R. I. 3885 APRIL 1946

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

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF RED MOUNTAIN CHROMITE DEPOSITS KENAI PENINSULA, ALASKA

BY

F. A. RUTLEDGE

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By F. A. Rutledge[2]

CONTENTS

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 3885".

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

ILLUSTRATIONS

INTRODUCTION

The chromite deposits of Red Mountain, 10 miles southeast of Seldovia, Alaska, are in an intrusive of ultramafic rocks. The earliest reference to the deposits was made by U. S. Grant[3], J. B. Mertie, Jr.,[4] made a brief examination in 1917; and A. C. Gill[5] spent 7 weeks studying the ore bodies and geology of the region in 1918. The Federal Geological Survey had a field party in the region from July until September 1940, and the Red Mountain area was mapped and geological data were assembled by P. W. Guild.[6]

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

4/ Mertie, J. B. Jr., Chromite Deposits in Alaska: Geol. Survey Bull. 692, 1919, pp. 265-267.

5/ Gill, A. C., Chromite of Kenai Peninsula, Alaska: Geol. Survey Bull. 742, 1922, 52 pp.

6/ Guild, P. W., Chromite Deposits of Kenai Peninsula, Alaska: Geol. Survey Bull. 931-G, 1942, pp. 139-175.

A preliminary investigation of the Kenai chromite deposits was made in July 1941 by R. S. Sanford,7/ district engineer of the Bureau of Mines, accompanied by P. W. Guild, assistant geologist of the Geological Survey. This was followed by surface sampling and core drilling, which were completed in September 1942 under the direction of John W. Cole,8/ associate engineer of the Bureau of Mines. G. O. Gates, associate geologist, and A. B. Unkelsbay, junior geologist, of the Geological Survey, logged cores and interpreted geologic features revealed by Bureau of Mines' drilling and trenching.9/

J. C. Roehm, associate engineer of the Territorial Department of Mines, examined the Red Mountain area in August 1941.10/

Additional exploration of other deposits in the Red Mountain area was completed during the summer of 1944. Work consisted of surface sampling, core drilling, and mapping. G. O. Gates, associate geologist of the Geological Survey, spent 4 days in August investigating results of the Bureau of Mines program.

ACKNOWLEDGMENTS

Throughout the exploratory work conducted by the Bureau of Mines the cooperation of Red Mountain Chromite, Inc., and especially of John W. Blodgett, Jr., and Collis E. Druley, president and superintendent, respectively, was greatly appreciated. Use of their camp in the Windy River cirque and shops at Kasitsna Bay facilitated the Bureau of Mines program.

Many courtesies were received from Mr. and Mrs. Herbert Miller, Ray Sharp, and Robert Heath of the Chrome Queen Mining Co., and Guy P. Kearns. Cordial hospitality was shown by all residents of Seldovia, Alaska, and the surrounding area during this examination.

Geological Survey bulletins on the Red Mountain chromite area were referred to for general geology and origin of the deposits, and the original authors are credited by footnote acknowledgments. Valued assistance was received from George O. Gates, associate geologist, Geological Survey, during his stay at the project.

Acknowledgment is made to R. S. Sanford of the Bureau of Mines for constructive criticism of the report; also, due credit is extended to Leo Saarela of the Territorial Department of Mines, Anchorage, Alaska, for analysis of samples.

7/ Bureau of Mines, Claim Point Chromite Deposit, Kenai Peninsula, Alaska: War Minerals Rept. 253, 1943, 34 pp.

8/ Bureau of Mines, Red Mountain Chromite Deposits, Kenai Peninsula, Alaska: War Minerals Rept. 191, 1944, 51 pp.

9/ Gates, George O., and Unklesbay, Athel B., Report on the Chromite Deposits of Red Mountain, Kenai Peninsula, Alaska: Geol. Survey, unpublished rept., 1943, 13 pp.

