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UNITED STATES DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
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War Minerals Report 49

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JOHN DAY DISTRICT
GRANT COUNTY, OREG.

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Chromium



WASHINGTON: 1948

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The War Minerals Reports of the Bureau of Mines are issued by the United States Department of the Interior to give official expression to the conclusions reached on various investigations relating to domestic minerals. These reports are based upon the field work of the Bureau of Mines and upon data made available to the Department from other sources. The primary purpose of these reports is to provide essential information to the war agencies of the United States Government and to assist owners and operators of mining properties in the production of minerals vital to the prosecution of the war.

WAR MINERALS REPORT

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

W.M.R. 49 - Chromium

March 1943

JOHN DAY DISTRICT

Grant County, Oreg.

SUMMARY

Sampling of underground workings and exploration by trenching and diamond drilling by the Bureau of Mines¹ at three prominent localities in the JohnDay area of east-central Oregon has indicated 128,000 tons of chromium ore that will assay 20 to 25 percent chromic oxide. A supplemental program of diamond drilling now in progress may greatly increase these reserves. Little is known of other deposits in the JohnDay area except that they are much smaller than the three deposits explored by the Bureau of Mines.

The John Day area ranks third in the United States in reserves of chromite. The deposits are accessible and readily minable, but their strategic importance is diminished by the low percentage of chromium in the chromite of the principal deposits. With very little preparation mining can be started simultaneously at the three largest deposits, now accessible by fairly good truck roads. Open-cut mining with mechanical equipment can be employed at these deposits while development and preparation for underground mining is in progress.

1

¹ O. H. Metzger, senior mining engineer.

Most of the ore is of milling grade, though some clean lump ore might be produced. In most of the deposits the chromite grains are larger than 1 mm., but in the Iron King deposit they average 0.2 to 0.5 mm. in diameter, and losses due to sliming during the necessary fine grinding of that ore may be excessive. The gangue of the ore is usually serpentinized dunite, differing sufficiently from chromite in specific gravity to permit concentration by gravity methods.

INTRODUCTION

Grant County lies in the central part of Oregon about midway between the Snake River on the east and the Cascade Range on the west. Nearly all of the chrome deposits are in the drainage area of the John Day River, which crosses the county from east to west about midway between the north and south county lines. John Day is the largest settlement; it is on the John Day River and about in the center of the area. Other settlements in the area are Mt. Vernon, Dayville, Prairie City, and Canyon City.

GEOLOGY AND MINERALOGY²

The chromium ores of this district are all contained in intrusive igneous rocks, which when fresh are collectively classed as peridotite, but when altered, as in the John Day area, are called serpentine. The most productive serpentine mass occupies an east-west belt about 20 miles long and 2 to 4 miles wide, south of the John Day River, along the north slope of the Strawberry Mountains. Two smaller serpentine masses, each about 5 miles long and 1 to 2 miles wide, north of the John Day River and in the vicinity of Mt. Vernon, probably are continuous with the main mass under a shallow cover of later volcanic rocks. Numerous irregular lenses of serpentine are

² Contributed by T. P. Thayer, Federal Geological Survey. See also Geological Survey Bull. 922-D.

also found in the valley of Fields Creek, some 20 miles west of John Day, and in the drainage basins of Murderers Creek and the Silvies River, south of the John Day River Valley.

The workable chromite deposits occur as well-defined, irregular lenticular bodies scattered haphazardly in the serpentine. They range in size from a few pounds to 50,000 tons or more, though relatively few of them contain more than 100 tons. Though the larger deposits are mainly irregular lenses, of which the long axes may plunge at angles between 15° and 90° in any direction, many small deposits are merely irregular lumps or blobs of high-grade ore.

The essential mineral of the deposits is chromite, which contains variable proportions of magnesia, iron oxide, chromic oxide, and alumina. The chromic oxide content of the pure chromite in this district ranges between 32 and 54 percent; in the Dry Camp, Iron King, and Chambers deposits it is about 54, 42, and 38 percent Cr_2O_3 , respectively. The ore consists of a mixture of chromite and serpentine in nearly all proportions between massive chromite and barren serpentine. By far the greater part of the ore in the large deposits is disseminated, consisting of one-half to two-thirds of chromite grains in a serpentine matrix. This ore must be milled to render it salable.

In most of the ores the difference in specific gravity between chromite and serpentine is great enough to permit concentration by gravity methods. The size of the chromite grains in disseminated ore controls the amount of grinding necessary to free the ore from the gangue. In most of the ore the grains are larger than 1 mm., and fine grinding probably is not necessary; but in the Iron King deposit the grains average 0.2 to 0.5 mm. and, as chromite crushes readily, losses due to sliming during the necessary fine-grinding of that ore may be excessive.

The composition of the chromite is of fundamental importance, because it is manifestly impossible to produce a high-chrome concentrate from low-chrome chromite by any mechanical process. Concentrates containing 50 percent Cr_2O_3 can be produced easily from the Dry Camp (Hananokrat) mine, for instance, whereas concentrates from the Chambers mine probably would not exceed 35 percent Cr_2O_3 .

HISTORY

It is not definitely known when chromium ore was discovered in Grant County. Lindgren briefly mentioned its occurrence in the area in 1901.³ The first placer miners must have been familiar with it in the form of the heavy black sands and the hard, heavy, black cobblestones that occur in all the placers of the John Day area. It is possible, however, that they did not know what it was nor recognize its possible commercial value for a long time after the first discoveries of gold. There is no record of chromium ore having been mined in Grant County previous to 1917 or 1918, though most of the deposits must have been known and some of them probably were staked before that time.

As a result of the World War, the value of chromium ore rose to an unprecedented level in 1917 and 1918. Roads were built to all of the more important deposits of the area as well as to many of the less important ones, and production was started immediately. Mining was by open-cut or glory-hole methods, except in one or two places where underground methods were used to a slight extent. As none of the workings reached depths greater than 50 to 75 feet, little planning or preparation work was necessary and production began as soon as transportation facilities were available. The roads to the mines were too steep for motor vehicles, so that horse-drawn wagons

³ Lindgren, Waldemar. The Gold Belt of the Blue Mountains of Oregon: U. S. Geol. Surv. 22d Annual Report, pt. 2, 1901, p. 713.

had to be used to haul the ore from the mines (most of which were situated 1,000 to 3,000 feet above the John Day Valley) to bunkers in the valley. From these bunkers it was hauled in trucks to Prairie City, which at that time was the terminus of the narrow-gage railroad from Baker, Oreg. From Prairie City the ore was shipped by rail to Baker and thence to points east. The Iron King and the Chambers mine (fig. 1) were the largest producers in the area. The total production of the Iron King has been estimated at about 6,000 tons; that of the Chambers a little less. The production of the other properties ranges from a few tons up to several hundred tons each. Shipments of ore from the whole area in 1918 totaled about 16,000 tons. With the cessation of hostilities in Europe in November 1918, the price of chromium ore suddenly dropped to a point where mining became unprofitable and all production ceased. Since then the only ore mined has been a small quantity for metallurgical research.

PHYSICAL FEATURES AND COMMUNICATIONS

The altitude of the east end of the John Day Valley is 3,800 to 4,000 feet, and at Dayville, near the west boundary of Grant County, it is about 2,400 feet. The mountains on the south side of the valley rise to altitudes of 8,000 to 9,000 feet. The climate in the valley is mild and temperate. Snow seldom lies at the lower altitudes for more than a few days in winter. At higher altitudes the winters are more severe and snowfall is much heavier. Precipitation is greatest in winter and spring.

Timber of the region is mostly ponderosa or western yellow pine, lodgepole pine, and Douglass fir. Ponderosa pine occurs principally at altitudes of 3,500 to 6,000 feet; lodgepole pine and Douglass fir at altitudes of 5,000 to 7,000 feet.

Seneca, a logging camp 22 miles south of John Day, is the nearest railroad shipping point. Express, however, must be handled through Burns,

70 miles south of John Day, or Baker, 95 miles northeast. U. S. Highway 28 runs east and west through the John Day Valley; route 395 runs south from John Day to Burns and north from Mt. Vernon to Pendleton.

THE CHAMBERS PROPERTY

This mine is on the west end of Bald Mountain at an altitude of 6,500 feet. It is approximately 6 miles south of the John Day River and 14 miles by road from the town of John Day. It consists of one claim which has been held by location since 1929 by C. B. Haight, of Canyon City, and the heirs of J. C. Howell, of Prairie City.

The ore bodies (fig. 2), as indicated by surface outcrops, are spaced at about equal intervals along the line of their strike, which is about N. 50° E.; dips are 45° to 50° to the south. Ore in the lower or east deposit is exposed only in two small test pits. A good deal of ore was mined from the middle deposit by a glory-hole, which had a short adit connecting with its bottom. A small amount of ore remains in this deposit above the adit. Ore in the upper or west deposit is exposed in a number of test pits and trenches. Some ore has been mined from this deposit through an adit that penetrates its eastern end.

Exploration by Bureau of Mines

Work on this deposit included trenching, rehabilitating drifts, underground sampling, and diamond drilling.

Seven trenches were excavated, and ore was exposed in four of them. Where ore was exposed, samples were taken in 5-foot sections and as nearly as practicable at right angles to the dip and strike of the deposit. Thirty-five to fifty pounds of material was taken for each sample. Because of the relatively uniform character of the ore, selective sampling was unnecessary.

Diamond drilling was contracted by R. S. McClintock, of Spokane, Wash., who furnished all labor and equipment (two gasoline-driven diamond drills) except three water tanks, one of 750 gallons capacity and two of 300 gallons capacity each. Contract price was \$2.70 a foot for drilling and \$4.95 an hour for time spent on extra jobs, such as reaming, setting casing, and cementing. A sampler or inspector for each drill shift was supplied by the Bureau.

