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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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G M I SHORT PAPER

No. 8

STRATEGIC AND CRITICAL MINERALS

A GUIDE FOR OREGON PROSPECTORS.

By

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FOREWORD

In normal times most prospectors look for gold, since that metal usually offers the quickest reward and is generally either easily recognized or the ore is susceptible of easy determination. Prospectors, in general, thus gain little or no experience with other minerals whose peacetime markets offer little incentive for search for new deposits. Under war conditions these minerals, needed for production of war materials, become of prime importance and an insistent demand is created for information concerning occurrences, mineral characteristics, uses and markets. The Department is publishing this paper to help meet this demand insofar as Oregon is concerned.

Dr. Staples is especially qualified to write on the subject of strategic minerals. In recent years much of his work, both in private practice and in teaching, has been concerned with this subject.

It is hoped that the paper will be of material assistance to Oregon prospectors as well as to small operators who have turned their attention from gold mining to those mineral deposits essential for war needs. It is believed that schools will also find the paper informative and timely.

Earl K. Nixon

Director

Portland, Oregon
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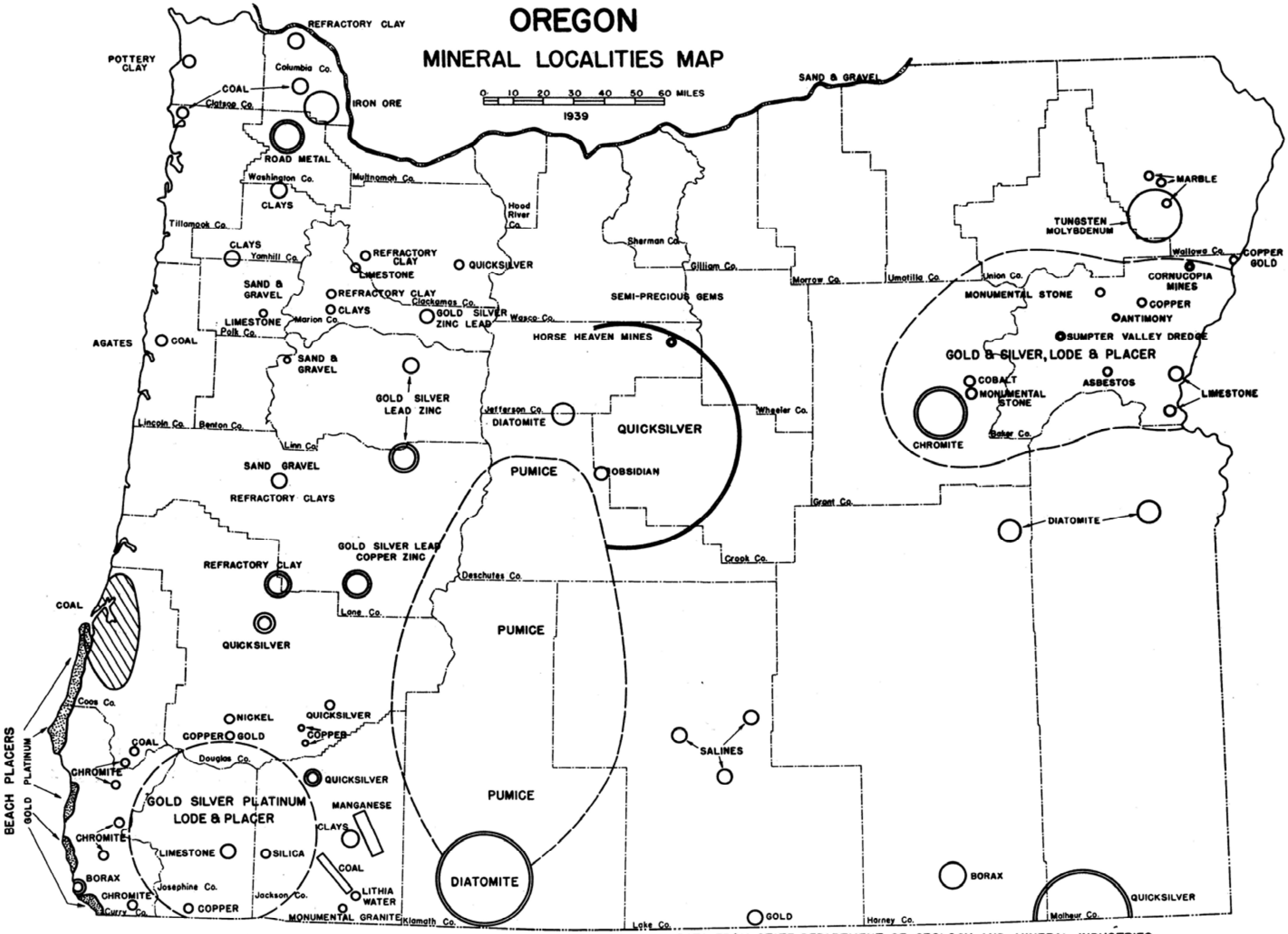

PREPARED BY O.S.H.D

DATA FROM STATE DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

STRATEGIC AND CRITICAL MINERALS

A Guide For Oregon Prospectors.

INTRODUCTION

The work of discovering the mineral deposits of the United States has fallen to the lot of the prospector during the development of this country, and with the odds usually stacked high against him, his pluck, initiative, industry and tenacity have brought forth results that could not be equalled by any organization or bureau ever established. Today, during the national emergency, prospectors are combing the hills as never before in an attempt to uncover deposits of minerals that will aid our productive capacity. The writer has been in close association with many of these men, and has had brought strongly to his attention their desire for more data regarding the type of materials needed by the nation, such as how to recognize certain minerals, what constitutes a commercial deposit, what to do with it when one is discovered, and where to find some literature on the subject that would cast further light on the mineralogy and economics of minerals important in war.

It has been clearly shown in the case of cinnabar that good deposits were overlooked by prospectors looking for gold, simply because they had only gold in mind when they were prospecting. If they had been on the alert for all valuable minerals that might appear, they could have discovered deposits yielding a greater profit to them than the substance they were seeking. This paper is an effort to answer the question so often stated by the prospector, "What else should we look for?".

In addition to pointing out the metals that are so greatly needed for conducting the war and the minerals from which they are obtained, an attempt will be made to indicate places in the state where one is most likely to find such minerals, as well as to outline the geological conditions under which they are usually found, and to include something regarding the market and price for them. In listing the Oregon mineral localities it should be noted that these do not necessarily represent commercial deposits, but may be places where only small amounts of the minerals are found. In the belief that the best odds and quickest returns in prospecting can be gained by working areas known to be mineralized, however slightly, these localities are presented.

For the purpose of classification, the Army and Navy Munitions Board Commodities Division has grouped essential war materials under two headings: strategic and critical. According to this grouping, "strategic materials" are defined as "essential to national defense, for the supply of which in war, dependence must be placed in whole, or in substantial part, on sources outside the continental limits of the United States, and for which strict conservation and distribution control measures will be necessary". In contrast to this, critical materials are considered to be those "essential to the national defense, the procurement problems of which in war would be less difficult than those of strategic materials either because they have a lesser degree of essentiality or are obtainable in more adequate quantities from domestic sources; and for which some degree of conservation and distribution control will be necessary".

Only those materials that are dependent on the processing of minerals will be studied in this report. This will throw out such important products as rubber and quinine, and limit the study to metals and minerals. The following is the list of strategic and critical materials which will be discussed.

STRATEGIC	CRITICAL
1. aluminum	1. platinum
2. antimony	2. vanadium
3. chromium	3. asbestos
4. manganese (ferro grade)	4. graphite
5. nickel	5. cadmium
6. quicksilver	6. titanium
7. tin	7. cryolite
8. tungsten	8. fluorite
9. mica	
10. quartz crystal	

Magnesium, copper, lead, zinc, and beryllium will also be discussed briefly. Since the original list of "strategic" and "critical" minerals was published and particularly since war was declared, most metals have become critical insofar as adequate supplies for both war and civilian needs are concerned. Adequate supplies of copper and steel, because of their universal application, are especially important.

Priorities and allocations are now in force for almost all of the metals (molybdenum and quicksilver are notable exceptions), but the scarcity in some cases is tied up with lack of productive capacity rather than scarcity of supply. It would be beyond the scope of this paper to discuss at length minerals of which we have adequate known reserves, but which are restricted because of bottlenecks in plant capacity.

The strategic minerals are discussed rather thoroughly but because of space limitations it has been necessary to refer more briefly to the critical minerals. It should be noted that in the case of the critical minerals, especially, the original list has been enlarged; there is no intention of indicating that the list given here is either complete or final.

Before entering the war with the Axis, as a far-sighted measure, the Treasury Department was authorized to stock-pile strategic minerals (1939). This work was entirely too slow in getting started and at the beginning of 1941 only a little more than 10 per cent of the commitments had been received. The year 1941 showed increased activity but without our having completed stock-piling according to commitments, the war in the Pacific broke. As a result the following metals, the major imports of which depend on Pacific transportation, are likely to become greatly restricted: antimony, tin, chromium, manganese, and tungsten. It will be increasingly difficult for China, for example, to repay over $90,000,000 in loans, by shipment to the U. S. of antimony, tin, and tungsten, as originally planned. The last metal shipments came out over the Burma Road and through Rangoon.

