UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Bulletin 922–J

CHROMITE DEPOSITS IN THE SEIAD QUADRANGLE SISKIYOU COUNTY, CALIFORNIA

BY

G. A. RYNEARSON AND C. T. SMITH

Strategic Minerals Investigations, 1940
(Pages 281–306)

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1940

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - Price 30 cents

CONTENTS

ILLUSTRATIONS

CHROMITE DEPOSITS IN THE SEIAD QUADRANGLE
SISKIYOU COUNTY, CALIFORNIA

By G. A. Rynearson and C. T. Smith

ABSTRACT

The chromite deposits described in this report are in the Klamath Mountains of northern California. The oldest rocks in the area are mica, chlorite, and hornblende schists of pre-Cambrian (?) age, which are overlain by a complex series of metamorphosed volcanic and sedimentary rocks of Paleozoic (?) age. Into all these rocks quartz diorite, peridotite, and granodiorite were successively intruded. Auriferous terrace gravels, possibly of Pleistocene age, Recent gravels, and alluvium partly fill some of the larger canyons.

The chromite deposits, which occur in peridotite, range in size from a few tons to more than 100,000 tons. The ore of minable grade has an average chromite content of 35 percent. Reserves in the district, as estimated from known outcrops, are believed to be approximately 125,000 tons. At current prices of $20 to $25 a ton it is unlikely that any of the deposits can be profitably worked. Though the major part of the tonnage is of low grade (20 percent of chromite), the material could be concentrated to a 45- or 50-percent product. Hand sorting would yield small tonnages of shipping ore.

INTRODUCTION

Location.--The chromite deposits described in this report are in the northeastern part of the Seiad quadrangle, Siskiyou County, California (see fig. 41). The nearest railroad shipping point is Hornbrook, 51 miles up the Klamath River from Seiad Valley. The first 24 miles of the route from Seiad Valley to Hornbrook is a narrow, graded dirt road; the remaining 27 miles is paved and oiled.

Basis of report.--The field work for this report was carried on from July 25 to November 8, 1938, and from May 22 to July 13, 1939, under an allotment from the Public Works Administration for the investigations of strategic minerals.

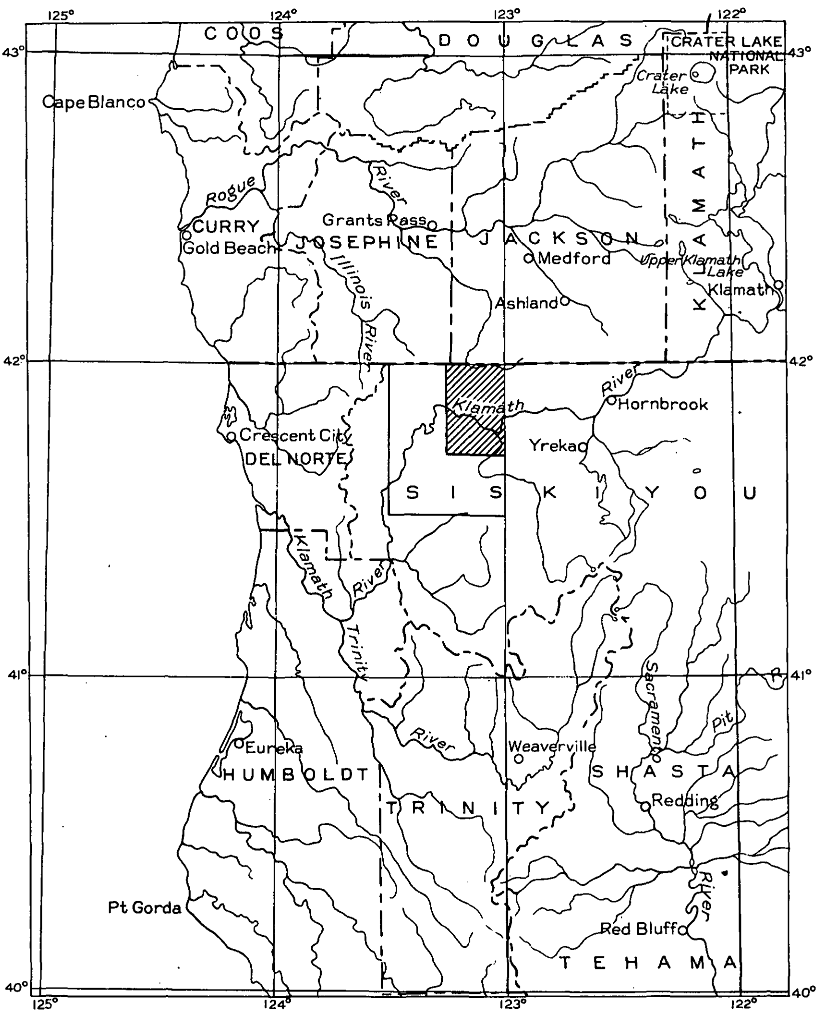


Figure 41.--Index map of northern California showing location of the northeastern part of the Seiad quadrangle.

The writers are indebted to Mr. H. F. Byram and the Rustless Mining Corporation for permission to study their properties. The aid of J. R. Bovyer in mapping the Seiad Creek chromite deposit and the constant cooperation of the U. S. Forest Service and the local inhabitants are gratefully acknowledged.

History of mining.--The deposits of the district were located during the intensive search for chromite in the last years of the first World War. Mining began in 1917, and a year later 10 mines in the district were producing ore. Mining stopped when chromite prices fell at the end of the war. Interest in the chromite resources of the district has been revived in the past few years. The Rustless Mining Corporation has acquired control of most of the deposits and is prospecting its holdings.

Earlier investigations.--Prior to the present investigation the area had not been mapped geologically. J. S. Diller briefly studied the chromite deposits during their early development in 1917;[1] and W. D. Johnston, Jr., spent several days in the area in 1931, examining some of the chromite properties and collecting specimens which he later described.[2] C. V. Averill has briefly described several of the mines.[3]

1/ Diller, J. S., Chromite in the Klamath Mountains, California and Oregon: U. S. Geol. Survey Bull. 725, pp. 1-84, 1921.

2/ Johnston, W. D., Jr., Nodular, orbicular, and banded chromite in northern California: Econ. Geology, vol. 31, pp. 417-427, 1936.

3/ Averill, C. V., Mines and mineral resources of Siskiyou County: California Jour. Mines and Geology, vol. 31, no. 3, pp. 255-338, 1935.

GEOLOGY

Metamorphic rocks

Older rocks.--The older metamorphic rocks of the area are mica, chlorite, and hornblende schists, not differentiated on the geologic map (pl. 40). The areas underlain by them, mainly in the east half of the region mapped, are densely covered with trees and underbrush and contain few good exposures, but the gray to brown soil derived from them is rather distinctive.

The mica schist ranges in color from light gray to nearly black. It contains both colorless and black mica and quartz. Some of the quartz occurs in small lenticular masses that lie parallel to the planes of schistosity. Thin bands of nearly pure quartzite, which also lie parallel to the schistosity, suggest that bedding and schistosity coincide and that the mica schists were derived from sandy argillaceous sediments.