The equipment was moved to the ground on September 28 and 29; drilling started on September 30. Water was hauled in 50-gallon iron drums from an 800-gallon wood tank at a spring 5 miles by road from the mine. A 1-1/2-ton truck could haul 12 full drums or 600 gallons with ease. Drums were selected because 12 of them weigh only about half as much as a 750-gallon tank, but it is doubtful whether this advantage was great enough to offset the delays in handling.

Overburden at the Chambers mine is 2 to 6 feet deep, and beneath is 5 to 15 feet of loose, caving rock. Where overburden was shallow, it was excavated to bed rock before starting a hole. Where it was deep, holes were 'fish-tailed' to bed rock and were then cased through the overburden and shattered rock. Bits for the regular 7/8-inch core were not used until the driller was reasonably certain that solid rock had been reached.

The ground in general proved difficult to drill. Shattered zones usually were encountered at the contact between ore and serpentine, and shear zones often made it impossible to recover the water without cementing. Water consumption ranged from 1,800 to 3,000 gallons per 24 hours for the two drills, each operating two 10-hour shifts. Sludge was saved during drilling in both ore and waste, but only the sludge samples from the ore were assayed. All core consisting of ore was split; one part was saved for future reference and the other was assayed.

As originally planned, there was to be 2,110 feet of diamond drilling, or 14 holes ranging in depth from 90 to 200 feet. Ten of these were to be drilled opposite the outcrops of the deposit and four at intermediate points. The purpose of the latter was to disclose deposits that did not outcrop. The

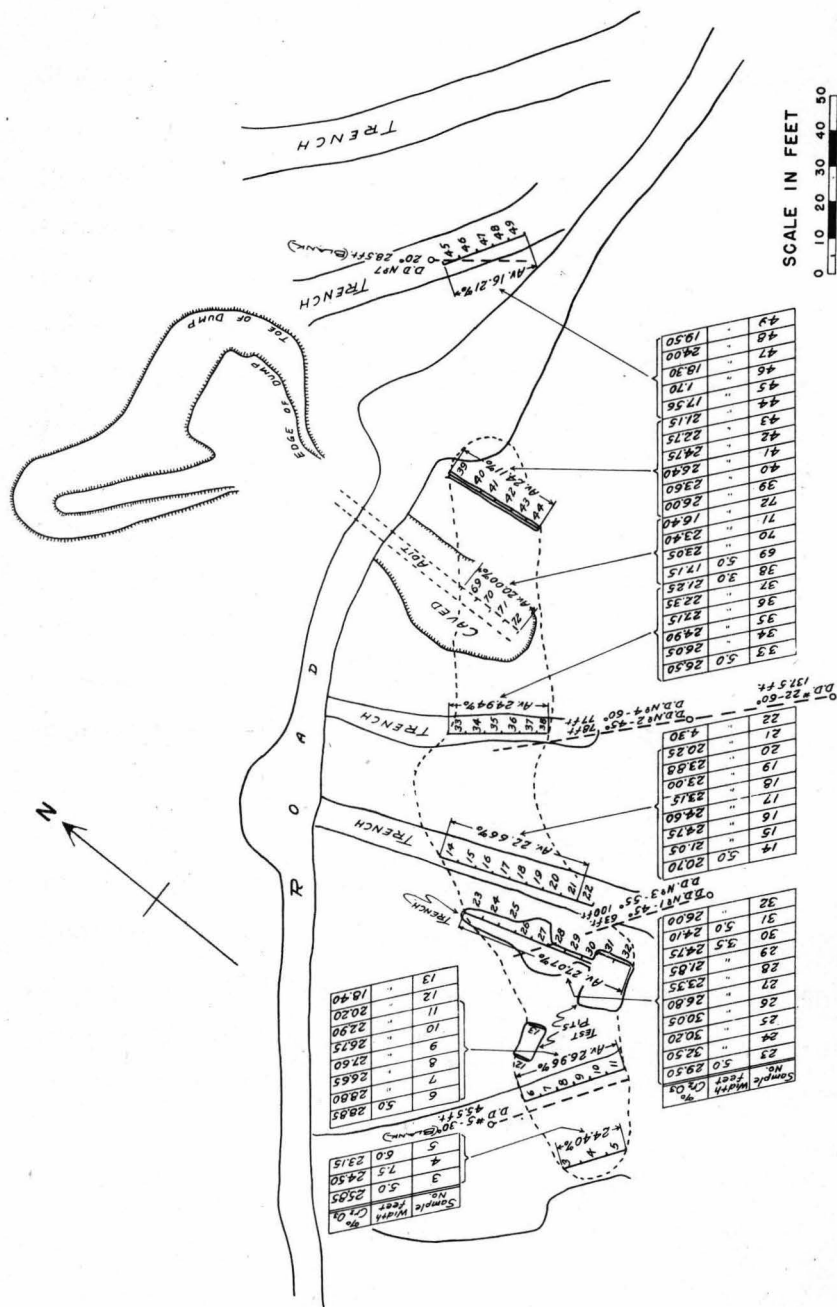


FIGURE 2A. PLAN OF UPPER DEPOSIT, CHAMBERS PROPERTY

general plan was to start the holes in the serpentine on the up-hill or hanging-wall side of the deposits and drill as nearly as practicable at right angles to the dip of the formation. At the middle deposit the holes were started in the lower or footwall side and were drilled at a relatively flat angle under the glory hole.

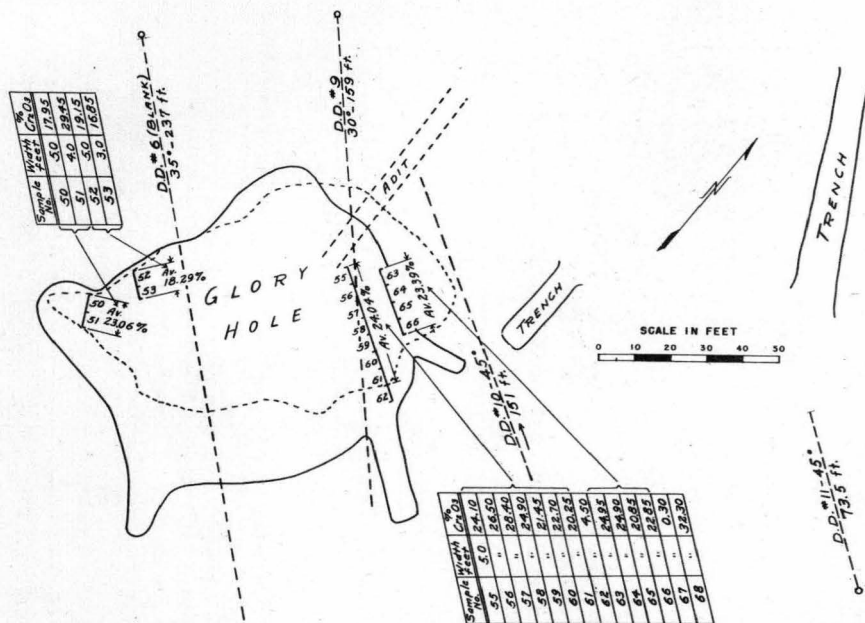


FIGURE 2B. PLAN OF MIDDLE DEPOSIT, CHAMBERS PROPERTY

Results of drilling under the upper (southwest) and middle deposits (figs. 2, 2a, 2b) were not encouraging. Five holes under the outcrop of the upper deposits showed this to be a lens 40 to 50 feet wide dipping about 45° southeast and plunging northeastward. The continuity of the dunite zone shown by the drill holes below the ore body proves that the ore pinches downward and is not faulted off. The northeastward extension of this body at depth is unknown. Two holes were drilled under the glory hole; one was

a blank and the other indicated 8 feet of low-grade ore 50 feet vertically below the bottom of the glory hole.

Holes 12, 14, 15, 16, 18 (figs. 2, 2c, 2d) are all in the same plane and start over the lower or northeast deposit. Holes 12, 14, 15, 16 indicate a

