through Eugene that the deposits of Oligocene are of importance. The Oligocene is exposed on the surface along the west slope of the Coast Range in Lincoln, Tillamook and Clatsop counties and on the east slope in Columbia, Tillamook, Washington, Yamhill, Polk and Benton counties.

In Section C-C, Plate 4, there is a thickness of about 7500 feet of Oligocene from the top of the Eocene to the bottom of the Miocene. The Oligocene was divided into three periods, the Toledo, the Yaquina, and the Acila shales.

The oldest and lowest division, the Toledo, consists of nearly 3000 feet of tuffaceous shales and sandstones. This entire thickness is made up of beds carrying almost no evidence of organic remains and there is a lack of indications of marine life. The great deposits of tuffaceous material were doubtless very unfavorable for the growth of much animal or vegetable life and the entire Toledo presents no material that would be encouraging as a source of petroleum products.

The middle division of the Oligocene called in this investigation the Yaquina, measures 2300 feet in the Section C-C, Plate 4. The lower 1300 feet is made up of coarse-grained sandstone, the upper 1000 feet is fine-grained bluish-colored sandstone fairly rich in fossil shells of the Oligocene period. In no part of northwestern Oregon where the middle Oligocene could be studied was it of a good character to be a source of oil.

The top member of the Oligocene was given the name of Acila shales because in the first section measured near Newport, it was found to be a dark-colored shale rich in fossil *Acila shumardi* shells. In this section, from Yaquina to Newport in Lincoln county, a thickness of 2100 feet of Acila shales was measured. This shale has great numbers of fossil fish scales and is quite generally rich in organic remains. The shale is fine-grained, and when fresh, a dark gray in color. Fresh fractured broken. This shale in the vicinity of Newport is a possible source of petroleum products if it can be found to have overlying it a porous reservoir bed, and, furthermore, properly folded and capped with an impervious layer to retain any accumulation of oil.

Miocene deposits overlie the Acila shales in the vicinity of Newport. These are dense sandy shale deposits largely composed of fine-grained tuffaceous material. This would be a good impervious capping but is not of satisfactory character as a reservoir material. The structure north and south of Newport as far as the Acila shales are exposed is a monocline dipping gently toward the west. For this reason, the overlying Miocene beds generally cover the Acila shales along the Pacific Coast line. At no place were there favorable folds in the Miocene where it covered the Acila shales and it is doubtful if such structure exists in this region as it is all part of the major structure of that part of the coast, namely, monoclinal.

There have been such frequent rumors of oil being found along the beach near Waldport that it may be possible that at some distance out to sea these Acila shales have been covered by a more favorable phase of the Miocene sediments and that a fold does exist under the Pacific which is seeping some oil. In this investigation difficulty was experienced in actually finding any evidence of real crude oil along the shore near Waldport, but the local inhabitants state that these oil showings are usually found after a strong coast storm in the winter.

The Acila shales forming the upper part of the Oligocene are found on the west slope of the Coast Range in Tillamook and Clatsop counties, and on the east slope in Yamhill, Tillamook and Columbia counties. In all of the other exposures of Acila shales found the shale was of a more sandy character and did not have the favorable petroleum odor observed near Newport. Volcanic intrusions so frequent in Tillamook, Clatsop, Columbia and Yamhill counties have broken through many of the anticlinal folds in the sedimentary rock. If in all of these counties there is one fold in which the Acila shale could be a source of oil under favorable conditions for accumulation and concentration, there are without doubt many folds that have been broken by volcanic intrusion or by erosion. There should be, under these conditions, innumerable oil indications in the form of seeps or sand showing oil residues. This is not the case, inasmuch as no real oil indications were seen in these counties and none of the inhabitants who have been interested in oil prospecting could be found who could show a real indication of oil.

MIOCENE

The Miocene is a marine deposit along the shoreline of the Coast counties where it is rarely over 500 to 800 feet thick. It is tuffaceous in character, being largely a series of sandy shale layers. As a source of petroleum, it offers no possibilities and is of interest only because it lies immediately above the Acila shales. Its qualifications as a reservoir for oil produced by the Acila shales has already been discussed, and with the exception of this one possibility, the Miocene deposits of western Oregon are of little importance in the question of petroleum development. The Pliocene and Pleistocene also are of no importance in this investigation, except that they are generally unconformable to the older sedimentaries that they overlie, and for this reason prevent the working out of good structural maps of geology in such regions where they cover the older formations.

JACKSON COUNTY

North of Medford, and as far south as Ashland, attempts have been made from time to time to find petroleum in Jackson county. As the more recent sedimentaries of this region are somewhat cut off from the balance of western Oregon by the basaltic flows and outcrops of older Pre-Cretaceous metamorphic rocks, Jackson county has been treated as a separate problem. It should be stated, however, that the range of sedimentary rocks in Jackson county extends from the Pre-Cretaceous metamorphics to the Upper Eocene and possibly Post-Eocene tuffaceous beds. These different horizons are so much like those already described in this report that there is really little reason to justify a repetition of the discussion of the Pre-Cretaceous, Cretaceous and Eocene as found in Jackson county.

The Pre-Cretaceous in Jackson county makes up the larger part of the Siskiyou mountains. It consists of metamorphic rocks, namely, schists, slaty shales, quartzites and serpentine. These have been cut by innumerable quartz veins, large and small, which, in some localities, are of so frequent occurrence that they give at a distance a whitish appearance to the entire exposure.

There is marked evidence that during Cretaceous time the Siskiyou mountains existed as a land mass and that in Jackson county numerous high points in the pre-Cretaceous metamorphics stood as islands above the sea-level. The Cretaceous sediments now exposed are found in a narrow area along the west side of Bear creek from Ashland at the south to the Rogue river. The width of the strip is quite variable as the deposits extend back into all of the small valleys. The lowest Cretaceous found is made up of hard fine-grained sandstone in thin layers from two to five inches thick. Slabs of this sandstone are used for sidewalks and doorsteps in this county. It is gray-brown to buff-colored and is composed very largely of Pre-Cretaceous material. Over this is about 1000 feet of sandy blue-colored shale carrying marine fossils. The Cretaceous beds all dip gently to the east with a maximum of about 10 degrees, and where there is some slight folding indicated, the folds are low plunging anticlines with their axes dipping toward the east.

Eocene sediments cover the district to the west and north of Bear creek and can be traced as far east as the lava flows. Beyond the lava which caps the hills to the east is a great thickness of tuffaceous deposits lacking in evidence of fossil life which seem to be terrestrial deposits in age older than the lava flows. The entire Eocene identified includes about 9000 feet of conglomerates, sandstones, shale and sandstone with the upper part carrying small seams of coal. On top of this are tuffaceous deposits. The sequence of beds and the character of deposition agrees very well with the measurements of the Eocene in Coos county.

The conglomerate is composed of boulders of quartzite, chert, igneous rock and eroded Cretaceous material. The sandstone overlying the conglomerate is largely made up of reworked Cretaceous sandstone. Above the conglomerate-sandstone member there is about 800 to 1000 feet of shale like the Umpqua shale already described. It also is lacking in evidence of marine life and, as elsewhere, offers nothing favorable as a producer of petroleum. Above this is about 2500 feet of sandstone with some interbedded shale. This sandstone is light-colored and carries occasional wood fragments. It is quite micaceous, carrying much of white muscovite mica. At the top of the sandstone are conglomerate beds in places 12 feet thick. These are much like the basal conglomerate beds of the Eocene. Above the thin conglomeratic beds are tuffaceous sandstones which show thin coal seams. Over this is about 5000 feet of tuffaceous sandstone, the lower part being dark brown in color and containing many angular igneous fragments that do not show waterworn edges. These tuffaceous sandstones are capped by lava flows which are separated from them by about 100 feet of white volcanic ash.

The lava flows cut off further investigation of these beds. In structure, they all dip gently to the east and while minor folds are found the axes of all likewise plunge gently to the east. In Antelope creek east of the outcrops of Eocene, the lava cap has been cut through and the white volcanic ash is exposed. In Section 4, T. 38 S., R. 2 E., on Antelope creek, a few small seams of dried, hard asphalt have been found. This asphalt is so dry that the tuffaceous material alongside of the seams rarely shows any discoloration due to the asphaltic oils. The seams are very thin and to date only a small amount of asphalt has ever been found. Antelope valley shows many intrusive dikes and it is possible that some of these have by distillation of the underlying shale beds produced a small amount of asphaltic material that has by pressure worked its way up to the seams in the rock to where it is now found.

Conclusion

The Cretaceous and Eocene deposits of Jackson county are well exposed for study and throughout their entire thickness offer no horizons favorable as a source of commercial quantities of petroleum. This region with its gentle monoclinal structure and its open plunging anticlines should show innumerable indications of petroleum if such material exists or ever had existed in any quantity in Jackson county. The region is such an "open" one and is so easily studied that a careful examination is very conclusive that it offers no favorable territory for the production of petroleum products in commercial amounts.

NEHALEM WAX

Since about 1810 somewhat more than 12 tons of material known as Nehalem Wax has been collected in the vicinity of Nehalem in Tillamook county. This has very generally been put to the same use as ordinary commercial beeswax. Much of this material has been taken from a recent sand bed lying just above high-tide level near the beach town of Manzanita and it is still possible to find small amounts of the wax at this place. Occasional fragments of the wax have been picked up along the shore as far as 40 miles north and south of Nehalem.

In the Public Library of Portland, Oregon, may be found nearly all of the reports and articles that have been published in regard to this interesting subject. Probably the most complete and scientific investigation of this wax has been made by Professor O. F. Stafford, formerly professor of Chemistry, Oregon University.* In his report Professor Stafford presents very conclusive chemical evidence that Nehalem wax is a real beeswax of possible Philippine Island source, and that it should not be confused with ozocerite or other mineral wax.

Nehalem wax has played so interesting a part in the early coastal history of Oregon and enters into so many of the legends of the coast tribes of Indians that one is tempted in writing of it to spend considerable time discussing these legends, in which the story of Nehalem wax is so interwoven with early-day pirates, wrecked ships, fugitive sailors, Chinese junks, Indian tribes with red hair, the early fur traders, etc. But after investigating the actual occurrence of this wax in the undisturbed sand beds at Manzanita together with a study of the geology of the region, and after a careful review of most of the reports, tests, legends and articles that have been published on the subject, the writer is satisfied that Nehalem wax offers nothing that is of any importance in the discussion of oil possibilities of western Oregon.

*Stafford, O. F., Nehalem Wax—Portland Oregonian Sunday Supplement, Sunday, January 26, 1907.

VOLCANIC ACTIVITY

In the foregoing pages only occasional reference has been made to volcanic activity. The great areas that are covered by lava flows and the occasional remnant of some crater or volcanic vent are not of so much importance in this investigation as are the intrusive volcanic rocks that are found so frequently as dikes or sills in all of the counties of western Oregon. If there could be carried out in western Oregon a careful mapping of the igneous dikes and sills such map would present some very impressive reasons for doubting if commercial production of petroleum could be expected even if there were favorable sedimentary deposits to produce and hold the oil.

Igneous dikes and sills are generally regarded as a menace in petroleum territory for there is evidence in many areas where such intrusions occur that by their heat they have either burned out or volatilized and destroyed the accumulated oil. In other regions, igneous dikes have upon cooling left open seams and passageways through which the gas and oil could escape. In nearly all petroleum territory where there are igneous dikes that have not entirely destroyed the oil, there are oil seeps of great extent through cracks opened up by the intrusives.

A study of the igneous intrusions in western Oregon gives evidence that these have very rarely altered the surrounding sedimentary rock for a distance of more than a few inches; and it is doubted if they would, as a rule, have been destructive of petroleum products for more than a short distance beyond the limits of the intrusive material. But there is good evidence that most of these intrusions have made ideal passageways for the escape of petroleum products and western Oregon should, therefore, have an almost unlimited number of oil indications in the form of live seeps, or of the heavier petroleum residues. This, however, is not the case, and throughout the most careful search for such seeps or other indications no evidence of petroleum products has been found. So many springs of water and very often sulphur springs of deep-seated origin exist at or near the igneous intrusions that one is certainly justified in expecting to find oil seeps or traces of petroleum in these springs if such petroleum existed in any of the sedimentary beds cut by the intrusive material.

It should be noted that these intrusions have cut through all of the sedimentaries from the oldest metamorphic rocks up to the surface of the earth and have actually prospected the oil possibilities to a far greater depth than can ever be opened up by any oil well. The statement has often been made that no one can say whether Oregon can produce petroleum until the state has been thoroughly drilled by a great many properly-located deep wells. The truth is that nature has already opened up passages for oil by these intrusive dikes and many of them are found breaking through the very crest of anticlines and, therefore, ideally located for prospecting the petroleum possibilities of all the sedimentary beds cut by such intrusives.

OIL SEEPS

Oil seeps in any of the petroleum regions of the world have been known of and talked about by the local inhabitants long before the development of petroleum. The seeps in California were known to the Indians long before the arrival of the first white explorers and the earliest records of the first Spanish to explore California tell of the "strange springs of black pitch." These are the asphaltic oil seeps found in the coast counties of southern California. A description of some of these seeps is given by Professor Peckham* in telling of a region on the east slope of the Coast Range mountains about one hundred miles north of the town of Ventura, California. He says:

"I have examined some of the most extensive veins of asphaltum yet discovered. They have been traced across the country continuously for miles and have been mined to a depth of more than 300 feet. In chemical composition the asphaltum bears a specific relation to the petroleum of Ventura county. They both contain the esters of the pyridine bases. These asphaltum veins lie on one side of, and irregularly parallel with a stratum of sandstone, which, like all of the strata of that region, stands nearly vertical. Along this sandstone stratum bitumen exudes for a long distance. Against it, and on the other side of it, rests a bed of infusorial earth at least 1000 feet in thickness, in some places saturated with bitumen, but for the most part clean and white. These formations extend across the country parallel for miles with the general trend of the Coast Ranges. Enormous springs of maltha, issuing therefrom at intervals, have produced at several points flood plains of asphaltum that fill the small valleys like a glacier, many feet in depth and square miles in extent. The maltha is invariably accompanied with water, and at several points there are evidences that at some period in the past history of those outflows the springs that are now cold have been gigantic hot springs of silicated water similar to those that I believe produced the famous Pitch Lake of Trinidad."

The description of Professor Peckham has been given to show the kind of evidence of petroleum to be found in a region that is badly broken so as to allow the free escape of the crude oil. It is true that there are many very productive oil territories in the United States where no oil seeps are to be found but such oil regions are in gently-folded sedimentary beds that are free from breaks or leaks of all kinds and their geologic structure cannot be likened to that found in western Oregon.

In general the geologic structure of western Oregon is much like that found in California and it should reasonably be expected that if oil does exist in Oregon there would be innumerable seeps, as there are in the oil regions of California. It should be noted that the California oil regions are not broken by volcanic intrusions as are found in Oregon,

* Peckham, Professor, Proc. Am. Philosophical Soc. Vol. XXXVI, No. 154, pp. 110-111.

and really, with these intrusions, if oil were to exist in Oregon there ought to be even a greater showing of seeps than found in California.

The igneous rocks of Oregon are generally rich in iron salts and this is also true of many of the sedimentary beds. These dissolved iron salts often give rise to a thin scum or film on the surface of quiet pools of water and throughout the state have frequently been regarded as oil seeps. Decayed vegetation will at times form a jelly-like mass in the bottom of springs and pools of water and this has frequently been reported as being "something like vaseline" and regarded as an indication of oil.

The Oregon Bureau of Mines and Geology, through the press, announced that an investigation would be made for petroleum in western Oregon and requested any who knew of oil indications to write to the Bureau. Answers came from every county in western Oregon and as far as possible the field forces visited and examined reported indications. In addition, as the field parties worked over the different parts of the area, the people were questioned as to their knowledge of oil indications and these were visited. Of all the reported oil indications examined during the investigation about 95 per cent were iron scums and the balance largely showings of decayed vegetation or odorous mud, which bear no relation to the occurrence of petroleum.

In no place in western Oregon was there found to be a live oil seep or any favorable indications of petroleum residues, except the oil trace described near Florence in Lane county, the Acila shales near Newport, and the asphalt found in the tuffaceous beds in Jackson county. These have already been discussed under other headings.

An oil seep, on the North Fork of the Yamhill river, above the McMinnville bridge about a quarter of a mile, was reported to the Bureau of Mines by J. W. Tilden. This spring had floating on its surface a layer of clear oil having the odor of kerosene. A sample of this oil was taken from the surface of the spring by Clarence B. Osborne on August 27, 1919, and sent to the Bureau of Tests and Inspection in Los Angeles, California. The sample was found to contain two per cent foreign matter in the form of water, leaves, dead insects and inorganic material. The remaining 98 per cent was kerosene of the commercial grade of "lantern oil." It had the same specific gravity, the same initial and final boiling points, the same flash and burning points, and the same odor and color as kerosene.

Kerosene is a highly specialized manufactured product and a pure kerosene seep would by the action of nature be extremely improbable. The nature of this seep and the character of the oil were such that the necessary time was not spent to determine how this lantern oil was reaching the spring.

FINAL CONCLUSIONS

A study of the rocks which make up western Oregon from the Pre-Cretaceous metamorphics through the layers of Cretaceous, Eocene, Oligocene, Miocene and Pliocene has shown only one horizon, namely, the Acila shales of the upper Oligocene, that could be a possible source of petroleum products in commercial quantities. Only in the region near Newport in Lincoln county were the Acila shales found to be of a favorable character, and here there was a lack of a good overlying porous sandstone to act as a reservoir. There was in this locality a lack of proper folding also to make possible the accumulation of petroleum products to be of commercial importance, even if these shales had been overlain by a good reservoir sand and a satisfactory capping layer.

In this investigation the Acila shales offer the only favorable source of oil and, without the other necessary conditions being fulfilled, there is little to hope for from them. While only the Newport region was found to have the Upper Oligocene of a favorable nature, it is possible that in the coastal region north of here the other necessary requirements may be fulfilled. It was not possible in this investigation to find indications that such an area does exist along the west slope of the Coast Range. East of the Coast Range in Columbia, Washington, Tillamook, Polk and Yamhill counties, the upper Oligocene where seen is not of a favorable character as a possible source of petroleum products.

In this investigation a careful study of the geologic formations and tests of the better looking shales failed to give any encouragement that western Oregon would have areas in which petroleum products exist in commercial quantities. The lack of satisfactory indications, in the form of oil seeps or the heavier residues, when considered with the fact that because of the generally broken condition of the formations there should be innumerable indications, leads to but one conclusion:—that hopes of productive oil fields in western Oregon are not founded on any satisfactory evidence that can be found by a careful study of the geology.

(Signed) HARRISON AND EATON,
By ARTHUR EATON.

Denver, Colorado, February 6, 1920.

BIBLIOGRAPHY OF THE GEOLOGIC PUBLICATIONS PERTAINING TO THE PETROLEUM INVESTIGATION

ANDERSON, FRANK M. Some Cretaceous Beds of the Rogue River Valley. Journal Geology, Vol. 3, pp. 455-468, 1895.
Describes the geography, stratigraphy and structure of the Cretaceous, with notes on the fossils.

ARNOLD, RALPH. Tertiary and Quaternary Pectens of California. U. S. G. S. Prof. Paper No. 47, 1906, p. 10. Tentative correlation table of principal marine Tertiary and Pleistocene formations of Oregon, Washington and California, 1905.

ARNOLD, RALPH AND HANNIBAL, HAROLD. The Marine Tertiary stratigraphy of the North Pacific Coast of America; Proc. Am. Phil. Soc. LII (November-December, 1913), 559-605, 12 pls.

CHAMBERLAIN AND SALISBURY. Geology, Vol. 3, 1906, Loess in Oregon, p. 414.
The Triassic on Pacific Slope, pp. 27-8; the Jurassic on Pacific Slope, pp. 61, 67; Correlation of Cretaceous on Pacific Slope, pp. 109, 122; Eocene of Oregon, pp. 201, 210; John Day beds in Oregon, p. 247; Oligocene beds in Oregon, p. 248; Miocene beds in Oregon, pp. 263, 266, 274.

CLARK, WM. BULLOCK. The Tejon Strata of Oregon. U. S. G. S., Bull. 83, p. 103, 1894.
Localities of.

CONDON, THOMAS. Oregon Geology. Portland, Oregon, 1910.

CONRAD, T. A. Fossil Shells from Tertiary Deposits on the Columbia River near Astoria. (Miocene species collected by J. K. Townsend), Am. Jour. Sci. 2d ser., Vol. 5, pp. 432-3, 14 figs., 1848.

DALL, W. H. The Miocene of Astoria and Coos Bay, Oregon. U. S. G. S. Prof. Paper No. 59, 1909.

DICKERSON, ROY ERNEST. "The Fauna of the Siphonalia Sutterensis Zone in the Roseburg Quadrangle, Oregon." Proc. Cal. Acad. Sci., Series 4 (December 30, 1914), 113-28, 2 plates.

DILLER, JOSEPH SILAS. Cretaceous and Early Tertiary of Northern California and Oregon. Bull. Geol. Soc. Am., Vol. 4, pp. 205-24, 1893.
Mainly California with reference to Oregon.

DILLER, JOSEPH SILAS. A Geological Reconnaissance in Northwestern Oregon. U. S. G. S. 17th Annual Report, Part 1, pp. 447-520.
Historical and structural geology, topography, historical notes, geologic formations, economic geology, the coal-fields, analysis of coal, building material.

DILLER, JOSEPH SILAS. The Coos Bay Coal Field, Oregon. U. S. G. S. 19th Annual Report, Part 3, pp. 309-76, 1897-8.
Location and size, topography, geology, structure, fossils.

DILLER, JOSEPH SILAS, AND OTHERS. Guidebook of the Western United States, Part D, The Shasta Route. U. S. G. S. Bull. 614, Washington, 1915.

DILLER, JOSEPH SILAS. The Roseburg Folio. U. S. G. S. Geologic Atlas of the U. S., Folio No. 49, 1898.
Describes minutely what is meant by the Klamath Mountains, topography, relief, geology and economic geology of Roseburg Quadrangle.

DILLER, JOSEPH SILAS. The Coos Bay Folio. U. S. G. S. Geologic Atlas of the U. S., Folio No. 73, 1901.
Boundaries, topography, geology and economic geology of the Quadrangle.

DILLER, JOSEPH SILAS. Topographical Development of the Klamath Mountains. U. S. G. S. Bull. No. 196, pp. 9-63, 1902.
Describes formation of Klamath Mountains, elevated beaches, marine deposits and earlier valleys of Southern Oregon rivers.

DILLER, JOSEPH SILAS. The Port Orford Folio. U. S. G. S. Geologic Atlas of the U. S. Folio No. 89, 1903.
Boundaries, general and economic geology of the Quadrangle.

DILLER, JOSEPH SILAS. The Rogue River Valley Coal Field, Oregon. U. S. G. S. Bull. No. 341, pp. 401-6, 1909.

FAIRBANKS, HAROLD W. Oscillations of the California Coast. The American Geologist, Vol. 20, pp. 240-1, 1897.

FULLER, M. L., LINES, E. F., and VEATCH, A. C. Record of Deep Well Drilling for 1904. U. S. G. S. Bull. 264, 1905, pp. 62-3.
Data of three wells in different parts of the state.

FULLER, MYRON L., and SANFORD, SAMUEL. Record of Deep Well Drilling for 1905. U. S. G. S. Bull. 298, 1906, pp. 1357-7.
Record for several wells in different parts of state.

HERSHEY, OSCAR H. A Curious Phase of Interstream Erosion in Southern Oregon. Science, new ser., Vol. II, pp. 614-5, 1900.

LEE, WILLIS T. Review of "The Coos Bay Coal Field, Oregon." By Joseph Silas Diller. Jour. Geol., Vol. 8, pp. 100-1, 1900.

LE CONTE, JOSEPH. On the Great Lava Flow of the Northwest and on the Structure and Age of the Cascade Mountains. Am. Jour. Sci., 3d ser., Vol. 7, pp. 167-80, April, 1874. Continued pp. 258-67. Also Proc. Cal. Acad. Sci., Vol. 5, pp. 214-20, 1873.

LOUDERBACK, GEORGE DAVIS. The Mesozoic of Southwestern Oregon. Jour. Geol., Vol. 13, No. 6, pp. 514-55, Sept.-Oct., 1905.
Defines horizons of quadrangles of Diller, between Cascade Range and Pacific Ocean.

LOUDERBACK, GEORGE DAVIS. Study of the Basin Range Structure and Glaucophane and Associated Schists of California and Oregon. Carnegie Inst. of Wash., Year No. 4, 1905, p. 191, 1906.

McCORNACK, ELLEN CONDON. A Student's Geological Map of Oregon, with Notes. Univ. of Ore. Bull., New Series, Vol. 3, No. 5, 1906.

MERRIAM, J. C., and SINCLAIR, W. J. The Correlation of the John Day and Mascall. (Abstract.) Jour. Geol., Vol. II, pp. 95-6, 1903.

MERRIAM, J. C., and SINCLAIR, W. J. The Tertiatry Faunas of the John Day Region. Univ. of Cal. publications, Dept. of Geol., Vol. 5, No. 11, pp. 171-205, Oct., 1907.
Discusses the stratigraphic succession and correlation of the Cenozoic formations in the John Day Basin of Oregon and their faunas, listing the vertebrate fossils by formations, and gives a bibliography of the geology and paleontology of the John Day region.

RAY, JOHN. The Older Coast Ranges with More Recent Geological Formations in Benton County. Corvallis, Oregon, 1892.
Describes occurrence of Eocene and Miocene in Benton County.

ROCKWELL, CLEVELAND. The Coos Bay Coal Fields, Oregon. Eng. & Min. Jour., Vol. 73, pp. 238-40, 270, 271, 1902.
Contains notes on the geologic structure of this area.

SMITH, WARREN D. Summary of the Salient Features of the Geology of the Oregon Cascades with Correlations between the Geology of the East Coast of Asia and that of the West Coast of America. Univ. of Ore. Bull. XIV, New Series, No. 16, 1917.

SMITH, WARREN D., and PACKARD, EARL L. The Salient Features of the Geology of Oregon. Univ. of Ore. Bull., Vol. 16, No. 7, July, 1919. Reprint from Journal of Geology, XXVII, No. 2, February-March, 1919.

STAFFORD, O. F. Nehalem Wax, Summary of Information, Historv and Tests of Nehalem Wax. Daily Oregonian, Sunday, Jan. 26, 1908. Portland City Library.

WASHBURNE, CHESTER W. Reconnaissance of the Geologv and Oil Prospects of Northwestern Oregon. U. S. G. S. Bull. 590, 1914, 111 pp., map.

WILLIAMS, IRA A. The Columbia River Gorge. Its Geologic History Interpreted from the Columbia River Highway. Ore. Bureau of Mines and Geology. Min. Res. Oregon II, No. 3 (November, 1916), 130 pp., 77 illustrations.

HENDERSON, CHAS. W., and WINSTANLEY, J. B. Subject index by Graham J. Mitchell, Bibliography of the Geology, Paleontology, Mineralogy, Petrology, and Mineral Resources of Oregon, University of Oregon Bull. New Series, December, 1912, Vol. X, No. 4.

