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OCCURRENCES OF PERIDOTITE - SERPENTINE IN OREGON

By
N. S. Wagner* and Len Ramp**

Over the past few years increasing interest has been shown in Oregon's ultrabasic rocks as a source for mineral deposits. Instrumental in stimulating this interest has undoubtedly been the successful mining and smelting of nickel ore from Nickel Mountain near Riddle, Douglas County. This operation has given Oregon its largest mine and the United States its only domestic source of nickel. Department and U.S. Bureau of Mines studies on nickel-enriched laterites found on the basic rocks has resulted in recent exploration of two areas in southwestern Oregon. Metallurgical-grade chrome ore is another mineral deposit found in the ultrabasic rocks; in fact, these rocks have been a principal source of domestic chrome supply in two wars and in the present stockpile program. Gold and platinum placers and copper deposits have long been known to occur in the peridotite-serpentine areas and a few investigations have been made on the occurrence of asbestos.

The following articles and maps have been prepared to describe briefly and show the distribution of ultrabasic rocks in Oregon. An extended bibliography is presented for further reference. N. S. Wagner is responsible for preparation of the data on eastern Oregon and Len Ramp is responsible for the map and report on southwestern Oregon. It is hoped this compilation will be found useful pending publication of more extensive maps and reports such as the bulletin on the occurrence of chromite in southwestern Oregon which is now in preparation.

Ed.

Southwestern Oregon

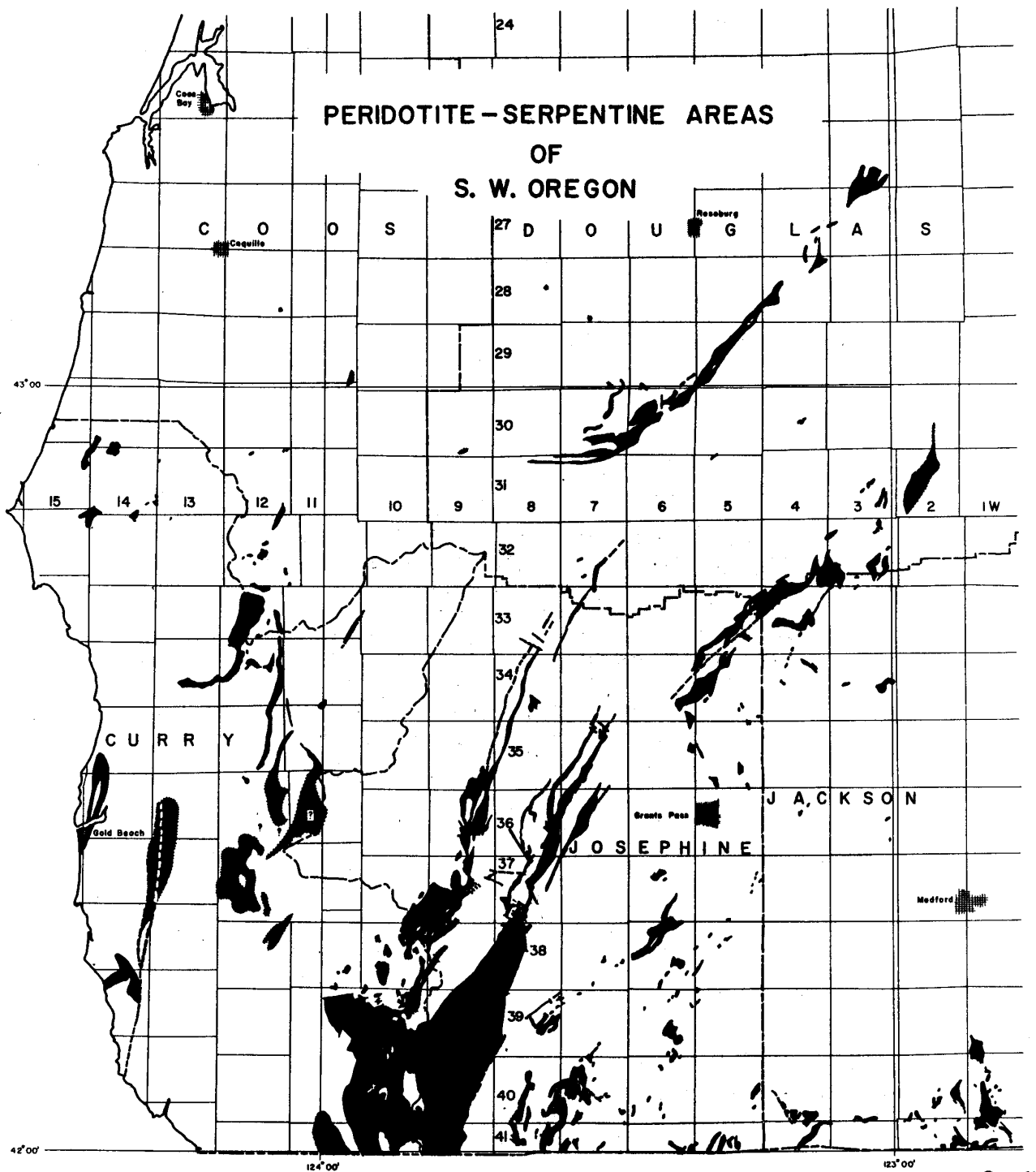
Peridotite, in large part altered to serpentine, has wide distribution in the Klamath Mountains area of southwestern Oregon as shown on the accompanying map. Exposures of serpentine range from 7,340 feet elevation at Observation Peak in southern Jackson County to sea level on the coast in Curry County.

