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OREGON STATE BUREAU OF MINES

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THE ECONOMIC GEOLOGICAL RESOURCES OF OREGON

1912

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Washington, on the north, spends annually $28,750 through her State Geological Survey investigating her mineral resources. Her mineral production is approximately $17,000,000 annually.

California, on the south, spends annually $30,000 through her State Bureau of Mines investigating her mineral resources, and the value of her mineral production annually is $86,000,000. Both these states have maintained their bureaus of investigation for many years.

Oregon has spent, to date, about $1200 through her State Bureau of Mines investigating her mineral resources, and has an annual mineral production of approximately $4,000,000.

Is it illogical to think that some relation exists between the mineral production of a State and the funds spent in investigation of the same?

Is it possible that Mother Nature discriminated against the State of Oregon by cutting off the mineral resources at a political boundary line?

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INTRODUCTION

Oregon produced approximately $4,000,000 worth of geological products in 1910. Oregon imported from other states and foreign countries more than $12,000,000 of geological products in 1910. More than three-fourths of this amount imported could have been produced within her borders. More than 1,500,000 barrels of Portland cement having a value of over $3,000,000 were used in the Portland territory in 1911 and not a single barrel was manufactured in the State. Over $4,000,000 worth of clay products such as brick, tile, pottery, terra cotta and fire clay materials were used in the vicinity of Portland in 1911 and approximately $1,000,000 worth of these clay products were manufactured within the State.

Oregon is in a very unfortunate if not embarrassing situation on account of the fact that she has such limited knowledge of her geological resources. Our neighbor states of California and Washington have been spending many thousands of dollars for a number of years in investigating the mineral resources of their states while Oregon has been doing practically nothing in this direction. As a result investors looking to the Pacific Coast for opportunities along these lines will naturally go where they can get reliable information as to the location and quality of the particular materials which they are seeking. The investor looking for an opportunity to locate a plant for the manufacturing of brick, tile, pottery, terra cotta, etc., will not be attracted to Oregon on account of the fact that in our neighbor state of Washington he can get information from Prof. Shedd's "Clays of Washington" on the location and qualities of the clays which he is seeking, while Oregon has no detailed information concerning her clay deposits.

The cement man will not naturally be attracted to Oregon as long as Oregon has no information concerning her limestone deposits while both the states of California and Washington are publishing information to the world concerning their resources along this line. Oregon has, without doubt, an adequate supply of cement materials, building stones, and clays for the manufacture of brick, tile, pottery, etc., but as has been stated above a very small amount of it is being made use of. Instead we are paying millions of dollars annually into the coffers of other states and adding to this a large tribute by way of transportation charges. It will be only when Oregon realizes these conditions that she will make it her business to investigate the geological resources of the state and publish the same to the world.

Nature has been extremely generous in endowing the State of Oregon with resources many and varied. The fertile soil which covers a large portion of our State is leading to a great development along the lines of agriculture. Her extensive forests are conducive to lumbering and manufacturing on a large scale. Her many fine harbors and increasing railroad facilities point to a large and increasing commerce. The waters teeming with fish have already become very important commercially while the rocks of large areas contain abundance of useful structural materials, precious stones and metals enough to make Oregon a wealthy state if a correct and accurate knowledge of its mineral resources is made accessible to the public. In order that these resources lying hidden in the earth may be utilized it is of the greatest importance that they be studied or examined in detail in order to determine the peculiar adaptability of each product and the best methods of utilization. In response to a general demand from those interested in the development of the mineral resources of the State the legislature of 1911 passed a law creating the Bureau of Mines of Oregon and appropriated funds to carry on the same.

In accordance with the plans of certain other states in which such bureaus have been of very great utility and benefit it provided that the work of this bureau should be as practical as possible; and that the economic products should be studied first of all and the results of these investigations published from time to time and distributed among the people.

The law establishing the Bureau of Mines of Oregon is as follows:

For an Act to establish and create the Bureau to be known as the State Bureau of Mines, defining its objects, powers and duties; providing for the appointment of a director, defining his powers and duties; permitting co-operation with Federal and State Bureaus in furthering the objects of this Act, providing for the publication of the findings of the Bureau; providing for the collection of exhibits of the natural resources of the State; authorizing entrance upon private lands in the prosecution of the work of the Bureau; and making provisions for the appropriation for the enforcement of this Act.

Be it enacted by the People of the State of Oregon:
Be it enacted by the Legislative Assembly of the State of Oregon:

Section 1. That there be, and is hereby created and established a bureau to be known as the State Bureau of Mines.

Section 2. That the said State Mining Bureau shall have for its object and duties the following:

1. A study of the State's mineral resources, with especial reference to their economic products, including coal, oil, gas, ores of the different metals, fertilizers, building stones, road

making materials, clays, cement materials, sands, gravels, mineral and artesian waters.

2. A more detailed study of the road making materials of the State, with reference to their character, distribution, and best methods of utilizing the same.

3. An investigation of the clays in the State, with reference to their adaptability for the manufacturing of brick, tile, pottery, etc., as well as the testing of all the clay manufactured products.

4. An investigation of limestones, slates, clays, of the State, to determine their fitness for use as cement materials.

5. An investigation of fuels of the State, including oil, coal, and gas, with reference to their character, distribution, and methods of utilizing the same.

6. A study of the different ores of the State, with especial reference to their conservation, concentration and reduction.

7. The preparation of special reports, with necessary illustrations and maps, which shall contain both general and detailed descriptions of the mineral resources of the State.

Section 3. That the work of the said State Bureau of Mines shall be carried on by the Department of Mines of the Oregon State Agricultural College, the equipment and buildings of the said Department of Mines to be available for the work of said State Bureau of Mines as herein provided.

Section 4. That the professor of mining engineering or head of the Department of Mines of said Oregon State Agricultural College shall be director of the said State Bureau of Mines.

Section 5. That it shall be the duty of the Director of the State Bureau of Mines to organize and direct the work of the State Bureau of Mines in field and office, to determine the order, character and publication, the reports of the Bureau, and to direct the preparation, printing and distribution of the same; to arrange for co-operative work with the various Federal and State Scientific Bureaus, where such work shall redound to the interests of the State, and to perform such other work as may be necessary to carry out successfully and speedily the work of the survey; to procure and have charge of the necessary field and office supplies and equipment and supervise the acquisition, care and distribution of the collections of the State Bureau of Mines, and to perform such other work as may be necessary to the successful conduct of the Bureau. He shall prepare a report to the Legislature before each meeting of the same, setting forth the progress and condition of the Bureau, together with such other information as may seem necessary and useful.

Section 6. That the State Bureau of Mines is hereby authorized to enter into co-operation with any Federal or State Scientific Bureaus for the prosecution at joint expense, of such work in the State, as shall be deemed of mutual interest and advantage, and under such conditions as said Bureau deems for the best interests of the people of the State.

Section 7. That in order to carry out the provisions of this act, it shall be lawful for any person employed hereunder, to enter and cross all lands within the State; *provided*, that in so doing no damage is done to private property.

Section 8. That for the purpose of carrying out this act, the sum of one thousand ($1,000) dollars or so much thereof as may be necessary, be and is hereby appropriated annually beginning January 1, 1911, out of any money in the State Treasury not otherwise appropriated.

Section 9. That the said appropriation shall be paid quarterly to the Treasurer of the Board of Regents of the said State Agricultural College at Corvallis, Oregon, and shall be used solely for the purpose of paying the current expenses incurred in carrying out the provisions of this act including traveling expenses of those actually engaged in the work of the aforesaid Bureau, all necessary clerical and laboratory assistance, office supplies and expense of printing all reports of said Bureau.

PURPOSE OF THE BUREAU OF MINES.

Stating it more briefly the purpose of the Bureau of Mines is to obtain and publish accurate, definite and unbiased information on the State's mineral resources for the purpose of promoting a larger and better use of those resources, thus increasing the wealth of the State and well-being of its citizens. The State Bureau of Mines is primarily a Bureau of Information on special subjects. This implies, first, the collection of the information, second, the study, systematizing, filing and preparation of that information, and, finally, the supplying of that information to the interested public.

A general scheme of the work is here set forth in order that the citizens of the State may be informed as to what the Bureau of Mines has attempted to do since the law went into effect last March.

The Department of Mining Engineering and Geology in the year 1910 made investigations of the road materials in the Willamette Valley and published a bulletin on the same in January, 1911. Since its publication seven quarries were located the first season as a result of its publication. The demand for the bulletin far exceeded our expectations and a second edition of the same seemed imperative. Since the Bureau of Mines has been given the responsibility for the investigation of all road materials over the State the Bureau has assumed the expense of publishing a second edition of 3,000 copies.

In common with the practice of other states the State Bureau of Mines has made co-operative arrangements with the United States Geological Survey whereby the annual mineral statistics of the State are collected. It was deemed advisable, therefore, with the limited funds available, that the Bureau should publish this bulletin dealing with the discussion of each of the mineral products of importance in the State together with suggestions as to future possibilities. Aside from the co-operation with the United States Geological Survey a considerable part of the information contained in this bulletin has been obtained through a number of investigations incidental to the work of the School of Mines in the past four years.

It is a fact acknowledged by everyone who has had any experience in the matter, that the hardest and most exacting work of such a Bureau is in the office. It is here the field notes must be most carefully elaborated, the minerals and rocks collected must be identified and described and numerous analyses made of the same, maps and illustrations must be made to illustrate the subject matter of bulletins and reports and great care must be continually exercised in order to make reports complete and accurate in every respect.

Since the inauguration of the Bureau of Mines a very considerable portion of the time of the director and his assistants have been taken in making replies to inquiries from our own citizens and from many outside of the State who desire information concerning our mineral resources. It is, of course, essential that these replies be very carefully prepared so that the facts concerning our resources may be accurately stated. The correspondence has already reached large proportions and is increasing by leaps and bounds as the Bureau is becoming better known.

One very important part of the work of the Bureau of Mines is the identification of minerals and rocks sent in by prospectors and mining men. Such specimens will be examined and promptly reported upon if the following rules are observed. First, the specimen should preferably weigh not less than one pound and should be taken from as great a depth as possible; second, accompanying each specimen should be a description of the exact location from whence the specimen came together with a description of its relation to the surrounding ledges or rocks. Third, the specimen must be sent postpaid and addressed to the Director, Bureau of Mines, Corvallis, Oregon.

A large amount of material which comes to the Bureau for information requires little or no expense in making the required determination, while other materials require exhaustive tests involving more or less expense in fuel and chemicals used. Investigations and reports will be made by the Bureau free of charge in the former case, while in the latter the recipient of the information will be expected to bear the expense of the fuel and chemicals used.

The amount appropriated by the Legislature in 1911 to carry on the work of the Bureau of Mines was $1,000 per annum. The appropriation must provide for the entire expenses of the Bureau, the field work, the printing of reports and mailing the same, all necessary traveling expenses, clerical and laboratory assistance and supplies. The cost of doing field work in Oregon is probably just as great as any other western state because of the extreme ruggedness of a large part of the State and the inadequacy of railway transportation. It is, therefore, only by practicing the most rigid economy and by getting all the work done without compensation that the Bureau of Mines is able to accomplish even a small fraction of the work outlined by the bill creating it.

The Bureau of Mines would like to accomplish the following provided sufficient funds were made available:

1. To obtain and maintain accurate and up-to-date information concerning the development work in every mining district in the State, in order that aid and encouragement may be given to every proper and legitimate enterprise.

2. To examine the rock outcrops within the confines of the State, in order to determine the areas of every type of rock, and to make all necessary tests to determine the grade for building material, cement material, lime, plaster, etc., with a view to creating or increasing the production along these lines.

3. To make a complete survey of the more densely populated areas of the State making a field examination of all rock deposits and making all necessary tests to determine the location of material suitable for road building.

4. To investigate the clay deposits of the State to determine their adaptability for the manufacture of clay products such as brick, tile, pottery, terra cotta, etc., with a view to increasing the production along these lines.

5. To keep especially in view the search for deposits of materials not now mined within our borders, which if found of the proper quality and extent would save us from the expense of transportation over long distances. This would not only reduce the cost to our consumers but would be encouraging capital to invest here as well as giving steady employment to labor.

6. To co-operate with the Federal Bureaus, and bureaus of other states and especially with other departments or bureaus within our own State, in order to obtain and disseminate accurate and reliable information with reference to the State's economic mineral resources; as well as to protect the investigating public against the unscrupulous stock peddler.

We are very anxious to make the Oregon State Bureau of Mines of real live benefit to the industry by carrying out fully the provisions of the legislative act. We cannot accomplish this great work alone. We earnestly request the active co-operation and support of all engaged or interested in Mining, one of the great primary sources of wealth.

We wish to acknowledge our appreciation for the courtesies tendered by the railroad companies both in furnishing information and transportation; by those who contributed photographs and illustrative material for this bulletin; and by the mineral producers of the State who furnished the information, without whose co-operation the collecting of the annual mineral statistics of the State would be a very difficult matter. We also wish to express our appreciation for the assistance of Messrs. Arthur M. Swartley and Sidney W. French whose work has added quite materially to the quality of this bulletin.

CHAPTER I.

COAL.

PRODUCTION AND DISTRIBUTION.

The total production of coal in Oregon in 1910 was 67,553 short tons having a value of $235,229. The coal mining industry of Oregon is suffering from the great increase in the production of petroleum in California and its use for domestic fuel as well as on railroads and for manufacturing. Although the production of coal in Oregon decreased from 87,276 short tons in 1909 to 67,553 tons in 1910, a loss of 19,743 or 22.62 per cent, the total value of the production increased .06 per cent or from $235,085 in 1909 to $235,229 in 1910, the average value for 1909 being $2.69 while in 1910 it was $3.48 per ton.

There were only two mines, the Newport and the Beaver Hill, both in Coos County, that shipped coal in any quantity, the shipments being made almost entirely by sea to San Francisco. All of the coal shipped from the Beaver Hill mine is washed, but the refuse from the washery contains sufficient combustible material to permit of its use for fuel at the mines, and it is so utilized. This is responsible for the comparatively large quantity of coal appearing as "used at mines for steam and heat." All of the coal mined in the State is lignitic in character, but because of the cheap water transportation to its principal market at San Francisco it has been able to compete to some extent in that city with the higher grades of coal from Washington, British Columbia, the Rocky Mountain states and Australia.

There were 153 men employed for an average of 257 days in the lignite mines of Oregon in 1910. There were no strikes or other labor troubles.

The statistics of production in Oregon, with the distribution of the product for consumption during the last five years, are shown in the following table:

DISTRIBUTION OF THE COAL PRODUCT IN OREGON, 1906-1910—IN SHORT TONS.

Year	Loaded at mines for shipment	Sold to local trade and used by employees	Used at mines for steam and heat	Total quantity	Total value	Average price per ton	Average number of days worked	Average number of employees
1906	55,232	7,398	17,101	79,731	$212,338	$ 2.66	209	224
1907	39,095	14,840	17,046	70,981	166,301	2.34	231	184
1908	45,375	22,518	18,366	86,259	226,021	2.74	249	214
1909	44,236	25,700	17,340	87,276	235,085	2.69		235
1910	40,497	13,583	13,453	67,533	235,229	3.48	257	153

COOS BAY FIELD.

Coal was first noted in the Coos Bay region about 50 years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention.

The first cargo was shipped from the Empire Basin, but the discovery of coal near the head of Coos Bay soon transferred the point of production to Newport which remained the principal mine until within the last decade, since the Beaver Hill mine has been more successfully managed and become the chief producer. The first record of coal production is contained in the census report of 1880, when 43,205 stort tons were mined. The production has exceeded 100,000 tons in four years only—1896, 1897, 1904, and 1905—the maximum being obtained in 1904, when it reached 111,540 tons. The total production to the close of 1910 has amounted to 2,031,460 short tons, as is shown in the following table:

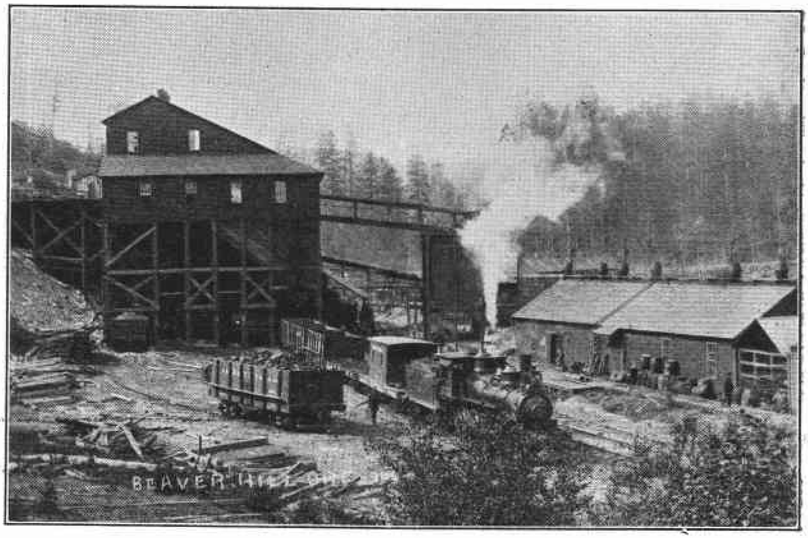
PRODUCTION OF COAL IN OREGON, 1880-1910—IN SHORT TONS.

Year	Quantity	Year	Quantity	Year	Quantity	Year	Quantity
1880	43,205	1889	64,359	1898	58,184	1907	70,981
1881	33,600	1890	61,514	1899	86,888	1908	86,259
1882	35,000	1891	51,826	1900	58,864	1909	87,276
1883	40,000	1892	34,661	1901	69,011	1910	67,533
1884	45,000	1893	41,683	1902	65,648		
1885	50,000	1894	47,521	1903	91,144	Total	2,031,460
1886	45,000	1895	73,685	1904	111,540		
1887	37,696	1896	101,721	1905	109,641		
1888	75,000	1897	107,289	1906	79,731		

The only productive coal field in Oregon is situated in the southwestern part of the State, in Coos County, and is known as the Coos Bay field, from the fact that it entirely surrounds that body of water. Other coal fields have been prospected in different parts of the State. Among them are the Upper Nehalem field in Columbia County, the Lower Nehalem in Clatsop and Tillamook counties; the Yaquina field in Lincoln County; the Eckley and Shasta Costa field, in Curry County; the Eden field in Coos County, and the Rogue River Valley field in Jackson County. All of these fields lie west of the Cascade Range, but none has been developed to the point of production. Another field has been located in the basin of the John Day River, east of the Cascade Range, but little is known concerning it. All of the fields west of the range, with the exception of the Coos Bay, are of limited area, the largest, outside of the Coos Bay, being the Upper Nehalem, which has an area of less than 20 square miles. All of the coal of these fields is lignitic in character, except the best coals of Coos Bay which are properly regarded as sub-bituminous.

Transportation is confined exclusively to Coos Bay and the Pacific Ocean, and San Francisco is the principal market.

The Coos Bay field occupies a total area of about 230 square miles, its length north and south being about 30 miles and its maximum breadth at the middle about 11 miles, tapering regularly toward both ends. It is divided by the Westport arch and it branches into six basins known as the Beaver Slough, the South Slough, the Newport, the Flanagan, the North Bend, and the Empire. The Beaver Slough with comparatively gentle dips is by far the largest and most valuable coal basin, with active mines at Beaver Hill, Riverton and near Coquille, as well as less important openings farther north.



SURFACE PLANT, BEAVER HILL COAL COMPANY, BEAVER HILL, OREGON.

The Newport basin, elevated over an angle of the Westport arch, is most favorably located for economic mining and has been worked more or less continuously for many years. It approaches exhaustion except at the northern end, where the South Marshfield mine still contributes to the local and the coast trade. The Flanagan and the North Bend basins are small and supply part of the local demands, and a small amount is mined for local use in the South Slough.

DISCUSSION OF FACTORS AFFECTING THE VALUE OF COAL.

The coal production in Oregon during recent years has been adversely affected by the great increase in the production of petroleum in California and its use for fuel purposes. As practically all of the product from Coos Bay has been shipped by water to San Francisco, the substitution of oil for coal in most of the manufacturing industries has cut off a considerable portion of the market for this coal. The effect upon Oregon's production is shown in a decrease from 109,641 tons in 1905 to 67,533 tons in 1910.

As many samples of coal are received by the Bureau each year accompanied by queries as to their commercial value we deem it advisable to mention a few of the more important factors bearing on the subject.

In discussing the valuation of public coal lands, Mr. G. H. Ashley of the United States Geological Survey states that "the sale price of coal at the mine may be divided roughly into three elements: (1) Cost of coal in the ground; (2) cost of removing from ground and preparing for the market; (3) profit."

The above factors would govern only in a section where there is considerable competition in the coal market. But the prospective coal producer in Oregon must consider the question from a different standpoint involving the same factors. His coal must compete as a fuel with wood and oil. Knowing how much heat each ton of his fuel will give and how much heat may be obtained from a cord of wood and from a barrel of oil he can easily find the price at which to sell his coal in order to give the same heat from a dollar's worth of either fuel. When this price is increased (or decreased) by the excess in cost of applying or firing the other fuel our producer has found the value of his fuel from the consumers' standpoint and he has merely to deduct the cost of mining, screening, etc., and his expected profits in order to find if the coal in the ground has any value to him.

High grade anthracite or semi-bituminous coals give 14,000 to 14,500 heat units per pound of fuel while many of the impure coals of our western states do not give over 8,000 to 10,000 heat units due to the large percentage of moisture and ash they contain. Ordinary air-dried wood has a heating value of about 6,000 units per pound or about one-half that of a good grade of coal; petroleum has a heating value of about 21,000 to 22,000 units per pound or twice that of some of our Oregon lignites.

From the above it is evident that a barrel of 275 pounds of petroleum has as much fuel value as about 600 pounds of lignite coal of an average grade of 10,000 units per pound. If oil sells at $1.50 per barrel, $5.00 per ton is as much as coal of this grade can bring for industrial purposes, while high grade anthracite would be worth about $7.00 per ton. In addition to this, oil can be fired more cheaply and more efficiently to industrial furnaces than coal, while for domestic purposes it is not considered very satisfactory on account of the complicated mechanical appliances necessary for its use.

The calorific power of a coal can be determined in the laboratory by burning a small sample of it in an enclosed vessel called a "calorimeter" and measuring the quantity of heat by delicate thermometers. If a calorimeter is not available a satisfactory idea as to the nature of the fuel may be had by merely weighing a sample of it into a crucible and determining the ash, fixed carbon, and volatile combustible matter.

Mere careful inspection will often show enough concerning the nature of a sample to make further tests unnecessary. Most of our Oregon coals have a low specific gravity and where such is not the case it is usually due to the presence in the coal of much shale and slate which gives the fracture a dull appearance and, of course, raises the ash to such a high percentage as to destroy its value as fuel. In most markets 15 per cent or more of ash is almost prohibitive in a fuel, though there are a few instances in which coals containing 25 to 35 per cent are being used.

Special features sometimes increase the value of a fuel, as, for example, a coking coal which would be in demand near a blast furnace. Unfortunately Oregon's coals are mostly noncoking.

The cost of mining coal and preparing it for market, storing, transporting, and selling is much more than many people suppose and is prohibitive unless the operations can be carried along on such a large scale as to permit the use and justify the purchase of the most elaborate mechanical equipment. Even in large towns near mines where the run of mine coal brings the mine operator only $1.00 per ton, the consumer is fortunate if he can get good fuel coal for his stove as cheaply as $4.00. This is due to the cost of screening, storing, and transporting, to the loss in handling, and to the payment of middlemen's profits.

This all means that beds of coal must be thick enough and near enough to the surface to be mined at a low cost (usually less than $2.00) per ton in order to be of any value commercially. A coal bed six to eight feet thick, if near the surface and lying nearly horizontally, can be mined economically. As the beds become thinner the cost of mining increases until that point is reached where profitable operation can no longer be maintained. In the United States at present fuel is not sufficiently scarce to make the mining of beds less than three feet thick usually profitable unless they are mined in connection with other seams close to them. In a few isolated cases beds as thin as one and one-half to two feet have been mined but this was due to some special factor and is exceptional.

CHAPTER II.

OIL AND GAS.

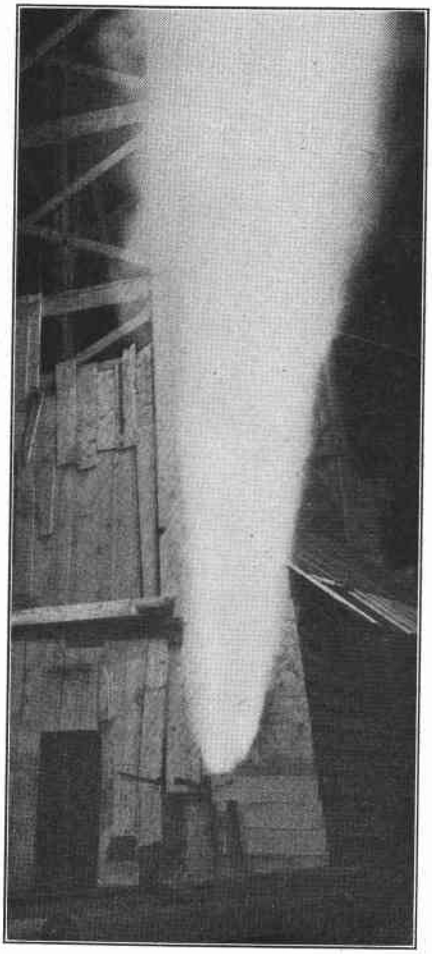
RECENT DEVELOPMENT OF PETROLEUM INDUSTRY IN THE UNITED STATES.

The United States is now by far the greatest oil-producing country. In fact, it produces more than all the rest of the world put together. In 1910 the wells of this country yielded nearly 64 per cent of the world's production, Russia scoring a very poor second with about 70,000,000 barrels, or 21 per cent. The production of other countries is comparatively negligible; the third on the list, Galicia, contributing only 3.87 per cent of the total.

The excess of the petroleum production of the United States over the normal demand is shown by the fact that the 209,556,048 barrels produced in 1910 brought a smaller return—$127,896,328—than the 183,170,874 barrels in 1909, which were valued at $128,328,427. The even smaller output in 1908, 178,000,000 barrels was valued at still more—$129,079,184. As the production has increased the average price has gone down from more than $1.00 a barrel in 1900 to 61 cents in 1910.

These repeated great increases in oil production have been due to the successive development of four great petroleum fields farther west than the old productive centers. By 1900 the country had adapted itself to the influx of oil from western Ohio and Indiana; then came in rapid succession the development of the Gulf field in Texas and Louisiana, the Mid-Continent field in Oklahoma and Kansas, and the Illinois field. In the meantime California's production had been increasing so rapidly that it became the dominant feature of 1909 and 1910, outstripping the production of any other state and promising to retain the supremacy in the future.

The trade effect of these developments was largely discounted by the small proportion of gasolene and kerosene yielded by the Gulf and California oils and it was only when the superior character of the Mid-Continent oil was recognized that the middle western contributions began to be taken seriously in the general trade. Geographic and technical factors put California petroleum at a disadvantage compared with the eastern supply, but the great production has compelled such advances in refining methods as to make it reasonably certain that California will in the future yield good refined products, including lubricating and illuminating oils.



BURNING GAS WELL, ONTARIO OIL
COMPANY, ONTARIO, OREGON.

There are now 148,440 oil wells in operation in the United States. They average about four barrels a day, but in Pennsylvania and New York old wells in some districts yield a profit on an output of less than one-fifth of a barrel a day. The original Drake well, drilled in 1859, would probably, if it were cleaned, be capable of yielding one-third of a barrel a day. Another well close to the Drake well is 45 years old and is still being pumped.

The use of fuel oils is steadily increasing. Railroads consumed 24,586,108 barrels in 1910, against 19,939,394 barrels in 1909. The Northern Pacific, Great Northern, and Canadian Pacific railways have all contracted for oil for their locomotives on the divisions reaching tide water. The advantages of oil over coal have been clearly recognized by the United States Navy. The two new battleships authorized by the last Congress will burn oil exclusively, and it is probable that subsequent battleships will be oil burners. The Canadian Pacific steamships on Puget Sound have also been converted to oil burners.

The oil market in Oregon is almost entirely influenced by the production of the State of California. As may be noted above, California heads the list of producers in 1910 with 73,010,560 barrels of oil. This output is more than twice as great as that of the State of Pennsylvania for any year and also greater than that of any foreign country. The average price per barrel in California during 1910 was 49 cents as compared with 55 cents during the year 1909. The increased use of fuel oil in 1910 over 1909 which was more than 23 per cent was largely due to California's energy in pushing the sales to the northwestern railroads.

Although Oregon produced no oil or gas in 1910 it is probable that some space in this bulletin should be given to the subject since there is considerable interest manifested of late in certain sections of the State in prospecting for this product.

