CHROMITE DEPOSITS OF SISKIYOU COUNTY, CALIFORNIA *

By Francis G. Wells ** and Fred W. Cater, Jr.**

OUTLINE OF REPORT

ABSTRACT

Siskiyou County, California's third largest in area, and fifth largest producer of chromite ore, is located along the Oregon boundary mostly within the sparsely settled Klamath Mountains. Geologically the county can be divided into two dissimilar parts; the eastern half is underlain by slightly deformed Tertiary to Recent sedimentary and volcanic rocks, and the western half by highly folded schists, metasedimentary, and metavolcanic rocks, which have been intruded first by ultramafic rocks and later by a series of igneous rocks of diverse composition. Masses of ultramafic rocks, most of which are peridotite, underlie less than a tenth of the county, but seem more abundant because they crop out in many places in the western part.

The chromite deposits are of two types, pod deposits and disseminated deposits. The pod deposits contain masses of clean chromite that can be mined, sorted, and shipped as lump ore. The disseminated deposits consist of dunite in which scattered chromite grains make up from a few to 80 percent of the mass. The pod type of deposit has yielded most of the output to date, but the deposits of disseminated ore contain the largest known reserves.

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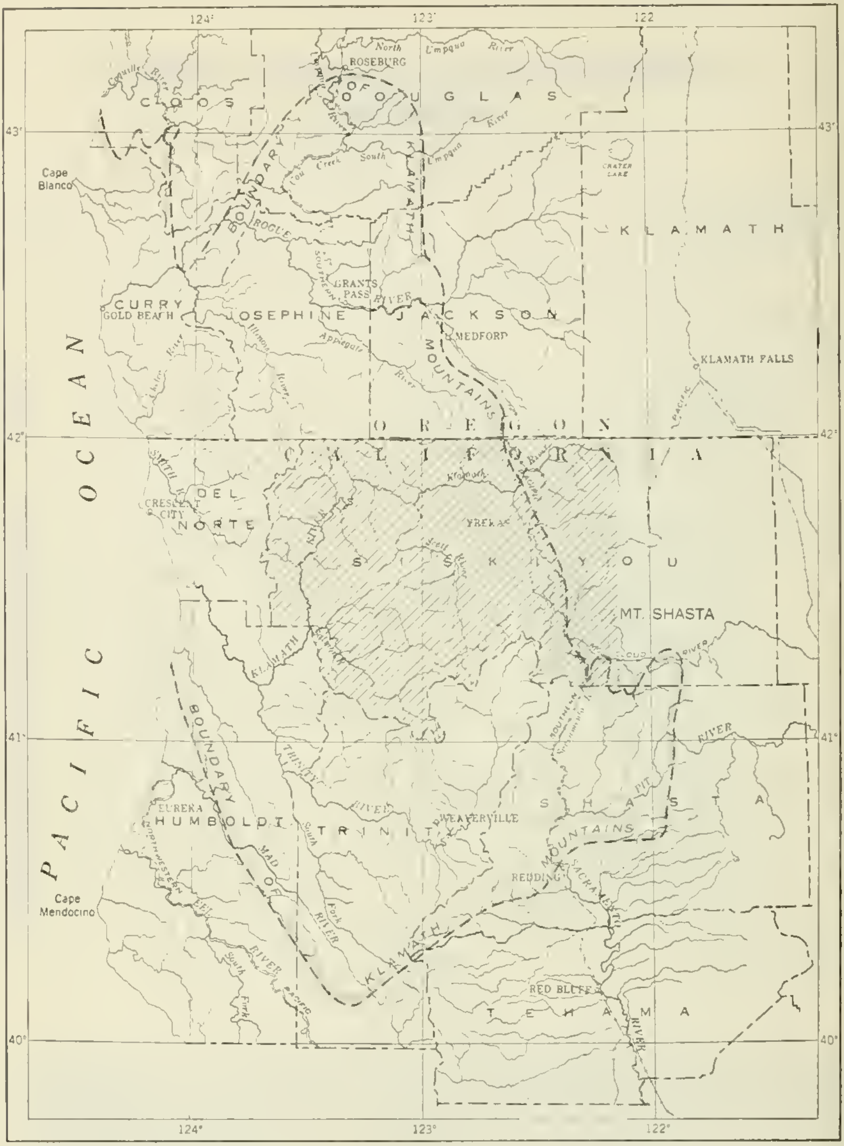

MAP OF NORTHWESTERN CALIFORNIA AND SOUTHWESTERN OREGON SHOWING THE KLAMATH MOUNTAINS PROVINCE

0 10 20 30 40 50 MILES

FIGURE 1. Ruled lines show area covered by Plate 12.

More than 90 deposits of chromite have been opened up within the county and ore has been shipped from 89 of them. They range in size from deposits that have yielded a few long tons to one that has a maximum of 4,000 long tons. Deposits of disseminated ore include the Mountain View mine which contains 212,000 short tons of 8.0 percent Cr_2O_3 indicated ore, and several others that contain more than 5,000 short tons of indicated ore.

The chromites found in Siskiyou County have, by and large, a ratio in excess of 2.50 and it should be possible to produce concentrates that would realize this ratio or but little less. In general the Cr_2O_3 content of the minerals exceeds 45 percent. A few very high-grade pod deposits have been mined.

The known production from Siskiyou County (to December 31, 1945) is 23,723 long tons. The vagaries in size and shape of chromite pods are so great that the only known ore is ore completely exposed on four sides. There is only a few long tons of known ore in the county. The amount of indicated pod ore is less than 5,000 long tons. In all probability future production of pod ore will not equal 20,000 long tons. About 274,500 short tons of disseminated ore of various grades is indicated in the county. This ore contains 21,000 short tons of chromic oxide or 38,000 short tons of theoretical chromite containing 55 percent Cr_2O_3.

INTRODUCTION

Geography

Siskiyou County has been an important producer of chromite in California, its output to December 31, 1944, placing it fifth among the counties of the state. In reserves of concentrating ore, it ranks second to El Dorado County. Siskiyou County is the third largest in the state and has an area of 6,256 square miles. It lies along the northern border of the state (fig. 1) and includes the part of the Klamath Mountains that falls within the drainage basins of the Klamath and Salmon Rivers above their confluence. The canyon of Klamath River, one of the great rivers of the Pacific Coast, has been cut several thousand feet deep through the mountains to the sea; with its tributary canyons it makes the relief of the county extremely rugged. The region is a wilderness of canyons and mountain ridges that rise in many places to altitudes above 7,000 feet (pl. 12). Scott, Shasta, and Little Shasta Valleys are open and rolling, but they are exceptional and together comprise less than 300 square miles.

The climate is mild in the valleys but severe on the high ridges and peaks where snow commonly falls as early as October and remains until June. Water is abundant and good; timber is everywhere close at hand.

Naturally such an area is sparsely settled. The population of the county according to the 1940 census was 28,598. Most of the people live in the main valleys named above. The principal highway of the region is U. S. Highway 99. There are gravelled roads in the valleys of Klamath, Scott, and Salmon Rivers, and a few Forest Service roads, passable in dry weather, give access to some of the ridge tops. The Southern Pacific Railroad traverses the eastern part of the area shown on plate 12 from south to north. Topographic maps are available for all the area.

Field Work and Acknowledgments

This report is based on the investigations of chromite deposits in the Pacific Coast States made by the U. S. Geological Survey between July 1938 and May 1945 as part of its strategic minerals program. Within Siskiyou County these investigations included the areal mapping of 273 square miles on a scale of a mile to the inch, and detailed studies of four important disseminated chromite deposits. During the detailed studies, topographic and geologic maps of the mineral-bearing areas and of all underground mine workings were prepared on various scales, the largest scale being 20 feet to the inch, and the smallest, 600 feet to the inch. Some large pod deposits were mapped in detail and many of the small pods that were being worked during this period were briefly examined. Furthermore, the Geological Survey cooperated with the U. S. Bureau of Mines in all of its exploration projects within the county. Many of the deposits were visited several times. The geologists who worked on these projects are: J. R. Bovyer, F. W. Cater Jr., D. H. Dow, D. E. Flint, Leigh French 3d, F. W. Gros, H. E. Hawkes, R. T. Littleton, J. S. Livermore, D. A. Phoenix, P. W. Richards, G. A. Rynearson, C. T. Smith, F. G. Wells, and W. P. Williams. This work was under the close supervision of Mr. Wells.

No attempt was made to revisit systematically all the chromite deposits that were worked during World War I but that were not reopened during World War II, because the time required to find and examine these old caved workings seemed excessive for the information to be obtained. Instead, use has been made of the unpublished data collected during World War I by geologists and engineers of the Geological Survey and the Bureau of Mines.

Some inconsistencies between the location of the deposits, as shown on plate 12 and given in the legal descriptions in the text, may be found by careful cross checking. They occur if the deposit has been accurately located in the field and plotted on the map in relation to the topography and if the legal description is in error with the conditions on the ground or the land net is not plotted correctly in relation to the topography, or vice versa. All three types of inconsistencies are found. As the person who uses the map to locate the deposit in the field will follow the topography, it seems better to plot the deposit accurately in relation to the topography, and let the inaccuracy in relation to the land net stand. The factor in error in the legal description is not known, but an examination of the map clearly shows how poor the land survey is.

This report has been prepared by F. G. Wells, who has made free use—without specific reference each time—to all available unpublished material. References to this material for each deposit are given in table 6.

This opportunity is taken to thank the many people in Siskiyou County who have helped the personnel of the Geological Survey during the 6 years that the investigations of chromite deposits were in progress. The Survey geologists received many courtesies and kindnesses and much assistance and cooperation. The operators, especially the officials of the Rustless Mining Company, and also Mrs. D. R. Moroney and Mr. J. K. Remsen, were most cooperative. The officials of the Klamath and Siskiyou National Forests, especially Messrs. Thomas Bigelow, Rex Denny, Chester Bartholf, and C. D. Cameron, never failed to be helpful. The engineers of the U. S. Bureau of Mines and the Metals Reserve Company all gave friendly assistance. Dr. Olaf P. Jenkins of the California Division of Mines helped most generously. To all these specially named and to many others the writers address their thanks, as well as to their associates on the Geological Survey, whose help contributes an important part to this report.

GEOLOGY

Geologic maps are available only for parts of Siskiyou County, but they suffice to show that the county shares the complicated stratigraphy and structure of the central Klamath Mountains. Among published geologic maps, a preliminary reconnaissance map of the eastern half of the county [1] shows in a general way the distribution of the ultramafic rocks. A carefully prepared map, scale 1 : 62,500, of an area of 286 square miles in the northwestern quarter of the Seiad quadrangle extends the area mapped a few miles farther west and is the only systematic geologic map available for the county.[2] To the west of these areas is an unmapped strip of mountains 25 miles wide that extends from north to south across the county. An exploratory reconnaissance map of the western margin of the county is available.[3] These maps, supplemented by a few traverses across the county, do not form a basis for a systematic treatment of the distribution and structure of the rocks that underlie the region, but they do furnish some pertinent data about the chromite-bearing peridotites and their host rocks.

Slates, metasedimentary and metavolcanic rocks, or schists and gneisses are the rocks into which the peridotite was intruded. All are highly deformed and are certainly older than the Franciscan and Knoxville formations within which so many of the large peridotite intrusions of California occur.

The Galice formation, the equivalent of the Mariposa slate of Upper Jurassic age,[4] has been traced from Oregon southward across the western part of the county and extends as far east as Cottage Grove on Klamath River (pl. 12). The slates, sandstones, and metavolcanic rocks that compose the Galice formation have been closely folded and intruded by peridotite and lighter-colored granitoid rocks. Metavolcanic and metasedimentary rocks, the Triassic (?) Applegate group,[5] lie to the east of the Galice formation along the northern boundary of the county; a traverse along Klamath River indicates that these rocks extend many miles southward. They have been intricately intruded by dioritic rocks and in places they have been converted to gneiss. Within the Applegate group is a massif of pre-Cambrian (?) Salmon and Abrams schist that lies between Seiad and Beaver Creeks and extends southward across Klamath River. Intrusions of peridotite occur around the periphery of this massif and separate the schists from the Applegate group. Sill-like bodies of peridotite are also interbedded with isoclinally folded Applegate rocks.

Limestones containing Silurian fossils [6] have been found in the mountains around Scott Valley, and to the west of Scott Valley non-

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[1] Jenkins, O. P., Geologic map of California, scale 1 :500,000, California Div. Mines, 1938.

[2] Rynearson, G. A., and Smith, C. T., Chromite deposits in the Seiad quadrangle, Siskiyou County, California : U. S. Geol. Survey Bull. 922J, pp. 281-306, 1940.

[3] Maxson, J. H., Economic geology of portions of Del Norte and Siskiyou Counties, northwesternmost California : California Jour. Mines and Geology, vol. 29, pp. 123-160, 1933.

[4] Diller, J. S., and Kay, G. F., Description of the Riddle quadrangle : U. S. Geol. Survey Geol. Atlas, Riddle Fol. (no. 218), p. 3, 1924.

[5] Wells, F. G., Hotz, P. E., and Cater, F. W. Jr., Preliminary description of the Kerby quadrangle, Oregon : Oregon Dept. Geol. Min. Ind. Bull. 40, p. 23, 1949.

[6] Stauffer, C. R., The Devonian of California : Univ. California, Dept. Geol. Sci. Bull. 19, pp. 81-118, 1930.

Westman, B. J., Silurian of the Klamath Mountain province : Geol. Soc. America Bull., vol. 58, p. 1263, 1947.

fossiliferous limestone beds are associated with argillites and metavolcanic rocks within which are small bodies of highly serpentinized and crushed peridotite. The stratigraphy and structure of these rocks and their relationship to the younger rocks of the region have not been determined. To the southwest, south, and southeast these rocks are cut off by peridotite and younger dioritic rocks. To the east they are buried under flat-lying volcanic rocks, but a few scattered windows of the older rocks, including peridotite, show through the volcanic cover near its western boundary. North of Grenada (pl. 12) the Chico formation rests on the east-dipping surface of the beveled pre-Cretaceous rocks and farther north the Chico in turn is overlain by Eocene sediments that dip gently east.

The peridotites intrude all the pre-Cretaceous rocks except the other intrusives. There is some evidence that they may be of more than one age. This question is discussed later in this report, for it has potential economic significance. Although experience has not proved that there are two or more periods of intrusion, it indicates that in general large, high-grade deposits of chromite are not apt to be found in the peridotites lying within pre-Jurassic rocks.

Diorite, Rodingite and Granodiorite. Younger dioritic and granodioritic rocks intrude the ultramafic rocks in a very irregular pattern. Most of the diorite occurs in short, relatively wide dikes that are irregular and discontinuous (pl. 15). Dikes of rodingite, a white calcium-rich rock consisting mainly of grossularite and diopside, are associated with the diorite dikes. The rodingite is believed to be genetically related to the diorite dikes, and both rocks cut across both the peridotite and the massive chromite. The presence of rodingite at the Cyclone Gap (pl. 16) and Doe Flat mines and its absence in the chromite deposits in the Red Butte-Seiad Creek and Hamburg-McGuffy Creek masses may indicate that the large diorite bodies found in these masses are of a different age.[7]

Dikes of granodiorite cut the peridotite in the McGuffy Creek area and large intrusive masses cut the peridotites elsewhere in the county.

As the peridotites and their alteration products contain all of the chromite deposits, they alone will be described in greater detail.

Peridotites. Chromite, the only ore of chromium, is an almost constant accessory of peridotite and is found only in such rocks or their alteration products. In the Pacific Coast States, noteworthy concentrations of chromite are apparently restricted to a variety of ultramafic rock called dunite. Prospecting for chromite in place can therefore be confined to areas underlain by ultramafic rocks and intensive search can be further limited to bodies of dunite where that rock can be distinguished; in many places, however, the peridotites are so greatly sheared and serpentinized that dunite cannot be distinguished from the more common variety saxonite.

The wide distribution of the peridotite through the pre-Cretaceous rocks has been discussed in the preceding section. The peridotite occurs as large, irregular but usually elongate bodies, the largest of which covers about 100 square miles, and also as small, separate but adjacent masses

[7] Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., Chromite deposits near Seiad and McGuffy Creeks, Siskiyou County, California: U. S. Geol. Survey Bull. 948B, 1949.

a few acres to a few square miles in extent. In general, they are tabular and rudely conformable with the enclosing rocks. A few dikes are known and possibly some plugs are present, though none has been definitely recognized. Some of the small bodies are blobs occurring in the host rocks like pustules in flesh.

The ultramafic rocks contain little or no feldspar and are characterized by one or more of the common magnesium-iron silicate minerals olivine, pyroxene, and amphibole. Those in Siskiyou County include at least two small areas that may consist largely of pyroxenite—a rock consisting mainly of pyroxene—but in the main they consist of peridotite, which is the name applied to rocks consisting chiefly of olivine.

Peridotite may contain more or less pyroxene which is chiefly enstatite, but in many places includes augite and, much more rarely, diopside; and it contains magnetite and chromite as accessory minerals. The relative abundance of these minerals may vary greatly in different parts of a single rock mass. In this report a peridotite that contains 95 percent or more of olivine is termed dunite; one that contains less olivine, the remainder being chiefly enstatite, is called saxonite. Both dunite and saxonite are common in Siskiyou County, but saxonite is by far the more abundant. Olivine and enstatite both alter to serpentine. Enstatite alters to bastite, a material having the composition of serpentine, a bronzy color, and a satiny luster. Both enstatite and bastite weather less rapidly than either fresh or serpentinized olivine, so weathered saxonite has a rough surface, studded with projecting crystals of enstatite or bastite left by the wasting of the fresh or serpentinized olivine. Dunite, on the other hand, has a smooth weathered surface. Weathering of either kind of peridotite liberates oxides of iron, which color the rock surface and soil a strong, yellowish red, but beneath this coating the unweathered rock has the dark-green to nearly black color and waxy luster of serpentinized olivine, or the water-green color and vitreous to greasy luster of fresh olivine. The soil on peridotites is generally thin, and vegetation is relatively sparse.

The ratio of dunite to saxonite in different peridotite masses varies widely. In some masses, the Red Butte-Seiad Creek mass for example, more than half the rock is dunite; in others dunite makes up only a few percent of the rock. The dunite bodies may be of any size and of any shape, and may occur anywhere within a mass of peridotite. The larger they are, the more they tend to be of simple form. Small bodies, a few yards in diameter, are likely to be very irregular, with tongues extending into the adjacent saxonite. Chromite invariably occurs in dunite, but a pod of chromite may be separated from the surrounding saxonite only by a thin rind of dunite. Where that is so the dunite, especially if sheared, gives little help in locating the chromite deposits.

THE CHROMITE ORE

Accumulations of chromite large enough to be mined may be more or less mixed with the host rock, or they may form dense aggregates of crystals. The former are called disseminated ore, and the latter massive ore.

Disseminated Ore

Disseminated ore may consist of chromite grains scattered at random through dunite, but more frequently it consists of narrow schlieren,[8] in which the chromite grains may constitute from 20 to 30 percent of the mass. Most of the schlieren are surrounded by a relatively thin shell of transitional rock, which grades outward into barren dunite. In many places irregular masses of dunite, enclosing straight or sinuous wisps, comet-shaped schlieren, lumps, and whorls of chromite, are scattered widely and at random through the peridotite. Masses of disseminated ore in nearly straight, ill-defined zones are common in Siskiyou County. In some places tabular or cylindrical schlieren are grouped, and those that alternate more or less regularly with dunite give the rock a banded appearance. Such material may sometimes be hand-cobbed to a shipping grade. When viewed broadly, the axes of these schlieren are likely to lie parallel to the major axis of the peridotite mass, but in detail they may be much contorted. If a body of disseminated ore is ellipsoidal, its longest axis is apt to be parallel to other linear elements in the mass. As far as is now known, bodies of disseminated ore, though always enclosed in dunite, may occur in any part of a mass of peridotite. A minable body may contain as little as a few hundred pounds or as much as 100,000 tons of ore that is at least 25 percent chromite. Rarely does any one group of closely spaced chromite schlieren contain more than a few thousand tons, but in places a large number of such groups are so bundled together that they could be mined as one large deposit that contains tens of thousands of tons of ore, and are surrounded by peridotite nearly devoid of chromite. More detailed descriptions of such bundles are given in other published reports.[9]

Massive Ore

Description of Massive Ore. Massive ore differs from disseminated ore in the concentration of chromite grains. In general, massive ore has sharp boundaries between ore in which gangue minerals are inconspicuous and practically barren dunite, whereas disseminated ore grades from almost barren dunite to almost pure chromite. Typically massive ore is black in color and lumpy in structure. The lumps commonly range in size between one half and one centimeter and may be rectilinear. In the purest ore the lumpy structure is suggested by scattered small zones of silicate minerals that occupy the space between lumps of ore that have not been quite squashed together; in general the lumps are partly or completely surrounded by interlocking threads of gangue mineral rarely more than 1 or 2 millimeters in thickness. Some of the ore looks as though the chromite had been shattered and gangue introduced between the fragments. When the ore is examined under the microscope all these structures are found on a smaller scale. Whether all the grains of chromite in any lump originally had the same crystal orientation has not been determined. Most massive ore contains a few percent of gangue mineral but rarely as much as 10 percent.