10/ Roehm, J. C., Some Chromite Occurrences at Red Mountain, Kenai Peninsula, Alaska: Territorial Department of Mines, unpublished rept., 1941, 14 pp.

LOCATION AND ACCESSIBILITY

The location of Kenai Peninsula is shown on figure 1. Red Mountain, a bald, rusty-colored mass rising to an altitude of 3,400 feet, is near the tip of Kenai Peninsula, about 10 miles southeast of Seldovia. Because of its visibility from the Gulf of Alaska, Cook Inlet, and Kachemak Bay, it is an old mariners' landmark. The principal chromite areas of Kenai Peninsula are shown on figure 2.

Red Mountain is 9.53 miles by a graveled road from Red Mountain Chromite's camp on Kasitsna Bay, which is 10 miles by boat from Seldovia. The area is part of the Third Judicial Division of Alaska, with headquarters at Valdez. Homer, northeast of Seldovia, is a small farming community on the north shore of Kachemak Bay, 12 miles by water from Kasitsna Bay.

The Alaska Steamship Co. has maintained monthly service to Seldovia since the entrance of the United States into the war in December 1941. The company's basic freight rate on machinery from Seattle to Seldovia during the summer of 1944 was 41¼ cents a cubic foot or 82½ cents a hundred pounds, whichever was greater, plus 16 percent emergency surcharge. With termination of the war it is expected that this surcharge will soon be dropped (October 1945). Seldovia wharfage is $3.00 a ton. Rates on groceries and other supplies varied from 50 to 90 cents a hundred pounds plus the 16-percent emergency surcharge. The freight charge from Seldovia to Seattle via the Alaska Steamship Co. on bulk ore valued at less than $60 a ton is $7 a short ton plus 16 percent emergency surcharge, totaling $8.12 a short ton or $9.09 a long ton. The wharfage charge at Seattle is $0.035 a cubic foot, or $0.07 a hundred pounds, making $1.57 a long ton. Freight and unloading charges total $10.66 a long ton. If the ore must be handled between ship's slings and closed cars, an additional $0.11 a hundred pounds is charged.

Minimum first-class passage by steamship from Seattle to Seldovia during the summer of 1944 was $77.00 plus a 16-percent emergency surcharge, making $89.32, plus a Federal tax of 15 percent, or a total of $102.72. The one-way trip requires 10 days to 2 weeks. Transportation may be had at slightly higher cost on the more frequent ships from Seattle to Seward, 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 airplane companies from Fairbanks to Seldovia. Plane fare is $170 plus 15 percent Federal tax from Seattle to Fairbanks, and the air express is $0.90 a pound plus $0.35 additional valuation charge for each $100 of value. Plane fare from Fairbanks to Homer is $65 plus a Federal tax of 15 percent, and air express is $0.32 a pound. The rate from Anchorage to Homer is $30 plus 15 percent for plane fare and $0.15 a pound for air express. Alaska Airways maintains tri-weekly service between Anchorage and Homer.

A privately owned radio station at Seldovia furnishes commercial telegraph service through the Alaska Communication System. Small ocean-going motorships maintain irregular freight service on Cook Inlet, but most local traffic is by small, gasoline-powered fishing boats. Groceries