The chlorite schist is light to dark grayish green and strongly foliated. It contains much more feldspar than the mica schist and is believed to have been derived from andesitic volcanic rocks. The relations between the chlorite and mica schists were not determined.

The hornblende schists are commonly found near contacts between chlorite schist and later intrusive rocks and appear to be a product of igneous metamorphism. They are dark green or gray where fresh and brownish where weathered.

Younger rocks.--Metamorphosed volcanic rocks whose relations and character indicate that they are younger than the mica and chlorite schists occur in the Marble and Siskiyou Mountains and occupy two areas in the west half of the region mapped. The area occupied by similar rocks north of the Klamath River extends northward into Jackson County, Oregon.

The original character of these rocks is best indicated in places north of the Seiad quadrangle, where they have been only moderately metamorphosed. Amygdaloidal and other volcanic textures may there be recognized, and the series appears to have consisted mainly of andesitic and basaltic flows and sills, though it also contained thin layers of sandstone, tuff, and shale, and some thick layers of limestone, now altered to marble. Within the Seiad quadrangle the volcanic rocks have mostly been altered, probably by intrusive processes, to schists and gneisses, though bedding is still recognizable in some of the sedimentary layers.

The marble occurs as lenses and layers, in places nearly 1,000 feet thick. The rock is coarse-grained and grayish white. Chert bands and thin quartzite beds, which are found in many parts of the exposures, give clues to the original bedding, much of which has been obscured by metamorphism. The marble is well-exposed on the west side of Grider Creek Canyon, where it forms cliffs more than 500 feet high.

Igneous rocks

Quartz diorite.--Quartz diorite, exposed in the southern half of the region, has been intruded into the schists and other metamorphic rocks and is older than the peridotites and the granodiorite. Its geologic age is not known more definitely than these relations indicate. It is medium-grained and medium gray, with a greenish cast in places. It consists mainly of andesine, hornblende, and quartz and contains a little biotite.

Gneissic structure resembling flow banding is commonly present but is not conspicuous everywhere. Both the gneissic quartz diorite and the volcanic rock have been so intensely metamorphosed that in several places the contact between them is not readily recognized. These rocks, therefore, are not distinguished on some parts of the map. Much of the area near Canyon Creek and Devils Peak mapped as younger metamorphic rocks is quartz diorite.

Peridotite and serpentine.--The largest body of peridotite wholly within the region extends north-northwest from the mouth of McGuffy Creek to Schutts Gulch, but many other bodies crop out in the western part, and two small ones are exposed in the northeastern part of the region. Some of the bodies are sill-like, but most of them are dikes.

The peridotite is mainly the variety dunite, a rock consisting essentially of olivine, but locally it grades into saxonite by an increase in the percentage of enstatite. The peridotite is for the most part relatively fresh, although it is largely altered to serpentine along fractures and shear zones. The small bodies of completely serpentinized rock may represent a different period of intrusion. The rock, where it is not much serpentinized, is yellowish green to greenish black on fresh surfaces and weathers to brown or brick red. Accessory minerals, such as pyroxene and magnetite, are relatively resistant to weathering and stand out in relief on weathered surfaces. The peridotite may usually be recognized in the field by its reddish outcrops and soil and by the sparse vegetation that it supports. The serpentines and the more highly serpentinized peridotites weather to a light-green or greenish-brown color and are characterized by slick, curved surfaces with a waxy luster.

The mineral composition of the peridotite varies only slightly. Olivine is the chief constituent, usually forming about 95 percent of the rock. Enstatite also occurs in varying amounts. Chromite and magnetite are, for the most part, accessory minerals, occurring as sparsely disseminated grains, although in places chromite forms masses large enough to be of economic importance. Tremolite, talc, anthophyllite, chlorite, magnetite, and serpentine minerals occur as products of metamorphism and hydrothermal alteration.

The peridotite bodies are intruded into all of the metamorphic rocks, including the quartz diorite, and granodiorite and associated pegmatites are in turn intruded into them. Their geologic age is tentatively classified as late Jurassic or early Cretaceous, on the basis of observations made in other parts of the Klamath Mountains.4/

Granodiorite.--The granodiorite is a light-colored, medium-grained plutonic rock, possibly equivalent to the "Siskiyou granodiorite" described by Maxson.5/ It crops out east of Seiad Valley and between Walker and Grider Creeks. The principal minerals are quartz, plagioclase, orthoclase, muscovite, and biotite. Considerable variations in the percentages of the different minerals result in facies that approach quartz monzonite or quartz diorite in composition. Border facies commonly contain large inclusions of the younger metamorphic rocks. These inclusions have been partly assimilated, and some contain much garnet.

Small pegmatitic bodies occur within the main mass. They are composed of coarse-grained quartz and sodic plagioclase, books of muscovite and biotite, and occasional garnet crystals. At many places in the area pegmatite dikes, thought to be related to the granodiorite, invade the peridotite and younger metamorphic rocks. The granodiorite is slightly affected by dynamic metamorphism.

4/ Diller, J. S., U. S. Geol. Survey Geol. Atlas, Port Orford folio (No. 89), p. 4, 1903. Diller, J. S., U. S. Geol. Survey Geol. Atlas, Riddle folio (No. 218), p. 4, 1924. Shenon, P. J., Geology and ore deposits of the Takilma-Waldo district, Oregon: U. S. Geol. Survey Bull. 846, p. 160, 1933. Maxson, J. H., Economic geology of portions of Del Norte and Siskiyou Counties, northwesternmost California: California Jour. Mines and Geology, vol. 29, p. 131, 1933.

5/ Maxson, J. H., idem.

Quaternary deposits

Gravels.--Some of the gravel terraces along the Klamath and Scott Rivers are as much as 1,000 feet above the present river beds. The gravels contain boulders of peridotite, schist, and quartz diorite in a partly consolidated sandy matrix. Some of the deposits are nearly 100 feet thick, but present-day hydraulicking operations for the recovery of gold are rapidly removing them.

The age of the gravel terraces has not been definitely determined. Repeated rejuvenation of the rivers, perhaps beginning in Pleistocene time, is indicated by the various terrace levels. No fossils were found, and no measurements or correlations were attempted.

Alluvium.--Unconsolidated mixtures of sand and gravel with a few large boulders partly fill many of the canyon bottoms in the area. A small alluvial plain underlain by as much as 30 feet of alluvium forms the floor of Seiad Valley.

Structure

The structure of the area is complex and far from being completely understood, but some of its main features may be stated. The most notable structural feature is the northerly trend of the rocks.

The schists, for the most part, strike from N. 40° E. to N. 25° W. and dip moderately or steeply to the northwest or northeast. Interbanding of the various kinds of schists suggests that isoclinal folding may have occurred.