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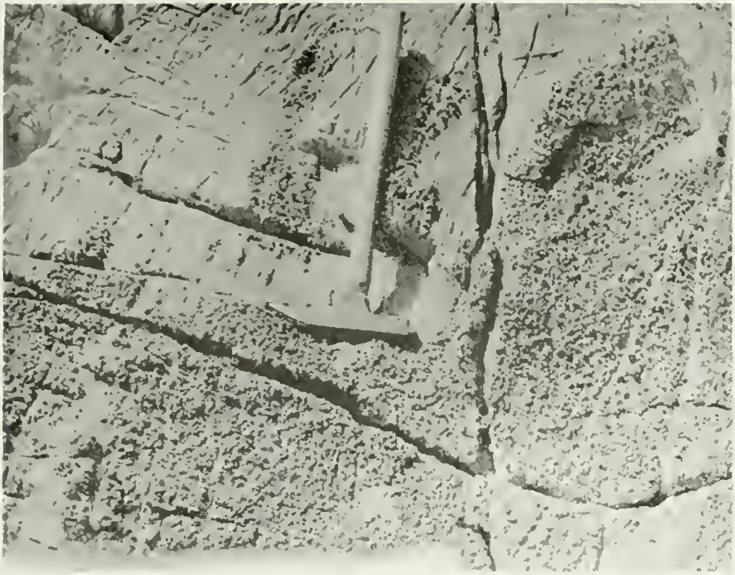
[8] *Schliere:* An irregular portion, ordinarily not everywhere sharply bounded, of an igneous rock, that differs in texture or composition from the rest of the mass but is an essential part of it. Plural, *schlieren.* (Fay.)

[9] Wells, F. G., Page, L. R., and James, H. L. Chromite deposits of the Pilliken area, El Dorado County, Calif.: U. S. Geol. Survey Bull. 922-O, pp. 417-460, 1940.

Rynearson, G. A., and Wells, F. G., Geology of the Gray Eagle chromite deposits in Glenn County, Calif.: U. S. Geol. Survey Bull. 945A, pp. 5-22, 1944.

Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., Chromite deposits near Seiad and McGuffy Creeks, Siskiyou County, Calif.: U. S. Geol. Survey Bull. 948B, 1949.



A, WEATHERED DUNITE (SMOOTH) AND SAXONITE (STUDDED)
Photo by T. P. Thayer

B, OUTCROP OF CHROMITE POD, DOE FLAT MINE
Photo by J. H. Maxson, 1930

Character of Ore Bodies. The dense aggregates of massive chromite are frequently called lenses or kidneys by the miner, but their forms are so widely varied and in part so irregular that terms of such definite meaning seem inappropriate. The writers prefer to apply to them the more noncommittal term "pod deposits."

The content of such a deposit may be anywhere between a ton and 20,000 tons. Allen [10] classified chromite deposits as (1) small, containing less than 100 long tons; (2) medium, containing 100 to 1,000 long tons; and (3) large, containing more than 1,000 long tons. Of the 235 deposits that he lists, he classes 48 percent as small, 24 percent as medium, and 28 percent as large. However, this list includes many disseminated deposits, and the deposits that he described were probably above average in size. In Del Norte County, which has yielded the largest output from pod deposits of any county in the state, 72 percent of the deposits are small, 20 percent are medium, and 8 percent are large. Therefore, it seems a fair guess that of the new finds of pod deposits in Siskiyou County, about 10 percent will be large and about 25 percent medium.

Usually there is no correlation between the size of a chromite deposit and that of the peridotite mass within which it is enclosed except that the largest ore deposits occur in the largest masses of peridotite.

Relation to Shear Zones. Many but not all pod deposits occur in shear zones, which may be as much as several hundred feet wide and many miles long, or as little as 20 feet wide and only a few hundred feet long. Shear zones are characterized by greenish-gray to honey-colored, more or less translucent serpentine that forms flakes and lenticular lumps with polished surfaces which are unusually slippery. The miners call this variety of serpentine "slickentite"—a term so descriptive that it seems worthy of adoption. As slickentite erodes readily, it usually underlies depressions in the surface. Roads that traverse peridotite bodies are, therefore, likely to be mainly in slickentite, and many people consequently get the mistaken idea that peridotite, or the serpentine derived from it, is all of this character.

Shear zones follow zones of weakness. The contact of the peridotite with older rocks is necessarily a zone of weakness, inasmuch as two different kinds of rock are readily broken apart. When fissures form along the border, the marginal peridotite may be serpentinized more readily and consequently weakened still further, so under continuing stress it becomes thoroughly sheared. Fissures likewise tend to form at the borders of dunite masses enclosed in saxonite.

Whenever two intermingled rocks that differ greatly in hardness are intensely sheared, the hard rock tends to break up into blocks, which, though at first angular, become abraded by the ensuing movement into smooth, polished, rounded masses that resemble horses in veins. The rounded masses of chromite in the peridotite shear zones have had such a history. These are sometimes called knockers, and will be called so here. Knockers of chromite may be widely spaced, closely spaced, or overlapping. Which condition exists in any deposit cannot be predicted, as it depends on the shape and size of the original pod or pods and the amount of shearing they have undergone. The attitude of the knockers depends on the original orientation of the chromite pod and the dragging

[10] Allen, J. E., Geological investigation of the chromite deposits of California: California Jour. Mines and Geology, vol. 37, pp. 101-167, 1941.

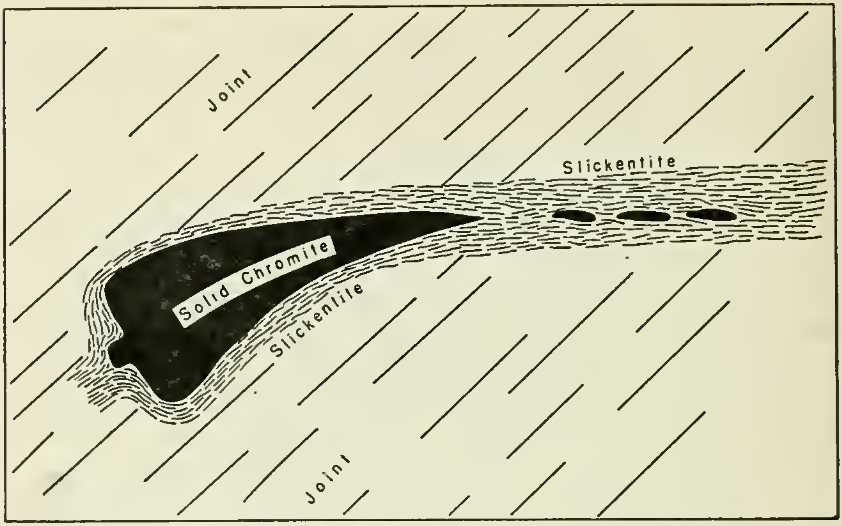


FIGURE 2. Diagrammatic sketch of a section across a pod of massive chromite near Elder Creek, Siskiyou County.

out or rotation that it has undergone during deformation. In prospecting for knockers of chromite, one should follow the direction of elongation of knockers or strings of knockers already discovered. The angle that this direction makes with the horizontal is called the plunge, and the plunge tends to remain constant throughout the peridotite that occupies the same part of a structure—that, for example, on either flank of a fold, or on its crest.

Knockers are found only in sheared serpentine, but not all shear zones contain chromite. There is no evidence that chromite pods were formed in shear zones after the shearing took place; the pods were there first, and caused a weakness in the peridotite that made it especially liable to shearing. All pods, moreover, are enclosed in dunite, which is more readily serpentinized than saxonite, and when serpentinized is readily sheared. A shear zone well within a mass of peridotite may therefore be a little more likely to contain massive chromite than a shear zone along the contact. As it cannot be a result of the weakening influence of the contact, it is all the more likely to mark the position of a streak of dunite, or a string of dunite bodies, which may have contained pods of chromite.

The widespread localization of pods of chromite in shear zones has led many observers to believe that the shear zones of slickentite were formed prior to the emplacement of the chromite and consequently exerted a definite control over the localization of the chromite.[11] In most deposits it is impossible to prove the correct relationships, but good evidence that the shearing is later than the chromite is found at a pod of chromite near Elder Creek (fig. 2). Here primary sheeting planes cut the enveloping dunite. The body of chromite, shaped like a milkweed pod, and having a slickensided surface, lies across the sheeting. The sheeting

[11] Newhouse, W. H., Ore deposits as related to structural features, p. 111, Princeton Univ. Press, 1942.

planes do not traverse the pod but end against an envelope of slickentite wrapped around the pod as a husk. This is shown diagrammatically in figure 2. The facts seem to prove the following sequence of events: (1) solidification of the dunite and of a body of massive chromite within it; (2) formation of sheeting in the peridotite during the end stage of solidification; and (3) application of shear stresses that broke off a chromite pod from the larger chromite mass, dragged the pod away from the parent body and across the sheeting, and sheared the contiguous serpentinized dunite to slickentite.

Chromium Minerals other than Chromite

Chromium-bearing minerals, other than chromite, that are found with the ore are in very small amount and are of no commercial value, but they are of scientific interest and may throw some light on the origin of the deposits. They include the chromium-bearing garnet uvarovite and the chromium-bearing chlorite kämmererite. The chromium-bearing pyroxene, diopside, was not found by the writers, but Diller [12] reports that he recognized it in a specimen from sec. 24, T. 44 N., R. 8 W. He writes, "it appears to be associated with pink chrome chlorite of secondary origin, derived from the alteration of the chrome diopside, which appears to be a primary part of the rock structure. The rare occurrence of chrome diopside with chromite is remarkable."

Uvarovite is emerald green, has a vitreous luster, and is harder than quartz. It forms incrustations of tiny, perfectly formed dodecahedrons or trapezohedrons on joint surfaces in homogeneous chromite. It is found in small quantities in the pods in Siskiyou County, but was not recognized in the large deposits of disseminated ore.

Kämmererite is soft, micaceous, and lavender to pink. Small plates of it are common in chromite and the contiguous gangue. Where well developed it forms hexagonal plates and books of plates. Unusually fine crystals of kämmererite have been found in the Veta Grande on McGuffy Creek. The plates were as much as 15 millimeters across and the prisms or books 20 millimeters long.

Chemical Characteristics of Chromite

Chromite, the only ore mineral of chromium, is a spinel. Most of the spinels are isomorphous mixtures of several end members, and chromite is a mixture in varying proportions of magnesiochromite ($MgO \cdot Cr_2O_3$), spinel ($MgO \cdot Al_2O_3$), magnesioferrite ($MgO \cdot Fe_2O_3$), ferrochromite ($FeO \cdot Cr_2O_3$), hercynite ($FeO \cdot Al_2O_3$), and magnetite ($FeO \cdot Fe_2O_3$). A dozen grains of pure chromite, therefore, may all differ distinctly from one another in composition; each may contain a measurably different percentage of chromium, of iron, of aluminum, and of magnesium. The chromium content of chromite is usually stated in percent of chromic oxide. Some chromite analyzed in the laboratory of the Geological Survey contained more than 61 percent of Cr_2O_3.[13] The market value and utility of chromite depends not only on the chromium content but on the iron content as well; hence the chromium-iron ratio, which is the percentage of chromium divided by the percentage of iron,

[12] Diller, J. S., Recent studies of domestic chromite deposits: Am. Inst. Min. Met. Eng. Bull. 153, pp. 1995-2040, 1919.

[13] Stevens, R. E., Composition of some chromites of the Western Hemisphere: Am. Mineralogist, vol. 29, pp. 1-34, 1944.

Table 1. Complete analyses of chromites in weight percent from Siskiyou County, California, made in the laboratory of the U. S. Geological Survey.

Sample number	1 [a]	2 [a]	3 [a]	4 [b]	5 [d]
Cr_2O_3	58.45	55.30	56.83	57.92	[e] 53.96
Al_2O_3	9.36	11.51	9.27	5.84	13.75
Fe_2O_3	[c] 4.47	[c] 4.67	[c] 5.19	6.40	[e, b] 2.50
FeO	[c] 14.15	[c] 15.58	[c] 17.19	14.83	[e, b] 13.71
MgO	12.71	12.06	10.77	13.12	13.96
MnO	.12	.22	.22	.25	.15
CaO	None	.08	None	.26	.40
TiO_2	.33	.41	.26	(NiO 0.06)	.23
SiO_2	.22	.32	.34	1.29	[f] 1.52
H_2O+	.08	.12	Trace	----------	.12
Totals	99.89	100.27	100.07	99.97	100.44
Cr	40.01	37.85	38.90	39.69	36.90
Fe	14.14	15.39	16.99	15.94	12.41
Ratio Cr/Fe	2.83	2.46	2.29	2.50	2.97
Impurity	Serpentine	Serpentine & olivine	Serpentine	----------	Serpentine
Cr_2O_3 in ore	41.39	39.90	17.40	----------	48.20
Chromite in ore	71.	72.	31.	----------	89.4
Sp. gr. of chromite	4.51	4.51	4.68	----------	----------

[a] Analyst, R. E. Stevens.
[b] Analyst, Charles Milton.
[c] Calculated to give 1 to 1 ratio RO to R_2O_3.
[d] Analyst, M. K. Carron.
[e] Cr_2O_3 and total Fe rechecked by R. E. Stevens.
[f] $-H_2O$, 0.14; P_2O_5, none; S, trace.
* Metals Reserve Company stockpile figures.

is one of the factors considered in judging the desirability of a chromite ore. Specifications for metallurgical chromite ore usually call for a Cr_2O_3 content of 45 percent or better and a chromium-iron ratio of not less than 3. In ore to be used as a refractory, alumina content also is important, and such ore should contain at least 60 percent of chromic oxide and aluminum oxide (Al_2O_3) together. Silica is an undesirable constituent; specifications for metallurgical ore require that SiO_2 content shall not be more than 10 percent. All the massive chromite, however homogeneous, that has been analyzed by the Geological Survey contains a few to 10 or 15 percent of silicate minerals, which coat the chromite grains or fill spaces between them.

To determine the value of disseminated ore it is necessary to analyze chromite that has been carefully concentrated from a fairly large sample. Analyses of rich lumps of coarse-grained material picked from a body of disseminated ore do not necessarily give the composition of the concentrate; it has been found that picked ore of this character may carry a higher percentage of chromium than a concentrate made from run-of-mine disseminated ore in the same ore body. Furthermore, magnetite or hematite may be present as small grains in the rock gangue and be concentrated with the chromite to give a product of lower chromium-iron ratio.

Assays of Ore from Siskiyou County. Chromite from Siskiyou County with few exceptions has a high chromic oxide content. Of the 16 partial and complete analyses of carefully cleaned chromite available (see tables 1 and 2), nine have a chromic oxide content of more than 55 percent, five of more than 50 percent, and only two of less than 50 percent and more than 47 percent Cr_2O_3. Furthermore, the tonnage of ore consisting of chromite containing less than 50 percent Cr_2O_3 (table 3) is very small. It should be noted that these analyses are mostly of ores of the disseminated type. None of the chromites from disseminated ores has a chromium-iron ratio of 3, but ten have a ratio of 2.5 or better and five fall below this. Hence it follows that much of the disseminated ore can be milled to yield a concentrate of metallurgical grade.

The direct-shipping ore, or so-called massive chromite, shows a wide range in content of chromic oxide (see analyses 5, 9, 14 to 37). This range is partly the result of varying amounts of admixed gangue, as can be seen by comparing analysis 9 with analysis 33, and partly the result of the care exercised in hand sorting. Much of the direct-shipping ore has a chromium-iron ratio of 3 or better (see analyses 9, 17, 18, 19, 24, 28, 29, 30, 32 to 36).

None of the ore mined from pods in Siskiyou County and shipped as lump ore had an iron content of more than 12.26 percent (see analyses 17 to 38). All but one of the analyses of carefully cleaned chromite from disseminated ores have an iron content greater than 14 percent (see analyses 1 to 4, 6 to 8, and 10 to 13). No such consistent difference between the chromic oxide content of these two types of ore can be detected because pure, carefully cleaned chromites from disseminated ores range in composition from 58.45 percent Cr_2O_3 (sample 1) to 54.18 percent Cr_2O_3 (sample 13) and the two analyses of carefully cleaned massive ore range from 59.83 percent (sample 8) to 53.96 percent (sample 5), extending above and below the range of the disseminated ores. The difference in total iron content between massive ore from pod deposits and disseminated ore is probably the result of a lower ferric iron content of chromite from pod deposits. It may be significant that chromite from pods in peridotite masses that are known to be surrounded by Paleozoic rocks has a high chromium-iron ratio (see analyses 9, 24, 28, 29, 30, 32 to 35).

Analyses of chromite in Siskiyou County
(See tables 1, 2, and 3)

1. Field number F.G.W.-40-41. Disseminated ore: grab sample from the northernmost pit, Veta Chica claim, SW¼ sec. 30, T. 45 N., R. 10 W. Collected by J. S. Livermore.
2. Field number F.G.W.-41-41. Disseminated ore: grab sample of massive chromite from southern end of Cerro Colorado claim, NE¼ sec. 25, T. 45 N., R. 11 W. Collected by J. S. Livermore.
3. Field number F.G.W.-43-41. Disseminated ore: ore showing linear structure from Veta Grande claim, SW¼ sec. 30, T. 45 N., R. 10 W. Collected by J. S. Livermore.
4. From Seiad Creek mine: disseminated ore, sec. 20, T. 47 N., R. 11 W. Collected by W. D. Johnston, USGS Bull. 878, p. 90, 1937.
5. Field number F.G.W.-32-42. Massive ore from Cyclone Gap mine, sec. 15, T. 17 N., R. 5 E. Collected by F. G. Wells.
6. Field number G.A.R.-100-42. Disseminated ore: channel sample cut across upper ore zone at top of Cut 5, Fairview mine, secs. 27 and 34, T. 46 N., R. 11 W. Collected by G. A. Rynearson.
7. Field number G.A.R.-103-42. Disseminated ore: channel sample cut across upper ore zone at south end of Cut 7, Fairview mine, secs. 27 and 34, T. 46 N., R. 11 W.
8. Field number F.G.W.-39-41. Disseminated ore: specimen from southwest pit on ore zone extending through southern half of Grand Falls claim in NW¼ sec. 25, T. 45 N., R. 11 W. Collected by J. S. Livermore.
9. Peg Leg (Lambert) mine. G.A.R.-40-43. Massive ore: grab sample of massive chromite. NE¼SE¼ sec. 26, T. 44 N., R. 8 W.

Table 2. Partial analyses of chromites in weight percent, from Siskiyou County, California, made in the Laboratory of the U. S. Geological Survey.

Sample no.	6 [d]	7 [d]	8 [g]	9 [d]	10 [d]	11 [g]	12 [g]	13 [g]	14 [g]	15 [g]	16 [g]
Concentrates											
Cr	39.49	40.28	40.10	[h]40.96	[i]35.30	38.82	37.47	37.08			
Fe	14.75	14.06	14.75	10.81	16.29	14.32	18.86	20.52			
Ratio Cr/Fe	2.68	2.86	2.72	3.79	2.17	2.71	1.99	1.81			
Cr_2O_3	57.67	58.82	58.58	59.83	51.58	56.73	54.75	54.18			
Ores											
Cr	25.21	29.68		39.11	24.88				32.99	32.67	34.53
Fe	11.55	11.81		11.35	13.16				11.55	12.13	13.53
Ratio Cr/Fe	2.18	2.51		3.45	1.89				2.86	2.69	2.55
Cr_2O_3	36.70	43.37	23.51	57.17	36.33	41.43	15.42	9.13	48.20	47.73	50.45
Chromite in ore	63.06	73.7	40.	95.5	70.4	73.	28.	17.			
SiO_2	15.3	10.9									

[d] Analyst, M. K. Carron.
[g] Analysts, R. E. Stevens and M. K. Carron.
[h] Specific gravity of pure chromite 4.389.
[i] " " " " 4.427.