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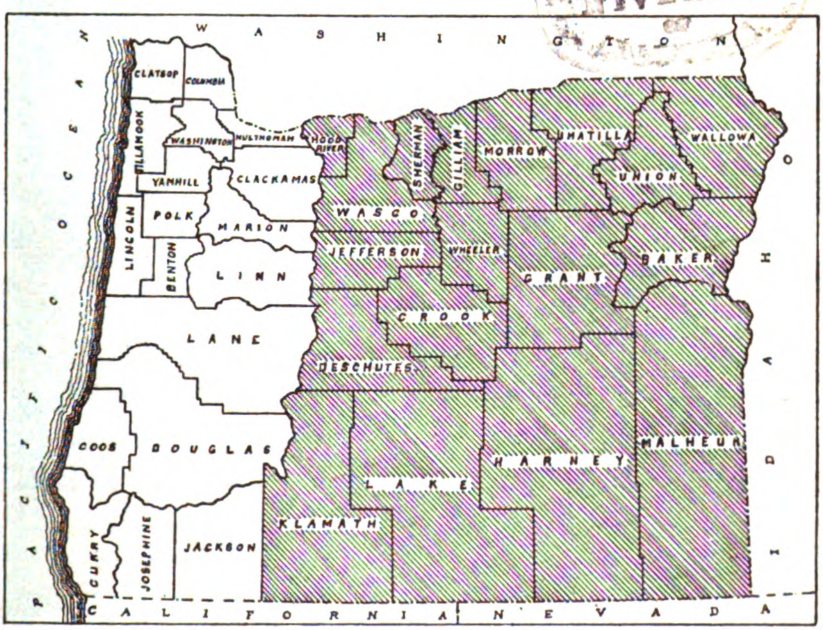

Sketch map of Oregon. Shaded portion covered in the oil and gas investigation.

REPORT ON

Oil and Gas Possibilities of Eastern Oregon

BY

JOHN P. BUWALDA.

IN CO-OPERATION WITH U. S. GEOLOGICAL SURVEY

Forty-eight Pages Four Illustrations

STATE OF OREGON

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ILLUSTRATIONS

INTRODUCTION

During the past ten or twelve years the annual consumption of petroleum and its numerous derivatives has increased enormously in the United States, due mainly to the expanded use of crude oil as fuel under boilers and the development of internal combustion engines and automotive vehicles. The use of natural gas as a fuel for producing heat and power has also greatly increased, so that it has long since come to be regarded as a very valuable commodity. As prices of crude oil have risen the natural response has been greatly increased production; but the increase of consumption of the liquid fuels has been even greater, amounting in 1920 to about 531 million barrels of oil. As a consequence, while we as a nation were a large exporter of oil a few years ago, in 1920 we imported nearly 100 million barrels, chiefly from Mexico, in excess of our exports of crude. The high prices and the hugh dividends paid by successful oil companies have created a strong interest among the public in oil-fields exploitation.

The people of eastern Oregon have been keenly alive to the benefits to be gained from the discovery of oil or gas in paying quantities in that region. The presence at certain localities of magnificent sections of stratified rocks resembling somewhat in appearance those from which oil is obtained in the California fields, and the occurrence of notable quantities of combustible gas in numerous springs, wells, and prospect drill holes, have encouraged the belief that oil and gas could be obtained if wells were drilled at the proper places and to sufficient depth. A considerable number of companies have been organized during the last ten years who have drilled holes to various depths at widely separated localities, and other companies are preparing to drill at the present time.

In view of these facts it seemed highly desirable that an examination of the geologic conditions and the evidence for the presence or absence of oil or gas in the various districts of the eastern part of the state should be made by a trained oil geologist. The Oregon Bureau of Mines and Geology accordingly entered into a co-operative agreement with the United States Geological Survey under which the expense of the work was shared by the two organizations. Dr. John P. Buwalda of Yale University, a geologist of experience, was employed to make the field investigations, on which he was engaged in the field seasons of 1919 and 1920. Additional information bearing on the oil and gas problem in the Ontario-Vale region was gained incidentally in the course of later studies in neighboring parts of Idaho during the summer of 1920.

The results of Dr. Buwalda's examination are published herewith by the Oregon Bureau as Number 2 of Volume 3, Mineral Resources of Oregon. This paper constitutes a general statement concerning the oil and gas possibilities of that portion of Oregon which lies to the east of the Cascade Range, while No. 1 of Volume 3, issued in March, 1920, covers from a similar standpoint all of Oregon between the Cascades and the Pacific Ocean. I regard the present report on eastern Oregon as a worthy complement of the western Oregon paper in that, so far as available knowledge can be brought to bear, it is a careful presentation of facts from which logical conclusions are drawn.

HENRY M. PARKS, Director.

VOLUME 3 NUMBER 2
JULY, 1921

THE MINERAL RESOURCES OF OREGON

A Periodical Devoted to the Development of All Her Minerals

PUBLISHED AT PORTLAND BY

THE OREGON BUREAU OF MINES AND GEOLOGY

HENRY M. PARKS, Director

REPORT ON OIL AND GAS POSSIBILITIES OF EASTERN OREGON

By JOHN P. BUWALDA

The only published reports on the oil and gas possibilities of eastern Oregon with which the writer is acquainted are two papers based upon investigations made by Chester W. Washburne,[1] then of the U. S. Geological Survey, about 1909, covering parts of the Vale and Harney valley districts, and a third, a short discussion by A. J. Collier[2] of asphaltum reported to have been found near Clarno in the John Day valley.

Certain districts where drilling has been or is being carried on, or is contemplated, as near Dufur, Ontario, Vale, Burns, Madras, Klamath Falls, and Lakeview, were inspected somewhat more carefully, but the examination of the larger part of the area covered was necessarily of a reconnaissance nature. Such reconnaissance sufficed for an appraisal of the oil and gas possibilities of many extensive areas since the writer had already acquired a first hand knowledge of the geology of the eastern part of Oregon during journeys across it in previous years and because the broader features of the geology of many of these areas had already been described by other workers.

The author is pleased to acknowledge the valuable aid received from the publications of other geologists, especially those of Bretz, Diller,

[1]Gas and oil prospects near Vale, Oregon, and Payette, Idaho. Bull. U. S. Geol. Survey, pp. 26–55, 1911.
Gas prospects in Harney Valley, Oregon. Bull. U. S. Geol. Survey, pp. 56–57, 1911.
[2]The geology and mineral resources of the John Day Region, Oreg. Bur. Mines and Geol., Mineral Resources of Oregon, vol. 1, no. 3, pp. 37–39, 1914.

Lindgren, Merriam, Russell, Waring, Washburne, and Williams. It has not been found practicable to cite references to all the publications from which information was gleaned in the course of the investigation.

The writer also expresses gratitude for the aid rendered him in the field by numerous public-spirited citizens, especially Mr. H. B. Cockrum of Ontario, Mr. D. W. Barnett of Madras, and Mr. H. M. Nolte of Lakeview.

This report does not pretend to be a contribution to the geology of Eastern Oregon but is a general discussion of the oil and gas possibilities of the various districts in simple terms for the non-technical reader. The geology of each district was reviewed in the field to obtain a basis for a judgment, and all reported evidences of the presence of either petroleum or natural gas were investigated. Large numbers of well logs which might have been included are omitted to economize space and because in the files of the Oregon Bureau of Mines and Geology in Portland many are available to those interested.

In the following pages the discussion of the oil and gas possibilities of the different districts is prefaced by brief statements relating to the nature and origin of oil and natural gas, the character and value of geologic principles in determining favorable areas, and the nature of the facts and principles used in the Eastern Oregon work. The units of discussion will be the various areas or divisions within which the geologic formations are more or less similar, at least so far as oil and gas possibilities are concerned.

NATURE OF PETROLEUM AND NATURAL GAS

Petroleum and natural gas are substances closely related chemically, even though the one is a liquid at ordinary temperatures, sometimes quite thick and viscous, while the other is an invisible gas. The principal constituent chemical elements of both are carbon and hydrogen; minor constitutents are often nitrogen and sulphur, and, more rarely, oxygen. Carbon and hydrogen are both very combustible elements, that is, they both unite readily with oxygen, and a great deal of heat is liberated when they combine chemically with that element. This is of course the reason why substances like oil, gas, coal, wood, and other materials made up chiefly of carbon, or of carbon and hydrogen, yield so much heat and power when burned, and it is the chief secret of their value to mankind.

Petroleums and natural gases differ from each other chiefly because of differences in the proportion of carbon and hydrogen present in them. Gas is composed to a larger degree of hydrogen, with relatively less carbon than has oil. The so-called lighter oils, which are generally more liquid in character and contain larger proportions of gasoline and lubricating oils and less asphalt and are hence more valuable, in turn contain more hydrogen and less carbon than the heavier oils.

Hydrogen is a gas and carbon a solid; mere mixtures of these two substances could not form petroleum or natural gas, which seldom contain any considerable quantities of free hydrogen. Carbon and hydrogen unite chemically, however, in definite proportions and form substances entirely different from either of the parent elements. For instance, if two atoms of carbon unite chemically with six atoms of hydrogen, a molecule of the gas ethane is formed. If nine atoms of carbon unite with twenty atoms of hydrogen a molecule of the liquid substance nonane is formed. Similarly if twelve atoms of carbon unite with twenty-six atoms of hydrogen a molecule of a solid paraffine is formed. Since the total number of possible proportions of the two elements carbon and hydrogen is very large, they form a long list of different substances. Some are gases; others are liquids or solids. Petroleum and natural gas are mixtures of these chemical compounds of carbon and hydrogen in indefinite proportion; the proportion of the different hydrocarbon compounds present determines whether the product will be a heavy oil, a light oil, or a gas. There is thus every gradation, as the proportions of the hydrocarbons vary, from the heavy oils to the very light combustible gases.

Since the different hydrocarbon compounds forming oil vaporize or volatilize at different temperatures, it is possible to separate crude petroleum into fractions, each made up of hydrocarbon compounds having about the same boiling temperature, by heating the crude petroleum gradually and condensing into different tanks the vapors given off at successively higher temperatures. In refinery practice crude oil is separated into such commercial fractions as naptha, benzine, gasoline, kerosene, distillate, light and heavy lubricating oils, vaseline, and paraffine or asphalt, many of which are mixtures. It is probable that some of the definite chemical compounds which can be isolated in the laboratory are produced by the decomposition or breaking down of other compounds existing in the crude petroleum.

ORIGIN OF THE NATURAL HYDROCARBONS

The existence of vast volumes of petroleum and natural gas within the crust of the earth has excited much interest, and anything like a general agreement among geologists as to their origin has been reached only within very recent years. It might at first be thought that these substances have always existed where they are now found, since the formation of the earth itself. But geologists are convinced that none of the rocks near the earth's surface, from which oil, coal, and the metals are mined, were part of the original surface rocks of the earth when it was first formed. On the other hand, these rocks have been formed in the later stages of the earth's history. The surface rocks have resulted either from the rising of molten material up to or near the surface and cooling and solidifying there, or from the deposition of fragments of waste rock worn off the land by the rivers, ice, and winds and deposited in the sea, or in lakes or river valleys as sedimentary strata. The oil and gas, which is practically always found in sedimentary beds, must also have originated during the formation of the beds or at an even later date, so that we are thus confronted by the problem of the *mode* of origin. It is important to know how the hydrocarbons originated because that knowledge will aid in determining the oil and gas possibilities of any area.

INORGANIC ORIGIN

Certain geologists and chemists have maintained that oil and gas were probably formed from rocks in the crust of the earth or at considerable depth containing large quantities of carbon compounds such as carbides. They argue that if water or other substances containing hydrogen came in contact with these rocks new chemical combinations might result, some of which would be hydrocarbons. These might concentrate in certain parts of the crust and form oil and gas pools. While such possibilities may be undeniable, little evidence has been brought forward to support this hypothesis, and relatively few geologists hold this view at the present time.

ORGANIC ORIGIN

While several modes of origin of petroleum and natural gas have been suggested, interest has centered chiefly around two. When oil first began to be produced in large quantities it was found, in most cases in the United States at least, in the same general regions which had been producing coal in large quantities. It was thus natural that the origin of the oil should be considered as related to that of the coal. But when oil was found in abundance in many areas where no coal was known and where it appeared improbable that coal existed, it was clear that the earlier explanation was not in general correct. It is no longer thought that the coal produced the oil.

Studies made largely during the last twenty years have shown that oil and gas are practically always found in sedimentary rocks, that is, rocks made from sand, clay, mud, or gravel which were carried into and deposited in the sea or in lakes or swamps, to be later compressed and hardened into sandstone, shale, or conglomerate. In most fields the oil is found in rocks which were deposited in the sea, or in nonmarine strata lying in contact with the marine rocks so that the oil could migrate from the latter; though freshwater beds are also to be considered as possible oil producers.

It has been found that in a large number of cases the sedimentary rocks in oil-bearing localities are made up in part of the skeletons or residues of organisms, many of them minute, which grew in the water, and of the partly carbonized fragments of plants. All these sank to the bottom and were buried in the accumulating sediments. At certain localities, notably in California, the oil and gas appear to be present in areas only where the rocks contain an abundance of the remains of an order of microscopic plants called diatoms; oil in considerable quantity has not been found in other regions even where all other geologic conditions are similar. It is thus the conclusion of most geologists who have studied the California fields that these particular organisms are, in this region at least, the chief original source of the petroleum and gas. Also, sinee most if not all of the great oil deposits are found in beds laid down in salt water, it is the belief of most geologists that oil originates only in beds formed in sea water. It is, however, to be noted that this view, which directly concerns the question of finding oil in Oregon, has not been proved and may not be correct.

When the small organisms have been buried in the sediments they do not decay like plant and animal remains commonly do at the surface of the earth. Decay consists for the most part of oxidation, the uniting of the oxygen of the air with the carbon in the decaying substances to form carbon dioxide gas, and the union of the hydrogen in the organic compound with oxygen, forming water. Carbon dioxide and water are the two most common products of decay but are usually accompanied by relatively small quantities of other gases having foul odors. Decay on the earth's surface is usually not direct oxidation by the oxygen of the air but is brought about through the agency of the bacteria of decay; these require moisture and hence moist climates hasten decay and dry climates retard or prohibit it. In the bottom of a body of stagnant water oxygen may not be abundant, and if the organic matter is deposited sufficiently rapidly or if it is quickly enough buried and sealed under muds, it does not decay and wholly disappear through oxidation but gradually decomposes or becomes transformed into a variety of substances, from which sooner or later petroleum and natural gas may result. How soon the oil is generated after burial of the remains is somewhat uncertain and, in part, is a subject of disagreement among scientists. Generation of petroleum probably goes on slowly for a long time, and may have been renewed at different periods. As a consequence shale, which is the type of rock usually richest in organic remains, is likely to contain a certain amount of oil wherever the original mud or clay enclosed an abundance of organic remains. But shale is not openly porous and no large quantity of oil can ordinarily be extracted from it through drill holes; concentration of the oil is required and this is brought about through certain geologic conditions to be discussed presently.

GEOLOGIC PRINCIPLES AS AN AID IN DETERMINING OIL AND GAS POSSIBILITIES

It seems desirable in a report of this kind, intended mainly for readers of whom many, perhaps the great majority, have had no technical training in geologic science, to indicate how geologic principles are used in judging the oil and gas possibilities of a given region.

During the past twenty-five years geologists have studied the geology of scores of oil producing districts in different parts of the world, and they have found that certain geologic conditions almost invariably accompany the production of oil or gas. The reasons why certain conditions should influence the presence or absence of the hydrocarbons are interesting, but it is the fact itself which is more important for practical purposes, and it is that which governs the well-trained oil geologist in reaching his conclusions regarding an area. The type of reasoning is not essentially different from that of the farmer who after long experience on the part of his forbears and himself has found that gravel and sand are not good soils on which to expect a heavy wheat crop and who therefore chooses loam or clay areas in which to carry on his agricultural operations.

The oil geologist similarly, from having noted the geologic conditions accompanying failures in exploratory drilling on the one hand and the conditions in the regions of successful drilling on the other, and having as well been educated by the experience of other geologists as stated in their published writings, is in a position to prophesy with a fair degree of accuracy what the chances of finding oil and gas will be. He can, moreover, indicate in a region of presumed small, mediocre, or large possibilities the most favorable areas, that is, the districts in which the chances are best for bringing in wells. To be sure, his judgments are not infallible, but oil companies the country over have learned through years of experience and the expenditures of enormous sums of money that the services of well-trained oil geologists are desirable if maximum production is to be secured.

The geologic factors and conditions concerned in a judgment of this sort are discussed in the following section, and it will be seen readily that the geologist uses no occult knowledge nor does he guess, but he utilizes his knowledge of the rocks of the earth, and applies common sense.

GEOLOGIC FACTORS CONCERNED

PRESENCE OF ORGANIC SHALE

Experience has shown that oil and gas are found almost invariably in a certain class of rocks. The rocks of the earth's surface are of three general kinds: igneous, sedimentary and metamorphic. Igneous rocks are those which have once been molten and have come up in that condition from deep down in the earth, either flowing out on the surface as lava and on cooling forming such fine-grained rocks as basalt or rhyolite, or not quite reaching the surface, and cooling under a cover of other rocks to form coarse-grained rocks like granite. Sedimentary rocks are formed for the most part from clay or mud, sand, and gravel which have been carried by rivers or by other means from upland areas into basins of deposition such as oceans, lakes or river valleys, where these fragmental materials accumulate in layers or strata. They are often known therefore as stratified rocks, and include shales, sandstones, and conglomerates. Metamorphic rocks are formed from either igneous or sedimentary rocks through alteration to such a degree that the original character is to some extent or sometimes almost entirely obscured. They are hence profoundly changed rocks, the changes being due to crushing during uplift or mountain-making, to heat, pressure, solution and re-precipitation, etc. Examples of metamorphic rocks are schists, marbles and slates.

Oil is not found, barring a few exceptional cases, in igneous rocks. This is not surprising, considering that igneous rocks have been molten, and therefore highly heated. The exceptional cases are apparently due to migration of the oil from nearby rocks of other types into the crevices of the igneous rocks and there is no reason to believe that it originated in the latter. Likewise, metamorphic rocks have commonly been so crushed, broken, or affected by solution and re-precipitation, that if they formerly contained oil or gas these would have escaped during the process of metamorphism. We do not find hydrocarbons in metamorphic rocks in important quantities.

The vast bulk of the oil and gas in different parts of the world is found in sedimentary rocks. All the evidence at hand suggests that in most cases it is formed from organic matter in shales, limestones and sandstones, but mostly, however, in such shales as are made up in considerable or large part of the remains of the small organisms already referred to. When such shales or earthy limestone containing organic matter are not found in an area, oil is not usually present in worth while quantities, and gas is rare in such amounts as exist in the important oil and gas fields. In drilling in a field the oil and gas are not usually obtained directly from the shales, but if such organic shales are absent the likelihood that large quantities of oil and gas will be secured is lessened.

Organic shales have originated in fresh water bodies as well as in the sea, but the fresh water shales do not usually contain liquid oil in notable quantities although they do often contain large quantities of solid hydrocarbons. Such are the oil shales of Colorado and Utah. Marine organic shale is therefore regarded by many geologists, including the writer, as, in general, favorable to the occurrence of oil in commercial amounts in a field, though its presence has not been shown to be necessary. The organic shale deposits should be preferably of considerable aggregate thickness. They are recognized as more or less clayey in substance, often dark brown or black in color due to the included organic matter, sometimes greasy when rubbed and commonly smelling like petroleum when broken open to fresh surfaces. Under the microscope the remains of the small organisms are usually visible. Such shales constitute one of the lines of favorable evidence for which oil geologists search in examining a territory.

In the course of geologic ages the organic debris in the rocks becomes gradually altered by the operation of dynamic forces within the earth so that progressive changes occur in the proportions of the carbon, hydrogen, and oxygen. These changes, marked by losses of volatile matter, are included under the terms "carbonization" and "metamorphism." They are the results of what is in effect, distillation of the organic matter in the buried strata by natural geologic processes attended by pressure and some heat. Gases and, supposedly, oils are products of these changes. When the carbonization and metamorphism have advanced too far, oil pools are no longer to be expected in the beds. This also is taken into account by the geologist.

POROUS SANDSTONES TO ACT AS RESERVOIRS

In general, shale is not a good reservoir for oil, because it is apt to be so compact and deficient in permeability by reason of the clayey matter of which it is composed that oil cannot readily move through it to escape into a well. Where it is less argillaceous it is more porous and may then serve as an oil sand though it seldom makes a good one. Usually the flow is relatively slow. More often there is no flow. This is well shown in most oil-fields.

The ideal underground oil reservoir is a porous rock which can hold large quantities of oil and gas in its open spaces and through which the oil and gas can flow freely to the drill hole and hence to the surface. It is for this reason that oil and gas are found in what are known as oil or gas sands, which are not particular kinds of sands but merely sands or sandstones or even porous shales, as noted above, which contain oil or gas. In some cases broken up or porous limestone strata or even honeycombed sheets of interbedded igneous rocks serve the same purpose. The oil or gas having been formed in the shale and limestone layers, move out of these into the porous sandstone or limestone zones lying over or under them, which then become the great underground reservoirs of commercial supply. Oil does not exist under the ground in great caverns or lakes, as is often thought, but merely fills the pores of open-textured rocks, or the solution circulation passages in such as limestone, from which it can be drawn freely through a well. The oil geologist, therefore, hopes to find in a prospective field not merely considerable thicknesses of organic carbonaceous shale, but between the shales sandstone beds also that are of sufficient thickness to serve as the oil reservoirs.

ANTICLINES AND DOMES

Experience has shown that oil and gas are not found evenly distributed throughout areas containing strata of favorable composition and physical condition, but that they usually occur under regions where the rocks have been arched upward, forming anticlines or domes. Shales and sandstones are deposited in nearly-horizontal sheets, each bed ranging in thickness from almost nothing up to several hundred feet. Later, however, as the result of lateral pressure, or for other reasons, these sheets are often warped or folded as sheets of paper will be when the ends are pushed toward each other. The arches are called anticlines; the troughs synclines. In other cases limited portions of what were once horizontal strata, have been pushed up apparently by pressure from below, above the general level of their continuation in the surrounding country; these are domes. Stated in simplest terms, gas is usually found in the highest part of the sandstone in the anticline or dome; below the gas lies the oil, also in the sandstone, and beneath the oil is usually water, commonly salt to some degree. This arrangement is undoubtedly due to the fact that gas is the lighter of the three, and the oil is lighter than water.

Oil has been found in strata not forming anticlines or domes. Sometimes it occurs beneath terraces as in Oklahoma, these being formed simply by the flattening of beds which otherwise have a uniform dip in one direction over large areas. It is sometimes found in synclines or troughs but not commonly. Lastly, oil has also been found under a considerable variety of structural conditions.

The reason why oil and gas are found largely in anticlines and domes is because these structures tend to concentrate the oil and gas into relatively small areas. When the hydrocarbons in the shales, where as indicated above they are largely inaccessible so far as extracting the oil and gas is concerned, migrate in part into the adjoining sandstone strata which lie horizontally, they are still distributed over large areas and the amount in the sandstone would in most cases probably be insufficient to produce commercial wells. But if the strata are folded into anticlines or domes and saturated with water as they usually are, the oil and gas on emerging from the shale into the sandstone find themselves surrounded with a medium heavier than themselves, and by gravity tend to rise in it as a piece of wood might do if liberated from one's hand at the bottom of a filled tub of water. Rising means movement within the sandstone stratum toward the top of the dome or anticline, for the shale which overlies the sandstone is more or less completely impermeable to the oil and gas and tends to oppose the further vertical passage of these hydrocarbons. Movement of the water aids the latter in their motion up the sides of the folds. Hence the hydrocarbons progress toward the tops of the anticlines and domes from the whole area of the sloping sides and thus bring about accumulation of the oil and gas, a very fortunate circumstance for mankind.

The pressure in the anticlines and domes, which is usually known as rock pressure and often drives out the oil and gas and causes thereby oil and gas springs and flowing wells, is not believed to be due in reality to the weight of the overlying rock at all; in my opinion, it is due to the fact that as the organic matter decomposes to form the oil and gas, solid material is being changed in part to a gas which naturally needs a larger space, and a certain degree of pressure is thus produced. The case is similar to the decomposition of preserved fruit in a can; the gas pressure often bursts the receptacle.

Having indicated here the important role which anticlines and domes commonly play in the accumulation of oil underground, it ought to be pointed out that anticlines and domes are not necessarily hills or ridges on the landscape. Hills are formed of course when the strata are folded rapidly but they are often worn entirely away by streams and other erosional activities, so that often a region is a plain or even a valley and yet has anticlinal or dome structure in the strata beneath it. The oil geologist in search of anticlines or domes in an area of sandstones or shales does not therefore simply seek ridges or round hills; he searches for areas where the outcropping rocks dip away in both directions from a line or in all directions from a point, the former indicating the anticline and the latter the dome. Surface topography often has little or no relation to the underground structure which governs the accumulation of the oil and gas.

OTHER FACTORS

Besides the presence of organic shales, preferably marine, porous sandstone beds interstratified with the shales, and anticlinal or dome structure, there are certain other field evidences favorable to the possible occurrence of oil or gas in a region. Such are oil seeps, oil springs, gas springs, presence of tarry material in the edges of outcropping strata, or of solid bituminous substance in veins or seams in the strata.

Seepages of oil are commonly characterized by accumulations of black or brown tarry material representing the heavier parts of the oil that are left after the light constituents which make up gasoline and kerosene have evaporated. This accumulation may weather to a light gray color so as to effectually conceal the character of the material which composes it, and even oil-impregnated sandstones may give no hint by their surface appearance that they were once saturated with live petroleum. Weathering rarely penetrates far from the surface, however, and a fresh fracture commonly not only reveals a brown or black color but liberates sufficient gas to give the characteristic smell of oil. Very light or thin oil with a paraffine base may not leave any tarry accumulation, and seepages of the liquid may be light brown to lemon yellow in color, in contrast to the blackness of most asphaltic oils. The presence of residues from such oils in sandstones which they have impregnated may sometimes be determined only through chemical tests, and through the petroleum odor of freshly broken surfaces of the oil-bearing rock. Oils that are clear or transparent have never been detected in seepages, and reports of natural occurrences of such oils in seepages can justifiably be doubted.

Oil springs are among the commonest supposed evidences of oil reported by the people living in a region under investigation. Oil in water wells may be grouped with these, since wells are in a sense only artificial spring holes. There is little difficulty in recognizing an oil spring; oil comes to the surface of the water as drops of amber, brown, or nearly black material, usually floats to the side of the pool and adhering there loses its lighter constituents and becomes a tar. The oil spring is therefore very commonly surrounded by viscous to solid asphaltic material. The water commonly has an iridescent or multicolored film on it characteristic of oil. By far the great majority of springs reported by interested people as showing signs of oil have films on the water which are often iridescent, but the films are not oil. They usually represent an iron compound which has been in solution in the water and which on coming in contact with the air at the surface has become insoluble and thus formed the film. Iron in the form of rust-colored material often coats the bottom of such springs or pools. The iron film can be distinguished immediately from a true oil film by pushing a stick through it; if it cracks and breaks into angular patches on the surface of the water it is iron or some other substance not oil. This is a simple test.

Gas springs and both artesian and common water wells are often cited as evidence of oil and gas in a region. In all three cases bubbles of gas sometimes rise through the water which it may even be possible to ignite as they burst on the surface, with a resulting explosive sound of greater or less distinctness. If the gas issues in sufficient quantity it is sometimes possible to pipe it for domestic use in nearby buildings. The quantity and the composition of such gas determines whether it is to be considered as suggestive evidence of the presence underground of quantities of oil and gas. If it issues in large amounts and at considerable pressure, and the pressure or amount do not decrease rapidly with time, it may be inferred that considerable quantities of gas possibly fill the porous rocks underlying the region and that it might pay to drill for such a gas supply at nearby points. If the gas consists almost entirely of the constituent methane or marsh gas, as is the case with gas showings in large areas of the country, it is not a favorable suggestion as to the presence of oil accompanying it. Marsh gas is commonly known as dry gas. It is usually derived from wood, leaves, and other vegetable material buried in the sediments at the time of their deposition. Larger or smaller quantities of it issue from a large fraction of all deep wells drilled in freshwater sediments.