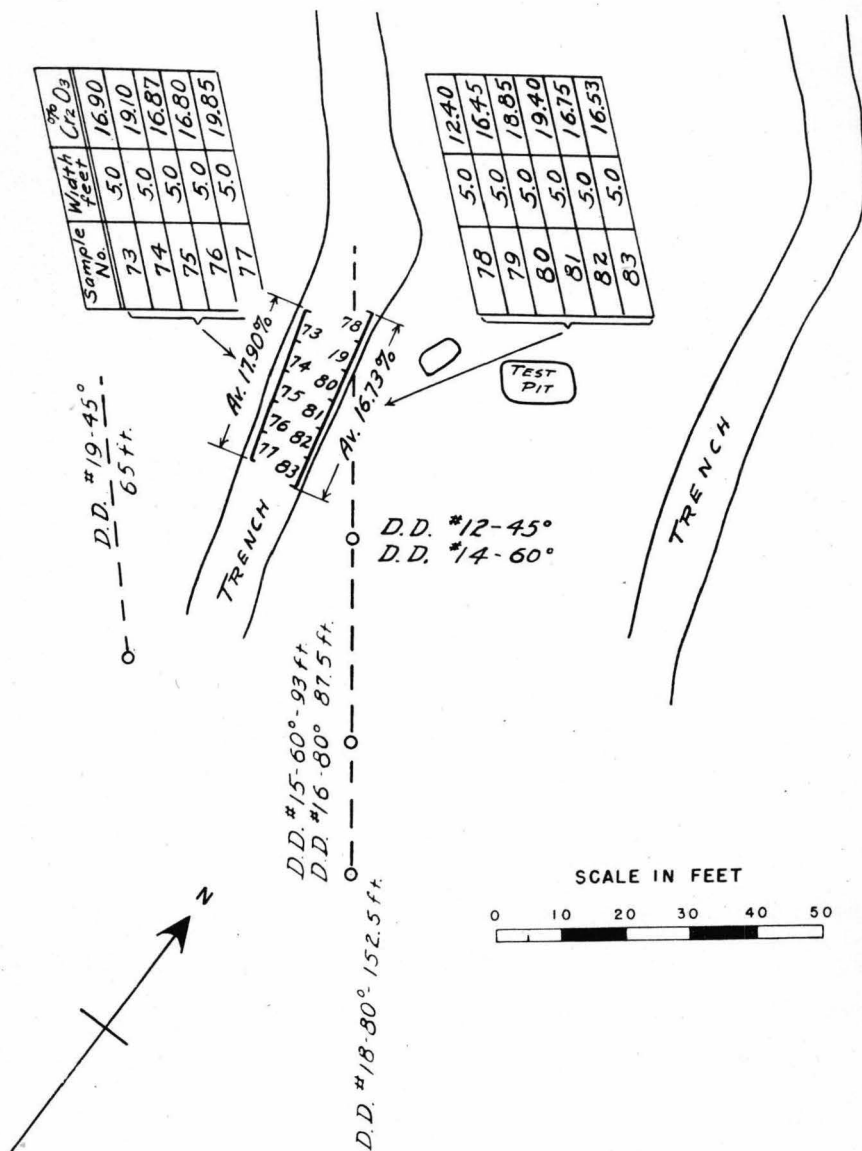


FIGURE 2C. PLAN OF LOWER DEPOSIT, CHAMBERS PROPERTY

continuous ore body about 80 feet deep and ranging in width from 25 to 30 feet. The deepest ore known in Grant County was cut in hole 18 at 119 to 145 feet below the collar. This ore is undoubtedly a part of the ore body indicated by the holes, but it appears to have been faulted downward.

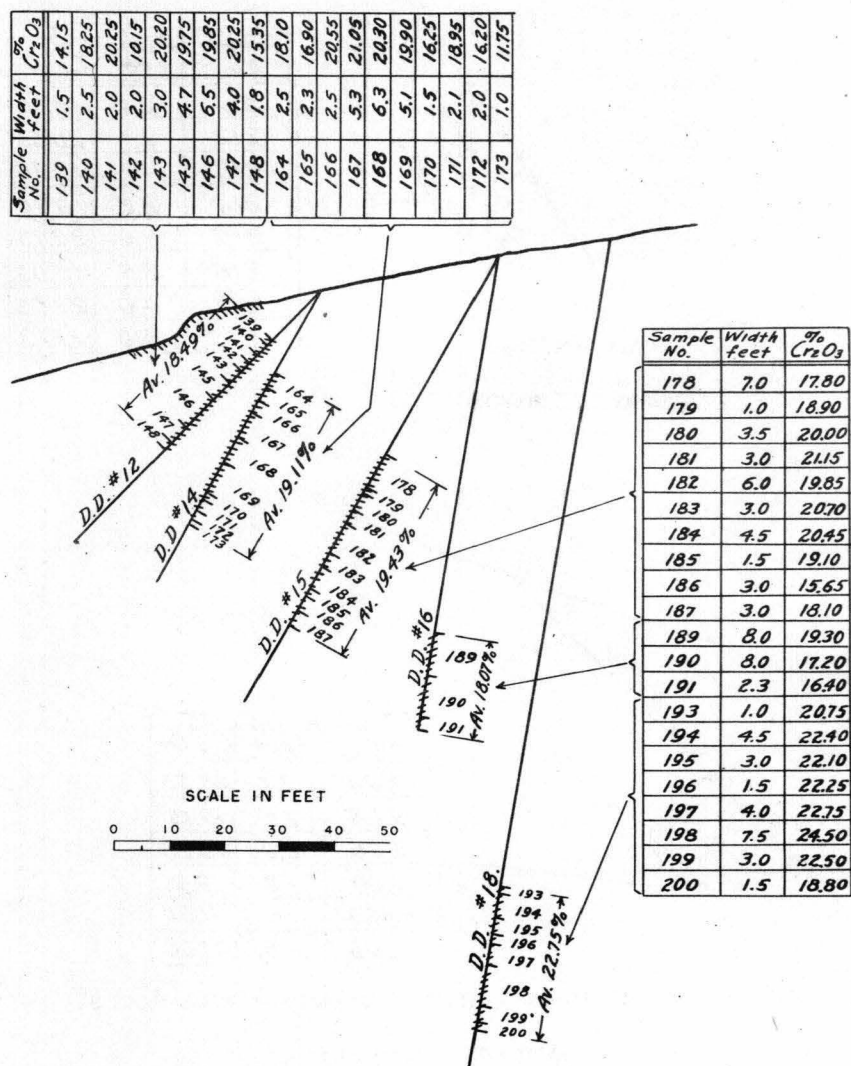


FIGURE 2D. SECTION THROUGH DIAMOND DRILL HOLES, CHAMBERS PROPERTY.

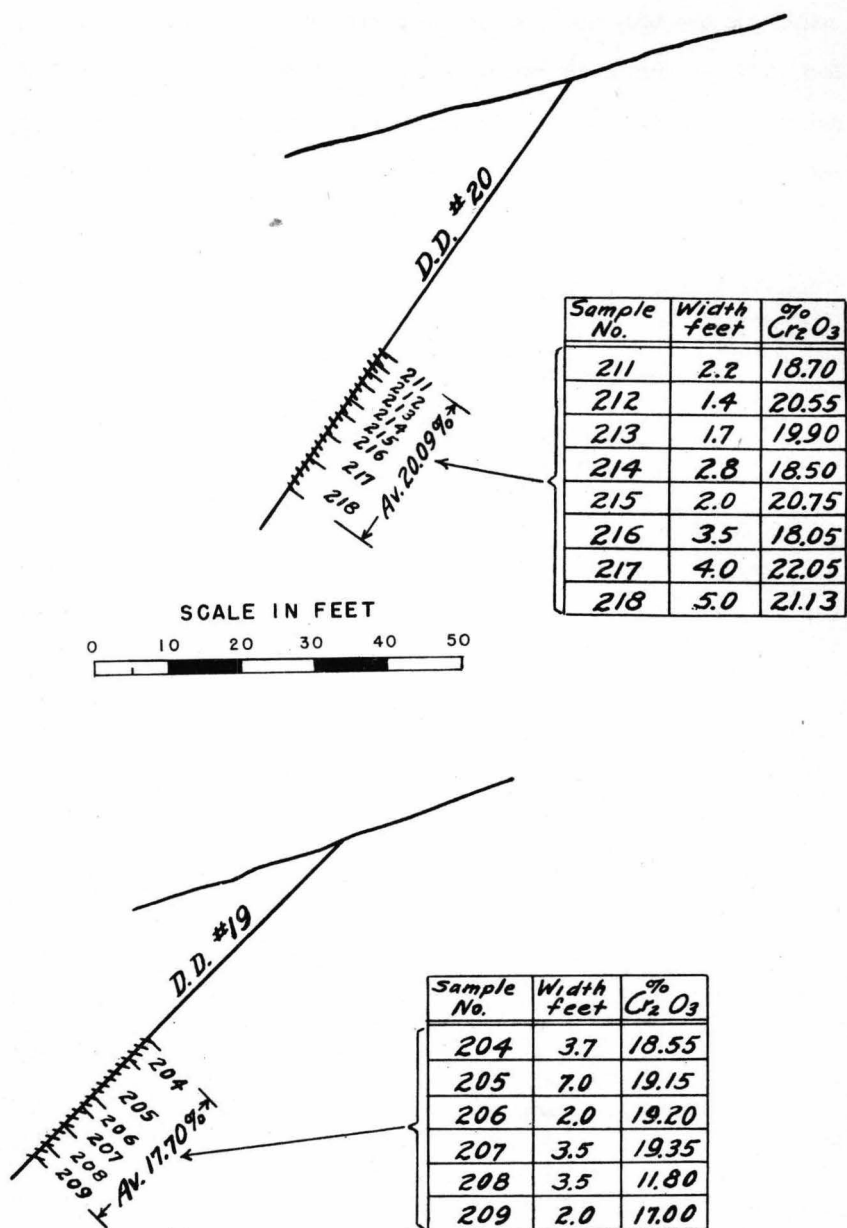


FIGURE 2E. SECTIONS THROUGH DIAMOND-DRILL HOLES,
CHAMBERS PROPERTY.