10. Bagley mine. G.A.R.-138-42. Massive ore: grab sample of massive chromite from the Josephine claim chromite deposit. SW¼ sec. 24, T. 41 N., R. 6 W.
11. Field number F.G.W.-42-41. Disseminated ore: contorted planarbanded ore from NW pit of Cerro Colorado claim, NE¼ sec. 25, T. 45 N., R. 11 W. Collected by J. S. Livermore.
12. Field number F.G.W.-44-41. Disseminated ore: nodular chromite from Black Spot No. 1 claim, sec. 19, T. 45 N., R. 10 W. Collected by J. S. Livermore.
13. Field number F.G.W.-45-41. Disseminated ore: orbicular ore from Mary Lou (Octopus) claim, NW¼ sec. 31, T. 45 N,. R. 10 W. Collected by J. S. Livermore.
14. Field number F.G.W.-32-41. Massive ore: composite sample from dump No. 4, Cyclone Gap mine, sec. 15, T. 17 N., R. 5 E. Collected by D. A. Phoenix, November 1941.
15. Field number F.G.W.-33-41. Massive ore: composite sample from dumps Nos. 1 and 2, Cyclone Gap mine, sec. 15, T. 17 N., R. 5 E. Collected by D. A. Phoenix, November 1941.
16. Field number F.G.W.-34-41. Massive ore: composite sample from dump No. 4, Cyclone Gap mine, sec. 15, T. 17 N., R. 5 E. Collected by D. A. Phoenix, 1941.
17. Dry Gulch, Massive ore: secs. 16 and 17, T. 38 N., R. 11 W. Owner unknown. Shippers: Hanefner and Stewart.
18. Meidell and Farrel claim: Massive ore: sec. 21, T. 38 N., R. 11 W. Shippers: Robertson and George.
19. Dry Gulch mine. Massive ore, sec. 16, T. 38 N., R. 11 W. Shippers: Gray and Lake.
20. Black Hawk mine: Massive ore, sec. 20, T. 38 N., R. 11 W. Owners and shippers: Gray and Eldridge.
21. Mary Lou mine: Massive ore, sec. 29, T. 38 N., R. 11 W. Owner and shipper: Francis George.
22. Chute Gulch mine: Massive ore, sec. 22, T. 40 N., R. 5 W. Shipper: Ross Johnson.
23. Bagley mine (Josephine): Disseminated ore, sec. 24, T. 41 N., R. 6 W. Shipper: Ellickson.
24. Gibbons Ranch mine: Massive ore, sec. 12, T. 41 N., R. 7 W. Owner: Gibbons; shipper, C. Baker.
25. Mountain House Ranch mine: Massive ore, sec. 2, T. 41 N., R. 7 W. Shippers: Thompson and Hayden.
26. Big Boy mine: Massive ore, sec. 2, T. 41 N., R. 7 W. Owner, Foster; shipper, H. Williamson.
27. Earl M. claim mine: Massive ore, sec. 35, T. 42 N., R. 7 W. Owner, H. Williamson; shipper, R. Knudsen.
28. Genesis claim: Massive ore, sec. 2, T. 41 N., R. 7 W. Owner, H. Williamson; shippers, E. Hayden and C. Thompson.
29. Scratch claim: Massive ore, sec. 35, T. 42 N., R. 7 W. Owner, Southern Pacific R. R.; shipper, R. V. Hayden.
30. Sunset Chrome claim: Massive ore, sec. 20, T. 42 N., R. 6 W. Shippers: Barney McCoy and Robt. Archibald.
31. Serpa Ranch mine: Massive ore, sec. 15, T. 43 N., R. 9 W. Owner, Southern Pacific R. R.; shipper, Joe Serpa.
32. Moffett Creek mine, Simas Ranch. Massive ore, sec. 35, T. 44 N., R. 8 W. Owner, E. T. Simas; shipper, J. K. Remsen.
33. Peg Leg (Lambert) mine: Massive ore, sec. 26, T. 44 N., R. 8 W. Owner, Lambert; shipper, F. S. Pollock by Ellickson.
34. Name unknown: Massive ore, sec. 26, T. 44 N., R. 8 W. Owner, Dorothy Luttrel; shipper, Paul Cichhorst.
35. Skin Shin: Massive ore, sec. 6, T. 44 N., R. 12 W. Owner, Ben Case; shippers, Harvey Atterbury, Grace Roberts and Cody.
36. Lady Gray mine: Disseminated ore, sec. 30, T. 45 N., R. 10 W. Owner, D. R. Moroney: shipper, A. W. Diggle.
37. Elk Creek mine: Massive ore, sec. 31, T. 45 N., R. 12 W. Shipper: I. D. Turner.
38. Snowy Ridge. Massive ore: Location, sec. 21, T. 48 N., R. 9 W. Owners, H. C. Whitney, Art Kleinhammer, and Arley Beasley; shipper, J. K. Remsen.

Table 3. Range of analyses made by Abbot Hanks Co. of ores bought by the Metals Reserve Company at Yreka, California.

Property number	17	18	19	20	21	22	23
Ore							
Range of Cr_2O_3	53.12-54.61	49.79	49.63-55.99	45.85-46.97	45.53	40.51	28.11
Range of Fe	10.17-10.86	11.06	10.85-11.13	11.73-12.16	12.08	10.99	11.28
Range of ratio Cr/Fe	3.44- 3.57	3.08	3.13- 3.44	2.58- 2.69	2.57	2.52	1.91

Property number	24	25	26	27	28	29	30
Ore							
Range of Cr_2O_3	41.51	41.65-42.53	43.98	41.73	42.37-44.22	47.84	52.12
Range of Fe	9.12	9.19-11.28	10.57	10.58	9.44-11.47	9.56	10.84
Range of ratio Cr/Fe	3.04	2.58- 3.10	2.85	2.70	2.58- 3.20	3.42	3.29

Property number	31	32	33	34	35	36	37	38 [a]
Ore								
Range of Cr_2O_3	36.02	52.45	52.12-53.21	52.85	52.12	35.18-38.30	39.51-42.00	40.22
Range of Fe	11.11	11.02	11.02-11.60	11.95	10.84	10.22-10.98	9.04-10.33	12.26
Range of ratio Cr/Fe	2.22	3.36	3.07- 3.31	3.03	3.29	2.28- 2.47	2.70- 3.18	2.21

[a] Shipped to Metals Reserve Company stockpile in Grants Pass, Oregon.

Table 4. Chromite production from Siskiyou County, California 1916-43

Property	Map number	1916	1917	1918	1919-40			1941	1942		1943		Total
					Year	Long tons	Total			Total		Total	
A. Bingham	72	172	103	22									297
Bagley (Josephine)	89												
Black Spot No. 1	20			[1]		[1]							
Black Spot No. 2	20			[1]		[1]							
Coggins	93	893	446	275	1920	58			*835		*228		
					1921	55	313		1,002	1,002	1,009	1,009	3,938
					1939	200							
Cyclone Gap	2								*1,778		*602		
									1,802	1,802		602	2,401
DeFerra (Facey)	64			73									73
Doe Flat	3								*1,691		*201		
									1,645	1,691		201	1,892
Dozier	80			89									89
Fairview	18								*336		*1,147		
									322	336	665	1,147	1,483
Grant	61			54									54
Grouse Creek	74		268	259									527
Hayden & Hilt	76			69									69
Jumbo (Veta Chica)	22			[1]		[1]					*149		
Ladd (Dolbear)	17			1,598							287	287	1,885
Liberty (Cerro Colorado)	23			[1]		[1]							
Leviathan (F. Chastain)	83		67	140									207
C. J. Masterson	81	179	49	71									299
McGuffy Creek group	20 to 27			509	1920	203	203						712
McKeen	71			6									6
Moffett Creek group	50												
	51			269				5	*123		*27		
	52								9	123	28	28	425
Neptune	24			[1]		[1]							
Octopus (Mary Lou)	32			[1]		[1]							
Peg Leg (Lambert)	53			94	1920	40	40	69	*138		*190		
									123	138		190	[2] 531

Table 4. Chromite production from Siskiyou County, California 1916-43—Continued

Property	Map number	1916	1917	1918	1919-40 Year	1919-40 Long tons	1919-40 Total	1941	1942	1942 Total	1943	1943 Total	Total
Red Butte (Veta Grande)	26			1		1							
Sciad Creek (Mountain View)	14			539							*1,227		
											1,011	1,227	1,766
Shebley	44			43									43
Siskiyou Syndicate (Plummer)	65			17									17
Snowy Ridge	36							130	*225		*33		
									110	110		33	273
Wandering Jew (Buckhorn)	41			162						223		33	1,039
Name unknown	19			1		1							
Known total		1,244	933	4,289			556	204	*5,126		*3,476		
									5,013	5,202	3,000	4,724	17,152
Flederman Bros.	57		94										94
Mule Shoe (J. W. Carter)				87									87
Snow Drift (H. Davidson)				52									52
Mt. Eddie (A. S. Calkins)				71									71
Ponderosa (A. J. Welker)			4	56									60
Union Creek Co.			146										146
J. M. Patterson			96	91									187
(16 other claims)				450									450
											*19		
Big Buckhorn (P. Eichorst)									3	3	18	19	22
									*85				
Blue Jay (J. Baldwin)									85	85			85
									*16				
F. P. Brown									16	16			16
									*11				
Dark Mystery (R. E. Shelley)									11	11			11
									*10				
Hayden									10	10			10
									*11				
V. Lindell (Knudsen)									11	11			11
									*10				

Nicholes (R.M.C.)									10	10			10
									*5				
J. Patterson (Remsen)									5	5			5
Range									7	7			7
									*10				
S. Rogers (Remsen)									10	10			10
									*3				
Silvas (E. F. Taylor)	66								3	3			3
									*7				
Summit (Ready)									7	7			7
J. K. Remsen (job lots)									46				
									*16				
C. C. Fowler (A. Young)										16			16
Hayden (Knudsen)									*11	11			11
Hayden (Young)									*7	7			7
Russell (Young)									*4	4			4
Munko (Remsen)									*17	17			17
Chastain (Young)									*57	57			57
Williamson (Knudsen)									*30	30			30
Granada (J. Baldwin)									*14	14			14
Gazelle (Knudsen)									*9	9			9
S. P. (Wild & Johnson)									*40	40			40
(Scott Valley) (U.S.V.)									*40	40			40
Facey (A. Young)									*6	6			6
Honey Bee (Bashaw & Baldwin) (W. Middel)									*21	21			21
Beaver Creek (Knudsen)									*21	21			21
Hayden (Ellickson)									*9	9			9
(I. D. Turner)									*9	9			9
Black Boy (D. Calkins)									*9	9			9
Risling (U.S.V.)									*5	5			5
Clyburn (U.S.V.)									*5	5			5
? (J. Baldwin)									*15	15			15
? (Crumpton & Gordon)									*10	10			10
Simas (Remsen)											*124	124	124
Genesis (Knudsen)	80										*51	51	51
Earl M. (Williamson)	77										*37	37	37
De Rosa (Taylor & Munko)											*4	4	4
Black Crow (Gray & Eldridge)											*82	82	82
Big Boy (Williamson)	80										*61	61	61
Rodgers & Allen	45										*12	12	12
Blue Doe (J. O. McBroom)	31										*8	8	8
Dry Gulch (Huefner-Stewart)	30										*75	75	75

Table 4. Chromite production from Siskiyou County, California 1916-43—Continued

Property	Map number	1916	1917	1918	1919-40			1941	1942		1943		Total
					Year	Long tons	Total			Total		Total	
Wildcat Creek (Johnson & Evans)											*8	8	8
Robertson & George											*14	14	14
Leland Young (Knudsen) (Whiskey Boy)											*18	18	18
A. Lowden (K. H. Walters)											*10	10	10
S. P. (Hayden)											*75	75	75
Sunset (McCoy & Archibald)											*12	12	12
Skin Shin (Ben Cage)											*39	39	39
?		432		373	1919		604		9		*75	75	880
							*523		*523		*802		
Unknown subtotal		432	340	1,180			604		233	533	18	802	3,891
									5,649		4,278		
									5,246		3,018		
Total		1,676	1,273	5,469			1,160	204		5,735		5,526	21,043
Serpa Ranch											*5	5	5
Gazelle Mtn. (H. Williamson)											*6	6	6
Chamberlain prop.											*5	5	5
F. Horn Ranch											*10	10	10
Meidell & Farrel											*5	5	5
Dorothy											*9	9	9
Unknown											*16	16	16
Lang											*11	11	11
Lame Duck											*11	11	11

* Stockpile figures from Metals Reserve Company.
[1] Members McGuffy Creek group; individual production not known. See McGuffy Creek total.
[2] In Moffett Creek group, but production quoted separately.

Production and Reserves

Ninety-three deposits of chromite have been discovered in Siskiyou County and 91 of these have been worked. Most of the deposits are massive ore of the pod type. By January 1, 1945, 16,805 long tons of massive ore had been shipped from them. The remainder of the total shipments of 23,723 long tons is hand-sorted ore mined from the disseminated ore in the Ladd and Fairview mines and in the properties on Seiad and McGuffy Creeks. The largest pod deposit has yielded 2,404, the smallest 3 long tons. Four deposits have yielded 61 percent of the massive ore.

Production by properties is given in table 4. Since 1940 these figures are for ore shipped; in no case since 1940 has the same ore been reported twice. The same statement is largely true for the earlier figures but some figures may be for ore that was reported when mined and reported again when shipped some years later. The writers have made every effort to eliminate such duplication but cannot be cetain that it has not occurred.

Practically all the massive ore in pod deposits in sight has been mined out. It is impossible to make any valid estimate of reserves of massive ore in Siskiyou County where, as is common in this type of ore, massive chromite exposed over an area of a hundred square feet or more may not extend a foot below the surface. Hence known reserves of massive ore are very small and not very significant. Reserves of inferred ore are hard to predict. Though undiscovered pods containing several hundred or even thousand tons of massive ore undoubtedly exist in depth at the same or other localities, the difficulties and cost of finding them will be much greater than they were for the original discoveries of pods that cropped out and in some cases projected conspicuously above the surface or were marked by abundant float. No new geophysical methods to aid in ore search have been developed. When it is realized that only three deposits unknown before the end of the World War I were discovered during World War II, the prospect for new finds is not promising. Some miners ascribe this paucity of new discoveries to an alleged lower price for chromite during World War II. If the aids to both development and marketing of ore that were furnished by Government are subtracted from the cost of production and marketing, it is probable that the average net profit to the operator per long ton of ore sold was greater during the period 1942-45 than during World War I.

This unfavorable prospect for new discoveries of massive ore is borne out by past production. According to Diller[14] 6,125 long tons of lump ore was produced in 1918. Slightly less than this amount was shipped in 1942; about 5,500 long tons was shipped in 1943 and about half this amount in 1944. When this declining production is evaluated against the fact that much of the county has been prospected and that it is becoming increasingly difficult to find new pods, it seems that any predictable future production from pods will not equal past output. The discovery of one or two large pods that could contain 10,000 long tons or more would nullify this statement, but in view of the record this is improbable.

Fortunately the reserve picture for disseminated ore is more favorable. The estimates of reserves of disseminated ore in the county total 274,500 short tons of indicated and inferred ore contained in six deposits, three of which are in the Seiad Creek-Red Butte peridotite mass, and

[14] Diller, J. S., Chromite in the Klamath Mountains, California and Oregon: U. S. Geol. Survey Bull. 725, pp. 1-35, 1921.

Table 5. Estimate of reserves of disseminated ore, May 1943.

Mass	Property	Average grade 8 percent Cr_2O_3 (reserves in short tons)		
		Indicated	Inferred	Total
Seiad Creek—Red Butte	Seiad Creek (Mountain View group)	112,000	100,000	212,000
	Emma Bell		2,000	2,000
	Kangaroo Mountain (Anniversary claim)	1,500	4,000	5,500
Hamburg-McGuffy Creek	McGuffy Creek	25,000	25,000	50,000
	Fairview claims	1,500	4,000	5,500
	Ladd (Dolbear)		3,000	3,000

three of which are in the Hamburg-McGuffy Creek peridotite mass. They are listed in table 5 in the order of decreasing size.

A detailed analysis of the reserves of the Seiad Creek-Red Butte mass and the Hamburg-McGuffy Creek mass is given in a report by Wells.[15] The ore as figured in these reserves will average 8 percent chromic oxide. To obtain ore of this grade it will be necessary to do selective mining or else to sort the mill feed, or both.

These estimates of reserves were made prior to June 1943 and include some ore mined since then. A total of 3,995 long tons of selectively mined ore that averaged 35 percent Cr_2O_3 was shipped from these deposits during the period June 1, 1943, to December 31, 1944. As additional ore may have been developed in the process of mining it cannot be assumed that the ore reserves have been lessened by this amount.

DESCRIPTION OF THE DEPOSITS

For purposes of description, adjacent peridotite bodies and their contained chromite deposits are collected into large units called "groups," some of which contain several smaller units called "areas." The groups and areas are named. The peridotite bodies in an area are believed to be geologically related, consisting either of a single peridotite intrusion, or a part of one, or including several peridotite bodies that in outcrop are separate but that are believed to be part of a single intrusion, or to occupy the same or closely related geologic structures. Though structural relationships have been followed insofar as possible in assembling the areas into groups, the areas in most of the groups are not structurally related.

The groups are seven in number and listed from east to west they are: the South-Central, Yreka-Fort Jones, Beaver Creek, Shackleford Creek, Seiad, Cecilville, and Western Boundary. The geologic units, either areas or groups, are: the Soda Creek, Mount Eddy and Gazelle Mountain, and Callahan areas in the South-Central group; the Yreka-Fort Jones group; the Beaver Creek group; the Shackleford Creek group; the Hamburg-McGuffy Creek, Seiad Creek-Red Butte, and Grider Creek areas in the Seiad group; the Cecilville group and the Indian Creek, Upper Clear Creek and Doe Flat areas, in the Western Boundary group.

[15] Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., Chromite deposits near Seiad and McGuffy Creeks, Siskiyou County, California: U. S. Geol. Survey Bull. 948B, 1949.

Table 6. Alphabetical list of chromite mines and prospects in Siskiyou County giving old names, location, owners, and operators.

Claim or mine name *	Map no.**	Location: Sec.	Location: Twp. a	Location: Range a	Owners and shippers b	Source of data b	Class by production c
Allison (Moffett Creek Northern claims, White)	50	26	44N	8W	Allison & Taylor (O); Kangaroo Mt. Chrome Co., F. S. Pollack (S)	Allen, D. M. vol. 37, p. 128, 1941. Metals Reserve Company, 1943.	C
Anniversary claim: see Kangaroo Mountaio	10	----	47N	12W			
Bagley (Josephine, Lucky Strike, Eddy Creek, Mount Eddy)	89	SW/4 24	41N	6W	Bagley Bros. (O); L. D. Taylor, E. Wheeler, P. Munko (S)	Rynearson, G. S., 1942 unp. Hawkes, H. E. 1943, unp.	D
Ball Ranch	63	9-10 15-16	41N	9W	Mrs. Ball (O)	Allen, D. M. vol. 37, p. 129, 1941.	
Barton	15	10	46N	12W	Ariel, Lowden (O), W. M. Middel (S)	Wells, G. S. 1945 unp. Metals Reserve Company, 1944. Rynearson & Smith, G. S. Bull. 922, p. 306, 1940.	C
Big Boy: see Dozier	80	2	41N	7W			--
Big Buckhorn (Eickhorn)	49	26	44N	8W	Rogers and Allen (S)		
Bingham, A. (The Chrome Mine)	72	12	39N	9W	Alonzo Bingham (O)	Logan, D. M. Bull. 76, p. 199, 1918.	B
Bingham, W. (Wild Cat)	68	34	40N	9W			
Black Cap: This property was owned by the same company that owned the Wandering Jew	41	17	46N	8W	Eastern Mining Co. (O)	Diller, G. S. 1918 unp.	--
Black Crow	35	26	38N	11W	Thos. Eldridge & Grey (S)	Metals Reserve Company, 1943.	C
Black Eagle	13	SE/4 7	47N	11W	----	Allen, D. M. vol. 37, p. 124, 1941.	D
Black Hawk	33	20	38N	11W	Thos. Eldridge & Grey (S)	Metals Reserve Company, 1943.	C
Black Spot No. 1	20	SW/4 SW/4 19	45N	10W	----	Rynearson & Smith, G. S. Bull. 922, p. 305, 1940.	D
Black Spot No. 2	----		----	----			
Blanton	39	34	47N	8W	W. Blanton (S)	Diller, G. S. 1918 unp.	--
Blue Doe	31	19	38N	11W	John O. McBrown (S)	Metals Reserve Company, 1943.	C
Blue Eagle	12	SE/4 7	47N	11W	----	Allen, D. M. vol. 37, p. 124, 1941.	D
Bluestone: see Grand Falls	25						
Buckhoro: see Wandering Jew also see Elk Creek No. 20	41						
Burns Ranch	86	SW/4 16	42N	6W	W. L. Burns (O)	Logan, D. M. Bull. 76, p. 190, 1918.	--
Burton (Fred) Ranch	48	24	44N	8W	----	Metals Reserve Company, 1944.	C
Butcher Hill (Shebley)	44	23 or 24	45N	7W	----	Logan, D. M. Bull. 76, p. 190, 1918.	--

Table 6. Alphabetical list of chromite mines and prospects in Siskiyou County giving old names, location, owners, and operators—Continued.