The younger metamorphic rocks are relatively undeformed. Their dips are generally low and are influenced by the proximity of intrusive bodies. Broad plunging folds are traceable in a few places. In general the rocks dip to the northwest and strike about N. 30° E.

The quartz diorite was intruded as an elongate body trending west of north. Gneissic structure resembling flow-banding is indicated by alinement of the mafic minerals. The well-developed gneissic structure in the northern part of the area is believed to be due in part to later deformation. North of Seiad Creek the quartz diorite has permeated the schist along the contact, forming a wide band of injection gneiss.

The larger bodies of peridotite also follow a north to northwest trend, closely parallel to the structure of the other rocks. In some places peridotite has been injected along planes of foliation in the quartz diorite to form alternating bands of the two rocks through a zone 500 feet in width. Foliation is prominent in the peridotite and is best developed near contacts with earlier rocks.

Fractures cut some of the chromite deposits, but the displacements on them are generally not more than a few feet. One fault zone was observed along Seiad Creek in sec. 33, T. 47 N., R. 11 W., but the amount of displacement could not be measured. Some mineralization is associated with this fault, and a number of gold prospects are located along it. Landslides in the peridotite and serpentine are numerous, and two of the smaller chromite deposits are in landslides.

ORE BODIES

The chromite deposits are enclosed in zones of partly serpentinized peridotite containing 50 to 90 percent of the original olivine. In this respect they contrast with the deposits in Del Norte County, which are in wholly serpentinized rock.[6/] The ore bodies, most of which are tabular, contain several distinctive types of ore. The most prominent ore bodies in the Seiad Creek and some smaller deposits are composed of massive

6/ Maxson, J. H., op. cit., p. 149.

or layered chromite-bearing rock. Individual layers taper out and become ill-defined toward the ends and are most sharply defined at the sides. A few claims contain small amounts of orbicular and nodular ore, but massive or banded chromite constitutes the main ore bodies in all the deposits visited.

The ore deposits strike approximately parallel to the elongation of the peridotite areas, but they are not confined to any single zone.

The lengths of individual ore bodies, except in the Seiad Creek deposit, are at most only a few hundred feet. The chromite zones are discontinuous individual lenses of ore only a few feet or a few tens of feet in length. The chrome-rich zones contain between 20 and 40 percent of chromite, analyses of which average more than 50 percent of Cr_2O_3.

Mineralogy

The only ore mineral found in the deposits is chromite, whose formula is generally written as $FeO.Cr_2O_3$. Pure chromite contains 68 percent of chromic oxide and 32 percent of ferrous oxide, but in nature this ideal composition seldom occurs owing to the presence of aluminum, ferric iron, and magnesium in the chromite molecule. Because of the présence of these other elements the formula for chromite is more accurately written as $(Fe,Mg)O.(Cr,Al,Fe)_2O_3$. An analysis of chromite from the district follows:

Analysis of chromite from the Seiad Creek deposit 1/

/Charles Milton, analyst/

	A	B		A	B
Cr_2O_3	57.92	59.19	NiO	0.06	0.06
Al_2O_3	5.84	5.97	MgO	13.12	12.73
Fe_2O_3	6.40	6.54	CaO	.26	
FeO	14.83	15.16	SiO_2	1.29	
MnO	.25	.25	Total	99.97	99.90

1/ Johnston, W. D., Jr., op. cit., p. 425.

A. As analyzed.

B. After deducting 2.2 percent for $(Ca,Mg)SiO_3$, assumed to be present as an impurity.

The chief gangue minerals are olivine and serpentine, with olivine usually predominant. Small amounts of carbonate (magnesite?), kaemmererite, and uvarovite occasionally accompany the serpentine. Separation and concentration of the ore is made difficult by this type of gangue. The small difference of about 1.0 between the specific gravities of chromite and olivine is especially unfavorable to gravity concentration. Averill 7/ has described the results of some metallurgical work on ore from the Seiad Creek deposit. Concentration experiments were made that involved three types of magnetic separation, two types of flotation, and a method of tabling. The results are shown graphically in figure 42. The most satisfactory results were obtained by flotation of the chromite in an ore that assayed 32.17 percent of Cr_2O_3; one cleaner furnished concentrates that assayed 56.35 percent of Cr_2O_3, with a recovery of 89.7 percent.

7/ Averill, C. V., op. cit., p. 268.

Character of ore

Four distinct types of ore--banded, massive, nodular, and orbicular--are found in the deposits in the quadrangle. The types most important economically are the massive and banded ores (pls. 41, A, B, and 42, B), both of which are represented in the Seiad Creek deposit.

