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THE NICKEL MOUNTAIN PROJECT*

Introduction

A very important event in Oregon mining history occurred on January 16, 1953, in Washington, D.C., when the Defense Materials Procurement Agency signed contracts with the Hanna Coal and Ore Corporation and the Hanna Smelting Company, both subsidiaries of the M. A. Hanna Company, Cleveland, Ohio, for the production of nickel from the Nickel Mountain deposit near the town of Riddle, Douglas County, Oregon. In addition, signing of the contracts marked the opening of an important chapter in the domestic mining industry since no nickel has ever been produced in this country on a commercial scale from ore mined in continental United States (a total of a few hundred tons is recorded as a by-product in smelting copper ores). We have always depended on Canada for our nickel. Start of nickel production at Riddle will make the United States partly independent of outside sources of this very strategic metal.

Because of the importance of the Nickel Mountain project, it seems desirable to assemble background descriptive material as a record.

Geography

Nickel Mountain is about 5 miles northwest of Riddle, an incorporated town in Douglas County, as shown on the accompanying index map. Elevation of the summit of the mountain is 3533 feet. The nickel deposit, occupying much of the upper part of the mountain, may best be reached from the Hanna plant site which is about 3½ miles west of Riddle. The Hanna Company has constructed a new road more than 2 miles long extending from the plant to the deposit at the summit. Because of the hazard of meeting heavy trucks on this road, permission to drive over it must be obtained at the Hanna Company office, at present in Riddle. A gatekeeper is stationed at the entrance to the new road and a pass is required to enter.

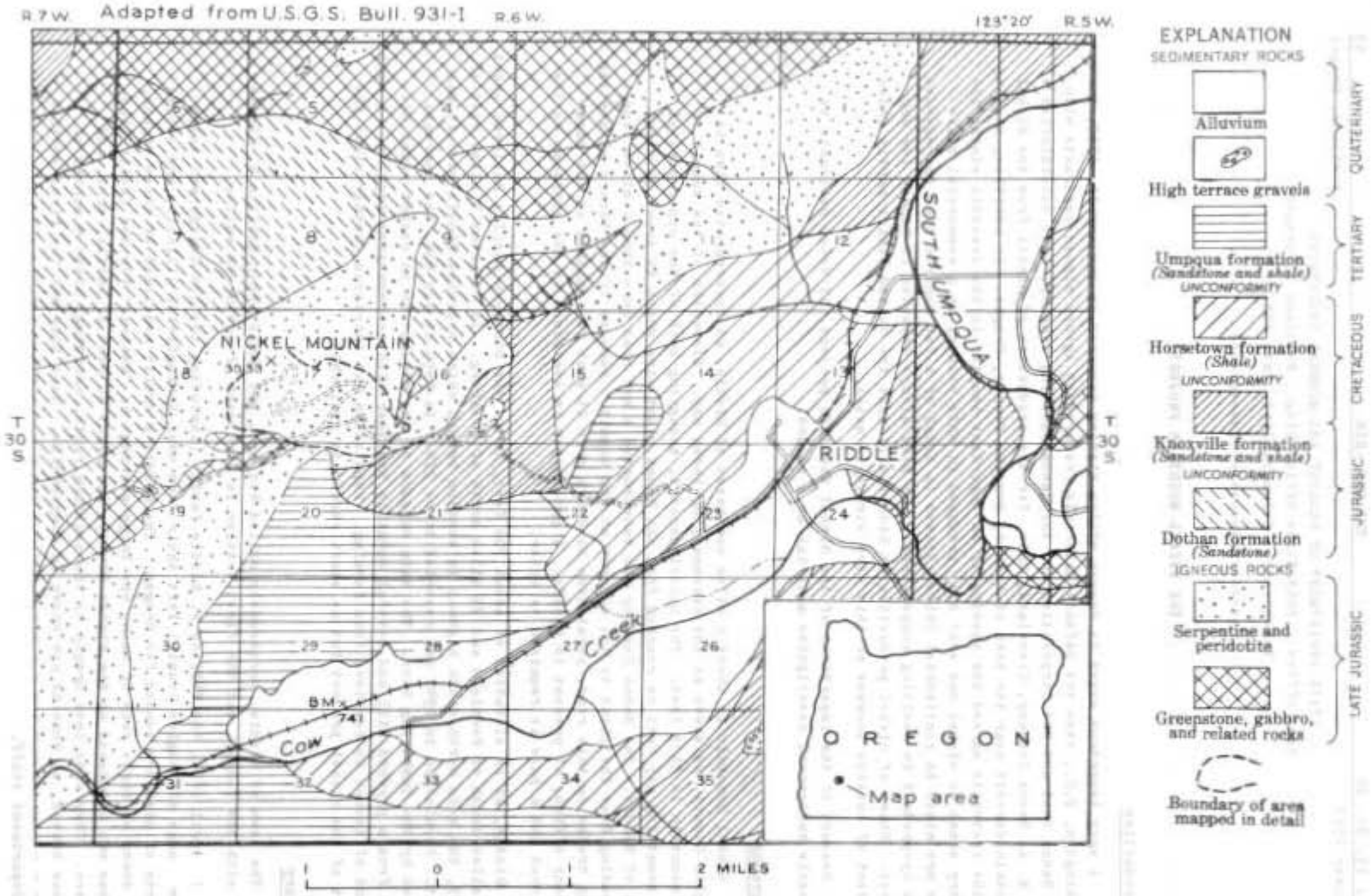
Riddle, at an elevation of about 700 feet, is on the Southern Pacific Railroad about 220 miles south of Portland and 25 miles south of Roseburg. It is about 4 miles west of US 99, the main north-south highway in western Oregon which bypassed Riddle when it was built. Population in 1940 was reported to be 214. In 1950 it was 634, the increase caused by the lumbering boom. The main support of the population in recent years has been from a plywood mill and several sawmills together with accompanying logging. A small amount of income is received from farming. Population has increased further since the start of the nickel project but no exact record is available.