BRIEF DISCUSSION OF GEOLOGICAL OCCURRENCE OF OIL AND GAS.

The Bureau of Mines receives a great many letters from oil and gas prospectors asking if oil could be expected in certain rocks and formations. Very often we receive samples from certain parts of the State asking us to predict the possibility of finding oil or gas in these certain rocks. On account of these numerous requests it seems necessary to include here a discussion of some of the more important factors governing the occurrence of oil and gas in the rocks of the earth's crust. In this discussion it will be the attempt to eliminate geological terms as much as possible in order to be of use to those who have had little geological training.

Oil and gas are usually found associated with such sedimentary rocks as sandstones, conglomerates, shales and limestones. Certain kinds of rock on account of their porous condition are more easily permeated by these substances than others. For example, oil or gas may pass through sandstones or conglomerates much more easily than through the more dense types, such as shales.

Oil is not necessarily found in the rock in which it was formed; in fact, it usually is not thus found, but may migrate for a considerable distance from its place of origin. This being true, oil or gas is found in paying quantities only where nature has made peculiar conditions for its accumulation. In other words, there must be some container to hold the oil or gas at least temporarily. Strata of porous rocks, such as sandstones, may be considered the body of the container while such impervious strata as shales may be considered as the containing walls of the vessel. Now if we eliminate the peculiar conditions due to water in the pores or openings in the rocks or between their grains, these accumulations would naturally be at the bottom of troughs. The shale stratum, for example, forming the bottom of the lower layer of the trough with the porous sandstone or conglomerate just above, we would then have an ideal condition for an accumulation of oil traversing these porous rocks in these troughs.

However, these conditions seldom obtain, but instead we find the underground water filling all the cracks, crevices, and spaces between the individual grains of all rocks of the earth's crust. Since oil and gas are lighter than water we would never find them accumulated in the trough as before mentioned, but instead our containing vessel must be inverted in order to make ideal conditions for the accumulation of these products.

It was formerly thought that the ideal condition for the accumulation of oil and gas would be found only in an area of sedimentary rocks which had been rather gently folded without much faulting or fissuring, it being thought that complex folding or faulting was fatal to the accumulation of oil owing to the fact that they would escape through the cracks and fissures. But it has been found of late that these faults and fissures seem to have promoted the migration of the oil in some places and to have sealed porous or permeable strata by bringing them into contact with impermeable rocks, thus forming reservoirs or more or less inverted vessels in which they are held by the hydrostatic pressure of the water below.

This brief discussion is intended to show that the probability of oil in any section is only determined by a very detailed examination of its structural geology to determine the nature of the strata and probable position of these reservoirs or containing vessels. Probably the most important indication which the prospector can make use of is the seepage of oil on the surface. This may, however, be confused with another occurrence which bears no relation to oil, namely, a scum of iron oxide on stagnant water where the soil is strongly colored with limonite. Closely related to the seepage of oil is the asphaltic substance sometimes found impregnating the soil at shallow depths. One of the most common evidences is the escape of gases. This condition, however, is so widespread that it is almost entirely unsatisfactory as an indication of a place where prospecting should begin. This condition again may be confusing to the prospector on account of the fact that there are a number of gases which escape from the surface of the earth which have no relation to "natural gas."

In answer to the large number of inquiries which we receive as to the progress of oil and gas prospecting in the eastern part of the State it should be stated that this area of the State was investigated in October, 1909, by Mr. Chester W. Washburne of the United States Geological Survey and his report may be found in the U. S. G. S. Bulletin No. 431. His conclusions are that the structural conditions as far as he was able to determine offered but little inducement to prospect for oil but the chance of developing a gas field is good in the vicinity of Vale. There had been only a limited amount of prospecting done, only two wells being drilled to a depth of more than 1,500 feet. Mr. Washburne also investigated the gas prospects in Harney Valley and his conclusions were that since it was found that the sediments in Harney Basin overlie the lavas and probably do not exceed a few hundred feet in depth any place in the valley, it is improbable that more than a small amount of shallow gas can be obtained in the basin.

Owing to the very recent establishment of the Bureau and the small appropriation for the same we were unable to visit the Vale territory last fall to learn of the progress in that field, therefore we cannot add to or modify the above conclusions. No production has been reported to date although prospecting, we are informed, is continuing with considerable vigor.

CHAPTER III.

STONE INDUSTRY.

DESCRIPTION OF THE MOST IMPORTANT TYPES OF ROCKS FOUND IN OREGON.

Basalt, granite, sandstone, limestone, slate and serpentine are the most important types found in Oregon.

Basalt.—Basalt is a dark colored lava rock. It is heavier than most rocks, color varying from dark gray to black. As a rule it is very fine grained, the crystals being microscopic in size; that is, too small to be seen with the naked eye. The fracture of the rock presents almost entirely curved surfaces similar to the fracture of glass, the broken fragments usually having sharp edges. The rock is very porous, due to the presence of steam holes. The pores so formed vary in size from microscopic to several inches in diameter. They may occur in such abundance that the rock approximates pumice in character. Basalt when very fine grained and compact is a very durable rock and is very slowly acted upon by the weathering elements. On account of the difficulty of working them, their dark color, and their tendency to change color upon weathering, basalts are not used to any considerable extent as dimension material in building stones. Basalt, however, is generally regarded as the best kind of rock for road material. On account of its wide distribution in the State this will probably be the most economical use. It is also used to a large extent as crushed rock in concrete work.

Granite.—Granite as here discussed will include all rocks which have solidified from a melted or molten state, other than the fine grained lava rocks. From this standpoint the granite may be described as a more or less coarse grained rock, usually in all the lighter colors of dark gray, light gray, almost white, and sometimes blue or pink. In granite the crystallization of the minerals has been completed and the color is usually due to the color of the prevailing mineral present. These minerals are usually feldspar, quartz, mica, hornblende, and pyroxene. This rock never occurs as lava sheets but is usually found in masses irregular in shape which at the time of forming from the molten condition was some distance beneath the surface.

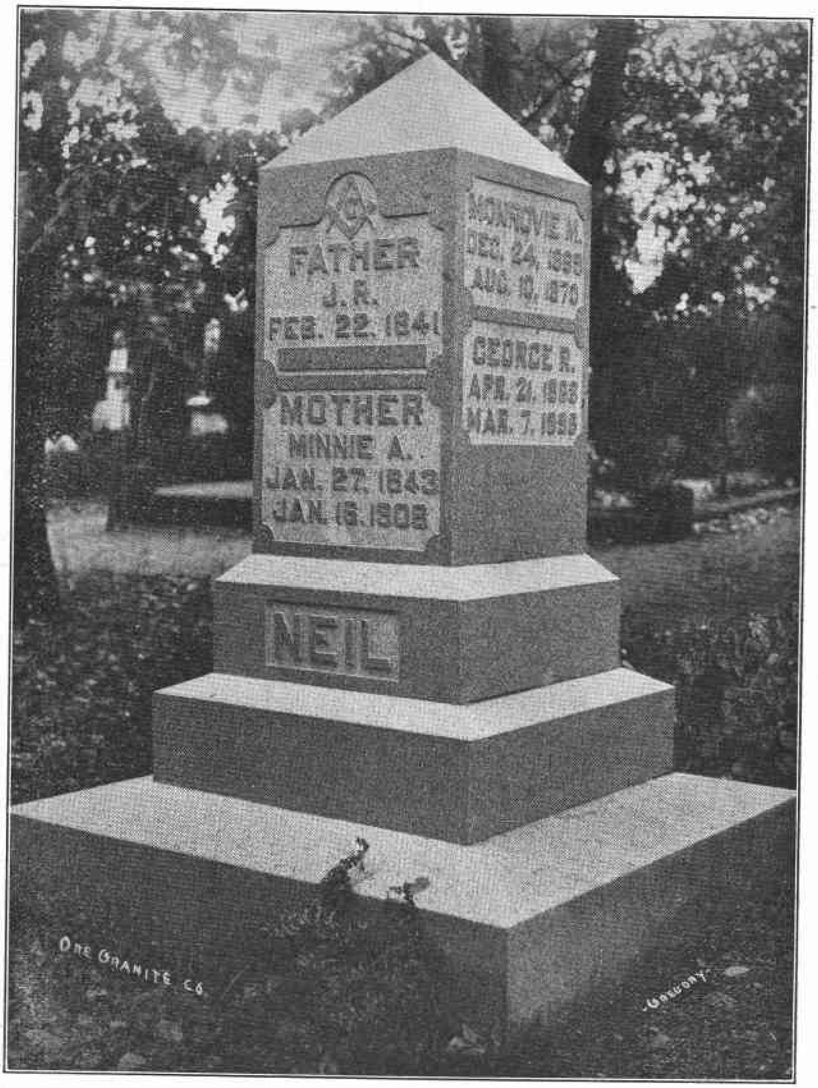
Granite is one of the common rocks used for building purposes and one of the most valued for monumental purposes. This is on account of its pleasing colors and because it holds its color and does not change by weathering as some other rocks do. It is a rock that takes and keeps an excellent polish. It is not much used for road building purposes on account of its being more brittle than some other kinds of rock. It is used quite commonly as crushed rock in concrete work.

Sandstone.—This rock is of sedimentary origin and may have been formed in lakes or in the sea. It is composed essentially of sand derived from rocks with a high percentage of silica. The hardness of a sandstone depends in part on the kind of cement which binds the sand grains together. When silica is deposited as a cement upon the grains a very hard sandstone results which may grade into a still harder rock known as quartzite. Sometimes during the deposition of the sand on the sea or lake bottom other sediments may be included due to a variation of the sorting action of the water. When coarser sediments are included such as gravel, the sandstone thus formed may grade into a conglomerate. When clay or silt is deposited with the sand the rock may grade into a shale.

These cementing substances between the grains of the sandstone form a smaller percentage of the rock mass than the grains, but often have a very important part in governing its value as a building stone since both the color and the strength of the sandstone are directly dependent upon this cementing substance. The most common in sandstones are iron oxide, clay, quartz, and calcite. Sometimes only one of these is present in any one stone but frequently two or more. As above stated silica or quartz cement alone forms a very hard sandstone or quartzite and one that is extremely hard and very difficult to work. Calcite cement makes a good hard rock and one that is more easily worked than the quartz cement. An excessive clay cement forms a stone that is apt to crumble easily especially in colder climates. Most of the sandstones that are strong enough to be economically quarried and dressed have as cementing substances either iron oxide or clay with calcite or silica. The iron oxide gives the yellow, red and brown sandstones, the clay with a little calcite or silica in addition gives the gray, blue and buff colored sandstones.

The ease with which sandstones can be worked, the variety of pleasing colors and the grain and texture that harmonize so well with brick and other building stones makes them most desirable.

Limestone.—Limestone is a sedimentary rock which is almost always of marine origin. It is usually made of broken fragments of shells which accumulate on the sea floor near the coast line but beyond the range of sediments brought from the land. When the sediments are made exclusively from



MONUMENT OF BEAUTIFUL DARK GRAY GRANITE FROM OREGON GRANITE COMPANY, MEDFORD, ORE. THIS STONE COMPARES FAVORABLY WITH THE BEST MONUMENTAL GRANITES.

shells the resultant limestone is quite pure. Sometimes, however, a varying amount of clay and sand may be deposited giving rise to impure limestones. These rocks will be clay limestones or sandy limestones and may grade directly into clays and sandstones. Sometimes the shells may be so thoroughly ground up and finely divided that the individual shells can not be recognized. Also quite often, after the limestone has been made, the shells may be dissolved by underground water which penetrates through them and the whole mass then assumes a more crystalline condition and is more like marble. In fact shell limestone in the State of Oregon is comparatively rare, most of it being of the more crystalline type.

Limestone is very often used for building and ornamental purposes but owing to the limited amount of it in Oregon and owing to the demands upon it for other uses it is not probable that it will figure very prominently in the building materials of the State. The most important uses of limestone as far as Oregon is concerned will be discussed in this bulletin in detail under the subjects "Lime" and "Cement."

DISTRIBUTION OF OREGON'S MOST IMPORTANT ROCKS.

The Bureau of Mines has not as yet had opportunity to make a detailed examination of the outcrops of the different types of rock in the State. However, we have had opportunity to make some observations and it is probable that some suggestions as to the approximate location of different outcrops of these important types of rocks in the State will be warranted at this time.

Basalt.—Basalt is without doubt the most common variety of rock found in the State of Oregon. It is most abundant in the section of the State lying east of the Cascade Mountains where it forms a part of a great lava plain covering over 200,000 square miles extending from California to Washington and across into the state of Idaho. This basalt has come to the surface in a melted or lava condition and has run great distances from the fissures before it solidified in broad sheets over wide areas. In some parts of the State very large quantities of these separate flows have been identified. The late Professor Condon of the University of Oregon identified as many as 33 different flows in the canyon of the Deschutes River. The canyons of some of these rivers such as the Columbia, Deschutes and Snake give us opportunity to measure to some extent the thickness of these great basalt flows. It varies in thickness in different places from thin sheets up to 4,000 feet. Basalt is also found in abundance in other parts of the State especially on both sides of the Willamette Valley, being the most important rock in forming the first foot-hills on both sides of the valley.

Granite.—The distribution of granite in the State is much more limited than that of basalt. The most important localities being an area of older crystalline rocks in the south part of the State in which Jackson, Josephine and Douglas counties are the most important, as well as a similar area in the eastern part of the State in which Baker, Grant, Union and Wallowa counties are the most important. Aside from these two areas it is not probable that granite will be found in large quantities except in the more isolated districts towards the heart of the Cascade and the Coast Range Mountains.

Sandstone.—Sandstones are quite widely distributed over the State occurring in limited areas in most of the counties west of the Cascades, as well as some of those east of the Cascades. The sandstones are found to some extent in the area of older crystalline rocks referred to under the distribution of granite in Baker, Grant, Union and Wallowa counties.

Limestone.—Occurrences of limestone in Oregon are widely separated; deposits of large size are found in the southwestern and northeastern portions of the State. When geologic investigations are more widely extended doubtless many bodies of limestone will be brought to light and additional data obtained regarding deposits now known. In nearly all the areas where limestones are reported there are abundant supplies of clay or shale which could be used in making cement. Fuel, however, is scarce except near the coast, where low-priced oil from Southern California is available.

Jackson County.—Limestones occur at various localities near Gold Hill Station on the Rogue River, and some of them have been burned for lime to be used locally and also to be shipped to Portland. A small amount has been used for flux in the smelter at Portland. The rock is in lenses of various sizes included in schist dipping steeply to the northwest. The largest mass, about 1½ miles southwest of the station, is not more than 200 yards long and 30 feet thick. Other smaller masses are in the ridge north of the station and in the slopes south of the river. A moderately large deposit appears near Rockpoint, three miles west of Gold Hill, on the north side of Rogue River. It is cut by dikes. An analysis made by J. S. Philips, of the United States Geological Survey, is as follows:

Silica	3.1
Iron oxide	2.2
Lime carbonate	89.4
Magnesium carbonate	5.3
	100.0

Analyses by P. H. Bates, of the United States Geological Survey, of two samples of limestone obtained near Gold Hill are as follows:

	1 mile northwest of Gold Hill	1-4 mile west of Gold Hill
Silica	.92	25.21
Lime carbonate	98.22	69.82
Magnesium carbonate	.84	1.30
	99.98	96.33

Limestone of similar character and conditions of occurrence appears at intervals in the valley of Applegate Creek, and it has been burned for lime at one or two points. It also appears in small bodies on the foot of the ridge west of Phoenix, or about five miles southeast of Medford. If coal is produced from mines near Medford, doubtless some of the limestones above described could be made economically into cement. Much of the schist probably is of suitable composition to supply the clay ingredient.

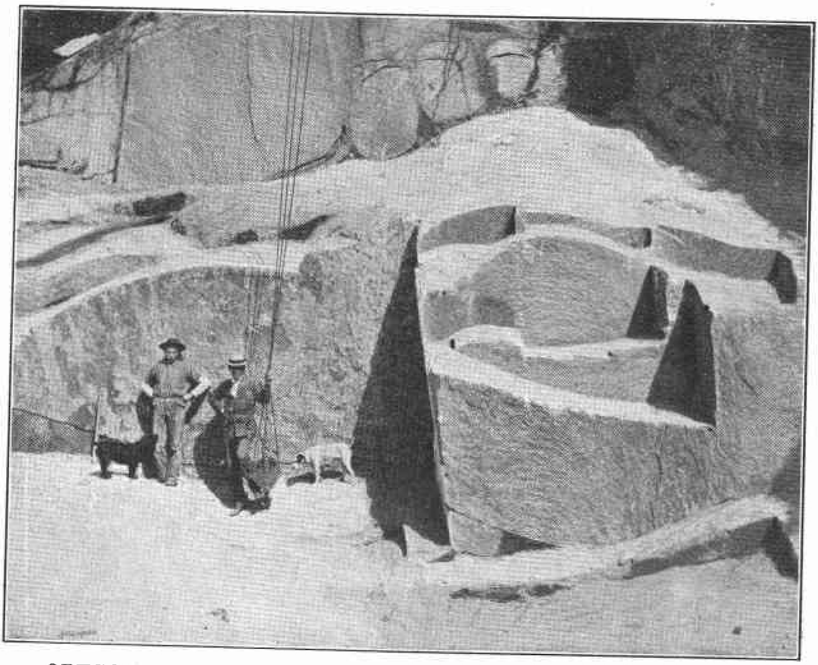
Josephine County.—Limestone occurs in large deposits in the southeastern portion of Josephine County and it is in this rock that the celebrated "Oregon Caves" are developed. Some lime and building stone have been produced, but no data are on record as to the conditions of occurrence or composition of the deposits. Steamboat, Sucker and Williams creeks are the principal localities.

Baker County.—Baker County, which is in northeastern Oregon, contains a number of large bodies of limestone, some of which have been extensively utilized for lime. One thick deposit crosses Burnt River canyon three miles above Huntington. The beds are several hundred feet across and upturned so that they dip to the northwest at a high angle. They are exposed in large quarries on the east side of the river and thence extend eastward for some distance across the high ridge between Burnt and Snake Rivers, but do not appear to reach the latter river. Another thick mass of similar limestone outcrops west of Conner Creek, 15 miles north of Huntington. The limestone quarried near Huntington is remarkably pure, carrying less than one per cent of silica, alumina, and iron. It lies in a series of shales, which appear to be suitable for admixture in cement manufacture.

A body of limestone with croppings several hundred feet wide extends along the ridge south of Burnt River six miles southwest of Durkee and smaller masses occur a short distance south and east of the larger one. Another small mass appears in the east bank of Burnt River three miles below Durkee.

rocks, but it may be continuous for a greater distance than is apparent, as the rocks on the hillside are not well exposed. The outcrop is 10 to 15 feet across, and a small quantity was quarried for a smelter that was in operation for a short time during 1900. At Winterville, 40 miles southwest of Sumpter, a stratum of limestone 300 feet thick outcrops close by the placer diggings. It strikes N. 70° W. In the Copper Butte mining district 18 miles northwest of Baker, several masses of limestone occur.

In the Snake River canyon below the mouth of Cedar Creek southwest of the Seven Devils, 80 miles from Baker, the older



OREGON GRANITE COMPANY'S QUARRY, MEDFORD, OREGON.

rocks appear from under the lava and among them are bluish-gray limestones of supposed Triassic age. "On the Klein-Two small outcrops are known two miles northeast of Pleasant Valley and another occurs three miles southeast of Baker. These all appear to be small lenses. A large amount of limestone is included in the Triassic series on Eagle Creek, especially on its east branch, about 25 miles northeast of Baker.

An outcrop of crystalline limestone of good quality occurs in the clay formation half a mile north of Sumpter. It could not be traced far either way in the direction of the strike of schmidt grade two miles west of Huntley's ranch limestone and shale crop with northerly strike at an elevation of 3,800 feet; more limestone is found northwest of this place in Lime Peak Gulch," finally a heavy mass of limestone crosses Snake River between Spring Gulch and Eckles Bar.

Polk County.—About three miles west of Dallas are extensive exposures of an impure limestone which is quarried for building stone. It is claimed to be a natural cement rock, although a single analysis made in the Agricultural College of Michigan given below does not support the claim.

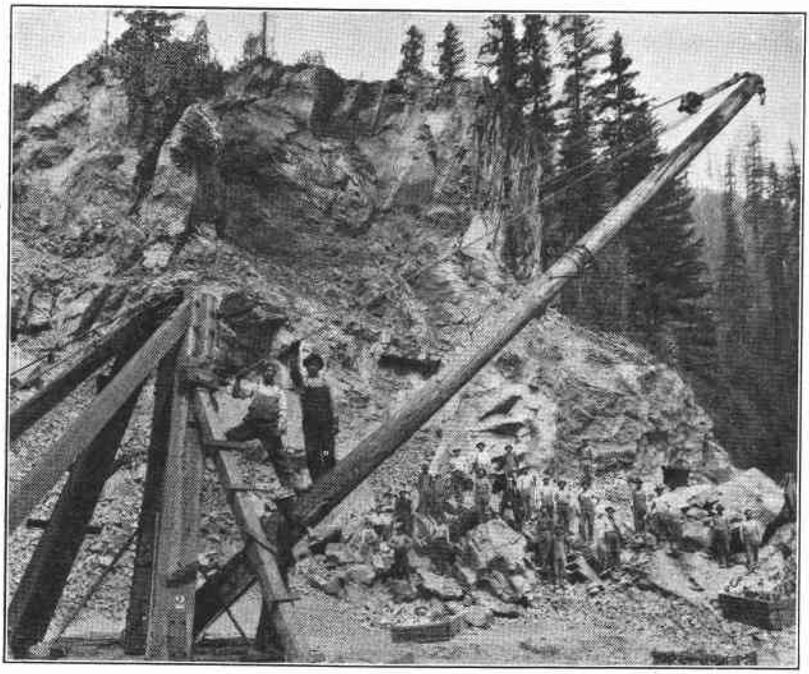
Analysis of "cement rock" from three miles west of Dallas, Oregon:

Silica	24.08
Lime	31.58
Alumina and iron oxide	15.66
Magnesia	2.74
Carbonic acid (CO_2)	20.24
Water at 105°	3.56
Undetermined	2.14

Douglas County.—In the sandstones and shales of the Shasta series ("Myrtle Formation") south and southeast of Roseburg are a number of lens-shaped masses of limestone, which Diller has designated the Whitsett limestone lentils. They occur at intervals along the ridge and slopes extending northeast from Umpqua River nearly to the head of the north fork of Deer Creek. The limestone is a massive gray rock and as it has yielded satisfactory lime at several localities it is probably of good quality. The southwestern occurrence is in Section 30, T. 28 N., R. 5 W., near the top of a prominent ridge; the rock is traceable for only about 100 yards, with a width of 30 to 40 feet, so the supply is not great. The next exposure, a mile northeast, in sections 20 and 29, shows a much larger body of the limestone rising in prominent ledges with the beds dipping northwest at an angle of 70°. The next body, which is mostly in section 14 of the same township, is somewhat smaller, but shows a thickness of 60 feet. Two small bodies occur on the south and north forks of Deer Creek in the next township northeast. They are so compact that they are regarded as marble and have been quarried to some extent for that material. The last mass to the northeast is only 15 feet thick.

Near Oakland there are three small masses of impure limestone which have been regarded as cement rock. One is by the road nearly a mile northeast of Oakland, another at the head of Green Valley, six miles northwest of Oakland, and the third on Starr's ranch about four miles northeast of Umpqua Ferry. The areas are less than an acre in extent. Near Oakland the rock is a bluish shaly limestone that falls to pieces rather rapidly on exposure. It contains, besides a few fossils, brownish veins and nodules of various sizes up to four feet in diameter. At Starr's ranch the limestone is full of broken shells and the beds dip gently to the northwest. Some of the limestone from this region was quarried several years ago and taken to Oregon City to be tested as cement material but the results were not reported.

Some deposits of tuff a few miles northeast of Wilbur have been claimed to be a natural cement rock, but no authentic tests are known. The material occurs in bodies of considerable size, but not well exposed. The analysis given below does not indicate a "cement rock."



QUARRY AT NIAGARA, MARION COUNTY, OREGON—USED IN CONNECTION WITH CONSTRUCTION OF BITULITHIC PAVEMENT.

Analysis of tuff near Wilbur, Oregon:

Silica	55.15
Carbon dioxide	3.64
Alumina, titanium oxide and phosphoric acid	9.75
Ferric oxide	7.76
Lime	10.48
Magnesia	2.22
Potash	.50
Soda	1.00
Water	9.29
	99.79

Clackamas County.—Five miles east of Monitor, a postoffice in Marion County, is a ledge of impure limestone which has been traced at intervals for twelve miles. It has been burned into a natural cement which it is claimed was used in the construction of the Oregon City Woolen Mills and in building the Coolidge Block at Silverton. No analyses are given.

Wallowa County.—Very extensive deposits of limestone are reported in Wallowa County. At Lostine quarries produce rock which is burned into lime. The yearly production is about 1,000 bushels. Another kiln is at Joseph, and the rock is also reported at Fruita. No data are available as to the conditions of occurrence, extent, or composition of these limestones.

CLASSIFICATION OF BUILDING STONES.

Rocks are commonly divided into two, sometimes three, great classes: The unstratified, or igneous; the stratified, or sedimentary.

The first class may be subdivided into the granitic or crystalline rocks, and the volcanic or glassy and stony rocks. The granitic class includes granite, syenite, etc.; the volcanic class includes basalt, trachyte, tuff, etc.

The sedimentary rocks include those formed in water, such as sandstone, limestone, etc.

The third class includes the metamorphosed forms of the other two classes. They may be formed from the igneous rocks, as gneiss, some of the schists, serpentine, and talc; or from the sedimentary rocks, such as marble, which is metamorphosed limestone; quartzite, which is metamorphosed sandstone; or slate, which is metamorphosed clay or shale.

USES OF STONE.

Stone is used in substructures almost universally. Wood, brick, and iron are frequently used as a substitute in superstructures, but whatever may be the material used in the upper building, stone is almost always used for the foundation and basement. In superstructures where first cost can be subordinated to architectural effect, stone will in most cases be used.

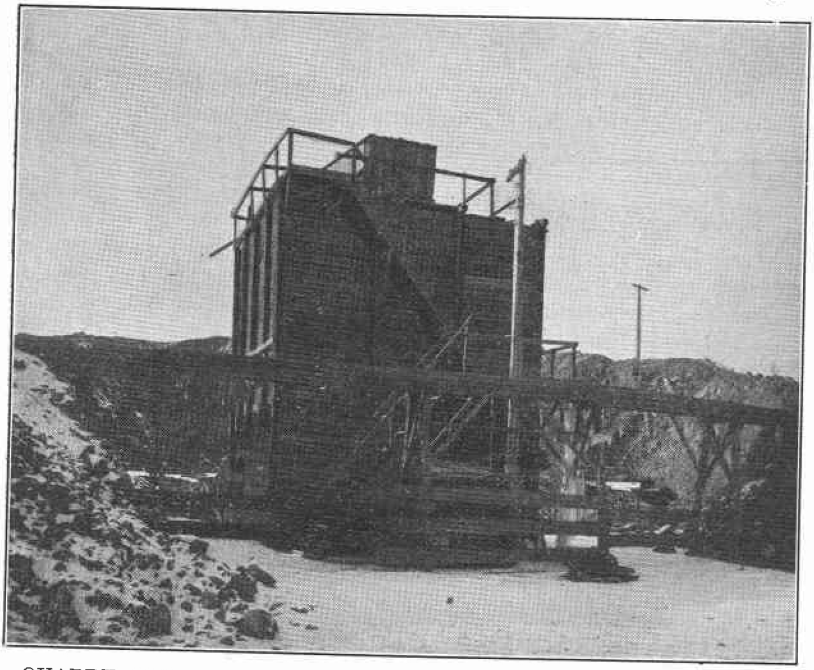
For monuments there is no satisfactory substitute for stone. For this purpose the stone is often shipped a long distance, in order to get one that has an established reputation. Many of the monuments in this State are of stone from New England, Indiana, Georgia, or Europe and often a large part of the cost of the monument is in railroad or steamship transportation charges.

Some of the other uses of stone are in the construction of breakwaters, bridge abutments, culverts, curbing, fences, flagstone, macadamizing, paving blocks, piers, retaining walls, reservoirs, sewers, sluiceways, etc.

POINTS TO BE OBSERVED IN SELECTING A BUILDING STONE.

In selecting a building stone for any purpose, there are a number of different things to be considered, among the most important of which are (1) adaptability, including the architectural effect, (2) cost, and (3) durability.