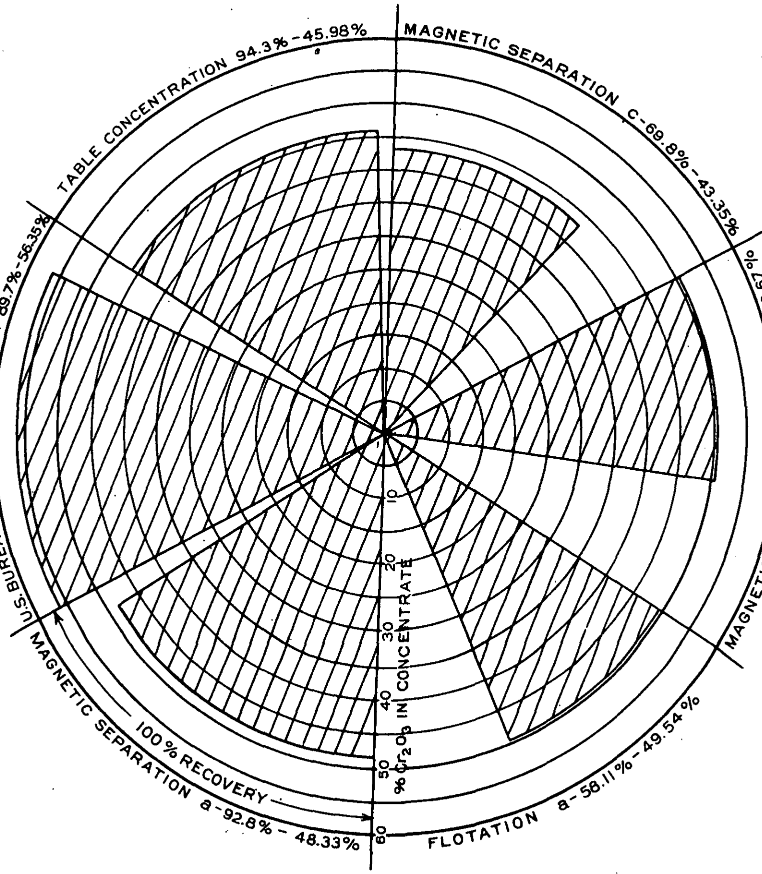
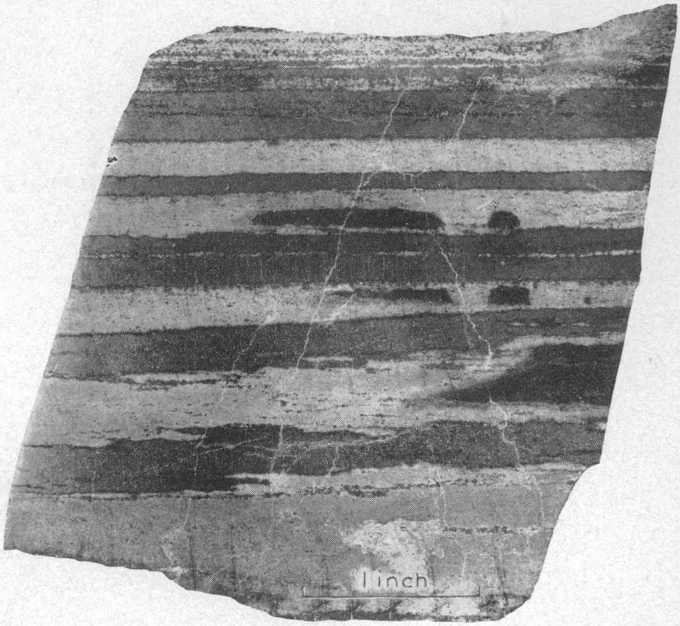
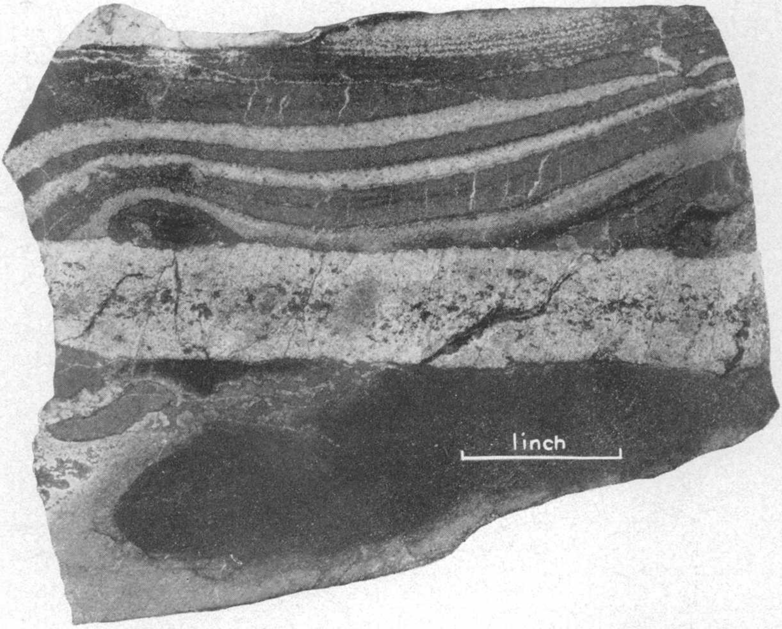


Figure 42.--Diagram showing results of metallurgical tests on Seiad Creek ore in percentage of recovery and percentage of Cr_2O_3 in concentrate, by six different methods. (After Averill.)

The banded ore consists of more or less continuous layers of chromite alternating with layers of partly serpentinized dunite. The chromite bands are mostly about a quarter of an



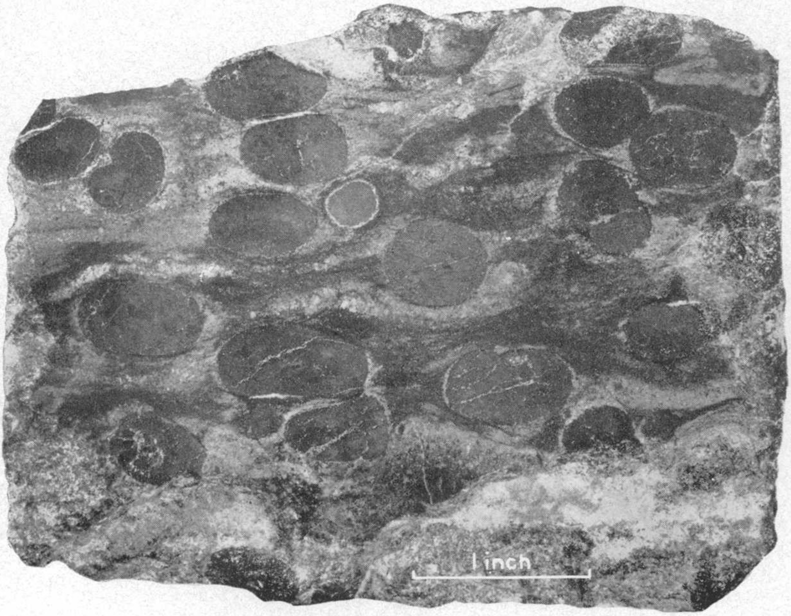
A. WELL-BANDED CHROMITE ORE SHOWING SMALL BLACK PATCHES OF UNWEATHERED PERIDOTITE.



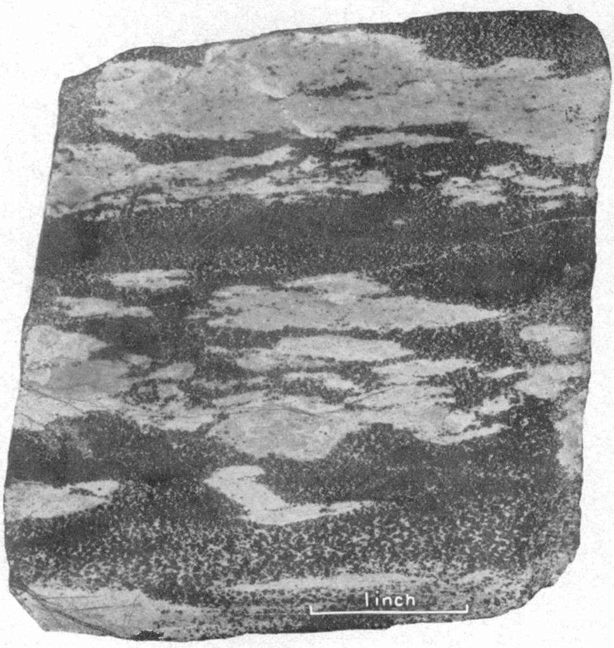
B. BANDED CHROMITE ORE CUT BY DIKE OF SAXONITE.

Saxonite is cut by later veinlets (black) of serpentine and carbonate. Cross fractures in the chromite are also filled with serpentine and carbonate. The dark area in the lower part of the specimen is unweathered peridotite.

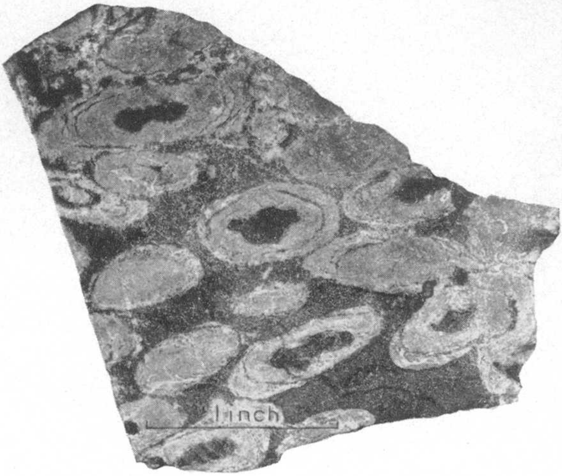
CHROMITE ORE FROM THE JUMBO CLAIM.