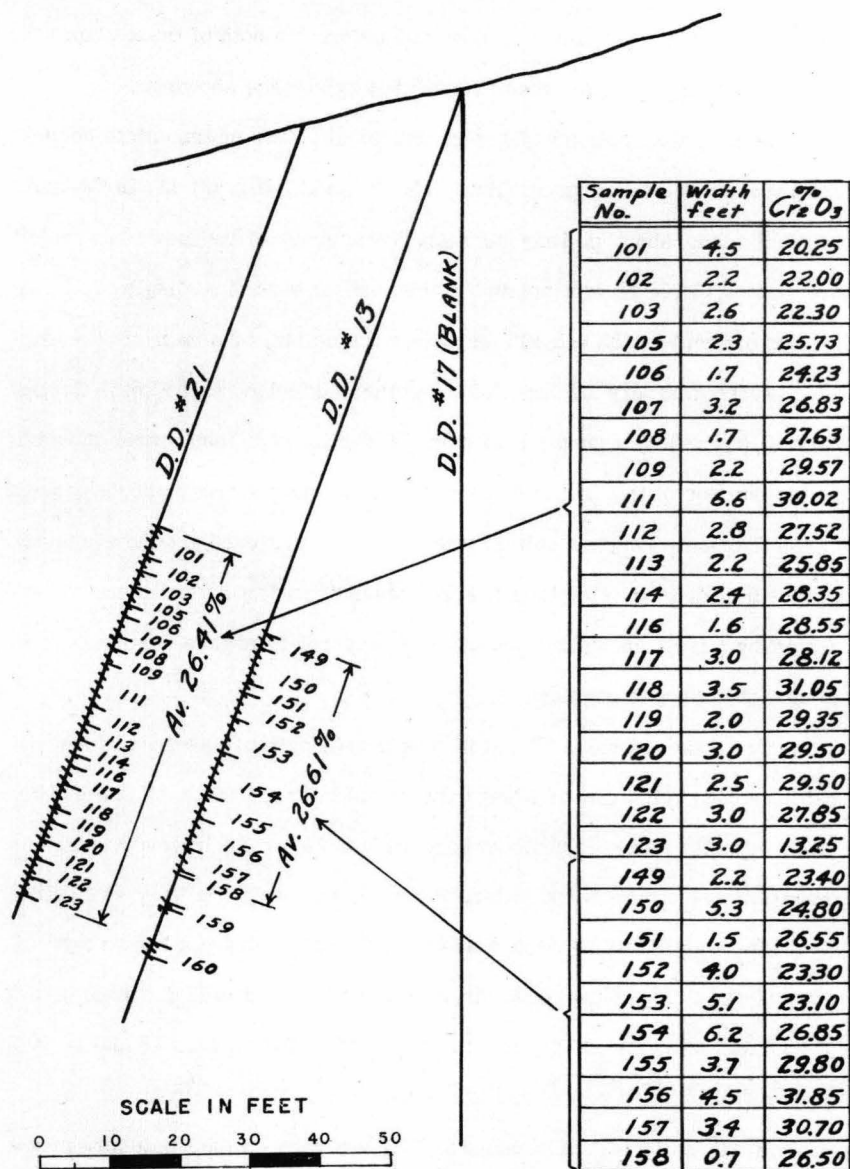


FIGURE 2F. SECTION THROUGH DIAMOND-DRILL HOLES,
CHAMBERS PROPERTY.

Holes 19 and 20 (fig. 2e) were drilled to determine the western limit of the lower or northeast deposit. Ore encountered in both of these shows the deposit to be much larger than is indicated by surface showings.

Four of the five holes that were drilled at points intermediate between outcrops are blanks (fig. 2). Holes 13, 17, and 21 (fig. 2f) lay in the same vertical plane about midway between the outcrops of the lower and middle ore bodies. Hole 13 was pointed to the north at a vertical angle of 70° and showed ore between 82 and 132 feet below the collar, or a total of 50 feet, of which 10 feet was very low-grade and the other 40 feet averaged 26.61 Cr₂O₃. Hole 21 (fig. 2f) was parallel with No. 13 but about 25 feet nearer the projected outcrop of the ore; 56 feet of ore in this hole averaged 26.41 percent chromic oxide. Vertical hole 17 was mostly in shattered ground suggestive of faulting. It is possible that the ore body indicated by holes 13 and 21 was cut off by a fault, in which case hole 17 may not have gone deep enough to intersect the lower segment.

Ore shown in holes 13 and 21 was first thought to be a part of a separate ore body lying about midway between the outcrops of the middle and the lower deposits. The occurrence of ore in holes 19 and 20, however, suggests that it may be a part of the latter, in which case this ore body will have a total length of 180 to 230 feet, a width of 25 to 50 feet, and a known depth of 60 to 80 feet. The depth, however, is not fully determined. Little is known of possible ore below what appears to be a fault between holes 16 and 18, and deeper drilling may reveal ore at greater depths than is already known.

In all, 2,346 feet of diamond drilling was done on the Chambers property. The last hole was completed on November 11, 1939. Costs were as follow:

	<u>Cost per foot</u>	<u>Amount</u>
2,346 feet	\$2.70	\$6,334.20
Extras	<u>0.50</u>	<u>1,170.66</u>
	3.20	7,504.86

Ore Reserves

Ore in the southwest deposit contains from an average of 20 percent Cr_2O_3 for 20 feet in the adit to an average of 27 percent Cr_2O_3 for 50 feet in the second trench from the west end. The average for the whole deposit is probably 24 to 25 percent Cr_2O_3 . The middle deposit appears to be slightly lower-grade - 23 to 24 percent Cr_2O_3 . The northeast deposit ranges from a low of 16.73 percent Cr_2O_3 in one of the trenches to a high of 26.61 percent for 35 feet in drill hole 13. The average for the whole northeast deposit is probably 22 to 23 percent Cr_2O_3 .

Tonnages based upon surface exposures and drill holes are estimated as follows:

<u>Deposit</u>	<u>Tons</u>	<u>Cr_2O_3, percent</u>
Northeast.	50,000	24 to 25
Middle	6,600	23 to 24
Southwest.	<u>17,500</u>	<u>22 to 23</u>
	74,100	23.5

Mining

The depth to which either of the two end deposits can be mined economically by open cut will depend primarily on the amount of waste to be moved. As the deposits dip into the hill, increasingly large amounts of waste will have to be handled as open pits increase in depth. Material can probably be hauled from the pit bottoms by trucks from depths down to about 30 feet, but at greater depths, mine cars on inclined tracks will be required. As the maximum depth of the upper deposit appears to be 50 to 60 feet, it is possible that this can be mined entirely by open-cut methods. Some hand sorting will be necessary. The cost of breaking, loading, sorting, and handling waste should not exceed \$2.50 a ton.

Open-cut methods will probably be economical at the lower deposit to depths of 40 or 50 feet; below that, underground methods will be preferable.

The plan of development for underground mining, on the basis of the present outlook, would be to run a crosscut adit from the surface to the bottom of the ore shown in drill hole 18 and then drift east and west along the footwall of the ore body from that point. The adit would have to be started down the hillside 140 feet vertically below and 550 to 600 feet horizontally from the outcrop. All of the haulage and most of the mining would be from this adit level. One sublevel above the adit level might be advisable, if not necessary.

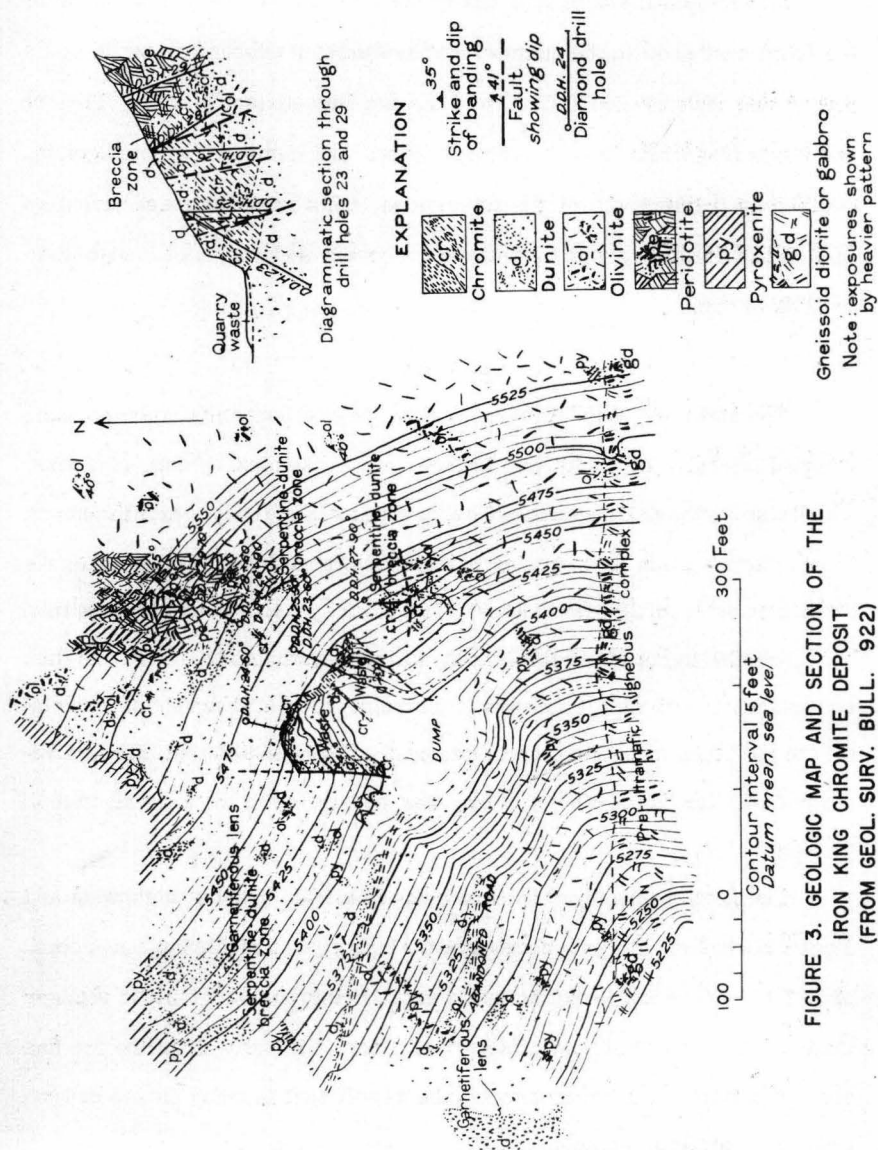
It is not known just how much ore can be extracted from these deposits by underground methods before steps must be taken to support the walls. It is therefore impossible to state what underground method is best suited to conditions, but some method of wall support must certainly be considered. Either horizontal or inclined cut-and-fill method might be applicable. It is doubtful whether mining costs, including development, can be kept below \$2.50 a ton.

The middle deposit should be mined entirely from the adit tapping the bottom of the glory hole. As only a small amount of ore remains here, it can probably be mined by hand or by improvised scraping outfits.

IRON KING MINE

The Iron King mine (figs. 2 and 3) lies on the steep southwest slope of Little Canyon Mountain at an altitude of 5,400 feet. It is about 4 miles from Canyon City by a road, much of which is passable but badly out of repair. From the mine to the nearest water, however, a distance of about a mile, the road is in fairly good condition. The property has been held by location since 1929 by Clint Haight, Jr., of Baker, Oreg., and the United States Chromium Mining Co. of San Francisco, Calif. The ore is exposed for about

100 feet in the face of an open-cut pit or quarry, from which it is stated approximately 6,000 tons of ore was mined in 1917-18. Calculations based on the thickness of the ore body apparently confirm this statement.



