R. I. 4419 MARCH 1949

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR



REPORT OF INVESTIGATIONS

# INVESTIGATION OF CLAIM POINT CHROMITE DEPOSITS KENAI PENINSULA, ALASKA

BY

R. S. SANFORD AND J. W. COLE

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CONTENTS



ILLUSTRATIONS



1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used, "Reprinted from Bureau of Mines Report of Investigations 4419."

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3/ Associate mining engineer, Bureau of Mines, Juneau, Alaska.

ILLUSTRATIONS (Cont'd.)



## INTRODUCTION AND SUMMARY

The Claim Point chromite deposits are at tidewater near the southern tip of the Kenai Peninsula in southwestern Alaska. The United States Geological Survey had a field party in the region from July until September 1940 under P. W. Guild, assistant geologist; maps and geological data were assembled and made available to the Bureau of Mines.

A preliminary investigation of the deposits at Claim Point by the senior author during July 1941 was followed by surface sampling and core drilling to determine the quantity and grade of the ore. The Geological Survey was represented at the project by George O. Gates, geologist. Cores were checked and the structural data revealed by drill cores were interpreted.

The principal chromite deposits have been sampled and delimitated by trenching and core drilling. Other deposits were trenched and sampled but were too small or too low-grade to warrant core drilling.

## ACKNOWLEDGMENTS

Metallurgical data included in this report were obtained from tests at the Salt Lake City Experiment Station of the Bureau of Mines.

Acknowledgment is made to the Geological Survey for the use of geologic maps and reports of the Claim Point area. Special acknowledgment is made to P. W. Guild and George O. Gates, of the Geological Survey, for detailed study and mapping in the area.

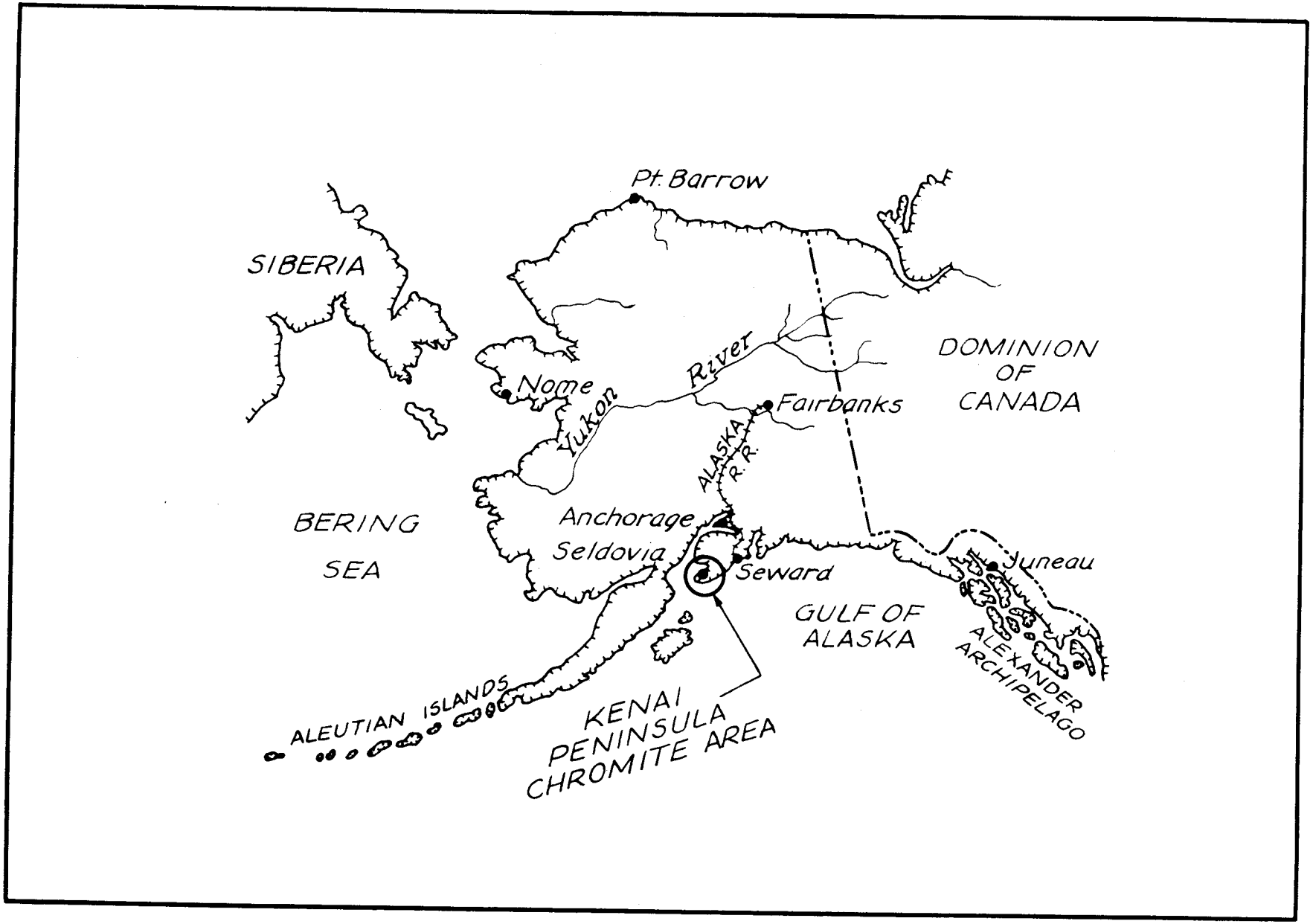
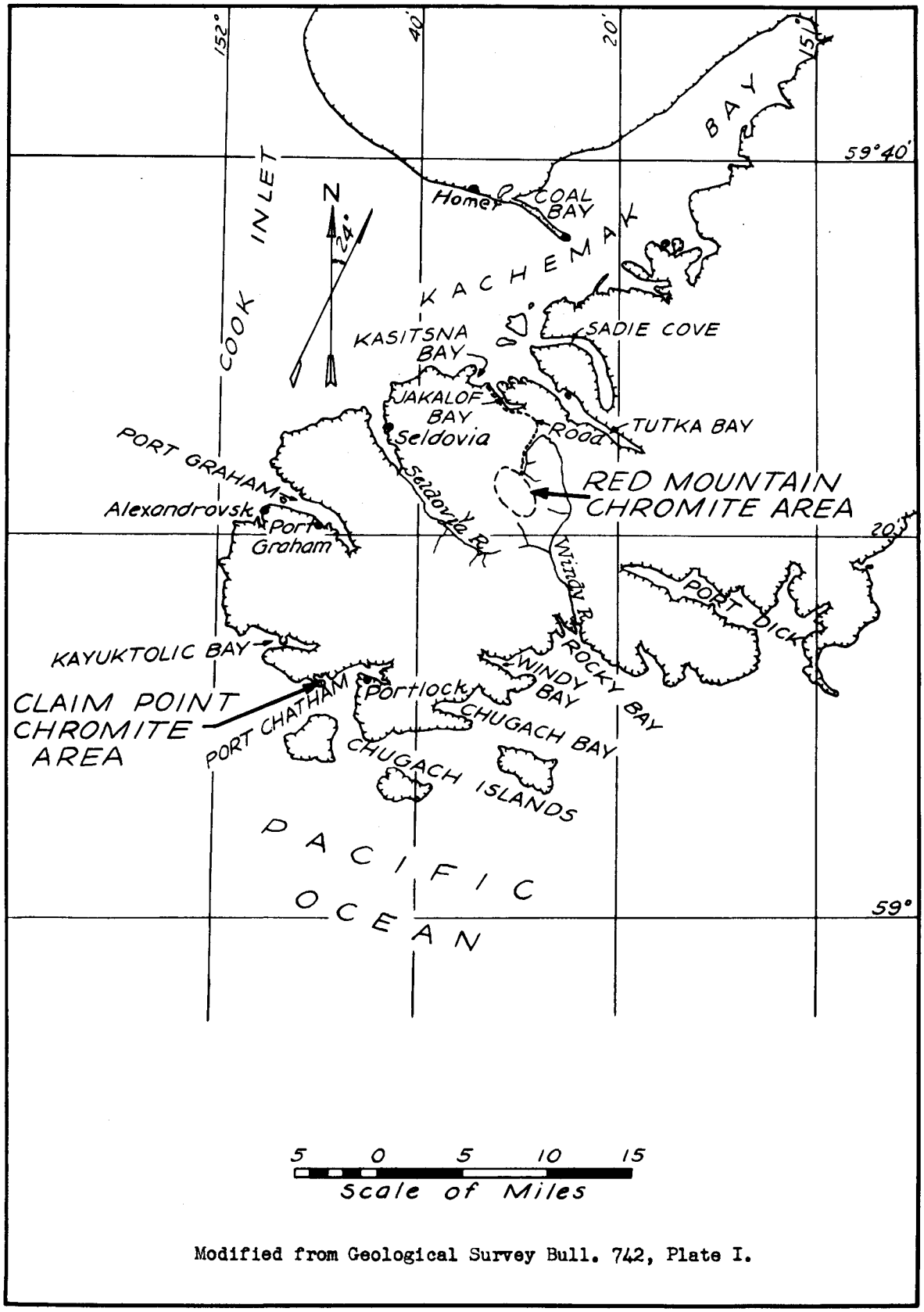



Figure 1. - Index map, Kenai Peninsula, Alaska.




Modified from Geological Survey Bull. 742, Plate I.

Figure 2. - Kenai Peninsula chromite areas.

## LOCATION AND ACCESSIBILITY

Claim Point is a small peninsula about one-fourth square mile in extent extending into the mouth of Port Chatham Bay from the north shore. Its general location is shown on figure 1. It is separated from the mainland by Chrome Bay, except for a grass- and tree-covered sandspit.

The nearest supply base is Seldovia, a small fishing village of about 400 population, about twenty-five miles by boat north of Claim Point on Cook Inlet. (See fig. 2.) The entire area under discussion is part of the Third Judicial Division of Alaska, with headquarters at Valdez.

Cook Inlet is served by the Alaska Steamship Co., which has maintained once-a-month service to Seldovia since the entrance of the United States into the War. The company's basic freight rate on machinery from Seattle to Seldovia during the summer of 1942 was 41-1/4 cents a cubic foot, or 82-1/2 cents a hundred pounds, whichever was greater, plus a 25-percent emergency surcharge. Rates on groceries and other supplies varied but were generally higher than the above figures. Freight on bulk ore valued at $60 a short ton is $7 a short ton plus 25 percent emergency surcharge from Seldovia to Juneau or from Seldovia to Seattle and $4.50 a short ton plus 20 percent emergency surcharge from Juneau to Seattle. Wharfage at Seattle is $0.07 a hundred pounds.

Minimum first-class passage by steamship from Seattle to Seldovia during the summer of 1942 was $111.65 plus 10 percent Federal tax. The one-way trip required about 2 weeks. Transportation may be had at slightly higher cost on the more frequent ships from Seattle to Seward, Alaska, thence by train to Anchorage, and from there to Homer or Seldovia by plane. Passengers and air express are carried by Pan American Airways from Seattle to Fairbanks and by local plane companies from Fairbanks to other parts of Alaska. Plane fare is $175.00 plus tax from Seattle to Fairbanks and $65.00 plus tax from Fairbanks to Homer. Charter plane service is also available at Anchorage.

There is a privately owned radio station at Seldovia that furnishes commercial telegraph service through the Alaska Communication System. Small ocean-going motorships maintain irregular freight service on Cook Inlet, but most local travel is by small gasoline-powered fishing boats. Groceries and other supplies are available at Seldovia and Homer. Standard Oil Co. maintains a bulk oil plant at Seldovia to serve the Cook Inlet area. Fuel and lubricating oils in reasonable quantities may be obtained at prices comparing favorably with the United States prices. Low-grade coal may be obtained from Homer at $10 to $12 a ton. There is a grade school and facilities for rather primitive living across Port Chatham Bay at Portlock. There are a high school and a modern hospital in Seldovia.

## PHYSICAL FEATURES

Kenai Peninsula is typical of the Alaskan coastal region in vegetation and climate. Claim Point and the adjacent mainland is covered by a jungle growth of vegetation, spruce trees of logging size being fairly abundant. Although the nearest weather station at Homer, Alaska, records an annual rainfall of only 30 to 40 inches, it is believed that the precipitation at Claim Point is nearly twice that amount. Sea-level temperatures range from zero to 80 degrees, rarely remaining below freezing for more than a few days at a time.