Adaptability.—Adaptability is the point that is frequently overlooked or receives but hasty consideration in selecting a



QUARRY AND BUNKERS USED IN CONNECTION WITH CONSTRUCTION OF BITULITHIC PAVEMENT, BAKER, OREGON.

building stone. A stone that may be very desirable in certain places for certain uses is quite unsuitable for other uses in other places. The selection of the stone is largely a matter of taste, and as the selective taste is good or bad, so in a large measure is the resulting structure. The stone should harmonize with its surroundings in its use, color, grain, and structure, as well as in the shape and size of the building.

Cost.—The principal items affecting the cost of a building stone are thickness of the bed, its position, the thickness and kind of material overlying the stone, the workability of the rock, remoteness of the quarry, and the transportation facilities. There are many other items, such as the price of labor, the cost of fuel, the equipment of the quarry, the skill in planning work, the climatic conditions, etc., that often materially affect the price of any given building stone.

The thickness of the overburden, the material of which it consists, the contour of the surface, and other local conditions affect the cost of the stripping. It is just as expensive to remove the waste from a thin bed as from a thick one. While it might not pay to remove 20 feet of waste from a bed of stone five to ten feet in thickness, it might pay to do so from a bed 50 to 100 feet thick. It also makes a difference whether there is scattered through the bed much waste material that must be thrown out in quarrying. In some quarries lack of uniformity (due to the presence of foreign material), change in color, or defect in structure means a corresponding increase in cost of quarrying, because of the expense in handling the defective or waste stone.

Having opened the quarry, the cost of removing the stone is often influenced greatly by the hardness, structure, grain, and rift of the stone, which properties are included under the general term "workability."

In many cases the principal item of cost in a building stone is that of transportation. It must be a very desirable stone that could be quarried with profit remote from railway or water transportation. It is frequently necessary to ship stone a long distance in order to get the kind required for a particular use; but the waste comes in when shipping from a distant country a stone of average quality, because it has been exploited and is well known, instead of using a stone from near-by deposits, equally good, or perhaps better, which has not been developed.

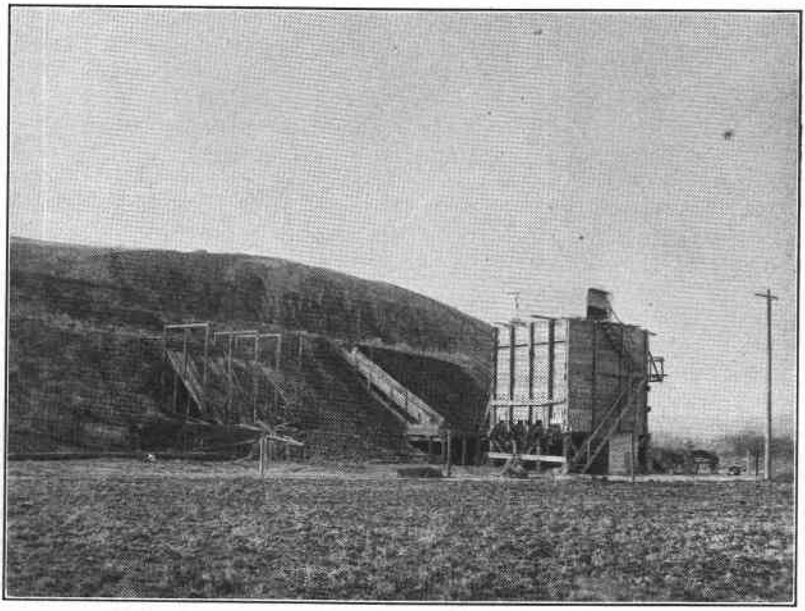
Durability.—The durability of a building stone, or its ability to withstand the action of weather and other agencies, is one of the most important properties to be considered in selecting a stone. No difference how pleasing the color, how cheaply it may be quarried, how small the transportation charges, if the stone will not stand intact in the wall it is dear at any price. There are many different points to be considered in determining the durability of certain stone. Too frequently the selection is made or not made on some point of minor importance, which, in some instances leads to the selection of an inferior stone, and in other cases to the selection of a stone from a distant locality, which means an enormously high freight bill, when a good, or perhaps better stone was near at hand and condemned on insufficient evidence.

The factors influencing durability may be divided into two classes—internal and external.

INTERNAL FACTORS AFFECTING THE DURABILITY OF A STONE.

The chemical composition, and more directly the mineral composition and texture, are important factors in the durability of a stone. Thus one with a high percentage of soluble substances, such as the alkalies, the haloids, or sulphates, is not as promising as one without these substances.

It also makes a difference in what mineral forms the elements are combined. Thus, soda, combined with silica and alumina, in a fresh feldspar is more durable than in some other combinations of these elements.



BASALT QUARRY, PENDLETON, OREGON — USED IN CONNECTION WITH STRUCTION OF BITULITHIC PAVEMENT.

The texture is an important factor in the durability. Thus, a finely crystalline rock is likely to be more durable than one very coarsely crystalline. A finely porous stone will likely prove to be less durable than one which is not so porous, especially in a cold climate. A homogeneous texture will generally prove to be more durable than one that is coarse in one place and fine in another.

EXTERNAL CAUSES AFFECTING THE DURABILITY OF BUILDING STONES.

The external agencies affecting the durability are (1) temperature changes, (2) chemical agencies, (3) abrasion,

(4) method of quarrying and dressing, (5) seasoning, (6) position in the wall.

(1) Temperature Changes.—The climatic and weather changes are among the most important agencies in disintegration. Probably the most important of these is the action of frost, or the freezing of water, in the pores and cavities of the rock. Each ice crystal formed in the rock acts as a little wedge to push apart the grains or burst it asunder. This is a consideration that becomes of great importance in the mountainous districts of this State and in the more rigorous climates of northern and northeastern United States.

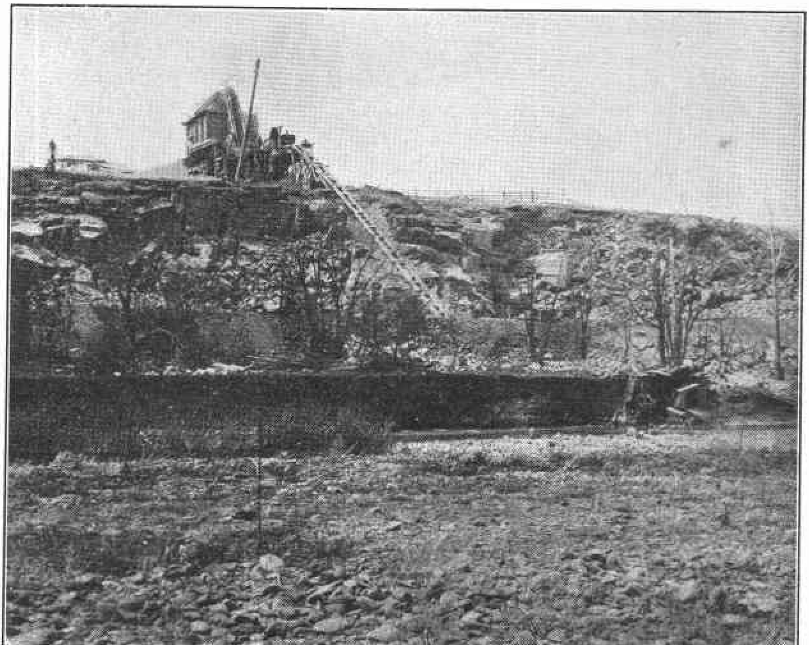
The expansive force of the heat of the sun is less conspicuous than the frost action, but it is a powerful agent of disintegration, everywhere active. The expansion caused by the heat of the sun on the surface while the interior of the stone remains cool produces a great differential strain on the surface layers both in the expansion under the heat and in the contraction from the cold at night or by the sudden cooling from a shower of rain. Rocks deficient in elasticity suffer the most in this way. In some instances it produces checking, or incipient cracks on the surface; sometimes it causes chips to split off from the surface, and sometimes even splits asunder large masses. The expansion under the bright sun is said to be sufficient to cause a perceptible motion of such structures as the Bunker Hill and the Washington monuments.

That frost is a more active agency of injury than sunshine is indicated by the obelisk known as Cleopatra's Needle, which was brought from Egypt to New York City. The stone that stood uninjured for many centuries in the dry, equable climate of Egypt began to crumble in a few years in New York by the frost splitting off chips from the surface of the stone.

(2) Chemical Agencies.—There are several more or less active chemical agencies in the atmosphere that are nearly as destructive as the frost and sunshine. They are more active in warm than in cold climates. The presence of moisture increases their activity. Water itself is a solvent of the materials in the ordinary building stone to such a very slight degree that it could be ignored except as a carrier to bring the more destructive agents into contact with the stone. The acids of the atmosphere, such as sulphuric, nitric, hydrochloric, and the less active but more abundant carbonic and organic acids, are all agents of disintegration, serious in proportion to their quantity. They are more abundant and hence more active in cities and manufacturing centers than elsewhere, due to the combustion of greater quantities of fuel. They are less active in a dry climate.

(3) Abrasion.—The greatest wear on a building stone from the friction of feet and other agencies will be in walks, steps, and sills, and stones for such places should be selected with this in mind. A stone that might last indefinitely in the wall of a building might wear away rapidly in the steps.

Wind-blown sands and dust are very often important agencies of injury. These are generally most injurious in a dry, windy climate, such as the Basin region between the Rocky Mountains and the fronts of many buildings in our large cities subject to the sweep of winds through the streets.



QUARRY AT ASHLAND, OREGON, USED IN CONNECTION WITH CONSTRUCTION OF BITULITHIC PAVEMENT.

(4) Methods of Quarry and Dressing.—The durability of a building stone may be very materially affected by the methods of quarrying and dressing. Thus, stone quarried by the careless use of powder in which it is subject to violent jars or explosions will be injured. Stone has a life which may be destroyed by the shock from heavy explosions, and the dead stone will crumble more rapidly than before. This inherent life or texture of the stone may be destroyed by heavy sledging or hammering which loosens the grains and forms incipient cracks, in which moisture, frost, and other agents of destruc-

tion gain a foothold and hasten the disintegration. Hence the keynote to successful quarrying and dressing of stone is to avoid explosions, concussions, and jars that will injure the grain or life of the stone.

(5) By Time of Quarrying.—It is pretty generally recognized that building stones, like lumber, should be seasoned before being placed in the wall. The necessity for seasoning is greater with some rock than with others, and greater in some climates. In a rigorous climate no building stone should be quarried in the winter or late fall. The reason for the need of greater care in cold climates is the liability to injury from frost. All freshly quarried (green) stone contains some water, known as quarry sap, or quarry water, similar in many ways to the sap in timber, which when once evaporated can never be replaced. The green stone is softer, weaker, and more susceptible to injury than the seasoned stone, hence the desirability of getting rid of the greater part of this quarry sap before the stone is subject to freezing or to heavy strains in the building. Many of the fragmental stones are so soft and friable in the green state that they lack strength to support the overlying material in the wall, but after seasoning they are quite firm and strong. Such stones should be dressed ready for the wall when first quarried, while they are soft and easily cut, but should be well seasoned before being placed in the wall, unless it be a very mild climate where the seasoning may be done after placing.

(6) Position in the Wall.—Stratified rocks should be placed in the wall in their natural position, that is, with the lamination or bedding planes horizontal. Stone in this position will withstand the action of the weather and crushing forces much better than the same stone on edge. The effect of this principle is shown in many sandstone buildings, notably the brown stone fronts of our eastern cities.

METHODS OF ASCERTAINING THE DURABILITY.*

"(1) Observation.—Careful study of a building stone on the outcrop, in the quarry, and in the buildings and monuments where it has been used, is probably the best means of ascertaining its durability. In a new country or with an undeveloped stone there would be no opportunity to study the stone in buildings or monuments, and observations on the outcrop become all the more important. Some experience and good judgment, combined with some knowledge of minerals and the principles of geology, are necessary to interpret what may be seen on the outcrop. It involves so many and varied local conditions that no very specific directions can be given for the

* California Mining Bureau, Bulletin No. 6.

guidance of the inexperienced, and almost any general rules might lead to mistakes if interpreted too literally.

"To the experienced eye a study of the outcrop often shows the uniformity or lack of it, in the color, texture, and structure of the stone. It also indicates the possible changes of color which the stone is likely to undergo in the wall. The relative durability of the stone is indicated by its influence on the topographic relief. Cross-grain, lamination, unequal disintegration, and presence of clay or other deleterious substances are some of the other points shown by a study of the outcrop.

"In the observation of buildings and monuments care is necessary to avoid wrong conclusions about the strength and durability of a building stone. If the stone has been injured in the quarrying or dressing, as indicated above, or wrongfully placed in the wall, it may appear to have rapidly deteriorated from exposure, while the fault was in the handling. Likewise, care in selection may not have been used, and the stone may have been badly injured when first placed in the wall. If the stone has been quarried, dressed, selected with care, and properly placed in the wall, then the effect of time on it after many years is one of the best and most rigid tests that can be applied to any building stone.

"(2) Laboratory Tests.—Some of the laboratory tests which are more or less helpful in determining the durability and strength of a stone are the chemical analysis, microscopical examination, specific gravity, absorption, acid, freezing, and crushing tests.

"Chemical analysis indicates whether or not there are soluble constituents in the rock. The microscopical examination, which is much more useful, indicates not only the elements of the rock, but also the separate minerals which compose it. It also shows the condition of the minerals, whether fresh or partly disintegrated, and the texture of the rock, whether the minerals are interlocked in a manner that is productive of strength. The microscopic examination, if properly interpreted, often proves more serviceable than any other laboratory test.

"The specific gravity and porosity tests, if properly made and interpreted in the light of other tests, may prove very helpful. There are several ways in which the specific gravity may be determined, with different results in each case, which must be taken into account in making comparisons between the different stones. The porosity is a more important factor in cold climates, as the stone which absorbs and holds much water is more liable to injury from frost than a non-absorbent stone, or one that dries quickly. To ascertain the strength of a stone in resisting the action of frost, the attempt is made to subject a sample to repeated freezings and thawings in the presence of moisture. A modification of this test is sometimes made with a saturated solution of some salt, like sodium sulphate, which will crystallize in the pores of the rock and exercise an action similar to that of frost.

"(3) Crushing and Transverse Tests.—One of the most common laboratory tests is the crushing of a small cube, and measuring the force necessary to crush it. The result is generally given in the number of pound pressure per square inch of surface necessary to destroy the stone. Nearly all the rocks are much stronger than required by any stress ordinarily placed upon them in any common building. It is only in such extraordinary structures as the Washington monument that actual danger from crushing is at all imminent; but if the result of the stress is properly interpreted in the light of the chemical analysis and other examinations, it is helpful as indicating the strength of the rock and the uniformity of texture, or the lack of it.

"The transverse test gives a clew to the relative value of the stone for lintels, jambs, water tables, etc., where it will be subject to transverse strains."

THE SELECTION OF A QUARRY SITE.

In selecting a site for a quarry the following points should be considered:

(1) The Overburden or Waste Material to be Removed.—In a rolling or hilly country the stone to be quarried will generally outcrop in many places under different thicknesses of overlying material. The removal of the waste is expensive, whether it be soil, disintegrated or fresh rock, and the aim should be to avoid as much expense of this kind as possible; but in doing so care is necessary not to incur a still greater expense, since a layer of soil or clay overlying a quarry stone protects it in part from disintegrating agencies so that practically all the bed, after the removal of the overburden is available for dimension stone, while the portion of the ledge not so protected may be so injured by the weather, either by discoloration or partial disintegration, that a large part of it must be discarded. Hence, where there is little or no overburden it is advisable to note carefully the condition of the rock before selecting it.

(2) The Drainage.—Frequently the removal of water from a quarry is a great expense that might have been avoided with proper care in selecting the opening where there would be a natural drainage.

(3) The Disposition of the Waste and Ease of Quarrying.—The outcrop on a cliff, for instance, already has one side free, and hence there will be much less expense in removing the

stone than on a flat area, where the quarry must be sunk down through the solid bed, and where the first blocks, inclosed on all sides, are difficult to remove. The waste material in the latter case must be carted far away, or it will have to be removed again on extending the quarry, while the quarry on the cliff may dispose of its waste by dumping it over the cliff, where it is disposed of cheaply and for all time.

(4) Transportation.—The cost of transportation of stone, great enough at best, may be greatly increased by a lack of discretion in selecting the quarry site. The site should not only be near the railway or water-way, but care should be taken to avoid up-grades wherever possible.

VALUE OF STONE PRODUCED IN OREGON.

Oregon has now reached a period in her history when the building stone resources of the State have greater economic importance than ever before. In the period of the first settlement in any country the demand is for cheap building material, and especially for one that can be handled rapidly, facilitating the quick construction of buildings. After the first mushroom growth, industries and settlements begin to take on an air of stability and permanence, due to the establishment of settled industries, such as agriculture, manufactures and mining; wealth begins to accumulate in cities, and in the hands of capitalists; then a desire arises for buildings, both private and public, which show stability, durability, architectural skill, and beauty. Each year finds additional inquiries for good building and ornamental stones of different kinds.

The average citizen of Oregon does not realize the immense amount of building materials other than wood used in this State annually. We have not been able to make complete statistics of the whole State but we have at hand the statistics of the city of Portland which may be of interest in this connection.

The total cost of building operations in Portland involving only fire resisting materials, including brick, concrete, building stone, etc., amounted to $12,556,235 in the year 1910. Of this amount there were $6,228,910 worth of brick, $5,392,325 worth of concrete and $935,000 of dimension building stone. Portland was the fifth city in the United States in the total cost of buildings in 1910. This record in building materials makes Portland the eighth city in the United States in the cost of *fire-resisting* buildings in 1910, jumping from the eighteenth place in 1909. San Francisco was the tenth in 1910 while Seattle was the thirteenth. Portland was the *second city* in the United States in the cost of *concrete construction* in 1910, Chicago being the only city which surpassed Portland in this line of building material. Portland was the tenth in the cost of brick construction materials.

The total value of various kinds of stone produced in Oregon in 1910 was $1,108,478 against a total in 1909 of $288,946, an increase of 283 per cent. In 1909 Oregon was thirty-seventh in the list of states and rose in 1910 to the twentieth and produced one-seventieth of the total amount and in 1909 she produced one-two hundred and fiftieth.

Multnomah and Washington counties produced $24,825 of sandstone and Jackson and Lane counties produced $3,594 of limestone. The remainder of the production, classified as granite, comes from ten different counties throughout the State. These figures have to do with the stone produced and sold by the quarrymen and includes only such manufacturing products as is put on the market by the quarrymen themselves.

This applies especially to rough and dressed building stone, dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to this manufactured product is the price received by the producer, free on board at point of shipment, and includes therefore the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works, and to cut-stone contractors for building purposes; stone sold as riprap, rubble, and flux; and includes the value of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. The value given to this stone is the price received by the quarrymen free on board at point of shipment. In case the stone is sold to local trade the value is given as the quarryman sells the material, generally at the quarry, but in some cases delivered, if this is done by the producer. In some instances a long haul to market or to the railroad increases the cost of material, and therefore of the selling price.

Owing to the variety of uses to which stone is put there is no regular unit of measurement employed by the quarrymen, the stone being sold by the cubic yard, the cubic foot, the ton, cord, perch, rod, square foot, square yard, etc. Building and monumental stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class of stone and with the locality; a large quantity of the rough stone is sold by the perch, cord, and ton. Rubble and riprap including stone for heavy masonry, such as breakwater and jetty work, are generally sold by the cord and ton. Flagstone and curbstone are sold by the square yard and the square foot, the thickness being variable and depending on the order received by the quarrymen. Paving blocks are sold invariably by number of blocks, and as such have been tabulated and published for several years; these blocks, however, are not of uniform size, the value depending on the size and amount of labor necessary to cut the block into the shape desired. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used. The weight of a cubic yard varies from 2,300 to 3,000 pounds, the average weight being 2,500 pounds.

The three kinds of stone products are limestone, sandstone and granite. The limestone and sandstone explain themselves but it will be necessary to indicate or explain the kinds of rocks included under the term granite.

The granite from a builder's standpoint and from the standpoint of this bulletin means any rock which was formed from a melted condition and may include anything from the true granite to a lava rock. Limestone does not include limestone burned into a lime nor limestone entering into the manufacture of Portland cement.

Sandstone, which comes almost entirely from Multnomah County with the exception of $1,000, was used in paving and rough building. Something over $6,120 in paving and $17,500 in rough building; $1,000 for dressed building stone and $150 for riprap, making a total of $24,875. In Jackson County $594 worth of limestone was used as flux for smelting of ores. The remaining production for the State came from Lane County, $200 going into broken stone for concrete work, $800 into broken stone for roads, and $2,000 into paving, making a total in all of $3,594.

Over a third of the total production of granite was used in road-making and paving stones; $303,846 used as broken stone in the making of macadam and roads having a binder of asphalt and bitumen; $20,000 of rough dressed paving stone, and only $250 was used in curbing.

Crushed rock or broken stone used as a coarse aggregate in concrete work is valued at $67,515. Rough stone for building, monumental, riprap and other purposes to the extent of $680,507 was used and dressed stone for building purposes to the extent of $6,391 and dressed monumental $1,500, making a grand total of granite $1,080,009.

Fourteen states produced granite valued at more than one-half million dollars each in 1910 in which Oregon stands seventh in the list of states and produced one-nineteenth of the total value of granite produced in the United States. California exceeds it by a little more than $440,000. No other western state equals it, the nearest being Wisconsin with less than $1,500,000. The neighboring State of Washington has $642,992 and Idaho and Nevada have negligible quantities.

The production of granite shows a remarkable increase in 1906 up to the present time—in 1906, $58,961; 1907, $117,625; 1908, $271,869; and 1909, $284,135.

CHAPTER IV.

LIME.

Lime is made by burning limestone and its occurrence is described in the chapter of this bulletin dealing with stone. Since the limestone used as such and that burned for the manufacture of lime both come from the same source it will not be repeated.

In 1910 Oregon produced 6,742 tons of lime worth $65,039. The average price was $9.65 per ton. The preceding year 3,205 tons were produced of an average price of $9.14 per ton or a total of $29,305 in value. This shows an increase of more than 100 per cent in the quantity of lime produced in 1910 as compared with 1909 and the demand was such as to increase the price even with this greater production.

In a list of the states Oregon held thirty-fourth place for the value of lime in 1909, but stepped up to twenty-seventh in 1910. The price of lime in 1910 was higher than any other State reported excepting Wyoming, where the price was $12.47 with a production of only 143 tons. The average price in the United States for 1910 was $3.99.

Lime is used for building purposes and in the chemical industries. Nearly half of the lime manufactured in the United States is used in making mortar, plaster, whitewash, etc., for building purposes, and the rest is used in the chemical industry for the manufacture of insecticides, bleaching powder, soda, potash, ammonia, calcium carbide, fertilizers, glass, etc. The following table from the mineral resources shows the amount and value of the lime used for the principal purposes in the United States in 1910:

	Quantity	Value	Average price per ton
Building lime	1,722,488	$7,333,837	$ 4 26
Alkali works	10,644	40,127	3 72
Chemical works	182,043	696,313	3 82
Paper mills	286,922	1,079,556	3 76
Sugar factories	29,421	239,536	8 14
Tanneries	28,921	133,640	4 62
Fertilizer	585,876	1,739,308	2 98
Dealers—uses not specified	496,930	2,120,685	4 27
Other uses	138,535	511,960	3 70
Total	3,481,780	$13,894,962	$ 3 99
Hydrated lime, included in total	320,819	1,288,789	4 02

The different average prices of lime used in the various industries as shown in the table is partly due to the fact that some industries demand a higher grade of lime than others. Lime is composed chiefly of calcium oxide with varying amounts of magnesium oxide and small quantities of other impurities. The following three general divisions are often made, first, high calcium lime containing 95 per cent or more calcium oxide; second, magnesium limes containing from 5 to 25 per cent magnesium oxide; and third, dolomitic limes having 25 to 45 per cent magnesium oxide. For building mortars either calcium lime or magnesian lime is suitable, but for some

BASALT QUARRY, BAKER, OREGON—USED IN CONNECTION WITH CONSTRUCTION OF BITULITHIC PAVEMENT.

purposes such as sugar manufacture it is only the calcium limes that can be used.

Of the 1,005 lime kilns reporting to the United States Geological Survey in 1910, 543 used coal for fuel, 224 used wood, the rest used such fuels as coke, oil, natural gas and producer gas. This last fuel is coming into use and is being received with great favor. One manufacturer reports that by using producer gas he can burn from 3½ to 4½ pounds of lime for each pound of coal used, while with coal-burned lime he gets but 2 4-10 pounds per pound of coal.

In the volume on the mineral resources of the United States for 1910 there is a discussion on the technology of lime from which the following is taken: "In June, 1909, the United States Geological Survey, in co-operation with the National Lime Manufacturers' Association, began a study of lime. Both field and office work were undertaken. In the field the conditions prevailing as to quarrying, crushing, burning, and hydrating were studied, and samples of stone, burned lime, and hydrated lime were collected from a wide territory embracing nearly all the states east of Missouri River and from quarries in various types of stone, grading from high-calcium to high-magnesian lime. In collecting the samples of stone, the geologic formations in which the quarry was situated were noted, as well as the dip and strike of beds and their lithologic and structural features that might have a bearing on the quarrying and utilization of the stone. In the laboratory, which was situated at Pittsburg, Pa., the work included chemical analyses and physical tests of the limestone and chemical and physical tests of quick lime and hydrated lime. The principal aim of the investigation is to show the effect of impurities contained in various limes, the effect of low and high temperatures on the quality of the lime burned, the different degrees of plasticity produced by different limes, the strength of the lime mortars, and to determine, if possible, the best conditions for hydration. The work was carried on for about one year under the United States Geological Survey, but on July 1, 1910, the structural materials laboratories at Pittsburg were transferred to the Bureau of Standards, under which organization the work has been continued. The laboratory work has been performed principally by W. E. Emley, assistant chemist. Some preliminary results have been published by the National Lime Manufacturers' Association and by the Bureau of Standards.

"The quality of lime has become of such importance to the consumer that it is necessary to devise specifications which shall serve as a basis for mutual understanding between consumer and manufacturer. Such specifications involve a thorough study of the properties of lime, how these properties must vary to meet the demands of different consumers, what tests must be made to indicate to what degree any limestone or any lime possesses these properties, and how to make the tests. For building limes the factors of most importance are sand-carrying capacity, crushing strength, and tensile strength; for plastering limes these factors are spreading quality, time of setting, color, hardness, and constancy of volume."

A preliminary statement of suggested tests and a discussion of the burning temperature of lime are also given but are too long for repetition here.

CHAPTER V.

CEMENT.

CONSUMPTION AND SOURCE OF SUPPLY IN OREGON.

Oregon manufactures no cement. A large amount is used in the State for concrete construction, especially in the City of Portland. It is estimated that the amount of cement imported into Portland from Germany, Belgium, England and Japan in 1907 was 381,356 barrels. From domestic mills, largely those in California, an additional 280,470 barrels making a total of 661,826 barrels used in Portland territory alone during that year. Although reliable figures for the present and intervening years are not available we would place the present consumption at 1,200,000 barrels in Portland territory.

Price.—This at $1.38, the average price received at the coast mills, plus 48 cents transportation, in 1910 would mean a value of two and a quarter millions. The price to the consumer in 1910 ranged from $3.90 in the eastern part of the State to about $2.00 per barrel at the principal seaport. For the western part the nearest producers are on Puget Sound in Washington and San Francisco Bay, California, and have both water and railroad transportation available. The eastern part of the State can purchase also from plants in Utah near Salt Lake City.

There were 111 producing Portland cement plants in 1910 in the United States having a total of 902 rotary kilns, an average of about eight kilns per plant. These kilns vary from 45 to 240 feet in length. Smaller kilns are the older ones while all the recent installations are of the larger sizes. Although there was a decrease of 28 kilns in operation over the previous year there was an increase of 42 kilns greater than 100 feet in length.

The total annual kiln capacity for 1910 allowing a reasonable time for repairs would be 97,670,000 barrels, while the total production amounted to 76,549,961 barrels or about 78 per cent of the total capacity. The apparent average production is then about 84,867 barrels per year for each kiln and the full capacity is over 100,000 which brings us up to the fact that the consumption in Portland territory is about what 12 average kilns could produce under the present conditions of consumption and at prevailing prices.

While the average manufacturer's selling price for the United States rose from 81.3 cents in 1909, the lowest on record, to 89.1 cents in 1910, with a corresponding increase in the eastern, central and western districts, the average selling price at the mills in Pacific Coast states—that is, California and Washington—dropped from $1.52 to $1.38 during the same time. A decrease of 14 cents per barrel, due no doubt to the advent of a large new mill in California, the Riverside Portland Cement Company, and new mills in the Rocky Mountain states as well as the Southwestern Cement Plant at El Paso, and to the increased capacity of other plants in the western territory, where attractive prices prevailing has stimulated production.