Two governmental agencies were created for the purpose of stimulating mineral production and stock piling. Since the prospector may desire information regarding the government's interest in certain minerals, these agencies will be noted here. The U.S. Treasury Department has a branch known as the Procurement Division, with offices in the Procurement Building, Washington, D. C. It is the duty of this division to stock pile certain strategic materials according to specifications of the Army and Navy Munitions Board. These materials include chromite, quicksilver, tungsten, mica, and quartz crystal. The Reconstruction Finance Corporation has a subsidiary known as the Metals Reserve Company, which has considerable more liberty in stating specifications of minerals desired than has the Procurement Division. The Metals Reserve Company has been buying chromite, tungsten, tin, manganese, graphite, and asbestos. In addition, the R.F.C. is empowered to make loans up to $40,000 for the development and production of strategic minerals, but no loans can be made for prospecting. Form R.F.C. L-254 entitled "Application for a Development Loan" may be obtained from the Reconstruction Finance Corporation, Washington, D.C.

For general information regarding strategic and critical minerals the following references contain valuable material:

Mineral Industry During 1940, G. A. Rousch, McGraw-Hill
Minerals Yearbook for 1941, U.S. Bureau of Mines
Metal and Mineral Shortages and Substitutions in National Defense; Frank T. Sisco: Mining and Metallurgy, October 1941

Development and Production of Domestic Supplies of Strategic and Critical Minerals; S. H. Dolbear: Mining Congress Journal, December 1940

Adequacy of Certain Mineral Resources; J. W. Finch: Mining Congress Journal, June & July 1941

Mineral Needs of a World at War; J. R. Suman: Mining and Metallurgy, Jan. 1942

The material presented here is derived from several sources. The bulk of it represents a summary of lectures given by the writer under the auspices of the General Extension Division of the State System of Higher Education to people in Eugene during the fall of 1941. The Oregon mineral localities are selected from a complete list of Oregon minerals, now being prepared by the writer.

In describing minerals for the purpose of identification, it is appreciated that however adequate the description may be it is a poor substitute for becoming familiar with mineral specimens by handling them. For this reason it is suggested that whenever possible a prospector will do well to buy, for comparison purposes, a set of the minerals in which he is interested. Mineral specimens may be obtained from the following dealers:

V. D. Hill, Rt. 7, Salem, Oregon
R. M. Wilke, Palo Alto, California
Western Mineral Exchange, 320 Madison Street, Seattle, Washington.

Collections of minerals are available for study at the Grants Pass, Portland, and Baker offices of the Oregon State Department of Geology and Mineral Industries, at the University of Oregon (Condon Hall), and at Oregon State College. There are also numerous private collections in every section of the state.

Prices of ores given in this paper are constantly changing, and for last minute quotations the seller should refer to metal prices in the newspapers or to quotations such as are given monthly in the Engineering and Mining Journal, New York. A weekly service may be had for about $5.00 per year from this journal.

Acknowledgments

For a careful reading of the manuscript and numerous helpful additions, the writer wishes to express thanks to Mr. F. W. Libbey of Portland. Valuable suggestions were also received from Mr. Ray Treasher of Grants Pass and Dr. W. D. Smith of the University of Oregon. Aid in compilation of mineral localities was received from Robert Brooke, now with the Cordero Mining Company.

ALUMINUM

Aluminum has been shuffled back and forth between the strategic and critical classifications, but because of local interest and to permit more detail it will be discussed as a strategic material. There is a huge demand for aluminum, but the present bottleneck is in productive capacity, not ore supply.

The principal ore of aluminum is bauxite, and at present all of the aluminum manufactured in this country comes from this substance. In case of difficulty in getting sufficient bauxite there is hope of obtaining a supplementary supply of aluminum from another mineral, alunite, by a process which although still in the pilot plant stage has yielded promising results. In connection with the manufacture of aluminum, the mineral cryolite (Na_3AlF_6) is used in the electrolytic process, and formerly this natural mineral was considered essential. Because there is only one commercial occurrence of cryolite, at Ivigtut in Greenland, it became highly desirable to find a supplementary supply, and synthetic cryolite is now successfully made, from fluorite. Rather than spend time searching for cryolite in Oregon, it would be more practical to seek fluorite which can be used as a substitute for cryolite and has many other uses which place it on the list of critical minerals. Small amounts of fluorite are known to occur in the Wallowas.

SCARCITY:

Most of the present scarcity of aluminum depends on plant and power shortage, but there is likely to be a shortage of the better grade ores in a few years. If domestic deposits of bauxite were called upon to supply the total estimated needs of the country, the known high grade ore would be exhausted in about three years. The known reserves of alunite are not sufficient to be a major source of supply. Our main source of aluminum ore would then be low grade bauxite together with large deposits of high alumina clays. Processes for the commercial extraction of alumina from clays is being studied intensively. Metallurgists of the U.S. Bureau of Mines, as well as private agencies are working on the problem of commercial treatment of low grade alumina minerals such as low grade bauxite, alunite, and clay.

Bauxite

Bauxite is really rock, being composed of a mixture of minerals which are aluminum hydroxides. The principal ones are gibbsite, diaspore, boehmite, (all crystalline), and cliachite, which is amorphous and the principal constituent. The crystalline minerals occur in such fine crystals that they cannot usually be recognized without the aid of a microscope. The combination of these minerals produces a rock, bauxite, which often has a very characteristic appearance and for a long time was considered a mineral species. It is most characteristically pisolitic in structure, though not necessarily so, since it may be massive and claylike. The color varies from white to red, with reddish brown being common. The hardness varies from 1 to 3 and specific gravity from 2 to 2½.

TESTS:

None of the simple tests distinguish it from clay. An analysis for silica and alumina may be necessary. The average Arkansas commercial bauxites have 55 - 60 percent alumina and 4 - 6 percent silica with only 2 - 4 percent iron.

DISTINGUISHING FEATURES:

Usually it has a pisolitic or coral-like appearance and this aids in its identification.

OCCURRENCE:

The rock is secondary, having been formed by the weathering under tropical conditions of rocks high in alumina and low in silica, such as syenite.

LOCALITIES:

About 96 percent of the U. S. production comes from Arkansas (60 percent underground, 40 percent open pit). Most of the imports and more than half of the United States consumption comes from Surinam (Dutch Guiana). None has been reported from Oregon, and rocks of syenite type are rare in the state, but a mass of nephiline syenite has been reported from Table Mt., Lincoln County, by Rogers, Howe, and the writer. On the whole, the chances of finding commercial bauxite in Oregon are very poor.

MARKET:

Since bauxite is not mined in the state there is no active market for it, but with the erection of two aluminum plants nearby, a great deal of interest has been shown in discovering deposits in the state which might yield alumina.

Alunite

Alunite is a basic potassium aluminum sulfate, occurring either in small crystals that may resemble six-sided plates, or in white to reddish massive aggregates or veins. H-4. G-2.8 *

TESTS:

If the mineral is powdered, placed in a closed tube and heated it will give off water which will be acid to litmus paper (blue litmus paper will turn red) and give a sulfate test. The mineral after roasting is converted into a water soluble alum (an alum is a double sulfate of aluminum and another metal with 24 molecules of water).

DISTINGUISHING FEATURES:

If crystalline the hexagonal shape of the crystals helps in its recognition. Massive varieties usually must be tested.

OCCURRENCE:

Sulfuric acid solutions, often produced from the breakdown of pyrite, working on rocks rich in potash feldspar, produce alunite.

LOCALITIES:

Marysville, Utah has already yielded commercial alunite. There are deposits in Washington which may be used. Oregon has no large deposits reported as yet, but alums occur in several places, such as near Wagontire in Lake County, and in the Crooked River canyon in Malheur County.

MARKET:

Kalunite Inc., a subsidiary of the Olin Corporation (Western Cartridge Co.) has a laboratory in Salt Lake City and there they have done considerable work on the alunite process. Kalunite Inc. has had $2,000,000 made availabe to it by the Defense Plant Corp. to construct a plant having a capacity of over 150 tons per day. This plant will probably be constructed at Marysville, Utah and will make alumina from alunite. The alumina will be reduced to aluminum at Tacoma by Olin Corp.

High Grade Clays

One of the greatest hopes of the U. S. for future aluminum supplies is from high grade clays. It has been reported that in Washington alone in one high aluminous clay deposit

* H stands for hardness
G stands for specific gravity

there is more than 200 million tons. High aluminous clays developed in the Molalla River Valley, southeast of Molalla, Oregon, form a deposit of $\frac{1}{2}$-1 million tons. Work is being prosecuted on methods for the utilization of such deposits. Oregon has numerous other clay deposits, but it must be remembered that the average good clay has about 45 percent silica and only 15-40 percent alumina (only half of which is aluminum), which is a long way from the desirable analysis of an alumina ore. At present it is commercially unprofitable to extract aluminum from any Oregon clays. For a discussion of the properties of some Oregon clays see Bulletin No.6 "Preliminary Report on Some of the Refractory Clays of Western Oregon" by Wilson and Treasher.

ALUMINUM REFERENCES:

The Aluminum Situation; H. A. Franke: Mining and Metallurgy, Nov. 1941
Are Our Aluminum Ore Reserves Adequate? G.C. Branner: Mining & Metallurgy, July 1941
Aluminum from Western Alunites; Frank Eichelberger: Mining Congress Journal, Nov.1941
Industrial Aluminum; A Brief Survey; L. L. Motz: G.M.I. Short Paper No.2, 1940

ANTIMONY

The only mineral mined for antimony alone is stibnite. There are not many good deposits of this mineral in the United States and most of the domestic antimony produced comes from other sources such as lead ores containing small amounts of antimony. Formerly our imports of antimony ore came from Mexico, China, Italy, France, and Japan. Of these nations, China has had its production seriously cut by the Japanese war, and there is no further chance to receive imports from the three last-named countries. Increased imports from Bolivia are helping somewhat to take up the slack.