Claim or mine name *	Map no.**	Location			Owners and shippers [b]	Source of data [b]	Class by production [c]
		Sec.	Twp. [a]	Range [a]			
Calf Lakes	29	14	43N	11W	F. W. Webster, James Hughes & Tom A. Land (O)	Smith, G. S. 1941 unp. Wells, G. S. 1942 unp.	D
Cerro Cólorado (Milne and Reichman, Liberty)	23	SE/4 NE/4 25	45N	11W	H. W. Gould	Livermore, G. S. 1941 unp. Rynearson & Smith, G. S. Bull. 922, p. 304, 1940.	D
Chamberlain	85	SE/4 17	42N	6W	Lang (O), F. S. Pollock (S)	Metals Reserve Company, 1943	C
Chastain and Bowen	87	33	42N	6W		Diller, G. S. 1918 unp. Wells, G. S. (?)	--
Chastain, F.: see Leviathan	83						
Chastain, W.	88	4	41N	6W		Diller, G. S. 1918 unp.	--
Chrome mine: see Bingham, A.	72						
Chrome Mountain: see Emma Bell	11						
Chromite King: see Peg Leg	53						
Chute Gulch	92	22	40N	5W	Ross Johnson (S)	Metals Reserve Company, (?)	D
Coggins	93	2	38N	4W	Coggins (O), J. K. Remsen (S)	Allen, D. M. vol. 37, pp. 130, 1941. Wells, Rynearson, Hawkes, G. S. 1940-42 unp.	A
Come Back: see Doe Flat	3						
Costello Ranch (Moffett Creek southern deposits)	56	3, 4, 9, 10	43N	8W	Oliver Costello (O and S)	Allen, D. M. vol. 37, p. 126, 1941. Metals Reserve Company, 1944.	B
Cramer	51	22	44N	8W	Chas. Harris (O)	Logan, D. M. Bull. 76, p. 193, 1918	--
Cramer, F. W.	52	26	44N	8W	Cramer (O), Beken & Cramer (S)	Metals Reserve Company, 1944	C
Creed: see Reddy No. 3	16						
Cyclone Gap (Mammoth)	2	SW/4 15	17N	5E	H. C. Cullan, F. Dunham, & D. R. Morrison (O), J. K. Remsen (S)	Wells, G. S. 1940, Rynearson, 1942, Cater, 1943 unp.	A
Davis	69	10	39N	9W	H. L. Davis (O and S)	Logan, D. M. Bull. 76, p. 194, 1918	---
De Ferra (Faccy)	64	center 36	41N	9W		Allen, D. M. vol. 37, p. 129, 1941	C
Doe Flat (Come Back)	3	NE/4 31	17N	5E	Homer White & J. D. Hoguo (O), Isgrigg and Lilley (S)	Wells, G. S. 1940 unp. Cater, G. S. 1943 unp.	A
Dolbear: see Ladd	17						
Dorothy: see Dozier	80						

Dozier (Mountain House, Big Boy, Genesis, Dorothy, Gould)	80	2	41N	7W	F. S. Pollock, Hugh Williamson, J. K. Remsen, Thompson and Hayden	Logan, D. M. Bull. 76, p. 195, 1918. Metals Reserve Company, 1943, 1944.	C
Dry Gulch	30	16, 17	38N	11W	Hauefrier and Stewart (S) Gray and Eldridge (S)	Metals Reserve Company, 1943	C
Earl M. claim	77	35	42N	7W	Southern Pacific RR (O) Hugh Williamson & Ronald Knudsen (S)	Metals Reserve Company, 1943	C
Eddy Creek: see Bagley	89						
Eichorn: see Big Buckhorn	49						
Elk Creek (Skin Shin claim, Buckhorn)	28	31	45N	12W	I. D. Turner (S 1942) Harold Ellickson (S 1944)	Smith, G. S. 1941 unp. Metals Reserve Company, 1944.	B
Emma Bell (Chrome Mountain, Stanton)	11	7	47N	11W	Mrs. W. P. Stanton	Rynearson, G. S. 1943 unp. Wells, G. S. 1944 unp.	--
Facey: see De Ferra	64						
Fairview (Hamburg Bar)	18	34	46N	11W	F. S. Pollock and Hollis Anderson (O), Harold Ellickson (S)	Metals Reserve Company, 1943, 1944. Rynearson, G. S. 1943 unp.	A
Flederman leases	57	28	43N	8W		Logan, D. M. Bull. 76, p. 196, 1918	C
Genesis: see Dozier	80						
Gibbons Ranch	82	12	41N	7W	Gibbons (O); C. Baker (S)	Metals Reserve Company, 1944	C
Gould: see Dozier	80						
Gottville: see Portugese Gulch	40						
Grand Canyon: see Grand Falls	25						D
Grand Falls, Grand Canyon, and Bluestone	25	25	45N	11W	D. R. Moroney (O)	Rynearson, G. S. 1943 unp. Livermore, G. S. 1941 unp.	D
Grand View							D
Grant	61	25	42N	9W	Southern Pacific RR (O)	Logan, D. M. Bull. 76, p. 196, 1918	C
Grizzly	37	34	48N	8W	D. Middel (S)	Metals Reserve Company, 1944	C
Grouse Creek	74	13	40N	8W	R. C. Latcham	Logan, D. M. Bull. 76, p. 198, 1918	B
Hamburg Bar: see Fairview	18						
Harris Creek: see Burns Ranch	86						
Hayden and Hilt	76	34	42N	7W		Diller, G. S. Bull. 725, p. 3, 1921	C
Hayes Ranch	58	SW/4 32	44N	8W		Allen, D. M. vol. 37, p. 128, 1941	--
Horn, Frank	60	29	42N	9W	Frank Horn (O) Meidell and Farrel (S)	Metals Reserve Company, 1943	C
Josephine: see Bagley	89						
Jumbo: see Veta Chica	22						

Table 6. Alphabetical list of chromite mines and prospects in Siskiyou County giving old names, location, owners, and operators—Continued.

Claim or mine name *	Map no.**	Location: Sec.	Location: Twp. [a]	Location: Range [a]	Owners and shippers [b]	Source of data [b]	Class by production [c]
Kangaroo Mountain (Anniversary claim, Kubli)	10	13, 14	47N	12W	E. W. Kubli	Livermore, G. S. 1941 unp.	D
Klamath: see Ladd	17						
Kubli: see Kangaroo Mountain	10						
Latrelle (Moffett Creek northern group, see Allison)	50	26	44N	8W	----------	Allen, B. M. vol. 37, p. 128, 1941	--
Ladd (Dolbear, Mammoth, Klamath)	17	16, 21	46N	11W	John Ladd (O) Ronald Knudsen, J. K. Remsen (S)	Rynearson, G. S. 1943 unp. Cater, G. S. 1944 unp.	A
Lady Gray	26	30	45N	10W	D. R. Moroney (O); A. W. Diggle (S)	Rynearson, G. S. 1943 unp. Metals Reserve Company, 1944.	C
Lambert: see Peg Leg	53						
Lame Duck	79	2	41N	7W	J. K. Remsen (S)	Metals Reserve Company, 1943	C
Lang Property	43	NE/4 14	45N	7W	F. S. Pollock (S); Lang (O)	Metals Reserve Company, 1943	C
Leviathan (F. Chastain)	83	32	42N	6W	----------	Diller, G. S. 1918 unp.	B
Liberty: see Cerro Colorado	23						
Lindell, V.	46	19	44N	7W	----------	----------	C
Lucky Haul: see Snowy Ridge	36						
Lucky Strike: see Bagley mine	89						
Lutrelle	47	26	44N	8W	Dorothy Lutrelle (O); Paul Eichhorst (S)	Allen, D. M. vol. 37, p. 128, 1941. Metals Reserve Company, 1943.	C
Mammoth: see Ladd	17						
Mammoth: see Cyclone Gap	2						
Martin	70	NW/4 11	39N	9W	Hughey Martin & Stewart McKeer (O)	Logan, D. M. Bull. 76, p. 198, 1918	--
Mary Lou	32	29	38N	11W	Francis George (O & S)	Metals Reserve Company, 1944	C
Mary Lou (Octopus)	26	SW/4, SW/4 30	45N	10W	Rustless Mining Corp. (O)	Wells, Rynearson, G. S. 1942 unp.	D
Masonic Bar claims 1, 2, and 3: see Reddy No. 3	16						
Masterson Ranch	73	N. edge 23	40N	8W	C. J. Joseph, and A. C. Masterson (O)	Logan, D. M. Bull. 76, p. 198, 1918	B

Masterson and McBride	62	1	41N	9W		Diller, G. S. Bull. 725, p. 3, 1921	--
Masterson, C. J.	81	1	41N	7W		Diller, G. S. 1918 unp.	--
Mathewson	38	33	47N	8W	P. S. Mathewson (O)	Diller, G. S. 1918 unp.	--
McGuffy Creek (name applied to many or all deposits on McGuffy Creek Nos. 19-27)	19-27						
McKeen: see Martin	71	N/2 11	39N	9W			
Meadow View (Scott Brothers)	91	17	41N	5W			
Meidell and Farrel	34	21	38N	11W	Robertson and George (S)	Metals Reserve Company 1943	C
Mil Diablos	22	30	45N	10W	Rustless Mining Co. (O)	Wells, Rynearson, G. S. 1942 unp.	D
Milne and Reichman: see Cerro Colorado	23						
Moffett Creek (Southern claims, Simas Ranch)	54	34, 35	44N	8W		Allen, D. M. vol. 37, p. 126, 1941	--
Mount Eddy: see Bagley	89						
Mountain House: see Dozier	80	2	41N	7W			C
Mountain View: see Seiad Creek	14						
Names unknown	5	26	18N	6E		Wells, G. S. 1944 unp.	--
Names unknown	6	7	17N	7E		Wells, G. S. 1944 unp.	--
Names unknown	7	7	17N	7E		Wells, G. S. 1944 unp.	--
Names unknown	8	4	17N	7E		Wells, G. S. 1944 unp.	--
Names unknown	19	19	45N	10W		Rynearson, G. S. Bull. 922, p. 306, 1940	--
Names unknown	90	19	41N	5W		Wells, G. S. 1944 unp.	--
Napatama (Neptune)	24	NW/4 25	45N	11W		Rynearson, G. S. Bull. 722, p. 305, 1940	D
Octopus: see Mary Lou	32						
Peg Leg (Lambert, Chromite King)	53	NE/4 SE/4 26	44N	8W	Basil Wood (O); F. S. Pollock, A. Young, and Harold Ellickson (S)	Rynearson, G. S. 1943 unp.	B
Piedra	21	30	45N	10W	H. W. Gould (O)	Livermore, G. S. 1941 unp.	D
Plummer: see Siskiyou Syndicate	65						
Portugese Gulch	40	9	46N	8W	The Eastern Mining Co. (O & S)	Diller, G. S. 1918 unp. B. M. 1942 unp.	
Red Butte: see Veta Grande	26	30	45N	10W			--
Reddy No. 3 (Creed, Masonic Bar claims 1, 2 and 3)	16	9	46N	12W	J. F. Reddy (O & S)	Rynearson, G. S. Bull. 922, p. 306, 1940	C
Rocky Gulch—probably Burton (Fred) Ranch	48	24	44N	8W	F. C. Burton (S)		--
Rogers and Allen	45	6	44N	7W		Metals Reserve Company, 1943	C
Runnalds	41	E/2 SW/4 35	14N	4E			D
Sally Anne: see Snowy Ridge	36						
Scott Bar: see McGuffy Creek							
Scott Brothers	91	17	41N	5W			

Table 6. Alphabetical list of chromite mines and prospects in Siskiyou County giving old names, location, owners, and operators—Continued.

Claim or mine name *	Map no.**	Location			Owners and shippers [b]	Source of data [b]	Class by production [c]
		Sec.	Twp. [a]	Range [a]			
Scott Mountain	75	NW/4 32	40N	7W	Ronald Knudsen (O & S)	Wells, G. S. 1944 unp.	D
Scratch	78	SE/4 35	42N	7W		Wells, G. S. 1944 unp.	D
Seiad Creek (Mountain View)	14	20	47N	11W	Rustless Mining Co. (O); Kangaroo Mountain Chrome Co. (S)	Smith, G. S. 1941 unp. Rynearson, G. S. Bull. 922, pp. 298-301; 1940.	A
Serpa Ranch	59	15	43N	9W	Joe Serpa (O); H. Ellickson (S)	Metals Reserve Company 1943, 1944.	C
Scott Brothers: see Meadow View	91						
Shebley: see Butcher Hill	44						C
Short Bend	9	SW/4 18	16N	8E	Forest Moore (O); Cowder Mining Co. (S)	Rynearson, G. S. 1943 unp.	D
Silva: see Taylor, E. F.	66						C
Simas Ranch	55	NW 12	43N	8W	E. T. Simas (O); R. Knudsen (S)	Metals Reserve Company, 1943.	C
Simas Ranch: see Moffett Creek	54	28 & 35	44N	8W	E. T. Simas (O); Kangaroo Mtn., Chrome, J. K. Remsen, Pettigrew, Boker & Craig (S)	Allen, D. M. vol. 37, pp. 126-127, 1941. Metals Reserve Company, 1943, 1944.	B
Siskiyou Syndicate (Plummer)	65	7	40N	8W		Diller, G. S. 1918 unp.	C
Skin Shin (may be the same as Elk Creek)	28	6	44N	12W	Ben Case (O); Harvey Atterbury, Grace Roberts, and Cody (S)	Metals Reserve Company, 1943.	D
Snowy Ridge (Sally Anne, Lucky Haul)	36	21	48N	9W	H. C. Whitney, A. Kleinhammer, L. C. Whitney (O); J. K. Remsen (S)	Cater, G. S. 1943 unp.	B
Sousa (reported by Metals Reserve Company; location uncertain)							C
Southern Pacific Land: see Hayden & Hilt	76						
Stanton: see Emma Bell	11						
Sunset Chrome (reported by Metals Reserve Company; location uncertain)	84	20	42N	6W			
Taylor, E. F. (Silva)	66	21	40N	9W		Diller, G. S. 1918 unp.	--
Taylor, W.	67	28	40N	9W		Diller, G. S. 1918 unp.	--
Thursday No. 1 (reported by Metals Reserve Company; location uncertain)							D
Veta Chica (Jumbo)	22	SW/4 NW/4 30	45N	10W	Rustless Mining Co. (O)	Wells, Rynearson, G. S. 1942 unp.	D

Veta Grande (Red Butte)	27	SW/4 SW/2 30	45N	10W	Rustless Mining Co. (O); Reichman & Milne (S)	Wells, Rynearson, G. S. 1942 unp.	B
Wandering Jew (Buckhorn, Blackcap)	41	17	46N	8W	Eastern Mining Co. (O)	Diller, G. S. 1918 unp.	C
White Feather	1	4	17N	5E	F. A. Andrew and C. W. Van Luven (O); Baker Brothers (S)	Wells, G. S. 1940 unp.	B
White (Moffett Creek Northern group)	50	26	44N	8W		Allen, D. M. vol. 37, p. 128, 1014.	--
Wild Cat: see Bingham, W.	68						
Williamson (reported by Metals Reserve Company)							C

* Most common name given first. Synonyms given in parentheses and also listed separately. Two contiguous claims may be listed under one number, together without parentheses.

** See plate 12.

[a] The land net east of longitude 123° 16′ is based on the Mount Diablo Meridian and west of this longitude on the Humboldt Meridian.

[b] List of abbreviations—
- O—Owner
- S—Shipper
- G.S.—U. S. Geological Survey
- B.M.—U. S. Bureau of Mines
- D.M.—California Division of Mines
- vol.—Volume—Calif. Jour. Mines and Geology
- Bull.—Bulletin
- Unp.—Unpublished

[b] List of persons—
- Allen, J. E.
- Cater, F. W., Jr.
- Diller, J. S.
- Hawkes, H. E.
- Livermore, J. S.
- Logan, C. A.
- Maxson, J. H.
- Rynearson, G. A.
- Smith, C. T.
- Wells, F. G.

[c] A—1,000 long tons or more
B—150-1,000 long tons or more
C—less than 150 long tons
D—no ore shipped

All the known occurrences of chromite are listed in table 6.

The reader will find in table 6 many examples of what appear to be inaccuracies such as duplication and inconsistencies of name. These are not inaccuracies, however, but represent the confusion due to a complex overlapping of ownerships and operators both during World War I and World War II and between wars. A good example of this confusion is furnished by the following properties: Masterson and McBride No. 62, Masterson Ranch No. 73, and Masterson, C. J. No. 81. Another example is No. 80 which is on the old Dozier Ranch. It has been called Dozier, Mountain House, Big Boy, Genesis, Dorothy, and Gould. This property was mined in 1900. During the first World War it was leased by Noble Electric Steel Company; during World War II, F. S. Pollack, Hugh Williamson, J. K. Remsen, and Thompson and Hayden operated it at one time or another.

South-Central Group

The South-Central group comprises an area of peridotite that crops out along the southern boundary of the county and extends from the lava cover westward to the crest of Scott Mountains, and southwest of Gazelle beyond Callahan. No systematic geologic mapping has been done in this part of the county, but the areas underlain by peridotite are known in a general way (pl. 12). They are irregular in shape and do not conform to the simple outcrop pattern of eroded, dipping, tabular bodies, the most common form of peridotite intrusive. This complexity results largely from the intricate intrusion into them of younger dioritic and gabbroic rock. Many pods of ore, some quite high in grade, have been found in these peridotite bodies, but no deposits of concentrating ore containing as much as 20,000 tons of 10 percent ore have been discovered.

Soda Creek Area

An area of peridotite to the east of Sacramento River in the vicinity of Dunsmuir is shown on the state geologic map. It comprises about 15 square miles of the valley of Soda Creek and Soda Creek Ridge and is crossed by several mountain roads. No production has been reported from this area.

Mount Eddy Area

The Mount Eddy area (Nos. 89, 90, 91, 92, 93 [16]) lies west of Highway 99 and the Southern Pacific Railroad between Weed and Dunsmuir, in southern Siskiyou County. It comprises about 100 square miles of peridotite on the eastern slope of the Trinity Mountains. Mount Eddy (altitude 9,038 feet) dominates this rugged terrain. A logging road that follows the valley of the South Fork of Sacramento River from the town of Mount Shasta crosses the southern part of the area, and short, steep logging spur-roads penetrate 3 or 4 miles up the valleys of the major streams, such as Parks Creek, Eddy Creek, and Dale Creek. The peridotite within the area is part of a large body that extends many miles south in Shasta County. It apparently occupies the crest or upper east limb of an anticline. Wherever seen, the peridotite is a partly serpentinized saxonite with a widely spaced jointing that causes it to break into large blocks. Slickentite appears to be very restricted in distribution. Five or possibly six chromite occurrences have been reported from this

[16] Numbers refer to plate 12.

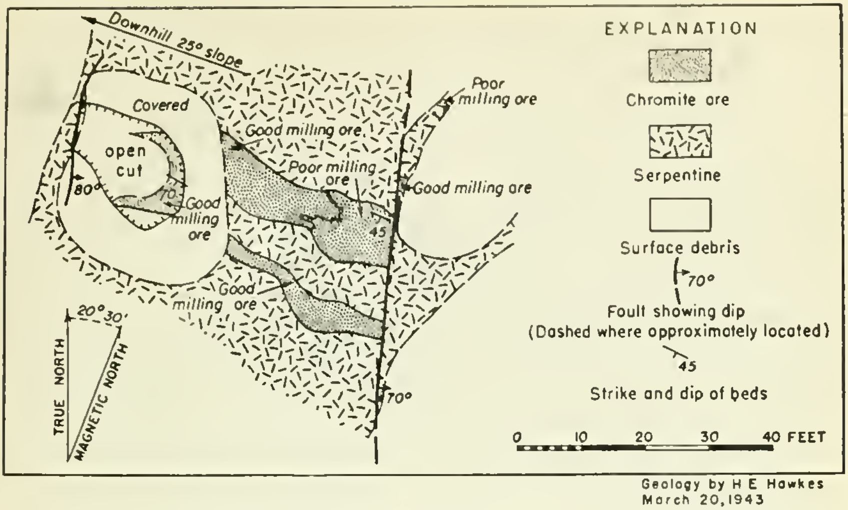


FIGURE 3. Geologic sketch map of Josephine deposit, Bagley mine, Eddy Creek, Siskiyou County, California.

area but only three are known to have produced. They are the Coggins mine (No. 93) and the Bagley mine (No. 89) (Josephine and Lucky Strike claims).

The Coggins mine is on the north side of the valley of Little Castle Creek just within the southern boundary of Siskiyou County. It is contiguous and structurally related to the other deposits that lie to the south in Shasta County. Except for the Coggins mine, the Bagley mine is the only deposit of chromite within this area that has been visited by the writers.

Bagley Mine (No. 89)—Josephine and Lucky Strike Claims. Several chromite deposits on Eddy Creek, Siskiyou County, California, are owned by the Bagley brothers of Mount Shasta and were, in the summer of 1943, under lease to L. D. Taylor, E. Wheeler, and P. Munko of Dunsmuir and Castella. The largest deposit is on the Josephine claim in the SW¼ sec. 24, T. 41 N., R. 6 W. The Lucky Strike claim and a millsite adjoin. They are 11 miles by road from Weed. The only other nearby claims of note are the Meadow View (No. 91) in the NW¼ sec. 17, and an unnamed claim (No. 90) in the NW¼ sec. 19, T. 41 N., R. 5 W. The Josephine claim is described in a report by the U. S. Bureau of Mines.[17]

The Josephine deposit is located on the steep southeastern wall of Eddy Creek at an altitude of 5,300 feet. Ore was developed by seven open cuts, and later the whole area above and below the original exposure was stripped by bulldozer. The ore is markedly banded and consists of discontinuous layers of disseminated chromite in altered dunite. The layers strike N. 45°-55° W. and dip 45°-70° SW. The main ore body is cut by numerous cross faults of very small displacement and is bounded on the east and west by two strong faults that strike a few degrees east of north and dip steeply (70°-80°) east. Ore exposed east of the upper fault may be the faulted segment of the main ore body, but exploration has failed to show any significant eastward extension.