The wholesale price of cement in Portland for the year 1911 was about $2.00 net, the lowest priced market in the State. In the eastern part the highest market is given as $3.90. The difference between $2.00 and $3.90 and $1.38 is the cost of transportation per barrel from the manufacturing point as well as the cost of distribution. The present consumption could keep 12 average kilns in operation. The most economical unit would be a two-kiln unit. We anticipate, however, that much longer and much larger capacity kilns would be used, probably a two-kiln unit with about 1,500 barrels daily capacity, followed as soon as possible with another unit bringing the capacity up to 3,000 barrels per day. The high transportation cost at present paid would be largely done away with. The manufacturer then could sell at a considerable reduction from present prices even as low as $1.38 and retain for himself the entire field. This reduction would result in a largely increased consumption especially in towns throughout the Willamette Valley which would no doubt cause a factory in the valley to have a market for all the cement its first units could produce.

Along this line an editorial in the Cement Age is well worthy of repetition:

SUPPLY AND DEMAND IN THE UNITED STATES.

"Considering the situation throughout the entire country production has not exceeded demand. The one drawback to an otherwise satisfactory condition is that which attracted attention a year ago, namely, the increasing demand for cement in localities far removed from the large mills. In other words, were it possible to transplant to other localities some of the mills that are now in rather congested districts, making a more even distribution with reference to demand and carrying charges, it is safe to say that the present capacity of the country would soon fail to supply the demand, so rapidly does the consumption of cement increase. The overcrowding problem, therefore, concerns the individual manufacturer, for it cannot be said that the industry has declined or is even standing still. On the contrary, the future is most promising. There is abundant reason to believe that the use of cement will show tremendous increase for years to come, and that the consumption five years hence will be astonishingly large compared with the amount used at the present time. The campaign of education inaugurated a few years ago by manufacturers and construction companies directly interested in promoting the use of cement has not only borne fruit, but has been supplemented by the valuable assistance of interests heretofore indifferent in the matter. For example, the great steel interests have realized that increased use of cement means increased demand for their own product. Their engineers and experts are not only giving cement construction technical consideration, growing out of commercial reasons, but are taking an active part in disseminating information as to the utility and economy of concrete. Even some of the clay interests, where represented by far-seeing men, realize the mistake that has been made by seeking to retard the use of concrete. As a specific instance, there may be cited the circular letter sent out to cement manufacturers by the National Paving Brick Manufacturer's Association, in which the first sentence described cement as the most important factor in the construction of vitrified-brick streets, the association even claiming that it has done more than the cement manufacturer to promote the use of cement in this field. While this is a matter of minor importance, it indicates the trend of affairs, just as the use of cement for foundations and drying kilns in brick plants shows how little regard many brick manufacturers have for the statements of agents paid to decry the use of concrete in the interest of brick. Examination of scientific and industrial publications of the past year shows a really remarkable situation so far as it pertains to the use of cement. * * * *

"Engineering societies representing every branch of that profession continue to discuss and publish papers relating to concrete construction. Insurance interests are falling into line, and recent publications of the National Board of Fire Underwriters include recommendations as to the use of concrete.

"The impetus given to cement construction by these various influences has been so pronounced that it would be mere conjecture to say when the large percentages of increase in annual output will cease. Most gratifying of all is the fact that back of engineering endorsement and progress is an insistent public demand for cement, a sentiment so pronounced in some localities as to develop antagonism between public officials and taxpayers where the former have declined to use cement in public improvements. The demand for cement on the farm is growing constantly, and to publish a list of its so-called novel uses would require pages.

"Everything considered, the American manufacturer is in better shape than manufacturers abroad. In this connection, however, it may be said that it would profit American manufacturers and engineers to note recent progress abroad. For example we might cite two important and new uses for cement, one the depot for government archives at Lille, France, and the other the use of cement in mines. The remarkable fireproof properties of concrete led to its adoption in the first instance. The fire-resisting properties of concrete cannot be too strongly emphasized for its virtue in this respect appeals with great force to every man who builds. The use of re-enforced concrete in mines illustrates an entirely practical and economical application of cement in a new field. The foreign engineer may have a more restricted field than the American engineer, considering operations from the standpoint of cubic yards, but in progressive ideas and quick perception as to the utility of concrete in untried fields he is more than holding his own.

"And, last but not by any means least, perhaps the most important matter of all has to do with costs. It is a popular fallacy that concrete means excessive cost over other materials. In a majority of cases it probably does exceed the cost of brick and stone, but we are firmly convinced that this is entirely unnecessary. The trouble has been that buildings of concrete have been treated inside and out as though constructed of brick, stone or timber. We believe this to be nonessential, and that the time is rapidly approaching when concrete will be so acceptable that all exterior and interior palstering and trim will be dispensed with. Then there will be a far different story to tell, and concrete will be known as the cheapest and best of our building materials. This means further education of the public, something that cannot be undertaken too soon. A few attractive dwellings in various parts of the country will have an immense influence in promoting this type of construction. Thus the cement manufacturer has it within his power to increase materially the good work he has already accomplished in seeking to promote the use of his product.

"In the meantime, American manufacturers have jealously maintained the prestige of the industry so far as the quality of their cement is concerned. There has been no complaint on that score. While there have been no radical changes in manufacturing processes, some improvements have been introduced in the way of mechanical appliances."

FEASIBILITY OF A PLANT IN WESTERN OREGON.

Now that we have shown the favorable financial conditions affecting the selling price of cement the question then arises as to the factors affecting the cost of manufacture. These are cheap fuel, cheap power, and favorable location to deposits of limestone and clay or shale. This brings us to a question of location of the mill, with reference to electric power, advantageous position on navigable stream or railroad for the shipment of fuel and other materials to the mill by either route as well as a close proximity to beds of shale and quarries of limestone of the proper quality for a first-class mixture, and in such a position that the quarrying of the same can be cheaply done. The location must be so made that the sum total of all these factors of power, transmission, fuel, and proximity to the best market, Portland, shall be most advantageous.

COST AND FACTORS AFFECTING IT.

The assumption is made that power can be obtained at $30 per horsepower year. It is evident from a glance at a map of Western Oregon that there are many places where electric power can be obtained readily at some such figure. This leaves us free to choose our location according to some other factors. If the mill were located anywhere between the quarries and the principal market or distributing point it would not affect to such a large degree the manufacturing cost, since the material must be shipped from its source to the market either as a raw or manufactured product and that process may be applied at any place along the route. Although there is a loss in weight by burning the limestone in the kilns so that one ton of undried material will make but little more than three barrels or 1,140 pounds of cement, yet the cheaper cost of shipping and handling the raw material as compared with the finished product might largely balance the transportation of this greater weight. With these facts in mind we arrive at the conclusion that a location would be the best if not farther up than Oregon City or some point on the Columbia below Celilo Falls, thus placing the factory close to our principal home market, as well as being favorably located to both water and rail transportation. Then if we can find suitable beds of clay and limestone within reasonable distance and can make a long-time contract at $1.00 per ton or less for the transportation of our material from the quarry to the mill we will have solved the problem of producing cement for $1.25 per barrel, f. o. b. at the mill, as can be seen from the following estimate of costs.

Using oil for fuel in the kilns but not for power the oil used would probably be 60 pounds per barrel of cement manufactured and with the nearest Washington coal 130 pounds would be required. This means that one ton of Centralia coal will be equal to 3.3 barrels of oil and either one of these amounts will be sufficient to make 15¼ barrels of cement. Now coal must be dried and pulverized which will cost about 25 cents per ton and will also require at the cement mill an extensive storage, drying and pulverizing plant upon which the interest and depreciation will amount to about 10 cents per ton of coal. Fuel oil will not require this and the burner requirements are more simple than those of coal. Freight charges from Centralia at $1.42 per ton and oil at $1.00 per barrel would require that coal be furnished and prepared at a total cost of $3.30 per ton. Then by subtracting the sum of 25, 10 and 142 cents, or $1.77, we find that coal must be furnished at the mine at $1.50 a ton to compete with oil laid down at the mill for $1.00. These prices we do not believe can be much reduced because a 3,000-barrel plant would require 225 tons of coal daily, which would require the purchase of more of the higher priced coal. Since one ton of coal or 3.3 barrels of oil each costing $3.30 is sufficient for 15¼ barrels we find that the fuel cost is a little less than 22 cents per barrel of cement.

The power consumed by a plant amounts to about nine-tenths of a horsepower for each barrel capacity per day, which means that a plant making 3,000 barrels per day should use about 2,750 horsepower. It is said that power can be secured for $30 per horsepower year, based on monthly peak loads maintained for 20 minutes. Then we would have a cost per barrel counting average power consumed at 75 per cent peak load:

$$\frac{3000}{365} \times \frac{100}{75} \times \frac{9}{10} = 10 \text{ cents per barrel.}$$

Without discussing in detail the other items we have an estimated expense as follows:

Fuel	$ 0.22
Power	10
Mill labor, packing and loading	16
Mill supplies	10
Office and general expense	10
Plant charges	09
Expense at the quarry	08
Transportation of rock to mill, 3 barrels per ton	33
Complete cost f. o. b. mill	$1.18

Making a total cost per barrel of about $1.18, including all fixed and operating charges, and allowing for the cost of transporting of limestone and shale from the quarries to the mill including the loading and unloading.

ESSENTIALS OF A GOOD CEMENT.

As to the materials from which we shall make our cement we can do no better than quote the following from Taylor and Thompson's treatise on "Cement Plain and Re-Enforced": "Natural cements are made by burning natural limestone containing suitable amounts of clay. Portland cement, on the other hand, is made from an artificial mixture of materials, of exactly correct composition. Limestones containing clay are of frequent occurrence. If a deposit of stone containing exactly the right amount of clay and of exactly uniform composition could be found, Portland cement could be made from it simply by burning and grinding. For good results, however, the composition of the raw material must be *exact* and the proportion of carbonate of lime in it must not vary even by one per cent. No natural deposit of rock of exactly this correct and unvarying composition is known or likely ever to be found; therefore Portland cement is always made from an artificial mixture, usually if free from organic matter, containing about 75 per cent carbonate of lime and 25 per cent clay.

MATERIALS USED.

For the manufacture of Portland cement the materials chiefly used are limestone, chalk or marl, and clay. In southeastern Pennsylvania and western New Jersey occurs an unlimited deposit of cement rock which consists of a slate-like limestone containing usually rather more clay than is required for a correct mixture. This is largely used for Portland cement manufacture, and is generally ground with a small amount of purer limestone to bring it to correct composition. At some of the factories in that section a correct mixture is obtained by grinding together, in suitable proportions, the upper and lower layers of the quarry. In the Central States, pure limestone or marl (a soft and finely divided form of carbonate of lime) and clay, are the materials employed. Whatever the materials used, the first stage of the process is the preparation of an intimate and finely ground mixture of carbonate of lime and clay, of a certain definite composition, and if this is accomplished the resulting cement will be the same, whatever the original materials may have been. Success in Portland cement manufacture depends, more than upon all other features of the process, in extremely fine grinding of the raw materials. Most of the faults found in inferior Portland cement are due to neglect in this regard. Either the wet or dry process may be used in preparing the mixture. The material is then dried and calcined at white heat, generally in revolving cylindrical kilns, from which it issues in the form of small, black, rounded fragments of clinker. By grinding this clinker to fine powder the finished Portland cement is obtained.

Magnesia in Portland cement, beyond a small percentage, has generally been considered objectionable. But little positive evidence on this point is, however, available. A committee of the German Portland Cement Manufacturers' Association, many years ago, reported that magnesia up to 8 per cent is harmless. Dyckerhoff, a member of the committee, presented a minority report stating that he had found more than 4 per cent injurious. The subject was referred to another committee in 1896, but this committee laid out a program of work which proved impracticable to complete and nothing further has been accomplished. Van Blaese, in the Thonindustriezitung, 1899, page 213, published a long series of tests of cements containing variable proportions of magnesia, which show that cement containing 8 per cent is faultless, while that containing 15 per cent is defective. The writer has made a similar series of experiments and has found that properly prepared cement with 9 per cent magnesia passes the boiling test perfectly, while that with 15 per cent magnesia shows expansion cracks after several hours' boiling. Comparative tests of tensile strength and expansion of bars of these cements, over long periods, are now in progress. From the evidence now available it appears that the presence of magnesia up to 8 per cent in a properly prepared Portland cement, is no disadvantage.

Sulphate of lime, in quantities exceeding about 2 per cent, is objectionable in the raw material, owing to liability of reduction to sulphide, causing the cement to turn dark blue in hardening and to give poor tests especially with sand. This fault is more frequent with cement burned in vertical kilns than in those of the rotary type, since the former are more liable to imperfect draft and consequent reducing action.

Clay for Portland cement manufacture should be highly siliceous and practically free from coarse sand. Siliceous clays, in which the silica is from 2.5 to 3.0 times the sum of alumina and iron oxide, give mixtures which stand the high heat of the kiln without fusing, produce a clinker which is comparatively easy to grind, and yield slow-setting cements which show steady gain in strength over long periods. More aluminous clays give hard, fusible clinker and quick-setting cement, and are in many respects troublesome to use. Highly aluminous cements are believed to be especially severely attacked by sea water.

Alkalies (potash and soda) appear to exert very little influence in the small amounts present in ordinary clays, on the character of burning or quality of the resulting cement. Excess of alkalies is believed to make cement unsound.

It will be found that the raw material at factories where the best Portland cements are made rarely falls below the composition:

Lime = silica x 2.7 plus alumina x 1.0

This may be taken as a safe practical formula for commercial use. With fine grinding of the raw material it will invariably yield sound cements, while the use of a lower proportion of lime will be likely to produce quick-setting cement, low in tensile strength. As already explained, commercial cements are considerably lower in lime, owing to change in composition produced by the fuel-ash.

The writer's experiments have shown that magnesia forms with clay no products having hydraulic properties. It should therefore be disregarded in calculating cement mixtures, the composition of which should be calculated on the basis of the silica alumina, and lime only without regard to the magnesia present. Iron oxide also in the quantities usually met with in ordinary clays, plays an insignificant part so far as the proportions of the constituents are concerned, and may be disregarded in the calculation.

As a practical example of the use of the above formula, let us suppose that we wish to make cement from limestone and clay of the following composition:

	Limestone	Clay
Lime	52.6	2.2
Magnesia	.7	1.9
Silica	3.2	65.4
Alumina	1.0	16.5
Iron oxide	.3	6.1
Loss on ignition, etc.	42.2	7.9
	100.0	100.0

The silica and alumina in the limestone will require 3.2x2.7 plus 1.0 = 9.6% lime, leaving 52.6 — 9.6 = 43.0% lime available for combination with clay.

The silica and alumina in 100 parts clay will require 65.4 x 2.7 plus 16.5 x 1.0 = 193.1 parts lime. Subtracting the lime contained in the clay we have 193.1 — 2.2 = 190.9 parts lime required for 100 parts clay. As the 100 parts stone contain 43 parts available lime, that amount of stone will require 43 x 100 divided by 190.9 = 22.5 parts clay.

The composition of the charge and of the resulting cement may be tabulated as follows:

	100 stone	22.5 clay	122.5 mix	78.52 cement	100 cement
Lime	52.60	0.50	53.10	53.10	67.63
Magnesia	.70	.43	1.13	1.13	1.44
Silica	3.20	14.71	17.91	17.91	22.81
Alumina	1.00	3.71	4.71	4.71	6.00
Iron oxide	.30	1.37	1.67	1.67	2.12
Loss, etc.	42.20	1.78	43.98	-------	-------
	100.00	22.50	122.50	78.52	100.00

As stated above, the ash of the fuel will change the composition of the resulting cement materially; analysis of the product, burned with coal, will probably show about 65 per cent lime and perhaps 24 per cent silica. This fuel-ash is, however, not uniformly distributed through the product, but attaches itself chiefly to the surfaces of the clinker. It is not, therefore, found practicable to materially raise the proportion of lime to counterbalance the silica and alumina of the ash.

In the above discussion the kinds of material and the proportions necessary for good mixture are well explained. It will be necessary, however, before investigating the occurrences of limestone, shale, and clay in our State to have some idea as to the quantities sufficient to warrant the erection and equipment of so large an undertaking as a cement mill must be.

QUANTITY AND AVAILABILITY OF MATERIAL.

It will take approximately three cubic feet of limestone and one cubic foot of clay for each barrel of cement made. As previously stated two rotary kilns make a most favorable unit of manufacture and giving this unit a capacity of 600,000 barrels per year would take 1,800,000 cubic feet of limestone and 600,000 cubic feet of clay or shale each year. Since the present consumption in Portland territory is about 1,200,000 barrels the first capacity should be the output of one of these large units as soon as it could be installed. Taking into account the rapid increase in population and the increasing uses of cement in the arts and since this is a manufacturing plant amortization rates should be low, we think the life of the enterprise should be considered no less than 15 years and the average capacity for that time will not be less than four rotary kilns or 1,200,000 barrels per year. We will then have a total production of not less than 18,000,000 barrels requiring 54,000,000 cubic feet of limestone and 18,000,000 cubic feet of clay.

To make these quantities easy of comprehension let us assume a deposit 100 feet in thickness, then at the end of

15 years the limestone quarry would be an opening 750 feet square the full thickness of the bed. (Of course, supposing all this limestone were of the proper quality and were all utilized.) Supposing we had a bed of clay or shale of the proper quality 50 feet thick it would have to extend over an area 600 feet square to afford this quantity of material.

Although no official survey has been made for this purpose in all probability a suitable clay or shale could be found near whatever site is chosen for the mill. The main difficulty will be to find limestone sufficiently pure, adequate in size, a good quarry site and not too far from the mill site. By reference to "Limestone" of this bulletin practically all the information available is given as to the occurrence and extent of limestone in the State. It is unfortunate that so little has been done in Oregon to investigate the occurrence, extent and quality of limestones especially in the Portland territory. By reference to the limestone chapter it is seen that the best and largest deposits of limestone are in the northeastern and southwestern parts of the State, that is, in the least desirable positions with reference to fuel, transportation, and the principal markets. Smaller deposits of good limestone are found near Roseburg and impure limestone deposits near Dallas, Marquam and Rufus which have been examined and reported upon somewhat in detail by engineers of the Portland Cement Company which indicate that proper mixes of these impure limestones with the quite pure limestone of Roseburg is entirely feasible. This company has a cement mill under construction at Oswego. We have no doubt, that a good sized properly designed mill efficiently managed, would pay well if soundly organized and adequately financed.

It is to be hoped that a company with ample capital, soundly organized and under capable management will be able to get into operation in the very near future. Because it will not only increase our present total mineral output 60 per cent but will furnish steady employment to labor and by very material reduction in general building costs would be the greatest single stimulant to the building industry of our State.

CHAPTER VI.

GYPSUM.

THE DESCRIPTION AND OCCURRENCE OF GYPSUM.

Gypsum is the hydrated sulphate of lime having the chemical formula $CaSO_42H_2O$. This when reduced to percentages of weight corresponds to the following composition:

Gypsum ($CaSO_42H_2O$)	Lime sulphate ($CaSO_4$	Lime (CaO)	32.6	79.1
		Sulphur trioxide (SO_3)	46.5	
	Water (H_2O)			20.9

It occurs most frequently in sedimentary rocks interbedded with shales or sandstones and limestones and is often more or less closely associated with rock salt. It is sometimes found as a separate deposit mixed with a considerable amount of clay and is then termed gypsite.

Gypsum is a soft white mineral when comparatively pure and in this form is commonly termed selenite or satin spar. Rock gypsum is the form which most extensively occurs for commercial use. Rock gypsum has a wide variety of colors such as gray, blue, brown or nearly black depending upon the amount and character of the impurities present.

USES OF GYPSUM.

The bulk of the gypsum produced in the United States as well as in foreign countries is manufactured by grinding and partial or complete calcination into the various plasters, such as plaster of Paris, molding and casting plaster, stucco, cement plaster, flooring plaster, hard-finish plaster, etc. Refined grades of plaster are used in dental work, also as cement for plate glass during grinding, for making pottery molds, stereotype molds, molds for rubber stamps, and as an ingredient in various patent cements. A steadily increasing quantity is being used in the raw state as a retarder in Portland cement. Considerable quantities are ground without burning and used as land plaster or fertilizer; smaller quantities are used in the manufacture of paint, wall tints, crayons, paper, imitation meershaum, and ivory and as an adulterant. The pure white massive form, known as alabaster is much used by sculptors for interior ornamentation, less, however, in this country than abroad.

For plaster of Paris and for dental molding and casting plasters, a high grade of rock gypsum, ground very fine, is required, and the product is not mixed with any foreign substance or retarder, but is used in the pure or "neat" condition. Such plasters are quick setting and usually white in color. Much of the so-called cement plaster is made directly from gypsite, an impure unconsolidated earthy or sandy form of gypsum, which in many places is found to contain a suitable percentage of foreign material, so that the addition of a retarder is not necessary to effect a slow set. Where gypsite deposits are not available, cement plasters are made from rock gypsum by the addition of various mineral or organic retarders. A large part of the structural plaster now produced is used in specially prepared conditions that appeal to the builder on account of their convenience. A plaster board is pressed from plaster interlaminated with sheets of thin cardboard or wood. This plaster board is furnished in thin sheets, 32 by 36 inches, comprising eight square feet of surface, and is designed to be nailed directly to the studding in place of lath, and to receive a coat of wall plaster directly on its outer surface. Fibered plaster is molded into both solid and hollow blocks and tiles, which are used in partitions and interior construction, and these, as well as the plaster board, have been proved to be of value as fire retarders.

Wall plasters are of two general grades, one, a brown or gray coat and the other a white or tinted finish coat. The wall plasters are commonly made with wood fiber or hair filler, and a wood-pulp plaster is also being made that is finding use on the outside as well as on the inside of houses.

A number of hard-finish, anhydrous plasters are also made from gypsum, the most prominent representative of the group being Keenes cement, which was originally manufactured under English patents that have expired. The name "Keenes" is now applied by several manufacturers in the United States to their product, made by calcining very pure rock gypsum in lump form at a red heat and adding to the resulting dehydrated lime sulphate a substance like alum or borax. Keenes cement makes a very white and very hard plaster. It is used as a backing and surface for artificial marble and for ornamental moldings and castings, and its use as a wall plaster is increasing. Flooring plaster is another example of this type of plaster.

Gypsum is used in the manufacture of calcimines, in water paints, and tints, and to a considerable extent as an ingredient in dry colors, notably in Venetian reds. When used in excess in mixed paints it is regarded as an adulterant. The unburned, or the dead-burned, forms of gypsum may be used to a certain extent with oil paints, because they are chemically inactive. The partially dehydrated form is not suitable for such use, but can be used with water.

CHEMISTRY AND PRACTICE OF GYPSUM BURNING.

In addition to the combined water shown in the outline of composition, the rock may contain as much as 25 per cent of absorbed moisture. If pure gypsum is heated to a temperature of more than 212° F. and less than 400° F. all the free moisture and a certain definite portion of the combined water will be driven off, and the gypsum thus partially dehydrated is converted into the half hydrate, or plaster of Paris. Plaster of Paris has the formula $CaSO_4\frac{1}{2}H_2O$, corresponding to the composition

$CaSO_4\frac{1}{2}H_2O$	Lime sulphate ($CaSO_4$)	93.8
	Water (H_2O)	6.2

Three-fourths of the original combined water has therefore been driven off in the course of the heating. Dehydration to this extent takes place in two stages: When gypsum is first heated in kettles the free moisture is driven off at about 220° F. or a little higher, and the mass begins to boil and later settles. The temperature is then increased to about 290° F. at which a second boiling occurs and part of the combined water begins to be driven off. In practice it is found most economical of fuel and time to carry on the heating at the highest allowable temperature, viz., between 350° F. and 396° F. The wide range of temperature at which the burning may be completed is probably due largely to the variation in the purity of the gypsum.

The general plan of preparing plaster of Paris and wall plasters comprises crushing and calcination. The size and weight of the machinery depend on the capacity desired. Certain of the plasters are reground after calcination. Wall plasters require the addition of retarders and of fiber, such as hair wood, or asbestos. The crushing of the raw material is performed in a number of different stages being finally reduced to about the size of a pea and smaller.

At this stage the gypsum is ready for calcining. There are two main processes of calcining used in the United States. The kettle process and the rotary kiln process. In the kettle process the kettles are cylinders of boiler steel, 8 or 10 feet in diameter and about the same in height. The bottoms are convex rising about one foot in the center. The kettles are inclosed nearly to the top in masonry with an open space between for the circulation of heat. The fire chamber is below the kettle, and the heated gases pass through ports into the open space at the base, then through horizontal flues through the kettle and out through a stack. Kettles are built with two or four flues. A kettle with four flues, measuring 10 feet in diameter by about 8½ feet high is considered to be capable of calcining 10 tons of ground gypsum into plaster at a single charge. Inside the kettle a vertical shaft propels paddles below and above the flues, which stir the gypsum constantly and prevent the hot mass from destroying the kettle bottom. There are generally at least two or more kettles in a mill.

After the calcining is completed the plaster is drawn off from the kettles and after being cooled is reground very fine and has mixed with it definite quantities of retarder, hair, wood, fiber, sawdust, etc., and is put into sacks as the commercial plaster.

COAST PRICE OF GYPSUM.

The ground, but uncalcined gypsum ranges in price from $1.75 to $3.50 according to quality while the calcined plaster is somewhat above $6.00. This is for the states of California, Nevada and Oregon.

GYPSUM IN OREGON.

Gypsum occurs in Oregon in two localities. One is on the eastern border of the State near the middle point of the boundary line on a ridge dividing Burnt River from Snake River about six miles north of the city of Huntington. The gypsum occurs here in lenses from 10 to 40 feet thick, interstratified in series of sedimentary rocks, limestone, shale and volcanic tuffs. The gypsum is in part white and crystalline but contains in places thin strata and films of greenish chlorite mineral. These deposits are worked mainly by open quarry, the rock being carried down to the railroad on the Snake River by the means of an aerial tramway 6,100 feet long, then carried by rail about 10 miles to a mill at Lime where it is calcined to plaster. This mill was destroyed by fire but will be reconstructed and in operation again in a few months. Another deposit of gypsum occures in Crook County near the town of Bend, but it has not yet been developed. As far as is known with reference to this deposit it is more or less impure and has been used to some extent as a fertilizer.

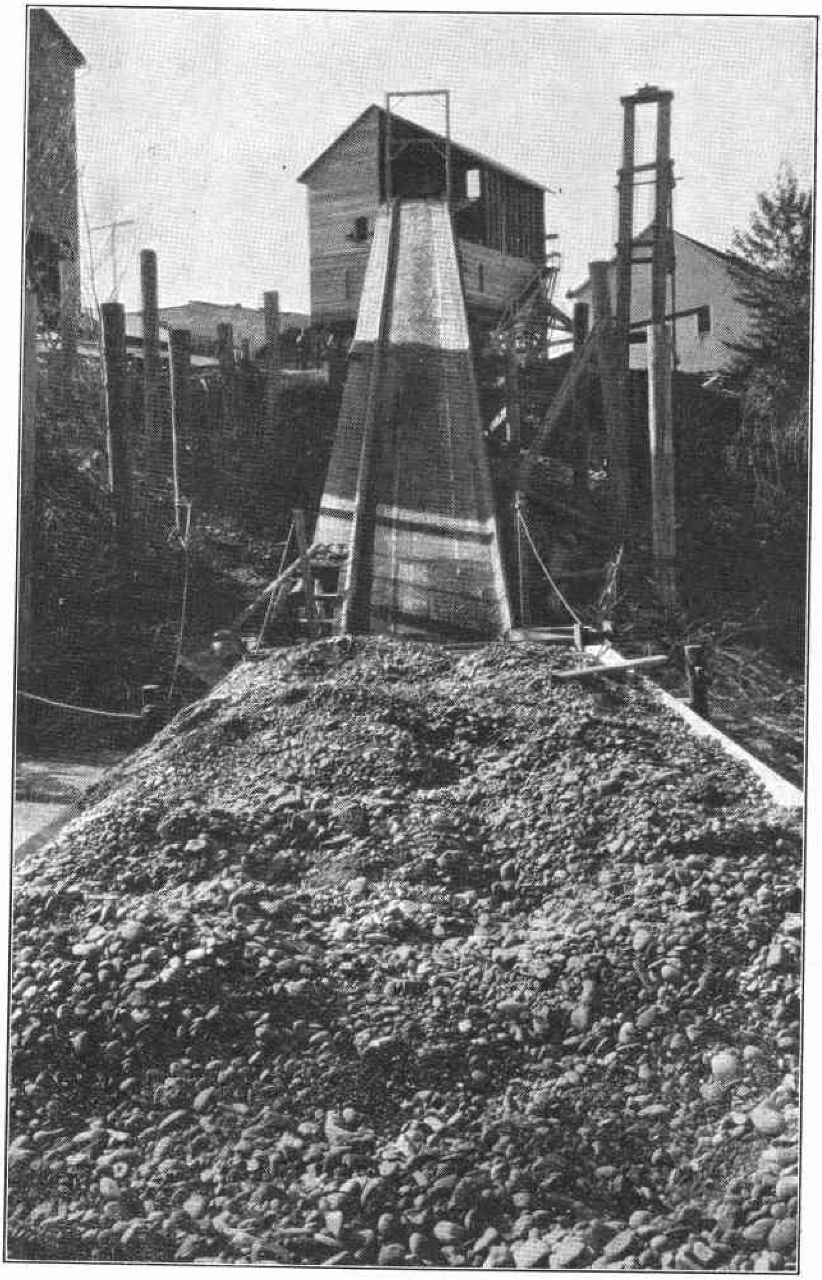
CHAPTER VII.