The principal uses of antimony are in alloys. Storage batteries take considerable antimony; babbitt metals for bearings, as well as type metal, also require a large part of the peace time supply. The chemical industry has been using increasingly large amounts of antimony, especially the oxide. Antimony is an essential part of shrapnel.

Stibnite

Stibnite is antimony trisulfide, with 71 percent of antimony when pure. Stibnite occurs most commonly in blades showing very good cleavage in one direction; it also occurs massive. It is metallic and lead gray in color. H-2. G-4$\frac{1}{2}$. Orthorhombic crystals are fairly common.

TESTS:

Very easily fusible, even in the flame of a match. Gives dense white fumes and sublimate when heated on charcoal with blowpipe.

DISTINGUISHING FEATURES:

The perfect cleavage, softness (can be scratched with fingernail) and easy fusibility make it easy to recognize. The bladed cleavage faces show striations on them like the steps of a ladder.

OCCURRENCE:

Stibnite is usually found associated with quartz in veins in extrusive rocks. It is characteristic of shallow deposits (epithermal), but occasionally may be more deep seated. It is often altered to stibiconite, a yellow mineral, and this association may lead to its discovery and recognition.

LOCALITIES:

Most of the stibnite in the U. S. comes from Idaho, Nevada, and California, with Alaska also being important. There is no present production of stibnite in Oregon, but stibnite is reported to occur in the following counties and places:

Baker County: In Sumpter and Virtue Dist. in Jim Dandy and Koehler mines. Flagstaff mine, 7 miles from Baker.

Curry County: Reported near Eckley (unconfirmed).

Grant County: Poorman Mine, Susanville Dist. Ben Harrison Mine, Cabell Mine, in Elk Cr. dist. Ritter Hot Spring.

Jackson County: Barron Area; 8 miles in a direct line E.SE. of Ashland. NW$\frac{1}{4}$ Sec 25, T. 40 S., R 4 W. (Lowry); Sec 23, T. 40 S., R. 4 W. (Merrick); Sec. 36, T. 40 S., R. 4 W, (Assays), S.E.$\frac{1}{4}$ Sec 24, T. 40 S., R4 W, about 3 miles miles north of Watkins. Antimony Prospect on Forest Cr. Sec. 30, T. 32 S. R. 12 W. (Assays reported)

Jefferson County: Near Crowley ranch on Little Muddy Creek.

Lane County: Bohemia Dist. Cripple Creek Mine,El Captain, Tall Timber, Patterson Creek. On Peters Creek a branch of Row River west of the Bohemia Dist.

Tillamook County: Edwards, 8 miles from Cochran by railway.

Union County: North of Anthony Lake.

MARKET:

There are smelters at Los Angeles (El Segundo); Laredo (Texas Mining and Smelting Co.), Texas; and Kellogg (Bunker Hill), Idaho (recovery of antimony from tetrahedrite.)

PRICE: For antimony ore (N.Y.) A unit equals 1% antimony.

50-60%	\$2.00-2.05
65-73%	\$2.25-2.35

(Mining Journal- Phoenix)

BUYERS:

A. J. Bishop, C/O Harshaw Chemical Co., 631 S. Inglewood, El Segundo, California
F. H. Daken, 2811 Hillside Drive, Burlingame, California
Ore, Metal & Engineering Corp., 112 Market Street, San Francisco, California
Paul W. Wood Co., 447 Hampshire Street, San Francisco, California

CHROMIUM

Although there are many minerals containing chromium, the only important source of the metal is chromite. The metal is an important one in time of war because its steel alloys have the properties of toughness, hardness, and resistance to corrosion, all of which are properties of invincibility. Our imports of chromite depend on open sea lanes and our stockpiles are sufficient for only about a year, so that any curtailment in delivery would result in hardship in a short time unless a greatly increased supply can be obtained from domestic deposits. For 1940 the domestic production was slightly over 2600 long tons of ore containing at least 35 percent chromic oxide (Cr_2O_3). This is considerably less than 1 percent of our needs.

Chromite

Chromite is essentially a ferrous metachromite ($FeCr_2O_4$), with magnesium commonly replacing the iron, and aluminum partially replacing the chromium. It is commonly massive, occurring in bunches, bands, blotches ("leopard ore"), or streaked through the host rock.

H-5½, G-4½. The luster is submetallic to pitchy. It is dense black to bluish black in color and gives a dark brown streak. Crystals from beach sands often show isometric crystallization, occurring in small 8-sided crystals (octahedrons).

TESTS:

Finely ground powder placed in a borax bead before the blowpipe gives a green color to the bead. The powder, fused on charcoal with sodium carbonate gives a strongly magnetic mass.

DISTINGUISHING FEATURES:

When crushed, chromite gives a brownish powder. Luster and brownish streak help identify it. Association with green garnet (uvarovite) or pink coating (kämmererite) is characteristic. The borax bead test is fairly conclusive.

OCCURRENCE:

Chromite is found in ultrabasic rocks, such as peridotites, or serpentines derived from them. Often associated with platinum, nickel, magnesite. May be in kidneys with sharply defined margins, like plums in a pudding, or finely disseminated throughout the rock. Chromite probably came into the rock near the end of the magmatic cycle and about the time of consolidation of the country rock. The localization of the chromite is often dependent on shear fractures which usually have formed before the peridotites altered to serpentine.

LOCALITIES:

Russia, South Africa, and Turkey are large producers of chromite. In 1940 most of our chromite came from Rhodesia, the Phillipines, and Union of South Africa. It is interesting to note that the Phillipines which as recently as 1934 did not produce chromite, came very close to being our chief source of supply in 1940.

Grant, Josephine, Curry, and Coos counties in Oregon have many deposits of chromite, most of them small. It is reported that Grant County has known ore reserves of 80,000 tons of 20-35 percent ore and over twice as much of 20-25 percent grade. The following list gives an idea of the location of deposits in the State:

Baker County: Conner Creek, Durkee.

Coos County: Johnson Mountain about 25 miles south of Myrtle Point.

Curry County: Baldface, 2 miles north of Sourdough guard Station, Windy valley group, Chetco, Signal Butte group, Indigo claims between Indigo Creek and the Illinois River, Agness group south of Agness and north of Lawson Creek, Illahe group.

Douglas County: Starveout Creek, Days Creek on the Umpqua River, Nickel Mountain.

Grant County: Iron King mine, Kingsley on the east fork of Dog Creek, Haggard and New located about 1 mile north of that property, Present Need, Celebration on east fork of Big Pine Creek, Chambers on Bald Mountain, Bald Eagle, Cry camp, Ray Chromite Deposit, Ajax, west side of Indian Creek, Silver's, Benson on Beach Creek, Spring and Chrome ridge, Record located 31 miles west of Sumpter(?).

Jackson County: 10 miles NW of Ashland in the drainage basin of Applegate Creek.

Josephine County: Elkhorn Creek, Horse Mountain, Illinois River 18 miles from Selma, Jack Shade on the Illinois River, Daley Creek 1½ miles northwest of Pearsall Peak, Squaw Creek, Charles Owen two miles south of Takilma, Chollard southwest bank of Sowell Creek, Esterly 6 miles south of Cave Junction, Mungers Creek, Graves Creek, Brigge Creek.

Chromite occurs as grains in "black sand" in noteworthy amounts in present beach and back beach deposits in several localities of the southern Oregon coastal area extending from Coos Bay south. The best known present beach deposits are at Bandon, Cape Blanco, and Ophir Beach. Extensive back beach lenses are known in the area north of Bandon extending from Whiskey Run north to South Slough. An important back beach deposit near the town of Denmark has been explored, and other lenses farther south are known.

Other localities from which chromite has been reported in the beach sands are: Clatsop County at Astoria, Carnahan (Sunset Beach), Clatsop Beach, Ft. Stevens, Gearhart Beach, Hammond, Seaside, and Warrenton; Coos County at Bullards and Marshfield; Curry County at Chetco, Gold Beach, Port Orford, Cuneffs Beach, and Mouth of Pistol River.

Sands containing chromite, but of much more restricted extent than marine sands, occur in present and ancient stream beds in many localities throughout the State. Some of these are as follows: Baker County - near Winterville placers of upper Burnt River, Bonanza District, Sumpter, Durkee; Clatsop County - Elk Creek; Coos County - S. Fork Coquille River; Curry County - Sixes River, 3/4 mile above Dry Creek; Douglas County - Glendale, Starvout; Grant County - Vincent Creek, Big Creek; Jackson County - Birdseye Cr., Watkins; Josephine County - Josephine Cr., Sucker Creek, Wolf Creek, Coyote Creek, Sutter Creek, Waldo; Linn County - Foster; Polk County - Falls City; Umatilla County - Weston; Union County - near La Grande; Wasco County - Hood River beach at entrance to Columbia; Wheeler - Antone.

Probably the marine sands contain the only "black sand" deposits which would be commercial for chromite production, since such projects would need to be operated on a relatively large scale which would require a large proven reserve. In addition to chromite, the sands contain gold, the platinum group, magnetite, ilmenite, garnet, and sometimes zircon and monazite - all heavy minerals - so that there is always the problem present of making the separation of a satisfactory grade of chromite concentrate. Sampling by the State Department of Geology and Mineral Industries, in cooperation with the U. S. Geological Survey, of back beach sands from areas about 8 miles north of Bandon indicates that these contain over 7 percent chromic oxide (Cr_2O_3) and that several hundred thousand tons are present. Considerable research work has been done at Oregon State College and by private laboratories on the most practical methods of concentrating the chromite, and probable feasible methods have been worked out. The preferred methods or method remain to be demonstrated in a commercial plant.

MARKET:

Government prices and specifications now determine the market for chromite. Buying by private companies would be subject to government control.