Early geologic mapping of ultramafic rocks (peridotite and serpentine) in the Klamath Mountains was done by J. S. Diller of the U. S. Geological Survey about the turn of the century. In more recent years, F. G. Wells, also of the U. S. Geological Survey, has been responsible for most of the regional geologic mapping in southwestern Oregon and has delineated the mappable areas of peridotite and serpentine.

Rocks of the Klamath Mountains are pre-Tertiary and range in age from the pre-Mesozoic schists of undetermined age to Upper Cretaceous marine deposits. They are overlain to the north

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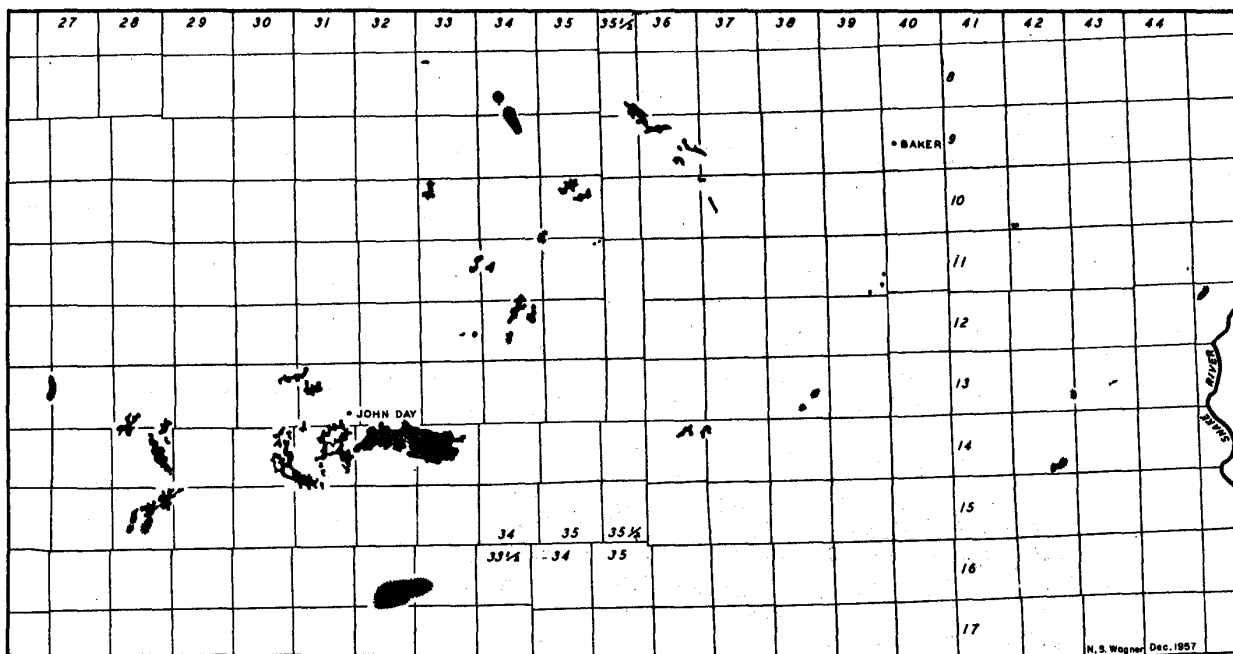
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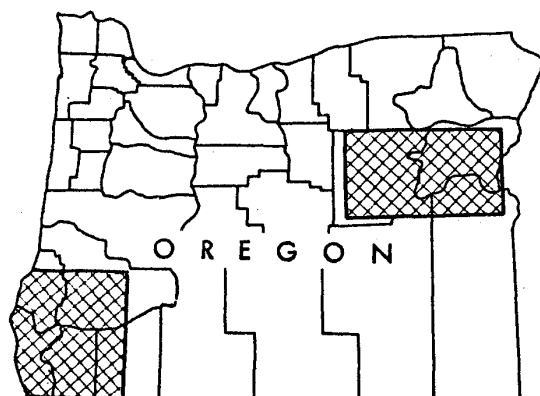
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Scale 0 6 12 18 24 30 Miles

PERIDOTITE-SERPENTINE AREAS OF E. OREGON



0 6 12 18 24 30
Scale Miles



Index Map

EXPLANATION



Peridotite and Serpentine



Peridotite and Serpentine
Approximate boundaries



Faults along which serpentine occurs
in bodies too small to show

and west by Tertiary marine sediments of the Coast Range and to the east by Tertiary volcanics of the Western Cascades. Wells, Hotz, and Cater (1949) date the intrusion of ultramafic rocks in the Kerby quadrangle as late Knoxville (late Jurassic) in age since they found cobbles of peridotite in the overlying Cretaceous Horsetown formation. Diller and Kay (1924) map serpentine cutting the Knoxville formation in the Riddle quadrangle. Wells and Cater (1950) suggest the possibility that there may be two ages of