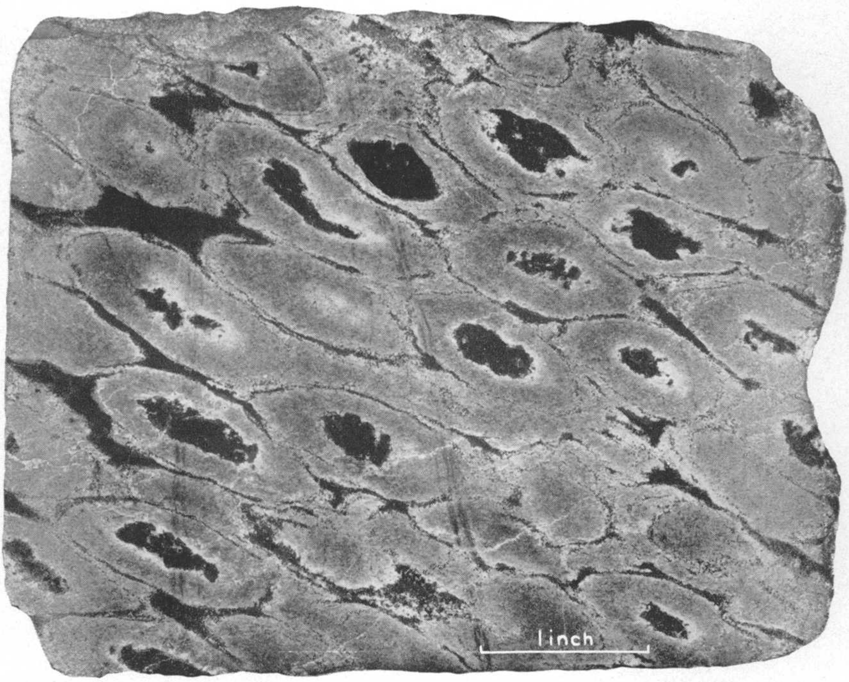
A. NODULAR CHROMITE FROM THE BLACK SPOT NO. 1 CLAIM.



B. RUDELY BANDED CHROMITE ORE FROM THE SEIAD CREEK DEPOSIT.



A. ORBICULAR CHROMITE ORE FROM THE OCTOPUS CLAIM.
Note successive shells of chromite and the abundance of inter-orbicular chromite.



B. ORBICULAR CHROMITE ORE FROM THE OCTOPUS CLAIM.

inch wide but may attain a width of 3 inches. In general they appear to have sharp boundaries, and the chromite grains are seen on close inspection to crosscut the olivine grains along the edges of the bands. Any single band extends for 15 or 20 feet at most and tapers out where another band a few inches to one side displays its maximum width.

Massive ore, averaging 60 percent of chromite, is found in several deposits, but only at the Seiad Creek deposit does it form ore bodies of noteworthy size. The banded ore grades into massive ore where the bands merge, but traces of banding are visible in even the most massive ore.

Nodular ore (pl. 42, A) occurs in two prospects. The nodules of chromite are embedded in a matrix of partly serpentinized olivine and pyroxene. The relation of the nodules to the foliation of the peridotite could not be determined.

Orbicular ore, consisting of close-spaced orbicules embedded in a matrix of serpentine, chromite, and serpentinized olivine (pl. 43, A, B), occurs in one deposit. The center of each orbicule consists of a mass of chromite crystals, which is surrounded by a shell of olivine. Some of the orbicules consist of several alternating shells of chromite and olivine. Where the chromite interstitial between the orbicules is abundant (pl. 43, A) the orbicular rock is good ore; elsewhere it averages only about 20 percent of chromite.

Origin

Chromite deposits have long been regarded as products of magmatic segregation. The universal association of chromite with ultrabasic rocks indicates a close genetic relationship.

Recent workers [8/] have questioned the magmatic segregation theory and have suggested that some of the chromite ores may be hydrothermal, or at least formed during a later magmatic stage than had previously been supposed.

Thin sections of the ores from the Seiad quadrangle are interpreted to indicate that chromite has replaced the olivine and pyroxene of the peridotite, for inclusions of olivine and of serpentine probably derived from olivine are common in the chromite, whereas the nearly complete absence of chromite inclusions in olivine implies that the olivine had almost completely crystallized before the chromite was formed. Chromite is always accompanied by serpentine, and olivine and chromite crystals are everywhere separated by thin sheaths of serpentine. Crystallization is believed to have yielded aqueous, chromite-rich residual liquors, which were introduced by a filter-pressing process into adjacent parts of the newly consolidated magmatic mass.

Most of the serpentinization accompanied the introduction of chromite in the late magmatic period. Later hydrothermal activity formed crosscutting veinlets of serpentine accompanied by carbonate, kaemmererite, and a little uvarovite. The distinction between the late magmatic and the hydrothermal serpentinization is emphasized by a small dike of relatively fresh saxonite that crosscuts the serpentinized banded ore and is cut in turn by hydrothermal veinlets of serpentine and carbonate (pl. 41, B).

Structural control is believed to have influenced the emplacement of the banded ores. Differential stresses set up in the partly consolidated magmatic mass could conceivably

---

8/ Sampson, Edward, May chromite crystallize late?: Econ. Geology, vol. 24, pp. 632-641, 1929. Ross, C. S., Is chromite always a magmatic segregation product?: Econ. Geology, vol. 24, pp. 641-645, 1929. Fisher, L. W., Origin of chromite deposits: Econ. Geology, vol. 24, pp. 691-721, 1929. Sampson, Edward, Varieties of chromite deposits: Econ. Geology, vol. 26, pp. 833-839, 1931. Eskola, P., On the chrome minerals of Outokumpu: Finland Geol. Comm. Bull. 103, pp. 26-44, 1933.

produce marginal zones of weakness into which, by a filter-pressing process, the chromite-rich liquid could migrate and replace the olivine and pyroxene. Osborne [9/] has deduced a similar origin for certain titaniferous iron ore deposits. The original nature of the marginal zones is not apparent, being obscured by serpentinization, but it is suggested by the foliation of the peridotite and by evidence of protoclastic structure and, possibly, of some recrystallization of the olivine. Such structure could result from differential flowage or fracture, or both, in the partly consolidated magma. The relative importance of the two processes is uncertain, but flow was probably dominant at first and fracture later. Evidence that stresses continued after the emplacement of the chromite is given by folding in the banded ore and by thin cross veins of serpentine and carbonate (pl. 41, B) in the chromite.