The government buying agency, Metals Reserve Company (Release of Dec.19,1941) will buy chromite classified as follows:

	High Grade	"Low Grade A"	"Low Grade B"
Chrome (Cr_2O_3) - Minimum	45.0%	40.0%	40.0%
Chrome (Cr) - Iron (Fe) Ratio - Minimum	2.5 to 1	2.0 to 1	No Minimum
Silica - Maximum	11.0%	13.0%	No Maximum
Phosphorus - Maximum	0.20%	0.50%	No Maximum
Sulphur - Maximum	0.50%	1.00%	No Maximum

The base price for "High Grade" is $40.50; for "Low Grade A", $28.00; and for "Low Grade B", $24.00; each per long dry ton (2240 pounds) delivered at Government stockpile designated by Buyer. An increase of 90 cents per ton per unit of Cr_2O_3 (a unit is 1 percent) will be allowed on each percent increase over the minimum set for "High Grade" and "Low Grade A". In addition, an allowance of $1.50 per ton is made for each tenth increase in chromium-iron ratio over the minimum in these two classes of ore. In "Low Grade B" an increase of 60 cents per ton per unit of Cr_2O_3 is allowed over the minimum established.

For "High Grade" and "Low Grade A" no ore should be in excess of 12 inches in size, and not more than 25 percent of contained fines shall pass a 20-mesh screen. Size specifications are waived for "Low Grade B".

Car lots will be purchased and paid for at stockpile after sampling and analysis. Under present specification contracts must be signed which require that a minimum of 1,000 tons be delivered. Further information may be obtained by writing the Metals Reserve Company, Washington, D. C.

BUYERS OF CHROMITE:

Under conditions existing in February, 1942, private buyers of ore are out of the market. There are, however, companies which would be in the market for properties, provided some evidence is present that a property for sale contains ore in sufficient quantity to warrant expenditure for exploration and production. Most of the larger mining companies in the State would investigate such deposits.

REFERENCES:

Chromite Deposits in Oregon; J.E. Allen: Bull. No. 9, State Dept. of Geology and Mineral Industries, 1938

U.S.G.S. Bull. 285-C; Contributions to Economic Geology, 1905

U.S.G.S. Bull. 922-D; Chromite Deposits of Grant County, Oregon, 1940, T.P.Thayer

U.S.G.S. Bull. 922-P; Chromite Deposits in the Sourdough Area, Curry County and The Briggs Creek Area Josephine County, Oregon, 1940

Ore.-Bin Vol. 4 No. 1, January 1942

MANGANESE

The principal source of supply of manganese comes from manganese minerals such as pyrolusite, psilomelane, wad, manganite, and rhodochrosite. When these minerals occur in commercial concentrations, they constitute manganese ore. The principal use of manganese ore is in the steel making process, and the customary way of utilizing manganese in this process is in the form of a ferro alloy, mostly, as ferro manganese containing about 80 percent manganese. Spiegeleisen, which contains about 20 percent manganese, is used chiefly for the Bessemer process, while ferro manganese finds its chief use in making open-hearth steel, which accounts for most of the steel produced. In addition to its use in the steel-making process, manganese is required as an alloying element to produce special manganese steels characterized by toughness.

Nearly all domestic manganese deposits are relatively low grade and in normal times over 90 percent of our ferro grade manganese is imported. Since imports have been greatly curtailed because of the war, much research has been, and is being done on methods of utilizing domestic sources of manganese ore. The U. S. Bureau of Mines, as well as private agencies, has done a large amount of work on beneficiating low grade ores to make a metallurgical grade product.

Black Manganese Ores

Because of lack of space and since from a commercial standpoint it is not important to distinguish the various black manganese ores, they will be described together. Psilomelane, pyrolusite, and manganite are usually intergrown and have many similarities. Commercially, pyrolusite is the most important. They are all oxides of manganese and black in color. Pyrolusite has a hardness of 1-2 and readily soils the fingers, while for psilomelane H-5-6. Pyrolusite is amorphous (non-crystalline), psilomelane though crystalline usually appears amorphous, while manganite often shows small orthorhombic crystals or fibrous to columnar masses. Wad (Bog Manganese) consists of manganese oxide and water and contains various impurities. For all of them the specific gravity is usually above 4.

TESTS:

All of them are soluble in HCl with the evolution of chlorine gas on heating. Sodium carbonate beads containing a little of the powdered minerals become opaque bluish green before the blowpipe.

DISTINGUISHING FEATURES:

The dark brown to black streaks, the color, and the tests given above make the minerals readily identifiable. There is usually enough pyrolusite present so that the specimens will soil the fingers.

OCCURRENCE:

All three of these minerals are secondary in origin, although manganite has been found occasionally as a vein deposit. As secondary minerals they are usually found derived from pre-existing sedimentary and igneous rocks, from which the manganese is leached. In Oregon, manganese, especially in the form of psilomelane, has been found in cherty strata near the coast, as pyrolusite in slates in irregular lens-shaped deposits, and in large rounded concretionary masses that have weathered out of the original host rocks.

LOCALITIES:

In 1940 this country received most of its ore from the following sources, in order of importance: U.S.S.R., Gold Coast, India, with appreciable amounts from S. Africa, Brazil, Cuba, and the Phillipines. Most of the domestic production comes from Tennessee, Arkansas, Montana and Georgia.

Oregon has had very little production of manganese but the McAdams property on the Coos-Curry line has recently shipped two carloads. Several of the deposits produced a small amount of ore during World War I. Following is a list of some of the properties in the State containing manganese: Curry County--Black Bear prospect (Chetco area), Copper Canyon (Agness), Clapshaw (Sixes River area), Crystal Creek, Iron Hill, Lloyd, Signal Butte, Hardenbrook, Lawrence, Colegrove, Long Ridge, and McAdams. Coos County-- Iron Mt. Baker County--Pleasant Valley station, Sheep Mt. (7 miles west of Durkee). Lane County-- Blue River district, Cinderella mine, Great Northern, Tate. Harney County-- Kusisto (North of Burns). Jackson County--Buzzard Mine area, Lake Creek dist, near Central Point, Vestal, Grand Cove, Homestake, Nichols, Star F., Newstrom, Tyrell, Goon Cr., Bush, Fox, Peters, Bailey, Headwaters of Butte Cr. Josephine County--Cave Creek (Waldo Dist.), Ow Yuen, Eden, McAllister-Campbell, Bulton, Elkhorn Creek; Grant County-- Mack's claim.

Rhodochrosite

Rhodochrosite is a carbonate of manganese ($MnCO_3$) when pure, but usually some of the manganese is replaced by some other element such as iron. The mineral occasionally occurs in rhombohedral crystals, which look like cubes that have been pushed at one corner and often slightly twisted. Coarse grained material shows perfect cleavage parallel to the faces of a rhombohedron, giving a cracked effect in three directions. The color is usually pink, but occasionally brown. H.-4, G.-3½.

TESTS:

In hot hydrochloric acid rhodochrosite gives the typical carbonate reaction of effervescence (bubbling due to loss of carbon dioxide). Like the other manganese minerals described, a little powder placed in a sodium carbonate bead yields an opaque bluish green bead. The bead is made by picking up sodium carbonate in the loop of a heated platinum wire.

DISTINGUISHING FEATURES:

The characteristic pink color and good cleavage makes one suspect the mineral. Its effervescence in acid and superior cleavage distinguishes it from rhodonite, the silicate, which is also harder than rhodochrosite. (H.-6). Calcite is lighter (G.-2.7) and effervesces readily in cold acid. The test for manganese clinches the identification.

OCCURRENCE:

Rhodochrosite is usually found in veins, often acting as a gangue for other minerals such as zinc and silver ores. It is frequently associated with the other manganese minerals mentioned earlier.

LOCALITIES:

Rhodochrosite is mined at Butte, Montana where, in the present emergency, it forms a most important source of manganese. In Oregon, rhodochrosite has been reported from several localities, but fairly large amounts are known at only one locality. The reported occurrences are: Baker County--Sheep Mt., Josephine County-- Waldo District on Davis claims in sec. 3, T. 41 S., R. 5W., west of Whiskey Creek, 7 miles from passable road; also at Ow Yuen Mine just south of Caves Highway 14.4 miles from Caves Junction.

MARKET:

Manganese ore is bought on a long ton basis (2240 pounds). Published market quotations may be in cents per unit (a unit is 1 percent) in which case to get the per ton value, it is necessary to multiply the price per unit by the percent of manganese.

Manganese carbonate ores are acceptable under Government specifications only if calcined.

Manganese concentrates must be nodulized or sintered to be acceptable.

High-grade ores run 48 percent manganese or better. Published market quotations have recently ranged up to 80 cents per unit for ores containing 51 percent manganese. Such quotations are nominal and actual prices to be paid would be subject to negotiation and would depend on various conditions, such as quantity of ore available and impurities present, besides percentage of manganese. Ores containing as low as 35 percent manganese may be marketable, but the price paid for such ores would be correspondingly low. Some manganese ores may be concentrated and it is interesting to note that results of testing work on a manganese ore by the U. S. Bureau of Mines show that this ore containing 18 percent manganese could be treated to obtain a concentrate containing 52 percent manganese with a 70 percent recovery.

The steel companies are the big consumers of manganese, but it should be realized that under present conditions Government buying dominates the market. The Metals Reserve Company (December 19, 1941) has issued a schedule of prices and specifications for three grades of ore as follows, showing maximum and minimum allowable percentages:

		High Grade	Low Grade "A"	Low Grade "B"
Manganese	(Min)	48.0	44.0	40.0
Alumina	(Max)	6.0	10.0	No Max
Iron	(Max)	7.0	10.0	No Max
Phosphorus	(Max)	0.18	0.30	0.50
Silica	(Max)	10.0	15.0	No Max
Zinc	(Max)	1.0	1.0	1.0

The base price for "High Grade" is $36.00 per long dry ton with increase of 75 cents per ton for each unit (1 percent) in excess of 48 percent.