SAND AND GRAVEL.

The total production of sand and gravel in Oregon in 1910 was 1,145,966 yards having a value of $625,405 as compared with 717,591 yards having a value of $379,705 in 1909, showing a net increase of quantity in 1910 over that of 1909 of 59 per cent and an increase in value of 64 per cent. In 1909 Oregon was the thirteenth state in the United States in the production of sand and gravel and in 1910 she jumped to the eighth place and produced one-thirty-fifth of the total United States production. Of this amount 347,248 yards were building sand valued at $269,878, 5,600 yards were engine sand valued at $500 and 793,140 yards were gravel valued at $355,027. With the exception of 10,000 yards of sand produced in Klamath County the sand and gravel produced in Oregon came entirely from points along the Willamette River, by far the greatest amount coming from near Portland in Multnomah County. This county produced 260,353 yards of sand and 304,275 yards of gravel having a value of $383,404. Marion County was next in importance with a production of 31,800 yards of sand and gravel with a value of $62,700. Lane County was third in importance with 17,474 yards and a value og $19,299. The remainder of the output is divided between Linn and Benton counties.

THE WILLAMETTE'S INEXHAUSTIBLE SUPPLY.

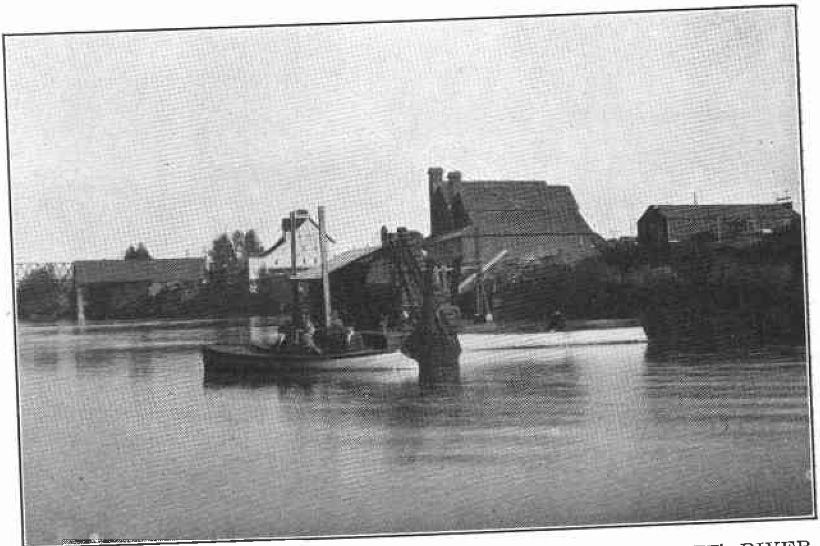
The Willamette River with its main tributaries winding through the Willamette Valley is without doubt the most important gravel asset that we possess. We have already seen in the description of the general geology of the Willamette Valley that the valley floor is bounded on all sides by foothills composed almost entirely of igneous rocks, and what is more, the best grade of igneous rocks, namely trap rocks. Since the gravels carried by any stream or found upon its bed must necessarily be derived from the outcrops of rock through which it runs, it would follow that the gravels will always be of the same material as the outcrops of rocks in place through which the stream passes. For thousands upon thousands of winters, the friendly old Willamette has been carrying and rolling these fragments of rock along its bed leaving in its train an immense amount of gravel. On this account we have a continuous deposit of gravel over 200 miles



GRAVEL BARGE IN POSITION FOR UNLOADING AT BUNKERS, ALBANY SAND AND GRAVEL COMPANY, ALBANY, OREGON.

in length with probably an average width and depth of 300 feet and six feet, respectively, winding through the central part of the valley. Upon careful examination at a number of different points along the Willamette River these gravels are found to be over 90 per cent trap rock.

A very large proportion of the gravel taken from the Willamette River for concrete construction is obtained by dredging from the river channel in or just above the city of Portland. The material is scooped up by dredges, screened and washed and the different sized products loaded directly upon the scows.



DREDGING GRAVEL FROM BED OF THE WILLAMETTE RIVER, ALBANY SAND AND GRAVEL COMPANY, ALBANY, OREGON.

The cost of obtaining gravel by this process is so low that for concrete work crushed rock is not able to compete. There are a number of dredges at different points along the river above Portland, namely, Salem, Albany, Corvallis and Eugene. These gravel plants are usually quite inexpensive, the equipment consisting of the cable drawn scraper having a tail rope operated through a pulley on the opposite shore to drag back the scraper. These plants handle gravel at a surprisingly low cost. This cost at certain of these plants under very favorable conditions and for a limited time amounting to less than ten cents per yard.

The writer wishes to take this opportunity to again call attention to the fact that the gravels in the Willamette River are the greatest good roads asset in the valley. The most important factors in connection with these gravels which command the attention of road builders are (1) the uniform distribution of an inexhaustible supply of material in the center of the valley extending through its entire length in close proximity with the main traveled highways; (2) the very low cost of handling the gravels and preparing them for the road bed as compared with rock obtained from quarries; (3) that the quality of the material is essentially as good as the best, it being nearly all trap rock. There will always be some difference in favor of crushed rock from quarries as compared with crushed gravel on account of the shape of

GRAVEL PIT OWNED BY A. H. METCALF, EAST PORTLAND.

each particle but the difference is slight and is by far overbalanced by the factors above stated. If any of the bitumen binders are used in the construction of the roads or pavements this difference on account of the shape of particles becomes still less obvious and by using these gravels the cost of road construction in the Willamette Valley must be very materially reduced. This subject is discussed more in detail in the Bureau of Mines' Bulletin No. 1, "Road Materials in the Willamette Valley" which can be had free of charge by application to the Bureau of Mines, Corvallis, Oregon.

GRAVEL GOOD CONCRETE MATERIAL.

There is considerable controversy among engineers as to the relative value of clean gravel and broken stone in a concrete mixture, but the concensus of opinion seems to be that, leaving cost out of consideration, there is very little difference between the quality of concrete made from clean gravel and that made of broken stone.

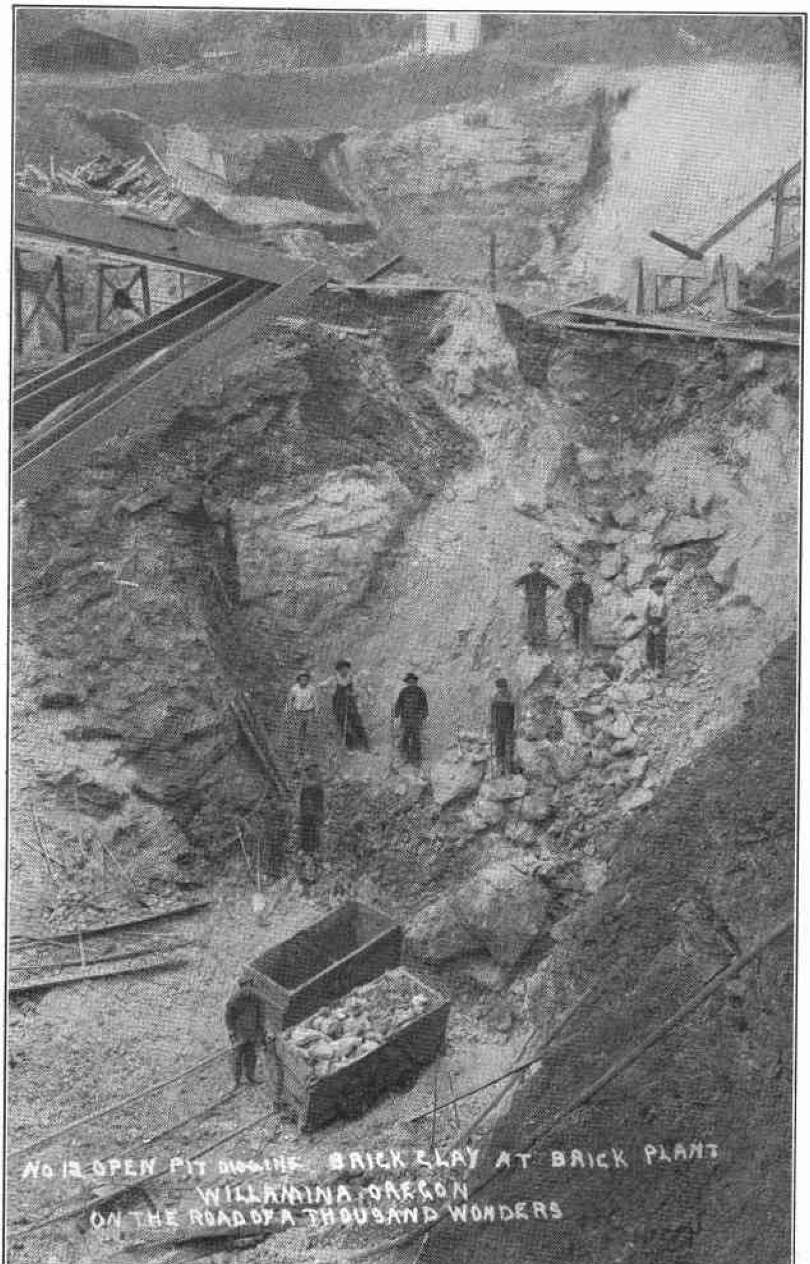
While there is a slight difference in favor of the broken stone in the strength of the concrete on the other hand the clean gravel concrete requires less cement on account of the smaller percentage of voids. In other words, a clean gravel concrete mixture will be denser than a crushed rock concrete and on this account will give a greater strength per volume of cement. It should also be stated that following the law of the "survival of the fittest" the average quality of the particles of gravel will be considerably better than that of crushed rock. When the factor of cost is considered it is seldom that crushed stone is a competitor of gravel where gravel can be conveniently obtained.

ESSENTIALS OF A GOOD GLASS SAND.

The Bureau of Mines is often asked for opinions and for analyses on glass sand and for general information we are here including a brief discussion of the subject.

The chief materials used in bulk in glass manufacture are silica, lime, and soda with smaller quantities of other material such as potash, lead and alumina. Since silica is the major ingredient it influences the character of the ware to a marked degree. Sand, with impurities, therefore, must be avoided especially if it is to be used for high grades of glass ware. The chemical analysis of almost any sand may show at least traces of iron oxide, alumina, titanium oxide, magnesia, and organic matter. Iron oxide in very small quantities tends to color the glass green, and is avoided by the selection of the very whitest sand. Although whiteness indicates comparative purity as far as iron oxide is concerned it would not necessarily indicate freedom from all impurities. Magnesia in small amounts causes trouble by rendering the batch less fusible. But this particular impurity is more apt to be introduced through the limestone than through the sand. Too much clay is undesirable as it tends to cloud the glass and therefore it can not be used in making a high grade material.

Common glass is usually made from the three ingredients, silica, lime and soda, as those materials are cheaper and more easily obtained than such as potash and lead, which are used in special varieties. Sand for the glass industry must be quite pure having only a very small percentage of the above suggested impurities.



CLAY PIT, PACIFIC FACE BRICK COMPANY, WILLAMINA, OREGON.

CHAPTER VIII.

CLAY AND CLAY PRODUCTS.

ORIGIN OF CLAYS.

By clays we mean those earthy materials often found in large deposits on or near the surface of the earth which become plastic when wet and permit of being moulded into forms and on drying and burning retain their forms and become hard and rock like. Most soils contain considerable clay and have the above properties to a limited extent, but in this discussion the term is intended to include only those materials that possess these properties to such an extent as to be commercially valuable.

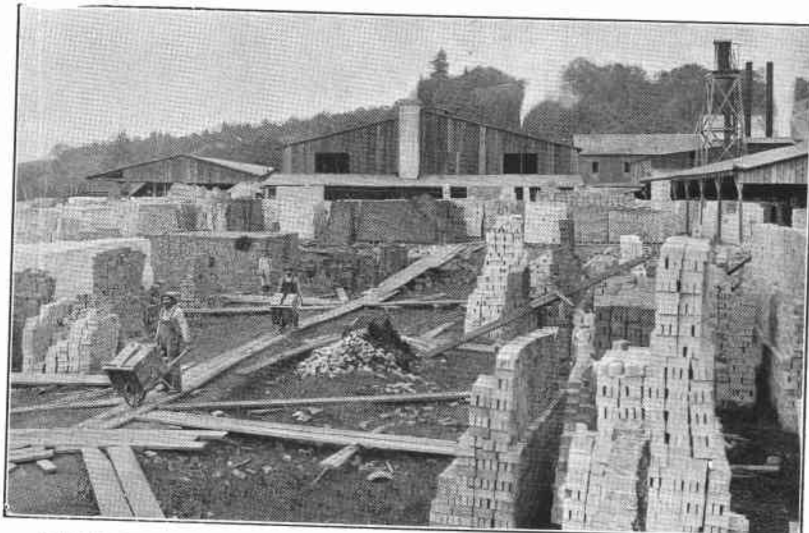
All such materials are produced by the action of air, water, heat, frost, and other destructive agencies acting on rocks of the earth's crust. Most of these rocks before being altered consist of a mixed aggregate of grains of two or more of the common minerals, quartz, or silica, feldspar, mica, hornblende, pyroxene, etc. Even the most dense and solid of these rocks contain many very small cracks and crevices formed by unequal contraction and expansion as the rocks are exposed to the varying temperatures on the earth's surface. These cracks when once started permit the entrance of air and water which are active in chemically changing the minerals which make up the rocks.

Water containing dissolved oxygen and carbon dioxide from the air slowly attacks feldspar dissolving its potash and leaving most of the aluminum combined with part of the silica of the feldspar with some water in combination the whole forming kaolinite. The excess silica is supposed to be left as free silica or removed in solution. In like manner other of the rock minerals are decomposed by the action of the weather forming hydrous silicates of alumina and lime, carbonates of lime and magnesia, hydrous oxides of alumina and iron, and other similar minerals very different in appearance from the hard brittle coarsely granular ones from which they were derived.

As the weathering progresses some minerals in a rock are so much more readily altered as to become entirely decomposed while others are practically unaffected. Quartz is the least affected of our common rock minerals. The grains of quartz in a rock often remain as grains of sand in the residual clay left by the complete weathering of the rock. Residual clay deposits are those which have formed from the decomposition of the rock in place and usually contain as impurities those mineral constituents of the rock which did not decompose by weathering and disappear. Transported clays are those which have been removed from their original location and deposited elsewhere by the action of streams or other agencies and have received a natural washing and sorting treatment often making them much purer.

CAUSES OF DIFFERENT QUALITIES OF CLAYS.

Kaolinite is the name of the hydrous aluminum silicate containing about 40 per cent alumina, 46 per cent silica, and 14



PACIFIC FACE BRICK COMPANY'S PLANT, WILLAMINA, OREGON. ONE OF OREGON'S LARGE PRODUCERS.

per cent water. It and other hydrous aluminum silicates were thought to be responsible for the plasticity of clays. The various clays are mixtures of these hydrous aluminum silicates with differing amounts of other substances such as sand or lime or iron oxide or particles of minerals only partly decomposed. Such clays which are composed chiefly of the hydrous aluminum silicates are usually found to be very plastic and smooth and are sometimes called pure clays, while those containing larger proportions of the other substances are generally not so plastic. Some exceptions to the above rule have been observed showing that the presence of these hydrous aluminum silicates is not always necessary and sufficient to cause plasticity and several other suggestions have been advanced. No one has as yet shown any one cause responsible for plasticity in all cases.

On drying, clay becomes hard and rigid and shrinks perceptibly. The shrinkage on merely drying in the air varies with the clay from about one per cent to twelve per cent, being usually greater for very plastic clays and less for sandy clays. It is probably due to the particles of clay drawing closer together in order to come into contact as the enclosing water film is removed by drying. It is known as air shrinkage.

Large air shrinkage is not very harmful in a clay except in so far as it necessitates very slow and careful drying to prevent checking. Clays which have too great a shrinkage are sometimes mixed with sand or other more sandy clays to lessen it.

On burning clays a second shrinkage takes place known as fire shrinkage. This also varies with the clay but is usually less than the air shrinkage. Fire shrinkage increases with the temperature at which the clay is burned being slight up to a red heat and increasing noticeably as the temperature approaches the point of vitrification or that point at which the particles begin to fuse. Fire shrinkage, if too great, causes the forms to warp or crack in burning. This is remedied by mixing with the clay, materials which have no fire shrinkage of themselves thus reducing the shrinkage of the mixture. Sand or ground clay which has already been burned and so has no further shrinkage is often used.

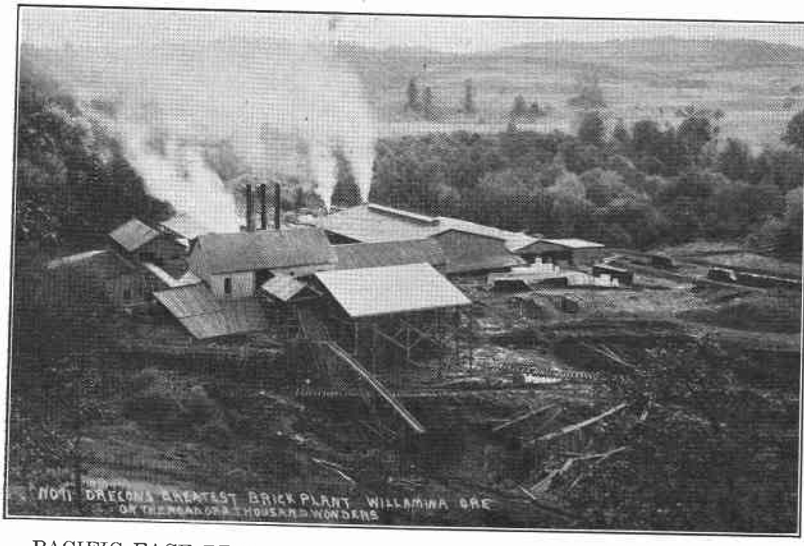
While the shrinkage of a clay is not especially harmful for most purposes it is essential to determine the total per cent of shrinkage for a clay before making the moulds for its manufacture so that they may be made of proper size to allow for shrinkage and give a finished product of the dimensions wanted.

THE USES OF CLAYS.

Clays are used for the manufacture of building materials, utensils, and ornamental ware of different kinds and a clay suitable for one purpose may be entirely unsuited for another. For brick to be used in lining industrial furnaces a clay is required which can be heated to a very high temperature without melting or cracking or being so weakened as to endanger a furnace wall. For fancy building brick it is essential that the brick shall be of just the required shade when burned and that the clay shall be of such a texture as to make a smooth clean brick free from soluble compounds. For other uses other factors govern the choice of the clay and it is only by testing it for these physical properties that the adaptability of the clay can be determined.

HOW CLAYS ARE TESTED.

All clays can be melted if heated to a sufficient temperature. This temperature for most clays lies between 1800 degrees and 3200 degrees Fahrenheit, and depends principally upon the chemical composition of the clay and the coarseness of grain. Pure kaolinite fuses at about 3200 degrees Fahrenheit but when mixed with other substances which act as fluxes the whole unites chemically and forms much more readily fusible compounds at a much lower temperature. Practically all of the impurities found in clays act as fluxes and lower the melting point appreciably. Iron, calcium, magnesium, sodium and potassium are the chemical elements commonly found in clay



PACIFIC FACE BRICK COMPANY'S PLANT, WILLAMINA, OREGON.

which have the greatest effect on the melting point and are accordingly usually classed as the fluxes. If these elements are present in amount greater than a few per cent they lower the fusing point so much that it cannot be classed as a fire clay.

If the clay is very fine grained and uniform so that the particles of different composition come into contact with each other, its fusing point will be about the same as that of a slag of the same composition. If a clay having the same proportion of the elements as above but composed of an aggregate of coarse particles each by itself of high fusing point, it would require a much higher temperature to melt, because the coarse particles could not as readily react each with the other chemically.

For some purposes a readily fusible clay is desirable as it permits the making of dense vitrified impervious ware without requiring excessive temperature in the kiln. Also for so called slip clays which are used to coat other clay ware to make a natural glaze.

The color to which a clay burns is often one of the most important properties from a manufacturer's standpoint and it is dependent on the chemical elements present and the way in which they are combined. Iron is the most common coloring matter in clays and as ferric oxide is the cause of the red color in common bricks. It is accordingly impossible to produce white or light colored ware from clay containing much iron. The shade given to brick by iron is largely a factor of the temperature to which the clay is burned. If burned just to a red heat considerably below the fusion point iron will usually be present as ferric oxide and give the usually red color but on raising the temperature until it approaches the point of vitrification the resulting color of the ware becomes darker and at the temperature of vitrifying is often dark brown to black. Manganese peroxide if present gives a black color. It is usually not present but is sometimes added to fancy building brick to produce a desired mottled effect. Other substances usually present do not noticeably affect the color except as they may decrease the intensity of those already mentioned and vary the shade a little.

We receive many samples of clays with an assortment of requests from the senders indicating that many people think a simple chemical analysis is sufficient to indicate immediately and positively the value. Sometimes it is true that an analysis for iron and calcium will show the presence of so much that the material is unfit for fire-clay or so much iron may be present as to prove the clay unfit for the manufacture of any light colored ware. But usually a series of tests is necessary to demonstrate the special physical qualities required by material used in making the kind of product contemplated since a chemical analysis does not show these things.

These tests include grinding and mixing the clay with water to find how much water is required to develop the greatest plasticity and whether the clay is very plastic. Sample bricks or test pieces are then molded and two marks made on them at known distances apart. These test pieces are then dried and the shrinkage measured and any tendency to crack noticed. The pieces are then burned in a furnace and the hardness, color, strength, and freedom from cracking noticed and the fire shrinkage measured. Also small test pieces are burned to a high temperature and the fusion point, if reached, is noted, as well as any change in color or other special features at this higher temperature. Very often these tests prove the clay unfit for the purpose desired, in which case it is unnecessary to go farther. If they show that the clay has the principal qualities desired then more extended tests can be made to show up the details.

DISTRIBUTION OF CLAY IN OREGON.

Clay is one of the most widely distributed of geologic products. It is usually only necessary to make some search in any community to find clays which are suitable for the manufacture of ordinary brick and tile. As has already been suggested above most clays have a sufficient amount of iron oxide, lime or other compounds present to give them a comparative low fusion point and therefore cannot be used for the manufacture of refractory wares or products which are required to resist high temperatures. For this reason then fire clays are not so widely distributed. The residual clays, formed in places from the decomposition of basalt rock, are found in a large part of the area of eastern Oregon. This clay makes very good common brick. Throughout most of the region of eastern Oregon where this basalt occurs the brick that is used is made from this material. A number of kilns are in operation, in many cases supplying the local demand. In the older geological area of which Baker and Grant counties may be the center, referred to in the "Distribution of Limestones," are found clays which are better adapted to the manufacture of refractory wares.

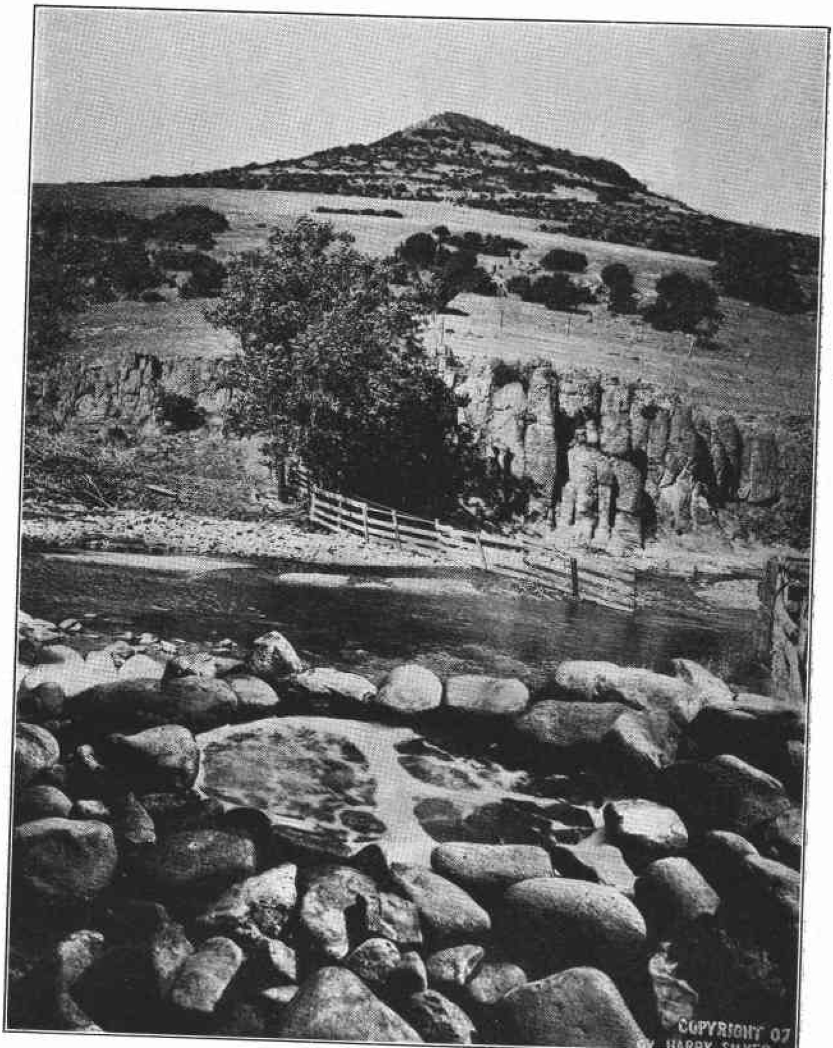
Western Oregon is exceptionally well supplied with clays of various qualities. At a certain geological period in the past where the Willamette Valley is now was then a quiet lake and very large quantities of clay accumulated in its quiet waters. That is probably the principal reason why we find such vast amounts of clay in the valley. These clays vary in thickness, up to more than 50 feet thick. It is safe to say that no equal area in the State is as well supplied with it as the Willamette Valley.

The Bureau of Mines has not had opportunity as yet to make any detailed survey to determine the quality of clays in the different sections. This, however, is contemplated in the near future and when that has been accomplished very useful information will be obtained and made available. The southern portion of the State west of the Cascades has many deposits of clays some of which have been tested by the Bureau of Mines and found to be of excellent quality for the manufacture of clay products.

STATISTICS OF PRODUCTION.

The total production of clay and clay products in Oregon in 1910 was $912,016. The different products being common brick, front brick, drain tile, pottery, sewer pipe, terra-cotta and fire brick. The order of importance of these clay products in the State is as follows: Common brick, $482,333; sewer pipe, $178,918; front brick, $137,040; drain tile, $51,516; pottery, $34,000. There were 66 plants operating in 1910 well distributed over the State. Clay products were produced in all but eight counties. Multnomah has by far the greatest production, this county alone producing $519,285 worth of clay products and has 14 different plants. This is about 42 per cent of the entire State production.

Yamhill County is second with a production $75,200 worth of clay products from five different plants, Marion County being third with a production of $46,117 from five plants.



LITHIA MINERAL SPRINGS, ASHLAND, OREGON.

CHAPTER IX.

MINERAL WATERS.

STATISTICS.

The output of mineral water in Oregon in 1910 was 88,970 gallons valued at $22,989. This compared with 41,000 gallons with a value of $12,269 in 1909. This gives a gain at 117 per cent in the quantity of mineral waters sold in the State over that in 1909. The seven springs reporting production in the State are as follows:

Ashland Lithia Springs, near Ashland, Jackson County.
Calapooya Spring, London, Lane County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
Sam-O Spring, Baker City, Baker County.
Selah Spring, Silverton, Marion County.
Siskiyou Spring, Soda Springs, Jackson County.