However, above 600 feet freezing weather and heavy snowfall are the rule from October to May. Tides are high on Cook Inlet, the maximum range at Seldovia being 28 feet, causing difficulty in the construction of docking facilities that can be used at both low and high tides.

## HISTORY

The earliest reference to the Claim Point chromite deposit is by U. S. Grant.4/ A. C. Gill5/ examined them in 1918, and P. W. Guild6/ investigated them from June to September 1940.

Past production has been limited to 1,000 long tons averaging 46 to 49 percent $Cr_2O_3$ in 1917 and 1,000 long tons averaging 40 percent $Cr_2O_3$ in 1918. Most of this ore came from the Reef mine. During 1918 and 1919, a stamp mill was constructed to mill the ore from Deposit No. 10, but no ore was milled, and operations ceased with the end of the war. The location of the principal deposits on Claim Point is shown on figure 3.

## PROPERTY AND OWNERSHIP

The Bluff No. 1 claim, which covers Deposit No. 10, is the only patented property at Claim Point. To the southeast of this is the Bluff No. 2 claim, which covers deposits Nos. 7 to 8b, inclusive. The Reef mine is covered by a claim parallel to the strike. Most of the mining property at Claim Point is held by Red Mountain Chromite, Inc., 900 Public Service Building, Portland, Ore.

## ORE DEPOSITS

### General Geology

The ore deposits are found in an intrusion of ultramafic rock, which underlies all of Claim Point, Chrome Bay, and an area on the mainland extending 800 to 1,000 feet from the shore of Chrome Bay. Except for the land area on the mainland opposite Claim Point, the contact is covered by the sea, so that the size and shape of the intrusion are not known.

According to Guild7/:

> The surrounding rocks consist of a series of graywackes, slates, cherts, limestones, and interbedded volcanic rocks. The ultramafic rocks are discordant intrusives into the graywacke

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4/ Grant, U. S., and Higgins, D. F., Preliminary Report on the Mineral Resources of the Southern Part of Kenai Peninsula, Alaska: U. S. Geol. Surv. Bull. 442, 1910, pp. 168-169.

5/ Gill, A. C., Chromite of Kenai Peninsula, Alaska: U. S. Geol. Surv. Bull. 742, 1922.

6/ Guild, P. W., Chromite Deposits of Kenai Peninsula, Alaska: U. S. Geol. Surv. Bull. 931-G, 1942.

7/ Op. cit., abstracted by authors.

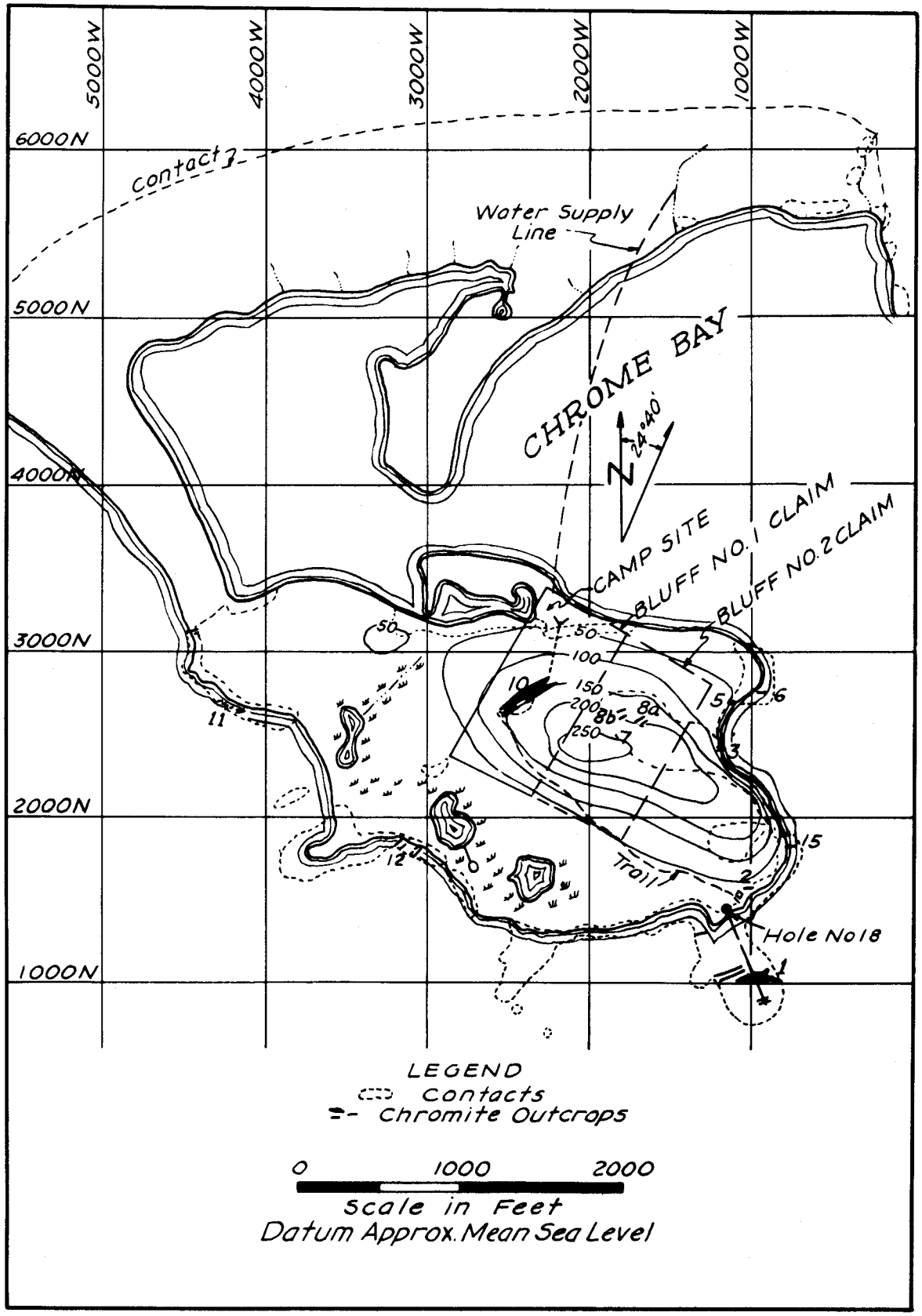


Figure 3. - Geologic and topographic map.

series. The predominant rock is dunite. Along the margins of the mass the dunite has been altered to serpentine. The Kenai Peninsula was strongly glaciated in Pleistocene and Recent time. The ultramafic rocks are characterized chemically by their high content of magnesium and iron, low silica and alumina, and almost complete absence of alkalies. The dunite consists almost entirely of olivine $(Mg, Fe)_2SiO_4$, with accessory chromite grains, averaging about 0.5 millimeter across, which usually constitute less than one percent of the rock. The chromite-bearing intrusives are tentatively assigned a late Jurassic or Cretaceous age. No ultramafic dikes are known to have been intruded into the surrounding sedimentary and metamorphic rocks. The outstanding characteristic of the intrusive bodies is the banding. Faulting and jointing are common.

These deposits were apparently formed by magmatic segregation. The mineral deposits are irregularly distributed throughout the dunite without apparent pattern, where exposed, and undoubtedly occur through the unexposed volume of the dunite in about the same proportion. The total volume of ore is so small, compared to the volume of the dunite, that discovery of buried ore bodies by present known methods is both uncertain and expensive.

## Mineralogy

According to Guild:

> Chromite is a black, opaque mineral with a submetallic luster belonging to the spinel group of the isometric class. It is distinguished from magnetite by its brown streak and low degree of magnetism. Its theoretical chemical composition is $FeO.Cr_2O_3$, with 32 percent FeO and 68 percent $Cr_2O_3$, but in fact it always contains MgO, $Fe_2O_3$, and $Al_2O_3$. Its formula, therefore, is usually written as $(Fe,Mg)O.(Cr,Al,Fe)_2O_3$. The percentage of $Cr_2O_3$ in the mineral may thus range between wide limits, but with few exceptions the range in the deposits under discussion is small, and the percentage of $Cr_2O_3$ is near 58.

The chromium-iron ratio of concentrate from this ore is expected to range from 2.5 to 2.8 to 1. The 45 percent concentrate of a sample of ore from deposit No. 10 was found to have a chromium-iron ratio of 2.71 to 1.

The dunite is composed principally of olivine containing approximately 40 percent magnesium oxide and 6 percent iron.

Similar rock has been found to have desirable qualities for the manufacture of refractories,8/ and investigations are said to be in progress to recover magnesium metal from olivine.

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8/ U. S. Department of Commerce, Bureau of Standards, Research Paper R. P. 645, Bureau of Standards Journal of Research vol. 12, February 1934.

Recent analysis of one sample of chromium ore from deposit No. 10 shows a trace of nickel. The nickel appears to occur as a silicate in the olivine.

## DESCRIPTION OF THE DEPOSITS

### Deposit No. 1 or Reef Mine

A deposit of banded chromite crops out about 400 feet south of Claim Point on a reef connected to the mainland at low tide. The main part of the ore body consists of two parallel lenticular bands in contact with each other at one point. Each band is more than 100 feet long and approximately 25 feet in maximum width. A hole drilled from the mainland to intersect the ore zone at 180-foot depth under the widest part of the ore body proved that direct shipping ore does not extend to that depth. The best zone intersected was 2 feet of 34.24 percent $Cr_2O_3$. The ore body may rake to one side or the other of the hole. A geologic plan of the deposit is shown on figure 4, and an assay section through the drill hole exploring the deposit is shown on figure 5.

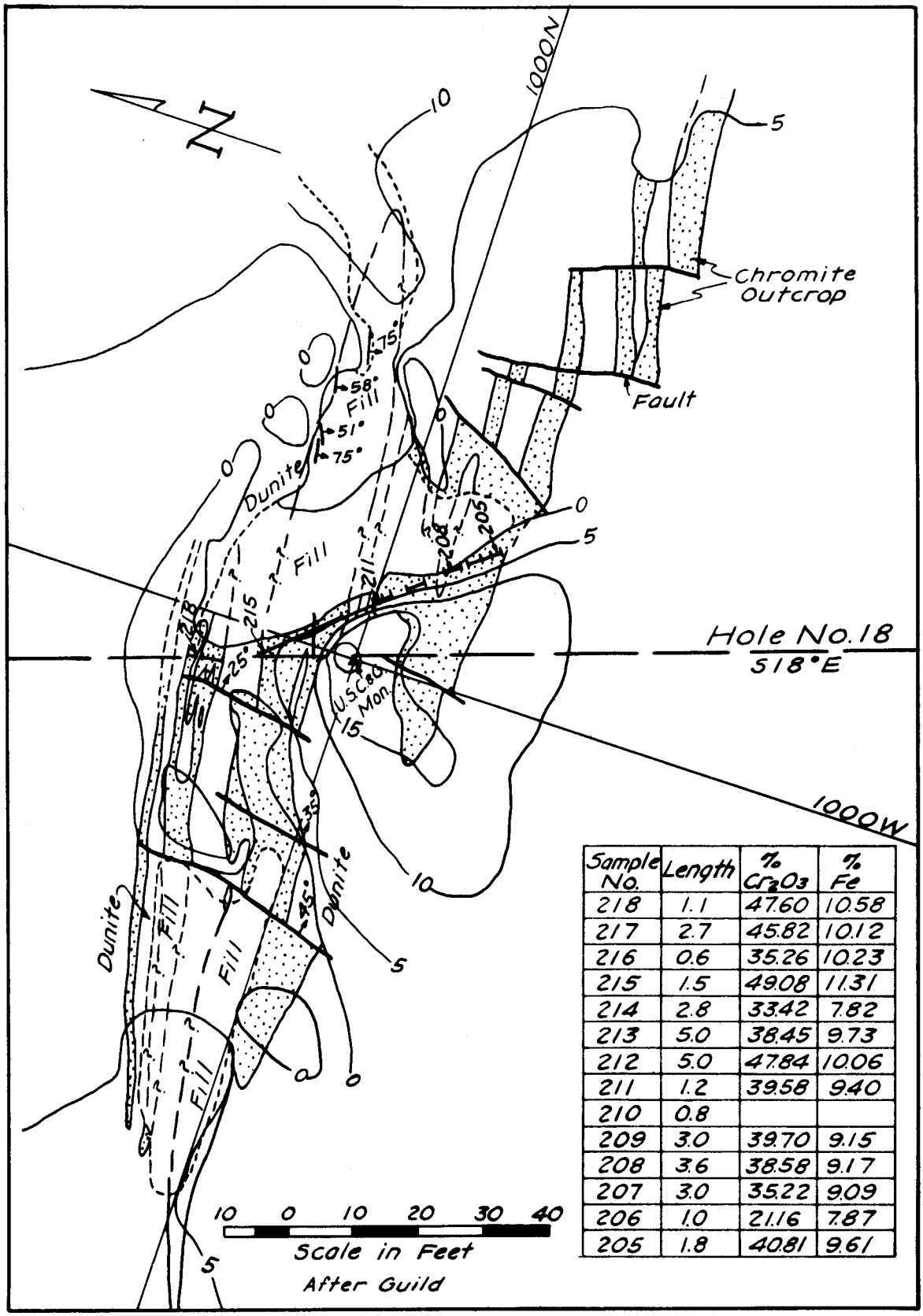
### Deposit No. 10

On the north slope of Claim Point adjacent to Chrome Bay is the largest known body of low-grade chromite on Kenai Peninsula. Trenching and drilling indicate that it consists of two irregular but generally parallel lenses of banded chromite in contact with each other at their midpoint at the outcrop elevation, striking northeast and dipping vertically. The outcrop elevation is approximately 140 feet. The ore body feathers out to the southwest. The lenses apparently rake to the northeast as they do not crop out above the drill holes on the north end. Geological data revealed by the outcrop and the drilling suggest that the body is terminated at the north end between the drill holes and the exposed bluff. Drilling indicates that the ore body is at least 350 feet long and 80 feet in maximum width where the two lenses are in contact at the surface. The width and grade of the ore body appear to decrease with depth. An assay plan of the No. 10 deposit is shown on figures 6, 6A, and 6B. Sections through drill holes on the No. 10 deposit and analyses of samples obtained in drilling are shown in figures 7, 8, 9, 10, and 11.