serpentine and that some may have been intruded during Triassic time. Most of the acid igneous intrusions in the Klamath Mountains are late Jurassic or early Cretaceous age. The older ultramafic rocks are intruded by gabbros, diorites, and granitic rocks.

Composition of the ultramafic rocks in the area is fairly uniform. The peridotites generally contain a large percentage of olivine. Pyroxenes, usually enstatite, and occasionally diopside or diopside are also common mineral constituents. Accessory minerals are magnetite and chromite. No feldspar has been found in the peridotites and they are uniformly low in alumina content. A few small areas of dunite (nearly pure olivine rock) and streaks of pyroxenite are not uncommon varieties of the peridotite which is normally a saxonite (olivine plus orthorhombic pyroxene). Considerable amphibole in the form of radiate clusters of anthophyllite and scattered needles of tremolite occur in peridotite in the Red Mountain area south of Ashland.

Alteration of the peridotite to serpentine is common and shows a higher degree of development in smaller bodies, along contacts of the larger intrusive bodies, and in zones of intense shearing.

In zones of major crustal weakness along contacts and faults the occurrence of ultramafic rocks is somewhat localized. A few sill-like bodies of serpentine and peridotite show remarkable conformance to the bedding planes of the older intruded rocks. Highly sheared serpentine, sometimes referred to as "slickentite," has in places been squeezed upward into faults so that it appears to intrude rocks younger than the Horsetown formation.