[17] Bagley chromite property, Siskiyou County, California: U. S. Bur. Mines, War Minerals Rept. 83, 1943.

Two-inch chromite lenses of no commercial value are exposed west of the lower fault; if these represent the faulted portion of the main ore body, chances are slight of finding commercial ore in this segment. A composite sample of the ore taken from the dumps assayed 22 percent Cr_2O_3. The ore is coarse-grained and should concentrate readily.

As exposed in March 1943, the strike length of the ore body between the faults was 53 feet, and the average width 12 feet, not including the sheet of barren serpentine that splits the eastern part of the body. Assuming a depth of 25 feet, the indicated reserves are about 1,600 short tons; assuming a 40-foot depth and a factor of 10 cubic feet of ore per long ton, the reserves are about 2,500 short tons. The actual tonnage probably lies somewhere between these two figures. If the average grade of the ore is 25 percent Cr_2O_3, the mill recovery 80 percent, and the grade of concentrates 45 percent Cr_2O_3, 1,600 tons of ore is equivalent to about 700 tons of concentrates, and 2,500 tons of ore is equivalent to about 1,100 tons of concentrates.

No development work has been done on the Lucky Strike claim, but heavy float in one area indicates the possibility of developing an ore body on the claim.

An unknown amount of high-grade ore was shipped from the claim in sec. 18 (No. 90) during the last war. The old workings are caved and the amount of ore remaining cannot be estimated.

Gazelle Mountain-Callahan Area

The Gazelle Mountain-Callahan area (Nos. 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88 [18]) extends from Gazelle, a station on the Southern Pacific Railroad and a speed zone on U. S. Highway 99 southwest to and beyond the village of Callahan. It includes the northern slope of the Scott Mountains and the part of the Salmon Mountains that lies south and west of Callahan. Much of the region is high and rugged; some peaks exceed 8,000 feet in altitude. The higher reaches are generally covered with snow during 6 months of the year. A gravelled road leads from Callahan southeastward across the Scott Mountains to Trinity Center. Callahan is 45 miles by paved road from Yreka, the commercial center and shipping point for eastern Siskiyou County, and is 23 miles from Gazelle by a gravelled road that follows the valley of the East Fork of Scott River and then follows Willow Creek.

Much of the area is underlain by the northern end of the large anticlinal peridotite mass that extends more than 30 miles to the south in Shasta and Trinity Counties and constitutes much of the range between Sacramento and Trinity Rivers. The peridotite is intricately intruded by gabbro and diorite that cut it into irregular patches about 30 square miles in extent. Two apophyses of highly serpentinized peridotite project outward from the northwestern flank of the main peridotite mass. One, slightly more than 2 square miles in extent, is exposed on Gazelle Mountain east of the county road and southward almost to Crater Creek. The second apophysis of serpentine, which is 6 miles long, crops out in the valley of the East Fork of Scott River. Both of these bodies are in sedimentary rocks probably of Paleozoic age and are closely associated with layers of banded chert.

[18] Numbers refer to plate 12.

Twenty-five occurrences of chromite in this area have been reported and others that have not been reported probably have had some work done on them. Only the Scott Mountain (No. 75), Hayden and Hilt (No. 76), Scatch (No. 78), and Lame Duck (No. 79) deposits have been visited by the writers, and the data available for the others are incomplete and conflicting. Most of the deposits are small pods. Only one deposit has a recorded production of as much as 500 long tons, and possibly 600 long tons has been produced from the various pods mined in sec. 35, T. 42 N., R. 7 W. The only assays of ore available are from the Big Boy (Dozier, No. 80), and the Hayden and Hilt (No. 76); these ores are of metallurgical grade.

Hayden and Hilt Mine (No. 76). During World War I Mr. R. V. Hayden leased from the Southern Pacific Railroad the E½NW¼SW¼ and the W½NE¼SW¼ sec. 35,[19] T. 42 N., R. 7 W., and he shipped some chromite from this area. During World War II Mr. Hayden renewed the lease and produced some ore in 1943, but transferred the property to E. A. Hayden and C. W. Thompson in 1944. The 12.4 long tons of chromite shipped by R. V. Hayden to the Metals Reserve Company stockpile at Yreka in 1943 from sec. 35, T. 42 N., R. 7 W., probably came from this property as well as the lot of 32.04 long tons shipped by Remsen from the same section. The former lot assayed 49.56 percent Cr_2O_3, and 10.18 percent Fe, and had a Cr/Fe ratio of 3.23.

Ore in this pod was reportedly followed to a depth of 140 feet.[20] It may be, however, that the ore mined in sec. 35 was confused with the ore mined in sec. 2, T. 41 N., R. 7 W. (Dozier, No. 80).

Scratch Claim (No. 78). The Scratch claim is in the SE¼ sec. 35, T. 42 N., R. 7 W. on the north slope of Gazelle Mountain at an altitude of 5,100 feet. It is 1 mile east of the county road and thence 9 miles to Gazelle. When visited in 1944 a claim notice dated October 1, 1944, stated that the owners were Clem Baker and Fred Frakes.

The deposit lies a few hundred feet south of the contact of the peridotite with sedimentary rocks that here trend slightly east of north. The peridotite is hard, massive saxonite, serpentinized but not comminuted. A vertical brecciated zone that strikes from N. 60° E. through east to S. 85° E. has been opened up on two levels. The upper tunnel, Tunnel No. 1, trends N. 60° E. and is 20 feet long. A winze has been sunk from this level 15 feet and an adit has been driven 50 feet S. 85° E. to connect with the winze. This is Tunnel No. 2. Open-cuts extend from Tunnel No. 1 up the mountain for 50 feet. No ore was seen in place. Rock on the dump showed chromite mixed with hard dunite. No uvarovite or kämmererite was seen.

Dozier (Mountain House, Genesis, or Gould) Claim (No. 80). During the year 1900 a chromite pod in sec. 2, T. 41 N., R. 7 W., was mined and during World War I and World War II several other chromite pods were mined in this vicinity. These operations have been known under various names. The original operation was called the Dozier mine, and as most of the deposits are on the Dozier Ranch this name is here used for all. The pods occur in the serpentine exposures that extend from the saddle on Gazelle Mountain southward into Scott River valley.

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[19] All references are to Mount Diablo meridian unless otherwise stated.
[20] Reported by R. V. Hayden.

The serpentine seems to be interlayered with sedimentary rocks. None of the deposits has been visited. According to Logan[21] a lens of chromite was opened up on the Dozier property in 1900 and 247 tons of high-grade ore was shipped. This is the largest deposit found in this section unless the deposit described by R. V. Hayden rightly belongs here. About 96 long tons has been shipped by F. S. Pollack, Hugh Williamson, and J. K. Remsen to the Metals Reserve Company's stockpile at Yreka from the Big Boy, the Genesis, and other properties in this section. They shipped the following tonnages, respectively: 36.31 long tons; 51.20 long tons; 2.25 long tons; 6.15 long tons; and 0.96 long ton. One lot from the Big Boy mine assayed 43.98 percent Cr_2O_3, 10.57 percent Fe, and 2.85 Cr/Fe ratio. The ore from the Genesis had the following range in composition: 42.37 to 44.22 percent Cr_2O_3, 9.44 to 11.47 percent 2.58 to 3.20 Cr/Fe ratio. In 1944 Thompson and Hayden shipped 21.75 long tons from this section under the name Mountain House Ranch. The ore assayed 41.65 to 42.53 percent. By and large, the pods contain less than 100 long tons of ore, but the ore is of high grade.

Chastain and Bowen (No. 87). Mr. Chastain told the writer that he mined out during World War I a pod of chromite located on top of the peak (alt. 6,873), in sec. 33, T. 42 N., R. 6 W., H. The pod contained 119 long tons of ore. Mr. Chastain packed out and shipped 110 long tons before the price of chromite broke in 1918 but, as far as is known, 9 long tons is still on the dump.

Deposits near Callahan (Nos. 64-75). During the first World War several chromite deposits near Callahan were mined and the Grouse Creek Chrome mine (No. 74), operated by Alonzo Bingham, produced more than 500 long tons of ore. A description of several of these properties is given by Logan.[22] There has been but little prospecting or production from this section during the period 1941-44. Mr. R. V. Hayden of Callahan, who operated during both wars, is of the opinion that the price for chromite has not been sufficiently high to justify prospecting away from existing roads.

Scott Mountain claim (No. 75) is located on the top of a northwest-trending spur of Scott Mountain at an altitude of 5,700 feet. It is in the NW¼ sec. 32, T. 40 N., R. 7 W., 0.8 mile north by truck trail from the Callahan-Trinity Center road at the divide, which is 8 miles east of Callahan. This claim was staked by R. V. Hayden and sold to Ronald Knudsen.

Here the peridotite is an intensely crushed serpentine. One trench and two pits have been dug over a distance of 250 feet along a line trending west-northwest. A reef of chert trending west by north for several hundred feet projects through the slickentite. No chromite was seen in place and production must have been small.

Yreka-Fort Jones Group

A tabular body of peridotite extends from Yreka 15 miles southwest by south to Scott Valley. The peridotites that crop out beyond the alluvium in Shasta Valley to the northeast and the exposures along the edges of the alluvium in Scott Valley to the southwest may be continuations of the same mass. The peridotite is about 3 miles wide and apparently dips steeply to the southeast. It has been altered to serpentine,

[21] Bradley, W. W., and others, Manganese and chromium in California: California Min. Bur. Bull. 76, pp. 195-196, 1918.
[22] Bradley, W. W., op. cit., pp. 190-200.

and much that is exposed along the three roads that cross the mass is intensely crushed to form what the miners call "slickentite." Small high-grade pod deposits (Nos. 43-59) have been mined from this highly serpentinized mass.

With the exception of Butcher Hill claim (No. 44) from which a few tons of low-grade lump ore was shipped in 1942 and the Lindell (No. 46) property in sec. 19, T. 44 N., R. 7 W., all the chromite produced from this peridotite mass during the period 1941-44 has come from the Moffett Creek area.

Moffett Creek Area

Moffett Creek has cut a steep-sided canyon into the southern part of the peridotite body exposed from Yreka to Scott Valley. This canyon and the adjacent area is called the Moffett Creek area (Nos. 48-56). Allen[23] has examined most of the diggings in it. He divides the area into the southern claims in the "Mineral Range" of hills south and west of Moffett Creek, and the northern claims lying north of Moffett Creek, and describes them as follows:

> The normal country rock for all the deposits in the southern claims is a dark-green serpentine that ranges from massive to highly sheared and broken. Slickentite zones are common and in places the rock grades into relatively unaltered peridotite and massive dunite facies, but these are both definitely subordinate in amount within the area.
>
> Local structural indications are very irregular and the attitude of the ore bodies is difficult to ascertain, owing partly to the bad caving of the mine openings and partly to the broken nature of the rock. The attitudes of those ore bodies that could be determined were irregular, but when the 12 occurrences in the whole group were carefully mapped, a surprisingly definite alinement into two coordinate systems appeared. The two directions are N. 18°-20° E. and N. 70° W. The ore from the southern deposits is generally rather low in grade. Much of it is badly mixed with serpentine and much is in narrow bands and grades into the disseminated type of ore. Some assays were made by the Rustless Mining Co. as follows:

No.	Cr_2O_3	FeO	SiO_2
1	53.98	15.52	2.87
2	44.20	17.62	6.98
3	48.51	15.23	6.24
9	53.68	15.86	2.79

> The Peg Leg (No. 53), called the Chromite King during the first World War; the occurrences on the Simas Ranch (No. 54) secs. 34, 35, T. 44 N., R. 8 W.; and the Costello (No. 56) sec. 4, T. 43 N., R. 8 W. are located here. Another property also called Simas Ranch (No. 55) is in sec. 12, T. 43 N., R. 8 W.
>
> The country rock north of Moffett Creek is more massive and less altered than that to the south, and consists predominantly of yellow-weathering diallage peridotite, with only small serpentinized areas. The ore bodies appear to be larger and of higher grade (less broken and mixed with serpentine) and more continuous than in the southern area. A slightly different alinement of ore bodies appears upon mapping nine of these deposits, the two directions being N. 40° E. and N. 65° W., with the suggestion that the plane of the latter dips steeply to the south.
>
> Nearly all the ore from the northern deposit is of much higher grade, and comes cleanly from the rock face.

	Cr_2O_3	FeO	SiO_2
Average of pits Nos. 1 and 4 to 9	49.66	15.36	5.05
(Lutrelle No. 47)	47.15	19.15	6.01
Allison, No. 50 (high grade)	56.31	14.45	0.87

> Total production from the area through 1943 is 956 long tons and the most important producer is the Peg Leg or Lambert mine (No. 53).

[23] Op. cit., pp. 126-128.

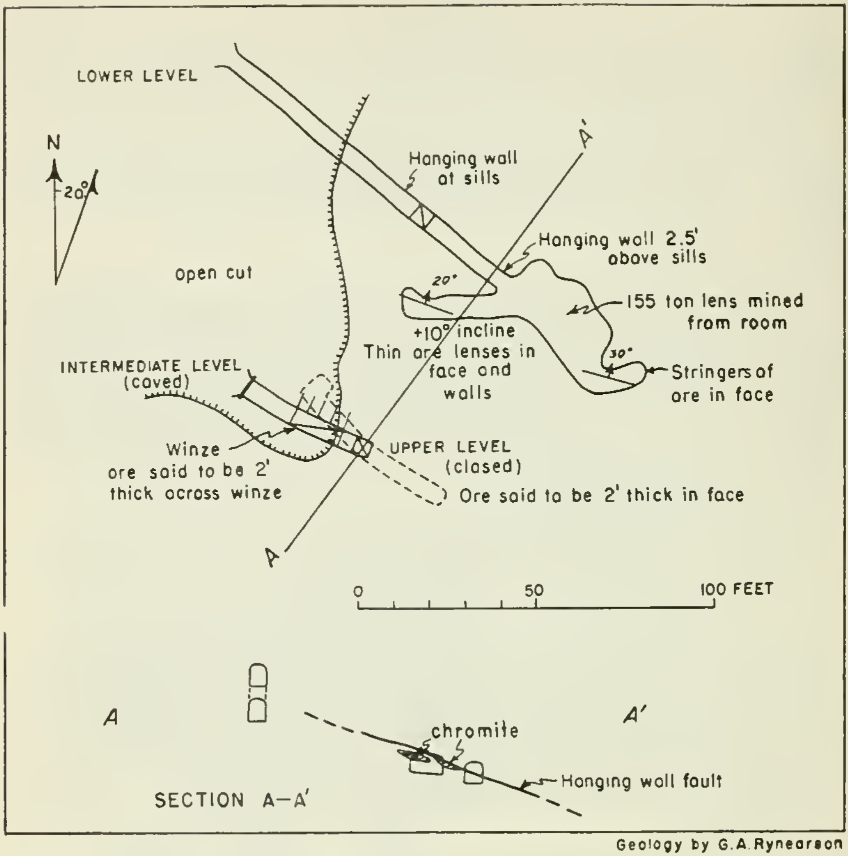

FIGURE 4. Sketch map of the Peg Leg (Lambert) mine, Siskiyou County, California.

Peg Leg (Lambert Claim) (No. 53). The Peg Leg (Lambert) mine is in the NE¼SE¼ sec. 26, T. 44 N., R. 8 W., on the south bank of Moffett Creek. It is 15½ miles from Yreka: 14 by paved road, 1 by gravel road, and the last one-half mile by dirt road. The owner is Basil Wood of Fort Jones, California, but he has leased it to several different operators from 1941 to 1944. Total production through 1943 was 531 long tons.

In March 1943, development consisted of a large open-cut and 250 to 300 feet of underground workings. The workings in the intermediate and upper levels are now closed or caved.

The country rock is mainly saxonite, but includes small masses of dunite. The ore occurs as lenses, pods, and stringers of massive chromite along zones of shearing in the dunite.

A sharp hanging-wall fault plane is the most distinctive feature of the deposit. This fault plane strikes N. 70°-75° W. and dips 20° to 30° N. in the lower level. Its position and attitude in the upper workings cannot be observed, because these workings are now caved. The ore occurs in the dunite and sheared serpentine beneath this fault plane. Although most of the ore lenses are small, most of them are connected by thin leads or stringers of ore. The largest lens found underground contained about 155 long tons of ore. Large lenses are said to have been mined from the surface, but their size is not known. In most places, the ore breaks cleanly from the walls, and very little serpentine is included in it. The clean ore has the highest chromic oxide content and highest Cr/Fe ratio of any ore mined in the Klamath Mountains province (see analysis 9).

Reports of production during the first World War ranged from 250 to 500 long tons. More recently, it is reported that Bradley and Ekstrom acquired 65 long tons of the ore (in 1941 ?). The U. S. Vanadium Corporation bought 108 long tons of the ore from Wild and Johnson and later resold it to the Metals Reserve Company. Wild and Johnson shipped 29 long tons of ore containing 54.40 percent of Cr_2O_3, 11.18 percent of Fe, 3.22 percent silica, 7.26 percent Al_2O_3, and 15.55 percent MgO, with a Cr/Fe ratio of 3.33, to the Metals Reserve Company stockpile at Yreka in 1942. C. F. Shaw mined approximately 50 long tons of ore during the winter of 1942-43 and shipped it to the Yreka stockpile in March 1943.

Except for ore actually in sight, reserves of this type of deposit are almost impossible to estimate. There is (March 1943) about 10 tons of probable ore in the lower workings. About 100 tons of ore is indicated between the upper and lower levels if the reports of ore still in place in the caved workings are accurate. This estimated reserve could be much higher or much lower depending upon variations in the size of the ore lenses in this partly explored block of ground.

Serpa Ranch Area

Small patches of peridotite are exposed on Chaparral Hill to the southwest of Fort Jones. During the first Wold War chromite was discovered in one of them, just above the paved road between Fort Jones and Etna on the Serpa Ranch (No. 59) in sec. 15, T. 43 N., R. 9 W. In 1942 the deposits were opened up by a bulldozer, and at that time widely scattered patches of low-grade disseminated ore were seen. This material did not appear to merit development. Apparently some higher-grade material was opened up later because Joe Serpa, the owner, shipped 5.15 long tons of ore in 1943 and Harold Ellickson shipped 10.17 long tons from this property in 1944. The ore probably contains much gangue, as the assays of the two lots were 36.02 and 31.62 percent Cr_2O_3, and 11.11 and 10.30 percent Fe.

Shackleford Creek Group

An elongate mass of peridotite caps the ridge between Canyon Creek and Shackleford Creek. This mass has not been mapped even in reconnaissance, but as it extends lower down on the Canyon Creek slope it is probably a thin westward-dipping tabular body. Where seen by the writers, the peridotite is only partly serpentinized. The area is accessible from Yreka by way of the Fort Jones-Scott Bar road and by trail up Shackleford or Canyon Creeks. Other parts of the area are accessible only by trail.

Chrome Deposits at Calf Lakes (No. 29). Some chromite is found as scattered accessory grains or small aggregates in the dunite exposed on the surrounding ridge and in the glacial cirque occupied by Calf Lakes. The area is in sec. 22, T. 43 N., R. 11 W., above an altitude of 6,600 feet and can be reached from the end of the road on Shackleford

Creek by 8 miles of poor trail. The dunite is fairly fresh. At places accessory grains of chromite may constitute from 1 to 2 percent of the rock.

A low bare ridge (roche moutonnée), trending N. 60° W., projects 50 to 75 feet above the floor of the cirque occupied by Calf Lakes. It consists largely of dunite, which is strongly jointed in a direction N. 60° W. A little chromite is scattered through this mass as accessory grains, and a few bunches and stringers of chromite are distributed in three zones parallel to the trend of the jointing. These aggregates are mostly less than 6 inches in longest dimension, but one a foot long and one 6 feet long were observed. The largest does not contain more than 1,000 pounds of ore and the total of these aggregates is probably less than 2 tons. No concentrations of chromite containing 5 percent Cr_2O_3 or more highly mineralized dunite were seen anywhere on this bare ridge or on the well-exposed walls of the cirque. Many reports of large deposits of concentrating ore in this area have been received, but the area was visited twice with different guides and no such deposits were seen. It is possible some prospectors have mistaken hornblende schist for chromite ore.

Beaver Creek Group

Peridotite crops out for several miles along Klamath River east and west of the confluence of Beaver Creek, a tributary from the north. As shown on the geologic map (see pl. 12), about 40 square miles in the basin of Beaver Creek and areas nearby (Nos. 36-42) is underlain by this rock and connects with areas of peridotite in the vicinity of Donamore Peak across the border in Oregon. The writers are of the opinion that systematic mapping will show a more complicated pattern of outcrop and more restricted distribution of peridotite. This is true to the north in Oregon where the largest peridotite body covers only 6 square miles. Along Klamath River both the eastern and southern, and western and northern contacts of the peridotite dip steeply east or southeast as do the contiguous schistose rocks. The peridotite tends to lie between the Abrams and Solmon schists and the gneissic facies of the Applegate group of rocks.