In the neighborhood of oil-fields the outcropping strata are often impregnated with oily or asphaltic material which is commonly brown or black in color. This material represents residues left after the evaporation of the lighter constituents of the oil which filled these beds. It is therefore first hand evidence at least of the former presence of oil in the region, and suggests strongly that oil may exist in commercial quantities in neighboring areas at the present time. It indicates that the proper formations are present in the region for the formation of oil. While the material in the outcrops may evidence the dissipation of that particular body of oil, the general region is likely to contain reservoirs from which the petroleum has not yet escaped.

The presence of veins or seams of bituminous substances are likewise suggestive evidence for the presence of oil in the general region where they occur, unless regional carbonization has advanced too far.

From the foregoing remarks it is apparent that the more favorable indications of the presence of petroleum and natural gas in a territory are the existence in it of notable quantities of organic shale, especially marine shale, the presence of porous sandstones to act as reservoirs, gentle folding in the strata by which anticlines and domes are produced, and oil seeps and oil-impregnated strata.

It is scarcely necessary to mention that the so-called divining rod and other similar devices, held in the hands of self-styled "oil experts" and claimed by them to indicate, by pointing, the position of oil or gas pools, are absolutely unreliable and valueless.

TOPOGRAPHIC FEATURES OF EASTERN OREGON

Nearly two-thirds of the area of the state of Oregon lies east of the Cascade Range. This portion is commonly known as Eastern Oregon. Topographically most of it is a plateau. It rises from a few hundred feet above sea level at the Columbia river which bounds this portion of the state on the north, to general elevations of about 5,000 feet in the central and southern parts. Along its eastern border in the Snake river region the elevations descend to about 2,500 feet. To the northeast of the center of this plateau area lies a mountainous tract known usually as the Blue Mountains, the principal parts of which consist of a main ridge west of Baker trending roughly north and south and three east-west ridges extending westward from it and descending gradually in elevation toward the Deschutes river. The main ridge near Baker attains elevations of over 9,000 feet and is continued northeastward beyond Pendleton into southeastern Washington. The southern portion of the plateau also contains mountainous ranges extending northward from California and Nevada. Except for the mountains noted the plateau surface is quite even. It is mainly a sagebrush country due to its semi-arid climate.

OUTLINE OF THE GEOLOGY OF EASTERN OREGON

A sketch of the geology of each district will precede the discussion of its oil and gas possibilities in the following pages, but it is perhaps desirable to present a brief outline of the broader geologic features.

The whole plateau region, north, west, and south of the Blue Mountains is underlain by volcanic rocks of Tertiary age in the form of lava flows and interstratified tuff and volcanic ash beds. Associated with these at some localities, as in the John Day region and in the vicinity of Vale and Ontario, there are thick series of Tertiary sedimentary rocks which usually contain also large admixtures of volcanic ash. The lavas are believed to have issued from fissure vents rather than from craters; the ashes were probably blown out of these same fissures and spread over the surrounding country. The sedimentary beds both underlie and overlie the lavas and are hence believed to have been deposited by lakes and streams both before the lavas flowed out on the country and afterward on the surface of the lavas. Since the lavas and sediments were deposited they have been warped, folded, and faulted somewhat, and to varying degrees in the different parts of the plateau area.

The principal exception to the geologic conditions just enumerated occurs in the Blue Mountains, where there are high-lying areas of granite,

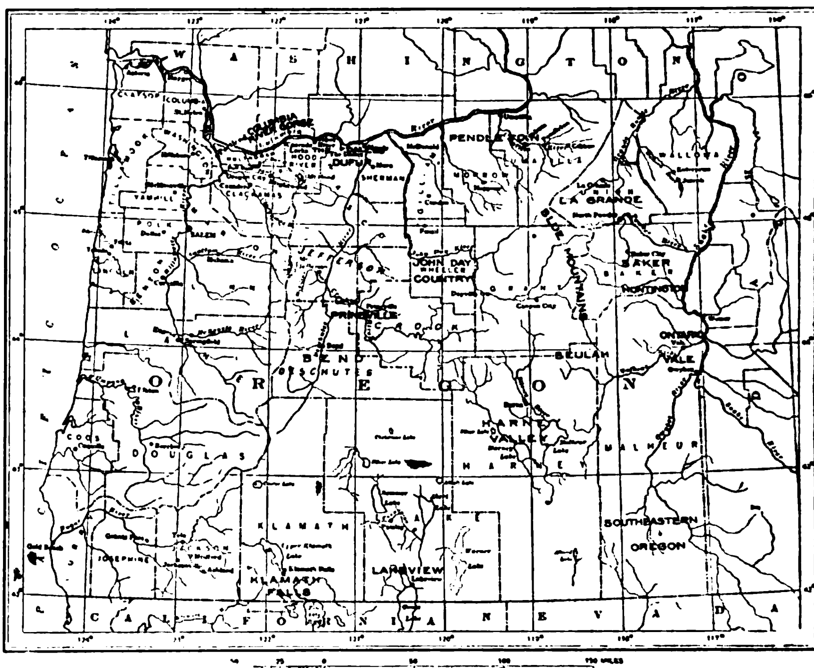

Fig. 1. Districts of Eastern Oregon discussed in this report.

Paleozoic and Mesozoic sedimentary rocks—all older strata than the Tertiary lavas, ashes, and sedimentaries of the plateau portion of the country. These areas of older rocks are, however, relatively insignificant in size as compared with the areas underlain by the volcanic rocks of the plateau. The older sedimentaries are acutely folded and considerably faulted.

The physiographic features of the country, such as the mountain ranges, valleys, plains and river canyons, are all relatively young, geologically speaking. They have been formed through crustal folding and erosion since about the end of the Miocene, that is, since the outflow of the most extensive of the lava series. It has been held in the past that the Blue Mountains stood as islands in this lava flood, but if so they were certainly much smaller and lower than at present, for the lavas still lie over much of the high areas and slope down the sides, indicating that the uplift has occurred mainly since, rather than before, the lava floods.

OIL AND GAS POSSIBILITIES OF THE DIFFERENT DISTRICTS

For purposes of discussion the eastern part of Oregon has been divided into fifteen districts based in part upon topographic and geologic considerations and in part upon the interest manifested in them by drilling and intentions to drill. These districts differ greatly in size and are not sharply marked off from each other.

A brief summary of the geologic conditions in each district will be given, followed by a statement of the exploratory drilling which has been done. A judgment as to the oil and gas possibilities will follow and the evidence on which it is based will be indicated.

COLUMBIA RIVER GORGE

The fact that oil and gas are commonly found in arches or anticlines in folded rocks has become rather generally known during recent years, even to those not technically trained in oil geology, and it is also a matter of common knowledge that mountain ranges are usually composed of a series of such arches alternating with downfolds or synclines. Presumably because of these facts a number of persons suggested to the writer during his investigation that the main fold of the Cascade Range, exhibited so beautifully in cross section in the Columbia river gorge, might contain oil and gas if properly drilled. The writer examined the gorge along both sides of the Columbia with this possibility in mind, and it seems desirable to give an answer to the above proposal here.

The Cascade Range trends north and south, and where the Columbia cuts through it, consists of three upfolds or anticlines separated by troughs or synclines, all trending roughly parallel to the Range itself. These folds are beautifully shown in cross section in the steep walls of the gorge, and have been clearly exhibited in drawings by Williams.[1] The major fold, the middle or axis of which lies somewhere near the

[1] The Columbia River Gorge: Its Geologic History, by Ira A. Williams. See "Mineral Resources of Oregon," published by the Oregon Bureau of Mines and Geology, vol. 2, no. 3, 1916.

town of Cascade Locks, is broad and forms the main ridge of the Cascades, but it is paralleled on the east by two sharper anticlines between Hood River and The Dalles which have steeper sides but are considerably narrower. The rocks which make up these folds consist mainly of lavas. The topmost or youngest rocks in the main fold, outcropping along the rim of the gorge, are basic lavas somewhat different from those found lower down in the face; they are termed andesites and basalts by Williams and Bretz. Beneath these sheets of lava lies a formation of river gravels, sands and ash prevailingly from one to two hundred feet thick. Under this gravel formation lie the great Columbia River basalt sheets, the main formation exposed in the gorge. The Columbia river flowed across this area before the Cascades were uplifted, and while they were being slowly upraised across its path it cut its great channel down through the 2,500 to 3,000 feet of basalts. It exposed beneath them a set of beds known as the Eagle Creek formation, made up mainly of volcanic ash, pumice, and other volcanic materials, along with sands, gravels, and shales. Its thickness is unknown because the river has not yet cut through it. The Eagle Creek formation is not of marine origin; its volcanic materials were for the most part distributed with the aid of fresh water. It contains fossil wood and fossil leaves.

No deep drilling has been done in the vicinity of Cascade Locks or Bonneville so far as the writer is aware. The exposed formations being dominantly volcanic in nature, obviously do not suggest the presence of oil or of gas in commercial quantities. The Coast Ranges west of Portland are composed mainly of marine strata, however, and these are interstratified with and extend under the lavas of the Cascade Range to a greater or less distance. It is possible that they underlie the Eagle Creek strata in the Cascade Locks and Bonneville region.

The prospects for striking oil in the gorge are nevertheless not encouraging. Even if the marine strata should extend beneath the Eagle Creek formation at Cascade Locks, there is little reason to think they will contain oil, for these marine beds where exposed over vast areas in western Oregon, have not to date produced oil in paying quantities. Furthermore, since the thickness of the overlying Eagle Creek formation is not known, they might even if present lie at such great depth that it would be impracticable to try to prospect them with the drill. Since the Eagle Creek beds are volcanic in character, it is not unlikely that lava flows would be encountered in them; this would make slow and expensive drilling.

It is quite possible that small flows of gas might be encountered in drilling in the Eagle Creek, since it contains a certain amount of fossil wood, leaves, and other vegetable matter, but the quantities derived from such sources are commonly not large or valuable.

If, in spite of the facts above adduced, there are still those who would wish to test out the gorge area with the drill, it might be suggested that the least undesirable locality in which to put down a hole would be near the axis of the fold, that is, at some point in the gorge between Bonneville and Cascade Locks, preferably a mile or two east of the mouth of Eagle creek. It should be recognized, however, that the chances for success are very slender.

THE DALLES

Several wells have been drilled in the past sixteen or seventeen years west of The Dalles at Chenoweth ranch and farther up Chenoweth creek, to depths ranging from about 100 feet to about 400 feet, to prospect for coal. The stimulus for this drilling was the report that a 15-foot seam of coal had been struck in a well on or near the Murray place many years ago at a depth near 400 feet. No oil or notable quantities of gas are reported to have been struck in these wells, but on account of the sedimentary rocks prominently exposed in the vicinity of The Dalles the writer examined the surrounding region in response to interest shown in the oil and gas possibilities.

The principal formations exposed in The Dalles region are, first, a sedimentary formation heretofore commonly known as The Dalles beds, consisting of white to gray and bluish white beds of sandstone and volcanic ash with some conglomerate strata; second, some basic volcanic rocks overlying The Dalles formation in the upper part of the drainage of Chenoweth and Mill creeks; and third, the Columbia River basalt underlying The Dalles beds and well exposed both north of The Dalles and to the west in the Columbia gorge. The lavas and overlying Dalles formation along the east side of the mountain west of Chenoweth creek dip eastward, but in the bluffs east of Chenoweth creek the sandstones lie approximately horizontal.

Since sedimentary rocks are the only types which need to be considered from the standpoint of oil possibilities, The Dalles formation above and such sedimentary beds as may underlie the Columbia River lava are the only formations in this region to deserve discussion. The Dalles beds are clearly of freshwater origin; they were apparently deposited in lakes and by streams. They may contain considerable amounts of vegetable organic matter but there do not appear to be among them strata which would originate petroleum. The structure, furthermore, so far as examined by the writer, is not favorable for oil accumulation, since the beds form a fold which is more nearly synclinal than anticlinal in form. The oil possibilities are therefore probably poor. Gas in small quantities might be produced by wells sunk into The Dalles formation, the gas coming from wood and other vegetable material buried in the formation at the time of deposition; but the experience of gas wells in freshwater deposits of similar character in other parts of the country does not encourage hopes of obtaining a large supply.

The chances of getting oil or gas from sedimentary rocks which may lie below the Columbia River basalt are conditioned by a number of uncertain factors: first, drilling through some 2,500 or 3,000 feet of basalt as exposed in the gorge to the west, a tedious and very expensive task; second, the uncertainty as to whether sedimentary beds underlie the basalt at The Dalles; third, the uncertainty whether oil or gas in important quantities would occur in the beds beneath the lavas, even if sedimentary beds are present there. There does not appear to be a basis for a more optimistic view regarding oil or gas beneath the lavas than regarding these substances in The Dalles beds resting upon them.

DUFUR

For more than fifteen years interest has been shown in the oil and gas possibilities of the Dufur region in northern Wasco county. At some time previous to 1907 the Dufur Oil Company drilled five holes, according to Mr. L. M. Smith of Dufur, about five miles west of Dufur on Fifteen-Mile creek. The writer found part of the casing in the ground and wreckage of derricks and machinery still remaining at three of these holes. The holes are reported to have been sunk only a few hundred feet. Farther west, on Ramsey creek, ten miles west of Dufur, the Beavis-May Oil Company drilled a hole in 1907 to a depth of 1,710 feet. The derrick is still standing. Another hole was drilled in April and May, 1919, about 200 feet from the first. It had reached a depth of 1,125 feet at the time of the writer's visit in July, 1919, and while work had been discontinued, the operators expected to resume drilling.

Geologic conditions in the Dufur region are essentially similar to those at The Dalles. The surface formation is a series of volcanic gravels, agglomerates, ash beds and sandstones, lying on basic lavas which are exposed to the west, the whole series dipping gently eastward in the region between Dufur and the wells on Ramsey creek. Like The Dalles beds the formation is not marine in origin but was formed as volcanic mud flows, by river deposition and in lakes. Small pockets of gas may be encountered in drilling through it, derived from vegetable material buried with the sediments, but the volcanic components of the strata, the lack of organic shales, and the absence of favorable structures for the accumulation of petroleum or natural gas in large quantities, indicate that there is little or no basis for the hope that commercial quantities of oil or gas will be secured in this territory. The task of drilling through the thick lavas which underlie the sedimentary beds is similar to what it would be at The Dalles, and since there is no evidence at hand that oil or gas is present in notable quantities in the sedimentary beds which may underlie the lavas at depths of presumably 3,000 feet plus the unknown thickness of the sedimentary beds, deep drilling through the basalts can only be characterized as most hazardous.

PENDLETON

The general region between The Dalles and Pendleton in Umatilla county and extending as far south as Shaniko in Wasco, Fossil in Wheeler county and the crest of the northern ridge of the Blue Mountains, is a relatively smooth surface sloping northward to the Columbia river. While deep drilling for water has been reported at two or three localities, no exploring for oil or gas has been done so far as the writer is aware.

The geologic conditions are somewhat similar to those at The Dalles and Dufur in that the bedrock of the country is mainly volcanic lava, though the sedimentary rocks which overlie the lavas are apparently not so extensive as at The Dalles and Dufur. Instead, there are surficial deposits of wind-blown silt and soil, and of clays and gravels in some districts. The lavas nevertheless constitute the surface rocks over large areas. Such sedimentary rocks as occur can scarcely be considered a likely source of oil or gas.

Holes put down in this region are almost certain to encounter the Columbia River basalt at no great depth; to drill through its thickness of 2,000 to 3,000 feet is obviously a highly expensive task and doubtfully justifiable in view of the uncertainty regarding the nature of the formations which underlie these lavas. This general region cannot be characterized, therefore, as one in which the indications for securing commercial quantities of oil or gas are hopeful. A well to hazard the test should be located on good structure and backed only by money the loss of which will not be seriously felt.

THE JOHN DAY COUNTRY

The term John Day country is here used to designate not merely the John Day valley along the south fork of the stream of the same name, but the whole region comprised by the drainage basins of the three forks of that stream, in Wheeler and Grant counties.

The John Day country has extensive exposures within its boundaries of a larger number of formations and probably as great a variety of rocks than has any other district in eastern Oregon to be discussed in this report. Sedimentary strata stand exposed in magnificent sections and those who depend merely upon similarity in appearance of the formations in a region to those of a productive oil territory, would be impressed with the possibilities of the John Day country.

The geology of parts of the John Day country was described by Professor John C. Merriam[1] some twenty years ago, and a geologic map of a part of the area with further description was published by Collier[2] as a bulletin of the Oregon Bureau of Mines and Geology about five years ago.

The oldest rocks are found in the east-west range paralleling the east fork of John Day river on the south. These are first, old sedimentary strata now much changed by folding, crumpling, faulting and other altering activities, and second, granitoid rocks. Overlying these formations are Cretaceous strata, in the southwestern part of the territory, distributed in several relatively small areas. The Cretaceous beds are of marine origin, having been deposited over this region at a time when the sea invaded northeastern Oregon. Whether they are present beneath the younger formations over most of the John Day country is not known.

The next younger formation is one of dominantly volcanic origin known as the Clarno, of Eocene age. Its most extensive exposures are in the region between Mitchell and Clarno. Lavas, volcanic ash, and some sandstones and shales of freshwater origin compose the series. While the older Cretaceous formations contain sea shells as fossils, and the overlying Tertiary rocks have numerous bones distributed through them representing the land life of the time, the Clarno has not thus far furnished fossil material except the imprints of leaves.

Overlying the Clarno is a set of strata exposed mainly between Twickenham, Spray and Monument known as the John Day formation. The large quantity of fossil bones found in these beds has made the John Day region famous as a collecting ground. The John Day formation is made up of volcanic tuffs, sandstones and shales, all laid down in lakes, by rivers, or on land. A great series of black basaltic lavas of middle or upper Miocene age, two to three thousand feet thick, rest upon the John Day beds and are exposed over extensive areas in various parts of the John Day region. This is the Columbia River basalt.

Along the south fork of John Day river middle or upper Miocene beds rest upon the Columbia River lava These strata consist mainly of volcanic ash and ashy sandstones and also contain the bones of land

[1]A contribution to the geology of the John Day Basin: Univ. Calif. Bull. Dept. Geol., vol. 2, pp. 269-314, 1901.

[2]Vol. 1, no. 3.

animals. They were deposited by fresh water and on land, and are known as the Mascall formation.

The youngest sediments in the region, excepting the alluvium of the valleys, compose the Pliocene Rattlesnake formation. Like the Mascall, these beds are distributed mainly along the south fork of John Day river. They are mainly gravels and coarse sands and like the Mascall and John Day contain bones of land animals sparingly. These sediments are of fresh water origin. The Rattlesnake formation includes also a prominent bed of rhyolitic tuff.

The thickness of these formations varies widely from place to place. The thickness of the Cretaceous strata is not definitely known, but the post-Cretaceous beds have an aggregate thickness of 7,000 or 8,000 feet. The whole area has been folded along east-west axes in general, and deep erosion has occurred since, resulting in a region of mountainous relief.

A number of wells and springs in the John Day country which were reported to carry films of oil were examined by the writer but in each case the material on the water was an iron scum. The most suggestive information reported is the supposed occurrence of asphaltum in the Clarno formation first cited in 1914 by Collier in the bulletin already referred to and located by him as approximately in S. 26, T. 7 S., R. 19 E.; this is two or three miles east of Clarno.

It was reported to Mr. Collier that quartz geodes were found containing grains of asphaltum; one geode is said to have contained a quart of the hydrocarbon. On the Huntley ranch a little farther east several bushels of asphaltum were reported to Mr. Collier to have been taken out of the bluffs, the whole deposit having been exhausted, only small particles of the asphalt being still found scattered through the ashy beds. The writer's rather hurried visit to this territory added few facts to those reported to Mr. Collier. This occurrence is certainly an interesting one. The writer examined considerable areas of the Clarno formation north of Mitchell but failed to discover any further occurrences of asphaltum.

The supposed asphalt occurrences east of Clarno are deserving of more careful investigation than either Mr. Collier or the writer have been able to make. The Clarno formation is the oldest of the Tertiary deposits in the John Day country; presumably the Cretaceous marine formations immediately underlie the Clarno formation if they are present in this part of the Blue Mountains. These facts are of interest because the Cretaceous strata are the youngest marine strata in the region; being marine they hold out somewhat more hope of being petroleum producers than the non-marine series overlying them. Cretaceous strata are known to have produced paraffine oil in the

Coalinga oil field in the Coast Ranges of California and it would not be a matter of great surprise if Cretaceous beds in the Blue Mountains were found to have originated a certain amount of petroleum. The immediately overlying Clarno formation would probably be the most likely set of strata, other than the Cretaceous beds themselves, to show indications of the presence of oil originating in the Cretaceous beds. These facts make the reported occurrence of asphalt in the Clarno formation all the more interesting.

The writer therefore agrees with Mr. Collier as expressed in Volume I, No. 3 of this publication, that the sinking of one or two deep wells near the Huntley ranch would be justified. The chances for success are of course small in any unproved oil territory, but speaking entirely in relative terms the chances at this locality appear to be better than in other parts of the John Day country or for that matter in most other parts of eastern Oregon. Before drilling is done, however, a more detailed examination of the whole surrounding region should be made by a competent geologist; the exact nature of the materials reported as asphalt should, if possible, be ascertained; other seeps should be looked for; and the structure of the country should be more thoroughly determined. The locality is an interesting one, but it should be emphasized that exploratory drilling will have only one chance in many of success.

The Clarno formation is exposed over considerable areas in the John Day region and it is possible that there are other localities in it or in the underlying marine Cretaceous formations that are fully as promising as the Huntley Ranch area. In the writer's rapid reconnaissance, however, no other such areas were outlined. Detailed work with this end in view would be worth while from the standpoint of furnishing helpful advice to those who desire to explore the John Day country with the drill.

The Columbia River lava and the John Day, Mascall and Rattlesnake formations, consisting entirely of volcanic materials such as lavas and ash, and of freshwater sediments, are not in general looked upon favorably by most geologists as originators of oil or gas in quantity, on account of their fresh water and volcanic origin. They lie much higher in the succession of beds stratigraphically, and it is not likely that they could have received important quantities of any hydrocarbons which might originate in underlying marine beds, though there is of course a bare possibility that oil or gas may have formed in one of these sedimentary formations if the carbonaceous matter is ample. The John Day country is, however, on the whole a district in which the chances for obtaining oil are not promising. Relatively small flows of gas can probably be obtained in some localities from the John Day or the Mascall formation, the gas having been derived from vegetable material buried with the sediments. The amounts are not likely to be large and the history of gas wells in fresh water formations suggests that they are usually short-lived.

BLUE MOUNTAINS

The Blue Mountains, situated in northeastern Oregon, are in a sense outliers of the high Rocky Mountain country of Idaho and western Montana, from which they are separated mainly by the faulted La Grande and Baker valleys. The trend of the higher parts of the range is roughly north and south along the west side of the above named valleys. From this north-south line of heights three broad ridges with intervening valleys slope westward to form the John Day country. The Blue Mountains can be thought of as a huge block of the earth's crust that has broken away from the country to the east by a zone of faulting situated at its eastern base, the block having been raised some thousands of feet along its eastern margin and tilted westward. The structure is of course complicated by additional faulting and folding which occurred for the most part at a yet earlier date, but the break along its eastern margin seems to have blocked out the range and produced the main features of the present topography. This faulting occurred in relatively recent geologic time, most of it at least since the extensive lava flows of the region were extruded

The higher parts of the Blue Mountains are made of older rocks than those which compose nearly all the remainder of the state. Older Paleozoic sedimentary formations and early Mesozoic strata are found here, sharply folded, faulted, and intruded at numerous localities by granite and other coarse-grained igneous rocks. Later lavas broke through these rocks and covered much of the middle and lower slopes. While these geologic conditions are favorable for the development of ore bodies, they are not likely to lead to the accumulation of oil or gas in quantity. The writer has received no reports of seeps or other indications in this territory. A large part of the rocks are of marine origin and it would not be surprising if asphalt or other carbonaceous residues were found in them locally but the deformation they have suffered has no doubt led to the leakage and dissipation of any oil or gas which may originally have been present.

LA GRANDE-BAKER-HUNTINGTON

A series of valleys extend along the east side of the Blue Mountains from north of LaGrande in Union county to the Rye valley region northwest of Huntington, in eastern Baker county. The geologic history of this whole valley region has apparently been quite similar in its broader aspects and it is therefore proposed to treat of its oil and gas possibilities in one section.

This valley district was formed through the depression of a north-south area of the earth's crust between the Blue Mountains and the Wallowa Mountains. The depression resulted in part from faulting along the western margin of the valley zone, and in part from warping of the crust. The rocks of the floor of the valleys are in part the old rocks of the adjacent mountains, but over large areas these are covered by later freshwater sedimentary strata and lavas of about the same age.

It has commonly been considered that the freshwater beds were deposited in lakes which in Miocene time filled essentially the present valleys, but the writer is of the opinion that the major part of the movements which created the present valleys and mountain ranges has occurred since the sedimentary strata were deposited. To be sure, the valleys in which the sediments were laid down and in which the associated lavas came to rest occupy areas in part identical with those of the present valleys, but the strata extended in many cases beyond the margins of the present valleys and were cut off by the faulting. The relief was apparently much less in Miocene time, and the present valleys and mountains are due mainly to post-Miocene faulting and warping.

During the Miocene, basaltic lavas flowed out over the older rocks and basins of deposition were formed, in part by warping of the surface and in part by damming of drainage lines by lava flows. Freshwater sands, clays, and gravels were deposited by streams and in part by lakes, together with beds of volcanic ash. Through faulting and erosion these strata and the lavas are now exposed at many points in the valley zone from north of LaGrande nearly to Huntington. They have been faulted somewhat and folded so that the beds seldom lie horizontal.

The older rocks are in a broad way similar to those found in the Blue Mountains to the west, from which they have been separated by faulting. In part of marine origin, they have, however, been folded, faulted, and metamorphosed to a degree which makes it improbable that they still retain stores of oil or gas. They are not unlike the rocks of the Blue Mountains in this respect. The younger rocks overlying them do not offer much greater hope. The basaltic lavas can at once be eliminated. The freshwater strata, if dependence can be placed upon the prevalently supposed absence of petroleum in beds of that origin, also do not offer much promise for an oil supply. Drilling in them can be expected to encounter pockets of gas especially on anticlinal or domal structure, and it is even possible that the freshwater beds may contain oil, though the rarity of oil in commercial amounts in non-marine strata is a somewhat discouraging factor. The freshwater beds do not lie in direct contact with marine beds.

PRINEVILLE

The great series of basaltic lavas of Miocene age, which is so extensive between The Dalles and Pendleton, and known as the Columbia River basalt, extends southward through the depression followed by the Deschutes river between the western end of the mountainous John Day country and the Cascade Range, and underlies much of south-central and south-eastern Oregon. The lavas extend varying distances up the south flanks of the broad east-west ridge which forms the southern part of the Blue Mountains between Prineville and Vale.