Analyses of Samples of Ultrabasic Rocks and Laterite

	1.	2.	3.	4.	5.
SiO ₂	41.43 %	42.81 %	---	---	7.58 %
Al ₂ O ₃	.04	not deter.	---	---	10.76
Fe ₂ O ₃	2.52	2.61	---	---	42.51 (Fe)
FeO	6.25	7.20	---	---	---
CaO	.55	none	---	---	---
MgO	43.74	45.12	---	---	---
Ni	.08	.20	1.74 %	1.22 %	0.845
Cr ₂ O ₃	.76	.79	---	---	3.31
Loss on ignition	4.41	.57	---	---	---

1. Peridotite (saxonite) with more than two-thirds olivine from Nickel Mountain, Douglas County: U.S. Geol. Survey Bull. 931-1, p. 211.
2. Olivine, not entirely free from enstatite and chromite from Nickel Mountain, Douglas County: U.S. Geol. Survey Bull. 931-1, p. 211.
3. Laterite from 8-foot auger hole on top of Nickel Mountain, Douglas County: The Ore.-Bin, vol. 10, no. 5, p. 38.
4. Laterite from 3-foot, 8-inch auger hole near top of Woodcock Mountain, Josephine County: The Ore.-Bin, vol. 10, no. 5, p. 38.
5. Laterite from 11-foot auger hole at Red Flat, Curry County (composite sample): The Ore.-Bin, vol. 9, no. 3, p. 23.

Recent nickel exploration

Laterized areas in peridotite, i. e., areas of red soil development resulting in surface enrichment of nickel, are the principal locations for nickel investigations in southwestern Oregon. The accompanying table gives analyses of two samples of ultrabasic rocks and three samples of laterite from this region, showing the enrichment of nickel in laterite developed on ultrabasic rock.

Recent nickel exploration in southwestern Oregon has been stim-

ulated by successful operations of the Hanna Coal and Ore Corporation on Nickel Mountain and by the Hanna Nickel Smelting Company at nearby Riddle, Douglas County. A program of exploration by churn drills and bulldozer trenching on Woodcock Mountain and Eight Dollar Mountain in the Illinois River district, Josephine County, was completed in the summer of 1957 by the Nickel Corporation of America. Exploration work is being done on Red Flat in Curry County by Southwestern Engineering Company. Earlier exploration at Red Flat was done by the U.S. Bureau of Mines and by this Department.

Some of the criteria believed significant in investigating areas of ultramafic rocks for nickel enrichment are:

1. A thick cover of red soil.
2. Fairly flat areas such as flat-top mountains, bench areas, or gentle slopes.
3. Float of white to pale-yellow or brown chalcedony boxwork.
4. Good cover of pine trees as compared to the usual lack of growth on serpentine and peridotite.
5. The presence of unserpentinized peridotite which weathers more readily than serpentine and is more likely to develop a thick soil cover. (The areas of nickel enrichment on Nickel Mountain are underlain by a fresh peridotite composed largely of fresh olivine.)
6. Lack of recent uplift and erosion. Much of the Klamath Mountains have undergone recent uplift and as a result most areas of laterite have suffered rapid erosion and only the roots remain of what may have been extensive deposits.

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Eastern Oregon

Areas of serpentine, peridotite, and dunite are represented in eastern Oregon by a series of widely scattered exposures all of which occur in the Blue Mountain ranges. The map on page 15 illustrates distribution excepting for two or three outlying exposures of very restricted extent. Occurrences shown in black represent exposures which have been defined by geologic mapping. Those indicated by the dotted boundary represent occurrences which are known to exist but which have not as yet been mapped in detail. The configuration of all mapped outcrops has been reproduced as accurately as practicable on a map of this scale but many of the smaller bodies are necessarily exaggerated in size.