### Deposits Nos. 7, 8a, 8b(S), and 8b(N)

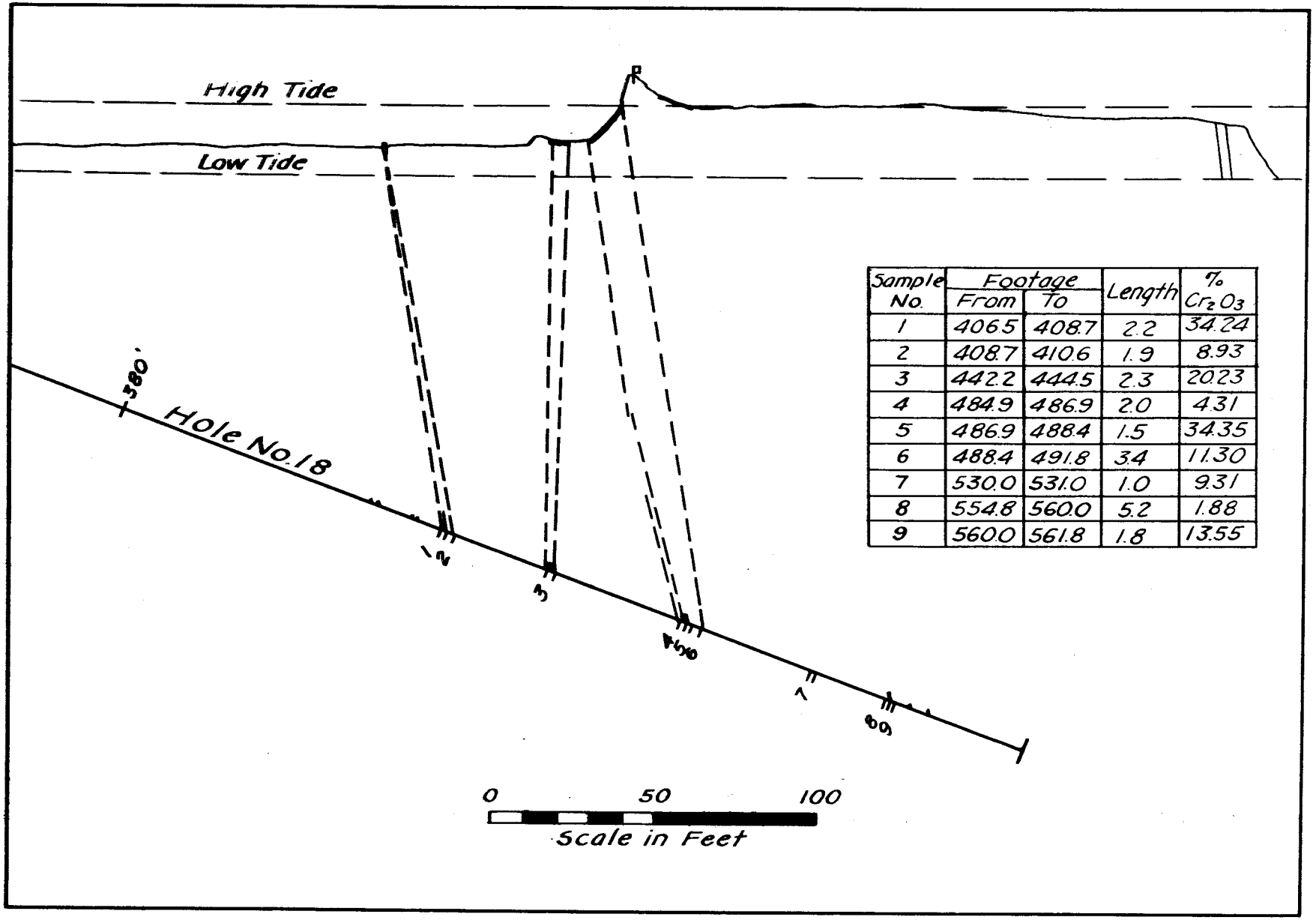
To the northeast of deposit No. 10, at slightly higher elevation, are four deposits of low-grade banded chromite that are thought to be faulted segments of deposit No. 10. They strike northeast and dip steeply to the south. Drilling indicates that these deposits do not continue far in depth.

Deposit No. 7 is 60 feet long and averages 13.2 feet in width; No. 8a is 70 feet long and averages 14.5 feet in width; No. 8b(N) is 110 feet long and averages 21.5 feet in width; and No. 8b(S) is 140 feet long and averages 31.4 feet in width. The assay plan of these deposits is shown on figures 12, 12A, and 12B. Sections through drill holes and analyses of samples obtained from drilling are shown on figures 13 and 14.




| Sample No. | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|
| 218 | 1.1 | 47.60 | 10.58 |
| 217 | 2.7 | 45.82 | 10.12 |
| 216 | 0.6 | 35.26 | 10.23 |
| 215 | 1.5 | 49.08 | 11.31 |
| 214 | 2.8 | 33.42 | 7.82 |
| 213 | 5.0 | 38.45 | 9.73 |
| 212 | 5.0 | 47.84 | 10.06 |
| 211 | 1.2 | 39.58 | 9.40 |
| 210 | 0.8 | | |
| 209 | 3.0 | 39.70 | 9.15 |
| 208 | 3.6 | 38.58 | 9.17 |
| 207 | 3.0 | 35.22 | 9.09 |
| 206 | 1.0 | 21.16 | 7.87 |
| 205 | 1.8 | 40.81 | 9.61 |

Figure 4. - Plan of Reef mine outcrop.




| Sample No. | Footage | | Length | % $Cr_2O_3$ |
|---|---|---|---|---|
| | From | To | | |
| 1 | 406.5 | 408.7 | 2.2 | 34.24 |
| 2 | 408.7 | 410.6 | 1.9 | 8.93 |
| 3 | 442.2 | 444.5 | 2.3 | 20.23 |
| 4 | 484.9 | 486.9 | 2.0 | 4.31 |
| 5 | 486.9 | 488.4 | 1.5 | 34.35 |
| 6 | 488.4 | 491.8 | 3.4 | 11.30 |
| 7 | 530.0 | 531.0 | 1.0 | 9.31 |
| 8 | 554.8 | 560.0 | 5.2 | 1.88 |
| 9 | 560.0 | 561.8 | 1.8 | 13.55 |

**Figure 5. - Assay section, Reef mine outcrop.**

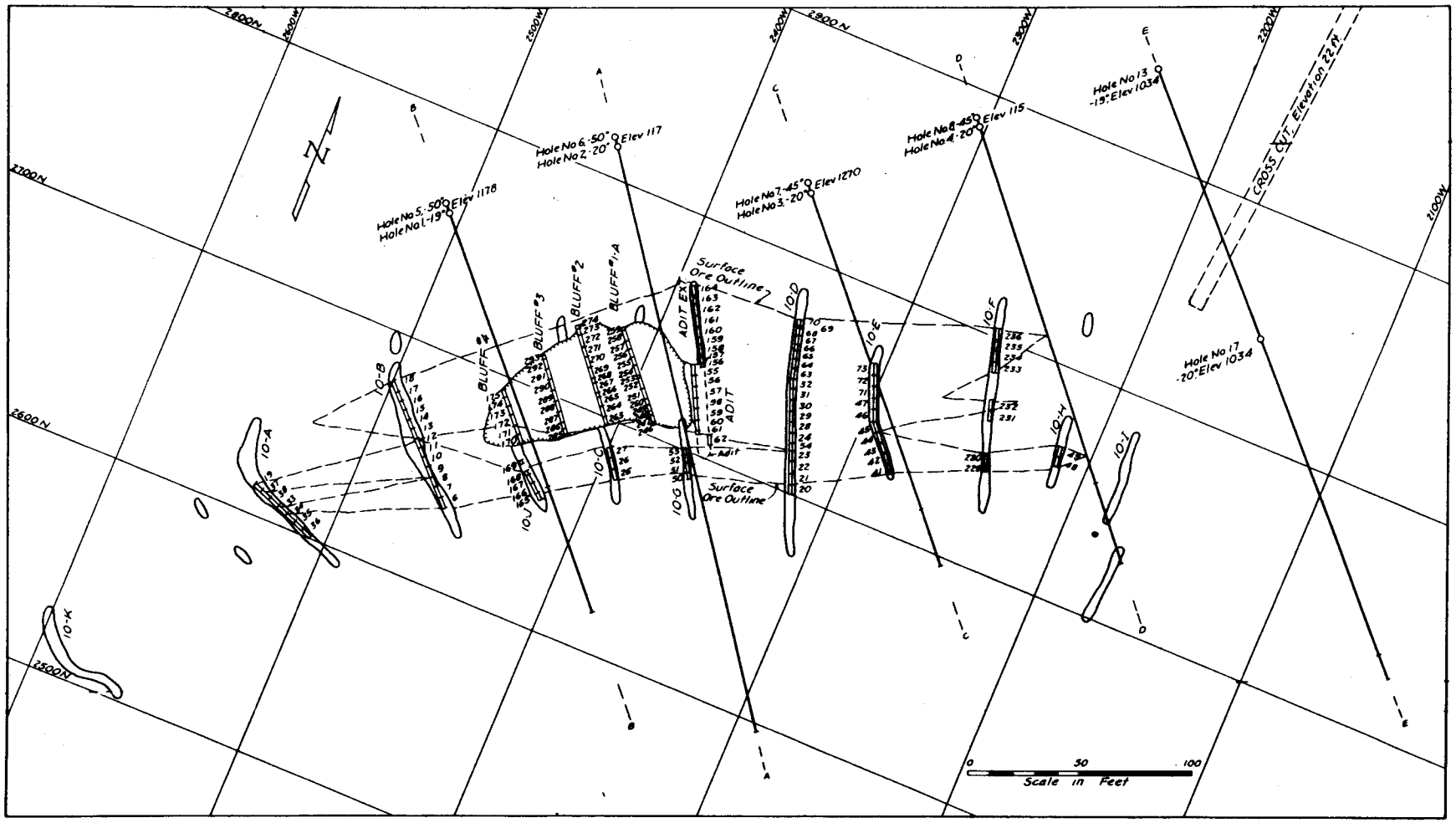


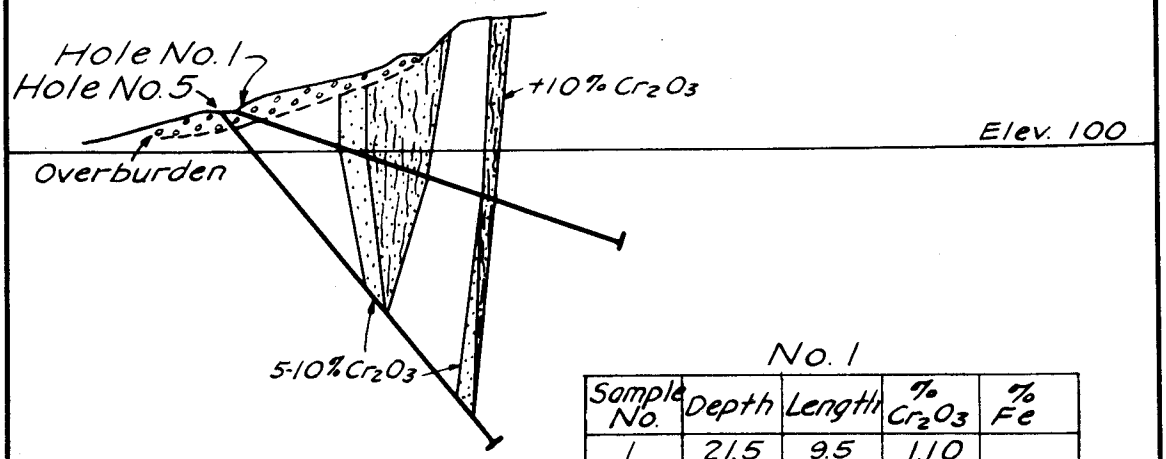

Figure 6. - Assay plan, deposit No. 10, Claim Point, Alaska.