History

The town of Riddle, erroneously called Riddles, was named after William H. Riddle who, with his family, was the first settler in that part of Cow Creek valley.

In April 1851, the William H. Riddle family (including the son George who later became Judge of Douglas County) left their farm near Springfield, Illinois, and joined a party of pioneers headed for Oregon. The Riddle's outfit consisted of three wagons, each drawn by three yoke of oxen, one large carriage or "omnibus" for the family (the omnibus was abandoned at the Platte River), and about 40 head of cattle, cows, and heifers. They came into Oregon by the southern route, arriving, after 5 months of arduous travel, at what is now known as Canyonville. Here they met the first settler

*By Department staff.



GEOLOGIC MAP OF THE VICINITY OF NICKEL MOUNTAIN, DOUGLAS COUNTY, OREGON

they had seen in Oregon, namely Joseph Knott, who had located the first donation land claim in the Cow Creek valley. Joseph Knott showed Riddle the Cow Creek valley, and Riddle, impressed by the beauty of the valley and the splendid range for cattle, selected a site near what is now the town of Riddle. Here he immediately cut and laid the first four logs of his cabin, this being sufficient in those days to hold a land claim.

Early in the spring of 1852, other settlers began to arrive in Cow Creek valley. One of these was John Smith, from South Bend, Indiana, who located a donation land claim embracing the present site of the town of Riddle. After establishing the claim, Smith returned to his home in Indiana, but sent his daughter and son-in-law, J.Q.C. Vandenbosch, out to take over the claim. The Vandenbosch family thereby were the first owners of the townsite of Riddle, and their name appears on all abstracts of title to Riddle town property. In 1866, Vandenbosch sold his claim to Abner and J. B. Riddle.

In 1882, the Oregon and California railroad (later the Southern Pacific railroad) began extending its line south from Roseburg and soon reached Cow Creek. Abner and J. B. Riddle donated land for a town site, and a depot was located on it. The little town which sprang up was named Riddle, sometimes called Riddleburg, and for 8 months it was the southern operating terminus of the railroad. Stages left from this point for Redding, California. A. G. Walling, in his "History of Southern Oregon," published in 1884, reports that during the time that Riddle was the railroad terminus, "the place was 'lively' in the broadest significance of the term, and its like the peaceful citizens of Cow Creek valley hope never to witness again." With the extension of the railroad, and the departure of "the horde which infested the terminus," Riddle became a subdued but thriving village and shipping point for a small but prosperous community. There were two hotels, a store, a warehouse, a saw mill, and a school house. Placer mines were being extensively worked and "a nickel mine was being worked with good results on a neighboring mountain called 'Old Piney.'"