Small deposits outcrop at a number of places in the vicinity of the open cut and at another place about 1,500 feet west, none of which is of any importance; the largest contains probably less than 100 tons of ore. Those in the vicinity of the open cut are probably fragments of the main deposit.

Intense faulting is evident where the ore has been exposed. Most of the faults that show in the quarry face have small displacement, but in some places they have caused a dilution of the ore with enclosing rock. The ore and waste fragments in such fracture zones are cemented with aragonite, completely filling some of the interstices. This proved a great advantage in diamond drilling, assisting both core recovery and return of sludge when drilling in ore.

Geology⁴

The main ore body appears to be a nearly horizontal tabular mass bounded laterally by faults and broken into a complex system of blocks, which rise northward in a series of steps. The main ore body seems to consist of two parts - a thin lens ranging in thickness from 3 to 12 feet lying above and separated from the lower and principal block by 5 to 20 feet of serpentine. The chromite is cut off on the west by a fault that strikes N. 40° E. and dips 40° southeast, although it appears to strike north-south because of its relation to the steep mountain slope. Recent drilling indicates that this is a reverse fault, for about 40 feet of ore was penetrated in the footwall in drill hole 48.

The north boundary of the ore block is a fault bearing northwest and dipping northeast. Hole 29 penetrated the hanging wall of this fault at a depth of 63 feet. Other and deeper holes indicate that this northern fault is younger than the footwall fault and offsets the latter. Virtually all of the ore has been brecciated and crushed, with the result that in many places ore and waste are intimately mixed.

⁴ Contributed by T. P. Thayer, Federal Geological Survey.

Exploration by Bureau of Mines

Trenching was unnecessary at this property because the ore of the main deposit is fully exposed in the face of the quarry. The ore was sampled at 20-foot intervals along this face. Nine channel samples were taken, which averaged 23 percent Cr_2O_3 (figs. 4 and 5).

The two diamond drills and other equipment were moved from the Chambers to the Iron King mine on November 11 to 13. Water was hauled in a 750-gallon tank mounted on a 1-1/2-ton automobile truck. The tank was filled and emptied by a small gas-driven pump at the rear of the truck.

Holes 23, 25, 26, 28, and 29 (fig. 3) were in about the same plane and a little to the east of the center of the deposit. Holes 23 and 25 were collared from the same set-up about 40 feet north of the edge of the pit; No. 23 was pointed at 60° to the north. Four of these holes went through 30 to 53 feet of ore (fig. 6). In each instance two ore bodies are indicated - a thin one near the surface, ranging in thickness from 3 to 12 feet, and a larger and deeper one ranging from 25 to 40 feet in thickness. The relative position of the ore in holes 23, 25, 26, and 28 indicate at least three faults between holes 23 and 28. The ore was either faulted down on the south side or thrust up on the north side of the fault planes. As the hill slopes to the south, successive segments of ore between faults are all about the same depth below surface, which should simplify mining operations. Hole 29 was collared about 150 feet horizontally north of the edge of the pit and pointed to the north at an angle of 70° . It went through 5 feet of low-grade ore at 63 to 68 feet below the collar. At about this point dunite on the south has been brought into contact with peridotite on the north by a fault that probably also forms the north limit of the ore body. Hole 24, west of the center of the ore body

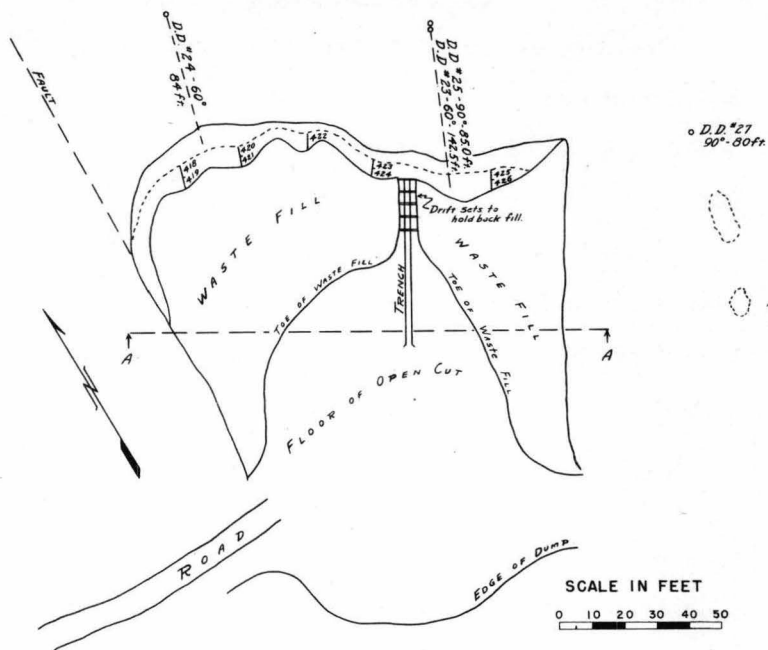


FIGURE 4. PLAN OF IRON KING OPEN CUT

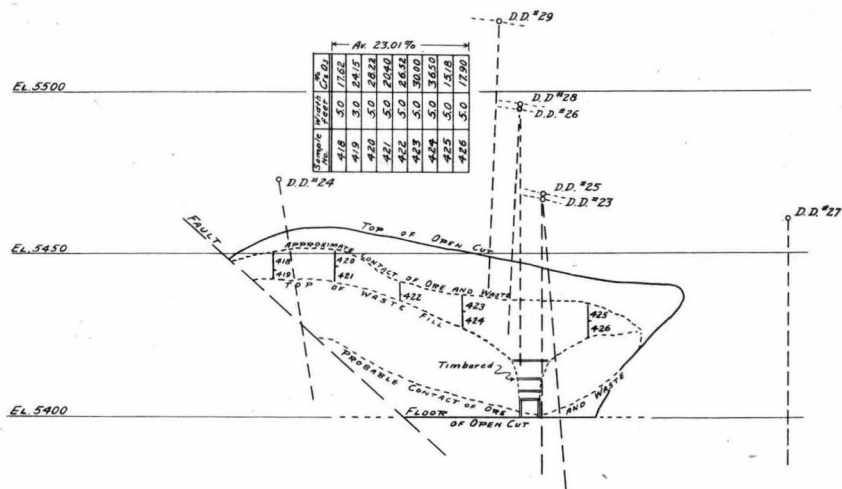


FIGURE 5. VERTICAL PROJECTION A-A IRON KING OPEN CUT

and about 80 feet west of the plane of holes 23, 26, 28, and 29, was collared about 35 feet horizontally north of the edge of the open-cut pit and pointed 60° to the south. It went through 39 feet of ore between 17 and 56 feet below the collar (fig. 7). The relative positions of the ore in this hole and that in the face of the quarry indicates a fault between the hole and the quarry face.

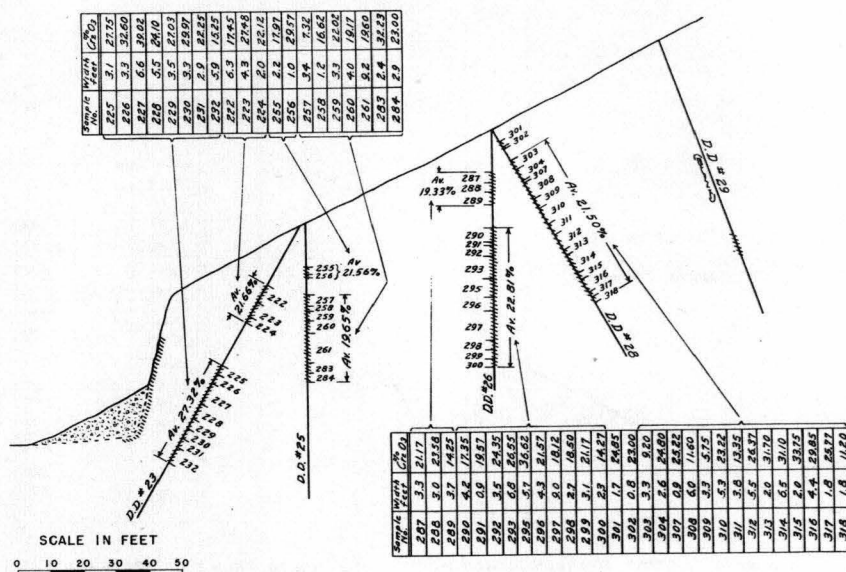


FIGURE 6. SECTION THROUGH DIAMOND DRILL HOLES, IRON KING PROPERTY

Hole 27, about 30 feet east of the northeast corner of the open pit, was vertical and was drilled to determine whether the ore extends to the east beyond the edge of the pit. It was stopped at a depth of about 15 feet below the floor of the pit. Since it was a blank, the east edge of the pit may be assumed to be about the limit of the ore body.