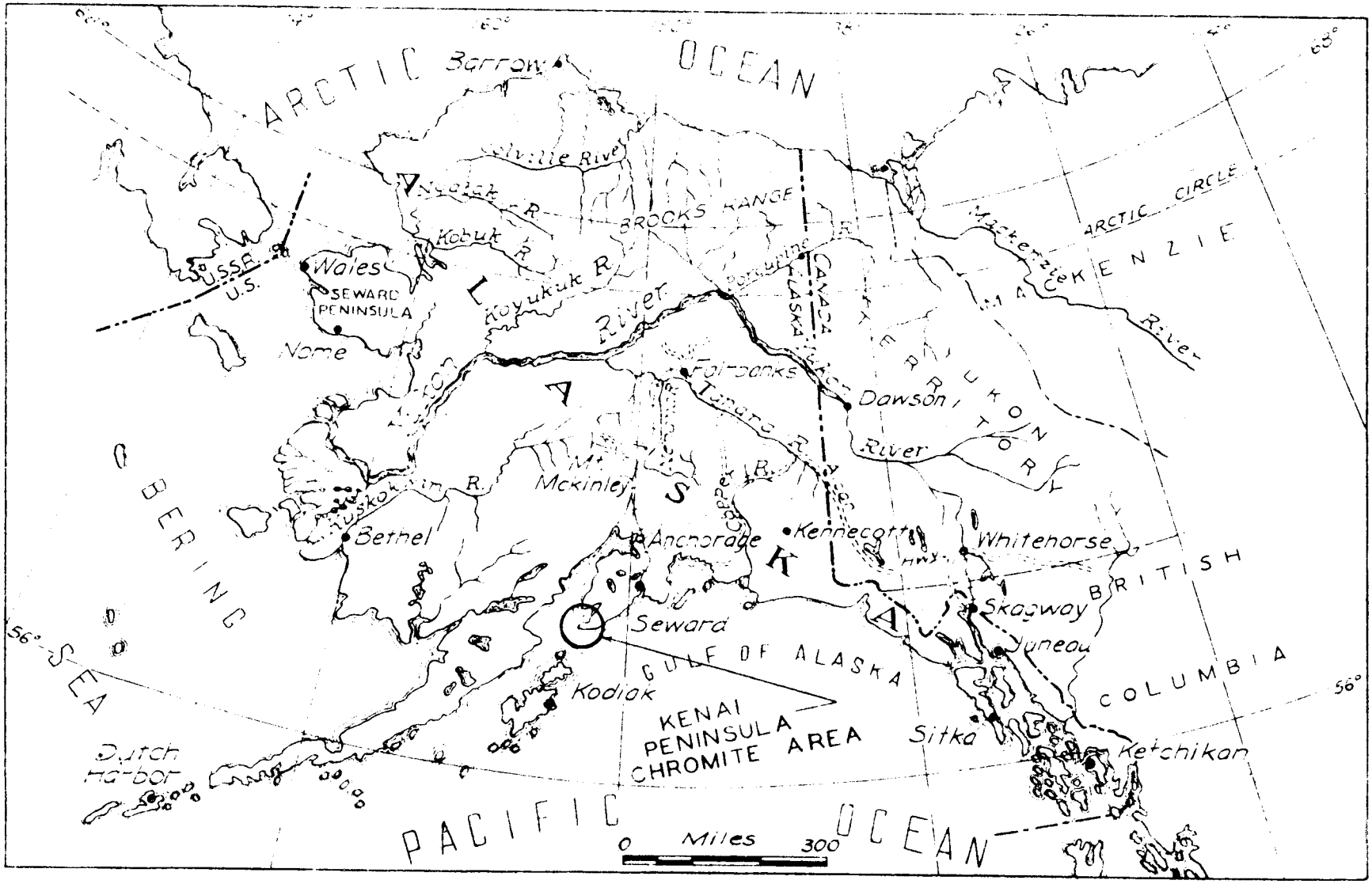


FIGURE 1.- Index map, Kenai Peninsula, Alaska.