The deposit of nickel was first discovered by sheepherders in 1865 and was thought to be tin. In the excavations the prospectors found green ore which they supposed was copper. Samples of the rock were sent to Mr. William Q. Brown, a mining expert, who was then mining on Althouse Creek in Josephine County. An analysis showed the ore to be not copper or tin, but nickel, and the sample contained 6 percent nickel.

According to a newspaper clipping dated January 17, 1908, Mr. Brown and associates purchased the property in 1882 and ran open cuts, tunnels, and shafts. More than 3,000 tons of the ore was piled on the dumps, showing an average of 5 percent nickel, the value of which at that time was about $150,000 (the price of nickel varied from 40 to 60 cents per pound). The mine was then placed on the market for sale at prices ranging from $400,000 to $1,000,000 but no purchasers were secured. In 1891, Mr. Brown and J. B. Riddle sold 200 acres of the property to the International Nickel Mining Company, of Chicago. The Company expended over $100,000 in surface improvements, including a hotel, houses for workmen, a large Corliss engine and boilers, and a saw mill. A complete smelting plant of 150 tons capacity was purchased but was never erected. The newspaper stated that the stockholders got into litigation, and the machinery for the smelting plant was still stored on the railroad at Riddle. Mr. Winslow of Chicago had become owner, and Mr. W. Q. Brown still held some of the original property. Both properties were idle in 1908, and the International Nickel Company had 60 acres in prunes, then a thriving industry in the Cow Creek valley.

Sometime during the latter part of the last century the Adams family of Oakland, California, acquired ownership in the nickel area, and early in the present century Edson F. Adams emerged as the owner of the land containing the deposit.

In the late 1930's and early 1940's at least two important groups examined the deposit. A few churn drill holes were put down, mainly on the lower deposit. It seems likely that some metallurgical testing work was done on the nickel ore at this time but the investigations were conducted quietly and no publicity was given to the field work or results obtained.

In 1941 Freeport Sulphur Company negotiated a lease with Mr. Adams and in 1942 carried on extensive exploration work. Besides geological studies, some 50-odd diamond drill holes were put down with the principal attention given to the upper deposit, which contains much the greater amount of nickel. Metallurgical testing work was done along with the drilling.

In 1943 Freeport relinquished the lease, mainly because of the seeming difficulties of economic treatment of the ore. (The market price of nickel was then 35 cents per pound.) Moreover the company had acquired the Nicaro nickel property in Cuba and put it in production under a government contract so that interest in the Oregon deposit waned. The area containing the deposit, as well as some adjoining land which had been acquired by Freeport, was turned back to Mr. Adams.

After World War II, the M. A. Hanna Company of Cleveland, Ohio, became interested in the Nickel Mountain property. Negotiations were carried on, first with Mr. Adams and then, after his death in 1947, with his estate and a deal was finally transacted. Geological work and extensive metallurgical testing were begun. This was supplemented by churn drilling, shaft sinking for testing purposes, and bulldozing deep trenches during the succeeding three years. The culmination of all the exploratory work was the signing of the government contract early in 1953.

Geology

1. General geology and geologic setting

Nickel Mountain is in the northwest part of the Siskiyou Mountains a few miles east of their juncture with the Tertiary rocks of the Coast Range. Approximately 30 miles to the northeast the Tertiary volcanics of the Cascade Range overlap the continuation of the rocks that are found in the vicinity of the nickel deposit at Nickel Mountain.