The geology of some of the region stretching westward from Prineville toward the Deschutes river, northwestward beyond Madras, southward and southeastward toward Burns and the Harney valley, is intimately related to this great lava series. The region is mostly hilly but not mountainous; it contains some exposures of sedimentary beds but the great bulk of the rocks are lavas. Besides the basalts there are areas of rhyolites and rhyolitic tuff, especially in the Madras, Hay creek and Ochoco regions. Between the lavas are often white beds of ash or volcanic agglomerate. Such sedimentary beds as occur are freshwater or landlaid; marine strata may occur in the mountains to the north or northeast, but none were found in the Prineville region.

A number of supposed oil seeps were visited by the writer, but all were found to be springs or pools bearing iron films.

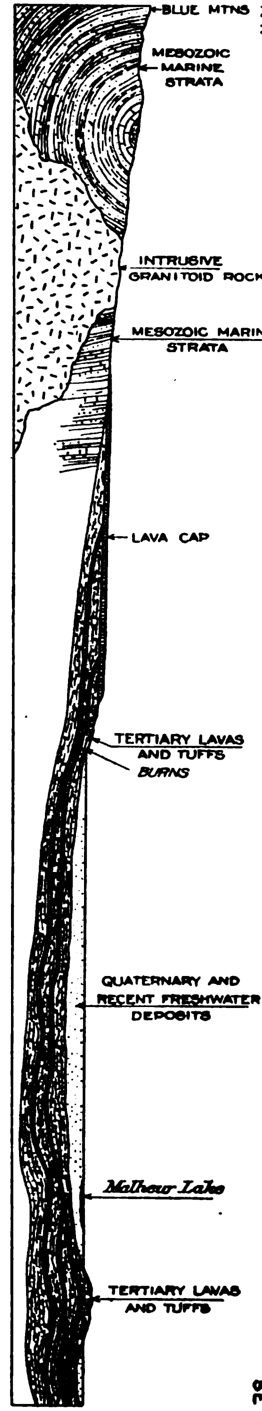

Fig. 2. Generalized northwest-southeast sketch section through Burns, Oregon. Vertical scale greatly exaggerated.

The volcanic nature of the country does not encourage hopes of striking petroleum. It is probable that the marine Cretaceous beds in the Blue Mountains extend westward beneath the lavas of the Cascade Range and intermediate country to connect with the Cretaceous formations of the Coast Ranges but it is not known through what region the connection occurs. It cannot be stated that it is not through the Prineville or Madras sections, but even if it were assumed to be present here, it is not known whether the Cretaceous rocks are oil-bearing in this region. If they are, the lava flows overlying them are very thick and are jointed rocks unadapted to storing petroleum. The occurrence of oil in the younger sediments is a possibility to be viewed only with much caution. While condemnation of any region where the geology underground is not fully known is unsafe, the facts as far as known regarding the Prineville region are not encouraging.

HARNEY VALLEY

The Harney valley has for many years excited the interest of those desirous of procuring a commercial oil or gas supply in eastern Oregon. Drilling has gone on intermittently and small quantities of gas have been struck in the wells from time to time. A brief note on these occurrences was published by Chester W. Washburne in 1911 in U. S. Geological Survey Bulletin No. 431.

Harney valley is a broad synclinal depression formed by downwarping while the Blue Mountains to the north and the region to the south were being uplifted. The drainage is therefore into the valley from all sides, forming the shallow Malheur and Harney lakes, which have no outlet to the sea. This drainage carries into the valley the products of the erosion of the surrounding country in the form of sand, clay and gravel, and it has built up a series of deposits of considerable but unknown thickness in the middle, and of some extent along the margins of the basin.

The rocks of the slopes of the Blue Mountains to the north are old marine sedimentary formations, probably of Jurassic age, containing marine shells and consisting of sandstones, shales and limestones. Granites have invaded these strata. They have been considerably folded and fractured, and metamorphosed to some extent by the granite. They were beveled by erosion before about middle Tertiary time, when lavas and tuffs were deposited across their beveled edges (see fig. 1). The Blue Mountains were then much lower than now, if indeed they were more than hills. The lavas too have been deformed somewhat by folding since their extrusion. Still later, probably during the Pliocene, basaltic lava spread as a thin sheet over nearly the whole region. It is these thin lava flows which form the rim of the valley at so many points near Harney and Burns. The considerable slope of these thin sheets toward the Harney valley probably indicates that the uplift of the Blue Mountains and depression of Harney valley has in the main occurred since the outflow of these latest lava sheets.

At the time of the writer's visit active drilling was in progress on two wells in the Burns region. About 1912 the Central Oregon Oil and Gas Company commenced drilling near Dog mountain, about 12 miles south of Burns (fig. 1). Mr. Stemen, the driller, reported the depth of this well at the time of the writer's visit as 3763 feet. The well is said to have given a little gas and to have shown a trace of oil. It is located in a gulch opening out into Harney valley. The formation into which it is being drilled consists of basic volcanic agglomerates, tuff and ash with some basic lava, the whole series gently folded. The well is reported to have been drilled through volcanic material its entire depth and fragments of the rock taken from the bottom of the hole at the time of the writer's visit were clearly basic lava. It is stated that between $100,000 and $150,000 has been spent on this well. The rig is a heavy one of the standard type.

The second well in the Burns region is that of the Fidelity Oil and Gas Co., located about 24 miles south and somewhat east of Burns and 8 or 9 miles from the Narrows connecting Malheur and Harney lakes. The company was organized early in 1918. At the time of the writer's visit the well was reported as having reached a depth of 1200 feet still in soft brown and gray clay. (This hole later reached a depth of approximately 1400 feet.) An earlier hole had been started 6 feet from the present one and carried to a depth of 460 feet, when gravel was struck and the hole was lost, it is said, through gravel sifting up into it for about 200 feet. The first hole was still producing a little gas. The rig used is a light one, without derrick. The location of the well is on the flat on which the two lakes lie (fig. 1), several miles from the margin of the valley, and the strata into which the well is being drilled are probably but a continuation downward of the silts and clays being deposited in the lake basin at the present time. If drilled sufficiently deep this well ought to strike the same strata into which the Central Oregon Oil and Gas Co. well penetrates 8 or 9 miles to the northwest.

Several wells were drilled 10 or 12 years ago into the sediments pierced by the Fidelity well out in the valley, to depths of a few hundred feet and some gas flows are reported to have been struck but they were not important in quantity.

The oil possibilities for wells drilled near the middle of the Harney valley depression cannot be said to be promising inasmuch as the beds are freshwater strata and are largely unconsolidated as well as recent; beneath these are thick volcanic formations. Gas, possibly only marsh gas, might, however, be secured in quantities sufficient for local domestic use from the soft lake beds, in which it originates mainly from vegetable material buried in the sediments. Chances for success in securing any considerable gas supply cannot be accurately appraised but the wells drilled thus far do not lead to great optimism. Deep wells which pierce the soft clays will presumably enter the thick volcanic series, in which the chances for securing oil or gas are not greatly different. This is the series in which the Central Oregon well is being drilled. Should it pass through the volcanics it will presumably strike the Mesozoic sedimentaries. These rocks, beautifully exposed 12 or 15 miles north of Burns, are much folded and intruded by granites, and it is improbable that they still contain any notable quantities of oil which they may once have held.

If, in spite of the discouraging outlook, further drilling is contemplated in the Harney valley region, it should be done either out in the flat where the relatively recent deposits are thick and the chances of securing a gas supply are relatively the best, even if not good, or it should be done on a favorable fold in the Mesozoic sedimentary strata on the slopes of the Blue Mountains north of Burns. A favorable locality would be one in which an anticlinal structure is present with dips not too steep on the sides and in which granite is absent. If localities can be found where the strata contain any traces of asphalt these with the proper structure offer the greatest promise. However, the meagre chances of success in untried territory do not justify risking a large fraction of any man's means in a drilling enterprise. A careful study by a competent geologist of a large region in which the marine sedimentaries are exposed should form the basis for the choice of a locality for exploratory drilling. Pains must be taken to ascertain, if possible, whether the marine strata are too far altered to offer hope for oil, even though gas may be present.

BEULAH

An area lying about 12 miles north of Beulah in northwest Malheur county on the old Burns-Vale stage road has been the center of a certain amount of interest on the part of oil men during the past two or three years. The writer did not have an opportunity to examine this territory in detail but the general features of the geology were ascertained and form the basis of the following discussion.

The area lies in the general zone along which the Tertiary lava tuffs lap up on the southern slopes of the Blue Mountains. The Tertiary lavas slope gently southward in a general way but they have in addition been somewhat warped or folded. Due to the dissection of the region by streams the line between the Tertiary rocks and the older formations is rather irregular, running northward on the ridges and southward down the canyons. The older rocks on which the lavas rest are reported to contain numerous large marine shells, which accords well with the idea that the strata here are but an eastward extension of the general belt of marine beds exposed to the north of Burns. The section is essentially like that north of Burns so far as oil possibilities are concerned, in that the underlying marine formations are also quite steeply tilted and deformed. Figure 1 showing the structure and relations of the rocks in the Burns region applies in a general way to the conditions in the Beulah country.

Since the underlying beds are of marine origin, many geologists will think more favorably of this area, but the writer has learned of no authentic seeps or tar accumulations. The highly disturbed condition of the strata, moreover, makes it rather possible that any oil or gas which might have originated in them has escaped to the surface. Pre-Cretaceous strata have not yielded petroleum in the West Coast states thus far, and while they may do so at some future time, these older beds in the Beulah region cannot be regarded as a likely source for oil or gas.

The Tertiary lavas and ash strata are of course not of a type to originate petroleum or notable amounts of natural gas and it cannot be presumed that they act as reservoirs for the hydrocarbons unless a source for the latter can be reasonably postulated.

BEND

From a point about 20 miles east of Bend in central Deschutes county, fresh lava flows extend westward to the Cascade Range. They overlie older volcanic formations. The recent flows still retain in many places the rough original surfaces of cooling. They extend northward from Bend; southward volcanic materials of relatively recent origin are met with as far at least as the Klamath lakes. Perhaps 15 miles east of Bend and about 3 miles south of the Burns-Bend road a cave in these lavas contains a considerable quantity of ice throughout the summer and is an interesting feature of the region.

The writer's reconnaissance was too rapid to permit him to become acquainted with more than the general features of the geology. No formations other than volcanic were noted and it is probable that any marine strata which may exist in the region lie at very considerable depth. The structure of any such beds would also be masked by the overlying cover of lavas, so that a determination of the location of any probable areas of accumulation would be difficult or impossible. The Bend region cannot therefore be regarded other than rather pessimistically so far as oil and gas possibilities are concerned.

KLAMATH FALLS

A number of wells a few hundred feet or more in depth have been drilled in the Klamath Falls region, southern Klamath county, within the last 12 or 15 years and at least one well was being carried downward at the time of the writer's examination of this region. Stratified rocks are exposed at numerous localities in this general area and it is not surprising that these should lend encouragement to those public-spirited citizens who desire to test the possibilities of their home district with a drill.

The rocks of the Klamath Falls region are largely, if not entirely lavas, tuff and volcanic ash beds, with occasional clay, sand and gravel formations of fresh water origin, locally of thicknesses to be measured in hundreds of feet. The area lies within that physiographic province of the United States which is usually known as the Great Basin, and while it has outside drainage to the sea southwestward through the Klamath river, the same fault-block structure so common throughout Nevada and parts of Utah and California is evident here.

The valley in which the Klamath lakes lie is a block of the earth's crust which has been separated from the block on the east, and probably also from the Cascades on the west, by a great break or fault, the valley block having dropped down at least a number of hundreds of feet while the two adjoining blocks rose. The displacement may have been as much as several thousand feet. Uplift of the two adjoining blocks caused them to be vigorously attacked by erosion, so that where soft formations were present good sized valleys, such as Poe valley, were soon sculptured out while those parts of the face which were made of hard rocks still remain quite steep and bold. The displacement along these fault lines occurred, for the most part at least, in very recent geologic time; it has taken place since the white so-called lake beds were deposited. These strata, contrary to popular notion, are not the product of deposition in a lake which filled the present valley, but were laid down while the region was still one of much less relief than at present, and the mountains have been uplifted since.

Wells have been drilled both in the main valley and in at least one of the subsidiary valleys cut into the uplifted mountain block—Poe valley. An oil company in which Capt. J. W. Siemens of Klamath Falls is the moving spirit, was drilling in August, 1919, on a knoll about 10 miles south of Klamath Falls well out toward the middle of the valley. The well already referred to on page 32 had attained a depth of about 500 feet, a good part of which was said to be in sand requiring casing.[1] The knoll on which the well is situated is quite certainly not a dome but an erosional residual; it stands about 25 feet above the surrounding flat. There is therefore no reason to believe that it is a favorable area for the accumulation of any oil or gas which might exist in the surrounding region. The strata through which the drill first passed are quite certainly part of the fresh water series of the district which offer very little encouragement as to oil, though a chance possibly exists.

In Poe valley drilling was begun by a group of gentlemen associated as the Poe Valley and Lost River Prospecting Co., about May, 1915, and carried on intermittently until about July, 1918, when a depth of about 606 feet had been reached, according to Mr. J. T. Roberts of Oline, Oregon. Mr. Roberts states that various kinds of material were passed through, most of it volcanic clay, sand and mud. Reconnaissance of the area surrounding the well indicates that the strata in the section are largely of volcanic ash and sediments of the freshwater type. It is not known at what depth other kinds of rock underlie this series, nor what type of rock it may be.

A question which comes up for answer is of course whether there may not be underlying formations which are or might be oil or gas producing. This is possible, but judging from the thickness of the lavas exposed in the face of the upthrown fault blocks, the underlying formations must lie at a great depth, at least under the main valley. Such underlying formations may or may not be marine, and they may or may not be oil-bearing; if oil-bearing it would be exceedingly difficult to determine from the surface exposures in the overlying lava series where the oil had accumulated, since only a small part at best of any region made up of marine rocks contains oil or gas reservoirs. And this is due to the fact that oil and gas ordinarily occupy certain structures, as pointed out earlier in this paper, the area of which is usually quite limited.

Relatively small quantities of gas, derived from the vegetable material buried in the fresh water sediments, can possibly be secured at certain localities in the Klamath Falls region but the chances of securing a commercial oil supply do not appear to be promising. On the whole there appears to be but a slender basis for expecting production of oil or gas in the district.

[1] Known as the Siemens well. Down to between 1,500 and 1,600 feet in June, 1921. The log shows a few hundred feet of lake-bed sediments below which are only basaltic lavas and related volcanic rocks.

LAKEVIEW

The Lakeview region in southern Lake county is remarkably similar in physiography, type of country rock, structure, and in the general features of its Tertiary history to the Klamath Falls district. It is a north-south valley occupied in part by Goose lake, from the eastern margin of which rises a very formidable range of mountains. On the west somewhat lower mountains rise less boldly from the valley floor. The valley is a dropped block with a fault of great displacement along its eastern side and possibly a second along its western margin, although the evidence for the latter is not so convincing. The bold face of the range to the east exhibits a section of some 3,000 feet of lavas, tuffs, and to a minor extent, gravel, sandstone and shale beds. The moun-

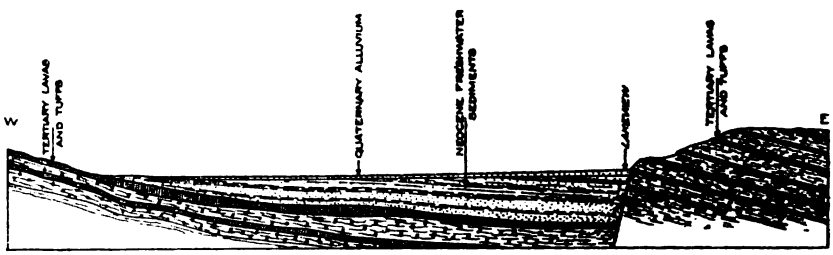

Fig. 2. Generalized sketch section from west to east through Lakeview, Oregon. Distance about 15 miles. Vertical scale greatly exaggerated.

tains to the west are composed mainly of the same sort of materials. The volcanic formations have been gently folded as well as faulted.

In the valley of Goose lake, in which the town of Lakeview lies, very recent clays and soils mask the underlying formations to a great extent but to the north and west of Lakeview exposures in some of the low hills in the valley indicate the presence of Tertiary strata made up of gravels, sandstones, clays, and ash beds with a total thickness of at least several hundred feet. These beds presumably overlie the volcanic rocks of the adjoining ranges in a normal section, but they have quite certainly been faulted down into their present position. They therefore do not represent the deposits of a lake which as a precursor of Goose lake occupied the valley. They were deposited in the gentler topography which existed before the mountains were thrown up and the valleys depressed by faulting. These strata have been deformed by warping or gentle folding so that dips of 10 or 12 degrees are not uncommon.

Mr. H. M. Nolte; one of a group of substantial business men of Lakeview, courteously accompanied the writer to a number of localities in the district which he and his associates regarded as interesting from the standpoint of oil and gas possibilities. Several springs which were reported as showing oil films were examined but in each case the substance was hydroxide of iron. An artesian well known as the Carter well, located nine miles southwest of Lakeview, having a depth of 370 feet of which the upper 260 feet was cased, was producing bubbles of an inflammable gas continuously. The well was drilled about 1915 and it was reported to have yielded the same amount of gas from the time it first began to flow. The amount was estimated at a few cubic feet per hour. A sample of this gas was taken and analysis in the laboratories of the U. S. Bureau of Mines showed that it had the following composition:

	Per cent
Carbon dioxide	0.5
Methane (marsh gas)	73.5
Nitrogen	26.0

No ethane gas, no free oxygen or free hydrogen were present in the sample. The gas had a specific gravity (air=1.0) of 0.67. Its heating value in British Thermal Units per cu. ft. of gas at 0^0C. and 760 mm. pressure was 783.

The well is reported to have passed through soft sediments its entire depth. The gas quite certainly originated in the soft alluvial material which overlies the Tertiary sediments in the middle portions of the valley possibly to depths of a few hundred feet, or in the underlying freshwater Tertiary strata. The composition of the gas indicates that it is a typical marsh gas such as is commonly derived from beds deposited in lakes, streams or on waste slopes, where vegetable material is buried in the process.

The fact that the formations which underlie the valley in which Lakeview is situated are of freshwater origin tends somewhat to prejudice the case as to oil, for as has been indicated earlier in this paper, freshwater formations do not in general seem good sources of oil in commercial amounts, though there appear to be exceptions. In this valley the thick section of lavas shown in the mountain face east of Lakeview underlies the Tertiary fresh water beds in the valley. It is not to be supposed that the beds would receive hydrocarbons from the lavas.

With reference to natural gas, it is possible that drilling in the valley might develop gas flows sufficient for local domestic use in nearby homes. At Prosser, Washington, gas in a fresh water formation developed a closed well pressure of about 10 pounds per square inch and the wells flowed many thousands of cubic feet of gas per day.

Drilling in the mountains of volcanic rock to the east and west of the valley cannot of course be hopeful if the oil and gas are to be derived from the volcanics. The only hope of reaching a possible oil-bearing formation would be by drilling through the lava section. The total thickness of the lavas is not less than about 3,000 feet and may be more than double that figure. In the valley this entire thickness would have to be passed through, as would also be the case at the top of the mountains east of Lakeview and in those to the west. But just east of the western base of the range east of Lakeview, near the base of the great scarp, drilling could be commenced in the oldest lavas, that is, the lowest stratigraphically, and it would be here that the formations underlying the lavas would be most easily reached. In view, however, of the fact that they may be granites or other igneous or metamorphic types of rock, or if sedimentary that they may be highly deformed and barren of oil or gas, and in view of their probable depth and the difficulty of determining where the oil would have accumulated in them if present at all, drilling in such locations would be fraught with great hazards.

SOUTHEASTERN OREGON

The southeastern portion of the state is very sparsely inhabited. It is a region of prominent north-south ranges which extend into Oregon from Nevada and of flat-floored valleys or extensive plateaus between the ranges. Nearly the entire region is lava covered. The altitude of nearly the whole territory is more than 5,000 feet.

From Lakeview eastward one crosses first the high range rising immediately from the town and after traveling for some distance across a plateau finds himself in Warner valley. The Warner range next to the east presents a bold fault scarp facing west like the Lakeview mountains. Beyond them lies another broad lava plateau stretching to the west base of the Steen mountains. This range appears to be faulted to some extent along its west side but it slopes westward and its eastern face is a magnificent escarpment indicating a displacement of thousands of feet. Lower mountains lie to the east, and beyond them are very extensive plateaus drained by the Owyhee river and its tributaries.

The lava series, made up mainly of basalts, is apparently thick throughout this whole region, for in the faces of the high ranges where they may be seen in section, it is seldom that the faults, often of several thousands of feet displacement, expose the base of the volcanic series. An exception to this is in the eastern scarp of the Steen mountains, where fresh water strata of Tertiary age have been brought up by the faulting, as well as a variety of still older rocks.

The writer did not attempt detailed work in any part of this vast area and his observations are therefore scarcely sufficient upon which to base a judgment. The predominance of the lavas as the country rocks, however, and the thickness of the series, as well as the absence of marine sedimentary beds so far as known, would tend to militate against the oil and gas possibilities of most of this region.

ONTARIO AND VALE

The valleys of Snake river near Ontario and of Malheur river near Vale display very extensive exposures of light colored stratified formations. Resembling in a superficial way the sedimentary rocks in many of the oil fields of the country, it is natural that the citizens of the local towns should desire to test their possibilities for oil and gas production. The scarcity of good local fuels and the long transportation required for coal or oil from neighboring states have enhanced the desire to supply this rich agricultural region with hydrocarbons from nearby sources. Intermittent drilling has hence been carried on in this region for 20 years or more. Gas in quantities probably larger than has been struck in any other well in eastern Oregon was obtained in the deep Boyer well at Ontario in 1902, and a comparable flow of gas was obtained a little later in a well drilled in Payette, Idaho, across Snake river and a few miles distant from Ontario. At least a few drops of oil are also reported to have been secured in this general region.

Geology

Chester W. Washburne, in Bulletin 431 of the U. S. Geological Survey, published in 1911, has discussed the geology and oil and gas possibilities of the Ontario-Vale region in interesting fashion. This paper contains the logs of several wells which had been drilled before that time, reports the extraction by solution with chloroform of a few drops of a light oil from sands exposed along the west side of Sand Hollow, 10 miles southwest of Vale, and enters into a discussion as to the origin of the gas and oil.

The large area of exposures of Tertiary strata, extending many miles to the north, west and south of Vale and Ontario, deserves a more careful and detailed examination than the writer was able to make in the limited time at his disposal. A conception of the broader features of the geology of the region was gained in the field, however, and it serves as a basis for the following discussion of the oil and gas possibilities.

Geologically the Vale-Ontario district is part of a much larger province which includes the Snake river valley from south of Boise, Idaho, to north of Weiser, Idaho, and many of the tributary valleys entering the valley of the Snake from the south and west. This province is characterized by being underlain mainly by Tertiary sedimentary strata in contrast to the mainly granitic composition of the rugged mountains of Idaho to the north and east, and the largely lava-mantled north-south ranges extending southward from the margin of the valley.

The Tertiary sediments are known to be very thick. They were studied in detail about 20 years ago by Waldemar Lindgren and the results were published in the Boise, Nampa, and Silver City folios of the U. S. Geological Survey. Mr. Lindgren divided the sediments into two formations, the older of which he named the Payette, and the younger the Idaho formation. The Payette was first regarded as of upper Miocene age on the basis of fossil leaves found in it which were studied by Dr. F. H. Knowlton, but in the two later folios it was considered Eocene on the basis of a redetermination of the plant material. The Idaho formation was believed to be Pliocene, fossil mammal bones having been discovered in it which were regarded as pointing to that age.

The investigations of the writer appear to indicate that at least the larger part of the areas regarded as of Eocene age are in reality Miocene or possibly lower Pliocene, and that the Idaho formation, if Pliocene, was deposited very late in that epoch and may be Pleistocene in age. It is probable, moreover, that the Tertiary strata are divisible into more than two formations. Collections of mammalian fossils made by the writer in Idaho very near the Oregon boundary suggest that the Payette formation is itself divisible into at least two formations of somewhat different age.

To indicate the complexity of the sedimentary section, a few exposures may be cited. Mitchell Butte, about 15 miles south of Vale, is composed of rather hard sandstones, conglomerates, and ashy shales resting upon older lavas and dipping at a considerable angle toward the Snake river valley. Strata of somewhat similar character outcrop on the hills immediately east of Vale. The hardness of these beds has been ascribed to cementation by hot waters which rise in springs along the base of the hills, and it may be due in part to that agency. The writer is of the opinion that the beds are harder because they are part of an older formation than the strata of the immediately surrounding country and that they outcrop among these younger strata because they have been brought up by faulting, through which process the position of the hot springs was determined. The strata at Mitchell Butte and Vale are therefore considered as older strata than those exposed over most of the region around Vale and Ontario; but whether the more extensive overlying beds rest upon them conformably or unconformably, and whether the older beds are to be considered a distinct formation, is not yet known. The older strata are probably upper Miocene or early Pliocene in age.

The younger beds so extensively exposed in the hills around Vale and Ontario, and in which the drilling around Vale has been started, have not yielded sufficient fossil material for a positive age determination. Their lithologic characters stamp them, however, as younger than the Mitchell butte and Vale butte exposures.

On the east side of Payette river, on the opposite side of the Snake river valley, are extensive exposures of strata which differ somewhat in appearance from the younger beds extensively exposed around Vale and Ontario, and they may well be still younger. A fourth series of beds which differ considerably in lithologic characters from the foregoing and which are apparently late Pliocene or Pleistocene in age, are exposed widely along Snake River just east of the Oregon boundary, in Idaho. These were termed the Idaho formation by Lindgren. It appears from these facts that the stratigraphy is by no means as simple as formerly believed, and a very considerable amount of detailed work will be required to determine the age of the different groups of strata, and their stratigraphic relations to each other. The writer hopes to take up this study during a succeeding field season.

From the standpoint of oil and gas possibilities our present knowledge of the stratigraphy may be summarized as follows:

The broad Snake river depression, including the Vale district, is underlain by a thick section of Tertiary sediments, possibly divisible into several formations, consisting of shale, sandstones and conglomerates. Shale seems to predominate, to judge from the sections of deep wells drilled through the sediments. The beds are at least 4,000 feet thick, since at Ontario the Boyer well, approximately of that depth, did not reach the base of the series. These beds have been considered as lake beds heretofore, but the writer's studies indicate that they are probably in large part river flood plain and waste slope deposits and were laid down only in part in lakes. They are fresh water deposits.

The Snake river region must have been an area of subsidence relative to the adjoining provinces for a long period of time, during which the sediments accumulated to enormous thickness. Probably during the various stages of this subsidence, the beds in the depositional trough were gently folded or warped, so that now they dip at considerable angles away from the margins of the trough toward its middle parts; in addition, the strata were gently deformed along irregular axes, so that while open folds can now be made out in some localities, the structure in the later beds is mainly of the nature of irregular warping. While inclinations at the border of the valley are 20 to 30 degrees, dips in the younger beds in the middle of the valley are usually less than 5 degrees, and often they lie nearly flat over large areas. Most of the series of strata contain a certain amount of petrified wood, while fossil leaves, fresh water molluscan shells, and mammal bones occur occasionally, indicating the non-marine origin of the sediments.