Scattered schlieren of chromite occur at many places in this body, but only a few small masses of chromite rich enough to make shipping ore have been found, and no deposit of concentrating ore containing as much as 5,000 tons has been discovered.

The region is rugged and ranges in altitude from 1,700 feet at Klamath River to 7,000 feet on the crest of the Siskiyou Mountains. It is traversed by a mountain road up Beaver Creek and a road that follows the crest of the divide to the west. These roads can be travelled during dry weather only.

Upper Beaver Creek Area

Snowy Ridge Mine (No. 36). The Snowy Ridge mine consists of one claim, which was located by H. C. Whitney, Art Kleinhammer, Arley Beasley, and Lloyd Whitney in 1940. It was leased to Fay Bristol. He subleased it to J. K. Remsen who operated the property from 1941 until the late summer of 1943. Total production is 298 long tons (December 31, 1943). Though it can be reached from the Klamath River road, access from Grants Pass, 36 miles to the northwest, by paved road and steep mountain dirt road is easier. The mine is generally snowbound from November to the end of May.

The claim is on a south-facing slope near the top of a ridge at an altitude of 6,300 feet in sec. 21, T. 48 N., R. 9 W. A small elliptical mass of serpentinized peridotite, the longer axis of which trends north, crops out on this slope. It is rudely conformable with the foliation of the enveloping metamorphic rock, which strikes a few degrees east of north and dips east at high angles. Enclosed in the serpentine (see pl. 14), and lying 65 feet from and trending parallel to the schist-serpentine contact, is a lens of near-massive to massive chromite. In this area the serpentine has a pronounced sheeting that strikes from N. 5° E. to N. 20° E. and dips steply either east or west. Numerous radiate clusters of anthophyllite crystals have developed along the western margin of the serpentine. These crystals decrease in size and number eastward away from the schist-serpentine contact and are not in evidence 70 to 80 feet east of the contact. Joints and fractures are commonly filled with talc and chlorite. Cutting the area and offsetting the schist-serpentine contact is a series of northwest-trending faults, the largest of which offsets the schist-serpentine contact 75 feet and cuts the chromite lens into two segments of approximately equal lengths (see pl. 14). Along these faults have been injected pegmatitic quartz-feldspar dikes that seem to pinch out as the faults enter the schist.

The chromite occurs as a tabular body, slightly irregular in detail but rather uniform in general. The two segments of the ore body produced by the large, northwest-trending fault differ somewhat in strike, the northwest segment striking N. 50° E. and the southeast segment striking N. 15° E. Both segments dip from 45° to 65° E. A steeply dipping fault that strikes northeast cuts the southeast segment. Movement has been such that the small block of ore southeast of this fault strikes N. 45° E. The ore body was from 1 to 4 feet thick and was never mined to a depth greater than 30 feet. A thin shell of serpentinized dunite surrounds the ore body. In places the contact between the ore and barren dunite is frozen and gradational through a few inches; in others it is sheared.

Operations at this mine ceased about the middle of August 1943. At that time a small stringer of ore less than a foot thick could still be seen in the face of the upper adit, but this was too thin for profitable mining. Mr. Remsen reports that a total of 298 long tons of ore has been produced, containing from 36.23 to 40.69 percent chromic oxide and having a Cr/Fe ratio of 2.24 to 2.50. The property is mined out, aside from a few tons of ore in the upper adit which under present prices do not warrant mining.

Gottville-Walker Area

Serpentinized peridotite crops out along Klamath River from Gottville west to Horse Creek. The distribution of this rock is irregular and the structure has not been determined. There has been no production from this area (Nos. 38-42) since 1918. During the first World War several properties were opened up in this area by P. S. Mathewson (No. 38), sec. 33, T. 47 N., R. 8 W; W. Blanton (No. 39), sec. 34, T. 47 N., R. 8 W.; the Eastern Mining Company which operated the Portugese Gulch or Gottville group (No. 40), sec. 9, T. 46 N., R. 8 W.; and the Liberty Mining Company which operated the Blackcap (No. 42), Wandering Jew and Buckhorn claims (No. 44), secs. 8, 9, 16, 17, 20, T. 46 N., R. 8 W. Diller examined these deposits and described them in unpublished notes as low grade, containing scattered chromite, in highly sheared serpentine or slickentite. The ore grades into barren rock. Apparently the ore shipped consisted of small lumps of dense chromite grains that were of shipping grade. Possibly a few thousand tons of concentrating ore are available at the surface.

Seiad Group

The peridotite bodies designated as the Seiad group (Nos. 10-27) crop out in the valley of Klamath River in the vicinity of Seiad Valley, a hamlet 51 miles by gravel road from Yreka. Three large peridotite masses, the Hamburg-McGuffy Creek, Seiad Creek-Red Butte, and Grider Creek, comprising 19, 9, and 17 square miles of outcrop area respectively, as well as several small bodies, have been mapped in this group by Rynearson and Smith.[24] Chromite production from this area has been mostly hand-cobbed ore mined from deposits of disseminated ore and the remaining reserves are largely of the disseminated type.

Hamburg-McGuffy Creek Area

The Hamburg group is west and south of the village of Hamburg, which is on Klamath River 2 miles downstream from the confluence of Scott River. The chromite deposits are in a sill of peridotite that extends from the valley of Scott River near McGuffy Creek north-northwest across Klamath River, a total distance of 10 miles. This body is a tabular mass that lines conformably within the west-dipping schistose rock. Intrusives of diorite and granodiorite complicate the structure. This area is very rugged. The mountains rise from Klamath River, altitude 1,500 feet, to the crest of the Marble Mountains at 7,000 feet, in 4 miles. Hamburg is 34 miles by paved road from Yreka.

Ladd (Dolbear or Klamath) Mine (No. 17). The Ladd mine, also known as the Dolbear or Klamath chrome mine, in secs. 16 and 21, T. 46 N., R. 11 W., is on the steep north bank of Klamath River, 800 feet above the stream. It is 3 miles by dirt road to the county road and thence 54 miles to Yreka. The property is owned by John Ladd of Seiad Valley, California, and is leased to Mrs. D. R. Moroney of Hamburg, California. During 1942 and 1943 the property has been subleased and operated by Ronald Knudsen and then by James K. Remsen. It has produced (December 31, 1943) 1,885 long tons of ore, 1,598 long tons of which was produced in 1918.

A complete description of the property is given in a report by the writers.[25]

Fairview Mine (Hamburg Bar) (No. 18). The Fairview property comprises four claims owned by F. S. Pollack of Washington, D. C., and an adjacent claim owned by Hollis Anderson of Scott Bar, California. They are in secs. 27 and 34, T. 46 N., R. 11 W., on top of the north-trending ridge that rises steeply from the south bank of Klamath River. The mine can be reached over 3 miles of very steep dirt road from a point on the graveled county road 46 miles west of Yreka (see pl. 12).

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[24] Op. cit.

[25] Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., Chromite deposits near Seiad and McGuffy Creeks, Siskiyou County, California: U. S. Geol. Survey Bull. 948B, 1949.

The property was operated during the first World War by Dr. J. F. Reddy. It was called the Hamburg mine and consisted of the Good Pasture, Hamburg, McGinnis, and Red Cap claims. According to an auditor's report 509 long tons of ore was mined, of which 216.29 long tons was shipped. From 1942 through 1944 the property was under lease to H. E. Ellickson for F. S. Pollack. He mined and shipped 2,043 long tons of ore.

The mine was mapped in detail by Rynearson in 1942, and a detailed description of the mine at that time has already been published.[26]

Deposits at McGuffy Creek (Nos. 19-27). The peridotite body of the Hamburg claim ends southward on the steep northwest wall of the valley of Scott River about 5 miles south of the mouth of this stream. Here a short southeast-flowing tributary, McGuffy Creek, has cut a deep canyon in the peridotite and exposes some deposits of chromite. Most of the deposits are on the southwest side of McGuffy Creek between altitudes of 3,400 and 4,900 feet, and the lower claims are accessible by a steep mountain road. The Cerro Colorado (No. 23), Veta Chica (No. 22), Mil Diablos (No. 22), Veta Grande (No. 27), Piedra (No. 21), and Mary Lou (No. 26) claims are owned by H. W. Gould and leased to the Rustless Mining Corporation; and the Lady Gray (No. 26), Grand Falls (No. 25), Grand Canyon (No. 25), and Bluestone (No. 25) claims are held by Mrs. Dorothea R. Moroney. The first group was mapped by J. S. Livermore and others of the U. S. Geological Survey in the summer of 1941 and was explored by the U. S. Bureau of Mines in cooperation with the Survey in the summers of 1941 and 1942.[27] The work indicated 25,200 short tons of 8 percent ore. These deposits are mostly of the banded type and bundles of bands are separated from others by barren dunite in such a way that much barren rock would have to be mined with the ore; the run-of-mine product would need hand sorting before mechanical concentration. The chromite from this area is largely of high grade, containing 55 percent Cr_2O_3 or better. Much of it has a Cr Fe ratio of better than 2.5. These deposits are fully described in a published report by the writers.[28]

Seiad Creek-Red Butte Area

The chromite deposits (Nos. 10-14) in the Seiad Creek-Red Butte area have been described fully by the writers[28] and pertinent data on the deposits are also given in publications by Rynearson[29] and Averill.[30] From this area has come the greatest output in the county and within it remain the largest reserves. All the ore is disseminated, and is sufficiently rich in some places to be hand-sorted to shipping grade. The peridotite in which the ore occurs crops out in the valley of Seiad Creek and forms the bold red peaks Red Butte, Kangaroo Mountain, and Rattlesnake Mountains along the crest of the Siskiyou Mountains. It is a tabular body several thousand feet thick and about 5 miles long, which dips steeply westward and occupies the east limb of a large south-plung-

[26] Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., op. cit.
[27] McGuffy Creek chromite, Siskiyou County: U. S. Bur. Mines War Minerals Rept. 76, pp. 1-8, 1943.
[28] Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., op. cit.
[29] Rynearson, G. A., and Smith, C. T., op. cit.
[30] Averill, C. V., Mines and mineral resources of Siskiyou County: California Jour. Mines and Geology, vol. 31, pp. 255-338, 1935.

ing synclinal structure, or synclinorium. Around its southern end it is terminated by intrusive diorite.

Schlieren of chromite trending north-northwest are found at many places in this sill. Those that have been large enough to warrant some prospecting are the Mountain View group (No. 14) of claims, commonly called the Seiad Creek deposits, the Anniversary (No. 10) claim, commonly called the Kangaroo Mountain deposit, the Stanton deposit, commonly called the Emma Bell claims (No. 11), the Blue Eagle (No. 12), and Black Eagle (No. 13) claims.

Seiad Creek Mine or Mountain View (Reddy No. 2) (No. 14). The Seiad Creek or Mountain View deposits are located between the forks of Seiad Creek in sec. 20, T. 47 N., R. 11 W. This property shipped 2,424 long tons of hand-sorted ore through December 31, 1944. This ore ranged from 30.93 percent to 41.42 percent Cr_2O_3; 9.87 percent to 11.87 percent Fe, and 2.20 to 2.43 Cr/Fe ratio, according to the settlements of sale. Most of this ore was shipped during 1943 and 1944 by the Kangaroo Mountain Chrome Co., which had leased the property from the Rustless Mining Co. These deposits were explored by the U. S. Bureau of Mines in cooperation with the U. S. Geological Survey in the summer of 1941, and 266,000 short tons of 6 percent Cr_2O_3 or 60,000 tons of 15 percent ore were developed.[31] Smith, assisted by Livermore and Phoenix, did the geologic work for this exploration. Some low-grade direct-shipping ore can be sorted from the disseminated chromite but most of it requires concentration. Although the chromic oxide content of the chromite in these ores is high, averaging better than 53 percent, the iron content is also high; production of concentrates with a Cr/Fe ratio of 2.5 may not be possible.

Kangaroo Mountain or Anniversary Mine (No. 10). The Anniversary claim is located on the crest of the Siskiyou Mountains at an altitude of 6,000 feet in secs. 13 and 14, T. 47 N., R. 12 W. A Forest Service road reaches within three-quarters of a mile of the deposit. This area was mapped in October 1941 by Livermore, Richards, and Phoenix. From surface exposures and from visual estimation of grade, they inferred that 10,000 short tons of ore of 5 percent Cr_2O_3 grade could be developed.[32]

Other Prospects. The Emma Bell claims, also known as the Stanton property, are described in the report on the Seiad Creek area.[33] The Blue Eagle and Black Eagle claims are described by Allen (No. 41).[34]

Grider Creek Area

The northern end of an elongate body of peridotite, here called the Grider Creek mass, has been mapped by Rynearson and Smith in the canyon of Klamath River just west of Seiad Valley. Reconnaissance indicates that this mass extends many miles south. It forms the crest of the ridge between Grider Creek and the basin of Elk Creek to the west, but its western and southern boundaries have not been mapped. It is at

31 Wells, F. G., Smith, C. T., Rynearson, G. A., and Livermore, J. S., op. cit.
32 Wells, Smith, et al., op. cit.
33 Wells, Smith, et al., op. cit.
34 Allen, J. E., op. cit.

least 12 miles long and has a maximum width of 2 miles in its northern part. The Grider Creek mass is a tabular body that dips at low or moderate angles toward the west. It is conformable with the younger metamorphic rocks that bound it on the east.

Barton Claims (No. 15). Near the northern edge of sec. 10, T. 46 N., R. 12 W. and close to the contact of the Grider Creek mass is an open-cut which when examined in 1939 was in massive chromite. Some kämmererite accompanied the chromite, which occurred in black serpentine. The claims are owned by Ariel Lowden who leased them to K. W. Walters and later to W. M. Middel. In 1944 Mr. Middel shipped 7.80 long tons from this property to the Metals Reserve Company at Yreka. Mrs. Dorothea R. Moroney shipped about one ton of ore from here in 1942. The production during World War I is not known.

Reddy Claim No. 3 (No. 16). The Reddy claim No. 3 is probably the Creed claim from which J. F. Reddy shipped during the first World War. It is near the northern contact of the Grider Creek peridotite mass close to the northern edge of sec. 9, T. 46 N., R. 12 W. It is developed by two open-cuts. The small scraps of ore left in these cuts is in part massive, in part disseminated, and apparently all of the ore has been mined out.

Elk Creek Claim (No. 28). In 1941 a pod of massive chromite was found on the ridge above the headwaters of the East Fork of Elk Creek in sec. 31, T. 45 N., R. 12 W. The claim can be reached from the Klamath River highway by 14 miles of Forest Service road. This deposit was not seen by the writers but it was reported to consist of massive chromite. I. D. Turner shipped 180.37 long tons of ore to the Metals Reserve Company stockpile in Yreka during 1942. This ore had the following range in composition: 39.51-42.00 percent Cr_2O_3, 9.04-10.33 percent Fe, having a Cr/Fe ratio of 2.70-3.18. Harold Ellickson shipped 5.67 long tons of ore to the stockpile in 1944 from the same section and probably from the same claim.

Cecilville Group

During 1943 and 1944, about 350 long tons of chromite was shipped to the Metals Reserve Company from the Cecilville area. This production came from secs. 16, 17, 19, 20, 21, 26 and 29, T. 38 N., R. 11 W. Cecilville is on the South Fork of Salmon River in the southwestern part of Siskiyou County. A steep dirt road 14 miles long connects Cecilville with Sawyers Bar, and Sawyers Bar is 57 miles by dirt and paved road from Yreka. This road passes over the crest of the Salmon Mountains at an altitude of 5,865 feet and is closed to traffic from November until May.

Table 7. Analyses of lots of ore shipped from the "Cecilville group" to the Metals Reserve Company stockpile at Yreka. (Analysts Abbot Hanks Co.)

Name	Location no.	Percent Cr_2O_3	Percent Fe	Cr/Fe ratio
Black Crow	35	38.00-52.12	10.81-11.76	2.21- 3.30
Black Hawk	33	45.85-46.97	11.73-12.16	2.58- 2.69
Dry Gulch H. & S.	30	53.12-54.61	10.17-10.86	3.44- 3.57
Dry Gulch G. & E.	30	49.63-55.99	10.85-11.13	3.13- 3.44
Mary Lou	32	45.53	12.08	2.57

The writers did not visit the deposits (Nos. 30-35) in this area, but they observed a few facts about the distribution of peridotite. Slates, with intercalated lenses of chert, limestone, and layers of pyroclastic rocks, appear to constitute the prevailing country rock. They have been highly deformed, and have been intruded by small bodies of peridotite and quartz diorite. The peridotite commonly occurs as elongated slivers of slickentite, probably along faults. One irregular body of serpentinized peridotite occurs at Cecilville; it is about 3 miles long and in general is less than a mile wide. Six pods of high-grade chromite have been mined within it. They are: Black Crow (No. 35), Black Hawk (No. 33), Blue Doe (No. 31), Dry Gulch (No. 30), Meidell and Farrel (No. 34), and Mary Lou (No. 32). The location, name of owners of these claims, and the name of shipper are listed in table 6. The range in the grade of ore shipped is listed in table 7. The high grade of ore from the Dry Gulch mine (No. 30) is noteworthy.

Western Boundary Group

The western boundary of Siskiyou County, from which the Western Boundary group (Nos. 1-8) is named, follows the sinuous crest of Siskiyou Mountains from the Oregon boundary southward to a point near Chimney Rock. From Youngs Peak southward for 18 miles this ridge forms the divide between the drainage basins of Smith River and Clear Creek, a tributary of Klamath River. The area is very rugged; Preston Peak, the highest peak in the range, is 7,310 feet above sea level, and Clear Creek, 4 miles distant, is 2,500 feet.

The distribution of peridotite is so complex and so little known that the region cannot be feasibly divided into areas underlain by a single peridotite mass, but it can be divided conveniently into the Indian Creek area and the Upper Clear Creek area as access to these two areas is by two unconnected sets of roads.

Indian Creek Area

The Indian Creek area (Nos. 5-8) lies within the drainage basin of Indian Creek, a tributary to Klamath River from the north. The confluence of the two streams is at the village of Happy Camp, which is 72 miles by gravel road west of Yreka. A road up the valley of Indian Creek crosses Siskiyou divide and gives egress to Grants Pass, Oregon, a commercial center and shipping point 65 miles distant. A Forest Service road leaves this road at the confluence of the South Fork of Indian Creek and leads to the top of Baldy Mountain.

This area has not been mapped geologically. The writers have examined the geology along the roads with sufficient care to prove that the rocks are metavolcanic and metasedimentary rocks similar to those in Oregon to the north-northeast along the strike. The metasedimentary rocks consist of argillites, cherts, and some lentils of marbleized limestone. Fossils in the limestones have been determined by Reeside to be lower Mesozoic, probably Triassic, in age. Most of the peridotite bodies in rocks of this age in Oregon are tabular, rudely conformable, and small, being less than 3 square miles in area. Generally these rocks are completely serpentinized. In places the peridotite is interlayered with sedimentary rocks; layers of peridotite a thousand feet thick or less alternate with layers of sedimentary rocks of similar or lesser thickness. Such sequences suggest that the sediments were unconsolidated or but slightly consolidated at the time the peridotite was emplaced. If this be true the peridotite is of Triassic age and consequently older than the peridotite intruded into the Franciscan or Knoxville formations. Evidence that serpentines have been intruded into sediments within a few thousand feet of the surface and during the accumulation of the sedimentary formation is found in the Wilbur Springs district, California.[35]

Very little search for chromite has been made in this area. Herbert Cook of Happy Camp has mined and shipped some ore from sec. 26, T. 18 N., R. 6 E. A little chromite has been mined in secs. 4, 6, and 7, T. 17 N., R. 7 E. Undoubtedly other deposits could be found in the area but they probably would be small. No analyses of ores from this area are available.

Upper Clear Creek and Doe Flat Areas

The Upper Clear Creek and Doe Flat areas (Nos. 1-3) are accessible over 12 miles of steep dirt mountain road from a gravelled road at Waldo in southern Oregon, or from the west over 20 miles of similar road from Symns Camp, California, on U. S. Highway 199. Waldo is 38 miles and Symns Camp is 71 miles from Grants Pass, Oregon. These roads do not join and road construction in much of the region is both difficult and costly.

Maxson[36] has mapped the Upper Clear Creek and Doe Flat areas in reconnaissance. A long narrow band of peridotite extends from the Oregon border south across northeastern Del Norte County[37] about 10 miles into northwestern Siskiyou County and thence another 20 miles across the valley of Clear Creek and into the valley of Dillon Creek. In Del Norte County this band is nowhere more than 2 miles wide. It is bounded on the west by rocks of the Galice formation that dip steeply east, and on the east mainly by metavolcanic rocks of the Applegate group. Near the border of Siskiyou County and southward for about 10 miles, the outcrop pattern of the peridotite is complicated by intrusions of diorite, granodiorite, and related rocks that, in the valley of Clear Creek, completely envelop the peridotite.[38] South of Clear Creek Valley rough reconnaissance mapping indicates that the peridotite is a narrow tabular body lying conformably within the Applegate rocks.