The summit of Nickel Mountain and the host rock of the nickel deposit is peridotite, an ultrabasic rock consisting chiefly of olivine and enstatite. All the peridotite is serpentinized to some extent - fresh specimens being rare. A band of serpentine several hundred feet wide divides the peridotite into two parts. Serpentine is an altered ultrabasic rock and in this area it may mark a zone of intense shearing and considerable movement within the main peridotite body. Feldspathic and quartzose dikes of small areal extent occur in the serpentine and metavolcanic rocks. The ultrabasic rocks are probably late Jurassic or early Cretaceous in age and are intrusive into metavolcanic and metasedimentary rocks of late Jurassic age. The metavolcanic rocks are greenish colored and were originally lavas or pyroclastic igneous rocks. They have undergone varying degrees of change and some may even be classified as schists or phyllites. The metasedimentary rocks are graywackes and shales with minor chert and conglomerate and belong to the Jurassic Dothan formation.

Sedimentary rocks belonging to the late Jurassic Knoxville formation, early Cretaceous formations, and the mid-Eocene Umpqua formation occupy a minor structural basin developed in the old terrain of the Klamath Mountains after the mountain-making period which followed or accompanied the intrusion of the ultrabasic rocks. The Knoxville and early Cretaceous formations are well indurated grayish-colored rocks. Graywacke type sandstones predominate in both but conglomerates composed almost entirely of chert pebbles from $\frac{1}{2}$ inch to 2 inches in diameter mark the Knoxville formation while shales are characteristic of the early Cretaceous formations. The jointing in the Knoxville formation is more pronounced than in the early Cretaceous rocks. It is most noticeable in the chert conglomerates where the fracture planes through the pebbles form smooth surfaces. The Umpqua sediments are lighter in color than the Mesozoic sediments. A yellowish sandstone is the most common material of this formation but a pebble to boulder conglomerate is found near the base and dark-colored, thin-bedded shales are found in the valley floor. The conglomerate is composed largely of pebbles derived from the metavolcanics and metasediments of the ancient Klamath Mountains. Chert pebbles are not as prominent as in the Knoxville conglomerate and the jointing is so poorly developed that the rock generally breaks around the pebbles rather than through them as in the Knoxville conglomerate. Fossils, the basis on which the age of these formations has been determined, are fairly common in the Umpqua and early Cretaceous formations, less common in the Knoxville formation and very rare in the Dothan formation.

The Dothan and metavolcanic formations generally have high dips to the southeast with a strike to the northeast. The peridotite and serpentine form a discontinuous band which can be traced for nearly 35 miles from Cow Creek near the mouth of Salt Creek northeastward to Little River near Peel. The Knoxville and younger formations have attitudes which suggest a basin in the Riddle area. All contacts of the serpentine and peridotite with the other rocks are faults, consequently when the younger formations are found lying next to the ultrabasics the otherwise low attitudes found near the middle of the basin are distorted and frequently quite steep. The contact between the Dothan formation and the volcanics appears to be gradational although in many places serpentine occurs between the two, indicating a fault. Differences in attitudes between the Knoxville, early Cretaceous, and Umpqua formations mark unconformities. The unconformity between the Knoxville and early Cretaceous formations is more pronounced than the one between the Cretaceous and the Eocene formations, while the unconformity between the Knoxville and older formations indicates that the most severe orogenic disturbances took place at that time.

2. Geology of the deposit

The nickel mineralization is confined to the area of the peridotite. The serpentine band separating the peridotite is barren.

The ore mineral is a nickel-bearing hydrosilicate. The name garnierite is generally applied to this light to dark green mineraloid but as pointed out by Pecora (Pecora, Hobbs, and Murata, 1949)* garnierite is not a single mineral but a mixture of at least two and possibly three hydrosilicates.

The source of the nickel was the olivine and enstatite, the main minerals of peridotite. Both olivine and enstatite are compatible to having nickel concealed in their structures. An analysis of olivine from Nickel Mountain showed 0.26 percent NiO while an analysis of bronzite (the alteration mineral of enstatite) showed 0.05 percent NiO (Pecora and Hobbs, 1942). According to Rankama and Sahama (1949), during weathering ultrabasic rocks are converted into magnesite by the carbon dioxide-bearing weathering solutions; the magnesite goes into solution as magnesium bicarbonate in the uppermost weathering zone, and only silica, hydrosilicates of nickel and magnesium, and iron oxide remain as a residue. Also, according to Rankama and Sahama, "Contrary to Fe^{2+} and Mn^{2+}, Ni^{2+} is very stable in aqueous solutions and is accordingly able to migrate for considerable distances under proper circumstances."