For "Low Grade A" the base price is $28.60 per long dry ton plus an increase of 65 cents per ton for each unit in excess of 44 percent.

For "Low Grade B" the base price is $22.00 per long dry ton plus an increase of 55 cents per ton for each unit in excess of 40 percent.

Ore should contain no pieces in excess of 12 inches in size and should contain not more than 25 percent of fines which will pass a 20-mesh screen.

Payment will be made after weighing and analysis at government stockpile. Railroad freight prepaid by seller will be refunded by buyer.

Details as to contracts may be obtained from Metals Reserve Company, Washington, D. C.

REFERENCES:

Development of Low Grade Manganese Ores of Cuba: F. S. Norcross, Jr.; Mining Technology, May, 1940

Bureau of Mines Pilot Plant, Mining and Metallurgy, p. 547, Nov. 1941

Domestic Manganese Sources During an Emergency: K.A. Kobe; Mining World, September, 1941.

Manganese in Oregon, Bulletin No.17, State Department of Geology & Mineral Industries. (1942)

NICKEL

The principal ore minerals of nickel are nickeliferrous pyrrhotite, pentlandite, and garnierite. The metal finds its chief use as an alloy for making steel with superior toughness and strength. It also is used in monel metal, a corrosion-resistant nickel-copper alloy, and stainless steel. Its properties make it a valuable metal at all times, but of increasing value in times of war. In the United States we produce only about ½ of 1% of our needs and the situation would be very serious if Canada did not produce 85 percent of the world's nickel. Except for the fact that there is a shortage of nickel for all Allied needs, the close bond between Canada and the United States gives us little more concern over our dependence for nickel on an outside nation, than if our production was as great as Canada's. Domestic production is less than 500 tons of nickel a year, all of it as a by-product from nickel scrap and the electrolytic refining of copper. The price for electrolytic nickel has been stationary at 35¢ per/lb.

The increased demands on Canada by Great Britain and the United States resulted in expansion of operations by International Nickel, but there is still an unsatisfied demand for the metal. Ore reserves are large, but plant facilities are inadequate.

In the United States, nickel is known in a low grade copper deposit in Nevada, and in Colorado in connection with nickel-cobalt mineralization. Deposits of garnierite occur in Oregon.

Garnierite

Garnierite is a hydrous nickel magnesium silicate. It is found as earthy masses, concretionary forms, or incrustations, with a color varying from a bright apple green to a pale green. H.-2-3. G.-2½.

TESTS:

Becomes magnetic when roasted. Powdered, placed in a glass tube closed at one end, and heated, it blackens and gives off water. A solution, made ammoniacal, turns red on addition of a saturated solution of dimethyglyoxine in alcohol.

DISTINGUISHING FEATURES:

The green color and earthy form are characteristic. Some copper minerals faintly resemble it but they can be distinguished by testing for copper.

OCCURRENCE:

Garnierite is a secondary mineral, representing an end phase in the leaching of small amounts of nickel from ultra-basic rocks, such as peridotites and pyroxenites (or serpentine derived from them), and redeposition as the silicate. The form of the nickel in the original rocks is not known but it may be either as sulfide or silicate. In the case of the deposit at Riddle the original peridotite contains 0.1 percent of NiO, while the olivine grains have 0.26 percent of NiO, so it seems likely that the olivine broke down depositing garnierite and silica. The blanket of ore is 60 to 70 feet thick.

LOCALITIES:

Garnierite occurs in commercial quantites in New Caledonia, and at this place it has made the second most important nickel deposit in the world. In 1940 the New Caledonia ores averaged 3.8 percent nickel. In Oregon, the deposit at Riddle, Douglas County, is similar to the one in New Caledonia, but the size has not been definitely determined. The mineral in this deposit is a hydrated silicate of nickel and magnesium which has been called garnierite, genthite, nickel-rich deweylite, or nickel-rich gymnite. Until more detailed work has been done on this group of minerals, the mineral at Nickel Mountain can be considered a variety of garnierite. According to a U.S.G.S. news release (1940), Nickel Mountain at Riddle contains an estimated reserve of 6 million tons of 1 - 2 percent nickel, possibly 250,000 tons of 2-3 percent nickel with 80,000 tons proved. Earlier work by Kay and the Oregon Nickel Mines Co. showed ore from 5-8 percent nickel. In Josephine County a similar deposit occurs in Sections 25, 36, T. 39 S., R. 9 W., on the south side of Woodcock Creek.

MARKET:

It has been estimated (Finch) that in order to stimulate domestic production in the United States the price of nickel would have to be up near $3.00 a pound. This estimate is rather high and it seems likely that ore could be mined at Riddle at a much lower price. It will be noted that the ore does not compare unfavorably with the New Caledonia ore, where smelting to a nickel matte with limestone and gypsum has been profitable for a long time. If the Riddle deposit can be worked successfully, other similar deposits in the State might also prove profitable, and the search for more properties would receive a new impetus.

It is interesting to note that the New Caledonia ores which formerly went mainly to France (as matte) have been contracted for by International Nickel, since France fell into the hands of Germany. This agreement helped to spur the New Caledonian industry to new efforts, with a return to production of a furnace that has been shut down. The war activity in the Pacific has undoubtedly affected the New Caledonian production, and deliveries may be completely stopped. This will not seriously effect the nickel situation, since the nickel production of New Caledonia was less than 10 percent of that from Canada. A drastic increase in the price of nickel is unlikely.

REFERENCES:

Nickel Deposits of Nickel Mt. Oregon; U.S.G.S. Bull. 315, PP. 120-127, 1906.

Geology of the Nickel Silicate Deposit near Riddle, Oregon; S. Hobbs & W. Pecora: Economic Geology, Vol. 36, No.8, P. 841. Dec., 1941. (Abstract)

QUICKSILVER (MERCURY)

Mercury is derived chiefly from cinnabar but a small part of the production is due to the native metal and some oxychlorides. When the principal world sources, Spain and Italy, were cut off from the United States there was some question as to whether local producers could meet the increased demands, since domestic production had only supplied about 40 percent of the domestic requirements. Under the stimulus of rapidly rising prices, exemption from excess profit taxes (now repealed), and a very active market, the industry rallied and has been able to keep the metal off priority lists. Mercury is extremely important in time of war as a source of fulminate for munitions, as an anti-fouling paint for ship bottoms, and in the chemical and drug fields. In spite of greatly increased production, producers are having difficulty keeping up with demands and at this writing there is no quantity of spot mercury obtainable.

Cinnabar

Cinnabar, the sulfide of mercury, usually occurs as veins through the host rock, disseminated in fine grains, as coatings of brecciated fragments, dispersed through opalite masses, or rarely as distinct hexagonal crystals in cavities. In the last case it may have beads of mercury with it. Some few deposits have associates of yellow or orange masses representing the oxychlorides eglestonite, and terlinguaite, small colorless crystals of calomel or black grains of metacinnabar. Cinnabar is scarlet red when fresh and pure, but many varieties turn dark gray to black on exposure to sunlight. The reason for this change has never been satisfactorily explained. The blackening forms a very thin crust and on breaking the specimen the true color may be seen, so in prospecting it is well to constantly break chips off outcrops. The opalite variety darkens very quickly as a rule. For cinnabar, H-2½, G.-8. The luster is adamantine except in blackened specimens which become dull. It has very perfect cleavage in three directions, but this does not show well in the dense massive varieties.

TESTS:

If cinnabar is finely powdered, mixed with twice its volume of sodium carbonate, placed in a piece of glass tubing sealed at one end, and heated, small globules of mercury will condense on the walls of the tube near the open end. Rubbed on a penny with a little dilute hydrochloric acid a silvery coating will be produced.

DISTINGUISHING FEATURES:

The color, high specific gravity, luster, and good cleavage of cinnabar generally distinguish it from cuprite, hematite, and ruby silver, which somewhat resemble it. In case of doubt one of the tests above will serve to identify it. Because of high specific gravity it pans very well and can be seen as a good tail. Garnets and rubies in the tail do not hang back like cinnabar.

OCCURRENCE:

Cinnabar is found in all types of rocks. It is characteristic of shallow low temperature conditions (epithermal), and cannot be expected to improve with great depth. The best deposits are found in places where the formations make local traps, concentrating the cinnabar beneath impervious clays. Regions in which hot springs fumeroles, or other evidence of fairly recent vulcanism are prevalent, are likely to contain mercury deposits. Silicification very frequently accompanies the deposition of cinnabar, and areas of opalite are always of interest as likely mineralized places. Cinnabar is frequently closely associated with near-surface basic intrusives, dikes and sills, especially basaltic or andesitic masses.