Three chromite deposits have been mined in the Upper Clear Creek area: the White Feather (No. 1), Cyclone Gap (No. 2), and Doe Flat (No. 3).

White Feather Claim (No. 1). The White Feather claim is partly in Siskiyou County and partly in Del Norte County in the SE¼ sec. 4, T. 17 N., R. 5 E. It is on the northeast slope of a ridge at an altitude of about 5,000 feet. The property was discovered by Homer White in 1917 and was held by F. A. Andrews and C. W. Van Luven in 1940. In 1942 Baker Bros. shipped 65 long tons of chromite.

The chromite occurred 300 feet south of the serpentinized peridotite and diorite contact in an irregular pod elongated N. 20° W. It was about

[35] Averitt, Paul, Quicksilver deposits of the Knoxville district, Napa, Yolo, and Lake Counties, California: California Jour. Mines and Geology, vol. 41, pp. 65-89, 1945.
[36] Op. cit.
[37] Wells, F. G., Hotz, P. E., and Cater, F. W. Jr., Preliminary description of the Kerby quadrangle, Oregon: Oregon Dept. Geology and Min. Ind. Bull. 40, p. 23, 1948.
[38] Maxson, J. H., op. cit., pl. 4.

30 feet long and averaged about 8 feet wide and 4 feet deep. The ore was massive and coarse-grained and was surrounded by ''slickentite.'' The surface of the pod was polished and striated by movement. After this pod was mined, no other ore was found. Allen[39] reports the following assay: 37.88 percent Cr_2O_3, 12.60 percent FeO, and 2.03 percent SiO_2. This ore has a Cr/Fe ratio of 2.63.

Cyclone Gap Mine (No. 2). The Cyclone Gap chromite mine (No. 2), also known as the Mammoth mine, is located in the SW¼ sec. 15, T. 17 N., R. 5 E., near the western edge of Siskiyou County (see pl. 12). It is at an altitude of approximately 5,350 feet on the south edge of a small cirque, and is about a quarter of a mile west of a low saddle called Cyclone Gap, which separates Copper Mountain from El Capitan. The ore is trucked 32 miles on graded dirt roads to Cave Junction, Oregon, and thence 30 miles on U. S. Highway 199 to Grants Pass, Oregon, the nearest stockpiling depot. Three claims—the Mammoth and two others whose names are not known to the writers—are owned (1943) by H. C. Cullon, F. Dunham, and D. R. Morrison, and are leased to J. K. Remsen of Portland, Oregon.

Extensive development of the property was undertaken by Remsen in May 1941. About 100 tons had been mined and left on the dump by previous operators. Initial shipments were made in 1942 after the mine was made accessible by 5.4 miles of privately constructed road and 8.4 miles of government-constructed road. During 1942 these shipments totaled 1,801 long tons of ore averaging 46.9 percent of Cr_2O_3; during 1943 they totaled 516 long tons of ore averaging 45.1 percent of Cr_2O_3. In October 1943 the operations were suspended temporarily, but Ben Baker mined 111.81 long tons of ore during the summer of 1944.

Brief descriptions of the deposit were made by Maxson[40] and Allen[41] prior to the recent operations. Personnel of the Geological Survey have examined the deposit several times between the first examination made by Wells in 1940 and the last examination made by Cater in 1943. A field party consisting of G. A. Rynearson, D. E. Flint, and D. H. Dow spent 7 days mapping the mine in November 1942, and F. W. Cater Jr., D. H. Dow, and W. P. Williams completed the mapping in July and September 1943. Transit and plane-table methods were used. Acknowledgment is made of the cooperation and valuable information given by J. K. Remsen and Ben Baker during this investigation.

The chromite of the Cyclone Gap mine occurs in a mass of serpentinized peridotite about 450 feet west of a large heterogeneous mass of dioritic rocks (see pl. 15). Numerous dikes of these dioritic rocks have been injected into the peridotite and several cut the ore bodies. The area in the vicinity of the mine has been glaciated, and the natural exposure of the uppermost ore body of the deposit resulted from the development of a small cirque. South and east of the mine, along the rim of the cirque, the bedrock is relatively well exposed, but below the mine, in the basin of the cirque, the bedrock is almost completely covered with talus and glacial debris. In general the most prominent outcrops are formed by the dioritic dikes, because these rocks are harder and more resistant to glacial erosion than the peridotite and serpentine.

[39] Op. cit.
[40] Op. cit.
[41] Op. cit.

The peridotite originally consisted of saxonite and dunite, but in most places these varietal types have been altered to serpentine. Attempts to separate the serpentinized dunite from the serpentinized saxonite on the geologic maps were not successful because most of the distinguishing characteristics of the original rocks have been obliterated. The dunite masses are apparently irregular in shape and are distributed at random within the saxonite. Some faulting and shearing has occurred within the peridotite mass, but there is no apparent system to these fractures and the displacements are not large.

A large number of small, irregular, and discontinuous dioritic dikes occur throughout a zone about 750 feet wide along the eastern margin of the serpentinized peridotite mass. These dikes range from 1 to 40 feet in thickness. Their length is commonly not more than several times their thickness, and some even appear to pinch out at shallow depths. One mode of origin suggested by the shape and random distribution of the dikes is that dioritic liquids were injected into preexisting fractures in the peridotite in such a manner that only parts of the fractures were forced open and pressures acting upon the surrounding peridotite caused the feeder channels to be squeezed off before the liquids congealed.

A few dikes of rodingite were well exposed in the chromite bodies. In the Pacific Coast states rodingite has been found without exception either in zones of slickentite or adjacent to chromite ore and associated with diorite dikes. At Red Mountain in Glenn County [42] and at the Oregon Chrome mine in Josephine County the rodingite is found in shear zones adjacent to the diorite dikes. In a few places the diorite grades into rodingite by gradual loss of recognizable feldspar and pyroxene. The writers believe that the rodingite is of hydrothermal origin, presumably having been formed by the action of solutions from or accompanying the end-stage of the diorite intrusion upon the diorite dikes and possibly to some extent on the enveloping peridotite or serpentine. This alteration probably took place in large part before the complete consolidation of the dikes. The best exposures of rodingite were found in the mine workings (see pl. 16), where mining operations had exposed dikes of that rock that cut the ore bodies. The intrusive material apparently found easy access to fractures in the ore, but in only a few places was it observed to have penetrated the dense serpentine surrounding the ore bodies.

Six distinct pods of ore had been found and partly or completely mined when field work for this report was completed (September 1943). All the pods were closely associated within an irregular mass of serpentinized dunite. Each pod had sharp boundaries and was surrounded by several inches of dense serpentine; some of the pods were cut or partly bordered by diorite and rodingite. The ore parted cleanly from the serpentine, but adhered firmly to the diorite and rodingite and some dilution was unavoidable where the dike rocks were mined.

The ore consists of an aggregate of anhedral and subhedral chromite crystals, which range from 1 millimeter to 5 millimeters in diameter, with small quantities of interstitial serpentine and minor amounts of uvarovite, kämmererite, and talc. A complete analysis of carefully cleaned chromite (see analysis 5, table 1) assayed 53.96 percent Cr_2O_3

[42] Rynearson, G. A., and Wells, F. G., Geology of the Gray Eagle chromite deposits in Glenn County, California: U. S. Geol. Survey Bull. 945A, p. 7, 1944.

and 12.41 percent Fe with Cr/Fe ratio of 2.97. The ore that has been mined and shipped contained 36 to 48 percent of Cr_2O_3 and averaged 46.5 percent of Cr_2O_3. The Cr/Fe ratio of this ore ranged from 2.5 to 3.0 and averaged about 2.8.

Calculations based on planimetric measurements of numerous reconstructed geologic sections of the ore bodies indicate that the tonnage of ore in the known pods ranged from about 1 to 2 long tons to about 1,100 long tons, and the total amount of ore originally present is estimated at 2,400 long tons. The size, shape, and distribution of the pods are shown on plates 16 and 17, but it should be noted that much of the geologic detail shown on these illustrations has been reconstructed from descriptions given by the operators and from the meager evidence still remaining in the workings. For the purpose of facilitating the following descriptions of the individual ore bodies, each has been designated by a Roman numeral.

Ore body I (pls. 16 and 17) is the uppermost in the deposit and was the only one exposed when mining was begun. A diorite dike has been injected into the ore, splitting it into two unequal parts (I-A and I-B), and the ore is "frozen" to the walls of the dike. Little evidence remains to indicate the actual magnitude and shape of the upper parts of the ore body, so the reconstructions shown on plates 16 and 17 are largely inferred. Considerable chromite float occurs in the talus and glacial debris on the slope below the deposit, suggesting that an appreciable part of the ore of the original body was carried away during the formation of the cirque. Originally, part I-A contained about 250 long tons of ore and part I-B contained about 600 long tons of ore, making an estimated total of 850 long tons of ore. Approximately 30 long tons of this ore has not been mined (1942), and it is possible that as much as 50 tons of the ore has been eroded.

Ore body II was the largest in the deposit and originally contained about 1,100 long tons of ore. All the ore has been extracted except a few fragments adhering to the walls of the workings. The ore was cut by two rodingite dikes. One of these dikes occurred between the ore and serpentine along the southwest margin of the ore body, and the other split the ore body longitudinally. The rodingite was frozen to the ore and enclosed small fragments of chromite broken from the ore body during the emplacement of the dikes. Some uvarovite was developed along the contact of ore and rodingite.

Ore bodies III and IV occurred at the level of the main adit and were the smallest found. Ore body III contained only 20 to 25 long tons and ore body IV contained only one or two long tons of ore. No ore now remains in either.

Ore body V, which yielded about 350 long tons of ore, was the most irregularly shaped body in the deposit. The upper part of the mass was rudely circular in cross section. It tapered rather abruptly and changed in plan so that the lower part of the body was crescent-shaped in section. A bulge on the northern side of the central part of the ore body was separated from the main part of the mass by a diorite-rodingite dike. As this dike did not appear to be completely altered to rodingite, it might represent the transition between a diorite dike occurring at greater depth and one of the rodingite dikes that cut ore body II higher in the deposit.

Ore body VI consisted of a relatively thin slab of ore that had been sheared and broken in many places. About 75 long tons of ore was mined from this ore body and only a few small fragments of ore were left in the sheared serpentine at the bottom of the workings.

The prospect of finding additional ore close to the deposit is not promising. The operators explored the ground adjacent to the mine openings by jackhammer drilling, but failed to locate any other ore. Future exploration should be restricted to the ground below the present workings. Inasmuch as the lower parts of the workings have been filled with waste, a new adit would have to be driven in order to make the exploration and development of this area most effective. An adit 250 to 300 feet long would be required to reach this area at a point 50 feet below the deepest workings. However, the possibilities of finding additional ore do not seem favorable enough to warrant the expense of driving such an adit.

A small amount of scattered chromite has been found to the south just below the crest of the ridge. A pit dug on this outcrop failed to open up any ore. The peridotite in the vicinity of the mine and above the level of the talus is so well exposed and has been so thoroughly examined that in all probability no outcrop of chromite remains undiscovered. Several unsuccessful attempts have been made to locate the source of float ore found about 1,000 feet west of the mine at a lower elevation. Although float found at this location ordinarily would indicate the presence of another deposit, this float could have been transported hither by glacial ice from the ore body outcrop.

Doe Flat Chromite Mine (No. 3). What is commonly called the Doe Flat mine was located as the Comeback claim by Homer White and J. D. Hogue in 1931. It was leased by Isgrig and Lilley in 1942, and by Linkhart and Messenger from 1943 to 1945. Production for the 4 years totaled 2,398 long tons.

The property is in the NE¼ sec. 31, T. 17 N., R. 5 E., 32 miles by Forest Service road east of Symns Camp. It is situated in a glaciated canyon bottom at an altitude of 3,450 feet and lies about 250 feet north of a stream tributary to Clear Creek from the west. The general area surrounding the mine is rugged and has a relief of 3,000 feet

The distribution of peridotite in the vicinity of Doe Flat is complex, as mapped by Maxson.[43] Apparently the peridotite intrusives are tabular masses that strike a few degrees east of north and dip steeply eastward. Later intrusion of dioritic rock and subsequent faulting have complicated this simple structure.

The western contact, or base, of the peridotite mass in which the deposits of the Doe Flat mine occur can be clearly seen half a mile to the west, trending northward slightly east of north over Twin Peaks and southward west of south part way up the north slope to Devils Punch Bowl. It has a steep eastward dip. In the canyon most of the bedrock is covered with glacial debris through which project scattered outcrops of the underlying peridotite. Most of the peridotite in these outcrops is serpentinized and sheared. Hence varietal distinctions are difficult to make, though dunite and saxonite are recognizable in a few places. Apparently dunite surrounds the chromite lenses, but the relationships

[43] Op. cit.

of the different varieties of peridotite cannot be determined because of the inadequacy of exposures.

Numerous diorite dikes, most of which strike north, cut the serpentine and have a slight schistosity parallel to their length (pl. 18).

Rodingite is exposed in the east pit at the mine. It is a white granular material of variable texture, mottled green in places, and in places having a pinkish tinge. Small brown crystals of garnet are scattered through it. The rodingite is irregularly distributed but occurs along the contact of the massive chromite with serpentine. In fact, fragments of chromite are included in it. A petrographic analysis of the rock by Charles Milton of the Geological Survey shows the rock to be composed of an aggregate of epidote, zoisite, prehnite, diopside, sphene, grossularite, pectolite, chromediopside, plazolite, uvarovite, calcite, and chromite. The veinlets of coarsely crystalline sphene which occur at random in the dikes are noteworthy. The rock is unusually high in calcium and low in iron and magnesium. The chromite found in the rock occurs as angular blocks or inclusions, which are especially numerous near the chromite contact.

Another type of rock occurs as a narrow dike that trends N. 5° W. and dips 56° W. It appears to cut peridotite and to be later than some of the faulting. It also cuts the chromite. This rock is fine grained and olive green in color and is marbled by bands about half an inch thick, or irregular masses of pistachio-green color. It consists of epidote, zoisite, diopside, much brown garnet, and sphene. This rock, though differing in color, is mineralogically similar to the white rodingite. Because of the nature of the contact and the composition of the rock, the rock is, in the opinion of the writers, a rodingite dike intrusive into the chromite and serpentine. The rodingite is probably genetically related to the numerous diorite dikes in the area.

Two pods of nearly pure chromite occur near the west contact of the peridotite. They are in highly serpentinized rock, which has been crushed into slickentite by deformation and in which two persistent planes of deformation, one striking about N. 60°-70° W., and dipping 55°-65° N., the other striking N. 55°-65° E. and dipping southeast, and possibly a third bisecting the two, are marked by slickensided surfaces, gouge, and small scales of slickentite. Before mining, the two bodies projected above the surface as *roches moutonnées* (see pl. 13*B*). The eastern pod was 50 feet long and 15 feet wide and trended a few degrees north of west. The western end was 18 feet higher than the eastern end. The south wall was bounded by a fault and the ore was polished but the north face was frozen to the rock. The west face was at right angles to the south face and was almost vertical. It also was polished. The chromite was massive, but a rind containing several percent of interstitial serpentine enveloped the top and sides. The bottom was not seen.

The second pod lay 90 feet northwest (see pl. 18). It was rudely square, about 22 feet on a side, and it rounded off at a depth of about 15 feet. The northwestern wall was vertical and the others were steep, the southern wall being bounded by a fault with chromite "knockers" in it.

The ore, which is massive and coarsely crystalline, has a uniform texture and consists of subhedral grains of chromite 1 millimeter to 5 millimeters in diameter. Unsheared ore is black and has a submetallic luster. Small amounts of uvarovite are present, especially along chromite-rodingite contacts. No analysis of the cleaned chromite is available, but shipping lots assayed from 35 to 37 percent Cr_2O_3, from 9.52 to 10.09 percent Fe, and had a Cr/Fe ratio of 2.52 to 2.65.

Mining continued through 1945. When the mine was visited in the autumn of 1946 the workings were flooded. The pods are probably mined out. The probability of finding new pods is small because glacial debris covers so much of the area. A hasty survey was made of the area with magnetometer but the results were negative.

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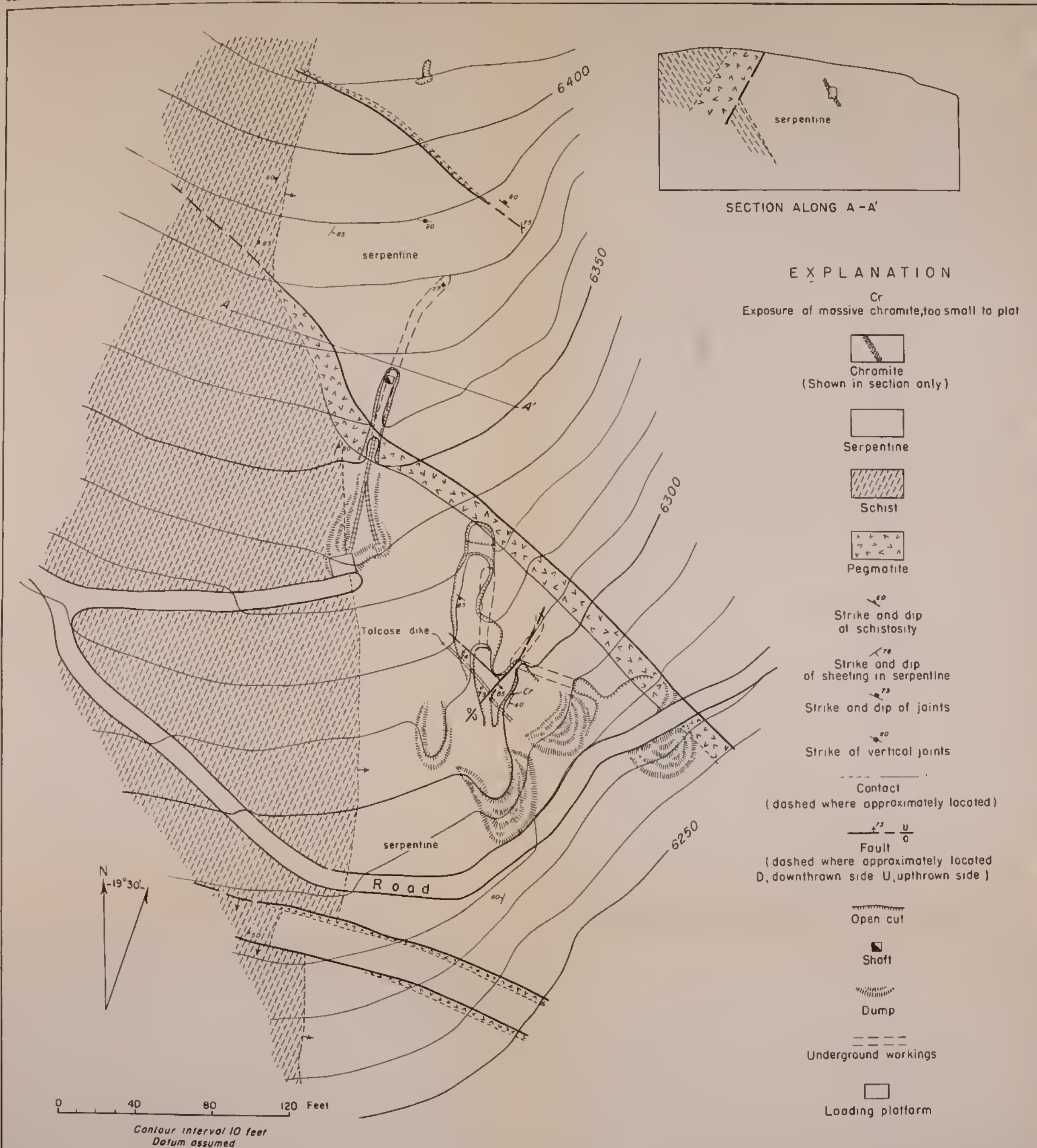
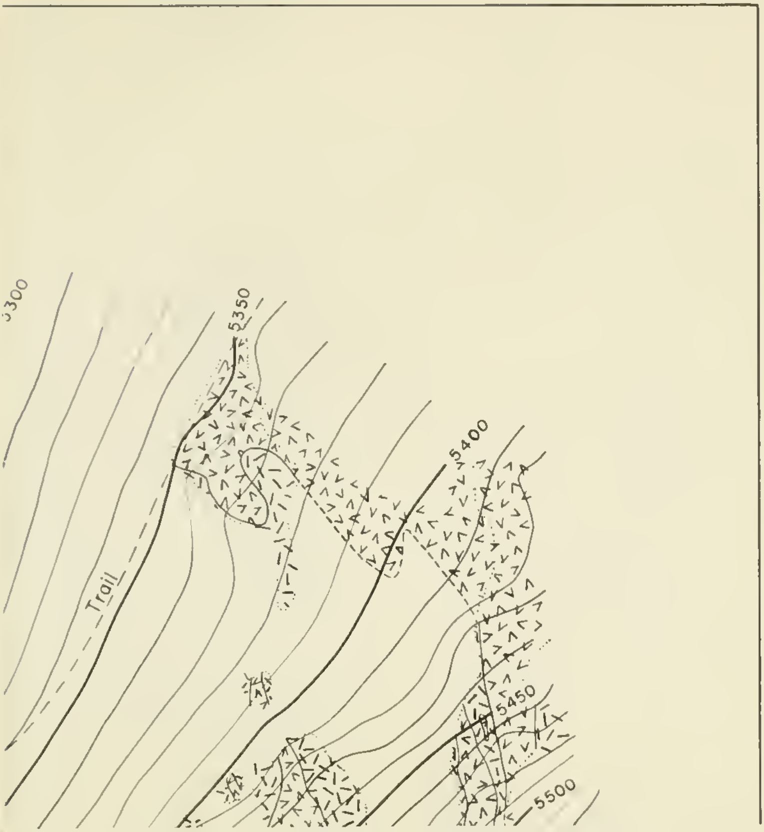