| Trench No. | Sample No. | Length Feet | $Cr_2O_3$ | Fe | Trench No. | Sample No. | Length Feet | $Cr_2O_3$ | Fe |
|---|---|---|---|---|---|---|---|---|---|
| | 19 | 4.5 | 14.92 | 6.90 | | 269 | 5.0 | 41.42 | 8.17 |
| | 37 | 5.0 | 1.20 | | | 268 | 2.2 | 49.40 | 9.03 |
| | 38 | " | 0.94 | | BLUFF | 267 | 4.7 | 32.00 | 7.50 |
| 10-A | 33 | " | 11.83 | 6.18 | #2 | 266 | 2.1 | 20.50 | 6.17 |
| | 34 | " | 6.17 | 6.39 | | 265 | 4.2 | 12.06 | 5.16 |
| | 35 | " | 8.34 | 6.23 | | 264 | 5.0 | 28.96 | 7.40 |
| | 36 | " | 0.92 | | | 263 | 4.0 | 45.46 | 9.21 |
| | 18 | " | 20.58 | 7.54 | | 27 | 5.0 | 12.58 | 6.52 |
| | 17 | " | 20.96 | 7.72 | 10-C | 26 | " | 15.72 | 6.48 |
| | 16 | " | 21.19 | 7.31 | | 25 | " | 23.88 | 7.38 |
| | 15 | " | 22.86 | 7.68 | | 259 | 1.7 | 14.60 | 6.20 |
| | 14 | " | 20.30 | 7.50 | | 258 | 5.0 | 20.63 | 6.85 |
| | 13 | " | 16.70 | 7.12 | | 257 | 4.0 | 26.04 | 7.21 |
| 10-B | 12 | " | 29.71 | 7.77 | | 256 | " | 28.53 | 7.74 |
| | 11 | " | 37.62 | 8.84 | | 255 | 3.5 | 38.79 | 8.36 |
| | 10 | " | 34.18 | 7.89 | BLUFF | 254 | 5.0 | 26.73 | 7.43 |
| | 9 | " | 28.10 | 7.82 | #1A | 253 | 1.0 | 8.90 | 5.63 |
| | 8 | 4.5 | 31.07 | 7.81 | | 252 | 5.0 | 16.36 | 6.68 |
| | 7 | 5.0 | 16.24 | 6.92 | | 251 | " | 12.05 | 7.93 |
| | 6 | 5.5 | 28.21 | 8.46 | | 250 | 2.7 | 22.07 | 7.10 |
| | 175 | 5.0 | 26.70 | | | 249 | 2.9 | 36.03 | 8.38 |
| | 174 | " | 20.91 | | | 248 | " | 12.80 | 6.04 |
| BLUFF | 173 | " | 13.36 | | | 247 | 2.5 | 41.96 | 8.95 |
| #4 | 172 | " | 37.24 | | | 246 | 1.0 | 21.83 | |
| | 171 | " | 3.97 | | | 53 | 3.5 | 10.85 | 6.09 |
| | 170 | " | 4.21 | | 10-G | 52 | 4.0 | 21.96 | 6.68 |
| | 169 | 1.5 | 11.62 | 6.38 | | 51 | 4.2 | 12.59 | 6.34 |
| | 168 | 2.0 | 7.47 | 5.50 | | 50 | 3.3 | 1.72 | 5.23 |
| 10-J | 167 | 4.0 | 9.27 | | | 55 | 5.0 | 39.62 | 8.02 |
| | 166 | 5.0 | 13.71 | 6.24 | | 56 | " | 29.80 | 7.37 |
| | 165 | 4.0 | 1.11 | | | 57 | " | 36.18 | 7.57 |
| | 293 | 1.5 | 29.63 | 7.44 | ADIT | 58 | " | 27.86 | 7.28 |
| | 292 | 5.0 | 25.58 | 7.15 | | 59 | " | 24.23 | 8.29 |
| | 291 | " | 29.10 | 7.36 | | 60 | " | 11.42 | 5.75 |
| BLUFF | 290 | " | 28.74 | 7.23 | | 61 | 1.5 | 3.56 | 5.30 |
| #3 | 289 | " | 20.68 | 6.52 | | 62 | 5.0 | 8.60 | 5.87 |
| | 288 | " | 23.98 | 7.03 | | 164 | " | 14.75 | |
| | 287 | " | 22.56 | 7.08 | | 163 | " | 12.91 | |
| | 286 | 2.5 | 30.54 | 7.82 | | 162 | " | 13.00 | 5.58 |
| | 285 | 4.0 | 50.66 | 10.60 | ADIT | 161 | " | 17.03 | |
| | 274 | 1.8 | 26.18 | | EXT. | 160 | " | 20.90 | 6.94 |
| | 273 | 3.2 | 23.70 | | | 159 | 3.0 | 9.16 | |
| BLUFF | 272 | 5.0 | 18.64 | | | 158 | 4.5 | 24.02 | 7.61 |
| #2 | 271 | " | 15.48 | | | 157 | 1.0 | 26.90 | |
| | 270 | " | 40.80 | 8.29 | | 156 | 5.0 | 24.06 | 7.42 |

Figure 6a. - Assay data, deposit No. 10.

| Trench No. | Sample No. | Length Feet | $Cr_2O_3$ | Fe |
|---|---|---|---|---|
| 10-D | 70 | 4.0 | 12.36 | 5.65 |
| | 69 | 1.5 | 13.42 | 5.42 |
| | 68 | 4.5 | 15.38 | 6.74 |
| | 67 | " | 6.66 | 3.96 |
| | 66 | 3.0 | 12.68 | 5.49 |
| | 65 | 4.0 | 16.28 | 5.74 |
| | 64 | 5.0 | 13.94 | 5.65 |
| | 63 | 4.7 | 12.08 | 6.03 |
| | 32 | 5.0 | 25.58 | 7.56 |
| | 31 | " | 36.78 | 8.81 |
| | 30 | " | 33.24 | 7.58 |
| | 29 | " | 27.87 | 7.78 |
| | 28 | 5.3 | 30.14 | 8.10 |
| | 24 | 5.0 | 35.18 | 8.58 |
| | 54 | 3.0 | 12.82 | 5.71 |
| | 23 | 5.0 | 23.88 | 6.92 |
| | 22 | " | 23.88 | 7.12 |
| | 21 | " | 21.32 | 6.97 |
| | 20 | " | 8.58 | 5.30 |
| 10-E | 73 | " | 20.90 | 5.59 |
| | 72 | " | 29.74 | 6.85 |
| | 71 | " | 16.96 | 5.74 |
| | 47 | " | 21.34 | 6.74 |
| | 46 | " | 14.36 | 6.12 |
| | 45 | " | 22.40 | 6.92 |
| | 44 | " | 9.94 | 6.09 |
| | 43 | " | 28.20 | 7.18 |
| | 42 | " | 19.96 | 6.83 |
| | 41 | " | 21.70 | 6.68 |
| 10-F | 236 | " | 39.28 | 12.65 |
| | 235 | " | 27.22 | 10.12 |
| | 234 | " | 24.37 | 11.49 |
| | 233 | " | 24.98 | 11.13 |
| | 232 | " | 28.87 | 10.33 |
| | 231 | " | 6.24 | 8.30 |
| | 230 | " | 19.88 | 7.77 |
| | 229 | 2.0 | 37.96 | 8.60 |
| 10-H | 49 | 5.0 | 15.22 | 6.26 |
| | 48 | " | 20.17 | 7.00 |

Figure 6b. - Assay data, deposit No. 10.



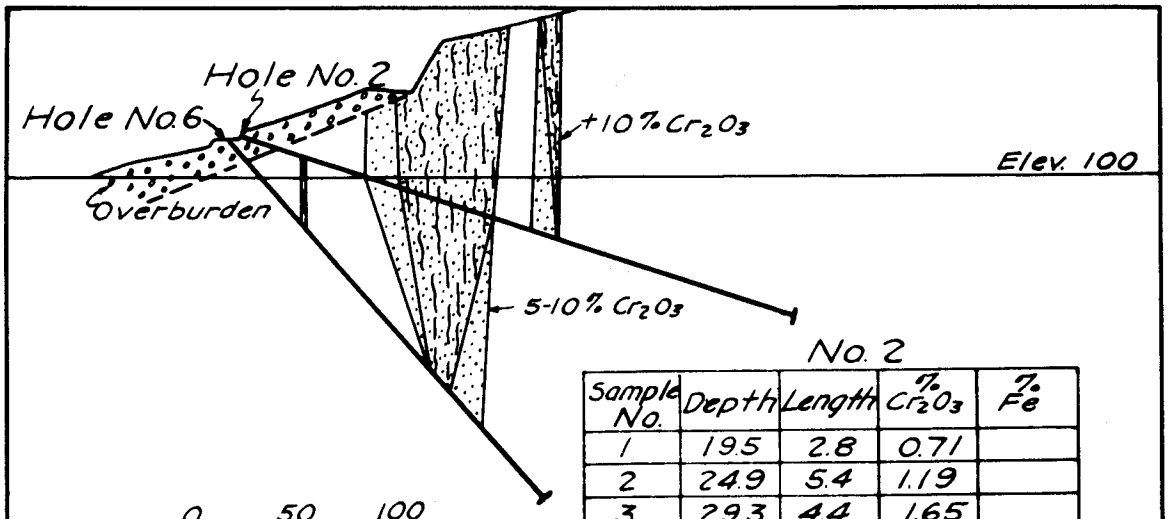

No. 1

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 21.5 | 9.5 | 1.10 | |
| 2 | 24.5 | 3.0 | 1.41 | |
| 3 | 25.5 | 1.0 | 7.12 | 5.46 |
| 4 | 28.5 | 3.0 | 1.41 | |
| 5 | 36.2 | 7.7 | 2.39 | 5.62 |
| 6 | 38.5 | 2.3 | 12.41 | |
| 7 | 44.8 | 6.3 | 1.45 | |
| 8 | 51.0 | 6.2 | 1.10 | |
| 9 | 55.8 | 4.8 | 6.51 | |
| 10 | 60.8 | 5.0 | 8.76 | |
| 11 | 62.8 | 2.0 | 8.09 | |
| 12 | 66.8 | 4.0 | 1.55 | |
| 13 | 70.8 | 4.0 | 14.48 | |
| 14 | 75.8 | 5.0 | 11.42 | |
| 15 | 80.8 | 5.0 | 12.68 | |
| 16 | 85.3 | 4.5 | 12.66 | 5.77 |
| 17 | 90.4 | 5.1 | 16.49 | |
| 18 | 94.9 | 4.5 | 14.35 | |
| 19 | 97.8 | 2.9 | 11.46 | |
| 20 | 102.9 | 5.1 | 2.97 | |
| 21 | 107.9 | 5.0 | 1.54 | 7.85 |
| 22 | 117.4 | 9.5 | 1.76 | |
| 23 | 125.0 | 7.6 | 1.50 | |
| 24 | 127.0 | 2.0 | 35.90 | |
| 25 | 129.7 | 2.7 | 5.77 | |
| 26 | 143.6 | 13.9 | 1.70 | |
| 27 | 153.3 | 9.7 | 1.08 | |
| 28 | 163.3 | 10.0 | 0.77 | |
| 29 | 172.0 | 8.7 | 0.89 | |
| 30 | 182.5 | 10.5 | 1.08 | |
| 31 | 189.8 | 7.3 | 0.86 | |
| 32 | 202.0 | 12.2 | 0.70 | 6.48 |

No. 5

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 19.0 | 11.3 | 0.80 | |
| 2 | 29.0 | 10.0 | 1.01 | |
| 3 | 37.0 | 8.0 | 0.66 | |
| 4 | 46.7 | 9.7 | 1.66 | |
| 5 | 57.0 | 10.3 | 0.33 | |
| 6 | 64.7 | 7.7 | 0.77 | |
| 7 | 74.0 | 9.3 | 1.08 | |
| 8 | 85.0 | 11.0 | 0.85 | |
| 9 | 94.9 | 9.9 | 0.75 | |
| 10 | 104.0 | 9.1 | 0.78 | 7.36 |
| 11 | 112.0 | 10.0 | 0.74 | |
| 12 | 114.0 | 2.0 | 6.34 | |
| 13 | 125.0 | 11.0 | 4.84 | |
| 14 | 135.8 | 10.8 | 1.85 | |
| 15 | 147.4 | 11.6 | 2.80 | |
| 16 | 157.4 | 10.0 | 1.07 | |
| 17 | 167.4 | 10.0 | 0.68 | |
| 18 | 176.0 | 8.6 | 3.68 | |
| 19 | 181.1 | 5.1 | 9.85 | |
| 20 | 189.8 | 8.7 | 7.61 | |
| 21 | 200.4 | 10.6. | | |
| 22 | 211.5 | 11.1 | 1.08 | 7.50 |

Figure 7. - Section B-B, deposit No. 10.