LOCALITIES:

Since Spanish and Italian production has been cut off, the domestic supply is being produced chiefly by California and Oregon, with smaller amounts of mercury coming from Nevada, Idaho, Texas, and Arkansas. In Oregon the principal producing areas are in the southwest (Jackson and Douglas Counties), in the Ochoco region, and in the southeast corner (Harney and Malheur). A partial list of the mines and prospects in the State is as follows: Baker County--at Sumpter; Clackamas County--below Oak Grove reservoir; Coos County--14 miles from Powers; Crook County--Mother Lode Mine, Independent Quicksilver mine, Johnson Creek mine, Westerling Prospect, Blue Ridge mine, Round Mountain, Quicksilver Consolidated, Champion mine, Gold hill, Staley and Barney mine, Byrom-Oscar mine, Maury Mountain, Ophir-Mayflower mine, Platner mine, Dunham Prospect, Red Bird hill: Douglas County--Nonpareil mine, Bonanza mine (largest producer in U.S.), Vicinity of Drew, Elkhead mine, Buena Vista, Maud S., James R. or Pollanz; Grant County--Reported at Susanville and Granite; Harney County-- Doan Prospect, new prospect 3 miles W. of Fields; Jackson County-- Bonita mine, the Birdseye Creek mine, Mountain King mine, Sams Valley, Cinnabar Mountain, Sugar and Hull, Steamboat mountain, War Eagle mine, Roxana group, Dave Force mine, Chisholm claims, Palmer Creek, Seventy three, Meridian, Brickpile, Ruby Mines (Red Feather); Jefferson County-- Horse Heaven Mine, Axe-handle mine; Josephine County-- Empire Mine, Pickett Creek; Lake County-- Red Hawk; Lane County-- Black Butte mine, Shoestring creek, near Disston; Malheur County-- Opalite mine, Bretz Mine; Wheeler County-- Bear mine.

MARKET:

Mercury is easily obtained from cinnabar by retorting or furnacing (although complete recovery usually provides plenty of problems) and consequently only mercury is sold, rather than the ore. The standard unit of sale is the flask which contains 76 lbs. (and 1 oz.). A ceiling on the price of mercury has now (February, 1942) been set at $191.00 per flask. At this price, under the most ideal conditions of mining and furnacing, ore running only 3 lbs. of mercury to the ton may be commercial, but nobody has any right to attempt operations on such a deposit if he is not in a position to sustain a loss. Deposits averaging above 7 lbs. are now worthy of consideration, and their value will depend on location, mining costs and quantity of ore.

Prospectors finding likely looking deposits of cinnabar may submit them to any of several large producers, who have field staffs for examining prospects. The following are recommended as dependable:

Horse Heaven Mines Inc., S. H. Williston, Vice Pres., 909 Studio Bldg., Portland
Bonanza Mining Co., H. C. Wilmot, Mgr., Sutherlin, Oregon
Idaho Almaden Quicksilver Co., L. K. Requa, Pres., Weiser, Idaho

For the sale of quicksilver the following brokers are recommended:

Merchants Chemical Company,	60 East 42nd Street, New York
George Uhe Company	75 Eighth Avenue, New York
Coast Chemical Company	55 New Montgomery St., San Francisco, Cal.
Wood Ridge Division of F. W. Berk & Co.	Wood Ridge, N. J.

The Quicksilver Producers Association, 407 Sansome St., San Francisco, also buys quicksilver, but in spite of its name most of the major producers of quicksilver do not belong to it or sell through it. It is well to shop around among quicksilver brokers to determine the current market demand before making a sale.

Metacinnabar

Because uncommon substances always bother prospectors, it seems worthwhile to mention metacinnabar briefly. This mineral, with the same composition as cinnabar, occurs as brittle black isometric crystals, also massive; H-3, G.-7.8. The mineral gives a black streak, is metallic and opaque. Numerous prospectors have claimed they had mercury deposits "with only metacinnabar in the pan, no red sulfide." In all of these cases examined by the author to date, the black mineral has turned out to be something other than metacinnabar. It is unlikely that pannings from any sizeable mercury deposit will yield a larger proportion of metacinnabar than cinnabar. The former mineral can be quickly checked by its hardness, the fact that it gives the same tests as cinnabar, and naturally does not become magnetic on heating as do most of the black sand minerals with which it is commonly confused.

MERCURY REFERENCES:

Quicksilver Prospecting; L. W. Staples: The Mineralogist, Feb. 1940.
The Horse Heaven Mercury Mine; L. W. Staples: Mining Congress Journal, June, 1941.
Quicksilver in Oregon; C. N. Schuette: Bulletin No.4, Ore. S.D.G.M.I., 1938
U.S.G.S.Bull. 850; Quicksilver Deposits of Southwestern Oregon: Wells and Waters, 1934

TIN

The only important sources of tin are the two minerals, cassiterite and stannite. Tin, as a native metal is a mineralogical curiosity, the only occurrence that has fair substantiation is from Oban, New South Wales, where it was obtained from washings in the Clarence River. Tin is used today for tin plate, terne plate, and alloys such as phosphor bronze, babbitt metal and in bronze. The designs of the Japanese on the Malay States is an indication of the importance of tin in our civilization. Our domestic supply is less than 1 percent of our needs and government stockpiles are reported to have less than two years supply.

Cassiterite

Cassiterite, tin dioxide, is found as tetragonal crystals in veins or in rounded masses as placer or stream tin. It occurs in a variety of colors, but brown and black predominate. It has an adamantine luster, H.-$6\frac{1}{2}$, G.-7., and a poor cleavage.

TESTS:

A good test for cassiterite (not for any other tin ores) is to wrap a grain in metallic zinc and drop into a test tube with hydrochloric acid. After the zinc has been dissolved the grain should be rubbed and it will have a bright coat of metallic tin, produced by reduction of the oxide.

DISTINGUISHING FEATURES:

The high specific gravity is its most noticeable property. The test given above, together with negative tests for other substances because of its refractory nature, helps confirm cassiterite. It gives practically no streak (quite hard) and has a brilliant luster.

OCCURRENCE:

In veins it is usually found associated with quartz and closely related to granite or intruded by pegmatites. It is also associated with tourmaline, wolframite, topaz, or greisen (muscovite and quartz). Stream tin is derived from the weathering and erosion of these rocks, and the major part of the world's tin comes from such deposits.

LOCALITIES:

The principal producers of tin in the world are Malaya, Netherland East Indies, Bolivia, Congo, and Siam. There is no production in the United States, although Alaska has produced a small amount. In Oregon there is only one confirmed discovery of cassiterite, and this is from Pine Creek, east of Baker, where stream tin has been found in sluice boxes.

MARKET:

Should any tin be discovered in the State there would naturally be no difficulty in disposing of it. Any questionable minerals may be sent to the State Assay Laboratories for identification. Spectrographic analysis may be made at the State Department of Geology and Mineral Industries. These tests will show the presence of elements even if the ore is so low grade that no positive evidence of the presence of an element can be obtained by ordinary methods.

The U. S. Government has undertaken the construction of the first tin smelter in the United States at Texas City, Texas, this site having been chosen because of supplies of natural gas, and convenient location. This smelter will be in operation in 1942 and will have a capacity of 20,000 tons a year, which is less than a third of our domestic needs. The smelter will use Bolivian tin concentrates.

Stannite

This mineral, tin-copper-iron sulphide, is a relatively unimportant ore of tin, except in Bolivia. It is steel gray to black in color, H.-4, G.-4½, has metallic luster, and fuses at a low heat to a globule which becomes magnetic. It also gives tests for copper. It is associated with cassiterite, which would help to indicate its presence. There are no known occurrences in Oregon.

TUNGSTEN

The important tungsten minerals are scheelite and the wolframite group. The most important use of tungsten is as a constituent of tool steels which hold their temper at high speeds. Its high fusing point permits its use in filaments for electric lights. It is now possible to substitute molybdenum for tungsten in some alloys, which may help to reduce the demand for tungsten. At present the supply does not seem great enough to meet our needs, but new production from the Pine Creek, California, property and the Yellow Pine district of Idaho, may fill a large part of our requirements.

Scheelite

Scheelite, calcium tungstate, is usually found in irregular grains disseminated throughout the host rock, or as subhedral crystal masses with sharp boundaries. Occasionally distinct tetragonal crystals may be found. The mineral is white, gray or sometimes pale yellow. H.-5, G.-6. The luster is sub-adamantine, so that it is more brilliant than quartz.

TESTS:

A bead of sodium phosphate containing some of the powder, held in a platinum loop wire before the blowpipe, will turn blue. Scheelite is decomposed by hydrochloric acid when powdered and put in a test tube, and it leaves a yellow residue which is soluble in ammonia.

One of the best tests and a standard method for prospecting is to place the mineral before the rays of an ultra-violet light. Night prospecting is now the established practice among scheelite prospectors. It should be noted that scheelite only fluoresces with radiations shorter than 2900 A.U., so only cold quartz tubes can be used for prospecting. Argon bulbs and black bulbs give radiations with wave lengths which are too long. Scheelite fluoresces a strong blue color, and unlike many minerals, this color is fairly characteristic. The results are much more satisfactory if a filter (such as Corning No.986) is used with the lamp to cut out some of the visible light. Care should be exercised not to confuse the fluorescence of calcite or powellite (calcium molybdate) with scheelite, and lamp work should always be followed up with assays. Care should also be taken to use the lamp on fresh fractures since weathered faces of rock often give poor results.

DISTINGUISHING FEATURES:

Scheelite resembles quartz but is distinguished from it by its more brilliant luster and noticeably high specific gravity. It will pan out as a pale powder tail in the gold pan. Fluorescence aids in its detection.

OCCURRENCE:

The association of scheelite with garnet and epidote, especially along contacts of igneous rock with limestone, is so characteristic in the West that such an association of minerals should always be checked for the presence of tungsten. The igneous rocks are usually of a granitic nature. Molybdenum, in the form of molybdenite and powellite, is often an associate, and at Yellow Pine, Idaho, gold and stibnite are found with the scheelite.

LOCALITIES:

The chief producers of shceelite in the United States are the Nevada-Massachusetts Co. of Mill City, Nevada, and the U. S. Vanadium Corp.'s property at Pine Creek near Bishop, California, where a 1300-ton mill has been installed. In Oregon scheelite has been reported from the following counties:

Baker: Flagstaff mine, Cliff mine, Bengal & Provider, Bonnie, Little Hill mine.