The most intensive study of the eastern Oregon ultrabasics was made by Dr. T.P. Thayer of the U.S. Geological Survey during the course of several investigations of the chromite occurrences in the John Day area and the mapping of the John Day, Mount Vernon, and Aldrich Mountain quadrangles. Thayer's findings are that the peridotites are intimately associated with gabbro with which they are essentially contemporaneous. Olivine-rich peridotite predominates although pyroxene-rich (50 percent or more) peridotite is also present together with pyroxenite along the border zones of the gabbro. Dunite is widespread in its occurrence, but individual bodies are usually small. The serpentine is derived from the peridotite and is usually highly sheared. Abundant water-worked serpentine debris in the lower strata of a sedimentary series of well-established upper-Triassic age shows that the serpentine and its related rocks are of pre-Upper Triassic age and probably Lower (?) and Middle (?) Triassic.

The peridotite-serpentine exposures occurring outside of the area mapped by Thayer are in all instances associated with Mesozoic gabbros and other Paleozoic-Mesozoic formations geologically similar to those in the John Day area. Accordingly, the probabilities are that Thayer's observations for the John Day-Aldrich Mountain ultrabasics can be applied to all the eastern Oregon ultrabasics.

Geologic references covering the area represented on the map are listed on the following page. The references marked with an asterisk show mapped ultrabasic bodies. The others show an absence of peridotite-serpentine in their mapped areas. Data for the unmapped occurrences indicated by the dotted boundaries originate from this Department's files of mineral-resource investigation reports and general geologic reconnaissance studies.

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AIME REGIONAL CONFERENCE TO BE IN SPOKANE

The 1958 Pacific Northwest AIME Regional Conference will be sponsored by the Columbia Section and will be held at the Davenport Hotel in Spokane, Washington, April 17, 18, and 19. This will be the 11th annual meeting of the organization. Its three sponsoring sections are the Oregon, Columbia, and North Pacific sections, which take turn-about each year as hosts for the Conference.

R. N. Appling, Jr., publicity chairman for the Conference, reports that technical sessions will be held in geology, mining, milling, physical and extractive metallurgy, industrial minerals, and education for the minerals industry. The latter session will be conducted by Dean Cook of the University of Idaho, and is expected to be a highlight of the conference, in view of the rising concern over the shortage of engineers and scientists.

Field trips will be made Saturday to the Dawn Mining Company's uranium mill at Ford, Washington, and its Midnight Mine, and the new Gladding McBean brick and tile plant at Mica, Washington. Both should be very interesting trips. The mill is one of two in the nation using a counter current decantation column ion exchange process. The brick and tile plant is well engineered and contains the latest and best equipment available. The 400-foot, gas-fired tunnel kiln is one of the largest in existence.

Prominent speakers are expected for luncheons on Thursday and Friday, and an informal buffet supper will be held Friday night. The Women's Auxiliary has scheduled activities for the ladies.

Additional details about the Conference will be made public as they become available.

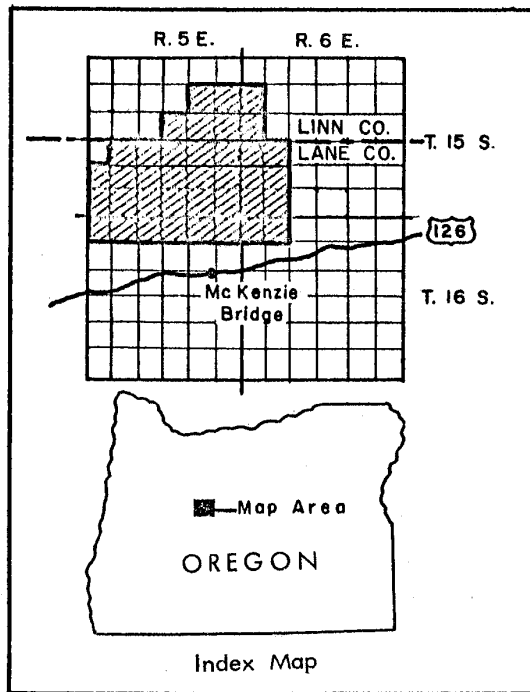
CALIFORNIA DIVISION OF MINES CHIEF TO RETIRE