Drilling at the Iron King mine was completed on November 22, with a total of 666.5 feet, at the following costs:

	<u>Cost per foot</u>	<u>Amount</u>
666.5 feet	\$2.70	\$1,799.55
Extras	<u>0.40</u>	<u>268.56</u>
	3.10	2,068.11

Ore Reserves

In the diamond-drill holes, ore ranges in grade from an average of 19.23 percent Cr_2O_3 for 10 feet in No. 26 to 28.90 percent for 39 feet in

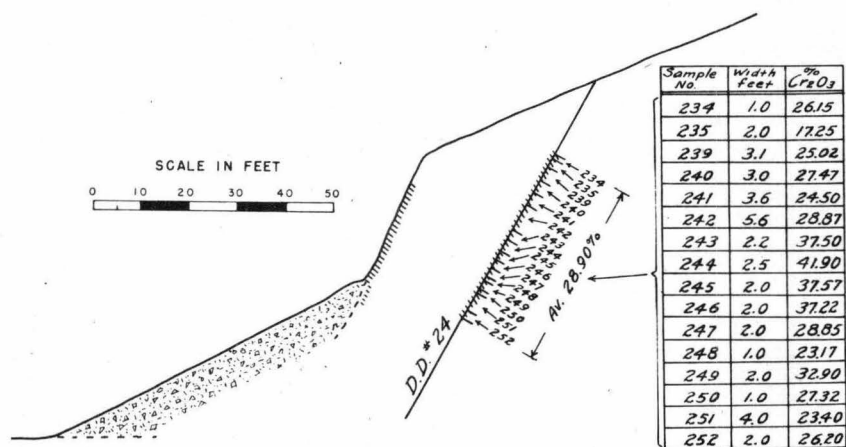


FIGURE 7. SECTION THROUGH DIAMOND-DRILL HOLE NO. 24, IRON KING PROPERTY.

No. 24. Holes 23 and 24 indicate that the ore in the main ore body near the edge of the pit is considerably higher in grade than that farther north of the pit. Hole 24, therefore, should not be considered in calculating the grade of the deposit as a whole, because there are no other holes in line with it to show a complete section of the ore in that part of the ore body. A complete north-south section, however, is shown in holes 23, 25, 26, and 28 (fig. 4). The average grade of the ore along this section, weighting each hole according to its footage in ore, is 22.55 percent Cr_2O_3 . Since the position of the

faults, and hence the size of the ore segments between fault planes, is not accurately known, it is impossible to calculate even approximately the relative tonnage represented by each hole. It is believed that 22.5 percent Cr_2O_3 is a fair but probably conservative average for all of the ore in the deposit.

Accurate tonnage calculations are not possible because of the faulted condition of the ore. From holes 23, 25, 26, and 28 it appears that the average thickness of the various segments of the main ore body is about 30 feet. Assuming the length of each segment from east to west to be 100 feet and the total width of all segments from north to south to be 140 feet, and taking a factor of 10 cubic feet per ton of ore in place, the amount of ore in the main deposit would be about 42,000 tons. To this should be added about 4,000 tons from segments of what appears to be a smaller deposit near the surface, making a total of 46,000 tons.

Mining

Open-cut methods are applicable to all of the ore at the Iron King mine. Waste would first be stripped, and the ore would then be broken and loaded into trucks. The amount of waste above the ore is not great; probably not more than a ton of waste would have to be moved for each ton of ore mined, and as it need be moved only about 300 feet, the cost should not be excessive. Although a considerable amount of hand sorting will be necessary, it is believed that much of the handling of waste and the loading of sorted ore can be performed mechanically, probably by scraper.

The direct operating cost of breaking, disposing of waste, sorting, and loading of product will probably be about \$2.50 a ton of ore.

DRY CAMP MINE

The Dry Camp mine (fig. 1) is on the east side of the west fork of Little Indian Creek at an altitude of about 5,500 feet, or 700 feet above the

creek level. It is about 15 miles by road from John Day and about a mile southwest of the Charles Howard ranch, which is at the end of a county road. The deposits are on patented agricultural land, which is assessed to I. B. Hazeltine of Canyon City, Oreg. The nearest convenient water is in Little Indian Creek about half a mile south of the Charles Howard range. The old road from this ranch to the mine is too steep and too badly out of repair to be used for any kind of transportation. The difference in elevation between the ranch and the mine is about 1,000 feet. It was necessary, therefore, to build 2-1/2 miles of 8-percent road before diamond drilling could be started.

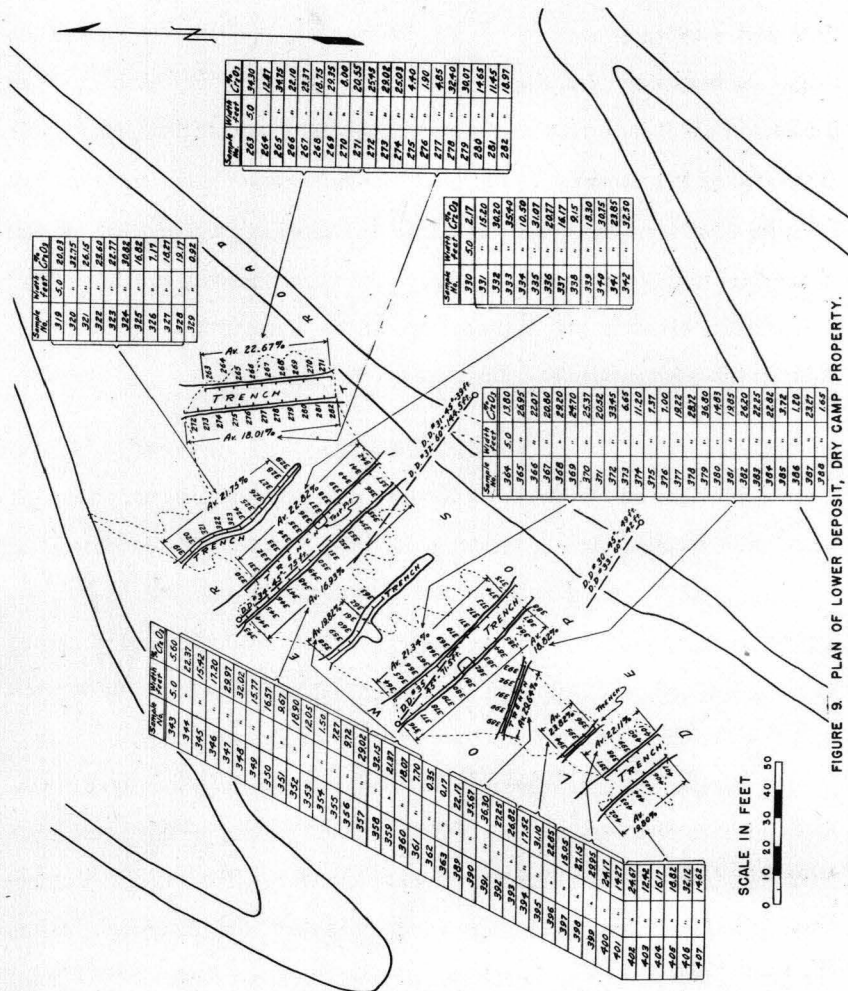
Geology

The Dry Camp deposits comprise two parallel ore bodies about 500 feet apart (fig. 8). The lower one is about 200 feet long and 20 to 60 feet in width; the upper one is about 120 feet long and 10 to 30 feet in width. The ore consists of chromite disseminated in dunite, with which it forms a well-defined banded structure. Occasional bands up to 6 inches in width may consist almost entirely of chromite. The ore bodies strike approximately N. 45° E. and dip to the southeast. Banding of the material near the surface indicates the dip to be about 50°; at a depth of 8 to 10 feet, however, the dip may be 70° or more. Geology will be discussed further in connection with diamond drilling.

Trenching and Test Pitting

The outline of the lower deposit was roughly determined by several trenches at approximately right angles to the strike of the deposit and some shallow surface workings, from which a small amount of ore had been mined. This work had been done by the owners of the property over a period of several years previous to 1939. As soon as the road was completed, other trenches were excavated to determine more definitely the extent of the

deposit and to expedite surface sampling. Of eight trenches on the lower deposit (fig. 9), four wide ones were made with tractor and bulldozer and four narrow ones by hand. Two 4- by 5-foot testpits were dug on the lower deposit, one 8 feet and the other 4 feet deep. Very little trenching was necessary on the upper deposit, where the overburden was thin, because it



had previously been exposed by open-cut and underground mining. One trench was made just north of the north end of the deposit to determine how far in that direction the ore extended; no ore was found in this trench.

Sampling

Small hand-excavated trenches about 1 foot wide and 1-1/2 to 2 feet deep were excavated on each edge of the bottom of the bulldozer trenches. This was necessary because the bulldozer blade could not cut through the tough, rubbery clay that caps the deposit. Samples were taken from the bottoms of all of the hand-excavated trenches and also from those previously excavated by the owners. A total of 117 samples were taken from the two deposits - 108 from the lower and 9 from the upper (figs. 9 and 10). It was impossible to take more samples from the upper deposit without doing a great deal of cleaning and retimbering, as the underground workings and some of the open cuts were badly caved.

Diamond Drilling

Equipment was moved from the Iron King mine and set up at the Dry Camp mine on November 23 to 25, and drilling started immediately.

As originally planned, 1,500 feet of diamond drilling was to be done at Dry Camp. Because of approaching bad weather it was decided to reduce this to about 800 feet. After the first two holes had been drilled it became apparent that not more than 450 to 500 feet would be necessary.

Looseness of the ground made diamond drilling exceptionally difficult. Although core recovery was fairly good in some places, the core consisted almost entirely of short broken sections seldom more than 1-1/2 to 2 inches long. It was seldom possible to recover more than 15 to 20 percent water, and sometimes there was no return. Cement usually proved of little help, because the rock was too soft and loose to hold it. Nearly all of the holes had to be cased for 30 to 60 feet.