Wells Drilled for Oil and Gas

A number of deep wells have been drilled in the Vale and Ontario regions during the past twenty years. Washburne stated in his report published in 1911, "Seven companies were operating in October, 1909. At that time there were fifteen wells in the field, including six wells drilled primarily for artesian water, having the depths of 3,596, 1,700, 1,506, 1,400, 1,140, 1,100, 1,050, 900, 850, 740, 340, 335, 320, and 163 feet. Drilling was progressing on seven wells near Vale and on well No. 2 of the Oregon Oil and Gas Company in Payette."[1] Washburne gives logs of eight wells, in all of which shale and clay are the most common materials passed through.

At the time of the writer's visit in the summer of 1919 drilling was in progress on one well, that of the Northwestern Pacific Oil and Gas Company in Sand Hollow about 13 miles southwest of Vale. The Sunset Oil Company had ceased drilling on a well about 12 miles north and slightly west of Vale in May of that year. In the summer of 1920 a well was also being drilled on the Idaho side of Snake river somewhat farther north at Weiser by citizens of that city.

The Northwestern Pacific Oil and Gas Company's well southwest of Vale has reached a depth of 1,140 feet in the summer of 1919, the materials passed through being entirely soft shales, sands, and ashy beds of light color. A heavy rig was being used but the casing had been reduced to 5⅝ inches, which would probably prohibit drilling to a much greater depth. The strata at this point dip about six degrees northward, an inclination that is mainted for about two miles to the south, which indicates that a very considerable thickness of sediments lies beneath the well. The series lies on lavas to the south. The beds appear to be stream and lake deposits, consisting of shales of gray and blue colors, stratified ash beds, and sandstones which are often very much cross-bedded. Freshwater molluscan remains are very common in the low cliffs along Sand Hollow not far from the well. The structure at the well does not appear to be distinctly anticlinal; the dip in the surrounding area for a considerable distance is in general northward with some fluctuations in degree of steepness. No notable signs of oil or important quantities of gas had been developed in the well.

The Sunset Oil Company well about 12 miles north and a little west of Vale was also drilled with a heavy rig, beginning with a 7-inch hole.

[1]Gas and Oil Prospects near Vale, Oregon, and Payette, Idaho. U. S. Geol. Surv. Bull. No. 431, page 26, 1911.

The depth reached was not ascertained, but it is reported in Vale to have been less than 500 feet. The strata penetrated belong to the same series as those in which the Northwestern Pacific well southwest of Vale was begun. The topography is hilly but the structure is rather difficult to make out further than that the strata dip at very gentle angles. A conspicuous hill about one mile north of the well is capped by a thin sheet of basic igneous rock. So far as the structure can be made out, the well has neither a particularly advantageous nor disadvantageous position.

The well being drilled at Weiser, Idaho, during the summer of 1920, by local capitalists under the leadership of Mr. Bradshaw of that city, had reached a depth of 1,140 feet, having been started with 12-inch casing and reduced to 6-inch. The well passed almost entirely through blue clay and emitted small quantities of gas.

Two wells drilled many years ago and discussed in Washburne's report yielded more data of interest from the standpoint of oil and gas possibilities than any others in the region. The first of these is the Boyer well in Ontario, already referred to, which was drilled to a depth of about 4,000 feet and which yielded notable quantities of gas. Washburne states:

> A small amount of gas was encounered at 640 feet, and at 986 feet a stronger flow of gas blew the water out of the well. At 1,070 feet, when the hole contained 1,000 feet of water giving a resistance of over 440 pounds per square inch, gas was struck which blew water and mud over the top of the derrick. This operation was repeated at 2,204 feet, when the hole contained about 2,000 feet of water giving a resistance of over 880 pounds per square inch. These depths were all measured from the derrick floor, about 4 feet above the ground surface. Instrumental measurement of the gas pressure, made somewhat later, gave 420 pounds per square inch. At the time of the writer's visit, in October, 1909, the well was capped and on opening the cocks the accumulated gas escaped with a roar which indicated high pressure but which decreased notably in half an hour. No means were at hand for measuring the pressure and no attempt has been made to determine the amount of gas which the well will deliver. It is probable, however, that if the well were cleaned and if the casing were cut at the higher gas horizons a very good flow night be obtained. The gas has an odor resembling gasoline and burns with an almost colorless flame.[1]

At the time of the writer's visit the Boyer well was capped, although gas was escaping around the casing. For some time previously Mr. Boyer had used the gas in lighting his house and for cooking but had discontinued doing so. When a small pipe tapping the casing was opened and the gas lighted, a yellowish flame about three feet in length was produced. The pressure was apparently slight but it might have been considerably more if small quantities of gas had not been per-

[1]Oil and Gas near Vale, Oregon, and Payette, Idaho. U. S. Geol. Surv. Bull. No. 431, p. 40, 1911.

mitted to escape constantly around the casing. It is certain that there has been a very notable diminution in the open-well pressure since 1902 and 1903 when the gas shot water and mud over the top of the derrick. It is now reported that the casing in this well has been drawn but that gas still bubbles up through the water. The writer collected over water a sample of the gas issuing from the Boyer well in 1919, the analysis of which in the laboratories of the United States Bureau of Mines gave the following composition:

	Per cent
CO_2 (Carbon Dioxide)	0.0
O_2 (Oxygen)	0.0
CH_4 (Methane or "marsh gas")	99.1
C_2H_6 (Ethane)	0.0
C_2H_4	0.0
H_2 (Hydrogen)	0.0
N_2 (Nitrogen)	0.9

The specific gravity of this gas (air=1) is 0.56. Its heating value in British Thermal Units per cu. ft. at 0°C., and 760 mm. is 1055.

No mention is made in any of the reports concerning this well of notable amounts of oil such as often occur in the unsuccessful oil wells drilled in the outlying parts of a producing oil field, and in view of the nature of the gas it does not appear that the well can be regarded as evidence of the presence of oil in the region. The gas, composed almost entirely of methane or marsh gas, is the characteristic type found in freshwater sediments, and is believed to have been formed through decomposition of vegetable material buried in the sediments. It is quite possible, however, that if the well had been manipulated with the sole purpose of securing from it the largest possible amount of gas instead of drilling it to greater depth for oil, it might have been the source of a certain amount of revenue for a number of years as a supply of gas for domestic use. This well is to be regarded as suggestive evidence for the possible occurrence of notable amounts of natural gas of good heating and lighting value in the region. It is nevertheless clear, in view of the number of other wells which have been drilled in the district without striking quantities of gas equal to that in the Boyer well, that reservoirs of gas under considerable pressure do not underlie the whole territory by any means, nor, probably, at shallow depths.

A second well producing considerable gas was drilled in Payette, Idaho, across the Snake river from Ontario and a few miles to the north, in 1907. Washburne says of this well:

The depth of the gas sand was 740 feet, and the pressure was sufficient to blow a column of water, sand and shale to a height of 150 feet. The well was drilled through an almost continuous body of smooth, blue-gray shale, with occasional thin layers of sandy material containing smaller flows of gas. This small hole became clogged with sand and gravel and was finally plugged. A new well of larger diameter has been started near by for the purpose of trying to get through the gas stratum, in order to obtain oil at lower depths.[1]

In the summer of 1920 two wells were producing small amounts of gas in Payette. One of these, in the basement of a fruit packing plant near the railway station, had been drilled for water supply. The water obtained was not suitable for use but sufficient gas bubbled up through it to supply several lights. The second well, in the rear of a steam laundry nearby, produced sufficient gas for the heating of one of the machines used in the laundry. The exact depth from which this gas rose was not ascertained. Gas also occurs here in small quantities in other wells.

Oily Sandstone in Sand Hollow

Besides these occurences of gas in the Vale-Ontario region, a locality of interest lies in Sand Hollow not far from the Northwestern Pacific Company's well, and about 13 miles southwest of Vale. Just east of an abandoned artesian well now flowing a very little water, sandstones outcrop in a bluff a few feet high. Somewhat similar strata outcrop on the west side of Sand Hollow a few hundred yards away. On being freshly broken these beds yield a strong odor of petroleum, or perhaps it would be more nearly correct to say that the odor is that of some of the lighter fractions of petroleum, such as kerosene or gasoline. Washburne reports that he dissolved out of these sands with chloroform a few drops of a very light colored oil. The beds are not markedly stained by oil like those outcropping in many productive oil fields. Such oil as is present must be diffused in very minute quantities through the rock exposed at the surface.

Discussion of Conditions

The Vale-Ontario region is manifestly one of the most interesting, if not the most interesting, of the various districts of eastern Oregon considered in this report. It probably contains the greatest thickness of Tertiary sediments. The rocks are largely shales and clays, in which types of sediments organic remains are most likely to accumulate in quantity. The beds are only in minor part volcanic in origin, in which character they differ from those underlying most of the other districts discussed. The strata are gently flexed. Small quantities of gas escape from most of the deep wells of the region and certain wells have flowed considerable quantities of gas at very notable pressures. Films of oil have been reported in a number of deep wells during drilling operations,

[1]Oil and Gas near Vale, Oregon, and Payette, Idaho. U. S. Geol. Surv. Bull. No. 431, pp. 41-42, 1911

and certain strata in the district emit distinct odors of petroleum on fresh fracture, although the oil is not apparent to the eye.

Considering the foregoing as favorable conditions, the district has also certain negative features that enter into an appraisal of its oil and gas possibilities. It contains so far as known only freshwater sediments, a fact generally regarded somewhat prejudicially. The region lacks oil seeps of the type common in and about oil fields. The odoriferous sandstone in Sand Hollow is an interesting occurrence but scarcely to be considered as a typical oil seep. The gas found in the region does not point to an association with oil. Gases are not entirely diagnostic as to whether or not oil is associated with them in the ground, but gases in oil fields commonly contain a considerable proportion of ethane, a constituent lacking in the Ontario gas. A considerable number of wells have been drilled to depths varying from a few hundred to 4,000 feet or over, distributed over a large part of the territory, without encountering notable quantities of oil; though they found in the most favorable cases pockets of gas under notable pressures which gave considerable flows for a short period but in which the pressures decreased very rapidly. Structurally the wells were probably not well located. While sandstones which would make good reservoirs for oil are present in the sections as shown in the outcrops along the valley margins where the beds are upturned, and in the wells, shales containing organic materials in such large amounts as to make them probable oil producers have not been identified in the sections.

The conclusion arrived at, after considering these various factors, is that the Vale-Ontario region is not impossible oil territory but that the probabilities of obtaining commercial flows of petroleum are not good. The area is not decidedly unfavorable like the granite mountains which bound the Snake river valley on the northeast or absolutely hopeless like the areas in which thick sections of lavas overlie granitic basement rocks. In a classification of territory on the basis of oil possibilities in which the grades of possibility decrease from certainty of production to impossibility, as follows, proven productive, unproven but probable, hopeful, possible but unpromising, impossible, the writer would characterize the Ontario-Vale region as possible but unpromising.

The chances of securing commercial quantities of natural gas are considered to be very much better. It should be recognized, however, that the chances in a particular well are correctly estimated, not by stating that it is quite probable that a commercial flow of gas will be struck, but that it is possible that such a supply may be obtained. In drilling test wells in the region the possible value of any gas obtained should be kept in mind as well as the desirability of securing oil, and the well should be handled from the outset so as to conserve the gas supply for future use and so as to permit of its free flow when the gas is to be utilized.

The origin of the gas is a matter of interest. Washburne was apparently inclined toward the view that it came from great depths into the Tertiary strata, for he says:

> The apparent solution of this question for the Vale field may be summarized by saying (1) that throughout the region hot springs are abundant and carry inflammable gas; (2) that the Payette formation is not a likely source of the gas and oil which it contains; and (3) that the Payette formation probably rests on granite and metamorphic rocks from which these substances could not have been derived. The presentation of these facts is a strong argument for the solfataric or abyssal origin of the gas and oil.[1]

The writer believes that the gas has originated in the strata themselves because, first, nearly all deposits containing carbonaceous organic matter contain certain amounts of gas; second, the deposits of the Snake river region contain considerable quantities of vegetable matter which by decomposition in the absence of oxygen would appear to be capable of producing the gas; third, if the rocks in which it is now found are so nearly impervious as to hold the gas under considerable pressure it is not probable that the gas would have risen up through them from great depths; fourth, if the gas had risen with the water in such hot springs as occur at Vale, there appears no reason why it should have moved out into the adjoining rocks and be held there under pressure instead of coming to the surface through the spring.

Future Drilling

It is not at present practicable to outline in the Vale-Ontario region the exact areas in which the chances of success in further exploratory drilling would appear to be best. Certain general considerations can, however, be stated which may prevent waste of money. Future prospect drilling should be done in the middle parts of the valleys in such areas as those within a few miles of Vale and Ontario, and should not be undertaken close to the higher hills which surround these valleys. The higher hills are composed almost entirely of lavas, in many cases of great thickness, and drilling carried on near the hills is very likely to result in striking the lavas before great depths are reached. The best chances for securing gas would appear to be in the areas where the greatest thickness of sediments can be penetrated and this is obviously away from the hills. With reference to the choosing of sites for wells in relation to the structure of the region, it is of course desirable to locate them on anticlinal areas, but this may not be as important as it

[1] Gas and Oil near Vale, Oregon, and Payette, Idaho: Bull. U. S. Geol. Surv. No. 431, p. 47, 1911

might seem at first sight, for it is possible that the surface rocks on which the structures are identified do not reflect very closely the structure in the older strata beneath them. If an unconformity occurs between the younger strata which are so extensive on the surface and such probably older strata as are exposed at Vale and Mitchell butte, it is quite possible that the axis of a fold in the older strata may not coincide with the axis in the surface beds; and even that the folds in the older rocks were beveled off before the younger beds were deposited upon them. While folding is apt to recur along the same axes, it may not, and it is quite possible that folds in the deeper strata trend in different directions and are of different intensity from those seen at the surface.

In the Ontario region and in other level parts of the Snake river valley it is impossible to make out the structure of the Tertiary strata beneath the river gravels of the valley, except by inference through projection of axes from adjoining areas. In the rolling country the structure can be made out but considerable careful work will be required to define it in detail.

SUMMARY AND CONCLUSIONS

The geology of eastern Oregon can be summarized by stating that nearly the whole of that portion of the state is underlain by Tertiary lavas. Relatively small areas of Cretaceous and older strata occur in the Blue Mountains, and Tertiary freshwater sedimentary strata, commonly more or less ashy in composition, overlie or locally underlie the lavas and form the surface formations in scattered areas. Tertiary strata of freshwater origin but chiefly non-tuffaceous in character and of great thickness occupy the valleys of Snake river and tributary streams in the Vale and Ontario region.

Drilling for oil and gas has been done or is now being carried on in The Dalles region, west of Dufur, south of Burns, south of Klamath Falls and east of that city, and around Vale and Ontario. All the wells have gone down in Tertiary sediments. Many of them have struck small quantities of gas and certain ones, such as the Boyer well in Ontario, have encountered considerable quantities at high pressure which, however, decreased rather rapidly. Traces of oil have also been reported in a number of these wells but no verifiable cases in which a notable quantity of crude petroleum was brought to the surface were discovered.

Many reported seeps of oil were investigated in various parts but no true seeps were found; the reported oil colors in every case turned out to be iron films.

As to prospects for oil in commercial amounts, eastern Oregon can not be regarded as impossible territory, but it is rather improbable territory. This judgment is based on the absence so far as known of typical oil seeps, the freshwater origin of all the sedimentary strata except those in relatively small areas in the Blue Mountains, the scarcity of the mother rocks of petroleum, the dominantly volcanic nature of the rocks underlying the sediments, and the failures to date. The chances of securing oil in the relatively small areas of considerably deformed marine strata in the Blue Mountains can not be appraised accurately on the basis of the brief examination made of them. An oil supply is probably not to be expected in them.

The possibility of a commercial gas supply is somewhat better; considerable drilling has thus far encountered, however, only one or two bodies of gas which in quantity approached a commercial supply. Gas occurs in small amounts at many points in the Tertiary strata, but it would appear that the thick sections in the Ontario-Vale region afford the best chances of encountering a commercial supply. It is to be recognized that even here, however, the likelihood of developing a large output does not seem very good. In drilling test holes in this region locations should be chosen on folds at some distance from the higher hills which surround the district. This is advisable, inasmuch as these hills are composed mainly of igneous rocks and because the thickest sections of strata undoubtedly lie in general in the middle parts of the valleys.

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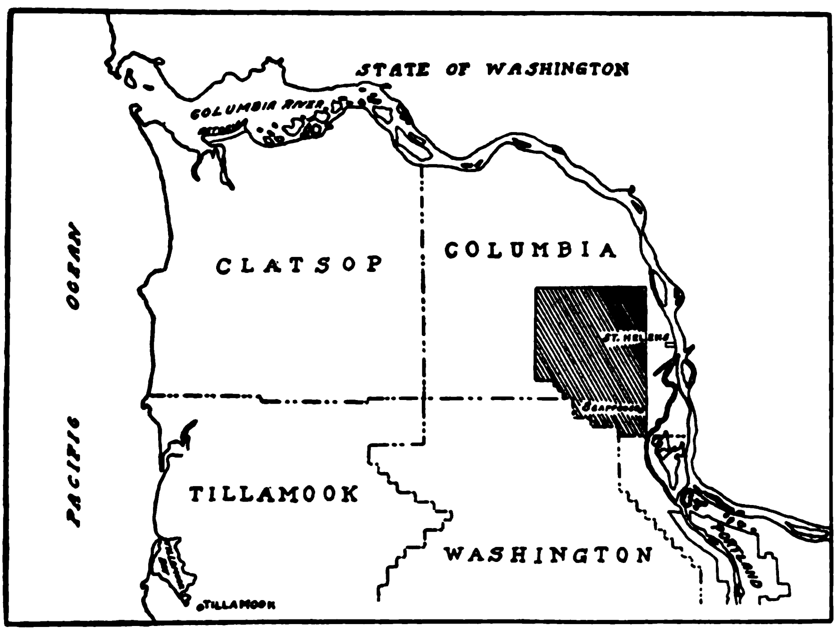

Outline map showing location of Columbia County iron ore deposits

REPORT ON

The Limonite Iron Ores of Columbia County, Oregon

Forty-four Pages Seven Illustrations

STATE OF OREGON

WALTER M. PIERCE, Governor

BUREAU OF MINES AND GEOLOGY

HENRY M. PARKS, Director

417 OREGON BUILDING, PORTLAND, OREGON

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COMMISSION

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INTRODUCTORY

The establishment of an iron industry on the Columbia River harbor would be an event of major importance in the commercial and industrial development of the entire state of Oregon. Since early in 1920 there has been considerable activity in the prospecting of iron ores in Columbia county contiguous to the Columbia river, within approximately 20 miles from Portland.

An appropriation was made by the 1921 legislature to determine the occurrence and magnitude of the iron ore resources of Columbia county, and to investigate the conditions which would control in the manufacture of iron in this vicinity. The present report sets forth the results of this investigation and is intended to be both a guide to future development work in the Coast range occurrences of iron ore, and a digest of the fundamental factors that determine the commercial feasibility of manufacturing iron near Portland.

The origin, character, and extent of the ore deposits are discussed. The economic features of iron production, the technical and commercial elements of charcoal manufacture, and the manufacture of sponge iron are authoritatively treated in three separate chapters. A map is presented which shows the topography of the principal area where the ore is found, the distribution of the rocks with which it is associated and the location of the chief ore occurrences yet discovered. This map and the accompanying discussion furnish the basic facts on which intelligent prospecting and exploitation of the ores of Columbia county will depend.

The geologic field work for this report was done by Ira A. Williams and G. E. Stowell of the Bureau staff, and the writer. The topography was mapped by D. C. Livingston and J. H. McFarland, who were in the temporary employ of the Bureau. Acknowledgment is hereby made for the constant co-operation of the officials of the different timber companies having holdings in the area. Thanks are due also to many persons for information particularly in connection with the development work on the several properties where the ore has been opened up.

HENRY M. PARKS, Director.

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A Periodical Devoted to the Development of All Her Minerals

PUBLISHED AT PORTLAND BY

THE OREGON BUREAU OF MINES AND GEOLOGY

HENRY M. PARKS. Director

THE LIMONITE IRON ORES OF COLUMBIA COUNTY, OREGON

By IRA A. WILLIAMS and HENRY M. PARKS

SUMMARY

Some of the salient facts brought out in this report are given in the following paragraphs—

(a) Important conditions favorable to the establishment of an iron industry on the Columbia river:

1. The existence of good limonite iron ores which can be mined and transported to the Columbia river harbor at a low cost.
2. Favorable conditions of transportation for all materials and products used in the industry.
3. An established Pacific Coast market for sufficient quantity of foundry iron to warrant an initial plant.
4. A price for the product which will be protected for an indefinite time in the future by the freight costs on iron from eastern producers.

(b) Factors of less certainty:

1. The fuel, which would be coke from Washington, British Columbia, Alaska, Australia or other foreign ports; or soft wood charcoal.
2. Limestone for flux, which would probably come with least cost from the North Puget Sound country by barge.

THE IRON ORES

A study of the geologic map accompanying this report and of the occurrence of the limonite ores as set forth in the following pages will show that these ores originated from basaltic rocks by weathering, and that they accumulated as bog iron deposits distributed intermittently over an earlier land surface than the present topography represents.

The prospecting of these ores to date is scattered, and in only a few cases has been prosecuted in any systematic way. The total quantity of ore developed is not large, amounting to approximately a million and a half tons, with an indicated additional tonnage of, in all probability, two to three times that amount at points well distributed over about four townships. The important feature, however, is that the present limited development, when viewed in the light of the occurrence of the ores, makes it highly probable that if a systematic plan of development were carried on over unexplored lands where iron indications are known to exist, the present known tonnage would be multiplied many fold, with the likelihood of a reserve which would be ample for the basis of a large iron industry.

The quality of the Columbia county ores is better than is usual for limonite ores the world over. The average iron content of Lake Superior hematite is now below 50 per cent. The ores in the great iron fields of Eastern France, Alsace and Luxemburg run from 31 to 40 per cent. The domestic ores smelted in the British Isles for the past five years have carried only 20 per cent iron. The limonite ores of the Birmingham, Alabama, district run only 35 per cent. Columbia county ores run better than 40 per cent iron (natural) and thus compare very favorably with those in other parts of the world which are now being used commercially.

MARKETS

Many opinions have been expressed recently concerning the market for iron on the Pacific Coast. The investigations of this question show that the demand for foundry iron varies from year to year, but that there is without question market for more than a thousand tons per day. This is a greater output than can probably be manufactured for a number of years to come.

FUEL

A supply of suitable fuel is probably the most uncertain of the factors entering into the manufacture of pig iron. The state of Washington at the north has coals in the Carbonado and Wilkinson districts from which a fair grade of coke has been made. The ash in Washington coke is a little higher than would be desired for iron smelting. Fairly good coke can also be had from northeastern British Columbia, but the freight would probably make the cost too high for consideration.

Beehive coke, similar in quality to the Washington product, is available on tidewater at Comox, in western British Columbia.

Alaska has some excellent coking coals and it is anticipated that the plans of the Alaska Coke and Coal Co. (a corporation financed by Portland capital), when fully matured, will make available coals of high quality which may have a very important bearing upon the manufacture of iron in this vicinity. Australian coke of good quality is also available. On account of water transportation, it can be delivered on the Pacific Coast in cargo lots at a cost that will make it a factor to be considered.

It is possible to manufacture pig iron with soft wood charcoal; but there is some uncertainty as to what the actual cost of this fuel would be on account of the lack of information as to the amount and value of the by-products produced from fir wood. There seems little doubt that charcoal would cost more than coke from the sources mentioned.

FLUX

Oregon has large deposits of limestone, both in the eastern part of the state and in the southern. It appears probable, however, that limestone can be had from the North Puget Sound country, delivered in the Columbia River harbor by barge, at a less cost than that of the Oregon product.

Taking all factors into consideration, it is a reasonable conclusion that there are sufficient ores of fair quality contiguous to the Columbia river and that the economic factors are sufficiently favorable to warrant the establishment of an iron industry at some convenient point on the Columbia river.

LOCATION OF THE IRON-BEARING AREA

Columbia county lies next to the Columbia river, which flows between Oregon and Washington, and is separated from the Pacific ocean by Clatsop county, which is in the northwest corner of the state of Oregon. The area under consideration, which is covered by the acompanying map and in which the main iron ore occurrences are found, occupies its southeast portion and is bounded in part at the south by Multnomah and Washington counties. It is included essentially within townships 3, 4 and 5 north from Willamette base line in ranges 2 and 3 west of Willamette meridian. The Columbia river is at its eastern edge. It is paralleled by the Columbia river highway and the Astoria branch of the Seattle, Portland and Spokane railroad, which connects with all transcontinental and coastwise lines at Portland.

TOPOGRAPHY

This portion of Columbia county is deeply gashed by a number of streams that flow to the eastward into the Columbia river and by the headwaters of others that take a southwesterly course and are tributaries of the Nehalem river, a major stream that cuts across the Coast range of mountains to the southwest directly to the Pacific. The divide between the two drainages is near the west side of the area, its highest points reaching altitudes in a few places of 2000 feet and over above the sea.

The north and south forks of Scappoose creek and Milton, Merill and Tide creeks with their tributaries drain eastward to the Columbia. Clatskanie river flows northwestward towards the Columbia and drains a section in the north part of the tract. Leading to the westward are the east fork of the Nehalem river with headwater branches, and Cedar and Oak Ranch creeks, which cross the boundary line near the northwest corner of the map.

All streams have steep grades and have cut sharp deep canyons into the rocks that underlie the region. Those that come down into the Columbia are traversed by logging railroads and, in general, by wagon roads that lead to the various camps and settlements back from the river. An east-west improved county road goes up Milton creek through Yankton and Trenholm and passing over the divide joins the main highway along the Nehalem river at Turrish, one mile and a half outside of the area being considered.

Practically the east three-fourths of this area has been logged off and clearing and occupancy of the land by settlers are in progress. The entire region was formerly heavily forested and logging operations are now under way at various points progressing towards and mostly in the western part of the area. The region is thus fairly open and accessible to examination and prospecting.

As already stated the relief of this part of Columbia county is marked. The country rises from the Columbia river, which is here less than 50 feet above tide, to a maximum altitude of about 2000 feet in less than six miles to the westward. Careful study of the land surface reveals the presence of portions of a series of terraces as one rises from the river. These appear as broad farming flats low down and as mere fragments of former flats against the horizon at many places on the divides between stream canyons. Sometimes they are a series of well-marked steps or even-topped benches, which appear most conspicuously near the summit of the divide in the south central part of the area. This summit itself seems in part the remains of a similar old even land surface with here and there along it some hills that rise above the former plain.

These benches represent portions of former land surfaces that were produced by erosion when the country stood at lower levels than now. That there are a number of them one above another indicates the different positions with reference to sea level that were successively occupied by the region during its elevation to its present position. The conception that one should have of this region is therefore that its present topography has been developed by a process of elevation, interrupted by repeated long intervals of quiet, during which the streams of today, the Columbia included, aided by all weathering influences, have been actively carving deep canyons into it. Any study of its surface features now, of the rocks that underlie it, or of the occurrence and character of such economic deposits as they may contain, can be intelligently made only with a full knowledge of these conditions of the past constantly in mind.

GEOLOGY OF THE IRON ORE

The rocks in this part of Columbia county are mainly sandstone, shales, and basaltic lavas, all of Tertiary age. Some of the lower lying lands near the Columbia are covered by alluvium, which extends varying distances up the main streams already named. The areas occupied by these three groups of rocks are sufficiently distinctive that they have been outlined, in color, on the accompanying map.