Olaf P. Jenkins, Chief of the California Division of Mines, retires March 1, 1958, after nearly 29 years with the organization. From 1929 to 1947, Dr. Jenkins served as Chief Geologist of the Division's Geologic Branch. In 1947, he was appointed State Mineralogist and Chief of the Division of Mines. Since 1947 the Division, under Dr. Jenkins, has doubled in size and has become internationally known for the quantity and excellence of its technical publications, which have been of great usefulness to industry and have contributed much to the general knowledge of the geology and mineral resources of California.

Dr. Jenkins is a graduate of Stanford University where he also received his master's and doctorate degrees. Before starting work for the California Division of Mines, he worked for state geological surveys in Tennessee, Washington, and Arizona. For several years he was Associate Professor of Economic Geology at the State College of Washington. From time to time he has carried on consulting work in economic geology in various parts of the world. Upon retirement from State service, Dr. Jenkins plans to continue with the new California geologic map, which he has under way, and do exploration work on a consulting basis.

(Abstracted from Mineral Information Service, February 1958.)

PROPOSED WITHDRAWAL



The United States Forest Service has filed an application for the withdrawal of 15,000 acres of land in the Willamette National Forest (see index map) from all forms of appropriation under the public land laws, including the general mining laws but not including the mineral leasing laws. The withdrawal, if made, will be subject to valid existing rights. The Forest Service desires the land for the H. J. Andrews Experimental Forest. All persons who wish to submit comments, suggestions, or objections in connection with the proposed withdrawal may present their views in writing to the Bureau of Land Management, Department of the Interior, 1001 N. E. Lloyd Boulevard, P. O. Box 3861, Portland 8, Oregon. If circumstances warrant it, a public hearing will be held at a convenient time and place.

OREGON MINING NEWS

Timber Beast Mining Company has concluded a \$24,772 contract with DMEA for underground exploration of the company's uranium claims in Harney County. Under the terms of the contract, Timber Beast pays for 25 percent of the total cost of the work, which will consist of underground drifting, and the balance will be paid for by the government. The 75-percent government share of the cost must be repaid by the company out of any royalties resulting from production of ore developed by the exploration program. Timber Beast partners include W. C. Teegarden, Charles Skeeters, Glenn Young, and George Slade. Company headquarters are at Prospect, Oregon.

R. L. Adams, Jr., Carl W. Lange, and Dean Lange have leased the Manzanita and Bluetop groups of claims on Quartz Mountain in southeastern Lake County from Don Tracy, Ross Foster, and Dean Lange, Lakeview. Considerable prospecting for cinnabar has been conducted in the area during the past few years. Heavy earth-moving equipment was reported to have been moved onto the ground early this month. A total of 12 claims is contained in the leased ground.

A 2½ million-dollar plant expansion program has been announced by Stephen S. Shelton, general manager of Oregon Metallurgical Corporation. The plant, located at Albany, is one of the few in the United States capable of handling the reactive metals titanium and zirconium. Oregon Metallurgical receives titanium and zirconium sponge from Wah Chang Company, also located in Albany, and reduces the sponge into ingots. Some forgings and castings of these jet- and atomic-age metals are also produced. The expansion program will include both new buildings and equipment. Recently Oregon Metallurgical received a 4 million-dollar contract from Westinghouse for zirconium ingots.

CHROME MINING NEARING END

The following announcement on the status of chrome ore to be purchased by General Services Administration under the government stockpile program was received February 12:

"TO ALL SHIPPERS UNDER THE DOMESTIC CHROME PROGRAM:

"In order that shippers to the Domestic Chrome Program may be fully aware of the pending termination of both the Grants Pass, Oregon and the Carload Programs, it has been arranged that information as to the tonnage which remains to be purchased will be available on a weekly basis.