The orbicular and nodular chromite is believed to have resulted from the replacement of the original structure in the peridotite, although the nature of the original structure is not understood, having supposedly been obscured beyond recognition by serpentinization. Marginal facies of the nodule-bearing rock exhibit structural features similar to the orbicular chromite; both types, therefore, are believed to have originated from similar processes. Flattening and elongation of the orbicules is probably due to the same stresses that affected the banded ore.

The exact stage at which the chromite was crystallized has little economic importance. It is important, however, that the chromite is a part of the enclosing dunite, so that its occurrence bears no relation to post-dunite fissures or to the present topographic surface.

9/ Osborne, F. F., Certain magmatic titaniferous iron ores and their origin: Econ. Geology, vol. 23, no. 7, pp. 750-752, 1928.

Localization

The chromite ore bodies lie parallel to the foliation of large peridotite bodies that trend about N. 20°-30° W. across the area. The foliation strikes N. 26°-64° W. and dips 37° to 75° SW. Two joint systems are present in places; one system is normal to the planes of foliation; the other is perpendicular in strike to the foliation and its dips are steep.

The chromite deposits are not found at any particular position within the peridotite masses, and there is no apparent relation between the sizes or distribution of the deposits and their distances from contacts.

The four types of ore--banded, massive, nodular, and orbicular--grade into one another without apparent change in the structure or mineralogy of the peridotite.

The largest ore bodies are roughly tabular masses rich in chromite which occur in partly serpentinized peridotite. At the Seiad Creek deposit individual layers and groups of layers lie parallel to the foliation but are arranged en echelon, so that the deposit as a whole cuts across the foliation of the peridotite at a small angle. In other deposits the relations are undetermined because of small outcrops and poor exposures, but individual ore bands appear to be parallel to the foliation.

Chromite is unevenly disseminated throughout the peridotite. In places disseminated chromite increases in amount until it constitutes 60 percent of the rock. Massive ore results where such concentration has been attained between several adjacent chromite bands. No structural control that influenced the distribution of massive ore could be found.

The orbicular ore is scant. Its mode of occurrence is similar to that of the banded ore.

Size and grade of known ore bodies

In this report ore bodies that are exposed on the surface and are intersected by an adit, although blocked on two sides only, are considered as probable ore. In open cuts exposing banded ore a depth of not more than 5 feet is assumed unless added information about the extent in depth was obtained.

Assays and measurements of grade were unavailable for most of the deposits. At the Seiad Creek deposit, grab samples taken across the strike of chromite-rich bands averaged 38 percent of chromite and gave a concentrate averaging 52.37 percent of Cr_2O_3. The amount of magnetite was believed not to exceed 5 percent in any of the samples, and it may be as low as 1 percent in some. An analysis of chromite in the orbicular ore showed an average Cr_2O_3 content of 51 percent.[10/] These analyses come from widely separated deposits and are believed to be representative for the area.

Reserves

Surface mapping and grab sampling at the Seiad Creek, McGuffy Creek, and Fairview deposits indicate about 45,000 tons of 35-percent ore. Geologically reasonable assumptions of continuity along the strike between exposures indicate an additional 60,000 tons of 35-percent ore. Deeper exploration by adits or diamong drilling would doubtless increase these estimates.

In the same deposits an estimated 200,000 tons of 20-percent ore lying above the lowest working or outcrop is indicated. The tonnage of 5-percent ore is much larger.

10/ Johnston, W. D., Jr., op. cit., p. 420.

MINES

Seiad Creek deposit

The Seiad Creek deposit, owned by the Rustless Mining Corporation, is in sec. 20, T. 47 N., R. 11 W., on a ridge between the forks of Seiad Creek (pl. 44), 7 miles by mountain road from Seiad Valley. Seiad Creek carries a good flow of water the year round, and the neighboring slopes are well-timbered.

The deposit is developed by 500 feet of underground workings in two adits (fig. 43) and by 27 open cuts and pits. Another adit is very short and has caved. Several foot trails and a sled trail make the adits and cuts accessible from the end of the road. In 1938 and 1939 the owners improved the road and trails and opened up several new cuts.

The country rock is peridotite originally consisting almost entirely of olivine, which is now partly altered to antigorite and talc. The peridotite has a well-developed foliation striking N. 26°-64° W. and dipping 37° to 75° NE. It is cut by a set of joints with a strike parallel, and a dip approximately perpendicular, to the foliation. The peridotite is in contact with chlorite schist along the east fork of Seiad Creek and with quartz diorite on the west slope of the west fork of Seiad Creek. At the contact with the diorite the peridotite has been injected along the gneissic planes of the diorite to form a zone of alternating sheets of the two rocks, in places 500 feet wide. Pegmatite dikes crop out on both sides of the ridge between the forks of the creek at an elevation of about 4,000 feet.

The chromite-bearing zone, which transects the foliation of the peridotite at a small angle, consists of a series of elongated bodies arranged en echelon. Exposed bodies of chromite from 2 to 15 feet in thickness extend discontinuously for