This classification of the rocks of the region will be more serviceable than a purely chronologic one in the present paper because of the proved general association of the iron ores with the basaltic lavas only. While the whole area is underlain with sedimentary and eruptive Tertiary rocks, the purpose of this report is not such as to require the working out in detail and recording of minor structural features and relationships. Columbia county is included within the area covered by the Coast range of mountains. This range has been formed by a broad upward arch of the Tertiary formations whose axis runs in a general north-south direction. If a cross section of the range were made it would be seen that this wide spreading geanticline, as it is called, is composed of a number of super-imposed lesser folds, most of which show a parallelism to the general course of the range.

In the study of a specific or restricted locality, however, it is not always possible to make out such a relationship in structure to the main Coast Range uplift. Its axis doubtless changes direction materially in places, more or less of faulting has in all probability taken place in connection with the growth of the range, and the intrusion of igneous rocks has disturbed the normal position of the sedimentary rocks to a large degree.

Within the limits of the map shown many observations of dip and strike have been made. Inclinations are prevailingly low, from a few up to 10 or 15 degrees, and although the basaltic lavas conform in general with the underlying sediments the small departures from the horizontal are of no practical importance. Though this iron-bearing area lies at the eastward side of the summit of the main uplift, the most evident deformation appears to be a series of low folds with axes running in a general east-westerly direction.

Reference to the map and cross sections brings out very clearly the fact that the basaltic lava overlies the shales and sandstones. Wherever it occurs it is the top or surface formation and much of the iron-stained "shot" soils of the region is due to its alteration. Parts of the area are thus lava-covered which vary in altitude from almost the highest to the lowest. It is apparent that for most of the region the basalt-covered portions found today are but remnants of what was a much more general lava blanket upon the surface of the land. Elevation and erosion have effected the removal of intervening portions, the latter process having continued deep-down into the underlying sandstones and shales.

While the lava cover shares in general the attitude of the underlying beds, in the field one is impressed at once with the fact that when these lavas came they must have flowed across an already uneven old land surface filling in all depressions and submerging as well most of its higher portions. We thus find at present an irregular contact of the lava upon the sedimentary rocks, an unconformity, it is called. Columbia county was at a much lower level than now when these lava flows came out upon it.

The sedimentary rocks that occur here are mostly such as have been deposited in deep water, probably in the depths of the ocean. Many marine fossils are to be found in the sandstones and shales, which tell of the age in which they were formed. On the basis of the fossil forms that have been identified, there probably exists within the boundaries of our quadrangle, rocks belonging to the Eocene, Oligocene and Miocene periods of the Tertiary. Bodies of partially cemented gravels occur in a few places which may prove to be of more recent age, while the gravel and silt-covered terraces along the Columbia and floodplain deposits range from Pleistocene to modern in the time of their formation. The earlier marine Tertiary beds, as indicated on the cross-section, occur mainly nearer to the Columbia, while the later Oligocene and Miocene appear successively above the Eocene towards the western side of the area. The basalts overlie all and are also probably Tertiary in age.

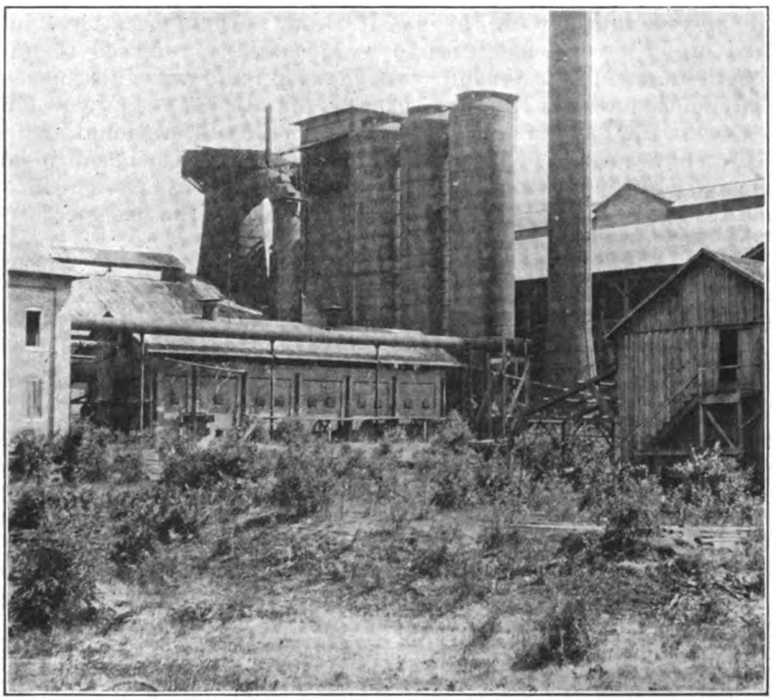
OCCURRENCE OF THE IRON ORES

Probably one-half or more of the area mapped is covered by the basaltic lava. It is the topmost formation and has thus suffered greatly by weathering and erosion. As a rule the principal outcrops of basalt are found well up towards the top and along the summits of ridges and not infrequently shales or sandstones, or both, appear below. It is upon the steeper slopes and along sharp stream gulches that the first signs of iron ore have been found. These consist usually of lumps of the hard variety of ore and less frequently outcrops of the soft brown type.

The basalts are commonly much altered by weathering. Sometimes the original rock has been changed into a deeply iron-stained soil and again into a clay residuum that is light yellow or whitish in color. The typical basalt soil is of reddish color and filled with shot-like concretions of limonite. This fact has given rise to a current use of the term "shot" soil. Some of these soils contain a fairly high percentage of iron. On the other hand, the light-colored residual clay, which occurs mostly some distance beneath the surface, is often nearly free from iron oxide. Many fresh basalts contain 10 to 12 per cent or more of iron oxide. A higher amount than this in the resulting soil means that in breaking down a process of iron concentration has gone on, while a partial or complete absence of iron in the residual clay on the other hand indicates as certainly that a removal or loss of this element has accompanied disintegration of the rock.

It is to be drawn from the foregoing that, first, the original basalt contains, among igneous rocks, a large percentage of iron, and secondly, that in weathering, the iron is released and may be taken away entirely or deposited in or near to the position of the original rock as we see in the iron-charged basaltic soil. The decay of the rock is brought about in large part through the agency of water which enters and gradually moves through it, producing chemical changes and dissolving such soluble substances as are formed. The iron of the unweathered rock exists largely in silicate combination.

When it is freed by weathering much of it becomes soluble and therefore subject to being dissolved and carried away. The iron compounds formed will remain in solution until somewhere in the course of its movement the circulating water meets conditions in which the iron is precipitated. The iron-bearing solution may seep out along hill slopes and give rise to iron springs where much of its iron is deposited. Capillarity may carry it to the surface over large areas and by evaporation or chemical reactions the soils may become saturated with hydrous iron oxide as in the red soils. Again, the waters which have gained their iron content from an area of altering basaltic rocks may not meet conditions by which they will be relieved



Blast furnace at former iron smelting plant of Oregon Iron and Steel Company, Oswego

of this iron until they have reached a swamp or shallow lake where beds of bog ore are formed.

In the Columbia county iron district the heavy bodies of basalt evidently consist of what remains of many separate lava flows. The source of these flows can only be conjectured, but it is entirely probable that they came up from the earth's interior through cracks or crevices in many places. It is not unlikely that some of these points of issuance are within the quadrangle under consideration. Neither is it certain how long a period of time is represented by the flows.

We know that the earliest of them came out upon an uneven land surface carved in other types of rocks. In many places outside of Columbia county abundant evidence is found that periods of time of considerable length elapsed between flows. During these intervals erosion and weathering, soil formation and plant growth proceeded much as at present. Each flow overwhelmed and covered whatever of sediment, soil and plant accumulation may have taken place upon the preceding one. When, then, we examine these flows as they are exposed today, we are studying a cross section, as it were, of the record of the happenings of those early times in which the repeated lava flows first spread out upon the land.

It has already been stated that the Columbia county iron ores occur in association with the basalt flows. These ores have been opened up in several localities to be specifically referred to later, where their exact relationship can be seen. In every instance the ore is enclosed within the lava, usually plainly between two of the flows, or at the base of the lava and upon the old erosional surface of sedimentary rocks below. So constant is this association it may be stated confidently that only in the basalt areas, shown on the map in red, is there any promise whatever to the prospector of finding iron ore.

ORIGIN OF THE IRON ORES

We have already seen that basalt is a lava sufficiently rich in iron-bearing minerals to furnish, by weathering, the iron for deposits of iron ore. Among those who have studied this region two main methods have been proposed to account for the beds of ore as they are found. By some they are believed to have been formed through a process of residual concentration in the position and during the weathering and alteration of the original basalt. The second method is one of accumulation in swampy places or shallow lakes as so-called bog iron ore. A knowledge of the exact mode of origin is of vital importance in connection with any proposed development or systematic prospecting of the iron deposits.

One may think of accumulation by replacement of the original rock as taking place either under surface conditions or at depth. In the first case the process would in general be that by which the ferruginous soils are formed, erosion being absent or so sluggish that layers of some thickness could form. Such old soils would then be covered by later flows in order that we may find them in their present positions. A second phase of residual accumulation is illustrated by the growth of concretionary masses within the earth away from surface influences. Concretions are large or small, often round or oval in shape, or may be bands or beds or ledges extending an indefinite distance along certain zones or horizons. The concretionary substance itself may have originated close by or at a distance. In order that sufficient rise in iron content to become an iron ore could take place in a weathering basalt a correspondingly large amount of the other constituents of the rock must be removed.

In breaking down under ordinary conditions of weathering the principal portion of the basaltic residue is clay. This clay forms through the hydration of aluminum silicates that were in the rock, and is the least soluble and most apt to remain of all the products of decay. Residual deposits of iron ore would therefore be expected to contain as a rule considerable amounts of clayey matter. The known commercial deposits of residual iron ores are all contaminated with more or less of clayey matter, though none have originated from rocks with as high an original content of silica and alumina from which the clay comes as the basaltic lavas contain. The percentage of insoluble impurities in the many samples of Columbia county ore that have been analyzed runs low as compared with the quantity that would remain in the normal weathering of the lava.

The second method of origin mentioned above, that of accumulation in shallow lakes or swamps as "bog" ore may be briefly treated. Bog ores form by the precipitation as hydrated iron oxide, limonite, and often some carbonate, of the iron brought in solution in the waters coming from nearby areas of weathering iron-bearing rocks. Basalt is rich in minerals that contain iron and this is dissolved, mainly due to the presence of carbon dioxide from the air, sulphuric acid when it is present, and decomposing organisms and the organic acids derived from decomposing vegetable matter. Precipitation of iron takes place when the carbon dioxide escapes, or when the ferrous sulphate comes in contact with the air. "Iron bacteria" are thought to be of importance in releasing the iron from its combination with the acids of organic decay.

The result of the operation of these processes is to produce deposits of impure iron ore, sometimes several feet in thickness and in a few places in the world of commercial quality. The common impurities which they contain are naturally such clayey matter and sand as would be brought in by streams at the same time, and the remains of plants, leaves, stems, the wood of trees, that either float or grow in or about the borders of the lake or swamp. Bog ores are forming today in many places where their nature and the process of deposition may be observed.

We may now examine the Columbia county ores in the light of our knowledge of bog iron ores and those of the residual type and their methods of accumulation. First of all, they are, wherever seen, what would be called "soft" ore, with more or less continuous bands of "hard" ore running through practically every deposit. The bands of hard ore are from one inch to 6 or 8 inches in thickness, and as a rule are higher in iron than the soft variety. The soft ore varies from pulverulent brown iron rust to a deep brownish red of granular texture. The ores occur in beds from three to twenty feet thick. Where prospecting has been carried on, these beds are found to underlie areas of considerable extent. Each bed rests upon altered basalt below or the bleached or vari-colored residual clay from the alteration of this rock. Altered basalt also covers the iron ore beds, and the ore, thus, so far as can be seen, is enclosed between lava flows and partakes of the same attitude or inclination as do the accompanying lava layers.

Between the ore and the overlying basalt in many of the cuts that have been made is a layer of fragmental material resembling a tuff-breccia or ashy clay. The latter is the more common and runs six to eight inches thick in places. It shows what is apparently the bedding planes that are characteristic of sediments deposited in quiet water, and its contact with both basalt above and ore below is customarily sharply marked. The ashy clay sometimes grades upwards into the iron-stained volcanic tuff which contains angular pieces of altered lava scattered promiscuously through it and lacks any evidence of having formed under water.

Within the ore at one well-developed series of prospect openings, and particularly toward the base of the bed, quantities of petrified wood are found. Pieces as large as logs and branches occur plentifully, in such position as to suggest quiet settlement upon a mass of accumulating iron ore. At some later time and long prior to the present the organic structure of the wood was largely replaced by the deposition of silica from mineralized moving underground waters.

We may thus most satisfactorily picture the formation of the iron ores that are now being discovered and opened up in Columbia county as having taken place in ponds, along sluggish water courses and in swamps or lakes, that existed upon a basalt land surface of long ago. It was a land surface of low relief and poor drainage, yet one so exposed to the action of the agents of rock decay that an abundance of iron compounds was contributed by the weathering basalt to the streams that discharged their waters into those places of accumulation. Here their iron content was precipitated as "bog" ore, and floating trees and other vegetal remains and whatever of soil particles, silt, clay or sand likewise settled into these depressions in the land.

Then came a day when ore deposition ceased. Perhaps not distant volcanic eruption contributed to incoming streams an unusually large amount of ash and then larger pieces to mix with the clays so that in places the iron ore was blanketed above by a seal of impervious sediments or covered by a sheet of volcanic tuff that filled to elimination the water body in which the bed of ore had grown. This series of events, whose progress doubtless extended through many thousands of years, was next succeeded by the coming of a deluge of lava, portions of which we now see above the iron ore, that must have swept across we know not how great a stretch of country. This flow, like that on the surface of which the iron ore was deposited, extinguished all life and produced many changes of topography. Following it came others, time and again repeated and with varying intervals between, which built the great thickness of the basaltic capping that today overlies the sedimentary rocks in parts of Columbia county.

We must regard the time of deposition of these ores as of long duration. Lava flow succeeded lava flow but between several of them conditions were favorable and the time interval long enough for vegetation to develop, perhaps forests to flourish, and iron ores to accumulate. And this opens to us at once the plausible and correct inference that the various ore bodies discovered were not necessarily deposited at the same time or in parts of the same body of water, but as likely represent different swamps or lake bottoms and even different time periods between lava flows. It should be kept in mind, however, that the ore is always associated with the lava and will not be found in the earlier sandstones and shales.

DEVELOPED ORE AND PROSPECTS

Somewhat outside of the particular area mapped for this report is the only deposit of iron ore from which there has been commercial production in Oregon. This is a deposit of limonite near the town of Oswego, about 8 miles south of Portland in Clackamas county. As described by J. S. Diller in Part I of the 17th Annual Report of the United States Geological Survey, the outcrop of the bed shows 2 to 8 feet of ore having a dip to the west of north varying from 8 to 30 degrees in several hundred feet of workings. It lies between two layers of basaltic lava.

As the only body of iron ore in Oregon that has been thoroughly opened up, the Oswego deposit is of particular interest since its character and relationship to the enclosing rocks are identical to those of the most extensive occurrences in Columbia county. The evidence of its having accumulated as a bog deposit seems conclusive and the facts on which this evidence is based are the same as observed in connection with the Columbia county ores.

The first and only iron yet produced in Oregon was made by the Oregon Iron Company and its successors at Oswego. The ore used came from the bed of limonite already referred to as occurring between sheets of basalt two and one-half miles west of the town of Oswego. The plant began producing in 1867 and was finally closed in 1894. Pig iron and cast iron pipe were made. Charcoal made at the plant was the fuel used. Records show that the plant was fully equipped and up-to-date at the time of its construction. Increased costs of mining and variations in the grade of the ore determined the final abandonment of this effort.

The Oswego deposit is known to be one by one-half mile in extent, its thickness, as shown in the workings, ranging from 2 to 20 feet. Chemical analyses of the ore given by Mr. J. S. Diller in the 17th Annual Report of the United States Geological Survey, Part I, page 508, are as follows:

	Per cent
Metallic iron	30.00 to 40.00
Silica	7.00 to 15.00
Magnesia	2.00 to 3.00
Manganese	4.00 to 8.00
Lime	2.00 to 4.00
Phosphorus	0.37 to 0.67
Sulphur	0.3 to 1.00

In physical character the ore varies from soft and friable to hard and flinty. The latter is apparently more highly siliceous in composition, although streaks of the harder variety were found to be richest in iron content.

A deposit of limonite known also many years ago was the Payne and Rafferty mine on the north fork of Scappoose creek within the area covered by the present map, and from which it is said a few hundred tons of ore were taken. The ore here lies between decomposed basalt flows and is otherwise similar to neighboring bodies of iron ore in Columbia county.

Again, outside of the present map, showings of limonite are found, associated with eruptive rocks, to the southwest in Washington county along and in the vicinity of the west fork of Dairy creek. None, however, has been worked, and it is not known how extensive deposits there may be in these regions contiguous to the area which the accompanying map covers in some detail.

IRONCREST PROPERTY

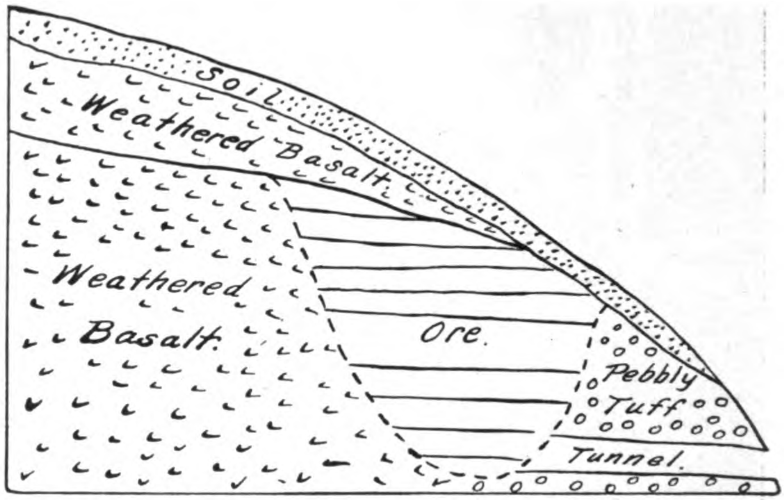
This group of claims is located in the south part of section 35, township 4 north, range 3 west, at an altitude of 2000 feet on the summit of the divide between the north fork and the south fork of Scappoose creek. A wagon road follows up the divide from the town of Scappoose to Pisgah Home, which is within about one mile of the edge of the property. It may be reached also by trail from the highway at Vernonia and other points within the drainage of the Nehalem river to the westward. The claims are held by Mr. H. E. Heppner, Mr. H. A. Heppner, and Mr. C. A. Finley, all of Portland.

Active prospecting was begun in this locality in 1918. The principal openings consist of a series of cuts and a number of tunnels in a distance of one-half mile along the north slope but barely below the top of the ridge in the southwest part of section 35. Some 30 drill holes have also been put down in a 40-acre strip along the adjoining saddle in the north part of the southeast quarter of this section. The holes were spaced about 200 feet apart and are said to have practically all reached ore through a shallow overburden of weathered basalt varying from two to twenty feet thick. The bed of iron ore shown in the holes is reported by Mr. Heppner to average 10 feet in thickness.

A number of interesting facts are displayed in the open cuts and tunnels which bear on the genesis of the Columbia county limonite ores. The face of ore shown in the openings ranges from 4 to 18½ feet and will probably average 10 feet. The ore is soft, yellow to brown in color, with irregular bands of the hard variety running through it. At the entrance to one of the tunnels, and in some of the more westerly of the series of open cuts, the bedrock on which the ore rests is a sticky gray clay containing occasional perfectly water-rounded gravel pebbles. The pebbles are large and small, light in color, siliceous, many of them undoubtedly vesicular rhyolite. The clay contains also numerous pieces of silicified wood and masses of opalitic cellular silica which is sometimes banded as if due to the imperfect replacement of a wood structure.

Open cut at Ironcrest. Fifteen feet of ore overlain by weathered basalt

This material, which now has the characteristics of a gravelly clay, appears to be in reality a much-weathered fragmental rock resembling a rhyolitic tuff which was obviously deposited in water and thus contains the wood and pebbles brought in by water action. One fossil mollusk was found in this bed but whether a fresh or salt water form is not determined for certain. In addition to appearing beneath the ore this clay-tuff is found in a number of the main openings to bear the relation to the ore indicated in the sketch. The beginning excavations were in the tuff, the boundary of the ore body when reached being an almost vertical wall.



Sketch showing position of the iron ore at Ironcrest

The sketch shows also the relationship of the ore to the basalt. The inner parts of the tunnels in every instance encountered a bleached yellow to white cellular residual basalt clay below the deepest portion of the ore. Within distances of 50 to 75 feet from the portal the base of the ore in all instances raised against a sloping face of weathered basalt until, where followed to that point, it pinched out at the contact with a later overlying lava flow.

While the depth of iron ore shown here in the open cuts and tunnels was thus promising at the start, the extent and therefore the actual quantity proven by this work were in an equal degree disappointing. The location of the ore, however, with reference to the immediately contiguous area to the northeastward where the drill holes already mentioned were put down, is such as to leave the inference quite clear that they are portions of the same bed of ore. Accepting the figures given for the thickness of ore found by drilling, there would appear to be outlined in the Ironcrest property as much as a million tons of ore.

The following tabulation shows the percentage of iron in 24 representative samples of ore taken by this Bureau from the cuts and tunnels at Ironcrest:

Sample	Iron (dry) Per cent
1	49.68
2	53.28
3	56.16
4	55.68
5	51.60
6	51.60
7	52.80
8	53.28
9	53.76
10	48.96
11	53.04
12	53.04
13	54.48
14	58.80
15	54.24
16	53.52
17	55.44
18	54.00
19	54.24
20	55.92
21	53.04
22	53.04
23	55.68
24	58.08

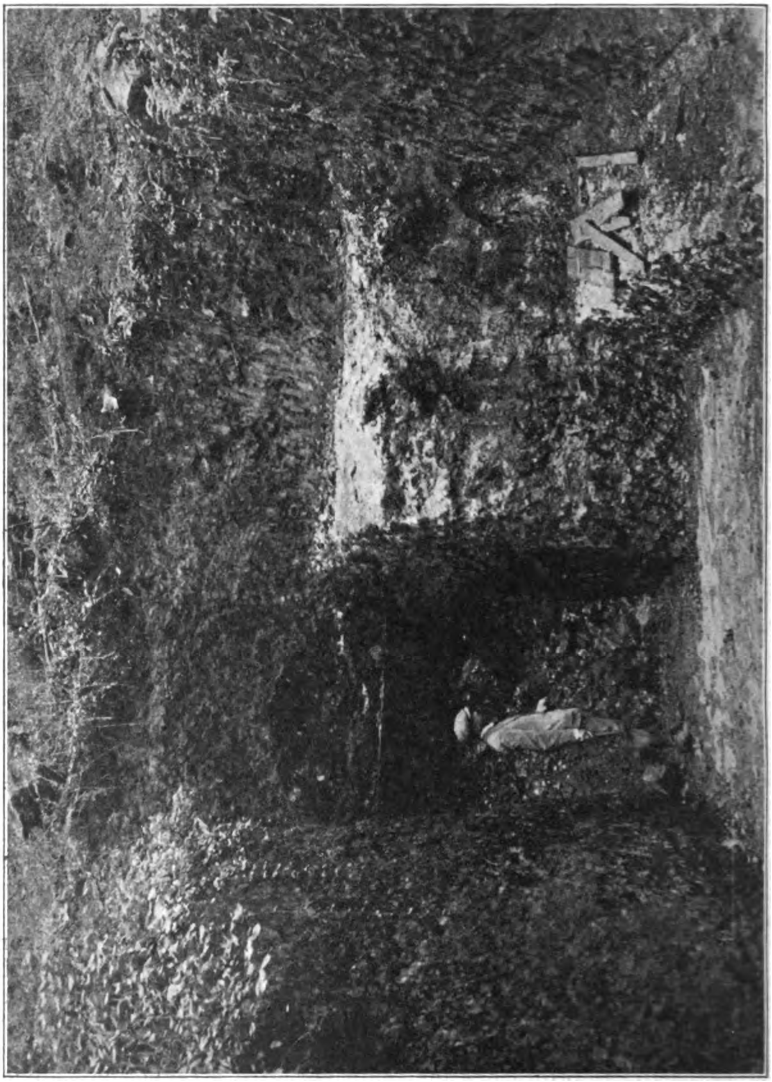
Phosphorus runs from 0.2 to 0.5 per cent. Sulphur, a trace.

A notable phase of this deposit is the quite general presence of a crust or casing of hard ore along the contact with the overlying basalt and especially the side or vertical contact with the pebbly tuff. This crust at the top has in places much the appearance of hematite, and while no analyses have been made to prove the fact, it is readily conceivable that the heat from the superincumbent lava, when it came, dehydrated to a slight depth the bed of bog ore over which it flowed and on which it finally came to rest, cooled and solidified. In the ore also is much of petrified wood. The wood occurs plentifully near the base of the ore body and in position resembles in all respects pieces that may have settled upon the ore as it was forming in the bottom of a pond, lake or waterway. Silicification of the wood by which its structure was preserved may have taken place through the action of hot silica-bearing solutions at the time the ore was covered by the later lava flow, or by infiltration of silica at some subsequent date during the weathering of the surrounding basalt.

The rather unusual shape of the main prospected body of Ironcrest ore as indicated in the drawing, is such as to suggest the filling with bog ore of a former channel or water course that here paralleled for a distance the unconformable contact of basaltic lava and a gravelly sedimentary rock. It may be thought of perhaps as a portion of the winding channel of a sluggish stream that flowed into the lake a small patch of whose bottom is now outlined by the bed of iron ore shown by the drill holes to exist along the ridge immediately contiguous to the northeastward.

OREGON CHARCOAL IRON COMPANY

The property of this company is about two miles northwest of the town of Scappoose on a low dividing ridge between the head of Apple valley and north Scappoose creek. It lies entirely in section



Open cut on property of Oregon Charcoal Iron Company. Seven to eight feet of limonite ore overlain and underlain by weathered basalt

3 of township 3 north, range 2 west of Willamette meridian and consists of 380 acres. The land is in part logged off and ranges in altitude from 300 to 650 feet above sea level.

The ore has been prospected by a series of open cuts and tunnels in the hillside and by drilling over a portion of the holding. By these means the presence of the ore has been proved to date beneath at least 80 acres. It occurs as a continuous bed which can be seen in the prospect openings to be between layers of altered basalt. A plotting of the position of the outcrops which range from 525 to 600 feet in altitude, and the drill logs, indicates that the bed of ore has a uniform inclination of a few degrees to the northeastward. This is apparently in conformity with the attitude of the basalt flows with which it is associated. The maximum capping of lava over the ore in that part of the property that has been drilled is not more than 200 feet. The overburden becomes heavier to the westward in the part of the property not yet prospected.

The thickness of the ore bed varies from 4½ to 13 feet and will average 7 feet. The ore is the soft and granular variety with streaks or bands of hard ore chiefly near the top of the bed. The basalt below is usually weathered to a bleached plastic clay of light or characteristic brilliant or variegated color. In some places altered cellular basalt rests directly on the ore. In many exposures, however, there is a layer from a few inches to a foot thick of micaceous stratified material resembling sandstone but composed largely of angular tuffaceous fragments some sufficiently large to give the bed the appearance of a breccia. The stratification is such as to indicate its deposition in water under conditions where little of sorting action was possible. Doubtful imprints of plant leaves and stems appear in this bed, and dendrites and at intervals irregular harder bandings that run high in manganese dioxide.