Topography and Geology by F. W. Cater, D. H. Dow, and W. P. Williams
June 1943

GEOLOGIC MAP AND SECTION OF THE SNOWY RIDGE MINE
SISKIYOU COUNTY, CALIFORNIA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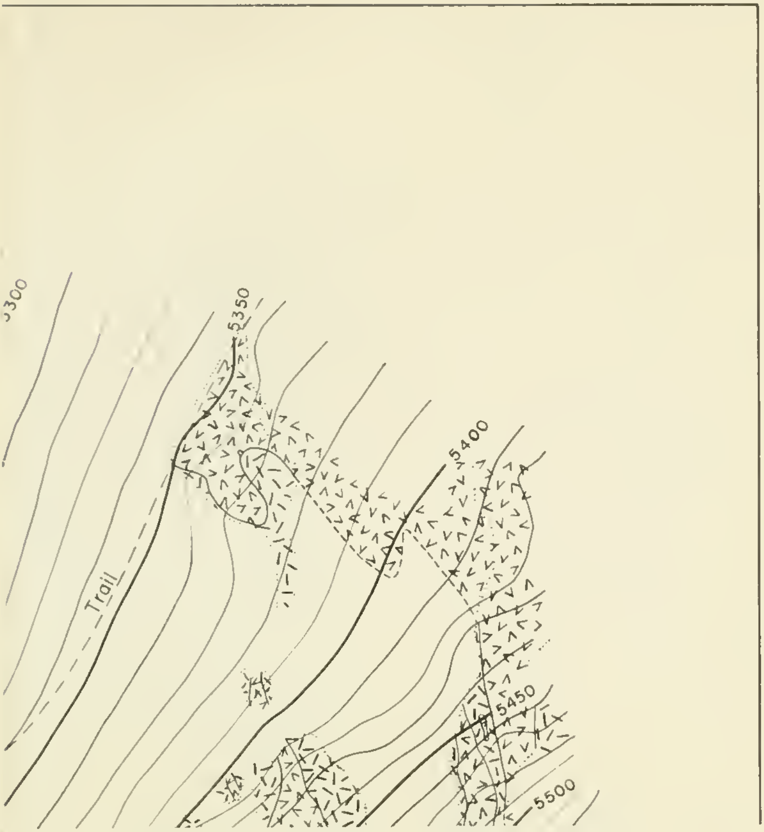
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Geology and topography by G.A. Rynearson, D.E. Flint, F.W. Cater, Jr., D.H. Dow, and W.P. Williams. Surveyed during parts of November 1942 and July and September 1943.

GEOLOGIC MAP OF THE CYCLONE GAP MINE, SISKIYOU COUNTY, CALIFORNIA

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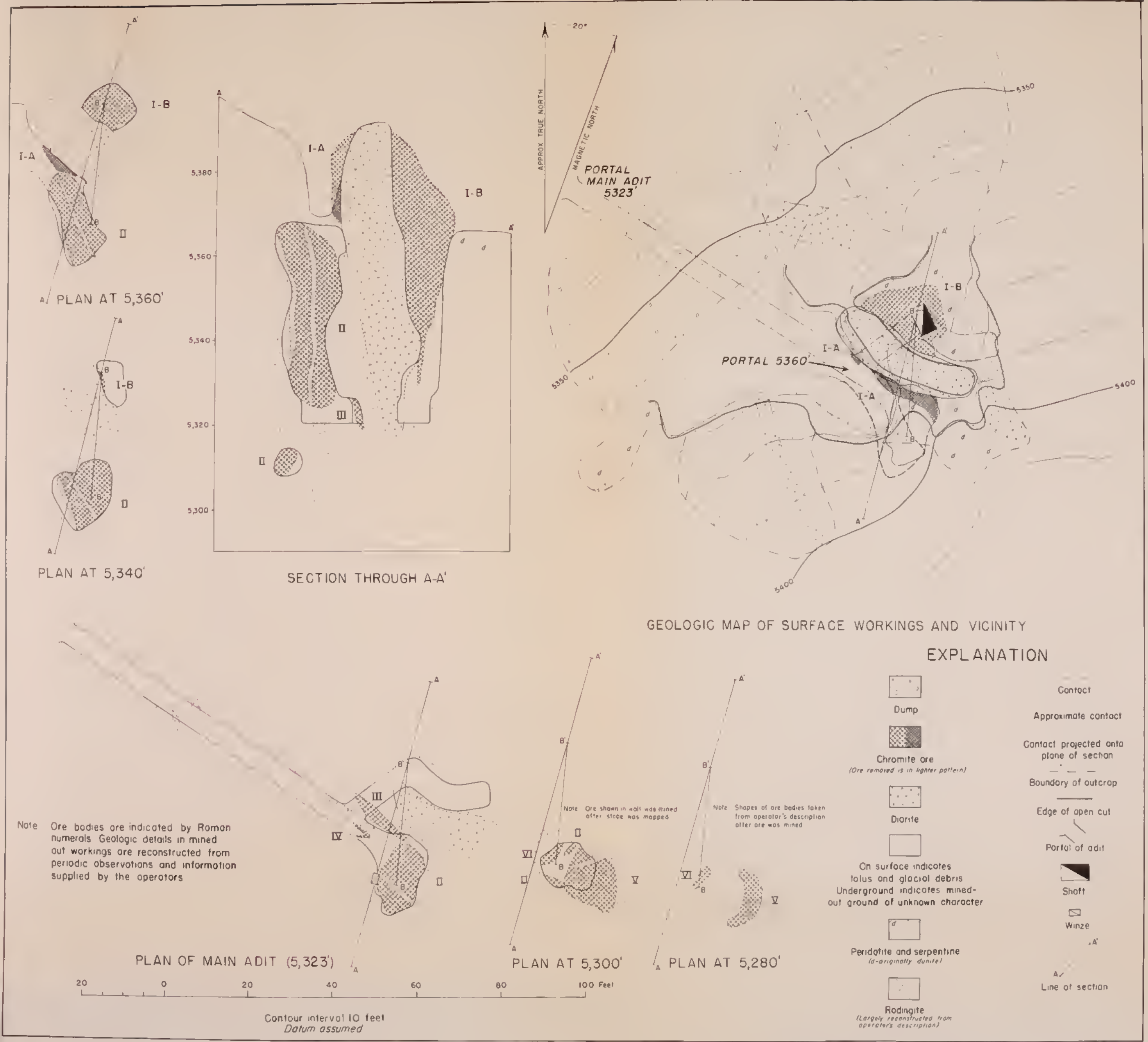
OLAF P JEN

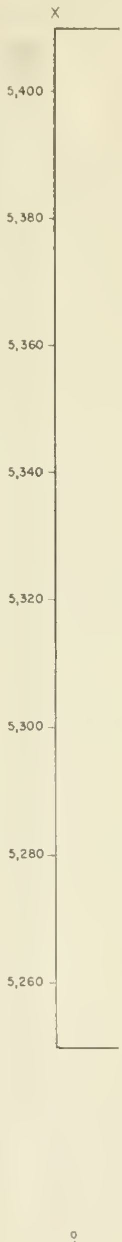
DIVISION
OLAF P. JEN



Geology and surveying by G. A. Rynearson, D. E. Flint, F. W. Cater, Jr., D. H. Dow, and W. P. Williams. Surveyed during parts of November 1942 and July 1943

GEOLOGIC MAP, SECTION, AND PLANS OF THE CYCLONE GAP MINE SISKIYOU COUNTY, CALIFORNIA

DIVISION OF MINES
OLAF P. JENKINS, CHIEF



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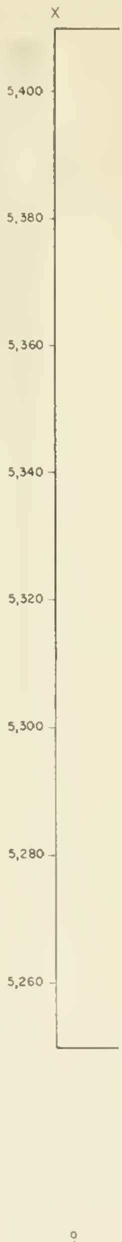

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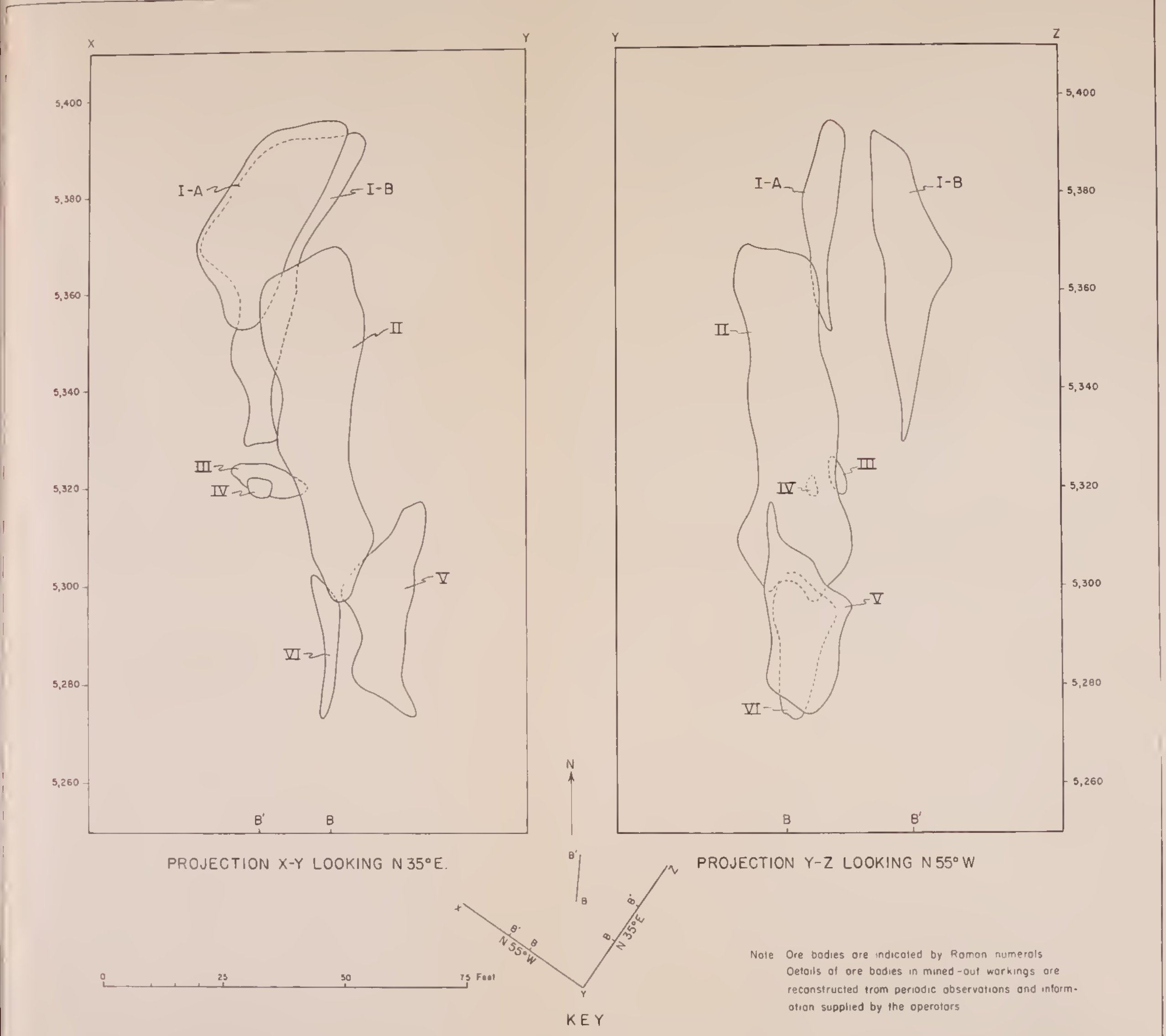
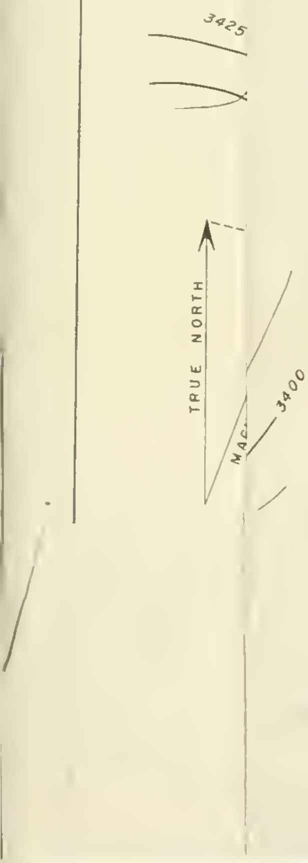


Geology by G. A. Ryneorson

VERTICAL PROJECTIONS OF ORE BODY OUTLINES (RECONSTRUCTED) CYCLONE GAP MINE, SISKIYOU COUNTY, CALIFORNIA



EXPLANATION

Cr

Chromite

Rhodingite

Serpentine

Diorite

75

Strike and dip of schistosity

65

Strike and dip of beds

Contact, dashed where inferred

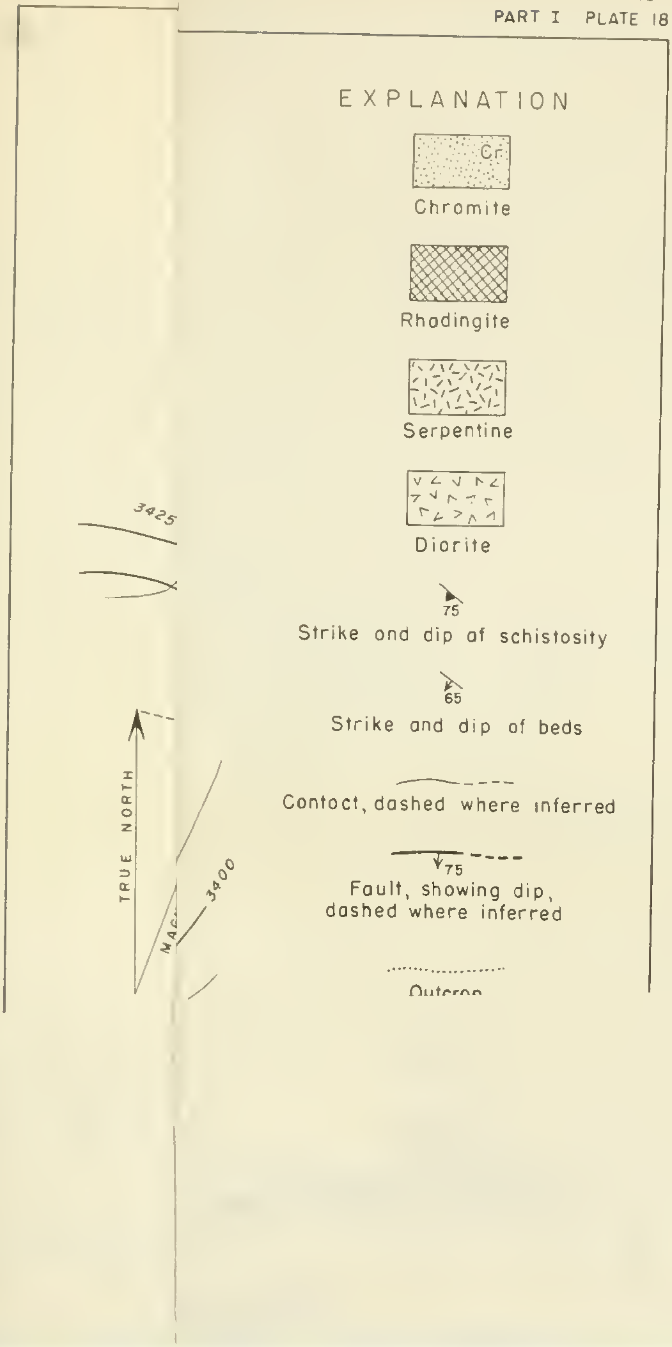
75

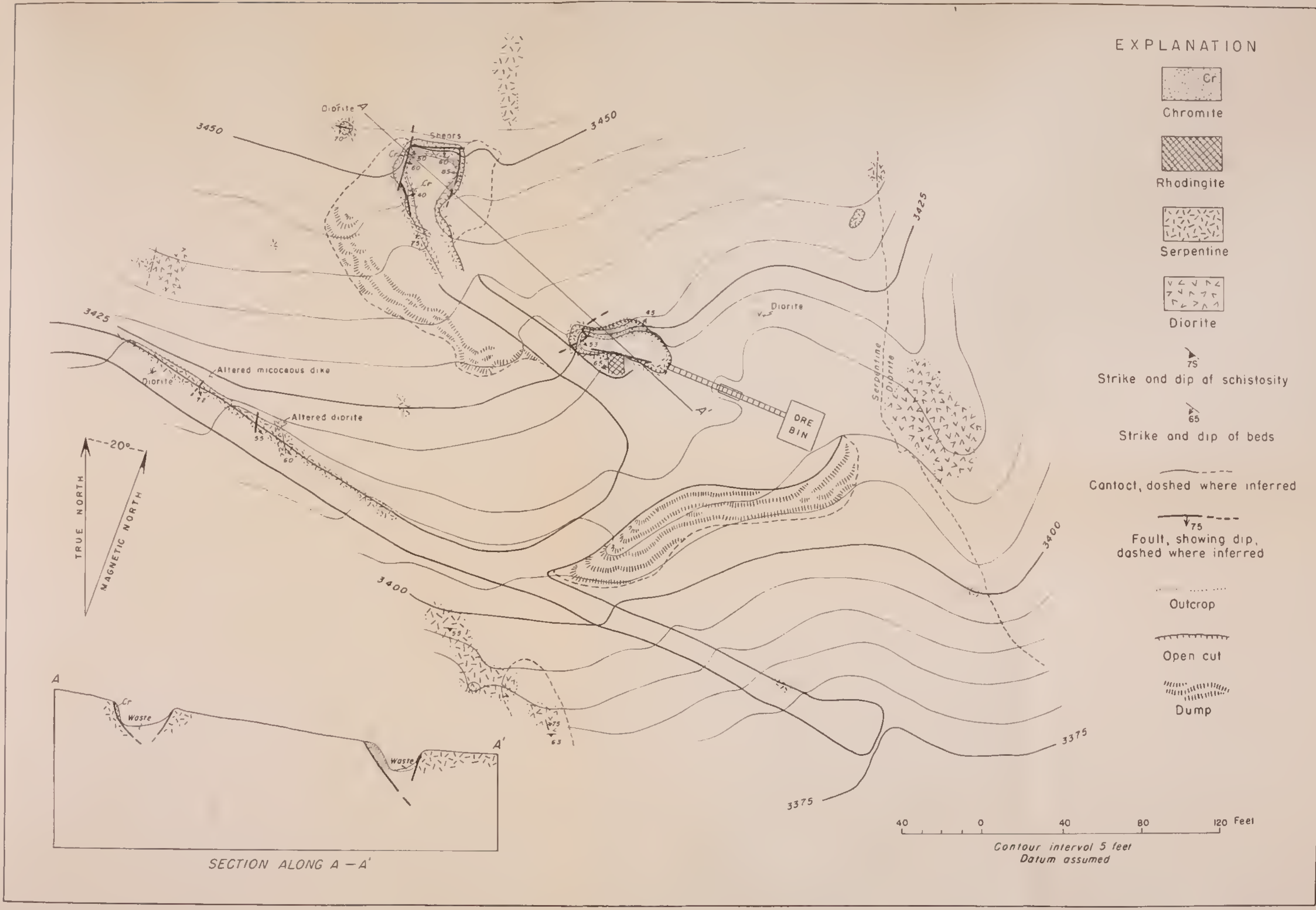
Fault, showing dip, dashed where inferred

Outcrop

DIVISION OF MIN
OLAF P. JENKINS, C

BULLETIN 134
PART I PLATE 18





Topography and geology by F W Cater, D H Dow and W P Williams. August 1943

GEOLOGIC MAP AND SECTION OF THE DOE FLAT MINE
SISKIYOU COUNTY, CALIFORNIA