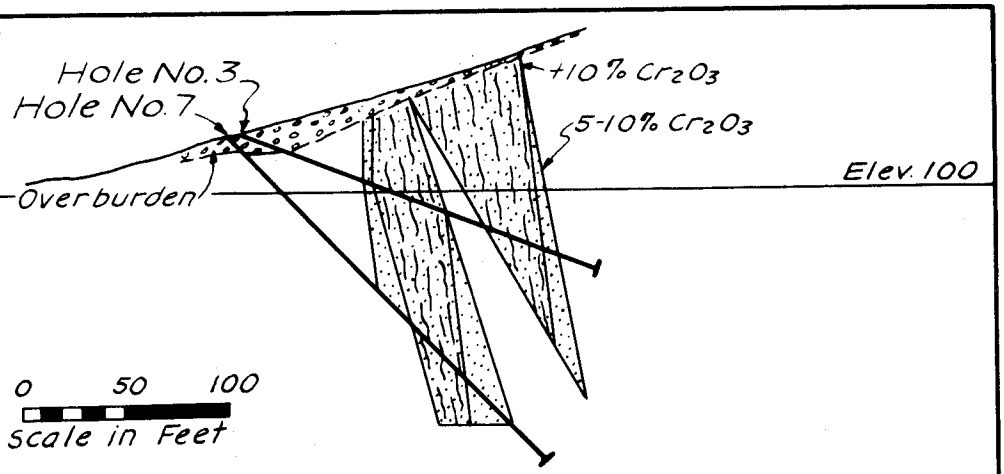

No. 6

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 26.0 | 9.8 | 1.01 | |
| 2 | 35.0 | 9.0 | 1.05 | |
| 3 | 45.0 | 10.0 | 1.02 | |
| 4 | 52.6 | 7.6 | 5.24 | |
| 5 | 57.2 | 4.8 | 11.42 | |
| 6 | 62.7 | 5.3 | 2.04 | |
| 7 | 71.9 | 9.2 | 1.18 | |
| 8 | 77.2 | 5.3 | 3.68 | |
| 9 | 87.4 | 10.2 | 3.64 | |
| 10 | 97.4 | 10.3 | 2.10 | |
| 11 | 108.4 | 10.7 | 1.08 | |
| 12 | 120.0 | 11.6 | 1.02 | |
| 13 | 130.0 | 10.0 | 2.70 | 5.94 |
| 14 | 141.1 | 11.1 | 0.92 | |
| 15 | 147.5 | 6.4 | 1.73 | |
| 16 | 153.4 | 5.9 | 19.30 | |
| 17 | 158.3 | 4.9 | 24.68 | |
| 18 | 164.2 | 5.9 | 10.11 | |
| 19 | 170.0 | 5.8 | 3.32 | |
| 20 | 176.5 | 6.5 | 6.40 | |
| 21 | 181.2 | 4.7 | 6.90 | |
| 22 | 184.4 | 3.2 | 4.55 | |
| 23 | 193.0 | 8.6 | 1.34 | |
| 24 | 203.1 | 10.1 | 1.17 | |
| 25 | 215.1 | 12.0 | 1.56 | |
| 26 | 223.1 | 8.0 | 0.78 | |
| 27 | 233.2 | 10.1 | 1.11 | |

No. 2

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 19.5 | 2.8 | 0.71 | |
| 2 | 24.9 | 5.4 | 1.19 | |
| 3 | 29.3 | 4.4 | 1.65 | |
| 4 | 33.2 | 3.9 | 11.67 | 5.73 |
| 5 | 40.0 | 6.8 | 1.47 | |
| 6 | 50.3 | 10.3 | 0.95 | |
| 7 | 56.8 | 6.5 | 3.22 | |
| 8 | 59.3 | 2.5 | 7.26 | |
| 9 | 63.5 | 4.2 | 2.23 | |
| 10 | 69.8 | 6.3 | 7.50 | |
| 11 | 71.2 | 1.4 | 8.50 | |
| 12 | 80.3 | 9.1 | 3.61 | 5.18 |
| 13 | 90.3 | 10.0 | 10.00 | |
| 14 | 100.3 | 10.0 | 20.00 | 7.00 |
| 15 | 110.0 | 9.7 | 24.64 | |
| 16 | 115.0 | 5.0 | 17.00 | |
| 17 | 120.0 | " | 25.35 | |
| 18 | 125.0 | " | 16.15 | |
| 19 | 132.9 | 7.9 | 1.58 | |
| 20 | 143.1 | 11.2 | 1.01 | |
| 21 | 148.5 | 5.4 | 9.71 | |
| 22 | 156.9 | 8.4 | 6.02 | |
| 23 | 167.3 | 10.4 | 1.10 | |
| 24 | 175.2 | 7.9 | 1.24 | 7.33 |
| 25 | 181.3 | 6.1 | 1.23 | |
| 26 | 186.6 | 5.3 | 12.45 | |
| 27 | 197.4 | 10.8 | 0.72 | 5.75 |
| 28 | 207.4 | 10.0 | 0.05 | |
| 29 | 217.8 | 10.4 | 0.84 | |
| 30 | 228.8 | 11.0 | 0.92 | |
| 31 | 239.0 | 10.2 | 0.88 | |
| 32 | 244.3 | 5.3 | 1.10 | |
| 33 | 255.1 | 10.8 | 0.89 | |
| 34 | 265.5 | 10.4 | 1.20 | 7.95 |
| 35 | 276.0 | 10.5 | 0.65 | 5.79 |
| 36 | 286.4 | 10.4 | 0.98 | |

Figure 8. - Section A-A, deposit No. 10.



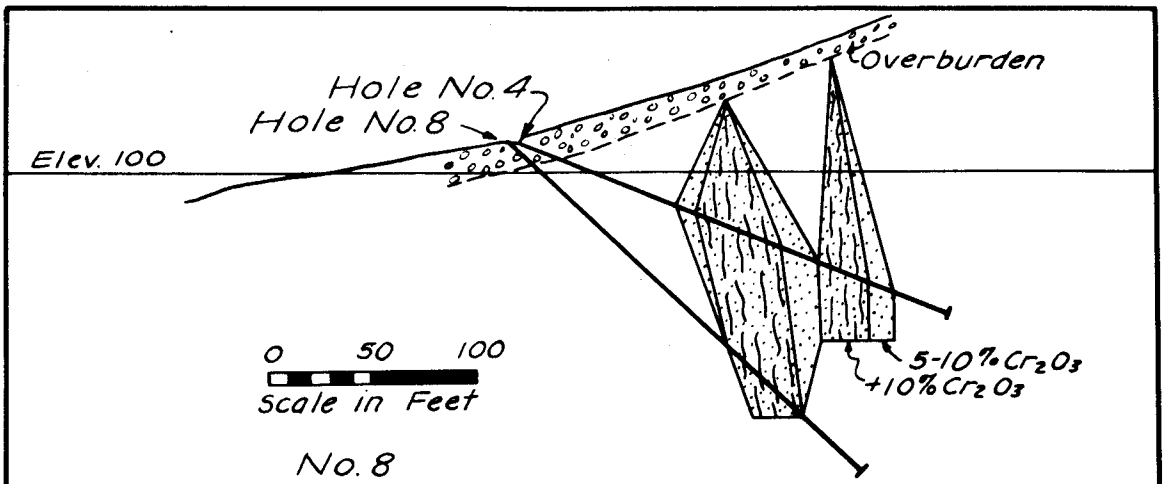

No. 7

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 21.0 | 10.0 | 2.54 | |
| 2 | 31.4 | 10.4 | 3.01 | |
| 3 | 39.5 | 8.1 | 2.83 | |
| 4 | 45.0 | 6.7 | 1.47 | |
| 5 | 46.2 | 1.2 | 9.64 | 5.48 |
| 6 | 50.8 | 4.6 | 9.30 | |
| 7 | 62.3 | 11.5 | 2.43 | |
| 8 | 72.0 | 9.7 | 0.84 | |
| 9 | 77.5 | 5.5 | 4.32 | |
| 10 | 89.0 | 11.5 | 1.49 | |
| 11 | 99.6 | 10.6 | 4.65 | |
| 12 | 104.8 | 5.2 | 10.83 | |
| 13 | 112.9 | 8.1 | 2.85 | |
| 14 | 123.0 | 10.1 | 4.71 | |
| 15 | 128.0 | 5.0 | 12.32 | 6.97 |
| 16 | 133.0 | " | 12.16 | |
| 17 | 138.0 | " | 13.62 | |
| 18 | 143.0 | " | 19.03 | |
| 19 | 148.0 | " | 22.93 | |
| 20 | 153.0 | " | 13.65 | |
| 21 | 158.0 | " | 20.73 | |
| 22 | 163.0 | " | 21.17 | |
| 23 | 170.3 | 7.3 | 5.88 | |
| 24 | 175.5 | 5.2 | 6.82 | |
| 25 | 180.5 | 5.0 | 8.40 | 6.08 |
| 26 | 189.5 | 9.0 | 6.39 | |
| 27 | 191.8 | 2.3 | 28.44 | 9.90 |
| 28 | 195.8 | 4.0 | 5.00 | |
| 29 | 205.8 | 10.0 | 1.85 | |
| 30 | 215.8 | 10.0 | 1.17 | |
| 31 | 221.0 | 5.2 | 0.92 | |

No. 3

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 32.8 | 10.0 | 1.31 | |
| 2 | 38.2 | 5.4 | 8.50 | 5.40 |
| 3 | 43.7 | 5.5 | | |
| 4 | 53.7 | 10.0 | 2.16 | 6.52 |
| 5 | 62.3 | 8.6 | 1.67 | |
| 6 | 67.4 | 5.1 | 9.45 | |
| 7 | 72.0 | 4.6 | 12.04 | |
| 8 | 76.8 | 4.8 | 17.54 | |
| 9 | 82.0 | 5.2 | 18.00 | |
| 10 | 86.5 | 4.5 | 14.77 | 5.76 |
| 11 | 91.5 | 5.0 | 9.63 | |
| 12 | 94.8 | 3.3 | 24.52 | |
| 13 | 99.8 | 5.0 | 15.14 | |
| 14 | 105.0 | 5.2 | 11.60 | 7.09 |
| 15 | 116.4 | 11.4 | 4.70 | |
| 16 | 126.7 | 10.3 | 2.94 | |
| 17 | 131.8 | 5.1 | 14.97 | |
| 18 | 136.8 | 5.0 | 15.93 | |
| 19 | 141.8 | " | 32.27 | |
| 20 | 146.8 | " | 34.25 | |
| 21 | 152.7 | 5.9 | 20.75 | |
| 22 | 157.7 | 5.0 | 13.28 | |
| 23 | 164.0 | 6.3 | 5.76 | 5.41 |
| 24 | 171.8 | 7.8 | 5.84 | 8.00 |
| 25 | 182.2 | 10.4 | 2.92 | |
| 26 | 187.4 | 5.2 | 1.58 | |

Figure 9. - Section C-C, deposit No. 10.