Analyses furnished by the company show the following iron content in clean samples taken from cuts and tunnels in the ore:

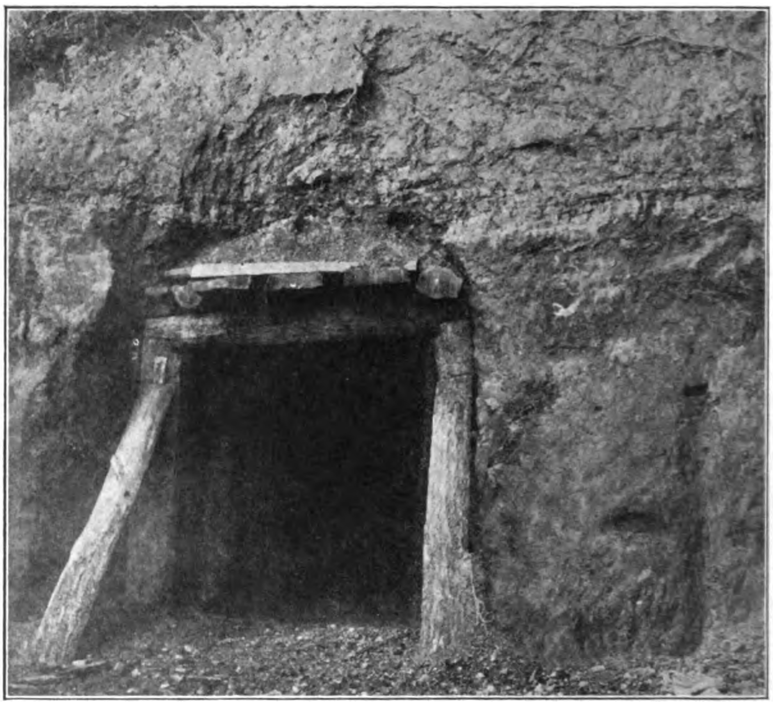
Face	Per cent Iron (dry)
7 feet	54.00
8½ feet	54.67
6 feet	54.04
7 feet	53.25
6 feet	53.78

Churn drill samples of the ore show the following:

Face	Per cent Iron (dry)	Face	Per cent Iron (dry)
10 feet	46.78	6 feet	51.62
9 feet	53.63	4½ feet	50.90
9 feet	55.00	13 feet	53.10
9 feet	51.87	6 feet	47.50
6 feet	40.05	4 feet	51.50
		10 feet	52.14

Many analyses show a phosphorus content of .65 to .85 per cent and of manganese ranging from .03 to .61 per cent. Within the limits of the 20 acres which have now been fully prospected, it is estimated there is approximately 500,000 tons of recoverable ore. There is reason to expect that prospecting will prove a continuation of the ore bed beneath the remaining portions of the Oregon Charcoal Iron Company's property that reach sufficient elevation that the ore and accompanying lava have not been worn away by erosion.

The general features of this occurrence of the iron ore are such, as in the case of the Ironcrest deposit, as to leave no question of its bog origin. Obviously it formed in a lake or pond of some extent on an early basalt land surface and was later sealed in by the oncoming of subsequent lava flows. The layer of sediment upon the ore apparently settled to the bottom of this body of water following



Ten-foot bed of iron ore overlain by clay-tuff, Oregon Charcoal Iron Company

a long period of iron precipitation. It seems probable that most of the materials of which this overlying bed is composed may have dropped from the air into this lake, as ash and other coarser ejecta, during a transition period of vigorous volcanic eruption in neighboring regions which presaged the heavy outflows of basalt with which the country was then flooded.

COLPORT DEVELOPMENT COMPANY

The holdings of this company adjoins the Oregon Charcoal Iron Company's property on the north and consists of 160 acres in the north part of section 3 and 50 acres in the southwest quarter of section 34, the former in township 3 north, and the latter in township 4 north, both in range 2 west of Willamette meridian.

The country, though deeply gashed by stream canyons, rises in this direction to a maximum altitude of 750 feet on the Colport property. A considerable portion is in standing timber.

The iron ore bed is a continuation to the northwestward of that being opened up on the above named property. The main openings on the two properties are at practically the same elevation. This fact and the position of the ore, as shown in the drill holes that have been put down, indicate likewise a general northeasterly dip which varies locally but averages about 3 degrees from the horizontal.

According to the report of Messrs. Elmer and Hogg, consulting mining and civil engineers, 15 cuts and short tunnels have been made in the ore bed and the ore has been penetrated by 24 drill holes on the Colport property. The ore is shown to run from 46.45 per cent to 56.98 per cent iron. A composite made by combining 18 average samples of the ore had the following composition:

	Per cent
Loss on ignition	14.34
Silica	3.58
Alumina	7.47
Iron (dry)	51.00
Manganese	1.24
Sulphur	.025
Phosphorus	.849
Lime	Trace

In estimating the ore blocked out on the Colport ground by the cuts, tunnels and drill holes, the engineers have assumed an average thickness of 4.95 feet running 50.24 per cent iron. On this basis there is shown to be 540,903 long tons of recoverable ore. On the remainder of the acreage under which the ore may reasonably be expected to be present, calculation gives a probable additional 955,367 long tons.

Close examination of the various exposures on the Colport tract reveal no new features of the ore bed. It is generally underlain by a soft light-colored or a variegated clay which in most instances can be seen to be the residuum from alteration of basalt into which it grades below. Above the ore there frequently appears a stratum of micaceous sandy clay that has the characteristics of a layer of sediment deposited in water. In one of the main tunnels a few feet of what appears to be an acid tuff-breccia, or possibly a bleached basaltic breccia, occurs between the ore and overlying basalt. Locally the top surface of the ore is somewhat irregular, mounds or bunches of ore having been apparently squeezed up into the overlying clay or tuff to some extent. The character of the ore and its relationship to the rocks above and below it are here, as elsewhere, such as could come about only by its having originated through deposition as bog ore. From all data available at the present time it appears likely that this bed of ore extends beyond the property boundaries of both the Oregon Charcoal Iron Co. and the Colport Development Co. Prospecting beneath the higher ground to the west and south would seem to hold the greater promise of finding more ore.

BUNKER HILL

In the southwest corner of section 31 of township 5 north, range 2 west, some prospecting has been done on a series of claims known as the Bunker Hill group. These claims are at an altitude of about 1200 feet on the north side of the divide at the head of one of the branches of Clatskanie river. Several cuts and tunnels have been made in the hillside, which show a maximum thickness of 9 feet 9 inches of ore. It is as usual, of the soft crumbling variety with variable bands of hard ore running through it. The ore here is obviously both under and overlain by weathered basalt. In a 40-foot tunnel the soft light-colored clay below can be seen to grade immediately into faded cellular basalt. The ore compares favorably in quality with that from other deposits mentioned.

Sufficient work has been done here to show the existence of a considerable body of good ore but its areal extent is not yet determined.

LADYSMITH CLAIMS

About two miles down the Clatskanie to the north from the Bunker Hill group are the Ladysmith claims in southwest section 24, township 5 north, range 3 west. Scattered pieces of hard ore occur here and at intervals to the south along the hill slopes bordering the Clatskanie gorge. A series of drill holes, pits and shafts have been sunk by which it is claimed the presence of the ore has been determined beneath about ten acres, the bed varying from 8 to 20 feet in thickness and the overburden from a few to 46 feet in depth over the ore. Where thinnest it is clay filled with basalt boulders, but as the ore passes beneath the higher slopes of the hill the overlying material is basalt in place and this continues as the country rock to higher altitudes to the west and south. Beneath the ore is a vari-colored residual clay which promptly grades into basalt within a short distance.

An estimate of 50,000 tons of ore has been made for the area thus far prospected. The limits of the ore to the north, west and south are, however, not known. Analyses of the Ladysmith ore show a high iron content and percentage of impurities comparable with the other ores that occur in the district.

It is only in the four different locations just discussed that the ore has been opened up to an extent such that its character and relationship to associated rocks can be determined. Loose pieces of the hard ore have been found in abundance in a number of other places in the basalt areas where their exact source has not yet been ascertained. Systematic prospecting will probably prove the existence of other commercial deposits.

The ore thus far prospected is distributed over four townships and is all within easy reach of established railroads or logging roads. A large part of this area has been logged off and the railroads or old grades which ramify the district would be of material advantage in the transportation problem.

The ores are generally soft and would be easily mined. The overburden is usually sufficiently heavy to necessitate some method of underground mining. The hanging and footwalls are, as a rule, of a clayey nature and would doubtless require considerable timbering. On account of the fairly uniform thickness of the beds of ore it is thought that some modification of the long-wall system of mining, such as is sometimes used in mining coal, may be found practicable. It is estimated that the ore can be mined and delivered at some point on the Columbia river at a cost not exceeding $2.00 per ton.

OTHER ORE INDICATIONS

Along the hill slope above Alder creek one mile west of north of Spitzenberg many pieces of float iron ore are to be seen. These are all hematite, in contrast to the prevailing type in the district which is limonite. The chief difference in the two ores is the absence of chemically combined water in the former which as a consequence runs correspondingly higher in iron. Limonite may be relieved of its water by heat, and it is, therefore, most logical to account for such an occurrence of hematite as the above through the dehydration of a body of limonite, probably bog ore, by its being covered over with a later flow of liquid basaltic lava.

Abundant limonite float resembling in all respects the hard ore in the various prospects already referred to occurs for a few hundred feet up the slope of the hill to the north of Milton creek in the northwest quarter of section 26, township 5 north, range 2 west. Some of the pieces are as large as boulders. The country rock is altered basalt, which outcrops in places. It is not apparent that prospecting has been done here to ascertain the source of this float or the extent of the deposit from which it may have come.

Similar float ore is found at intervals to the northwestward of the above locality for a couple of miles along the Milton creek slope of the divide. Within the loop of Milton creek and well up towards the summit of the ridge in about section 20 of the same township particularly abundant showings are reported.

Some 400 to 500 feet above the Columbia river beyond Columbia City a bed of limonite ore in the basalt has been prospected in the north part of section 18 and adjacent portions of section 7 in township 5 north, range 1 west. A series of cuts were made and holes drilled without proving the presence of a commercial quantity of ore.

The so-called "shot" soil, which is characteristic of many regions of weathering basalt has been mentioned. Considerable areas within the region mapped are covered with this type of soil. The term "shot soil" comes from the presence of small rounded "shots" which approach limonite iron ore in composition. These can in many cases be seen to be concretionary in structure and are doubtless formed in the process of disintegration of the basalt by which the soil is left as a residue. The shot soils are prevailingly reddish or some shade of brownish-red in color though at times they have a bright red hue.

In such basalt soils the percentage of iron is quite high and concentration of iron compounds may go on so far as to make even a low grade iron ore. It would not be surprising therefore if there should be found in Columbia county, in few or many places, evidences of old reddish shot soils between lava flows, which would have the appearance of possible iron ores. It might be expected that such ancient soils would be more or less compacted or hardened or possibly modified by chemical action or by the heat of the lava that rests upon them and by the coming of which they were buried.

Croppings and float from what appear to be such buried and hardened old iron-charged soils are not infrequently seen. At about 850 feet in altitude and well up towards the summit of the divide one mile nearly east of Spitzenberg much of this shot variety of iron ore crops out in the road and is scattered about. The limonite "shots" are held in a fairly hard matrix that is deep red in color; the whole having at least the superficial appearance of iron ore. The accompanying rock here is basalt of the usual type. Similar material may be seen in an old railroad cut to the south of Cox creek one-fourth mile south of Yankton. Again, two miles west of Yanktown on what is known as the Salzer place, a thin bed of siliceous shot ore is exposed. All are closely associated with the basalts and they are to be regarded as decomposition products of these lavas. Their silicification in places may be accomplished in the soil-forming process by the silica normally released in the breaking down of a basaltic rock or, more probably, by the incursion of silica bearing solutions long after the old soil mantle became entrapped within the lava layers where we now find it. Another occurrence of the buried shot soil type is on the land and near the northeast corner of the Colport Development Company property. A few feet of reddish "shot ore" was exposed here in a prospect cut. None of the showings of this class of material thus far prospected has proved to be sufficiently high in iron or large enough in quantity to be given serious consideration.

A DISCUSSION OF THE ECONOMIC FACTORS CONTROLLING THE MANUFACTURE OF IRON ON THE COLUMBIA RIVER

By DWIGHT E. WOODBRIDGE, Consulting Mining Engineer
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The distribution of iron ores throughout the United States is more general than that of any other metallic ores; there is no state that does not contain them in considerable quantity except Florida, Idaho, Nebraska and North Dakota. From 24 to 26 states contribute their quotas to the seventy or more million tons produced annually.

Not all known deposits are available for use at present. Some carry deleterious elements such as sulphur, phosphorus, titanium, or silica, in prohibitive quantities. Some, otherwise suitable, are so far from manufacturing centers that transportation costs are excessive. Deposits sometimes lie in scattered beds in narrow veins or lenses. Others contain elements that make them undesirable for the iron requirements of the particular region in which they occur.

As the value of a unit of iron is small compared with that of other leading metals, transportation costs govern the usefulness of iron ores to a far greater extent than is the case with most other mineral substances. Price of transportation, cost of mining and quality of ore determine the worth of an iron ore mine. In other words, the value is based on three main factors: location with regard to markets; mode of occurrence; and composition. Subordinate to these factors are others that may be regarded as of local importance. None of these are absolute, but they vary in relation to each other.

An available iron ore is one that can be produced profitably by proper mining and treatment, or that can be used economically in the manufacture of some other article. Hence, an ore of low iron content may be available because of cheap transportation, easy mining, adaptability to beneficiation, or worth in metallurgical processes, whereas a far richer ore may wait indefinitely, having less favorable situation or characteristics.

Evidence of the interdependence of these factors is easily had. For instance, the ores of southwestern Utah yet remain untouched. They comprise high grade hematites and magnetites, and great quantities can be mined from surface openings without expensive equipment or preparation; but mountain ranges and great distances separate them from present large markets and the fuel question has but now been solved. The iron ores of the Sierras of California are somewhat similarly situated. On the other hand, the fossil ores of Alabama, though they average as low as 35 to 38 per cent in iron, form beds of great lateral extent, contain enough lime to be self-fluxing and lie near coking coal. In consequence they are mined to the limit of the demand for iron and steel in the region tributary to them.

Similar illustrations may be seen in many other parts of the world, and in almost every iron ore region of the United States. The supply of brown ores in the southern states is undoubtedly vast, and their mining is not difficult, yet the consumption of these ores is half what it was thirty years ago, although the iron and steel requirements of the nation have increased tenfold. Billions of tons of ideal ores exist in the interior of Brazil, but the cost of transportation still denies them use. Ores carrying 50 per cent iron lie far under the sea off the coast of Newfoundland, but as transportation is easy they are being mined thousands of feet beyond the shore line and are shipped 2500 miles to a foreign market. Enormous quantities of hydrated soft ores along the north coast of Cuba are cheaply mined and are convenient to shipping, but their moisture content and their sticky nature combine to make the cost of handling so high that they cannot be utilized as widely as might seem logical.

Another controlling factor, one of a group that may be regarded as of secondary importance, is that of allied industries. A study of freight rates on steel and iron products from the great centers of manufacture—Birmingham, Chicago and Pittsburg—shows that the country divides itself, according to lines of neutral freights, into three areas that contain surprisingly similar proportions of the total population of the United States. But the area tributary to Birmingham lacks that diversity of manufactures that has made Chicago and Pittsburg such centers of industry. This diversification can be brought about only by wider development of the south and southwest, and by an increased technical ingenuity of the people from whom the supply of labor is drawn.

Materials necessary for the making of iron are ore, flux, and fuel. The prices at which iron is sold makes it imperative that these ingredients be comparatively near at hand, or that they be assembled over efficient and inexpensive routes. In England, distances traversed by them on their journeys to blast furnaces rarely exceed 75 miles, and when converted into iron the latter is on ocean waterways, reaching all parts of the world at minimum charges. In the United States, on the other hand, distances of a thousand miles may intervene between the ore and the fuel. The average length of haul for all the iron ore consumed in this country is not far from 600 miles, while the haul for coke with which this ore is smelted is not less than 300 miles. Were it not for the vast quantities moved and the consequent refinements of transportation, the cheapness of mining and the high quality of the ore used, the United States would suffer under overwhelming handicaps.

The foregoing remarks, while they seem to be far from the subject of a discussion of the economics of the manufacture of iron on the Columbia river, nevertheless bear a very close and definite relation. It is established that a market exists along the Pacific coast for more iron than probably can be made there for many years to come. It is established that there exists near Portland a comparatively small tonnage of fairly good iron ore of a nature suitable for the making of foundry or other irons. It is probable that additional exploration will increase this tonnage to a point where abundant supplies for a commercial smelting operation can be expected. This ore can be mined at low costs, and the question of its transport to suitable furnace sites is a simple one. Flux, though not readily obtainable, probably can be had at a cost not prohibitive.

Fuel may be either soft wood, charcoal, or coke. The former, while not entirely satisfactory, is possible. More charcoal will be required per ton of iron than would be the case were it of hard woods. It is entirely practicable to make iron from soft woods fuel; no great departure from occasional former practice is involved. But, be this as it may, the use of coke is to be favored if coke is obtainable at a proper cost. It has been the hope that Alaska coals might be brought down at a low price. Perhaps this hope was unduly optimistic. It now seems certain that Australian or English coke can be had at prices varying from, say, $9.00 to perhaps $11.00 a ton, Columbia river delivery. It is stated that it is possible to make long-time contracts for Australian coke of a reasonable metallurgical quality at $10.00 a ton.

During the activity of the Oswego, Oregon, furnace of the Oswego Iron Company, prior to 1894, a very lean ore was secured from nearby banks, and this was smelted by fir charcoal fuel, 150 bushels, or probably about 2200 lbs., being the requirements per ton of iron. At that time this cost 6.5 cents a bushel, or $9.75 per ton of iron, which does not vary much from the expected cost of Australian fuel today. I cannot estimate the probable present cost of making charcoal from fir waste in that vicinity, but question if it can be as low as this old-time figure. In other words, it is improbable that fir charcoal need now be considered seriously in connection with the manufacture of pig iron on the Columbia river.

At that time the total materials cost for making iron at the Oswego furnace were said to be as follows:

Ore, 3 tons at $2.10 per ton	$ 6.30
Fuel, 150 bu. charcoal at 6.5 cents per bu.	9.75
Flux, 1 ton stone at $5.50	5.50
	$21.55

This would have brought the total cost of iron to, say, about $24 or $25 a ton. But it is entirely probable that the true cost was higher, and that the discrepancy is due to a more expensive ore.

It would seem that the cost of making iron from the ores lying to the northwest of Portland in Columbia county should now be about as follows:

Ore, 2⅓ tons at $2	$ 4.67
Fuel, 1 1-10 tons coke at $10 a ton	11.00
Flux, 1200 lbs. stone at $4 a ton	2.40
Overall charges, say	4.00
Interest on investment and amortization	1.50
	$23.57

With iron made at that cost, or approximating it, there should be a fair margin. The coast cities are now supplied from imports or from Birmingham. In both, heavy freights are an important factor in costs. No. 2 iron is now (January 1, 1923,) selling at Birmingham at about $24 a ton, on Atlantic tidewater at $27.13. A year ago southern iron sold at Birmingham at $16.00 and tidewater iron at about $24.00. These latter were very close to bottom prices. Furnace coke is now selling at Birmingham at about $6.00 a ton. These figures indicate the probable prices for competitive irons delivered at coast points.

It is evident that manufacturers in the United States must adjust themselves to the tendency to divide the country into trade zones along natural geographic and transportation lines, in order that the economic condition of the nation shall right itself. That is, long and unnecessary hauls on materials must be obviated as far as is practicable. The argument is clear that the coast should, so far as it may, become reasonably independent of distant localities on products that it can make competitively. The advantage of local manufacture of iron is clear, since it is a low-priced commodity, and the economic necessity for its use is paramount.

Commercial history shows that demand for a product grows with the cheapening of the product. While the daily requirement for iron on the coast may now be met by a small output, there is no way to determine what this demand may become ultimately, with a reduction in the price of irons.

From my own personal knowledge of the district, the result of an examination made two years ago, I can not assume that sufficient tonnage has been developed to form the foundation of an iron smelting industry, and its concomitant investments, but it is authoritatively stated that explorations prosecuted since that time have increased the known reserves of ore of commercial grade to a present total of approximately 1,500,000 tons, and that the total to be looked for is still larger.

Based on this statement it is probable that enough ore now exists to warrant an industry. The business must be approached from the viewpoint of a local manufacturing enterprise. That is to say it must be based on a pig iron unit of a size sufficient for economical operation and to return a profit commensurate to the general commercial risk plus an amortization charge to wipe out the investment during its life, all to be in addition to interest on the money invested. I feel that an iron output of, say, not less than 40,000 tons per annum, continued over a period of not less than 12 years, is about the lowest attractive possibility.

That means the daily mining of 300 to 350 tons of ore and smelting capacity of 120 to 150 tons of pig iron; or a total of about 1,500,000 tons of ore, guaranteeing an iron product of above 500,000 tons.

Whatever the truth may be as to quantities of commercial ores in the region, one fact is clear. There are several districts in the United States where iron ores, when mined, enter at once an established market zone, where all mechanical and human machinery for distribution is at hand, where sales agencies are available, where transportation is specialized, and where price quotations on ore are more or less stable and known. The Pacific coast region is not one of these. No iron in quantity is made on the coast, nor is it practicable to transport ore to places where exists the means of manipulation. The entire coast is cut off by long distances from any field in which iron-making is an established industry. Ore from the Portland district is not of a quality to command a market to which high freights are a factor. The whole question of the value of iron ores in the Portland region hinges on the local, the Pacific coast, market possibilities, providing always that there are at hand the materials out of which iron can be made on a commercial scale.

SPONGE IRON

The usual method of making iron and steel is to reduce the metal in the ore to pig iron in the blast furnace, the construction and operation of which require large capital. To make steel, impurities such as excess carbon and silicon gained in the blast furnace must be removed from the pig iron in a converter, another process necessitating heavy financial outlay.

Many attempts have been made in recent years to produce the metal (sponge iron) without going through the customary routine of smelting into pig or cast iron which requires both fuel and flux. It is obvious that if steel can be made direct by melting sponge iron in electric furnaces, with the correct amounts of carbon and other desired elements added, a much smaller plant investment would be demanded and very large operating economies could be realized.

As already pointed out, fuel and flux are to be crucial factors in the development of our Oregon iron ores. Considerable attention has therefore been given to the possibility of making sponge iron, in which neither flux nor coke would be required, but in which local coals or charcoal could be used. The commercial manufacture of sponge iron has recently been accomplished by Messrs. A. G. S. Anderson and E. B. Thornhill, metallurgists, at the Chino Copper Company, Hurley, New Mexico, where a 5-ton daily capacity furnace has been in constant operation for the past seven months.

The successful development of a process for the manufacture of sponge iron on a commercial scale is to be regarded as an exceedingly important advance in iron and steel metallurgy. Mr. Anderson has kindly prepared for publication in this report the following description of the process, the equipment employed and the results obtained:

The process was developed at the property of the Chino Copper Company at Hurley, New Mexico, by Mr. E. B. Thornhill and myself for the purpose of securing an acceptable precipitant for dissolved copper. Any kind of iron ore of a suitable grade may be used. The relative ease of reduction of various iron ores is as follows:

Pyrite calcines
Limonite
Hematite
Magnetite

The iron ore is crushed to pass 30 mesh and is mixed in the proportions of 3 iron ore : 1 reducing agent. It is preferable that the reducing agent be a partially distilled coal containing between 10 and 15 per cent volatile combustible matter, and be a non-coking coal, or a lignite. Charcoal or charred wood-waste also make an excellent reducing agent. The reducing agent is passed through a 6-mesh screen before mixing with the iron ore; therefore, a very fine slack coal may be used. It is more desirable to employ coals in which the carbon is in the amorphous condition rather than coals which approach the anthracite state and in which the carbon is more or less graphitic, because the reducing reaction will take place at a much lower temperature.

The mixture of iron ore and reducing agent is introduced into the center of a muffle type furnace with a horizontal revolving hearth which is filled with coal about 15 inches deep. The furnace is heated with fuel oil and the heat is radiated from carborundum tubes extending across and immediately over the hearth. The charge is rabbled from the center to the outside edge of the hearth by two fixed rabble arms with graphite rabble blades. It requires about 30 minutes to move the charge from the center to the outside edge of a 12-foot diameter hearth. During this period the iron ore is reduced to metallic iron.

The process is a non-slagging and non-melting operation. The iron ore is merely deoxidized to metallic iron which is really a wrought iron and is soft and malleable. The iron does not agglomerate or sinter and issues from the furnace in substantially the same sizes as it was charged as iron ore, i. e. minus 30 mesh.

The temperature employed is between 950 and 1000 degrees Centigrade. The carborundum tubes within which the fuel oil is burned are heated several hundred degrees higher.

The metallic iron, accompanied by the excess carbon used as a reducing agent and the ash from the coal and gangue from the iron ore, is rabbled off of the side of the hearth and into a water-cooled screw and thereby cooled so that it will not reoxidize when it comes into contact with the air. It is dropped from the screw conveyor onto a Dings Magnetic Separator, where the metallic iron is separated from the non-magnetic material. A small amount of ash and carbon will still remain with the iron and the product will generally average about 85 per cent metallic iron, the remainder being associated carbon and insoluble.

The reduction to the metallic state is substantially complete. If there is sulphur present, it will combine with the iron forming ferrous sulfide. Ferrous sulfide does not interfere as a precipitant for copper, in fact, it is useful. In manufacturing steel the ferrous sulfide will have to be taken into account and the sulfur eliminated in the electric furnace.

The sponge iron so produced can be briqueted into dense hard briquets without any binder. The finely divided sponge-iron or the briquets may be melted in an electric furnace to steel. The briquets may also be charged into the cupola furnace with varying percentages of scrap iron high in carbon, sulphur or other deleterious substances and used as a diluent making acceptable castings.

The cost of operating a small furnace producing an average of 5 tons of sponge-iron per day with fuel oil at $2.25 per barrel delivered; raw coal at $6.00 per ton delivered, and labor at $5.00 per shift is about $18 per ton, exclusive of the cost of the iron ore. The labor cost is about $11 per ton, but this same amount of labor will be able to produce 100 tons of sponge-iron per day as well as 5 tons per day. A furnace capable of producing 100 tons of sponge iron per day, with average cost of the principal supplies, will be able to produce sponge-iron at a cost of $10 per ton exclusive of the cost of the iron ore.

The type of a furnace capable of producing 50 tons or more of sponge-iron per day will be somewhat different in design than the small size furnaces but will employ the same basic principles.

The cost of a plant capable of producing 100 tons of sponge-iron per day is estimated to be between $250,000 and $275,000 for the furnace and if a partially distilled coal is used in preference to purchasing charcoal or charred wood-waste an additional $75,000 will be necessary for a distillation plant for the partial distillation of the non-coking coal. If the sponge-iron is to be melted into steel an additional expenditure will be necessary for the electric furnace equipment.