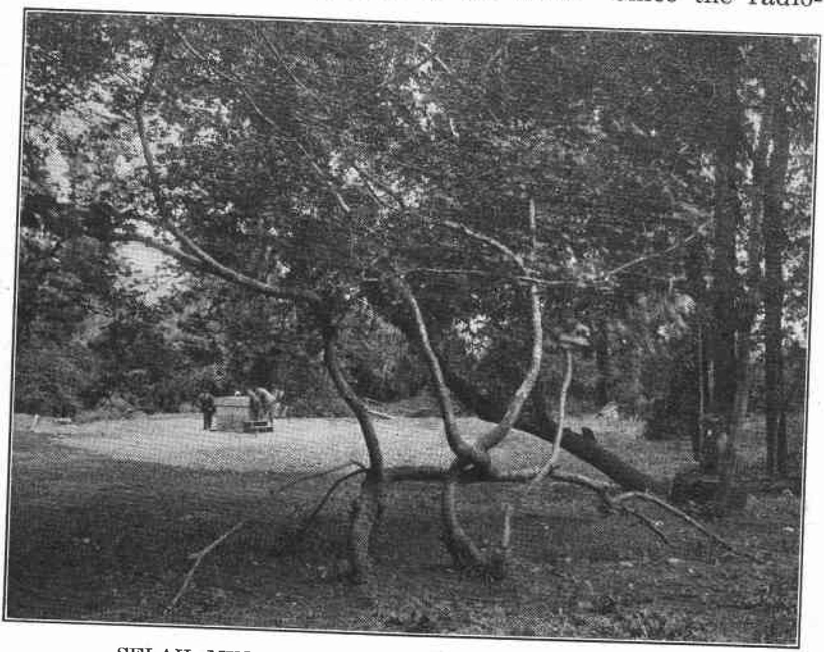
There were three new springs that reported in 1910 for the first time, namely, the Ashland Lithia Springs, the Sam-O, and the Selah. There are resorts situated at four of the above springs with accommodations for about 200 people. The water at three of the springs is used for bathing. In addition to the amount sold as indicated above there was a considerable quantity of mineral water used in the manufacture of soft drinks.

The term mineral water is commonly applied to those spring waters containing a variable amount of dissolved solid matter of such character as to make them of medicinal value. It is not possible to adopt any satisfactory scientific classification of mineral waters on account of the fact that they vary so greatly and in addition to the natural variations many of the waters are subjected to certain treatment, such as carbonation or a certain amount of evaporation before they are placed on the market.

MEDICINAL AND TABLE WATERS.

On the basis of use, the waters reported may be arranged in two groups, medicinal and table. This method of grouping does not permit sharp distinctions, for waters that are highly mineralized may be sold for domestic purposes, while those containing very small quantities of minerals in solution may be regarded as medicinal. However, the average amount of mineral matter in solution is higher in the waters sold for their therapeutic value than it is in those sold for ordinary use.

Probably the most common medicinal waters are those containing lithia, sulphur, or sulphates; another important class of waters has received considerable attention in recent years because of their radio-activity. It seems that there are a large number of springs containing small quantities of radium and possibly possessing important medicinal qualities. Probably the greatest amount of radio-activity is to be found in some of the thermal springs in the west. Since the radio-



SELAH MINERAL SPRINGS, SILVERTON, OREGON.

activity of the water diminishes rapidly after its emergence from the earth, it would be necessary to utilize the supplies at their source.

It may be that the benefits derived from the use of many of the waters are a result of the consumption of plentiful supply of wholesome water, as it is a well-known fact that careful and systematic use of pure water is usually beneficial.

The so-called sulphur waters contain more or less hydrogen sulphide gas, which gives them a disagreeable odor. They are usually consumed at the springs and are not bottled. Probably the principal therapeutic value depends largely upon the various substances in solution in the sulphur waters. Inasmuch as these waters are usually highly mineralized this view appears credible.

The sulphate waters usually contain the sulphate radicle and such bases as magnesium and sodium, together with many other radicles and elements. These waters are often strengthened by the addition of magnesium sulphate (Epsom salts) or sodium sulphate (Glauber's salts) and their action is usually very pronounced.

Among the waters used for medicinal purposes lithia waters have extensive sales. They are usually sold in half-gallon bottles and are among the highest priced mineral waters.

Large quantities of water are sold for table use and the supplies from many important springs are used entirely for domestic consumption. In general, these waters are not highly mineralized, though in some places water sold for this purpose might also find a ready market for medicinal purposes.

Table waters may be grouped as natural (still waters) and carbonated waters. The demand for the former is much greater than for the latter, the still waters being often sold for less than ten cents a gallon while the carbonated waters may be worth four or five times as much.

SOURCE AND MINERALIZATION OF WATERS.

With the possible exception of a few thermal springs in regions of recent volcanic activity and of some salt springs, mineral waters are all derived from rainfall. Inasmuch as the meteoric waters are practically pure, the mineralization must take place after they enter the ground. In their passage through the earth these waters encounter an infinite variety of soluble materials, consequently the kinds of material in solution will vary greatly. The quantity of soluble matter encountered is also variable and the amount of material dissolved differs in a similar way. The freedom of circulation and the length of the underground course of the waters also affects both quantity and quality of material in solution, because if the water is long in contact with soluble materials it is enabled to take them up in large quantities and there may be more or less re-deposition of some substances and solution of others as the composition of the water changes. An excellent example of the effect of long contact with soluble materials is seen in many of the wells of the Atlantic Coastal Plain. Those wells that are nearest the outcrop frequently yield hard water, while other wells penetrating the same horizon at a greater distance from the place where the water enters the ground furnish alkaline water.

Some of the thermal springs in regions of recent volcanic activity may be supplied by water from volcanic rocks. It is a well known fact that molten lavas coming from within the earth bring with them a quantity of water, and in the process of consolidation this water may be concentrated in crevices or porous rocks, to emerge finally in hot springs. Such springs are not numerous and it is practically impossible to differentiate them from thermal springs resulting from the heating of underground waters by the molten lavas. It has also been suggested that fracturing and slipping of fractured beds has resulted in the heating of underground waters and the consequent production of thermal springs at some places.

Some of the water from saline springs may be oceanic water included in sedimentary beds at the time of their deposition. Other springs are supplied by saline water that has dissolved its salt and other substances from the formations through which they have passed. Inasmuch as strata in different localities have similar composition it follows that there may be general groupings of mineral waters, depending upon the character of the beds through which they have percolated. However, there is usually very great variation in the relative quantities of materials in solution, and consequently any classification based on the character of the water-bearing beds is necessarily artificial. Moreover, the physiologic action of various waters would differ so much that any commercial classification would need to have an entirely different basis than the geologic occurrence of the waters.

CHAPTER X.

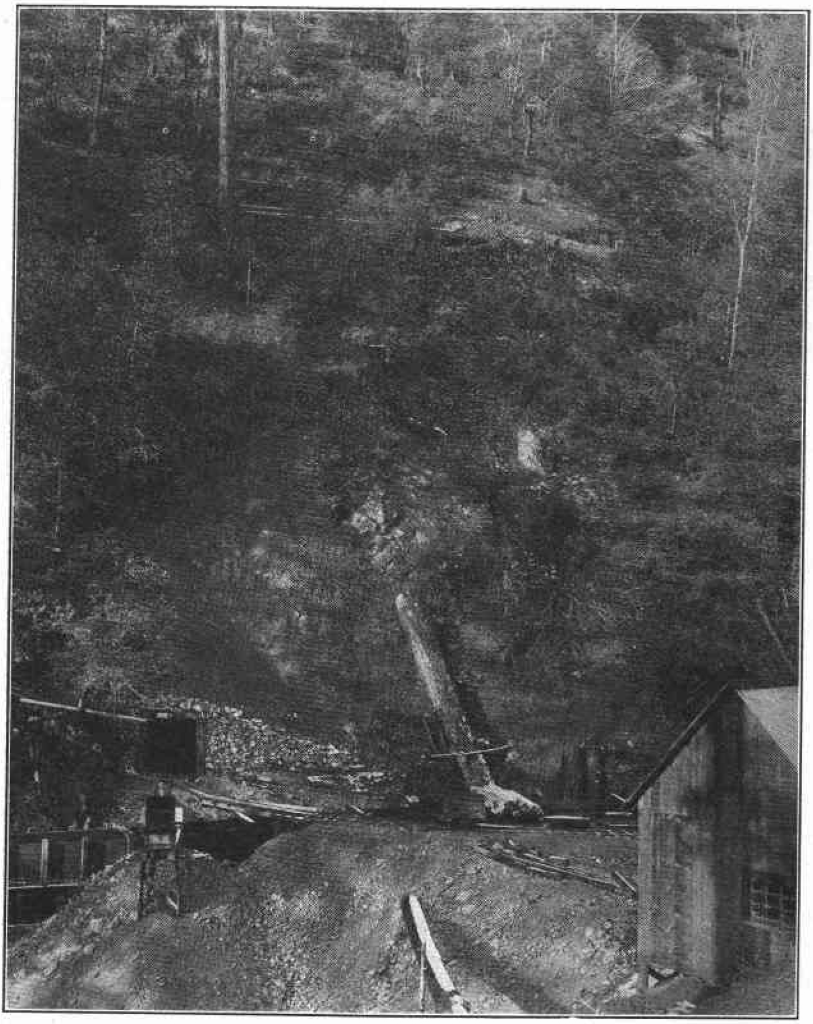
GOLD, SILVER, COPPER AND LEAD.

We are quoting from the "Advance Chapter From Mineral Resources in the United States in 1910" in which the production of Oregon is discussed by Chas. G. Yale.

PRODUCTION.

"The aggregate value of the mine production of gold, silver, and copper in Oregon in the calendar year 1910 was $700,676, as compared with $827,001 in 1909, a decrease of $126,325. The production was derived from 180 mines, of which 116 were placers and 64 deep mines. The number of deep mines producing in 1910 decreased by 2 and the number of placers increased by 20, resulting in a net gain of 18. Of the total output for 1910 the gold yield was 32,870.23 fine ounces, valued at $679,488; the silver yield was 35,978 fine ounces, valued at $19,428; and the copper, 13,861 pounds, valued at $1,760. The total quantity of ore mined and treated in 1910 was 82,132 short tons, an increase of 22,851 tons over the quantity mined and treated in 1909. The siliceous ore sold or treated amounted to 82,064 tons in 1910 (including 12,142 tons of old tailings); in 1909 there were 57,634 tons (including 1,900 tons of tailings)—an increase for 1910 of 24,430 tons. The copper ores in 1910 amounted to 68 tons, as compared with 1,647 tons in 1909, a decrease of 1,579 tons. The average value of siliceous ore per ton in gold and silver in 1910 was $6.42, as compared with $9.87 in 1909 and with $12.49 in 1908. The copper ore sold or treated in 1910 yielded an average value of $4.85 per ton in gold and silver, as compared with $2.92 in 1909. The average recovered value per ton of all metals was $6.42 in the siliceous ore in 1910, as compared with $9.87 in 1909 and with $12.50 in 1908. This reduction in average value per ton accounts largely for the falling off in gold yield for the year 1910.

"There were treated in 1910 at gold and silver mills 68,841 tons of ore, yielding $450,275 in gold and 9,307 ounces of silver. In milling the ore $320,304 in gold and 6,215 ounces of silver were recovered by ordinary plate amalgamation, the average value being $4.65 in gold and 5 cents in silver per ton. The concentrates saved from all concentrating ore were 1,988 tons in quantity, yielding $129,971 in gold and 3,093 ounces



ORIOLE' MINE, GALICE DISTRICT, JOSEPHINE COUNTY, OREGON.

of silver, or an average value of $65.37 in gold and 84 cents in silver per ton. The average total extraction per ton of crude ore in gold and silver mills, both by amalgamation and in the concentrates, was valued at $6.54 in gold and 7 cents in silver. Crude siliceous ore shipped to smelters amounted to 1,081 tons, containing $47,510 in gold, and 23,895 ounces of silver, an average value per ton of $43.95 in gold and $11.93 in silver. In addition there were 68 tons of copper ore smelted, which yielded $41 in gold, 991 ounces in silver, and 13,861 pounds in copper, valued at $1,760. The copper ores yielded 60 cents in gold, 7.9 ounces in silver, and 204 pounds of copper per ton. There were 12,142 tons of old tailings treated, yielding $10,737 in gold and 1,002 ounces of silver, an average value of 88 cents in gold and 4 cents in silver per ton.

"The production of 1909 and 1910 of gold, silver, copper, and lead in Oregon was as follows:

MINE PRODUCTION OF GOLD, SILVER, COPPER AND LEAD IN OREGON IN 1909 AND 1910.

Metal	1909		1910		Increase (+) or decrease (—)	
	Quantity	Value	Quantity	Value	Quantity	Value
Gold ....fine ounces	37,827.51	$781,964	32,870.23	$679,488	—4,957.28	—$102,476
Silver ....fine ounces	27,827	14,470	35,978	19,428	+ 8,151	+ 4,958
Copper..............pounds	235,000	30,550	13,861	1,760	— 221,139	— 28,790
Lead ....pounds	400	17	....	....	— 400	— 17
Total	....	$827,001	....	$700,676	....	—$126,325

GOLD.

"The total output of gold in Oregon in 1910 was 32,870.23 fine ounces, valued at $679,488, a decrease of 4,957.28 fine ounces in quantity and of $102,476 in value, as compared with the output of 1909. The largest yield in gold from one county, valued at $401,002, came from Baker County, as has been the case for some years, although it was $16,536 less than in 1909. The next county in rank was Josephine, followed by Jackson, Grant, Malheur, Douglas, and Lane, in the order named. The largest production from deep mines was from Baker County, and of placer mines from Josephine County. The most productive quartz mine in the State was in Baker County, and the most productive placer (hydraulic) was in Josephine County. Sixty-four deep mines produced gold in 1910, 2 less than in 1909. Productive placers numbered 116 in 1910, as compared with 96 in 1909. The placers in 1910 yielded $170,925 in gold, as compared with $221,318 in 1909, a decrease of $50,393. The hydraulic mines in 1910 yielded $118,189 in gold, or $39,174 less than in 1909, and the surface placers, drift, and dredge mines yielded $52,736, or $11,219 less than in 1909. There were in 1910, 64 productive hydraulic mines, 6 dredges, 7 drift, and 39 surface placers.

"The mine production of gold in fine ounces, with classification of ores and increase or decrease for 1909 and 1910, is as follows:

MINE PRODUCTION OF GOLD IN OREGON IN 1909 AND 1910, BY KINDS OF ORE, IN FINE OUNCES.

Year	Placers	Deep mines			Grand total	
		Siliceous ore	Copper ores	Total	Quantity	Value
1909	10,706.26	26,893.89	227.36	27,121.25	37,827.51	$ 781,964
1910	8,268.50	24,599.75	1.98	24,601.73	32,870.23	679,488
Inc'se (+) or dec'se (—)	—2,437.76	—2,294.14	—225.38	—2,519.52	—4,957.28	—$102,476

"The gold production from different kinds of mines, by counties, for 1910, is given in the following table:

SOURCE OF GOLD PRODUCTION IN OREGON, BY KINDS OF ORE, IN 1910, BY COUNTIES, IN FINE OUNCES.

County	Placers	Deep mines			Grand total
		Siliceous ores	Copper ores	Total	
Baker	545.48	18,851.01	1.98	18,852.99	19,398.47
Coos	10.93	7.64		7.64	18.57
Curry	156.01				156.01
Douglas	94.38	348.11		348.11	442.49
Grant	871.77	879.46		879.46	1,751.23
Harney	11.12				11.12
Jackson	1,834.67	219.62		219.62	2,054.29
Josephine	4,197.74	3,060.83		3,060.83	7,258.57
Lane		196.12		196.12	196.12
Malheur	485.93	1,026.95		1,026.95	1,512.88
Wheeler	60.47	10.01		10.01	70.48
Total	8,268.50	24,599.75	1.98	24,601.73	32,870.23
Decrease	2,437.76	2,294.14	225.38	2,519.52	4,957.28

"The following table shows the source of placer gold in Oregon, by counties, in 1910:

SOURCE AND VALUE OF PLACER GOLD IN OREGON IN 1910, BY COUNTIES.

County	Hydraulic	Drift	Dredging	Surface placers	Total
Baker	$ 5,269	$ 1,577	$	$ 4,430	$ 11,276
Coos				226	226
Curry	1,393			1,832	3,225
Douglas	1,571			380	1,951
Grant	10,985	1,850	2,500	2,686	18,021
Harney				230	230
Jackson	7,576		30,010	340	37,926
Josephine	81,871	20	1,500	3,384	86,775
Malheur	8,274			1,771	10,045
Wheeler	1,250				1,250
Total	$ 118,189	$ 3,447	$ 34,010	$ 15,279	$ 170,925

"The following table shows the increase or decrease in gold production in Oregon, in 1910, by counties:

INCREASE OR DECREASE OF GOLD PRODUCTION OF OREGON IN 1910, BY COUNTIES.

County	Increase	Decrease
Baker	$	$ 16,536
Coos		48
Crook		1,000
Curry		5,407
Douglas	7,353	
Grant		5,127
Harney		585
Jackson		57,752
Josephine	1,051	
Lane		10,118
Malheur		11,079
Wheeler		3,228
Total	$ 8,404	$ 110,880
Net decrease in 1910		$ 102,476

SILVER.

"The yield of silver in Oregon in 1910 aggregated 35,978 fine ounces, valued at $19,428, an increase of 8,151 fine ounces in quantity and of $4,958 in value, as compared with the production of 1909. Baker County made in 1910 the largest silver output, 29,835 fine ounces, valued at $16,111, as compared with 19,514 ounces, valued at $10,147, in 1909. No other county in the State produced over 2,322 ounces in 1910. The placer mines of Oregon yielded 1,329 fine ounces in 1910, as compared with 2,054 ounces in 1909. The quartz mines yielded 34,739 fine ounces in 1910, valued at $18,759; of this, 535 ounces, valued at $289, came from copper ores, all the remainder being from siliceous ore.

"The source of silver, by kinds of ore and by counties, in 1910 is shown in the following table:

SOURCE OF SILVER PRODUCTION IN OREGON, BY KINDS OF ORE, IN 1910, BY COUNTIES, IN FINE OUNCES.

County	Placers	Deep mines			Grand total
		Siliceous ores	Copper ores	Total	
Baker	117	29,183	535	29,718	29,835
Coos	4	----------	----------	----------	4
Curry	18	----------	----------	----------	18
Douglas	24	74	----------	74	98
Grant	148	2,174	----------	2,174	2,322
Harney	2	----------	----------	----------	2
Jackson	298	780	----------	780	1,078
Josephine	517	448	----------	448	965
Lane	----------	67	----------	67	67
Malheur	98	1,476	----------	1,476	1,574
Wheeler	13	2	----------	2	15
Total	1,239	34,204	535	34,739	35,978
Incr'se (+) or decr'se (—)	—815	+8,658	+308	+8,966	+8,151

COPPER.

"The mine production of copper in Oregon in 1910 was only 13,861 pounds, valued at $1,760, from 68 tons of ore. This ore also carried gold to the value of $41, and 535 fine ounces of silver. In 1909 Josephine County produced 235,000 pounds of copper, valued at $30,550, but there was no copper output from this county in 1910, which accounts for the material reduction in copper production for the year, amounting to 221,139 pounds in quantity and to $28,790 in value.

LEAD.

"Although there was a nominal mine output of lead in Jackson County in 1909, there was no production of lead from that county nor from the entire State in 1910.

MINING INDUSTRY IN OREGON IN 1910.

"Southwestern and northeastern Oregon form two distinct mining regions which differ in character of deposits and ores. The mines in southwestern Oregon form an extension of the California gold belt.

"The counties in this region of Oregon are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. There was no production from Benton County in 1910, but the other counties named made a combined gold production of $209,324, which was a decrease of $64,921 from the output of 1909. The production of placer gold from this region in 1910 was valued at $130,103, or a decrease of $55,149, and the gold production from the deep mines was $79,221, a decrease of

$9,772. The silver production in southwestern Oregon in 1910 was 2,230 fine ounces, valued at $1,204. Of the total decrease in gold in this section 85 per cent was due to the falling off in placer production and 15 per cent to reduction in quartz gold output. In 1909 there was a decrease of $8,232 in placer gold, and in 1908 there was a decrease of $46,458 in placer gold, showing that the gold yield from placer operations is annually declining. The decrease of gold yield from deep mines was $9,772 in 1910, $63,670 in 1909, and $99,376 in 1908.

"Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler, among which is the most productive county in the State. The combined gold yield of this region in 1910, omitting Crook, Umatilla, Union, and Wallowa, with no output, was $470,164, a decrease of $37,555. The placer gold yield was $40,822 in 1910, an increase of $4,756. The lode mines yielded $429,342 in gold, a decrease of $42,311. The silver production of northeastern Oregon in 1910 was 33,748 fine ounces, valued at $18,224. The placer gold yield of these counties in 1909 was $43,043 less than in 1908, and the quartz gold yield $63,670 less. The placer gold yield in 1908 was $12,355 less than in the year 1907, and the lode mine gold $105,784 less. These figures show that both quartz and placer mines in northeastern Oregon, as well as those in southwestern Oregon, are gradually declining in gold yield.

"The subdivision of tonnage and production of gold and silver in Oregon in 1910, according to methods of treatment, is shown in the following table:

SUBDIVISION OF TONNAGE AND PRODUCTION OF GOLD AND SILVER IN OREGON IN 1910, ACCORDING TO METHODS OF TREATMENT, BY COUNTIES.

County	Ore to gold and silver mills			Concentrates treated		
	Tonnage	Gold (value)	Silver (fine ozs.)	Tonnage	Gold (value)	Silver (fine ozs.)
Baker	43,935	$225,505	3,639	1,860	$121,510	1,818
Coos	5	158				
Douglas	2,310	7,196	74			
Grant	2,341	12,381	1,815	30	851	78
Harney						
Jackson	1	30				
Josephine	16,390	55,807	380	3	1,905	54
Lane	807	4,054	67			
Malheur	3,031	14,966	239	95	5,705	1,143
Wheeler	21	207	1			
Total	68,841	$32[illegible],304	6,215	1,988	$129,971	3,093
Average value per ton		$ 4.65	$ 0.05		$ 65.37	$ 0.84

Average recovery value (per ton) from both bullion and concentrates: Gold=$6.54; silver=$0.07.

SUBDIVISION OF TONNAGE AND PRODUCTION OF GOLD AND SILVER IN OREGON IN 1910, ACCORDING TO METHODS OF TREATMENT, BY COUNTIES—*Continued.*

County	Crude ore to smelter			Old tailings treated		
	Tonnage	Gold (value)	Silver (fine ozs.)	Tonnage	Gold (value)	Silver (fine ozs.)
Baker	1,028	$ 34,830	23,335	11,300	$ 7,881	926
Coos						
Douglas						
Grant						
Harney	32	2,092	206	812	2,856	76
Jackson						
Josephine	62	4,510	780			
Lane	25	5,561	15			
Malheur						
Wheeler	2	558	94			
Total	1,149	$ 47,551	24,430	12,142	$ 10,737	1,002
Average value per ton		$ 41.38	$ 11.48		$ 0.88	$ 0.04

"The total tonnage, by kinds of ore sold or treated, in each county in Oregon in 1910 is shown in the following table:

SUBDIVISION OF TONNAGE OF ORE SOLD OR TREATED IN OREGON IN 1910, BY COUNTIES, IN SHORT TONS.

County	Siliceous ores	Copper ores	Total ore
Baker	56,195	68	56,263
Coos	5		5
Douglas	2,310		2,310
Grant	3,215		3,215
Jackson	63		63
Josephine	16,415		16,415
Lane	807		807
Malheur	3,033		3,033
Wheeler	21		21
Total	82,064	68	82,132
Increase (+) or decrease (—)	+24,430	—1,579	+22,851
Average value per ton in gold and silver	$ 6.42	$ 4.85	$ 6.43

"The following table gives the number of producing mines, classified according to their chief product, in the counties of Oregon in 1910:

NUMBER OF MINES, CLASSIFIED BY CHIEF PRODUCT, IN OREGON IN 1910, BY COUNTIES.

County	Gold placer mines					Deep mines			Total producing mines
	Hydraulic	Dredging	Drift	Surface	Total	Gold	Copper	Total	
Baker	11		5	13	29	24	1	25	54
Coos				3	3	1		1	4
Curry	2			6	8				8
Douglas	3			2	5	4		4	9
Grant	9	1	1	2	13	14		14	27
Harney				2	2				2
Jackson	9	3		1	13	3		3	16
Josephine	26	2	1	7	36	10		10	46
Lane						4		4	4
Malheur	2			3	5	2		2	7
Wheeler	2				2	1		1	3
Total	64	6	7	39	116	63	1	64	180

"The following table shows the mine production of gold, silver, and copper in Oregon in 1910, by counties, with the tonnage:

PRODUCTION OF PRECIOUS METALS IN OREGON IN 1910, BY SOURCE, AND PRODUCTION OF COPPER, BY COUNTIES.

County	Ore treated (short tons)	Quartz gold		Placer gold		Total gold	
		Quantity (fine ozs.)	Value	Quantity (fine ozs.)	Value	Quantity (fine ozs.)	Value
Baker	56,263	18,852.99	$389,726	545.48	$ 11,276	19,398.47	$ 401,002
Coos	5	7.64	158	10.93	226	18.57	384
Curry				156.01	3,225	156.01	3,225
Douglas	2,310	348.11	7,196	94.38	1,951	442.49	9,147
Grant	3,215	879.46	18,180	871.77	18,021	1,751.23	36,201
Harney				11.12	230	11.12	230
Jackson	63	219.62	4,540	1,834.67	37,926	2,054.29	42,466
Josephine	16,415	3,060.83	63,273	4,197.74	86,775	7,258.57	150,048
Lane	807	196.12	4,054			196.12	4,054
Malheur	3,033	1,026.95	21,229	485.93	10,045	1,512.88	31,274
Wheeler	21	10.01	207	60.47	1,250	70.48	1,457
Total	82,132	24,601.73	$508,563	8,268.50	$170,925	32,870.23	$ 679,488

PRODUCTION OF PRECIOUS METALS IN OREGON IN 1910, BY SOURCE, AND PRODUCTION OF COPPER, BY COUNTIES—*Continued.*

County	Quartz silver		Placer silver		Total silver		Copper		Total value
	Quantity (fine ozs.)	Value	Quantity (fine ozs.)	Value	Quantity (fine ozs.)	Value	Quantity (lbs.)	Value	
Baker	29,718	$16,048	117	$ 63	29,835	$16,111	13,861	$1,760	$ 418,873
Coos			4	2	4	2			386
Curry			18	10	18	10			3,235
Douglas	74	40	24	13	98	53			9,200
Grant	2,174	1,174	148	80	2,322	1,254			87,455
Harney			2	1	2	1			231
Jackson	780	421	298	161	1,078	582			43,048
Josephine	448	242	517	279	965	521			150,569
Lane	67	36			67	36			4,090
Malheur	1,476	797	98	53	1,574	850			32,124
Wheeler	2	1	13	7	15	8			1,465
Total	34,739	$18,759	1,239	$ 669	35,978	$19,428	13,861	$1,760	$ 700,676

PRODUCTION BY COUNTIES.

BAKER COUNTY.