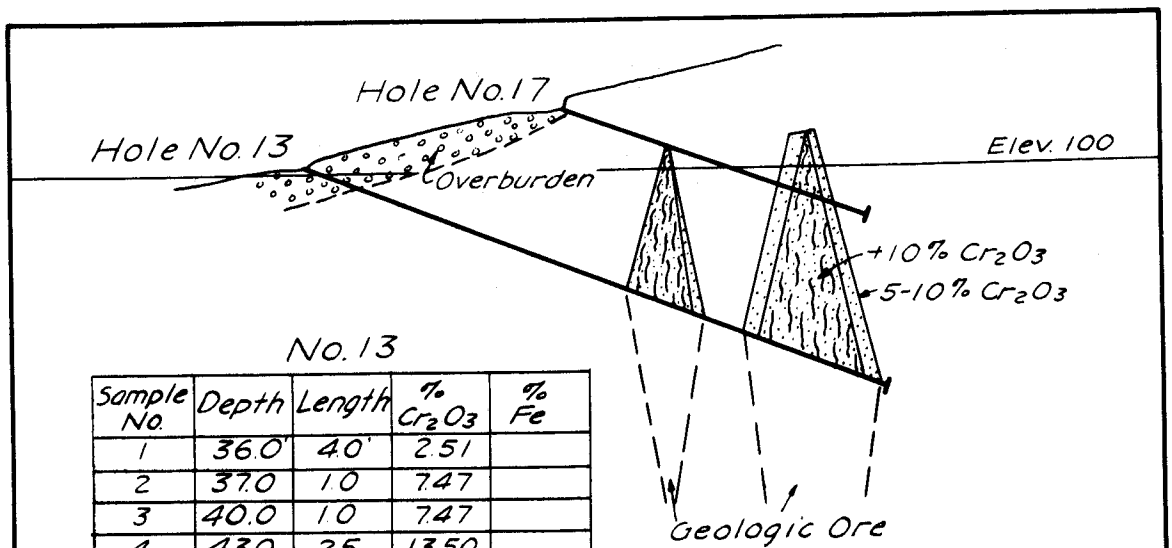

No. 8

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 28.0 | 12.7 | 0.86 | |
| 2 | 38.0 | 10.0 | 0.79 | |
| 3 | 47.7 | 9.7 | 0.65 | |
| 4 | 58.5 | 10.8 | 0.80 | |
| 5 | 68.5 | 10.0 | 0.85 | |
| 6 | 78.5 | 10.0 | 1.20 | |
| 7 | 80.2 | 1.7 | | |
| 8 | 90.3 | 10.1 | 1.00 | 8.12 |
| 9 | 100.3 | 10.0 | 1.82 | |
| 10 | 110.6 | 10.3 | 1.10 | |
| 11 | 120.6 | 10.0 | 1.63 | |
| 12 | 130.6 | 10.0 | 1.32 | |
| 13 | 140.6 | 10.0 | 1.50 | |
| 14 | 147.3 | 6.7 | 1.01 | |
| 15 | 155.3 | 8.0 | 12.13 | 7.62 |
| 16 | 157.5 | 2.2 | 8.28 | 8.55 |
| 17 | 162.0 | 4.5 | 8.75 | 6.91 |
| 18 | 164.4 | 2.4 | 18.68 | 7.36 |
| 19 | 167.8 | 2.7 | 10.92 | 8.39 |
| 20 | 173.0 | 5.2 | 16.35 | 10.22 |
| 21 | 176.4 | 3.4 | 10.58 | 8.31 |
| 22 | 181.4 | 5.0 | 11.96 | 7.29 |
| 23 | 184.8 | 3.4 | 7.78 | 6.76 |
| 24 | 189.4 | 4.6 | 16.74 | 7.70 |
| 25 | 194.4 | 5.0 | 16.13 | 7.81 |
| 26 | 197.0 | 2.6 | 27.40 | 8.98 |
| 27 | 199.4 | 5.0 | | 7.53 |
| 28 | 208.5 | 9.1 | 0.65 | |
| 29 | 213.5 | 5.0 | 1.50 | |
| 30 | 218.5 | 5.0 | 1.82 | |
| 31 | 228.0 | 9.5 | 1.13 | |

No. 4

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 32.6 | 10.8 | 0.76 | |
| 2 | 45.6 | 13.0 | 0.91 | |
| 3 | 58.0 | 12.4 | 0.86 | |
| 4 | 59.0 | 1.0 | 2.26 | |
| 5 | 61.5 | 2.5 | 9.79 | 6.35 |
| 6 | 69.3 | 7.8 | 2.26 | |
| 7 | 79.3 | 10.0 | 1.30 | |
| 8 | 89.3 | 10.0 | 5.66 | |
| 9 | 95.0 | 5.7 | 12.74 | 7.75 |
| 10 | 101.8 | 6.8 | 10.96 | 6.50 |
| 11 | 107.7 | 5.9 | 11.63 | 6.76 |
| 12 | 112.8 | 5.1 | 12.63 | 6.49 |
| 13 | 117.8 | 5.0 | 22.40 | 7.16 |
| 14 | 122.8 | 5.0 | 24.48 | 7.40 |
| 15 | 126.0 | 3.2 | 23.89 | 8.60 |
| 16 | 134.2 | 8.2 | 17.54 | |
| 17 | 145.1 | 10.9 | 8.82 | |
| 18 | 154.5 | 9.4 | 4.48 | |
| 19 | 163.8 | 8.9 | 12.48 | 11.41 |
| 20 | 168.4 | 5.0 | 17.53 | 6.98 |
| 21 | 173.4 | 5.0 | 22.61 | 8.40 |
| 22 | 178.4 | 5.0 | 22.62 | 8.07 |
| 23 | 180.8 | 2.4 | 21.15 | 9.40 |
| 24 | 183.6 | 2.8 | 3.76 | 7.60 |
| 25 | 194.0 | 10.4 | 7.43 | 7.63 |
| 26 | 203.0 | 9.0 | 2.11 | |
| 27 | 208.0 | 5.0 | 1.83 | |
| 28 | 218.0 | 10.0 | 1.94 | |

Figure 10. - Section D-D, deposit No. 10.




No. 13

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 36.0' | 4.0' | 2.51 | |
| 2 | 37.0 | 1.0 | 7.47 | |
| 3 | 40.0 | 1.0 | 7.47 | |
| 4 | 43.0 | 2.5 | 13.50 | |
| 5 | 49.9 | 6.9 | 4.06 | |
| 6 | 57.4 | 8.5 | 1.34 | |
| 7 | 67.3 | 9.9 | 1.83 | |
| 8 | 77.6 | 8.3 | 1.36 | |
| 9 | 87.9 | 10.3 | 5.29 | |
| 10 | 136.0 | 48.1 | 1.26 | |
| 11 | 138.0 | 2.0 | 13.70 | |
| 12 | 148.0 | 10.0 | 2.12 | |
| 13 | 153.3 | 5.3 | 2.22 | |
| 14 | 161.8 | 8.8 | 1.76 | |
| 15 | 165.6 | 3.8 | 2.20 | |
| 16 | 168.0 | 2.4 | 14.40 | |
| 17 | 170.6 | 2.6 | 1.440 | |
| 18 | 180.6 | 10.0 | 7.08 | |
| 19 | 185.6 | 5.0 | 16.28 | 6.96 |
| 20 | 190.6 | 5.0 | 16.05 | 6.62 |
| 21 | 195.4 | 4.8 | 14.93 | 6.88 |
| 22 | 200.5 | 5.1 | 19.86 | 7.48 |
| 23 | 204.9 | 4.4 | 7.87 | |
| 24 | 214.9 | 10.0 | 1.99 | |
| 25 | 221.9 | 7.0 | 0.80 | |
| 26 | 233.3 | 11.4 | 6.47 | |
| 27 | 243.0 | 9.7 | 15.30 | 7.43 |
| 28 | 248.5 | 5.5 | 14.98 | |
| 29 | 255.9 | 7.9 | 18.90 | |
| 30 | 259.0 | 3.1 | 18.16 | |
| 31 | 264.0 | 5.0 | 24.80 | 7.62 |
| 32 | 274.0 | 10.0 | 7.30 | 6.00 |
| 33 | 279.0 | 5.0 | 22.05 | 7.22 |
| 34 | 289.3 | 10.3 | 13.31 | |
| 35 | 299.3 | 10.0 | 7.62 | |
| 36 | 309.3 | 10.0 | 1.90 | |

No. 17

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 24.5' | 10.0' | 0.70 | |
| 2 | 34.5 | 10. | 0.87 | |
| 3 | 44.7 | 10.2 | 0.84 | |
| 4 | 52.3 | 10.0 | 2.08 | |
| 5 | 54.7 | 2.4 | 14.16 | 6.96 |
| 6 | 64.8 | 10.1 | 2.09 | |
| 7 | 74.8 | 10.0 | 1.58 | |
| 8 | 84.8 | 10.0 | 1.35 | |
| 9 | 95.0 | 10.2 | 1.21 | |
| 10 | 105.0 | 10.0 | 1.29 | |
| 11 | 111.0 | 6.0 | 2.08 | |
| 12 | 113.5 | 2.5 | 10.86 | 6.65 |
| 13 | 117.6 | 4.1 | 2.36 | 6.27 |
| 14 | 118.5 | 0.9 | 8.12 | 5.86 |
| 15 | 123.5 | 5.0 | 11.13 | 6.50 |
| 16 | 124.3 | 0.8 | 9.21 | 6.16 |
| 17 | 126.7 | 2.4 | 24.61 | 7.77 |
| 18 | 128.5 | 1.8 | 15.83 | 6.60 |
| 19 | 133.5 | 5.0 | 19.78 | 7.27 |
| 20 | 139.0 | 5.5 | 6.86 | 6.46 |
| 21 | 149.2 | 10.2 | 4.43 | |
| 22 | 158.1 | 8.9 | 4.24 | |

No Sample taken 37.0'-39.0' & 40.0'-40.5'

Figure 11. - Section E-E, deposit No. 10.