"Beginning immediately, a phone call to the Grants Pass Depot (Greenwood 6-5098) or to the San Francisco Office (YUkon 6-3500, Ext. 453 or 452) will be given latest information. The report will be available Tuesday afternoon and will include shipments received as of the close of business the previous Friday.

"Currently the balance remaining to be purchased at Grants Pass Depot is 10,562 L.D.T. * as of February 7, 1958.

"The balance remaining to be purchased under the Carload Program is 6,130 L.D.T. as of February 7, 1958.

"At a later date it may be decided to adjust tonnages between the Grants Pass Depot and the Carload Program so that both programs may be closed out at approximately the same time. If so, this change will be given the necessary publicity.

R. E. Reno, Jr., Regional Director
Defense Materials Service
General Services Administration"

As of February 21, GSA reported that the balance to be purchased at Grants Pass was 10,216 L.D.T. with 527 tons on hand but not paid for and the balance under the Carload Program 5,335 L.D.T. It was understood that between 800 to 900 L.D.T. remained to be purchased at Seattle which receives barge shipments from Alaska and carload shipments from central Oregon. Production of chromite from the West Coast has been close to 40,000 tons a year; therefore, it is obvious that the end of chrome buying through the present government stockpile program is very close at hand.

Last fall a questionnaire was sent to all shippers of chrome ore to the Grants Pass depot asking:

- (1) Did the U.S. Department of Interior contact you to determine how much of a bonus would be necessary to keep you mining chrome?
- (2) Can you mine chrome by doing your own selling to industry and receiving a \$21 bonus (the Department of Interior's Long-Range Minerals Program)?
- (3) At present prices how much does it cost you to produce a ton of ore?

Answers were received from approximately 50 of the 200 questionnaires sent out. Not one of these people had been contacted by the Department of Interior on the amount of a bonus necessary to keep them mining and not one stated the proposed government Long-Range Minerals Policy was adequate. Reported cost of producing ore varied but it was apparent from the returns that little, if any, production would result if a price was set up that would be less than that now paid.

* Long dry tons.

Here is a painful example of the failure of government planning by not consulting the industry involved. The statement of the Secretary of Interior, when announcing the Long-Range Minerals Program, that "The basically short world supply coupled with the strategic nature of three of these minerals - namely, beryl, columbium-tantalum, and chromite - as well as the heavy dependence of the United States on distant overseas sources of supply, underscore the desirability of making every effort to develop and maintain some production of these commodities from domestic sources," makes the proposal on chrome even more absurd. Either the authors of the Program were very ignorant of the facts of domestic chrome production or they were influenced by advice of those who did not want domestic mining.

If something isn't done within the next few weeks, chrome mining in Oregon, California, and Alaska will become just a rapidly fading memory. The damage will go deeper than loss of chrome mining and its employment, however, for prospecting and exploration, now going on at a very reduced rate, will be curtailed even more. Without prospecting, mining is through.

H.M.D.

PORT ORE SHIPMENTS INCREASE

The Commission of Public Docks, Portland, Oregon, announced that ores and ore concentrate tonnages have increased threefold since modernization of their facilities in 1954. The more than 112,000 tons of bulk concentrates imported through the terminal in 1957 helped make Portland the leading import-export harbor on the Pacific Coast in dry cargo tonnage. Among the large consumers of ores and concentrates are the Bunker Hill Company, the Anaconda Company, and American Smelting and Refining Company.

Ore arriving in Portland is unloaded from the ship's hold by two whirley cranes at the Dock Commission's Terminal No. 4 bulk cargo pier. The cranes, with their 3-cubic-yard buckets, are each capable of discharging vessels at the rate of 125 long tons per hour in free digging. These cranes can discharge bulk commodities from ships into barges, into open stockpiles, or through specially constructed hoppers into rail cars or trucks. Stockpile areas will hold 17,500 tons. Double rail tracks at this pier permit direct transfer of ore concentrates from ship to gondola cars for immediate haul.