The deposit can be divided into three zones that conform well with this data. The upper zone is a brick-red soil layer from 0 to 10 feet thick that was formed under lateritic conditions. In this zone silica nodules are common but the boxwork structure of the underlying zone is lacking. Small round pellets of red iron oxide and the brick-red soil are characteristic. The green nickel-bearing silicate is not found and the mineral which contains the nickel is not known. Pecora and Hobbs (1942) give a nickel content for this zone from 0.61 percent to 1.10 percent on four composite samples. The second or medial zone is characterized by a preponderance of silica in the form of a limonite-stained boxwork. Garnierite also stains the boxwork, imparting to it a pleasing mint-green color. Boulders of peridotite which contain garnierite veinlets are common in this zone. The lower zone is referred to as the root zone by Pecora and Hobbs. Here garnierite veinlets are found filling fractures within the peridotite. The limonite-stained silica boxwork is missing, indicating that the waters depositing the nickel were relatively lower in silica and iron than those which formed the medial or boxwork zone. Undoubtedly the garnierite of this lowest zone is confined to the more permeable shear zones within the peridotite. Shearing has fractured the peridotite and localized the nickel-bearing solutions to definite zones to impart a rootlike shape. The depth to which this zone extends is not known but distances of over a hundred feet may exist. All three zones will grade into one another and the depth to which economic mineralization will extend will also probably be gradational as well as variable.

The age of the mineralization is directly related to the period of laterization. It is thought that this is Tertiary, probably early Tertiary, but until the topographic development

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*Bibliography at end of this report.

of southwestern Oregon has been more accurately dated a more precise dating is not readily assignable. Probably the mineralization of the medial and lowest zones owes a great deal of its enrichment to leaching of the lateritic horizon. This suggests that mineralization in these zones has been continuous since laterization and may possibly extend to the present.

Government-Hanna contract

According to the contract between the Defense Minerals Procurement Agency and the Hanna Nickel Smelting Company and Hanna Coal and Ore Corporation, the Hanna Nickel Smelting Company will produce from 95 million to 125 million pounds of nickel in ferronickel to contain at least 25 percent nickel and not more than 75 percent iron. The government will pay not more than 79.39 cents a pound for the first 5 million pounds and 60.5 cents a pound thereafter. DMPA agrees to advance 24.8 million dollars for construction of smelting facilities and all but 2.4 million dollars will be spent on construction of the smelter. The loan will be written off under a mortgage for 24.8 million dollars recorded in Douglas County on June 25, 1953. The mortgage calls for liquidation by June 30, 1962.

The Hanna Coal and Ore Corporation contracts to develop the mine on Nickel Mountain at its own expense to cost approximately 4.3 million dollars. It is provided that ore from the deposit will be sold to the government at $6 a ton. In turn the government will sell the ore to the Hanna Nickel Smelting Company at the same price.

Plans have been made for transportation of the ore from the mine down the mountain to the smelting plant, a distance of about 1½ miles, by means of an aerial wire rope tramway. It is reported that the smelter will have four primary furnaces, one refining furnace, and two auxiliary furnaces. The company has obtained the rights to use the process of Societe D'Electro-Chimi, D'Electro Metallurgie et des Acieries Electrique D'Ungine. This process has been used successfully in treating New Caledonia ores having characteristics similar to the nickel silicate ore on Nickel Mountain.

At the time the DMPA announced the contract between the government and the company, it was stated that the ore to be treated would have an average grade of 1.5 percent nickel and that the ore would be mined by surface methods, put through a primary crusher and then conveyed to the smelter. A contract for construction of facilities was let to the Bechtel Corporation and construction has been underway since early in the spring. At the plant site furnace construction is well underway as well as numerous buildings. A railroad spur has been run from the Southern Pacific main line to the plant site, a distance of about 2½ miles. A pipe line and other water supply facilities have been installed. Sources of water will be Cow Creek and Rail Creek. Foundations for the tramway have been poured and the new first-class road from the plant to the mine has been completed. Timber is being logged off the ore body, some stripping has been done, and an office building erected at the mine. It is reported in the Mining World that production of ferronickel from one furnace will be started before September 30 of next year and that the remaining three furnaces will be installed by the end of 1954. The General Manager at Riddle is Earl S. Mollard and E. Emmons Coleman is Plant Manager. Mr. D. N. Vedensky, metallurgist, is Director of Hanna's Research and Development department.