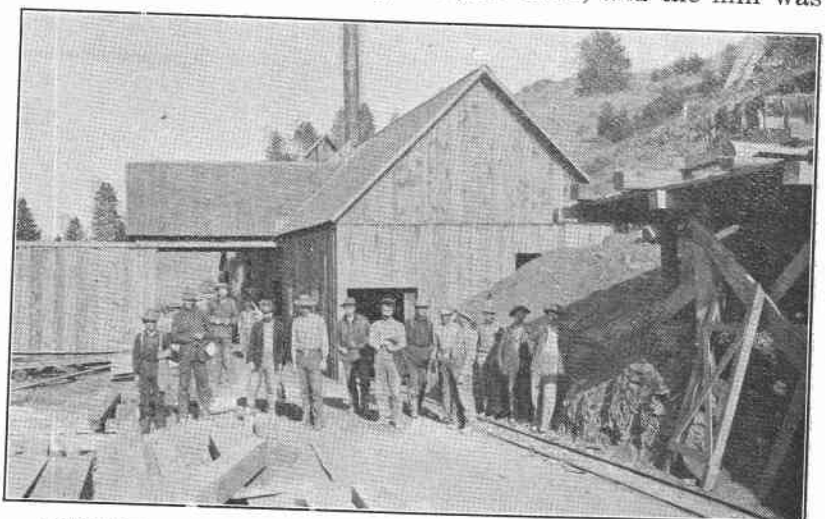
"The total value of the metals mined in Baker County in 1910 was $418,873, as compared with $427,685 in 1909, a decrease of $8,812 for the year 1910. The yield in gold, valued at $401,002 in 1910, was $16,536 less than in 1909, and the yield of silver was 29,835 fine ounces, valued at $16,111 in 1910, an increase of 10,321 ounces in quantity and of $5,964 in value. There was also a yield of 13,861 pounds of copper, valued at $1,760, in 1910. No copper was mined in the county in 1909. There were 54 producing mines in the county in 1910, as compared with 42 in 1909. The placers numbered 29, of which 11 were hydraulic, 5 drift, and 13 surface or sluicing properties. These placers combined yielded $11,276 in gold, and 117 ounces in silver in 1910, as compared with $16,470 in gold and 183 ounces in silver in 1909. The total number of deep mines from which product was reported was 24 and their output of siliceous ore was 56,195 tons in 1910, or 23,674 tons more than in 1909. The gold yield of this ore was valued at $389,685, and the silver yield was 29,183 fine ounces, valued at $15,759. The average value of the ores per ton was $6.93 in gold and 3 cents in silver, a total of $6.96 per ton in 1910, as compared with $12.64 in gold and 31 cents in silver, a total of $12.95 per ton in 1909. Of the total of 56,195 tons of siliceous ore, 43,935 tons were treated at gold and silver mills and yielded $225,505 in gold and $1,965 in silver (3,639 ounces) on the plates, an average value of $5.13 per ton in gold and 4½ cents in silver. From the 43,935 tons of milling ore were derived 1,860 tons of concentrates, yielding $121,510 in gold and 1,819 ounces of silver, a total value of $122,492, or an average of $65.86 per ton. The tonnage of concentrates was larger in 1910 than in 1909 by 142 tons, but the average value per ton was $22.72 less. Crude ore was shipped to smelters to the amount of 1,028 tons and yielded $34,830 in gold, 23,335 fine ounces of silver, and 13,861 pounds of copper, a total value for the smelting ores of $49,191, or an average of $47.85 per ton. In addition to this there were 11,300 tons of old tailings treated, yielding $7,881 in gold and 926 ounces of silver, an average value of 74 cents per ton.

"*Baker District.*—The mines at Baker City and Virtue are included in this district. There were 6 producing mines reported in 1910, which yielded $37,052 in gold and 22,819 ounces of silver, a total value of $49,372. The most productive deep mine was that of the Highland Gold Mines Co., which has no reduction works but ships its crude ore to a smelter for treatment. None of the placers are worked on an extensive scale, and all of them are sluicing properties.

"*Cornucopia District.*—The 4 deep mines operating productively in this district are the Cornucopia, the Queen of the West, the Ross, and the W. P. C. Co. Their combined production was 30,798 tons of ore, which yielded $113,258 in gold and 4,470 ounces of silver. The Cornucopia mine has a 20-stamp mill with concentrators and a cyanide plant. The property is developed by a 400-foot inclined shaft and several adits. The Queen of the West Mines Co. has a 10-stamp mill with concentrators. The W. P. C. Co. has a 35-ton cyanide plant for handling tailings.

"*Cracker Creek District.*—This district includes the mines at Bourne and Sumpter, of which there are 6 producing deep mines and 2 placers. At Bourne are the Climax Group, the Northwestern, the South Pole Consolidated, and the Taylor, all deep mines; and at Sumpter are the deep mines of the Columbia Gold Mining Co. and the Belle of Baker, as well as the Buck Gulch and the Brodie placers. The Climax group is developed by a tunnel 800 feet long and has a 20-ton amalgamating and concentrating mill. The mine was operated by the company up to July 20, 1910, when it was placed under bond and lease. The South Pole is equipped with a 5-stamp amalgamating and concentrating mill. The Belle of Baker has a Bryan mill for reducing its ores. The Columbia Gold Mining Co., which operates the most productive mine in Oregon, has a 20-stamp amalgamating and concentrating mill and a 100-ton cyanide plant. It has a shaft 900 feet deep and several tunnels.

"*Mormon Basin District.*—The 4 deep mines and 2 placers in this district from which production was reported in 1910 are located at or near Rye Valley. The deep mines are the Blue Jay and the Morning Star, properties of the Commercial Mining Co., the May Queen, and the Justis. The combined output of the mines in the district in 1910 was $71,713 in gold, and 602 ounces of silver, with a total value of $72,038. The placers are the Deer Creek and the Rye Valley mines, both operated by the hydraulic system on gravels of an ancient river bed. The most important of the deep mines is that of the Commercial Mining Co., where there is a 50-ton stamp mill with concentrators. The mine has an inclined shaft 240 feet deep and a 400-foot tunnel. About 1,600 feet of development work was done during the year 1910, and the mill was



SURFACE PLANT, RAINBOW MINE, MORMON BASIN, MALHEUR COUNTY, OREGON.

only operated at half its capacity while exploration and development was being carried on. The May Queen is equipped with a 5-stamp mill.

"*Other Districts*.—At Bridgeport there are 7 productive placers, 3 of which are hydraulic, 2 drift, and 2 sluicing mines. These are the Bartholomew, Clark Creek, John Dix, Johnson, Surprise, Pine Creek, and some smaller ones. Their combined output was $2,500 in gold and silver. At Connor Creek the Connor Creek Mining & Milling Co. operated its 20-stamp mill only a short time, as the mine was closed down most of the year. The Camp Bird and the Gardner hydraulic mines are at the same place. At Durkee, Lost Basin district, there is 1 productive deep mine and 1 placer. At Geiser, in Bonanza district, the Consolidated Bonanza is the only productive mine, a deep one. At Greenhorn the following deep mines are producing in a small way: Banzette, Golden Eagle, Kansas Girl, Man-of-War, and Royal White. At Hereford are the White Cloud and the Cow Creek hydraulic mines, the Bull Dog and the Old Channel drift mines, and the Tom-Tom sluicing mine; these had in 1910 a combined output of $1,654 in gold and silver. At Homestead the Iron Dyke Copper Mining Co. is shipping copper ores, carrying also some gold and silver. At Richland there is one small producing placer, and at Robinette there is another. At Sparta are the Rattlesnake and the Sparta placer mines, both sluicing properties. At Weatherby the Dan group is the only productive deep mine, and the Fostering drift mine the only placer.

COOS AND CURRY COUNTIES.

"Coos County showed a slight reduction in its gold output for 1910, and Curry County showed a lessened output of $5,407. The only deep mine producing in Coos County was the Washington, in Johnson Creek district. Of placers, the Bullard and the Rustler and the Flanagan Bar are small sluicing properties. In Curry County no output was reported from deep mines, the entire production having been derived from placers. At Corbin the Kalamazoo is a small sluicing property. At Selma, Chetco district, are the Golden Dream and the Higgins, both hydraulic mines. The Eureka Creek mine is at Marial, in Mule Creek district. There are several beach sand mines at Port Orford, in Cape Blanco district. The total gold and silver production of the two counties (aside from $518 worth of platinum) was valued at $3,621.

DOUGLAS COUNTY.

"Douglas was one of the two counties of Oregon which showed an increase in gold production in 1910, the increase amounting to $7,353. Four deep mines and 5 placers were productive. Of the deep mines the Gold Leaf is at Booth, on Starvout Gulch, a tributary of Cow Creek district. The Kelso Gold Mining & Milling Co. has a 5-stamp amalgamating and concentrating mill. The Black Diamond, at Glendale, in Cow Creek district, has its ore worked by arrastre. The Continental Mines Co., at Nugget, has no reduction works, and the ore is shipped to the smelter at Tacoma, Wash. Of the placer mines of the county, the Boulder and the O'Shea hydraulic mines are at Booth, and the Cunes Creek hydraulic mine is at Glendale. There are also small sluicing mines at Glendale and Dillard. From this county there were 2,310 tons of ore mined and treated in 1910, yielding $7,196 in gold and 74 ounces of silver, valued at $40. The placers yielded $1,951 in gold and 24 ounces of silver, valued at $13. The total yield of the county in gold and silver was valued at $9,200.

GRANT AND HARNEY COUNTIES.

"The production of Grant County in 1910 was $36,201 in gold and 2,322 fine ounces of silver, valued at $1,254, a total value of $37,455. The deep mines produced 3,215 tons of ore, yielding $18,180 in gold and 2,174 fine ounces of silver, valued at $1,174; and the placers yielded $18,021 in gold and 148 ounces of silver, valued at $80. The total gold yield in 1910 was $5,127 less than in 1909. At Austin, in Poker Flat district, are the Belmont and the Goldfield quartz mines, both small producers, and the Poker hydraulic mine. At Beach Creek, in the same district, the Black Butte Mining Co. has a Merrill roller mill, but no ores were mined during the year, the production having come from working over old tailings. This same company operates productively a hydraulic mine, 2 miles from Beach Creek postoffice. In Canyon Mountain district, at Canyon City, 1 deep mine and 4 placers produced $10,438 in gold and 81 ounces of silver, valued at $44. The deep mine is operated by the Canyon Mountain Mining Co., and only specimen ore was worked in a hand mortar. The placers in the district are all worked by the hydraulic process, and are the Mule Gulch, Caledonia, Marysville, and Quartz Gulch. At Galena there is 1 productive hydraulic and 1 drift mine. At Granite the only deep mine is the Garrett, and the Gold Center dredge is at the same place. The Onion Creek hydraulic mine is also at Granite. At Greenhorn the Morning and the Myrtle deep mines are productive. The Morning has a 5-foot Bryan mill and concentrator and is developed by a 1,000-foot tunnel and also 250 feet of drifts. The Myrtle has a 3-stamp mill.

"Greenhorn is in Baker County, but is the nearest postoffice to these mines. The Equity Copper and Gold Mining Co. operates the Colorado mine at Prairie City, in Quartzburg district. The lower grade ore only is milled in a 5-stamp mill, the richer ore being shipped to a smelter. The Saw Mill Gulch hydraulic mine is in the same district. The Red Boy Mines Co. in Red Boy district was a small producer in 1910. At Susanville are the following quartz mines: Gold Bug, Kennerly, Heilig, Maisie Ridge, and a few small properties.

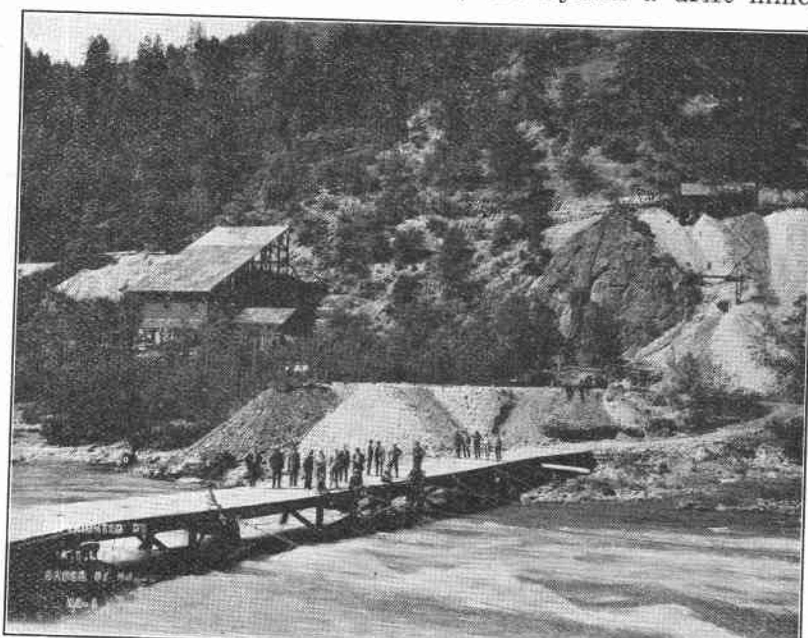
"In Harney County there are only two producing mines, both small sluicing properties at Harney City.

JACKSON COUNTY.

"In Jackson County there are 3 deep mines productive and 13 placers; of the latter there are 9 hydraulic mines, 3 dredges, and 1 sluicing mine. In 1910 the county produced $42,466 in gold and 1,078 ounces of silver valued at $582. The decrease in gold production in 1910, amounting to $57,752, is the most material of any county in the State. This is largely accounted for by the decreased yields in 1910 of the principal quartz mine in the county and of the principal dredge mine. There were only 63 tons of ore treated in the county in 1910, and the placers yielded $37,926 of the gold produced in Jackson County during the year. The deep-mine operators were the Opp Mining Co. at Gold Hill, the Sterling Gold Quartz Mining Co. at Medford, and the Pearl Mining Co. at Trail. At Applegate, the Johnson is a small hydraulic mine. At Draper, Foots Creek district, the Mattie hydraulic mine was productive. At Gold Hill, in the same district, are the Carr Bros. and the Glen Ditch hydraulic mines, and the dredges of the Champlin Dredging Co. and of the Electric Gold Dredging Co. The Black Channel and the Boys are both hydraulic mines at Rock Point, in Foots Creek district. At Woodsville, also in the same district, is the Lance Bros. dredge. The Foots Creek district mines combined made a yield in 1910 of $38,574 gold and of 1,033 ounces of silver, valued at $558, from the mines named. It is the most important of the productive districts of the county. At Jacksonville are the Forest Creek and the Spaulding hydraulic mines, and at Weimer is the hydraulic mine of the Sykes Creek Mining Co.

JOSEPHINE COUNTY.

"The total output of Josephine County in 1910 was valued at $150,569, as compared with $180,402 in 1909, a decrease of $29,833. There was an output of $30,550 of copper mined in this county in 1909, whereas there was no production of copper in 1910. In gold there was an increase in the county of $1,051 in 1910 as compared with 1909, and a decrease of 679 ounces of silver, valued at $334, for the same period. The 10 deep mines in the county in 1910 produced 16,415 tons of ore, which yielded 3,060.83 fine ounces of gold, valued at $63,273, and 448 ounces of silver, valued at $242. The 36 placers comprise 26 hydraulic mines, 2 dredges, 1 drift, and 7 surface or sluicing mines. Combined, these mines produced 4,197.74 fine ounces of gold, valued at $86,775, and 517 ounces of silver, valued at $279. The total gold product of the county in 1910 was valued at $150,048, and its silver output was 965 ounces, valued at $521. The placer yield of the county exceeded the deep-mine gold yield by $23,502. All the ore produced in the county was treated at gold and silver mills, with the exception of 25 tons which were shipped to the smelter. The output of crude ore in the county in 1910 exceeded that of 1909 by 10,453 tons. In Althouse or Sucker Creek district, at Holland postoffice, the 2 deep and the 5 placer mines made a combined yield of $3,577 in gold and silver. The Brooklyn is a pocket mine and only worked in "bunches." There is a 2-stamp mill on the property. The January has its ore worked in an arrastre run by water power. The Goldsby is a hydraulic mine, the Rynski a drift mine,



ALAMEDA MINE, GALICE DISTRICT, JOSEPHINE COUNTY, OREGON.

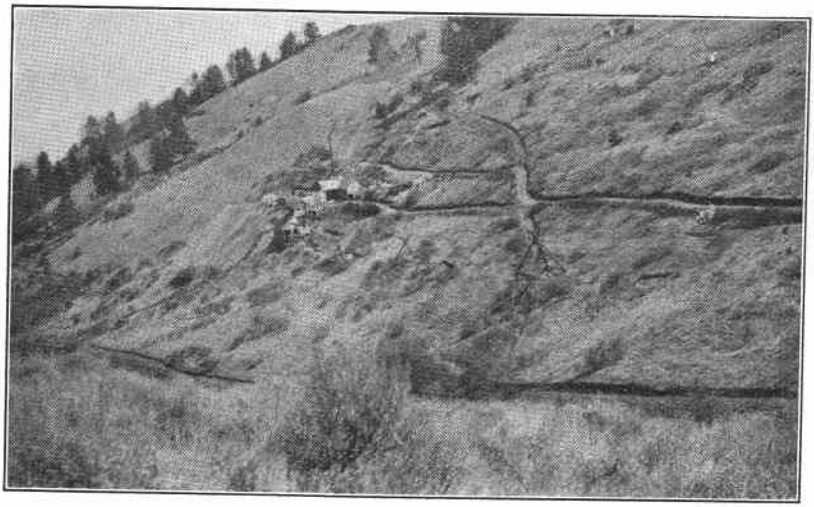
and the Little Homestead, the Surprise, and the Trevor are sluicing properties. The American Belle Mining Co. in this district has acquired an area of gravel claims along the creek for a distance of about 10,000 feet and is bringing in water under a high head. A 3-mile flume was being constructed during 1910.

"The Mountain Lion mine, being operated in Davidson district, is developed by 1,920 feet of tunnels and drifts. It is equipped with a 5-stamp mill, using electrolytic chlorination and amalgamation for treatment of the ore. In Galice district there are 4 producing deep mines and 9 placers, the total output from which in 1910 was $26,769 in gold, and 85 ounces of silver, valued at $46. The deep mines producing were the Gold Road, Oriole, Sugar Pine, and the Nesbit group. The Sugar Pine has a 10-stamp mill. The placers in the district are the Rogue River, Scandanavian, Dean, Gold Bar, Galice placer mines, and the Old Channel, all hydraulic properties, and the Cheldelin, Copsey, and several small sluicing mines. The Old Channel was the largest producer. The Rogue River Dredging Co. worked with a steam shovel at first and has a drag line bucket dredge under construction, not completed in 1910. In Grave Creek district, at Placer and at Leland, the total yield from 2 deep mines and 4 placers, was $57,156 in gold, and 450 ounces of silver, valued at $243; it is the most productive district in the county. The Greenback Gold Mining Co. and the Martha Mining Co. own the quartz properties at Placer. At the Greenback there is a 40-stamp amalgamating and concentrating mill, and the ores of the Martha are worked at this same mill. The Columbia Mines Co. at Placer, in this district, is operating a very productive hydraulic mine. At Leland, in this same district, are the Archer, Crackerjack, and McMickle hydraulic mines. In Josephine district, at Kerby, 5 hydraulic mines produced $3,549; these mines are the Canyon Creek, the Gold Lead group, the Flint Lock, the Wilson & Anderson, and the Illinois & Josephine.

"In Picket Creek district, at Merlin, are 2 producing hydraulic mines, the Big Four and the Flanagan & Emerson. At Waldo the 4 hydraulic mines are the Allen Gulch, the Davis, the Deep Gravel, and the Fry Gulch, with a combined production for the district of $32,135 in gold and of 133 ounces of silver, valued at $72. The Davis is the most productive placer in the State. Since the close of the year 1910 these four mines have been transferred to the Waldo Consolidated Gold Mining Co. of Oregon, which is now operating them under one ownership. At Williams there is only 1 producing mine, the Williamsburg hydraulic property. In Winona, or Jump Off Joe district, are 3 hydraulic mines, the Cook & Howland, the Sexton, and the Swastika. In Wolf Creek district, at Wolf Creek and Golden, are 1 deep mine and 3 placers. The quartz mine is that of the Glendale Mill & Mining Co., at Golden, which is developed by a shaft 135 feet deep and a tunnel 425 feet long; the property is equipped with a 5-stamp amalgamating mill, with concentrator and a cyanide plant. The Jason or Marshall hydraulic mine is near Wolf Creek, and the Ruble and the Copper Knob placers are at Golden.

LANE COUNTY.

"In Lane County there were only 4 productive mines, all deep ones, in Blue River and Bohemia districts. The total product of the county was 807 tons of ore, yielding $4,054 in gold, and 67 ounces of silver, valued at $36. The Blue Bird Mining Co. owns the Red Star and the Red Cloud mines at Blue River, which are developed by 3 tunnels 600 feet long. The mines are equipped with a roller mill with a capacity equal to 10 stamps. In Bohemia district, at Bohemia, the West Coast Mines Co. has a 30-stamp mill, but it was not operated in 1910. The Sweepstake and the Cline are producers at Cottage Grove, also in Bohemia district. The Sweepstake has a 2-stamp mill. For the year 1910, Lane County showed a falling off in gold yield of $10,118, owing to the fact that operators of the most important deep mine milled no ore in 1910.



RAINBOW MINE, MORMON BASIN, MALHEUR COUNTY, OREGON.

MALHEUR AND WHEELER COUNTIES.

"The total yield of Malheur County for 1910 from 2 deep and 5 placer mines was $31,274 in gold and 1,574 ounces of silver, valued at $850. This was a decrease of $11,079 in gold. In Malheur district the Black Eagle Mining Co. has ceased to operate its quartz property. The placers are the Quartz Gulch hydraulic and a few sluicing mines. In Mormon Basin district is the Colt Bros. hydraulic, and the Anders and Head sluicing mines. The only productive deep mine in the district is that of the Humboldt Gold Mines Co., at Rye Valley, which is developed by a vertical shaft 200 feet deep and a tunnel 2,000 feet long. The property is equipped with a 10-stamp amalgamating and concentrating mill.

"Wheeler County made a total production of $1,457 in gold and of 15 ounces of silver, valued at $8, in 1910, the decrease in gold yield being $3,228. There is one small producing deep mine in the county and two hydraulic mines, all in Spanish Gulch district."

The excellent analysis of production given above by Chas. G. Yale of the United States Geological Survey cannot be improved upon as a record and analysis of production. We would desire, however, to do more than this if we were in the position so to do. The ascertaining of facts at first hand requires considerable money for traveling and incidental expenses. The Bureau of Mines has only $1,000 annually for all purposes covered by the law. We would like to have an intimate and detailed knowledge of the mining camps of Oregon gained through extended observations and study on the ground, this knowledge to be incorporated in frequently published bulletins for the free use of those engaged or interested in the work. We would also like to be in a position to give definite information upon individual problems to all who seek it.

We can say most emphatically that Oregon's failure to have kept pace with other states in the gathering and dissemination of reliable information upon her mineral resources has been a large factor in keeping her production down to its present level.

We feel almost like apologizing to the many courageous men and organizations who have gone ahead with money, muscle, and brains to carve out success, unaided by any information from the State and Federal surveys so common in other states. We would like to have visited them at their properties as well as their less fortunate neighbors and to have written of them understandingly, with authority, giving to each a proper appreciation. This we are unable to do with the annual appropriation now given us. We are giving in the following a very incomplete statement of the more active mines of Oregon of which information has been collected by correspondence with friends in the district and some of it by personal observation while in the districts upon other business.

DISCUSSION OF THE MORE ACTIVE PROPERTIES.

The mining situation in the State as far as the future is concerned promises to be brighter than in the past four or five years. During the last two years at least eight mines in the eastern part of the State have been developed to a point that justifies the erection of milling plants and it is estimated that one alone, the Rainbow mine, in the Mormon Basin district, Malheur County, will double the present annual gold production of the State when the new mill is put in operation. There is a large amount of ore blocked out in this particular mine which in the judgment of conservative mining men warrant this anticipation. About six months ago this mine was purchased by the United States Smelting, Mining & Refining Company for $550,000. The property is under the able management of Mr. H. S. Lee. Since taking charge of the mine he has done considerable additional development work including the sinking of the shafts for an additional 100 feet and a large amount of drifting. The management contemplates dismantling the present mill and the erection of a new up-to-date mill of much larger capacity.

The Humboldt mine joins the Rainbow property on the east and is said to contain the same ore zone as found in the Rainbow. A depth of 300 feet is obtained in this mine and very flattering assays have been reported from different points in the ledge. This mine is under the management of Mr. John Arthur and is owned by the Oregon-Idaho Investment Company.

Another mine in the Eastern Oregon district that may be expected to add to Oregon's output in the very near future is the Dixie Meadows located 10 miles northeast of Prairie City, Grant County. This mine is also said to have a large tonnage available for milling with the ore estimated to have an average of $8.00 per ton. The mine is owned by L. Vogelstein & Company, New York. The 10-stamp mill for testing products is now in operation on this property but plans for a larger plant having a capacity of 150 tons are now being worked out. This property is managed by Mr. L. A. Greenley.

The Ben Harrison mine in the eastern part of Grant County four miles south of Olive Lake is also very promising property. This property is under the efficient management of Mr. W. C. Fellows, mining engineer, and is owned by L. A. White, a prominent locomotive manufacturer of Lima, Ohio. In the development of the property the manager is keeping close to the ore body, keeping a complete set of assay maps and contemplates development to 1,000 feet depth the full length of the ore body before laying any plans for the erection of a mill on the property. This management deserves favorable mention on account of the conservatism and good judgment exercised in carrying the development of the property to such an extent that sufficient data is obtained to warrant the erection of the particular kind of plant which will be of most efficient service to the property in the reduction and marketing of the ore.

The Ibex property, which is situated about eight miles northwest from Sumpter, according to Fred R. Mellis is a very promising property owned by the Arthur Hill estate. The property is managed by Mr. David Ross. After considerable development the ore bodies of milling quality are found to be from 6 to 25 feet in width and over 1,200 feet in length. This property also contemplates the erection of a mill in the near future. The ore to be treated is as yet very largely free milling.

The Columbia mine located at Bourne is the only deep mine that has been producing steadily during the past year and it continues to produce on the average of about $25,000 per month. Mr. Frank S. Baillie has been manager of this property for the last 15 years and the success of the property is due very largely to his able management.

The Cornucopia mine sends a carload of concentrates to the Baker Sampling Works about every ten days, the net returns of which, according to an official of the latter, are from $3,500 to $4,500. Robert M. Betts is manager. Mr. Betts is now arranging for a new plant which will materially increase the production of this mine.

One of the placer mines which have attracted some attention in the last few months is the Underwood placer mine in the Cornucopia district which according to a private communication has recently been sold for $330,000. There are a considerable number of other rich placer mines in the Cornucopia district which are being operated at a good profit. The North Pole mines which have been noted in past years and have produced over two and a half million dollars bids fair to repeat their past record. Very recently an option was given on the property to some Portland capitalists, and the mine has been placed under the charge of Mr. Albert Geiser, former owner of the Bonanza mines which he sold for $500,000. It is reported that Mr. Geiser is already encountering new ore bodies in this mine of high value. This property is equipped with a good mill and bids fair to again assume considerable importance among the gold producers in Eastern Oregon.

Other mines which might be mentioned that are expected to contribute to the output of Eastern Oregon are the Red Boy under the management of Mr. John Farrell and the Morning mine in charge of Mr. Frank Pierce.

The production of the Southern Oregon mining district in 1910 in gold, silver, and copper was $210,142. The major portion of this amount was derived from numerous placer mines well distributed over the counties, Josephine and Jackson. Deep mining has not been developed in this district to the degree that we find it in the Eastern Oregon mining district. However, in the past year or two, there has been considerable attention paid to the development of deep mines, a number of which it is said promise to add materially to the State's output of gold, silver, and copper. Among the most important is the Oriole in the Galice district. There is a very large amount of underground development work, amounting to more than a mile of underground openings in this mine. The order has already been sent for the equipment of a reduction plant which will be put in operation just as soon as it can be erected. The mine is fortunate in having plenty of good water power available. It is already equipped with some excellent buildings such as a sawmill, laboratories, sampling plants, etc. This property is under the management of Mr. Fayette A. Jones.

Another property in this district which has had rather a varied experience in the last two years is the Alameda. It is now reported that their new smelter is running steadily after several months of experimenting with inexperienced help and the lack of careful investigation with reference to the nature of the ore to be treated. It is said that this company has a large body of copper ore.

The Greenback mine has recently been purchased by Mr. Robert Robertson, who intends to continue explorations on a large scale and expects to make this property as large a producer as it has been in the past.

The Granite Hill mine is just now making preparation to resume active operation. This is a large low grade proposition equipped with stamps and milling machinery. Some time ago it was closed because of litigation. The owners of this property expect to make it produce in a very short time.

The Jewett mine is another very good property being bonded by eastern parties who expect to continue further development.

According to a statement by Mr. O. S. Blanchard of Grants Pass the Greenback, the Granite Hill, and Jewett mines promise to become important producers in a short time.

CHAPTER XI

POPULAR DISCUSSION OF MINERALS HAVING LITTLE PRODUCTION TO DATE IN OREGON.

AGATES.

Agates are found in some abundance on the Oregon coast especially that of Lincoln and Curry counties. Several hundred dollars have been collected by the sale of the finer specimens and many more earned by lapidarists in grinding and polishing the stones picked up by those who visit the coast during the season and wish their specimens prepared for settings and ornaments.

The agate is a form of quartz and is named according to its appearance as banded, clouded or moss agate each due to the impurities they contain and the manner of their deposition from solution in the irregular cavities in the rocks. The bands are the edges of the layers of depositions from solutions intermittently supplied and of unequal purity. The impurities having the appearance of moss is the "dendritic" or branched form of manganese oxide seen also deposited on the faces of jointed rocks near the surface of the earth which attract our attention by their interesting shapes.

The layers of the banded forms differ often in degree of porosity thus permitting the layers to be varied in color by the forcing in of colored material by artificial means known to those skilled in the art thus increasing the beauty of the agate and the selling prices as well.

ALUMINUM.