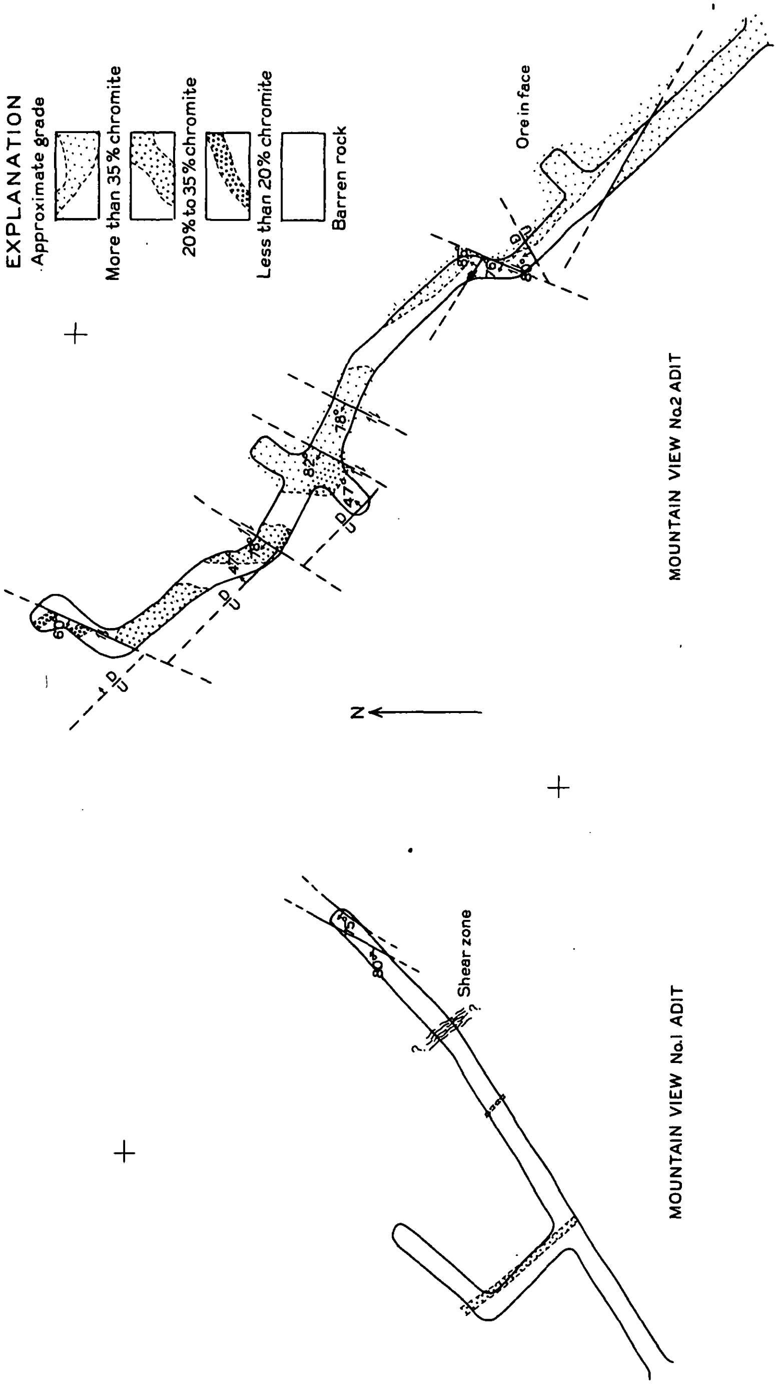


Figure 43.--Plans of underground workings at the Seiad Creek chromite deposit.

a distance of 3,000 feet. In general the ore is rudely banded and consists of small lenses of chromite intermixed with olivine. Most of the bands range from a fraction of an inch to a few inches in width, but individual bands of massive ore attain a width of 2 feet. Grab samples taken across chromite-rich zones in various parts of the deposit contained 17 to 64 percent of chromite and less than 5 percent of magnetite. The concentrate from these samples averaged 52.37 percent of Cr_2O_3. The grade of some of the ore sampled could be substantially raised by mechanical concentration or hand sorting. Kaemmererite, antigorite, and talc occur in cross fractures.

Minor post-chromite faulting was observed in the underground workings, but measurable displacements were not more than a few feet. Although surface indications are obscured by serpentinization and weathering, faulting has undoubtedly occurred in other parts of the deposit. Whether the faulting is of sufficient magnitude to displace chromite bodies into unexposed positions could not be definitely determined.

Chromite-rich bodies from 2 to 15 feet in width are exposed in several open cuts and adits, commonly as alternating bands of "high grade" and barren rock. The widths can be stated only approximately, as the "assay boundaries" of the ore would vary with the mining and milling methods used. Many of the bodies are pod-shaped and consist of massive chromite with little or no olivine; others are of relatively low grade, containing from 5 to 20 percent of disseminated chromite. Variations in shape and grade are great and unpredictable. The ore bodies show both lateral and vertical thinning, and chromite bodies are exposed underground that do not appear on the surface.

In calculating the reserves of this deposit, several assumptions are made that apply to all the deposits described.

1. The ore is assumed to average 9 cubic feet to the ton.

2. The ore exposed in each open cut is considered to be a separate unit except where ore is exposed on the surface between cuts.

3. The widths of the ore bodies are only approximate, as they would vary with such factors as assay boundaries, hand sorting, and mining and milling methods.

4. Ore was assumed to extend at least to the two adit levels unless a shallower depth was indicated by other evidence; and in some places it was proved this deep.

5. Probable ore is defined as ore in sight from adits, open cuts, and surface exposures.

6. Possible ore is defined as ore that is not exposed on the surface or cut by adits but assumed to be present along the strike of the ore zone.

On the above assumptions, indicated reserves, in tons, of the Seiad Creek deposit, averaging 35 percent of chromite, are estimated in the table below.

	Assuming vertical ore shoots	Assuming average dip of ore shoots as 50°
Probable ore	38,000	49,000
Possible ore	51,500	67,000
	89,500	116,000

Fairview group (Hamburg Bar mine)

Five claims (fig. 44) located on both sides of the ridge in sec. 34, T. 46 N., R. 11 W., are owned by Mary F. Reddy, of Medford, Oreg., and are under option to the Rustless Mining Corporation. Two miles of graded road connect the property with the Klamath River highway. The workings consist of five open cuts in ore. This deposit has not been worked since the first World War.

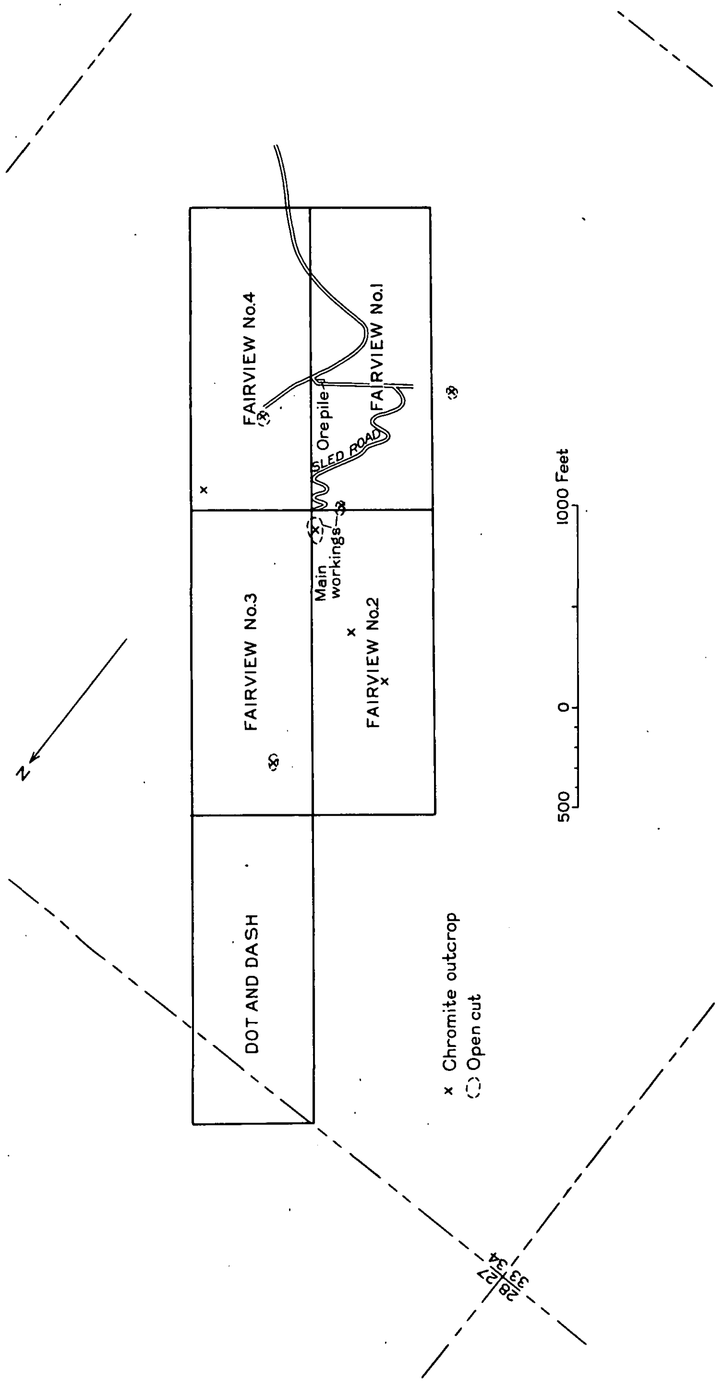


Figure 44.--Map of the Fairview group of chromite claims.