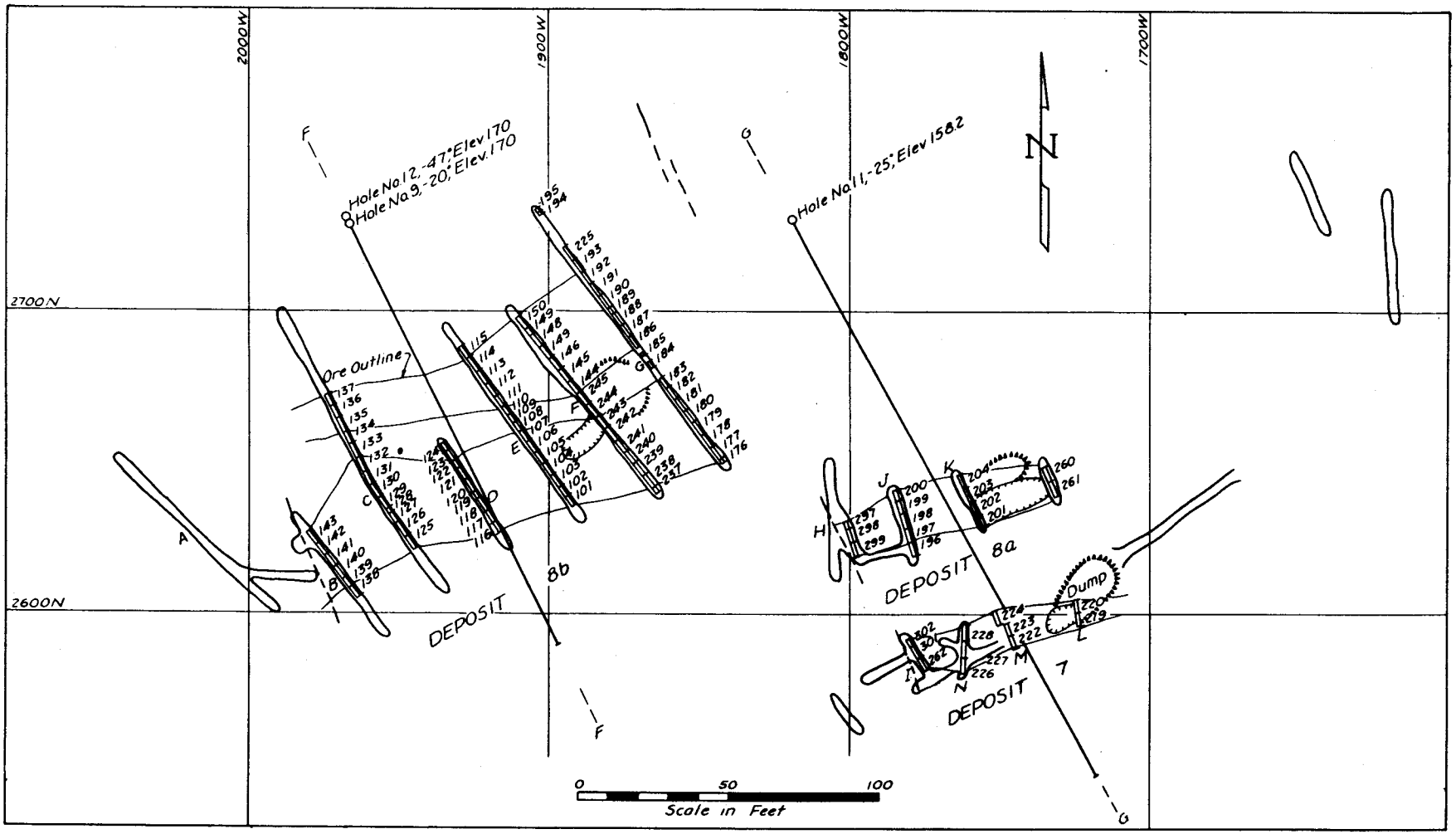


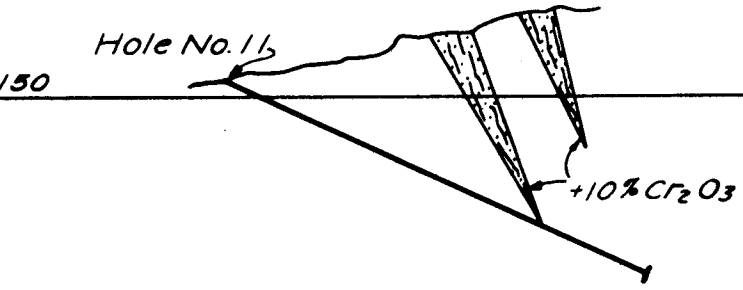

Figure 12. - Assay plan, deposits Nos. 7, 8a, and 8b.

| Trench No. | Sample No. | Length Ft. | $Cr_2O_3$ | Fe |
|---|---|---|---|---|
| H | 297 | 2.8 | 17.42 | |
| | 298 | 5.0 | 20.42 | |
| | 299 | " | 17.34 | |
| J | 200 | 3.0 | 6.49 | 5.68 |
| | 199 | 5.0 | 19.19 | 6.75 |
| | 198 | " | 10.32 | |
| | 197 | " | 5.11 | |
| | 196 | " | 13.33 | |
| I | 302 | 2.7 | 30.05 | |
| | 301 | 5.0 | 35.04 | |
| | 262 | " | 17.36 | |
| N | 228 | " | 34.68 | 7.95 |
| | 227 | " | 26.85 | |
| | 226 | " | 24.04 | 7.21 |
| M | 224 | " | 23.20 | 7.00 |
| | 223 | " | 36.72 | 8.09 |
| | 222 | " | 16.18 | 6.49 |
| L | 220 | " | 28.28 | 7.32 |
| | 219 | " | 21.92 | 6.81 |
| K | 204 | 5.5 | 8.41 | |
| | 203 | 5.0 | 20.05 | |
| | 202 | " | 21.07 | |
| | 201 | " | 19.71 | |
| | 260 | " | 15.43 | |
| | 261 | " | 18.92 | |

Figure 12a. - Assay data, deposits Nos. 7 and 8a.

| Trench No. | Sample No. | Length Ft. | $Cr_2O_3$ | Fe | Trench No. | Sample No. | Length Ft. | $Cr_2O_3$ | Fe |
|---|---|---|---|---|---|---|---|---|---|
| B | 143 | 5.0 | 34.36 | 7.42 | E | 102 | 4.0 | 28.94 | 7.85 |
| | 142 | " | 30.83 | 7.43 | | 101 | " | 32.44 | 8.12 |
| | 141 | " | 11.04 | 6.26 | F | 150 | 5.0 | 1.35 | 4.88 |
| | 140 | " | 29.59 | 7.07 | | 149 | 2.5 | 3.00 | 5.89 |
| | 139 | 3.5 | 10.18 | 5.99 | | 148 | " | 17.42 | 7.08 |
| | 138 | 5.0 | 1.47 | | | 147 | " | 17.29 | 5.68 |
| C | 137 | 4.0 | 8.99 | 6.44 | | 146 | " | 13.54 | 6.51 |
| | 136 | 5.0 | 19.94 | 6.97 | | 145 | " | 25.47 | 6.62 |
| | 135 | " | 13.48 | 7.15 | | 144 | " | 14.45 | 6.48 |
| | 134 | " | 5.39 | 7.16 | | 245 | " | 13.59 | |
| | 133 | " | 7.02 | 7.09 | | 244 | " | 3.57 | |
| | 132 | " | 14.88 | 7.42 | | 243 | " | 12.16 | |
| | 131 | " | 17.98 | 7.74 | | 242 | " | 19.02 | |
| | 130 | " | 12.65 | 5.36 | | 241 | " | 20.36 | |
| | 129 | " | 23.44 | 8.19 | | 240 | " | 29.20 | |
| | 128 | 1.0 | 28.78 | 8.17 | | 239 | " | 32.28 | |
| | 127 | 5.0 | 8.85 | 6.71 | | 238 | " | 12.28 | |
| | 126 | " | 29.92 | 7.93 | | 237 | 2.5 | 7.80 | 8.05 |
| | 125 | " | 15.80 | 7.11 | G | 195 | 2.2 | 10.12 | 6.34 |
| D | 124 | 3.0 | 1.72 | | | 194 | 0.8 | 3.98 | 5.83 |
| | 123 | 5.0 | 4.84 | 6.42 | | 225 | 5.0 | 2.93 | 5.69 |
| | 122 | 3.0 | 12.56 | 6.61 | | 193 | " | 4.73 | 5.65 |
| | 121 | 4.5 | 14.41 | 7.10 | | 192 | " | 10.40 | 5.59 |
| | 120 | 5.0 | 22.41 | 6.38 | | 191 | " | 12.91 | 8.71 |
| | 119 | 2.5 | 46.93 | 9.58 | | 190 | " | 14.58 | 6.01 |
| | 118 | 4.5 | 30.55 | 7.15 | | 189 | 2.4 | 17.33 | 7.23 |
| | 117 | 5.0 | 37.65 | 7.56 | | 188 | 4.0 | 11.58 | |
| | 116 | 4.0 | 18.97 | 6.12 | | 187 | 5.0 | 12.94 | |
| E | 115 | 5.0 | 2.43 | 5.02 | | 186 | " | 11.18 | |
| | 114 | 6.0 | 18.67 | 5.97 | | 185 | 1.5 | 11.22 | 7.29 |
| | 113 | 5.0 | 13.29 | 5.56 | | 184 | 2.8 | 8.48 | |
| | 112 | " | 13.76 | 5.59 | | 183 | 5.0 | 10.47 | |
| | 111 | " | 16.33 | 6.39 | | 182 | " | 9.68 | |
| | 110 | 3.5 | 1.36 | 4.83 | | 181 | " | 14.73 | 6.06 |
| | 109 | 3.0 | 8.72 | 5.87 | | 180 | " | 21.87 | |
| | 108 | 4.0 | 2.21 | | | 179 | " | 30.30 | 7.37 |
| | 107 | 5.0 | 24.30 | 5.85 | | 178 | " | 35.71 | 10.28 |
| | 106 | " | 23.29 | 6.00 | | 177 | " | 18.86 | |
| | 105 | " | 18.96 | 6.12 | | 176 | 1.5 | 13.22 | 7.14 |
| | 104 | 4.0 | 20.28 | 7.06 | | | | | |
| | 103 | " | 15.06 | 6.65 | | | | | |

Figure 12b. - Assay data, deposits Nos. 7 and 8a.

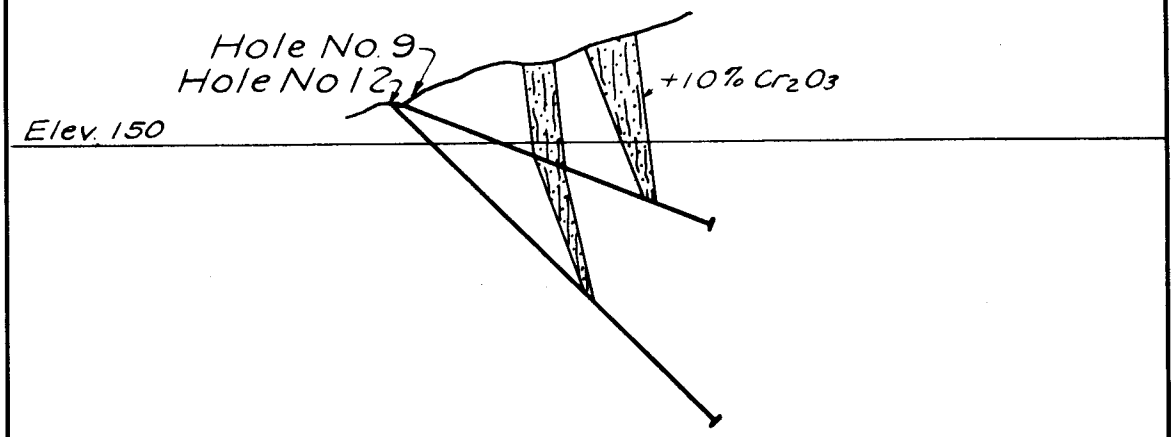



0 50 100
Scale in Feet

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 9.0' | 5.0' | 1.94 | |
| 2 | 18.7 | 9.7 | 1.09 | |
| 3 | 24.0 | 5.3' | 0.84 | |
| 4 | 44.0 | 10.0 | 0.74 | |
| 5 | 53.6 | 0.6 | 13.00 | 7.50 |
| 6 | 64.5 | 10.2 | 1.97 | |
| 7 | 75.0 | 10.5 | 1.80 | |
| 8 | 85.5 | 10.5 | 2.05 | |
| 9 | 95.5 | 10.0 | 1.64 | |
| 10 | 106.0 | 10.5 | 0.71 | |
| 11 | 116.0 | 10.0 | 0.92 | |
| 12 | 126.0 | 10.0 | 0.78 | |
| 13 | 132.2 | 0.3 | 11.14 | 9.60 |
| 14 | 145.9 | 10.4 | 0.73 | |
| 15 | 155.8 | 9.9 | 0.99 | |
| 16 | 165.8 | 10.0 | 0.78 | |
| 17 | 170.5 | 4.2 | 10.37 | 6.49 |
| 18 | 174.1 | 1.8 | 12.81 | 6.60 |
| 19 | 181.0 | 5.0 | 1.14 | |
| 20 | 191.0 | 10.0 | 1.04 | |
| 21 | 200.0 | 9.1 | 1.27 | |
| 22 | 209.2 | 9.2 | 1.22 | |
| 23 | 218.9 | 9.7 | 1.14 | |
| 24 | 224.0 | 5.1 | 1.32 | |

No samples taken, 24.0-34.0; 44.0-53.0; 53.6-54.3; 126.0-131.0, 132.2-135.5; 165.8-166.3; 170.5-172.3; 174.1-176.0.

Figure 13. - Section G-G, deposits Nos. 7 and 8a.