Wallowa: Frazier mine.

Jackson: Steamboat (Mocks Gulch Claims), upper workings of Sylvanite mine.

MARKET:

Scheelite is sold by the ton and on a unit basis, one unit being 1 percent of tungstic oxide (WO_3). The price is now about \$26-\$27 per unit, of 65 percent WO_3. Nevada-Massachusetts Co., and U. S. Vanadium are always interested in acquiring new properties that have merit. Fairly low cost concentrating mills can be constructed by small companies and, under the proper conditions, tungsten production, like the mercury production may be handled by small groups.

Wolframite Group

Included in the wolframite group are the minerals wolframite, ferberite, and hubnerite. They are the chief source of tungsten throughout the world, and although they are not reported from any Oregon localities, a brief description of them might be in order since it is quite possible that in the future they will be encountered somewhere in the State. These minerals are tungstates of iron and manganese, ferberite being the iron end of the series and hubnerite the manganese end with wolframite being an intermediate and isomorphous mixture of the two. In color they range from black to reddish brown with a metallic to metallic-adamantine luster. H.-5, G.-7-7½. They have one direction of perfect cleavage.

TESTS:

The iron bearing members are fusible before the blowpipe to a magnetic globule. They give bead tests for tungsten, manganese and iron (which see under those headings). They are insoluble in common acids.

DISTINGUISHING FEATURES:

These minerals somewhat resemble ilmenite, chromite, and columbite, but they can be distinguished by their superior cleavage and higher specific gravity.

OCCURRENCE:

These minerals are found in pegmatite dikes associated with granite or in high temperature quartz veins, along with tin, manganese, and other tungsten minerals.

LOCALITIES:

The world's major supply of tungsten is found in China in the form of wolframite. Ferberite is the principal ore in the Boulder Co., Colorado deposit. Wolframite is found in the pegmatites of the Black Hills, South Dakota. Hubnerite is the chief ore of the Idaho's largest producer in Lemhi County (Ima Mine). It is not impossible that some of these minerals will be found in northeastern Oregon.

MARKET:

This is discussed under scheelite.

REFERENCES:

Milling Tungsten Ores at Pine Creek; Blair Burwell: Mining Cong. Journal, Oct., 1941.
The Yellow Pine Mine; John D. Bradley: Mining Congress Journal, September, 1941.
America's Largest Tungsten Mine; Mining World, October, 1939.
Fluorescent Light and Its Application; Dake & DeMent: Chemical Publishing Co., 1941.

MICA

Mica has entered the list of strategic minerals because of its importance as a dielectric or insulating medium in electrical apparatus. This is especially important from the standpoint of communications. In normal times the United States produces about a quarter of its needs, but this does not give the whole picture since there are some essential varieties which must be imported in their entirety. The two types of mica most in demand are muscovite, the white potash mica, and phlogopite, a pale brown mica. Phlogopite is supplied by Candadian mines and an important use is in airplane spark plugs. The mica on the strategic list is the so-called sheet and splittings types. The three main sources for these have been India, Madagascar, and Canada, with South America becoming of increasing importance.

An idea of the prices on sheet mica can be gained from the following: 2 x 2 inches 30-60¢, 3 x 3 inches $1.25-1.50, 4 x 6 inches $2.75-3.50 and 8 x 10 inches $8.25-8.75, all sold by the lb. Prices on fines (200 mesh to 20 mesh) vary from about $14 to $80 per ton, but specifications have to be obtained for individual products. At present there is no serious shortage of mica, and because of the rarity of deposits in the State, Oregon will not be an important producer. Deposits have been reported (unconfirmed) from Douglas County (N. Umpqua River) and northern Jackson County.

QUARTZ CRYSTAL

The highest grade of rock crystal is used for piezo-electrical purposes. For such uses the quartz must be entirely free from flaws, such as cracks, inclusions, twinning, and phantom growths. The color is not so important because colored crystals can be used, but the colorless ones are preferred. Brazil has been the only source of piezo-electrical quartz. The importance of this type of quartz is evident when one realizes that plates of it are used in radio and telephone work for frequency control and quartz plate resonators are essential for oceanic cables for dividing frequencies. Most of these plates are about 1 inch square and 1/10th of an inch thick. An average price of $2.00 per lb. has been paid for imported quartz crystals, but in a few cases prices as high as $18.00 per lb. have been paid for exceptional material. Less perfect material is supplied for fused quartz purposes, and doemstic sources, especially California and Arkansas are able to supplement the imports.

Good quartz crystal is rare in Oregon, but clear crystals up to 3 inches in length have been found in the Wallowas. Smaller crystals are found in geodes and "thunder eggs" in Jefferson and adjoining counties, and northern Jackson County. Commercial sale of these is not practical at present.

REFERENCE:

Precious and Semiprecious Stone, Their industrial Uses, Particularly in Relation to National Defense, S. H. Ball: Mining and Met., June 1941.

CRITICAL MINERALS & METALS

These will be described in less detail because, for the most part, they are of less interest in Oregon, and because limited space makes it impossible to discuss them fully. The materials on the critical list vary considerably from time to time, and with the United States at war, most of the metals, not already discussed, as well as numerous non-metals, could safely be included as critical.

Some liberty has been taken with the list usually given for the critical minerals in order to include a few which are of special interest to Oregon prospectors.

Asbestos

There are many uses for asbestos, but those that have placed it on the critical list are its use in brake-linings and clutch facings. The very high grade material for these purposes must be imported. Our domestic production of all types of asbestos is less than 8 percent of our needs, and most of this is of short fiber type. There are two varieties of commercial asbestos; chrysotile, the more important, and amphibole asbestos. Most chrysotile comes from Canada and amphibole from Union of South Africa.

Asbestos occurs in Oregon but up to the present time there has been very little either in the way of development of such occurrences or of production. Both chrysotile and amphibole varieties are known. Small amounts are reported from the following: Baker County--Pine creek, Lewis camp, Burnt River district, Buttercup mine, Upper Burnt River; Clackamas County-- Clackamas River; Curry County--Near Gold Beach (?), amphibole variety on Diamond Creek; Douglas County--Cow Creek, Canyonville, Perdue, Starvout; Grant County--North of Mt. Vernon; Jackson County--Pleasant Creek, Rasberry Creek, tributary of Evans Creek, Upper Graves Creek, Upper Applegate River, Buncom, Liberty Asbestos Mine (iron free-tremolite amphibole asbestos in sec. 7, T. 34 S., R 2 W); 8 mi. E. of Copper on Upper Applegate, sec. 32, T. 33 S., R. 4 W. on Graves Creek; Josephine County--Brownston, 10 mi. W. of Kerby; Lake County--Lakeview; Lane County--Meadow; Wheeler County--Barite.

A recent report indicates that the Georgia-Carolina Mineral Co. of Franklin, North Carolina is testing asbestos from the Liberty asbestos property in Jackson County.

Cadmium

This metal will not be discussed here because its production in the United States is tied up almost entirely with the smelting of zinc. It has been reported in some of the zinc ores of the western Cascades.

Cryolite

This is briefly discussed under aluminum.

Fluorite

Very little of this has been reported in Oregon. See discussion under aluminum.

Graphite

Most of the supply of graphite has been imported from Ceylon and Madagascar. The reason that graphite is considered so important is that it is used to make crucibles for special castings and secondary zinc retorts. Stock piling of Madagascar graphite was attended with considerable difficulty and our supply is not very great. However it seems probable that domestic production, which is rapidly increasing (especially from Alabama), plus artificial graphite manufacture, will prevent any great shortage or large price increase.

In Oregon graphite has been reported from the following places: Jackson County--near Buncom, Upper Applegate district, near Coleman Creek, 4 miles S. of Medford (Sec. 18, T.38S. R. 1 W.); Josephine County--Mayflower and Golden Wedge Mines; Union County--Northwest Graphite Co. (unconfirmed)

Platinum

Although platinum was placed on the critical list, there has been no great fear of a shortage and the Government has not stockpiled it. Most of our supply comes from Canada, where it is obtained as a by-product of the nickel industry, so that a good supply is fairly well assured. In addition, dredging operations in Alaska are yielding a large amount (most of which has been going to England).

For 1940, Alaska produced 35,000 troy ounces, California produced 1400 ounces, and Oregon was third with 69 ounces. Quotations for 1941 have been steady at $34 to $36 per troy ounce; local producers have little reason to expect any great scarcity or price increase. With increase in nickel production, Canada's platinum production should also rise proportionally.

Platinum has been reported from many Oregon localities, but in few places has it been recovered commercially. Production is as a by-product from gold placer operations. Some of the more important localities are as follows:

Josephine County: Esterly and other placers in Illinois Valley on Althouse Creek.

Coos County: Eagle and Pioneer Mines, north of Bullards on Seven Devils Road in secs. 28 and 33, T. 27 S., R. 14 W. (Platinum and associated metals osmium and iridium,occur in the proportion of 5 to 10 percent of the gold content).

Fletcher Myers property in SW$\frac{1}{2}$ of sec. 16, T. 27 S., R. 14 W.
Geiger Creek Mines in SW$\frac{1}{4}$ of SE$\frac{1}{4}$ sec. 32, T. 26 S., R. 14 W.

Curry County: Red Flat Placers in secs. 15, 19, 30, T. 37 S., R. 3 W.
Cape Blanco beach placer, Corbin placer on left bank of Sixes River about 1 mile above mouth of Dry Creek.
Meeks Mine near Port Orford.

Grant County: Psyche mine in El Dorado district.
Kit Carson mine in sec. 17, T. 10 S., R. 35 E. in Greenhorn district (platinum occurs in lode deposit).