The chromite occurs in layers and in disseminated grains along zones parallel to the foliation of the peridotite country rock. The largest concentrations of chromite are exposed in two open cuts near the common corner of Fairview claims Nos. 1, 2, 3, and 4. The larger cut, which is on top of the ridge, exposes two zones of banded ore containing 20 to 25 percent of chromite, each zone 2 to 3 feet wide, 75 feet long, and separated by 3 to 6 feet of barren rock. The bands strike roughly N. 50° W. and dip 40° SW. About 10 tons of 20-percent ore is stacked on the dump. The other open cut also exposes two zones of chromite bands, which may represent the displaced extension of the bands in the upper cut. The zones are of lower grade in this cut than in the other; they range from 6 inches to 4 feet in width.

There are scattered outcrops of chromite at other places on the claims, but they are small and the major part of the chromite has already been mined.

Indicated reserves are estimated to be about 1,800 tons of 35-percent ore, of which 1,250 tons is probable ore and 550 tons is possible ore.

McGuffy Creek deposits

Several chromite deposits, known collectively as the McGuffy Creek deposits, occur in the northern part of sec. 25, T. 45 N., R. 11 W., and in the western part of sec. 30, T. 45 N., R. 10 W. Ore was shipped from three of these deposits during the first World War. Since that time four of the claims have been resurveyed and are now leased by H. W. Gould to the Rustless Mining Corporation. A sled trail and several foot trails connect the deposits with the Scott River road. The claims are described under their former names because it is not known whether the new claims include all the old workings. Where it is possible the new names also are given.

Octopus claim (Mary Lou, Chromite).--The Octopus claim was later relocated as the Mary Lou claim by Gus Kehrer, of Scott Bar, and is now known as the Chromite claim of the Rustless Mining Corporation. Workings consist of three open cuts and a short adit that is thoroughly caved. Much faulting and slipping are indicated in the peridotite. The chromite occurs in layers striking N. 38° W. and dipping 50° SW., parallel to the foliation of the peridotite. On the western margin is a small quantity of orbicular chromite, with the orbicules flattened in this same plane. Chromite bands are exposed over a width of 20 feet, a depth of nearly 50 feet, and a length of at least 25 feet along the strike, but more than half of the exposed width of the zone consists of barren rock. The richest part of the zone contains 25 to 35 percent of chromite. About 1,390 tons of ore averaging 35 percent of chromite is indicated.

Red Butte claim (Veta Grande).--The Red Butte claim is now known as the Veta Grande claim of the Rustless Mining Corporation. Workings consist mainly of two large open cuts. In only one are appreciable amounts of chromite exposed, and a short adit, now caved, has been driven across the chromite zone at the end of this cut. As in the Octopus claim, the chromite occurs as bands in peridotite. Individual bands range from a fraction of an inch to an inch in width and occur in a zone about 10 feet wide. Chromite is exposed in this cut along the strike for 150 feet, and it may extend discontinuously to the other cut. The average grade is about 20 percent. Large crystals of kaemmererite occur with talc and serpentine in cross-fractures in the chromite zone. About 3,340 tons of ore averaging 35 percent of chromite are indicated.

Liberty claim (Cerro Colorado).--The Liberty claim is now the Cerro Colorado claim of the Rustless Mining Corporation. The workings on the old Liberty claim consist of two open cuts on the west side of McGuffy Creek. The chromite occurs in bands that conform to the contorted foliation of the peridotite, suggesting that the rocks were contorted after the chromite was introduced. The bands are, on the average, approximately vertical and strike S. 10° E. into the side of the hill. Chromite is exposed in a zone 50 feet wide, about 10 percent of which would be minable. About 10 tons of 20- to 30-percent ore is stacked on the dump. About 139 tons of ore averaging 35 percent of chromite is indicated.

Jumbo claim.--Workings on the Jumbo claim consist of an open cut with a 15-foot adit. The ore is of the banded type and is contorted as in the Liberty claim. No ore has been shipped, but about 25 or 30 tons containing 30 percent of chromite has been mined and stacked on the dump. No estimate of additional reserves was made.

Neptune claim (Napatama ?).--Two open cuts and several prospect holes are opened up on the Neptune or Napatama (?) claim. The chromite rock is banded and occurs in a zone 5 feet wide and more than 100 feet long that trends N. 17° W. and dips 60° SW. No ore has been shipped, and because of the spotty distribution of the chromite the reserves are not believed to be large.

Black Spot claims.--Two chromite claims, Black Spot No. 1 and No. 2, have been located by Elmer Weeks, of Scott Bar, on the ridge north of McGuffy Creek. In both claims the chromite occurs as nodules. The chromite of Black Spot No. 1 was found in a slide and that of Black Spot No. 2 in a small outcrop on the top of the ridge.

Reliable tonnage estimates of the McGuffy Creek claims could be made only after extensive development. Trenching along the side of the ridge between the Red Butte and Liberty workings has uncovered small outcrops of chromite, indicating the possible presence of other chromite bodies.

Dolbear mine

The Dolbear mine is about 800 feet above the Klamath River, on the line between secs. 16 and 21, T. 46 N., R. 11 W. The property is patented by the Reddy interests of Medford, Oreg. There are several open cuts in ore, but they are so much caved that the extent of the ore in the deposit is concealed. Outcrops were observed along the ridge to an elevation of about 3,000 feet. A small amount of uvarovite was noted in cross fractures of the chromite. Reserves are roughly estimated to be 2,000 tons of rock averaging 35 percent of chromite.

Barton claim

The Barton claim, near the northern edge of sec. 9, T. 46 N., R. 12 W., is developed by two open cuts. The chromite left in these cuts is in part massive, in part disseminated. Ore was shipped during the first World War, and nearly all of it seems to have been mined out, as the reserves appear to be negligible.

Unidentified prospects

Near the southern edge of sec. 3, T. 46 N., R. 13 W., is an open cut in massive chromite, nearly all of which has been removed. About a ton of ore remained on the dump. Some kaemmererite accompanies the chromite, which occurs in black serpentine. No minable ore is thought to remain.

Three open cuts in disseminated and banded chromite on the eastern edge of sec. 19, T. 45 N., R. 10 W., were visited. Some of the chromite bands are 2 inches wide, but the total amount of chromite cannot be more than a few tons.

O