No 12

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 7.2 | 7.2 | 3.38 | |
| 2 | 16.0 | 8.8 | 1.02 | |
| 3 | 26.1 | 10.1 | 1.24 | |
| 4 | 34.5 | 1.5 | 11.32 | |
| 5 | 36.0 | 1.5 | 6.67 | 6.97 |
| 6 | 43.5 | 1.2 | 9.88 | 6.34 |
| 7 | 51.1 | 6.9 | 1.37 | |
| 8 | 60.7 | 9.6 | 1.74 | |
| 9 | 68.3 | 7.9 | 1.39 | |
| 10 | 71.3 | 3.0 | 16.47 | 7.48 |
| 11 | 82.5 | 3.3 | 9.05 | 6.43 |
| 12 | 92.7 | 5.2 | 4.54 | 5.95 |
| 13 | 108.2 | 11.7 | 0.84 | |
| 14 | 118.2 | 10.0 | 1.47 | |
| 15 | 128.2 | 10.0 | 0.59 | |
| 16 | 133.2 | 5.0 | 16.75 | 6.81 |
| 17 | 138.2 | 5.0 | 8.53 | 6.20 |
| 18 | 148.2 | 10.0 | 2.15 | |
| 19 | 158.2 | " | 1.11 | |
| 20 | 168.2 | " | 0.90 | |
| 21 | 178.2 | " | 1.08 | |
| 22 | 188.2 | " | 0.96 | |
| 23 | 198.2 | " | 1.06 | |
| 24 | 210.2 | 12.0 | 1.00 | |
| 25 | 220.5 | 10.0 | 1.15 | |

0 50 100
Scale in Feet

No. 9

| Sample No. | Depth | Length | % $Cr_2O_3$ | % Fe |
|---|---|---|---|---|
| 1 | 15.2 | 2.1 | 3.74 | |
| 2 | 17.1 | 1.9 | 8.97 | |
| 3 | 37.9 | 2.6 | 4.99 | |
| 4 | 50.3 | 10.0 | 1.28 | |
| 5 | 60.2 | 9.9 | 3.16 | |
| 6 | 70.2 | 3.2 | 11.90 | |
| 7 | 75.2 | 5.0 | 14.21 | |
| 8 | 80.2 | 5.0 | 17.73 | |
| 9 | 81.9 | 1.7 | 17.27 | 7.29 |
| 10 | 85.2 | 3.3 | 6.22 | |
| 11 | 90.2 | 5.0 | 8.72 | |
| 12 | 95.2 | 5.0 | 6.75 | |
| 13 | 105.3 | 10.1 | 3.72 | |
| 14 | 115.5 | 10.2 | 77 | |
| 15 | 123.6 | 3.1 | 19.49 | 7.38 |
| 16 | 128.4 | 4.8 | 18.75 | 8.09 |
| 17 | 133.4 | 5.0 | 4.89 | |
| 18 | 138.4 | 5.0 | 3.18 | |
| 19 | 147.4 | 9.0 | 1.88 | |
| 20 | 159.5 | 12.1 | 1.67 | |
| 21 | 164.5 | 5.0 | 2.19 | |

No. Samples taken

37.5-42.3
43.5-44.2
82.5-87.5
92.7-96.5
17.1-35.3
37.9-40.3
60.2-67.0
115.5-120.5

Figure 14. - Section F-F, deposit No. 8b.

## DEVELOPMENT

A forty-foot crosscut has been driven through deposit No. 10 at a 140-foot elevation. During the past year a 290-foot crosscut was driven from the site of the old mill to intersect deposit No. 10 at a 25-foot elevation. Some timber was required through a faulted section about 100 feet from the portal, but indications are that the rock will be comparatively easy to mine. The face of the crosscut lacked 30 feet of reaching the ore boundary, as indicated by drilling when operations ceased in July 1942.

## SAMPLING AND ASSAYING

Six-inch by one-inch samples were cut at varying intervals along the outcrops depending, on the apparent continuity of the ore body and the excavation work required to expose it, and the core-drill holes were planned to intersect the ore bodies at 80-foot intervals along the strike and 60- to 75-foot intervals in depth. Drill cuttings were collected and assays of cuttings averaged about 1 percent less than corresponding core samples, probably because of sliming and loss of chromite in overflow. Core and cuttings samples were split before being sent for analysis, being held at the project until the assays were received. Core and cutting assays were combined by the use of the E. J. Longyear tables9/ to arrive at the final grade of the ore. All assaying was done at the Reno station of the Bureau of Mines.

## BENEFICIATION OF CLAIM POINT CHROMITE

Results of beneficiation tests on a sample of chromite ore from deposit No. 10 indicate that the low-grade ore is amenable to concentration. An abstract of the report by the Metallurgical Division follows.

### Nature of the Ore

The ore was of medium grade, and the chromite was disseminated through an olivine and serpentine gangue. The bulk of the chromite was freed by grinding to 48-mesh. However, many gangue particles still had chromite inclusions, and the liberation and separation of this gangue mineral was the chief problem in treating the ore. The particles occur in veinlets and are dispersed through the fracture planes. The chemical analysis of the ore follows:

TABLE 1. - Chemical analysis of the Claim Point chromite ore

| Assay, percent | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $Cr_2O_3$ | Fe | $SiO_2$ | $Al_2O_3$ | MgO | S | CaO | $TiO_2$ | $ZrO_2$ | P |
| 28.2 | 7.7 | 19.2 | 3.2 | 31.4 | No | Tr. | 0.05 | 0.40 | Tr. |

9/ Jackson, C. F., and Knaebel, J. B., Sampling and Estimation of Ore Deposits: Bureau of Mines Bull. 356, 1932, 155 pp.

## Methods of Concentration

As the chromite in the ore was uniformly disseminated throughout the olivine and serpentine groundmass, tabling, magnetic separation, and flotation appeared to be the most favorable methods of concentration. Although many separate experiments involving variations in procedures and treatment were made, the following methods were found to be most effective and will be discussed in detail:

1. Tabling unsized sands from ore ground to all minus 65-mesh.

2. Tabling sized-sand fractions of ore ground to minus 48-mesh and all plus 200-mesh table tailings and middlings reground to minus 200-mesh before finally being discarded as a tailing.

3. Magnetic concentration of chromite from sized fractions of ore ground to all minus 48-mesh.

4. Magnetic concentration of chromite from sized fractions of ore ground to all minus 48-mesh, followed by tabling the chromite products to reject the gangue minerals.

5. Concentration of chromite by flotation methods.

Detailed discussion of only the most successful of the methods of concentration are discussed in detail in the following abstract.

### Tabling sized fractions of ore ground to minus 48-plus 200-mesh, table tailings and middlings reground to minus 200-mesh before making finished tailing.

A sample of ore crushed to minus 10-mesh was ground to minus 48-mesh, deslimed by decantation, and screen-sized into the following products: Minus 48 plus 65-mesh, minus 65 plus 100-mesh, minus 100 plus 150-mesh, minus 150 plus 200-mesh, and minus 200-mesh sands. These products were then tabled, and the table rejects were ground to minus 200-mesh and retabled. The results of this test are shown in table 2. Table 3 gives the results obtained on a similar test, wherein the table middlings were combined and ground to all minus 65-mesh before retabling.

Table 2. - Tabling sized fractions of ore, table middlings ground to minus 200-mesh

| Products | Weight, percent | Assay, percent | | | Distribution $Cr_2O_3$ percent | Cumulative recovery, percent | Cumulative grade, percent | | | Chromium to iron ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $Cr_2O_3$ | Fe | $SiO_2$ | | | $Cr_2O_3$ | Fe | $SiO_2$ | |
| Table concentrates | 43.3 | 52.8 | 12.6 | 3.7 | 81.8 | 81.8 | 52.8 | 12.6 | 3.7 | 2.9 |
| Table middlings (minus 200-mesh) | 5.3 | 25.1 | 7.0 | 23.6 | 4.8 | 86.6 | 49.7 | 12.0 | 5.9 | 2.85 |
| Slimes | 9.8 | 15.6 | 7.5 | 28.3 | 5.5 | 92.1 | 44.0 | 11.2 | 9.6 | 2.70 |
| Table tailings (minus 200-mesh) | 41.6 | 5.4 | 4.9 | 33.7 | 7.9 | 100.0 | 28.0 | 8.6 | 19.7 | |
| Heads calculated | 100.0 | 28.0 | 8.6 | 19.7 | 100.0 | - | - | - | - | 2.1 |

Table 3. - Tabling sized fractions of ore, table middlings reground to minus 65-mesh and retabled

| Products | Weight, percent | Assay, percent | | | Distribution $Cr_2O_3$ percent | Cumulative recovery percent | Cumulative grade, percent | | | Chromium to iron ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $Cr_2O_3$ | Fe | $SiO_2$ | | | $Cr_2O_3$ | Fe | $SiO_2$ | |
| Table concentrates | 44.1 | 51.20 | 12.3 | 4.9 | 80.4 | 80.4 | 51.2 | 12.3 | 4.9 | 2.85 |
| Table middling (minus 200-mesh) | 5.3 | 25.15 | 7.0 | 23.6 | 4.7 | 85.1 | 48.4 | 11.7 | 6.9 | 2.83 |
| Slime | 6.0 | 17.90 | 8.6 | 25.8 | 3.9 | 89.0 | 45.1 | 11.4 | 9.0 | 2.71 |
| Table middling (plus 200-mesh) | 5.5 | 14.14 | 6.2 | 31.6 | 2.8 | 91.8 | 42.3 | 10.9 | 11.0 | 2.66 |
| Table tailing | 39.1 | 5.9 | 4.7 | 35.4 | 8.2 | 100.0 | 28.1 | 8.5 | 20.5 | 2.26 |
| Total | 100.0 | 28.1 | 8.5 | 20.5 | 100.0 | - | - | - | - | - |

## Discussion

As is shown in table 2, by tabling sized fractions of the ore, plus regrinding of all plus 200-mesh table middlings and tailings to minus 200-mesh and retabling before finally rejecting a tailing, 81.8 percent of the $Cr_2O_3$ was recovered as high-grade concentrates assaying 52.8 percent $Cr_2O_3$, 12.6 percent iron, and 3.7 percent silica. As the combined table concentrates assay higher than the 45 percent $Cr_2O_3$ specified for high-grade chrome ores, the middling can be mixed with the concentrates and more chromium can be saved; the combined middlings and concentrates assayed 49.7 percent $Cr_2O_3$ and contained 86.6 percent of the $Cr_2O_3$ in the ore. Further, by combining the middlings and slime with the high-grade concentrates, 92.1 percent of the chromite was recovered in a concentrate assaying 44 percent $Cr_2O_3$, 11.2 percent iron, and 9.6 percent silica, or, as is shown in table 3, 89.0 percent of the $Cr_2O_3$ was recovered at a grade of 45.1 percent $Cr_2O_3$, wherein a slightly simpler grinding procedure was used; however, it was necessary to retable the reground middlings several times to obtain results comparable to the finer grind. These results clearly show that the ore responds readily to gravity concentration if the table feed is closely sized and the middling particles reground before rejecting a final tailing.

TABLE 4. - Grade of chromite at different recoveries

| Product | Assay, percent | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Cr_2O_3$ min. | Cr/Fe ratio min. | $SiO_2$ max. | P max. | S max. | $Al_2O_3$ | $TiO_2$ | MgO | CaO | Fe | $ZrO_2$ |
| Specifications, high-grade chrome ore ..... | 45.0 | 2.50 | 11.0 | 0.20 | 0.50 | - | - | - | - | - | - |
| Concentrate plus middling, table 2; 86.6 percent recovery ..... | 49.0 | 2.85 | 5.9 | Tr. | None | 9.7 | 0.50 | 18.2 | Tr. | 12.0 | 0.60 |
| Concentrate plus minus 200-mesh middling plus grinding slimes, table 3; 89.0 percent recovery. | 45.1 | 2.71 | 11.0 | Tr. | None | 13.8 | 0.46 | 16.5 | Tr. | 11.4 | 0.52 |

## Conclusions

1. The lot of chromite ore from the Claim Point property on the Kenai Peninsula was found to be readily amenable to the production of high-grade chromite concentrates by ore-dressing treatment.

2. The best results were obtained by tabling sized fractions of the ore plus grinding and retabling middling products. In this manner 81.8 percent of the $Cr_2O_3$ was recovered as a product assaying 52.8 percent $Cr_2O_3$; 86.6 percent

was recovered as a 49.0 percent product; and 89.0 percent was recovered as a 45.1 percent product. All these products met the chemical specifications of the Metals Reserve Company for high-grade chrome ore, and the choice of grade would depend on the economic conditions.

3. By tabling the entire 65-mesh ore without sizing, 74.4 percent of the chromite was recovered as a product assaying 41.5 percent $Cr_2O_3$ and showed the importance of sizing the table feed prior to tabling.

4. By magnetic separation of sized fractions of ore ground to minus 48-mesh, 74.0 percent of the $Cr_2O_3$ was recovered as a product assaying 43.4 percent $Cr_2O_3$.

5. By a combination of magnetic separation and tabling of sized fractions of the ore, 81.7 percent of the chromite was recovered in a product assaying 49.6 percent $Cr_2O_3$.

6. Neither flotation of the chromite with fatty acid nor flotation of the gangue with cationic reagents gave results comparable with those obtained by gravity or magnetic concentration methods.

7. The chromium to iron ratio of the concentrates made from this ore was very favorable, ranging from 2.7 to 2.9.