AN ESTIMATE REGARDING CHARCOAL PRODUCTION POSSIBILITIES IN OREGON

By O. F. STAFFORD, Head of the Department of Chemistry,
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Any proposal to establish an iron industry in Oregon must be accompanied by at least one solution of the problem of securing carbon for use as a reducing agent. The lack of adequate local deposits of coking coal makes the formulation of the problem simple enough. Either coke must be imported, whatever its cost, or charcoal must be made from local wood supplies. It is the purpose of the present chapter to forecast as nearly as may be the probable status of a charcoal producing industry, insofar as this can be done by taking into account experience elsewhere and by the use of assumed values for such local factors as are essential for the discussion.

This task is attempted with a full realization of the difficulties involved as well as of the unavoidably approximate nature of the conclusions presented. In scarcely any other industry are the factors entering into production so variable as in the charcoal or wood distillation industries. As a material for making charcoal, wood is quite as inconstant in its properties as it is for structural purposes. Yields of charcoal and of by-products are influenced by not only the species of wood used and its condition, but also by the particular carbonization method employed, by the state of repair of the appliances, as well as by the carefulness and expertness of operators. In addition to such obvious considerations as those just mentioned there are others not easily characterized but none the less influential. This is illustrated by the fact that in plants owned by the same company and under the same management, operating under apparently identical conditions but at different points, results are often obtained which are consistently unlike.

In addition to uncertainties such as the foregoing, the present discussion must also be burdened by the fact that there is no adequate local experience in the wood carbonizing industry which can be used to evaluate such factors as labor and construction costs. Even climatic conditions must be considered, and these, as well as all of the things mentioned above, are different from their counterparts in localities where this industry has been established.

In spite of the fact, however, that owing to a dearth of definite experience no precise forecast of the costs of making charcoal is possible, it is worth while to set forth the situation in as detailed a manner as may be. With the prodigious amounts of cheap waste wood available in the Northwest, it is the firm conviction of the writer that the time will soon come when amounts will be carbonized corresponding to the quantities of products which can be sold; and that, moreover, by the growth of industries at home as well as by the development of markets abroad, the demand for wood carbonization products will, before long, justify an industry of significant magnitude.

MATERIALS AVAILABLE

The materials available for charcoal manufacture in Portland territory comprise the local species of wood which figure in the lumber industry.

CHARACTERISTICS OF DOUGLAS FIR

Douglas fir is so predominant among these species that for practical purposes it may be considered the sole material. In connection with the proposed use of Douglas fir, however, it is to be remembered that fir is not considered by wood distillers to be a highly favorable material for the reason that it occupies an intermediate position between the hard woods which give a high yield of wood alcohol and acetic acid, on the one hand, and soft or resinous woods, such as southern long leaf pine, which give low yields of alcohol and acid but an exceptionally high yield of turpentine-like oils and tar. This unfortunate half-way status of Douglas fir has at times been held responsible for past failures in attempts to establish a wood carbonization industry in the Northwest. It is certain that this has been contributory to those failures, but in the opinion of the writer, only in a minor way.

WOOD SUPPLY MUST BE DEPENDABLE

The supply of wood for a charcoal industry must be absolutely dependable in the large amounts which are required. It takes practically a ton of charcoal, for example, to produce a ton of pig iron. To make the 50 tons of charcoal needed for a 50-ton per day iron furnace there must be at hand from 125 to 150 cords of wood daily, the amount depending upon the method of carbonization used and the character of the wood supply. The task of procuring an unfailing supply of wood in such amounts is of itself no simple matter and can be accomplished only through a smoothly working wood buying organization.

CORDWOOD, MILL WASTE AND STUMPS

As a practical matter the wood must be obtained either directly from the forests as cordwood or from mill waste, such as slabs or hogged wood. Proposals involving the use of stump wood as material for charcoal making can have merit only when coupled with land clearing operations of unusual magnitude which are at the same time of a character that will admit of a considerable proportion of the cost of delivering the stump wood being charged to the land. The recovery of stump wood as an operation by itself is far too expensive to compete ordinarily either with cordwood or mill residues. The utilization of stump wood, moreover, will be a more expensive matter in the plant than the use of cordwood or slabwood, although it can be handled on a cost parity with hogged wood. Stump wood frequently is rich in resin, however, and should give higher yields of oil and tar than run-of-forest material.

COST OF CORDWOOD

As regards cordwood for charcoal making there is no doubt at all that through an active wood buying organization wood can be secured in this form in any amount. The cost figure at which it must be charged to the carbonizing department of the plant will, of course, vary with conditions, lying presumably between $5.50 and $9 per cord. This cost estimate is based upon a stumpage value of 50 cents to $1 a cord; a labor cost of $1.50 per cord for cutting and stacking in the forest; a cost of from $1 to $2 per cord for delivery f. o. b. railway cars; a transportation cost of say $1 to $2 per cord with 50 cents for unloading and stacking in the yard plant; a cost of 25 cents per cord for moving from the yard stacks to the retorts; and an overhead cost of 50 cents to $1 per cord for such items as expenses of the wood buying organization, office costs, interest upon the value of the wood stored in the yard, rental of storage space, shrinkage, etc.

AMOUNT OF WOOD IN A CORD

A vital matter connected with the buying of wood by the cord, which may be mentioned at this point, is the amount of absolute wood substance to be expected in this unit. A standard cord is nominally 128 cubic feet by volume. Depending upon circumstances, however, the actual solid wood content in a standard cord will vary between 50 cubic feet and 100 cubic feet. The lower value is to be met in the case of crooked or small material. The higher figure can be expected only where the wood is in the form of perfectly straight and smooth round bolts, carefully piled so as to prevent unnecessary voids. In the literature dealing with wood measurements one most often meets with figures based upon a solid content of 70 to 72 cubic feet, this quantity being regarded as a standard cord by a majority of people. In other instances cords figure as much as 85 cubic feet, such a cord really being heavier than may be expected where split wood is in question. A tendency has lately grown among users of wood for chemical purposes such as making paper pulp, tanning extract, charcoal, etc., to assume 90 cubic feet as a standard cord. Such a cord, however, is a rare exception indeed where commercial wood is stacked in four-foot lengths and in practice is constituted of lengths ranging from 52 to 60 inches instead of 48 inches.

In making charcoal and wood distillation products with a given species of wood the yields to be obtained are determined, other things being equal, entirely by the actual amount of wood used, expressed as pounds of absolutely dry wood substance. It follows that in any discussion such as the present one it is imperative to call attention to the great variability to be met in cordwood measurements and to specify what a cord should mean. In the opinion of the writer a standard cord of four-foot wood should be defined as 83 cubic feet of solid material. Since the average specific gravity of dry Douglas fir wood is 0.52, it follows that the absolute wood substance contained in a cord of Douglas fir should weigh 2700 pounds. This corresponds to a weight of 3850 pounds where 30 per cent of the wet weight of the wood is moisture, or 4500 pounds where the moisture is 40 per cent of the wet weight.

SLABWOOD

Another possible source of wood for use in charcoal making is slabwood from the sawmills along the Columbia river. The writer has no accurate data regarding the weight of absolute wood substance to be expected in a cord of slabwood. Undoubtedly this weight will vary over wide limits, just as in the case of cordwood. In entering into any engagement to buy wood in this form it is desirable, therefore, that an exact understanding should be had with the sawmill operators to deliver the material in units which will correspond as nearly as may be to some definite amount of absolute wood substance.

Heavy slabwood delivered upon a barge, or upon the railroad cars, has a selling value approaching that of cordwood. In discussions which follow, therefore, it will be assumed that 2700 pounds of absolute wood substance in the form of wet slabwood can be delivered to the carbonizers for say $6, this figure assuming a cost of $2 per unit at the mill, $1 for loading, $1.25 for transportation, 75 cents for yarding from barge, 75 cents for overhead and 25 cents for delivering from yard to the carbonizing appliances.

HOGGED WOOD

In the systems of wood carbonization heretofore commercially operated it is necessary to use either cordwood or slabwood for the reason that until very recently no commercially feasible method of carbonizing hogged wood had been devised. Through a development of the autogenous carbonization principle, however, hogged material can now readily be converted into charcoal and its usual by-products. This method of wood carbonization is described in detail later.

The cost of hogged wood varies between $1 and $2 per so-called "unit" represented by a volume of 200 cubic feet. This unit, however, is again variable for the reason that the volume of hogged wood going into a space of 200 cubic feet will depend upon conditions attending the packing of the material. In a certain case, for example, 95 cubic feet of solid wood when hogged and shoveled loosely into a box gave 330 cubic feet. When fed into a tall tank so that the upper portions compressed the lower, the volume of this same amount of wood was 260 cubic feet; but when tamped down as it was fed into the tank, 230 cubic feet of chipped material resulted. It follows, therefore, that in dealing with hogged wood a variation of 75 per cent may be expected, depending upon circumstances. For this reason it is necessary for buyers of hogged wood to specify definitely the character of the units to be supplied. One large buyer specifies a standard unit which shall contain 2500 pounds of absolute wood substance, corresponding to a 4000-pound unit carrying 37½ per cent of free moisture. In the neighborhood of Portland, contracts are based customarily upon an amount of hogged wood which represents approximately 2200 pounds of absolute wood substance. In the estimates to follow this Portland practice will be assumed.

CARBONIZATION PROCESSES

THE PIT PROCESS

The oldest process for making charcoal, and one which still is occasionally used, particularly where operations may be carried on to advantage at the point where the wood supply originates, is the so-called pit process. Cordwood or slabwood for this purpose is first allowed to dry for a year or so and then is stacked on end in the form of a cone-shaped pile containing usually from 40 to 60 cords. At the center of this pile an opening is left for building a fire. It is necessary before firing, however, to cover the pile with a layer of hay or leaves, and then with earth, so that air may not have free access to the wood but may penetrate only very slowly. In this way a slow combustion of a part of the mass is maintained, the heat produced serving to carbonize the rest of the material.

This process of making charcoal has the advantage of requiring little equipment, but on the other hand the expenditures for labor are excessive. Furthermore, the yield of charcoal per unit of absolute wood substance is lower than by the use of any other method and there are no valuable by-products at all. The quantity of charcoal to be expected from 2700 pounds of absolutely dry Douglas fir, by this method, would be 600 to 700 pounds, so that to produce a ton of charcoal it would be necessary to use at least 3 cords of wood. The cost for wood alone, therefore, at say $6 per cord, would be $18. Adding to this the labor and overhead costs estimated conservatively at $4 per cord, the total cost per cord becomes $10, or roughly $30 per ton of charcoal produced.

A somewhat better showing could be made by locating the char-pit operations in the forest or near a mill supplying slabs. Assuming that year-old seasoned slabs or cordwood could be had at the operating site for $3 per cord, the cost per ton of charcoal would be reduced to say $21. To this figure there must be added, of course, the cost of transporting the charcoal to the furnace.

It requires approximately three weeks to carry a single char-pit through to completion, and since the yield from a 60-cord pit would be approximately 20 tons, or a production of say a ton of charcoal per day per pit, it is seen that at least 50 pits would have to be going night and day in order to supply a 50-ton iron furnace. An organization which could maintain this number of pits in operation would itself be no inexpensive affair, so that all in all, it is difficult to see how pit charcoal could be delivered in this territory for less than $25 to $30 per ton.

A further consideration in connection with pit charring is that this is not an operation adapted to the winter climate of the Pacific

Northwest. The weather has a very considerable influence on the working of a charcoal pit and for best results operations should be conducted in the summer time when everything is dry. An all-the-year-round char-pitting operation consequently might be very difficult.

CHARCOAL KILNS

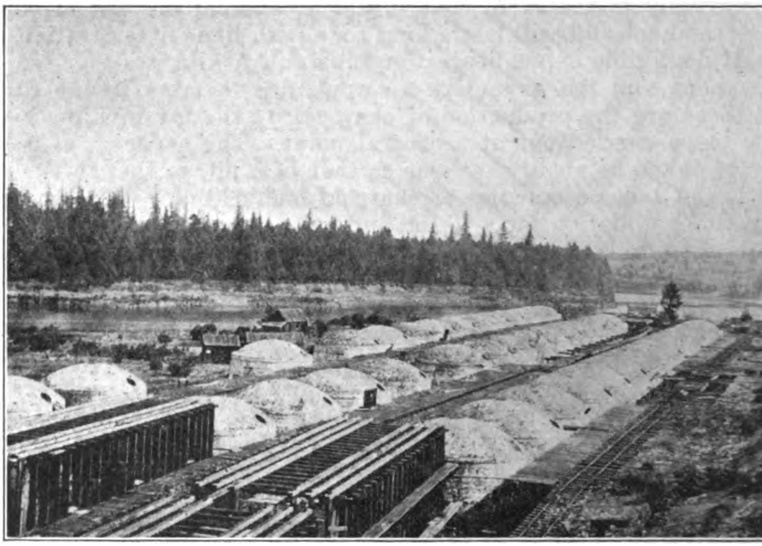
A modification of the pit method for producing charcoal is found in the use of masonry kilns. The walls of such kilns correspond substantially to the earth covering of a charcoal pit, but of course are permanent and will last a long time with little deterioration and almost negligible expenditures for repairs. A kiln is altogether too permanent and too expensive an appliance to erect in the forest, and therefore the production of charcoal by the use of kilns would have to be carried out at a central point. The capacity of a kiln may be taken as about the same as that of a pit, so that in the production of large quantities of charcoal many kilns would be necessary, the installation for a 50-ton output as a matter of fact covering acres of ground. The yield of charcoal is somewhat greater than by the pit process and it is also possible to attach a condenser to the layout, thereby saving by-products.

The cost of wood delivered to a kiln plant would be, say the figure of \$6 mentioned above. Assuming that 2½ cords of wood are required to make a ton of charcoal, it follows that the expenditure for wood alone would come to \$15 per ton of charcoal produced. Adding to this the labor and overhead charges, the total cost of charcoal production in kilns would of necessity be at least \$20 per ton.

As intimated above it is entirely feasible to conduct the vapors from a kiln to a condenser with a consequent recovery of by-products. There is, however, absolutely no dependable experience known to the writer upon which to base an estimate regarding the quantities of such by-products to be expected from Douglas fir carbonization in kilns. It is certain that some oils and tar would be obtained. Fir oil is in demand for making shingle stains, etc., while doubtless considerable quantities of tar can be sold in Pacific coast markets in competition with pine tar from the south. Indeed if only a limited wood carbonization industry ever should exist in the Northwest the tar output should command a price of 20 to 30 cents per gallon. It is conceivable that 40 gallons of tar and 5 gallons of fir oil might be recovered in kiln practice from the amount of Douglas fir required for a ton of charcoal. These products, at present, might sell for \$10 or so. It would cost something to recover them, of course, and to market them—probably half as much as their selling value. A credit of possibly \$5 per ton would in such an event become available against the cost of kiln charcoal indicated above, making the final cost something like \$15 per ton.

The use of selected wood in kilns with by-product recovery would make a still better showing, provided the additional cost of the selected material were not disproportionate. Rich stump wood, for example, should give heavier yields of oils and tar than the above estimate, but such wood is expensive both to obtain and to carbonize as compared with cordwood; its irregular condition with respect to shape of pieces, particularly, increasing all handling costs as well as decreasing the capacity of the kilns.

Finally, recurring again to the matter of selling tar, it must be remembered that the market for this commodity on the Pacific coast is limited and without question could be overstocked easily were there to be any considerable development, eventually, of the wood



Beehive charcoal ovens at former plant of Oregon Iron and Steel Company, Oswego, Oregon

carbonization industry. Consequently it would be hazardous to stake any kind of a business venture solely upon the expectation that tar will command a high price. It is probable that Douglas fir tar, produced under the right conditions, will have a future minimum value of 7 cents to 10 cents per gallon, entirely aside from any of its present uses. In estimates of its value, therefore, some such lower figure should be considered as in the long run strictly applicable.

ROUND RETORTS

In the soft wood distillation industry in the southeastern states, a type of carbonization apparatus is used which consists of an iron cylinder set horizontally in a furnace and provided with charging doors and a vapor outlet. In the south, so-called "light wood" is used for distillation, such wood being the stumps and fallen logs from forests of long leaf pine where turpentine production has been carried on for years. These stumps and tree butts are almost solid masses of resin and consequently are particularly favorable material for the production of resinous by-products. Because of this fact it is possible to carry on charcoal production in small appliances, since the by-products are more valuable than the charcoal, the latter indeed being disposed of at any possible obtainable price or even being used as fuel around the plants. It is obviously out of the question to make use of this type of carbonization apparatus with the run of material available in the Northwest, since the yields of resinous products are insignificant as compared with those from southern light wood, and charcoal here must be the principal product instead of a by-product as in the South.

OVEN RETORTS

The round retorts just described were formerly in use in the eastern parts of the United States for the destructive distillation of hard wood where the purpose was to secure wood alcohol and acetic acid rather than charcoal. Here again the charcoal was a by-product and was disposed of at very low prices or burned around the plant. Of late years, however, the tendency has been to reduce carbonization costs by use of a more economical type of appliance known as the oven retort.

The oven retort consists of a steel-plate shell of rectangular cross section usually 57 feet long, 8 feet 4 inches high and 6 feet 3 inches wide. It is provided at each end with doors which can be sealed and is suspended in a furnace so that the whole can be heated. The wood to be carbonized is loaded upon four special iron cars, each holding about 2½ cords, making the total charge for an oven ten cords. These cars are run directly into the oven, the doors are closed, and the fires in the furnaces beneath are started. Vapor outlets from the ovens are provided, these outlets leading to suitable condensers for the recovery of the liquid products of the distillation.

Usually the carbonization is completed in 20 to 22 hours so that it is possible to repeat the operation every 24 hours. The charcoal in this system remains upon the cars and is withdrawn into steel plate coolers similar in shape to the oven but built, of course, in the open air outside of the retort house. Freshly formed charcoal ignites spontaneously when exposed to air and it is necessary to let a string of four cars freshly drawn from the oven retort remain in coolers for 48 hours. This means that for each retort two such coolers must be provided in tandem if a turn of the retorts is made once each day.

Oven retorts of the kind just described represent as a matter of fact the standardized appliance of the day in wood carbonizing work. The yield of charcoal is higher than where pits or kilns are used and the recovery of by-products may be complete. Installation costs are higher than with kilns and owing to the severe heat treatment to which the steel retorts are subjected, depreciation is heavy. Nevertheless there is usually a distinct advantage in the use of ovens as against pits or kilns.

It is estimated that an installation of oven retorts at an eastern point would cost at this time approximately $3500 for each cord of wood carbonized per day, the figure including all appliances necessary for the production of calcium acetate, wood alcohol, wood oils, tar, etc., besides the charcoal. The alcohol in this case would, however, not be the refined product, but a grade known in trade as 82 per cent.

It is probable that a finished plant under this system would cost in Portland territory, because of higher costs of materials and with more expensive labor than in the East, at least $4000 per cord of daily capacity. The wood to be used necessarily would have to be either cordwood or large mill-waste, since oven retorts cannot carbonize hogged wood. The wood charged to oven retorts must be seasoned, so that it would be necessary either to store it for a year or provide a system of tunnel dryers whereby unseasoned wood might be deprived of its moisture on its way to the ovens.

The estimated cost of carbonizing fir wood in oven retorts, assuming a plant capacity of at least 100 cords per day, is as follows. In the first place the item of depreciation is heavy, amounting to as much as $1 per cord of wood carbonized. The fuel requirement is considerable also, the ovens themselves using the equivalent of 300 pounds of coal per cord, while steam and power requirements call for as much more. Labor, superintendence and other charges are such that the total costs, reckoning wood at $6 as charged to the ovens, will amount to a round figure of $18 per cord. Eight hundred pounds of charcoal, more or less, should be expected from the carbonization of 2700 pounds of absolutely dry Douglas fir, making the gross cost of producing a ton of charcoal say $45.

As a credit against this gross production figure, there might be the following values adapted from the results of experimental work with mill-run fir slabs done at Seattle some years ago jointly by the United States Bureau of Forestry and the University of Washington (a). The prices given below are assumed for this discussion as conservatively possible and so are to be taken as illustrative merely, since of course the prices actually to be obtained in any case will be matters of momentary market conditions.

8 gallons fir oil, say 75 cents per gallon	$ 6.00
10 gallons crude wood alcohol at 50 cents	5.00
70 gallons tar at 10 cents	7.00
200 pounds calcium acetate at 2½ cents a pound	5.00
	$23.00

Deducting this credit from the gross cost of $45, estimated above, it follows that the net cost of the charcoal is in the neighborhood of $22 per ton.

The investigation into yields of products from mill-run waste referred to above included also a series of tests upon selected material. The selection was determined by the appearance of the slabs, each choice showing a pitch seam or other evidence of a heavy pitch content. The proportion of this material in the entire run of slabs was 13 per cent. The yields of products reported, calculated to cor-

(a) See Journal of Industrial and Engineering Chemistry, volume 7, page 918.

respond as nearly as may be to what can be expected in the production of a ton of charcoal, are as follows, values for these items being assumed as in the example above.

20 gallons fir oil at 75 cents	$15.00
100 gallons tar at 10 cents	10.00
10 gallons crude alcohol at 50 cents	5.00
200 pounds calcium acetate at 2½ cents	5.00
	$35.00

The net cost of a ton of charcoal by use of selected material might therefore be as low as $10 per ton, provided selected slabs of the quality tested above could be charged to the ovens at a cost of $6 per cord.

CARBONIZATION OF HOGGED WOOD

The desirability of utilizing small waste wood instead of cordwood in carbonization operations has long been recognized. Literally hundreds of processes for accomplishing this objective have been proposed but for one reason or another have heretofore proved to be impracticable.

The principal difficulty encountered in the use of material such as hogged wood is that of transmitting heat to the interior of a mass of finely divided woody material. Such a mass is conspicuously a poor conductor of heat, so that only the portions of it in contact with the hot walls of a retort can in any reasonable time reach a carbonizing temperature, the central portions of the mass long remaining unaffected.

The numerous attempts to handle such material have had to do principally with overcoming this difficulty of heat transmission. Many of the projects have sought to heat the fine wood by exposing it in thin layers to the source of heat. Others have attempted to secure the necessary heat transfer by agitating the charge in the retort either by means of stirrers or by rotating the retort itself. Still others have proposed the use of a current of highly heated gas as the carrier of the heat to and through the wood mass. The almost universal failures of these efforts have in general been due to heavy costs of installing and maintaining the complicated mechanical appliances required, together with the fact that the carbonizing capacities of such installations usually are low.

A procedure has been developed during the last six years, however, which depends upon an entirely new principle. It has grown slowly through its early experimental and semi-commercial stages into commercial use at one plant having a daily capacity of nearly 100 cords, while just lately the erection of another plant of 210 cords daily capacity has been started.

This new process depends upon the fact that when perfectly dry wood is heated to the temperature at which charring begins, the carbonization then may go along to completion of its own accord without further application of heat from outside sources, the temperature of the charring mass indeed actually rising by the heat spontaneously set free in the process. This remarkable behavior of wood has been a matter of knowledge for but a relatively short time since it is exhibited only in the carbonization of perfectly dry wood, whereas heretofore the wood used for carbonization has almost always contained 20 per cent or more of moisture.

To make use of the above principle the moisture is first removed from the wod by use of a suitable dryer. The dry wood so produced goes in a continuous stream to the carbonizers. These carbonizers consist of vertical cylinders built of steel plate and lined with refractory and heat insulating materials. Valve devices permit the continuous introduction of wood at the top and withdrawal of charcoal from the bottom without introduction of air or escape of vapors. Special vapor outlets at the top connect with suitable water-cooled condensers.

The carbonization process in this type of appliance is carried on as follows: In order to obtain a suitable working temperature initially, a fire is maintained in the carbonizer for a time, whereby the interior is heated to a point somewhat above the temperature at which wood carbonization occurs. During this warming up procedure a stack valve provided for the purpose is kept open at the top while at the same time air for maintaining combustion is admitted at the bottom. As soon as the interior of the carbonizer is hot, both the stack valve and the air opening are sealed and the stream of dry wood is started.

The first portion of this stream falls upon the hot bottom of the appliance and is brought into a condition of active carbonization by the heat stored in the surrounding walls of the vessel. Meanwhile the continuous addition of incoming material has formed a layer over this active first portion. The hot vapors from beneath, filtering upward through this newly-added material, bring it in due time to a temperature of active carbonization. The heated products of this activity are in turn available for raising the temperature of new material which has been coming right along, and so on indefinitely, the process being continuous so long as properly conditioned wood is supplied. Charcoal is removed from the bottom, of course, as may be necessary.

The carbonization of hogged wood by this procedure has been proved beyond question to be commercially practicable. The carbonizer is relatively inexpensive and suffers almost negligible depreciation. Carbonizing capacities are enormous, a machine having interior measurements corresponding to 500 cubic feet of volume easily handling 100 cords per day. Yields of products correspond closely to those obtained in oven retort practice although certain products, calcium acetate particularly, appear in greater quantity.

In this system, it is to be noted, no fuel whatsoever is used to effect the actual carbonization after the process has once been initiated in the carbonizer. It is necessary, however, to burn fuel to remove the moisture from the wood to be carbonized. This drying is accomplished in rotary dryers and where hogged wood of average moisture content is handled the fuel requirement for drying is the equivalent of about 200 pounds of coal per cord of wood treated. This is substantially less fuel than is required to carbonize a cord of wood in oven retorts.

The cost of installing a plant using this continuous system is less than that of building an oven retort plant of equivalent capacity. The system in question has, moreover, a number of obvious other advantages, notable among which are low depreciation, labor, and fuel costs as compared with other systems. The fact that in this process hogged wood may be used instead of cordwood is of course a pre-eminent advantage.

Opposed to these advantages, however, is the fact that from its very nature hogged wood must produce charcoal in a finely divided state. For use in blast furnace work it is necessary that charcoal shall have certain minimum requirements as to strength and size of pieces. A small percentage of the charcoal from hogged wood might be large enough to use directly, but the major part undoubtedly would have to be briqueted for blast furnace work.

A large amount of experimental work has been done on the problem of charcoal briquet manufacture, with the result that certain processes actually are at this time operating commercially. So far as the writer knows, however, no attempt has been made to utilize charcoal briquets for making charcoal iron. Since it is easily possible to manufacture briquets which are stronger than ordinary charcoal there seems to be no reason at all why briquets might not be used in the blast furnace with entire success.

The estimated gross cost of producing a ton of charcoal briquets from hogged wood stands in the neighborhood of $38, including all overhead. The by-products will correspond closely to those indicated above for oven retorts both in quantity and kind. The assumed value of these by-products as obtained from unselected mill waste is about $23, making the estimated cost of briquets appear as $15 per ton. This figure, so far as can be seen, can be lowered, even, in proportion as selected resinous waste may be available. The briquets bring a higher price in the market than lump charcoal.

CONCLUSIONS

Douglas fir as material for making charcoal is disadvantageous as compared with certain other kinds of wood, owing to the low yields of by-products obtainable from it.

The estimated cost of a ton of charcoal from fir by char-pitting methods is in round figures $30 per ton. Char-pitting would probably be a difficult year-around operation in Oregon.

Charcoal can apparently be made in kilns, without by-product recovery, for $20 per ton. By saving and marketing by-products, the cost of charcoal possibly could be reduced to $15 per ton.

Oven retorts with by-product recovery should produce charcoal for $22, more or less, per ton.

By the use of hogged wood it is estimated that high-class charcoal briquets can be made at a cost of about $15 per ton.

All of these estimates are to be taken as approximations based upon the best information now available. No effort has been spared to make the figures as exact as possible, but absolute exactness can be secured only from established practice in the field, and such practice is non-existent. The figures therefore are merely indicative in their significance.

Copies of this report may be obtained by application to the Oregon Bureau of Mines and Geology, 417 Oregon Building, Portland, Oregon.