The largest single cargo of lead concentrates yet received by the Commission of Public Docks was discharged from the "Hoyo Maru" under charter to C. Tennant Sons & Co., New York, in November 1957. Eight-thousand, eight-hundred tons of lead concentrates, valued at $1\frac{1}{4}$ million dollars, were brought to Portland from Port Pirie, Australia, for rail delivery to the Bunker Hill smelter at Kellogg, Idaho. (From Commission of Public Docks Harbor News, Portland, Oregon, February 1958.)

ASHLEY HONORED IN NATIONAL SCIENCE TALENT SEARCH

Roger Ashley, a senior at Lincoln High School in Portland and a student worker with the Department since 1954, is one of the 260 senior students in the United States to receive honorable mention in the Seventeenth Annual Science Talent Search. All students receiving such an award are considered to have unusual potential scientific ability. Roger's scientific project was "Construction of a differential thermal analysis apparatus for qualitative determination of thermally active minerals."

Senator Alan Bible of Nevada has spearheaded a move directing the Tariff Commission to investigate the effects of foreign competition on the domestic mercury industry. Joining Senator Bible in signing a letter to Finance Secretary Chairman Harry Byrd requesting his committee to instruct the Tariff Commission to make a comparative study of the domestic and foreign mercury industries was Senator Neuberger of Oregon and six other senators from mercury producing states as follows: Nolan and Kuchel of California, Murray of Montana, Watkins of Utah, Barrett of Wyoming, Church of Idaho, and Malone of Nevada.

In a speech on the Senate floor, Bible pointed out that the domestic mercury industry's "very existence" depends on a continuance of a government purchase program which is due to end next December 31. "As I have pointed out before the members of the Senate" the Nevadan declared, "the domestic mining industry is in a perilous state. During the past year mines all over the country producing minerals and metals essential to our defense effort and national welfare have been forced to close or seriously curtail operations." Continuing he said, "These closings have not been brought about by a decrease in demand, nor have they been brought about because they have run out of paying ore bodies. These mines have been forced to close because of violent drops in world prices of minerals and metals. The prices they obtain for their products will no longer pay the cost of labor and materials used. In other words, these mines, necessary to our national well being, have been forced to close because they cannot compete with low cost foreign produced metals." Bible explained that mercury prices have declined from \$295 per flask in 1955 to an average of \$266 in 1956 and \$225 in 1957. He added that the only factor preventing further decline had been the Government support price of \$225, considered by domestic producers as the break-even point.

The Nevada Senator warned that unless the Government purchase program is continued the world market price will drop to such level that domestic producers will be forced out of business.

The following resolution directed to the Tariff Commission will be voted on by the Senate Finance Committee:

RESOLVED that the United States Tariff Commission is hereby directed, pursuant to the Tariff Act of 1930, to make an investigation of the conditions of competition in the United States between quicksilver produced in the United States and in foreign countries, and to report to the Senate Finance Committee the results of the investigation on or before December 1, 1958.

The report of the Commission shall set forth a summary of the facts obtained in the investigation including a description of the domestic industry, domestic production, foreign production, comparative costs of domestic and foreign production, including labor costs, imports, consumption, channels and methods of distribution; prices, including comparative London and New York prices quoted by foreign producers; U.S. exports, U.S. Customs' treatment since 1930; the impact of Government purchase programs authorized under Title III of the Defense Production Act of 1950 on domestic production, and the possible effect of the termination of that program on world prices and domestic production, and other factors affecting the competition between domestic and foreign mercury. In the course of the investigation the Commission shall hold hearings giving adequate opportunity to interested parties to appear and be heard.

LONG-RANGE MINERALS PROGRAM

The Senate Interior Subcommittee on Minerals, Materials and Fuels has announced that it will begin public hearings March 24 on an all-inclusive, long-range minerals program.