Holes 30 and 31 (fig. 8) were collared to the southeast of the lower deposit about 35 feet from the edge. They were drilled at approximately right angles to the strike of the deposit and at a vertical angle of about 45°. Because of slow progress and the excessive cost of cementing and reaming, it was decided to stop them at approximately 50 and 40 feet, respectively,

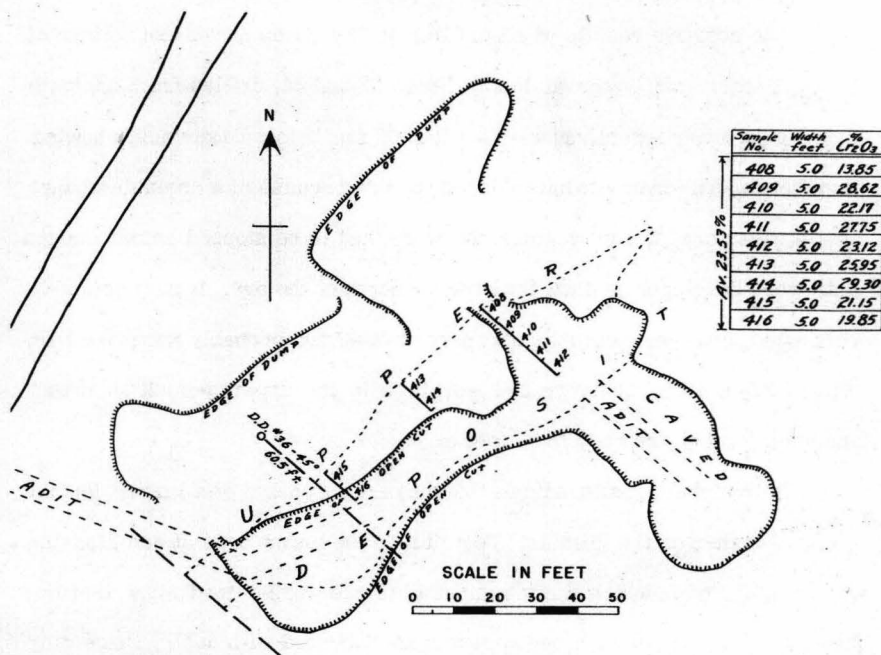


FIGURE 10. PLAN OF UPPER DEPOSIT, DRY CAMP PROPERTY.

and try drilling at a steeper angle. Hole 32, from the same set-up as 31, and No. 33, from the same set-up as 30, were pointed at angles of 60°. No. 33 was lost at about 42 feet. According to the dip indicated by the banding at the surface, ore should have been encountered in hole 32 at 40 to 50 feet. Owing to indications that the dip of the deposit becomes steeper at depth, No. 32 was drilled to a depth of 145 feet, all in waste, before being stopped.

Holes 34 and 35 (fig. 8) were both pointed at an angle of 45° to the southeast. No. 34 was near the footwall edge of the deposit opposite holes 31 and 32; No. 35 was near the footwall edge opposite holes 30 and 33; No. 34 was 75 feet deep and all in waste; and No. 35 was 71-1/2 feet deep, all in waste.

Hole 36, was drilled under the upper deposit from the footwall side at a vertical angle of 45°; it was 60.5 feet deep and all in waste (figs. 8 and 10).

The negative results of all drilling at Dry Camp shows that neither of the two deposits has any great depth. Holes 32 and 34, drilled from opposite sides of the lower deposit, overlap at about 65 feet below the surface, showing that there was no chance to have missed the ore because of a possible change in dip. Because of bad weather the work had to be stopped before enough data were developed to show the precise depth of the ore. It may be safely estimated, however, that it is not more than 40 and probably not more than 15 or 20 feet deep. Underground workings in the upper deposit show that the depth of that ore body is 20 feet or less.

Both of the deposits indicate that they are only parts of a larger deposit situated higher on the hillside. Test pits in the lower deposit and also the old trenches from which limited amounts of ore were mined show that the broken character of the ore becomes more pronounced with depth, suggesting that this ore body rests upon a flat fault of large displacement. In the workings of the upper deposit, ore that appears to be in place is seen to rest directly upon large broken fragments of waste rock.

Diamond drilling was completed on December 7, with a total of 485.5 feet, the cost of which was as follows:

	<u>Cost per foot</u>	<u>Amount</u>
485.5 feet	\$2.70	\$1,310.85
Extras	<u>1.58</u>	<u>767.30</u>
	4.28	2,078.15

Ore Reserves

Of the 108 samples taken from trenches on the lower deposit, seven are beyond the limits of the ore and are excluded from the averages. The other 101 samples average about 20 percent Cr_2O_3 . The average of 9 samples from the upper deposit is 23.53 chromic oxide.

The length of the lower deposit is 220 feet and its average width is 39 feet. Assuming the depth to be 10 feet, and taking 12 cubic feet of ore in place per ton, the deposit would contain 7,150 tons. Tonnage in the upper deposit is more difficult to estimate, because the old workings are covered and inaccessible. The length is about 110 feet, the average width 20 feet, and the depth about 15 feet. Thus, there was about 2,600 tons of ore in the deposit before any was mined; probably less than 1,000 tons remains; possibly only 850 tons. The total available ore in the two deposits is therefore estimated at about 8,000 tons.

Mining

The Dry Camp deposits can be mined with mechanical equipment such as a scraper. The thin overburden can easily be removed by bulldozer or scraper. Little, if any, drilling and blasting should be necessary at the lower deposit. The total direct mining costs should not exceed \$2.75 a ton.

CONCLUSIONS

Mining could be begun immediately at the Chambers, Iron King, and Dry Camp properties with very little preparation. Open-cut methods and simple mechanical equipment can be employed for mining these deposits, except the deeper portion of the Chambers.

Operating cost will vary according to the amount of overburden to be removed and the method of its disposal, the extent of the deposit, and the amount of drilling and blasting required. Wages will probably be as follows:

<u>Class</u>	<u>Rate per hour</u>
Miners	\$0.75
Surface labor625
Scraper operator	1.25
Scraper helper75
Truck drivers	1.00
Bulldozer operator	1.25

Estimated Cost of Mining Equipment

	<u>Price</u>	<u>Total</u>
3 Scraper outfits, complete, 1/2 cu. yd.	\$ 3,000	\$ 9,000
1 Bulldozer, Diesel, with blade, 95 hp.	9,100	9,100
4 Dump trucks, heavy-duty, 5 yd.	6,500	26,000
2 Compressors, portable, 300 cu. ft.	6,600	13,200
2 Tripod drills, large	600	1,200
2 Jackhammers, complete.	250	500
Mine tools, equipment, and shop		<u>8,400</u>
		67,400
Pipe, hose, steel, bits, etc.		<u>19,000</u>
		86,400

Enough chromite ore has been developed in the John Day area to warrant the installation of a centrally located 300-ton jig and table mill, the cost of which will be about \$120,000. The ore from the Dry Camp property probably should be stock-piled and milled separately because of the higher grade of concentrate derivable from this ore.