Aluminum has the highest percentage composition of all metals in the crust of the earth making up over eight per cent of it, nearly double the percentage of iron, the most widely used of all metals. The lightness, strength and other pleasing and useful qualities of this metal makes us inquire why with twice the percentage of iron it is used to such a small degree and even now the price per pound is more than twenty times that of iron. The answer is found in the high reduction costs.

Iron is found in nature always in combination with other elements such as oxygen but is separated from them with great facility and cheapness in the iron furnaces. On the contrary aluminum which is so common that we can hardly escape its presence, no matter where we walk, cannot be separated from any of the other elements combined with it, in any ordinary furnace using coke as a reducer as the iron furnace does, but must be subjected to very high temperatures and reducing atmosphere of the electric furnace in order to take away from the aluminum the other elements it holds with the tenacity of a miser.

To create this high heat in the electrical furnace consumes a great deal of power and power is expensive. Only at those points where electricity is sold at a very low rate can this be done. From this it can be readily seen that not only must we use only the highest grade of aluminum ore, the oxide Bauxite, which is found in few localities, but we must of necessity ship this ore to the point where cheap electric power can be secured. The above shows sufficiently why the price of the metal still remains too high (19 cents per pound) to be used as a structural material or in other ways to compete with iron.

Aluminum in combination with quartz and oxygen is found in every clay bank, the metal varying from 200 to 500 pounds per ton. We look forward to the time, which may not be far distant, when we can separate it so cheaply by using water power for the generation of the electricity and by new reduction methods now being perfected that we can become indifferent to the fact that we have in Oregon but little iron ore, no coking coal and are subjected to high freight rates on iron from the furnaces of the eastern states.

ASBESTOS.

Asbestos is the commercial name for the minerals which are found crystalized in threadlike form of sufficient length and flexibility to be utilized in the useful arts. Its usefulness and consequent market value depends on the flexibility and length of the fiber, upon its being a poor conductor of heat and electricity, and on the fact that it is somewhat difficult to fuse.

When the fibers are long and flexible it can be woven into cloth such as the asbestos curtains in the theaters required by law in some of the cities. When of somewhat inferior quality it is useful in making asbestos board for oven linings and the many purposes where it can be utilized to either retain heat, or to keep heat out of parts which might be injured by it. This is possible because it is a poor conductor of heat and does not burn or melt readily.

Still poorer grades are used to make the heavy steampipe covering, for packing in fire proof safes, for blocks and many other uses. Still poorer grades having short fibers can be used for electric insulation where heat resistance is necessary.

The wide differences in prices due to difference in quality is strikingly shown by the following range of prices for the year:

No. 1 high grade crude asbestos per ton	$275-$350
No. 2 crude asbestos	150- 250
Asbestos fiber according to grading	25- 150
Fines according to grading	10- 25

The United States is the largest manufacturer of asbestos products but less than one per cent is mined in this country, nearly all the remainder being imported from Canada.

Asbestos is found in rocks which have been banded, twisted, or otherwise altered in appearance by the action of compression and consequent high temperatures due to shifting, sliding and folding of the earth's crust producing gneiss, schist or serpentine. In these rocks where the conditions were favorable asbestos is found. Since serpentine is a hydrous magnesium silicate as is also one variety of asbestos, although not in the same proportions, it is not unreasonable to expect the latter to be found when serpentine is as abundant as it is in the Rogue River Valley.

IRON ORE.

Iron occurs as one of the most universally distributed elements and occurs in enormous quantities in the earth's crust. It, however, seldom occurs as a metal alone but is usually combined with oxygen, silica and other substances and is in this way one of the most important mineral forming elements. It is nature's most common and universal pigment, the different colors and tints of rocks being due more to this element than to any other. It is very common to find rocks such as our basalts, which occur in such large quantities in the Pacific Coast regions, carrying from 15 to 20 per cent iron. Although iron is very widely distributed in nature, iron ores are comparatively few and far between.

The iron ores smelted in the United States averaged in 1910 a little over 50 per cent iron. Under very favorable conditions iron ores may be smelted which carry as little as 35 per cent, but in the common accepted use of the term it is probable that anything less than this could not be considered today as iron ore. However, the existence of iron ores carrying good percentages of iron is one thing and the availability under ordinary conditions of smelting is another. Iron must be produced at a low cost if it is to continue to fill its present place in modern civilization. On this account the sources of supply are restricted to comparatively few regions. Nearly all the iron and steel in the world is now produced from two localities, Western Europe and Eastern North America, about 60 per cent in the former and 40 per cent in the latter.

There are two principal sources in the United States, namely the Lake Superior region and the Alabama region. The Lake Superior being by far the greater of the two, furnishing four-fifths of the American production.

Three products are absolutely necessary and must be considered in the location of any iron smelter. First, iron ore, second, coke for fuel, and third, limestone as a flux. The Alabama region above referred to, is peculiarly fortunate in having all three of these in large quantities within a few miles of each other so that the low cost of production is probably not equalled elsewhere in America.

West of the Mississippi the iron industry in the United States is relatively small. One moderately large plant is in operation at Pueblo, Colorado and another is just being completed on Puget Sound.

The average price of pig iron in 1910 ranged from fourteen to twenty dollars per ton according to the grade and demand at different times of the year. It will readily be seen that these prices include the cost of fuel, flux, labor, and other items. Considered from this standpoint the price of iron ore must necessarily be quite low. The average price per ton for the different kinds of iron ore in the United States in 1910 were as follows:

Hematite	$2.52 per ton.
Limonite	1.76 per ton.
Magnetite	2.36 per ton.
Carbonate	1.61 per ton.

These prices represent the value at the mines. In order to answer the question which we are often asked as to the value of iron ore if it should be found in Oregon it might be helpful to quote from facts from the state of Texas. An exceptionally good grade of iron ore was recently discovered in the eastern part of that state and a company has been organized and has just contracted to supply over 300,000 tons of iron ore annually to the smelters in the eastern part of the United States. This ore must be laid down at Atlantic ports, the price not to exceed $3.00 per ton.

The question, however, may be asked. Are our present methods of the reduction of iron destined to continue? To this it may be replied that electric smelting only seems likely to change it and that to only a limited degree. In the reactions in a blast furnace about two-thirds of the fuel is employed in supplying the necessary heat while the other one-third is used in the reduction of the iron oxide. Electric energy supplied by water power may replace the two-thirds of the fuel which is used as heat, the remaining one-third will probably always be necessary. In favorable locations in this State electric smelting may become feasible if cheap coke or charcoal be furnished. Electric smelting is, as yet, quite in its infancy but is of sufficient importance and promise to deserve mention as a possible factor in the future.

CHROMIC IRON ORE.

Chromite is widely distributed through areas of serpentine, and associated rocks in various parts of the United States. There are without doubt considerable quantities of the mineral in the State as is evidenced from the fact that we have received a large number of samples at this office for examination.

Chromite is the only commercially important ore of chronium. Its principal uses are in the manufacture of special steels alone or in combination with tungsten, manganese, nickel or other steel hardening materials. It is also used for alloying copper, lead, steel, and other purposes where the corrosive action is great. The third important use is the manufacture of various pigments and dyes, mordants, and tannages.

The production of chrome iron ore in the United States came mostly from California in 1910. The imports from New Calidonia, Greece, and other countries enormously exceed the domestic production. The price of chrome ore varies from ten to twenty dollars per ton according to the grade of ore and conditions of supply. The average price of the imported ore in 1910 was $15 per long ton.

MANGANESE ORE.

Manganese is a rather widely distributed element in nature, the more important minerals, however, being the oxides and carbonates. Only the oxides are mined in the United States. The principal use of manganese is much the same as that of chromite, namely, in the manufacture of steel. It is also used in the formation of certain alloys with copper, aluminum, zinc, tin and other metals. A number of minor uses are, as an oxidizer in the manufacture of chlorine, bromine, and oxygen; as a dryer in paints and varnishes; as a decolorizer of glass; as a coloring material in coloring glass, brick and pottery and as a pigment in the manufacture of paints.

The manganese industry in the United States is to some extent on the decline largely due to the cheaper foreign ores imported from Brazil, France, British India, and Russia. It seems that we cannot compete with foreign producers as is evidenced from the fact that many of our mines were reported idle in 1910. The price of manganese in 1910 ranged from ten dollars to twenty dollars per ton.

INFUSORIAL EARTH.

Diatomaceous or infusorial earth resembles chalk or clay in its physical properties, but can be distinguished at once from chalk by the fact that it does not effervesce when treated with acids, and by its very low specific gravity, it weighing when dry only half as much as dry pine. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter. Owing to its porosity it has great absorptive powers. Chemically it is a variety of opal.

Heretofore the principal uses of infusorial earth have been largely for abrasive purposes in the form of polishing powders, scouring soaps, etc., but of late its uses have been considerably extended. Owing to its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerine. The porous structure also renders it a nonconductor of heat, which property, in connection with its lightness in weight, has extended its use as a packing material for safes, steam pipes, and boilers, and as a fireproof building material in general. The California product, according to Arnold and Anderson, may be cut into any shape desired and, like the Missouri tripoli, may be used as a filter stone. The material is quarried for building stone in Southern California, for which purpose it seems to be well adapted, especially in that region of earth tremors, owing to its elasticity and because the minimum amount of damage is likely to result from the falling of so light a material.

In Europe, especially in Germany, it has of late years found extended application. It has been used in the preparation of artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles and artificial stone, of ultramarine and various pigments, of aniline and alizarine colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papiermache, and a variety of other articles, and there is a large and steadily growing demand for it.

The present San Francisco price is ten dollars to fifteen dollars per ton. During the course of a year several samples are sent to this office for determination but without favorable freight rates it is problematical whether even the best grades could be mined at a profit.

Since the time when it ceased to be used as an absorbant in the manufacture of dynamite the total consumption has usually been considerably less than 10,000 tons although of late the consumption has been increasing.

MICA.

Mica or isinglass as it is sometimes called is a mineral which crystalizes in thin sheets which have been found as large as two by three feet. The three kinds of mica are the black, the amber, and the white. The white mica, generally called muscovite, is practically the only kind found of commercial value in the United States.

Mica is used in large quantities in both sheet and ground form. Sheet mica is used in stoves, for gas-lamp chimneys, for lamp shades, and for glazing, and is punched into disks and washers or cut by shears operated either by hand or by power into patterns for use in stoves and electrical apparatus. The electrical industry consumes by far the greater part of the sheet mica produced. The mica serves as a perfect insulator in various parts of dynamos, motors, induction apparatus, switchboards, lamp sockets, etc. The domestic or muscovite mica is satisfactory for all insulation except for commutators of direct-current motors and dynamos built up of bars of copper and strips of mica. For this purpose no mica is as satisfactory as the "amber" mica. This mica is of about the same hardness as the copper of the commutator segments, and therefore wears down evenly without causing the machine to spark. A large quantity of the sheet mica used in electrical apparatus is built up into "micanite" or mica board," the thin sheets being built up layer after layer with shellac, with or without tissue paper, and then subjected to great pressure under heat to dry out the shellac.

Sheet mica with black specks of magnetic iron between the laminae is inferior to clear mica for electrical insulation. Such mica is used, however, in electrical apparatus conveying only currents of fairly low voltage. This variety of mica is satisfactory if used with discretion, but some electrical manufacturers will not use it in any of their apparatus.

A large quantity of scrap-mica—that is, mica too small to be cut into sheets and the waste from the manufacture of sheet mica—is ground and used in many ways. Among these are the manufacture of wall papers, lubricants, and fancy paints, and of molded mica for electrical insulation. Ground mica applied to wall papers gives them a silvery luster. When mixed with grease or oils finely ground mica forms an excellent lubricant for axles and other bearings. Mixed with shellac or special compositions, ground mica is molded into desired forms and is used in trolley wire and other insulators. Ground mica for electrical insulation must be free from metallic minerals. Mica used for lubrication should be free from gritty matter. For wall papers and brocade paints a ground mica with a high luster is required, and such luster is best obtained by using a clean light-colored mica and grinding it under water. Coarsely ground or "bran" mica is used to coat the surface of composition roofing material to prevent the tar or other composition used in its manufacture from sticking when the material is rolled for shipping.

The total production in the United States in 1910 is valued at 337,097. The average price of sheet mica was 11½ cents per pound ranging from 3 6-10 cents to 42½ cents according to quality. The scrap mica averaged $13.00 per ton during the year. No deposits of commercial mica have been reported in this State. Although a frequent constituent of many igneous rocks, commercial needs demand a very high quality of the product which limits mining to a few deposits of superior purity and size.

MINERAL PAINTS.

In classification of mineral paints the United States Geological Survey recognizes three main groups as follows:

Group 1, comprises ocher, umber, sienna, hematite, siderite, limonite, ground slate and shale, and whiting (ground limestone).

Group 2, comprises lead and zinc oxides, these being mixed together in all proportions giving such products as basic carbonate white lead, litharge, red lead, orange mineral, lithopone, and Venetian red.

Our discussion in this bulletin will only have to do with group 1, because groups 2 and 3 are dependent largely upon manufacturing operations and these commercial products can never be sold in the rough, or as a natural product.

The total value of the second and third groups is enormously greater than that of the natural pigments. For example, lead and zinc white pigments form the basis of the greater part of all the standard paint manufactured at present.

OCHER, UMBER AND SIENNA.

These three terms used in paint manufacture are quite similar from the standpoint of their character, the most important part of each being the iron oxide or manganese oxide as the case may be, which furnishes the peculiar tint desired. These oxides are found permeating a clay base, the clay usually occupying a very large proportion of the mass.

The names ocher, umber, and sienna, are largely descriptive of the different tints produced; the ocher being the yellows or light brown; the umber being made considerably darker by the addition of the black oxide manganese; and the sienna a grade between these two, obtained by a less amount of the black oxide manganese.

The average price per ton in 1910 of ocher in the United States was about ten dollars. The price of umber and sienna averages considerably more than this being about twenty-six dollars per ton in 1910.

For certain purposes pigments of low tinting value, such as colored shales, have been found to be equal to those of more uniform composition and deeper color. In the manufacture of oilcloth and linoleum the mineral coating on which the color patterns are printed and also the under surface can be prepared as well from yellow and red shales containing only a small percentage of iron as from yellow and red ochers in which the iron content is much higher. Similarly the paint that is applied to a fresh surface of wood or metal primarily for the purpose of filling the pores and small cavities in order to make a smooth surface on which later coats of paint are spread, can be manufactured from materials with low tinting value. Black, red, and yellow shales are utilized for these purposes, and the materials when prepared for the market are known as paint fillers.

A very important point in the manufacture of such pigments is to determine the amount of linseed oil required for each pigment, as in the cheaper paints the oil costs much more than the dry colors, and the materials requiring the minimum amount of oil are preferred by the manufacturers of mixed paints. Many of the claims of superiority of one product over another are based on its lower absorption of oil.

The prices of the prepared pigments range from $3.00 to $50 per ton and depend on their adaptability for definite purposes and the supply available. As a rule the margin of profit is moderate and the market is limited, otherwise the annual production would be greatly increased. Each company in operation could readily increase its output with a minimum of expenditure and would undoubtedly do so if the demand were greater. Although most of the ground shale produced in Pennsylvania is utilized by local paint and linoleum manufacturers, a considerable portion is shipped to remote parts of the United States and even to foreign countries.

SALINES.

Under this head are classed those soluble mineral substances of commercial value usually found in the beds of dried up lakes. The important salines are potash, salt, borax, soda, niter, sodium sulphate, bromine, and iodine. Our records show no production of any of these in Oregon in 1910.

SALT.

Salt is an article of daily use with which we are all familiar and is obtained in either of two ways. One by mining out the solid rock salt, and second, by evaporating salt solution. Deposits of rock salt occur in various parts of the United States due probably to the evaporation in some previous geological period of inland lakes. These deposits are covered with considerable thickness of other material which has been washed in since their formation. Such deposits are often mined as coal or other rock would be and placed on the market.

Solutions for the production of salt are obtained from several sources. Sometimes ocean waters are used, sometimes waters from salt lakes, sometimes water from wells drilled into salt beds or in ground highly impregnated with salt, and sometimes water is forced through holes drilled into salt beds so that it dissolves the salt and returns again to the surface. Solutions are evaporated either by artificial heat or by exposure to air and sun and the products marketed. The production in the United States in 1910 was over thirty million barrels.

There appears to be no probability of Oregon becoming a producer of common salt in the near future unless that sodium chloride present in the waters of some of the lakes in the eastern part of the State should become a by-product in working up some of the other salts. Current New York quotations are $1.10 per barrel for fine salt and $2.90 to $3.50 per short ton for agricultural.

BROMINE.

Bromine is the chemical element used in making bromides for medicinal, photographic and other purposes. It occurs in small amount in sea water and other brines and becomes concentrated in the mother liquor left from recovering salt. It is obtained as a by-product in the production of salt from brines in some parts of the country, especially in Michigan where the salt solution carries more than the average amount of bromine. In 1910 the United States produced 245,437 pounds of bromine valued at $31,684. There is no indication of Oregon becoming an important producer.

IODINE.

Iodine is an element similar to bromine but occuring in smaller quantities. It occurs in such slight amount in solutions used in the production of salt that it is not recovered commercially as bromine is. It is used for medicinal and laboratory purposes.

Certain seaweeds extract iodine from sea water and it may be recovered from the ashes on burning these weeds. This is the only important source of the substance in the United States. If the contemplated production of potash from seaweed along the Pacific Coast should be developed in Oregon it is probable that much iodine would be recovered also.

SODIUM SULPHATE.

Sodium sulphate (glauber salt) occurs as one of the constituents of many salt lakes and as the main constituent in some of them. It is known to occur in Wyoming and over nine per cent of the solid matter in solution in Harney Lake is sodium sulphate (according to the U. S. G. S. bulletin 330). The United States Geological Survey gives no figures on the production of glauber salt for the year. Present wholesale prices in New York are from 60 to 80 cents per 100 pounds.

SODA.

Soda (sodium carbonate) occurs in solution in alkali lakes and as a deposit on or near the surface of former lake bottoms. It is obtained by evaporation of these solutions though the chief producers are the chemical manufacturers who make it from salt by rather an elaborate procedure.

In 1910 a company applied for lease of certain lakes in eastern Oregon but no production from this source has been recorded. According to the U. S. G. S. Bulletin 330, the waters of Lake Harney and Albert have the following composition:

	Albert	Harney
	Per cent	Per cent
Solids in waters (salinity)	3.9172	1.0477
Composition of the solids—		
Chlorine	36.04	27.5
Sulphate (SO_4)	1.90	7.67
Carbonate (CO_3)	20.67	25.87
Borate (B_4O_7)	-------	.92
Sodium	39.33	35.78
Potassium	1.44	1.91
Magnesium	-------	.07
Silica	.62	.28

This would indicate excellent possibilities for the production of soda, salt, and glauber salt. The price of soda is about the same as of glauber salt.

BORAX.

Borax (sodium biborate) is a white soluble material with which most people are familiar. The only important occurrences of borax in the United States are in arid regions of California, Nevada, and Oregon. In these places it occurs in the waters of some of the salt lakes and in bedded deposits derived from such lakes. It is accompanied usually by the calcium borate which is also of value in its contents of boron. Borax is used in welding metals, soldering brass, assaying, refining gold, making glass, as an antiseptic, and preservative, and in the manufacture of boric or boracic acid which is used in medicine. The main production is from the desert regions in southern California, where it occurs in such large quantities as to be produced cheaply.

No production of borax is shown for Oregon at present but according to U. S. G. S. Bulletin 330 some borax has been produced in former years from an incrustation of it which covers a marsh just south of Lake Alvord in Harney County. Without better transportation facilities than exist in this region it can hardly expect to compete with California producers. The production in 1910 was 42,357 tons worth $1,201,842.

NITER.

Niter or salt peter is potassium nitrate. The more common sodium nitrate being called soda niter or chili salt peter. Soda niter is used in the manufacture of chemicals, in metallurgy, assaying, and in medicine. It is also used in large quantities as a fertilizer for soils low in nitrogen. Soda niter occurs in small amounts in places in the desert regions of southern California but no occurrence of it in the United States is of great commercial importance. The American supply comes from large deposits in Chili. Soda niter is quoted in New York at $2.20 per 100 pounds.

A substitute for niter as a fertilizer is being made in some parts of the country by causing nitrogen in the air to combine with other elements by the use of electricity. This requires cheap electric power to be commercially successful.

POTASH.

Potassium carbonate is a white compound somewhat like soda and readily dissolves in water. It is the main soluble constituent of wood ashes and may be obtained by evaporating the solution obtained by treating the ashes with water.

Potassium either combined as the carbonate or in some of its other compounds is a valuable plant food and is used in large quantities in fertilizers. This use has recently become so great that the potash obtained from wood ash is in no way adequate to meet the demand and other potassium compounds from different sources are used under the name of potash. So commonly is this the case that in most press reports the term potash means any compound of the element potassium and when any idea of the proportion of potassium present is indicated it is usually done by interpreting the term to mean potassium oxide. Thus if a preparation is referred to as containing 50 per cent potash it means that every hundred pounds of the preparation contains as much potassium as would be present in 50 pounds of the oxide.

We quote from a recent press bulletin of the U. S. G. S. "to meet the numerous inquiries received by the U. S. G. S. as to the exact meaning of the terms potash, pure potash, potassium, etc., a non-technical explanation has been printed as part of bulletin 530-B on potash by W. C. Phalen just issued by the survey. The metallic element potassium represented by the symbol K is the basis of all potash salts but the combination potassium with oxygen represented by the symbol K_2O has been generally adopted as the standard for measuring the potash value. The following table gives the per cent potash on this basis in some of its compounds.

Potassium chloride	63%
Potassium sulphate	54%
Potassium nitrate	47%
Potassium carbonate	68%
Potassium hydrate	84%
Potassium cyanide	72%

The known occurrences of potassium compounds in the form to be used commercially in the United States are quite limited and most of the present supply comes from the German salt mines near Stassfurt. These have a monopoly of the supply are controlling the price at a point which strikes dismay to the heart of the American consumer who has no alternative unless an American production can be stimulated. Imports in 1910 of potash salts were nearly 1,800,000,000 pounds.

In order to assist in discovering an American source of supply congress last winter appropriated $20,000 to enable the Geological Survey to search for potash and the sum of $12,500 to be used by the Bureau of Soils for the same purpose and it was mutually agreed that both bureaus should work in co-operation and avoid duplication. In a summary of the occurrence of potash in the United States published by the survey last winter five general sources are mentioned. One, igneous rocks; two, marls; three, alunite; four, salines; five, organic sources, including wood ashes, beet sugar molasses and residue, wool scourings, and sea weed or kelp.

No. 1. Large masses of igenous rocks occur in some parts of the country containing from five to ten or more per cent potash. These would afford an inexhaustible supply of potash if it were in a soluble form so that it would be of use to plants, but this can come about only through a decomposition of the rocks. Several methods of treatment have been suggested to get the potash from these rocks but none have been developed of a sufficiently economical nature to be of importance commercially.

No. 2. Marls appear to be relatively unimportant, excepting the greensand marls of New Jersey which contain both potash and phosphates.

No. 3. Alunite is a mineral composed of the sulphates of alumina and potassium with water of crystallization. By heating, water and sulphuric acid are driven off to the extent of about 45 per cent of the weight taken and of that remaining about one-third is soluble potassium sulphate in a suitable form for plant use. According to a recent number of the U. S. G. S. press bulletin there has lately been discovered near Marysville, Utah, an important deposit of alunite which is now being developed. It is a large regular vein which is at least 135 feet long and as nearly as it has been measured it is ten feet or more in average width. This is estimated to contain enough potash to be equivalent to 30,000 tons of potash for each one hundred feet in depth mined. This is not more than about one-sixth of the annual importation into the United States but it might be sufficient to meet the local demand. Alunite is known to occur in other places in smaller amounts and it is likely that other commercial deposits of it may be found but it is not likely to be found in such large quantities as to afford a permanent national supply of potash.

No. 4. Salines—The fourth source of potash enumerated is considered by the United States Geological Survey to be the most promising. The survey has accordingly shipped a drilling outfit to a point in the Carson Sink near Fallon, Nevada, and is drilling a hole in the hope of finding a salt bed similar to the German deposits. This location was chosen since geological considerations show that a large lake once occupied this basin and did not overflow but dried up. If the desired material is not found here other favorable localities in the basin region will probably be tested in the same way.

At the same time the government desires to assist any private parties who may be prospecting for potash as is indicated by the following quotation from the press bulletin of last August. "One of the possible sources from which potash may be derived is in association with saline deposits left by the drying up of large bodies of salt water, such as are known to have existed at one time in many of the now desert areas of southeast Oregon, Nevada, southeast California, Utah and elsewhere.

It is hoped by testing these saline deposits some may be found sufficiently rich in potash to have a commercial value, and that there may even be located some large and important deposits.

FREE ANALYSIS OF SALTS.

"As a part of this work the survey will soon fit up a temporary laboratory at Fallon, Nevada, for the purpose of testing samples of salines from the Great Basin or desert areas.

"Samples of such alkaline salts will be tested at this laboratory free of charge if a definite statement of the locality from which they were obtained be sent with the samples. The location should be given by section, township, and range, if possible, otherwise by distance and direction from the nearest post office or settlement. Samples should be addressed to Hoyt S. Gale, United States Geological Survey, Fallon, Nevada. Upon receipt of a request small sample sacks for sending the material by mail will be forwarded from the above address.

"If so requested at the time that a sample is submitted for test, the accompanying information concerning the locality of the deposit will be treated as confidential; and the evidence thus obtained is not to be used for the purpose of making land withdrawals."

No. 5. Organic Sources. It seems to the writer that the ashes collected in our western cities where wood is so largely used for fuel could be utilized to advantage and turned to a profit in making fertilizer if the subject were investigated by those in charge of the garbage crematories.

Beet Sugar—Beet sugar residues and wool scourings would undoubtedly afford some potash but by far the greater supply could be obtained according to those who have investigated the problem from the forests of seaweed and kelp which grow along the Pacfiic Coast of the United States from California to Washington. In fact it has been stated that enough potash to supply the total demand of the United States could be obtained from this source by a proper system of harvesting without decreasing the growth and that in this way it could be made to afford a permanent supply.

SERPENTINE.

Serpentine is a soft rock varying in color from dark green, light green, to yellowish green and in composition is a hydrous silicate of magnesia. It is thought to be in all cases a secondary rock, that is, it is formed from some other rock by a gradual change in the mineral character. These rocks are usually found in areas where considerable folding and movement of the rocks have taken place. Serpentine forms extensive rock masses in the coast mountains, especially in the southwestern part of the State. On account of its softness and pleasing colors it is used to a considerable extent for interior decoration. It is a very highly prized rock and brings good prices when it can be found in masses where considerable dimensions can be obtained. The greatest difficulty with this rock being that it is usually found with numerous fissures and cracks, making quarrying quite expensive. On this account large dimensions are very scarce in all serpentine quarries. It is possible that favorable locations for serpentine quarries may be found in the large masses of this rock in Josephine and Jackson counties.

TALC AND SOAPSTONE.

Talc is usually marketed under three general heads: First, the ground fibrous talc used in paper making; second, the massive varieties known as steatite or soap stone; and third, ordinary ground talc. This material is also a hydrous silicate of magnesia, having a greenish white or gray color.

The price of talc in 1910 varied from $8.00 to $20 per ton for American talc, and $15 to $25 for French talc and from $30 to $40 for Italian, the higher grades used in this country being entirely imported. Very little talc is sold as it comes from the mine, nearly all of it being milled. The milling process separates the gritty material from the fine smooth talc. Nearly all the production in the United States comes from the Eastern Atlantic States, extending from New York and Vermont to Alabama and Georgia. A very small amount of talc was produced in California.

Uses of Talc.—Talc is very highly resisting to ordinary acids, and on this account it is used in the form of soapstone slabs in chemical laboratories, hospitals, etc. It is not easily affected by heat and on this account is used for griddles, hearth stones, gas tips, laundry tubs, and sinks. Powdered talc is used in the manufacture of paper, toilet powders, foundry facings, sizing for cotton cloth, insulated covering for electric wiring, dressing for skins and leather and inferior grades to some extent in soaps and paints.

TELLURIUM.

Tellurium is an element similar to sulphur in its chemical nature but very rare and of no value except as a laboratory curiosity. It occurs in small quantities as a mineral in some localities. It is silver white, crystalline, and has a metallic lustre. Tellurium has won far greater fame in the public mind than it deserves due to the fact that the gold in many ores exists chemically combined with it as a mineral which resembles tellurium in appearance. These telluride minerals are often called tellurium, which confuses the uninformed.

Rather than being of any value tellurium is usually a detriment in an ore as gold in combination with it is harder to recover by ordinary processes than that not so combined.

What tellurium is produced is recovered from slimes in refining copper or from flue dust from furnaces used for roasting gold ores containing tellurides.