Platinum may be found associated with gold in some of the beaches of the southern Oregon coast. It is also found in some stream sands and has been reported from counties other than the above, as follows: Baker, Clatsop, Douglas, Jackson, Jefferson, Linn, Multnomah, Polk, Umatilla, Union, Wallowa, Wasco, Washington and Wheeler.

REFERENCES:

U.S.G.S. Circular No.8., Beach Placers of the Oregon Coast: by J. T. Pardee, 1934.
U.S.B.M. Tech. Paper 196, Notes on black sand deposits of southern Oregon and northern California: by R. R. Horner, 1928.

Titanium

Most titanium comes from the mineral ilmenite. Virginia, Arkansas and California supply considerable amounts but most of the ore has been imported from India.

Oregon has not produced ilmenite commercially. Whether or not a pure ilmenite fraction may be produced economically from coastal black sands has not been determined, but testing work is being done. The ilmenite would possibly be a by-product of the beneficiation of chromite sands.

Ilmenite (50-60 percent TiO_2) has been worth only about $20.00 per ton on the Atlantic Coast, but the price may rise.

Another source of titanium is the mineral rutile, which is the dioxide of titanium. In 1940 the United States made an all time record in the production of rutile, chiefly from Virginia and Arkansas where it is found in pegmatites (very coarse grained rocks). Imports from Brazil, Africa, and Australia have been small but important. Rutile is used for coating welding rods for use in electric welding, as well as a source of titanium. Titanium finds many uses, chief of which are smoke screens in warfare, mordants in dyeing, catalysts, coloring, and the oxide is used as a paint pigment. Oregon has no known commercial rutile deposits, but some is reported on Eagle Creek in the John Day region in Grant County, and in actinolite schist from the Middle Fork of Coquille River between Bridge and Remote in Coos County.

REFERENCES:

Day, D. T. & Richards, R. H., "Useful Minerals in the Black Sands of the Pacific Slope", U.S.G.S. Mineral Resources of the U. S. for 1905, pp. 1175-1228, 1906.

Vanadium

The principal supply of vanadium in the United States comes from Colorado, but more than half of our needs must be imported. Peru is the principal source.

Vanadinite has been reported in Baker County (Snow Creek Mine), but this report is unconfirmed.

Zirconium

Zircon, the silicate of zirconium and chief mineral of zirconium, has not been mined in Oregon. However, it is found in fairly large quantities in the black sand deposits of both the beach and stream types. The list of localities given for chromite sands is equally applicable for zircon.

The remarkable refractory properties of zirconium as well as its uses as an abrasive and alloy metal make it important.

Magnesium

Because magnesium is very important in war and further because large sources of supply as magnesite occurs in our northern and southern neighboring States, the metal is very interesting to Oregonians. The increasing use of magnesium (62 times our 1939 consumption) depends on two of its properties; its low specific gravity, and the rapidity with which it combines with oxygen so that it burns with a brilliant light and gives off intense heat. Because of these properties it is used in light weight metal construction (aircraft), and for flares, tracer bullets and incendiary bombs.

There has been a tremendous increase in the demand for magnesium metal during the past two years. The expansion in production has been spectacular but has lagged behind demand. At the end of the last decade, the Dow Chemical Company was sole producer of metallic magnesium, the production coming from electrolysis of brines from wells at Midland, Michigan. Output at Midland has been more than doubled in the past two years. In addition, the Dow Company has built a large plant at Freeport, Texas, of double the capacity of the present Midland plant and, using Government funds, a second plant which is double the capacity of the first plant has been constructed by this company. At the Texas plants magnesium is recovered from sea water. Capacity of the Midland and Freeport plants is about 63,000 tons of metal annually.

In 1941 the Permanente Corporation started production of magnesium metal at Permanente, California. Brucite (magnesium hydroxide) and magnesite, (magnesium carbonate) are the raw materials. The Hansgirg process of reduction, new to this country, is being used.

Basic Magnesium, Inc. will have three plants in Nevada and will treat magnesite by chlorination and electrolysis. Three other large plants, one in Texas, one in Louisiana, and one in Ohio, are either built or being built.

Total rated capacity of all these plants, either producing or under construction, is 400,000,000 pounds annually.

Research at Pullman, Washington, by the U. S. Bureau of Mines has indicated the feasibility of reduction of magnesia (calcined magnesite) to magnesium metal by an electrothermic process differing from the Hansgirg process in method of condensing the metal fume and in continuous operation, rather than in batches.

The large deposits of magnesite in Nevada and Washington are crystalline, while the many separate smaller deposits in California are of the so-called amorphous variety.

It may be noted that magnesite which has a market value of from $22 to $25 a ton as a refractory contains theoretically 576 pounds of magnesium to the ton. According to the present market price of metallic magnesium this would mean about $167 a ton for the magnesium content (in the form of the finished metal).

A large supply of magnesite occurs near Chewelah, Stevens County, Washington; California also has important deposits. Magnesite occurrences near Luning, Nevada are probably the largest in the country. In addition, it has been estimated that a deposit of brucite at this locality contains about 3,000,000 tons. Oregon has small amounts of magnesite reported from Baker, Curry, Grant, Jackson (not confirmed) and Lane Counties. As far as is known, none of these represent commercial deposits. Southwestern Oregon, especially Jackson, Josephine and Curry Counties seem to be most hopeful for prospecting. The limestones in these counties are not likely sources of magnesite because they are unusually low in magnesium content. Consequently the most favorable place to find magnesite is in the serpentines or peridotites which abound in the area. It should be remembered, however, that regardless of how successful the present projects may be in producing large quantities of magnesium, magnesite from small deposits will always have to be shipped to a large plant, and it is unlikely that many deposits will ever be able to stand high shipping costs.

Whether the industry will ever be forced, in the near future, to accept magnesium silicates as a source of supply is problematical. Under normal conditions a treatment process using magnesium silicates would probably be too costly.

BUYER: Northwest Magnesite Co., Chewelah, Washington.

REFERENCES:

Magnesium by Electrothermic Reduction; H. A. Doerner: Mining World, Nov. 1940.
Our Magnesium Resources; H. A. Franke: Mining Congress Journal, Aug. 1941.
Magnesium from the Sea, By S. D. Kirkpatrick: Magnesium from the Sea, Chem. and Met. Eng., Nov. 1941.

Copper, Lead, and Zinc

These metals were not listed by the Munitions Board as either strategic or critical. However, the huge demand for war supplies has made them critical and all possible sources of supply will be needed. Recently (January,1942) the Metals Reserve Company has announced that it will pay delivered prices of 17 cents a pound for copper; 9¼ cents for lead, and 11 cents for zinc. These prices would apply both to new production and to increase in production over that of 1941 except that previously arranged for under contract.

There is a possibility that an electrolytic zinc smelter will be built on the lower Columbia River in order to provide smelting facilities for zinc properties in the Northwest. The location would be especially favorable because of cheap electric power and water transportation. Should the smelter be built, there would be increased interest in prospecting for and developing zinc ores along the western slopes of the Cascades where Oregon's major deposits occur.

Beryllium

This metal is not included in the critical list but since the beryllium industry is still very young, war time uses are likely to increase its importance. Most of the supply is imported from Argentina and Brazil. It is not likely that there will be a scarcity, because there are fairly large reserves in Colorado, North Dakota, Massachusetts, and Maine. So far, domestic consumption of beryl, the only ore of beryllium, has not exceeded a few hundred tons annually. However, according to the U. S. Bureau of Mines Minerals Yearbook, imports for 1940 amounted to a record high of 805 tons.

Beryllium will be discussed here because of the great interest in it shown by local prospectors. This interest has undoubtedly been stimulated by two things. First, the uses of the metal in connection with its copper alloy indicate a bright future for the industry and a growing demand. The heat-treated alloy has the properties of great tensile strength and hardness. A second reason is that the ores of beryllium are easily confused with quartz, and naturally the prospector is always wondering if by chance he is overlooking something good. The minerals beryl and phenakite are the principal minerals of beryllium and they both may closely resemble quartz. In fact, the name "phenakite" is from a Greek word meaning "a deceiver", because the mineral was mistaken for quartz. The following observations are made to guide the prospector.

1. Phenakite is a very rare mineral, and has never been found in sufficient quantities to make a commercial beryllium deposit.
2. Beryl, when pure, contains only 14 percent beryllium oxide, so naturally could not compose deposits of higher grade than that.
3. The only deposits of beryl which have been commercial are those in which the beryl occurs in pegmatites. There is no use in spending time prospecting for beryl in areas that do not contain pegmatite dikes.
4. The price for beryl is low, only $30-$35 per ton at the quarry. Since hand-sorting is necessary and several tons of rock must always be broken to obtain a ton of beryl,

the only way in which beryl can be made to pay is when it is associated with other minerals that also can be sold. In pegmatites these may be feldspar and mica.

5. Chemical analyses of beryllium are difficult to make and inaccurate analyses have given false hope to many prospectors.

6. With the installation of two spectrographs in Portland and one in Seattle,* more conclusive and accurate reports should be available. When correctly operated these instruments are absolutely reliable.

CONCLUSIONS:

At present, due to the low price and ample supply of beryl, the search for it in Oregon is not likely to be as profitable as that for numerous other minerals.

REFERENCE:

Fundamentals in the Search for Beryllium; P. H. Brinton: Mining Congress Journal; May, 1941.

* Spectrographs for ore analyses are located in the following places:

1. State Department of Geology and Mineral Industries, 702 Woodlark Bldg, Portland, Ore.
2. Charlton Laboratories, 2340 S. W. Jefferson St., Portland, Oregon.
3. Laucks Laboratories, 314 Maritime Bldg., Seattle, Washington.