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RIDDLE NICKEL WILL HAVE LONG LIFE

Under a Roseburg October 18 dateline the Oregon Journal published facts about the Hanna nickel project quoting Mr. Earl S. Mollard, General Manager of the project. Mr. Mollard stated that about 400 employees would be needed when the plant gets into production in the summer of 1954. It is expected that nearly all employees will be hired in the State. There will be five electric furnaces, four for the production of ferronickel and one for ferro-silicon. About 65,000 kilowatts of power will be required. The ore from the open pit mine will probably yield about 25 pounds of nickel to the ton of ore. The plan is to mine about 1800 tons of ore per day. The plant is expected to run three shifts a day for seven days a week, and ore reserves are sufficient for 30 to 40 years of operation at the capacity now planned, assuming that the operation is economic after the government contract is completed.

Mr. Mollard stated that the furnaces would not be able to refine anything but nickel. Some other elements in the ore would go to the slag pile and tests are being made to determine uses for the slag.

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PHIL BROGAN NOW ASSOCIATE EDITOR

Phil Brogan, who has been on the Bend Bulletin staff for 30 years since graduating from the University of Oregon, has been named associate editor of the Bulletin, by Robert W. Chandler, the new owner. Brogan has been the geologists' spokesman in Oregon for many years, and a great many people look forward to his weekly article on Oregon geology in the Oregonian. He is chairman of the Oregon Geographic Board, member of the Legislative Interim Committee on Historical Institutions, member of the Geological Society of the Oregon Country and the Bend Geological Society.

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MINING CLAIMS ABANDONED

The Bureau of Land Management, under William C. Guernsey, Regional Administrator, is trying cooperation with mining claimants in a new approach to administering the mining laws. The BLM sent letters to about 400 persons holding 890 mining claims on O & C land. These letters reminded the claimants that they had not filed the required notice that assessment work on the mining claims had been performed during the 1952-1953 assessment year. Replies have been received by BLM that 126 mining claims have been abandoned. Mr. Guernsey stated that he felt encouraged by the cooperation of mining claimants, and he urged those who have received a letter concerning lack of assessment work and have not replied to do so at once so that the status of the claim may be cleared.

Holders of mining claims on O & C lands must file an affidavit of proof of labor showing that annual assessment work has been done. This proof must be filed in the United States land office as well as the office of the county recorder of the county in which the claim is located.

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OIL AND GAS CONSERVATION LAW HEARING HELD

On September 15, 1953, the Governing Board of the State Department of Geology and Mineral Industries, which administers the new oil and gas conservation law (Chapter 667, Oregon Laws 1953), held a public hearing in the auditorium of the State Office Building in Portland. The Board had previously compiled rules and regulations as required by the law and presented these rules for approval at the hearing. Minor changes were suggested by representatives of the industry and these have been taken under consideration by the Board. The final draft of rules and regulations is now being prepared.

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NEW CHROME CONCENTRATOR

The Thompson Milling and Manufacturing Company owned by L. H. Thompson and Lawrence Wilson of Ashland, Oregon, has constructed a concentrating mill on the south bank of Bear Creek near the end of Oak Street in Ashland for the purpose of concentrating chromite ore. It was put into operation October 6, 1953. The mill, powered by Buda Diesel engine, includes a 12-inch jaw crusher, a 32 x 48 Denver ball mill, and a Deister table. The owners plan to enlarge the mill by addition of another ball mill and two tables. Most of the ore is from deposits on the Klamath River in California under lease to Thompson and Wilson. Ore is also being shipped from three properties near Red Mountain which is nearly 30 miles southwest of Ashland on the Mt. Ashland road. One deposit on patented ground in sec. 32, T. 40 S., R. 1 W., has been leased from Larry Basey. Another in sec. 3, T. 41 S., R. 1 W., near Red Mountain Creek has been leased, and the third property is a claim adjacent to Basey's claim located by L. H. Thompson.

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