oOo

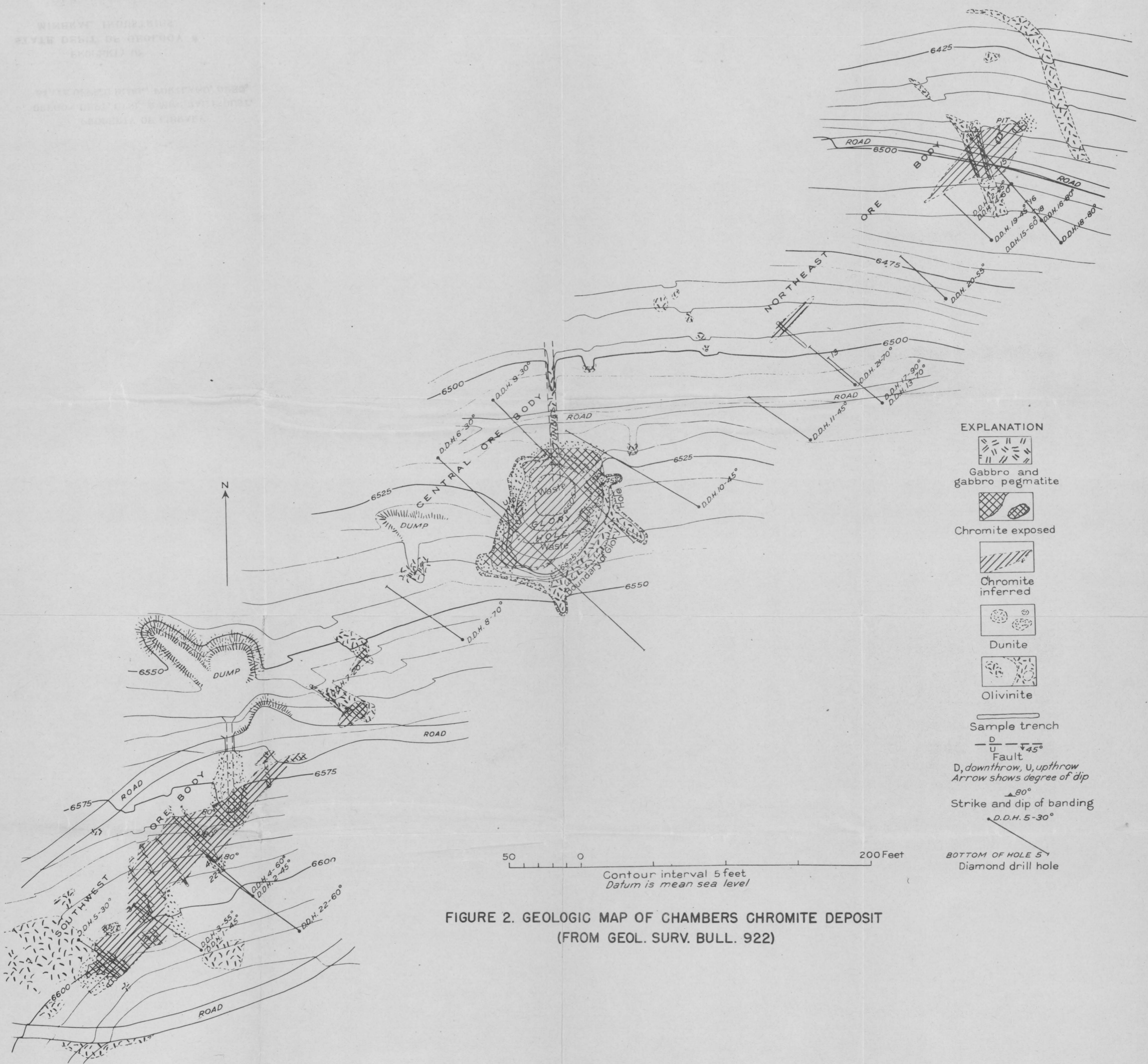
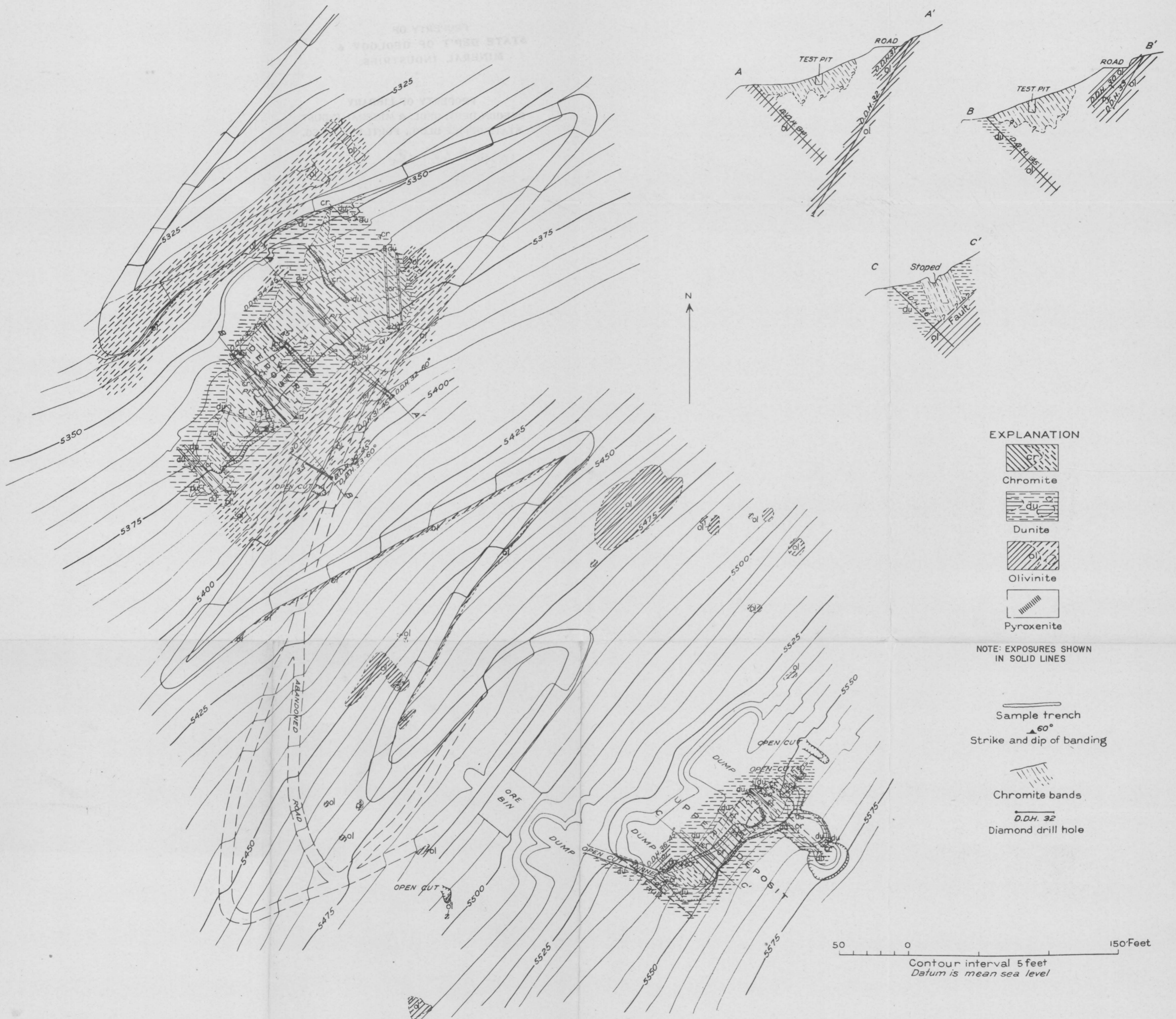
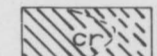


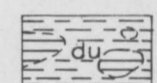
FIGURE 2. GEOLOGIC MAP OF CHAMBERS CHROMITE DEPOSIT
(FROM GEOL. SURV. BULL. 922)



EXPLANATION



Chromite



Dunite

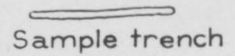


Olivinite



Pyroxenite

NOTE: EXPOSURES SHOWN IN SOLID LINES

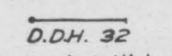


Sample trench

▲ 60°
Strike and dip of banding

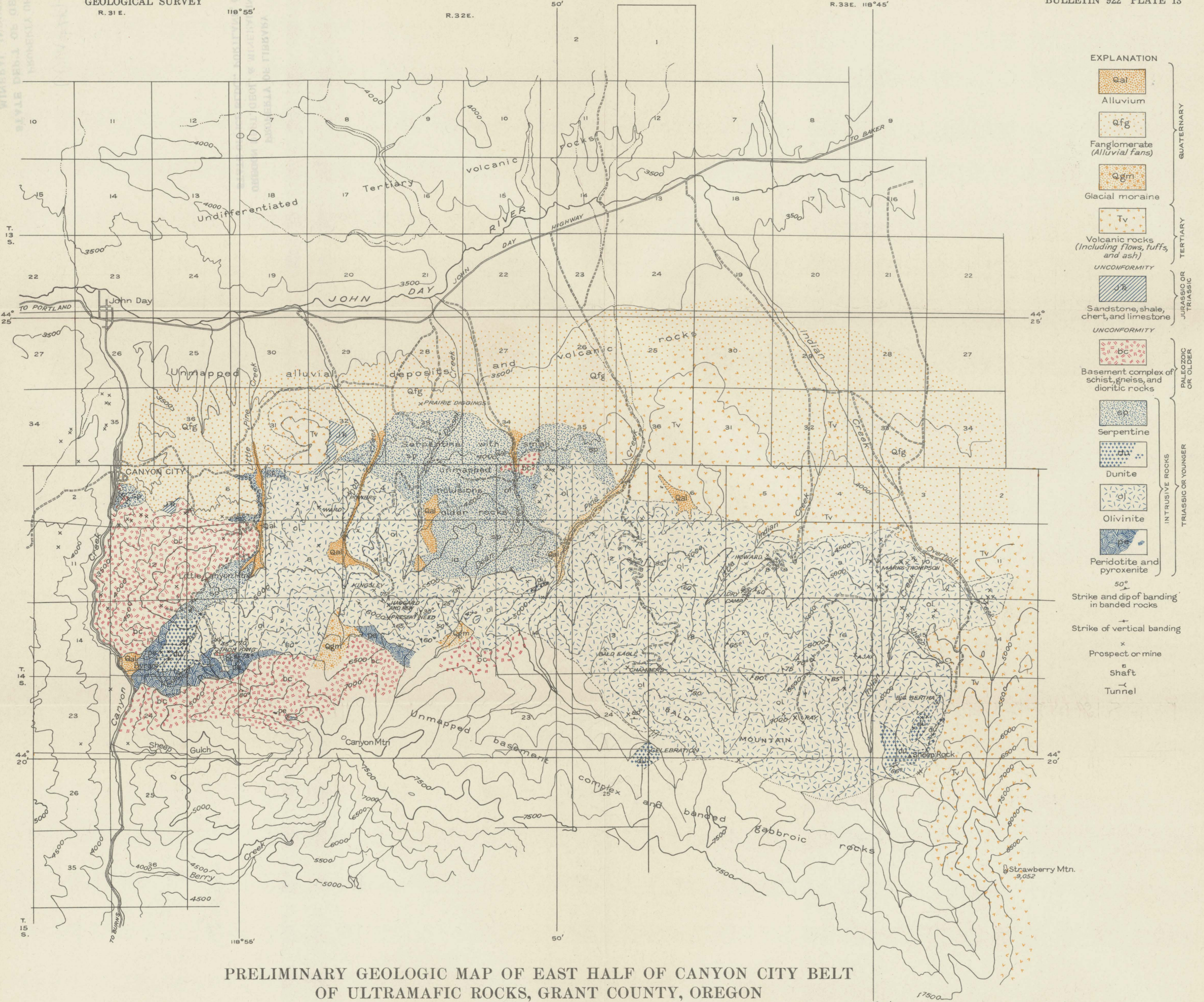


Chromite bands



D.D.H. 32
Diamond drill hole

FIGURE 8. GEOLOGIC MAP AND SECTIONS OF DRY CAMP CHROMITE DEPOSIT. (FROM GEOL. SURV. BULL. 922)



- EXPLANATION**
- Qal
Alluvium
 - Qfg
Fanglomerate (Alluvial fans)
 - Qgm
Glacial moraine
 - Tv
Volcanic rocks (Including flows, tuffs, and ash)
 - UNCONFORMITY**
 - Jf
Sandstone, shale, chert, and limestone
 - UNCONFORMITY**
 - bc
Basement complex of schist, gneiss, and dioritic rocks
 - sp
Serpentine
 - du
Dunite
 - ol
Olivinite
 - pr
Peridotite and pyroxenite
- 50°
Strike and dip of banding in banded rocks
- Strike of vertical banding
- x
Prospect or mine
- Shaft
- Tunnel

PRELIMINARY GEOLOGIC MAP OF EAST HALF OF CANYON CITY BELT
 OF ULTRAMAFIC ROCKS, GRANT COUNTY, OREGON

Scale 63,360 3 Miles
 Contour interval 500 feet
 Datum is mean sea level
 1940

Geology by T.P. Thayer assisted by P.W. Guild