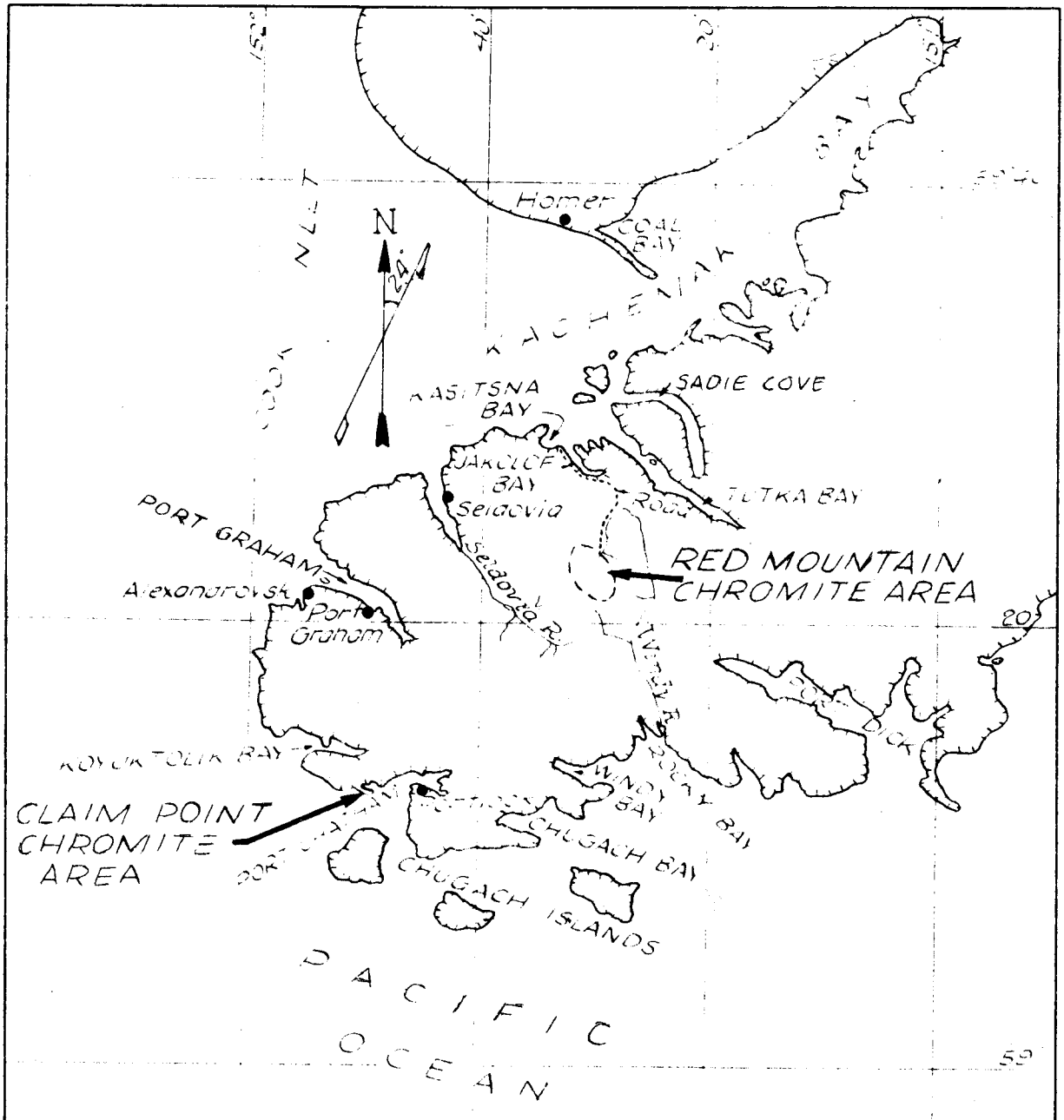


FIGURE 2.- Kenai Peninsula chromite areas.

5 0 5 10 15
Scale of Miles

From U.S.C.& G.S. Navigation Chart No. 8531

and other supplies are available at Seldovia and Homer. The 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 that compare favorably with those in the United States. Low-grade coal may be obtained from Homer at $10 to $12 a ton. Seldovia has a modern high school and hospital.

PHYSICAL FEATURES

Vegetation and climate of the Kenai Peninsula are typical of the Alaska coastal region. Although the Red Mountain dunite area is virtually bare of vegetation, there are abundant stands of spruce and poplar along the road in Jakolof Creek Valley and along Jakolof Bay. The nearest weather station is 20 miles north of Red Mountain, at Homer, where the annual precipitation is 30 to 40 inches. Precipitation is greater on Red Mountain because of the higher elevation and exposed location. Average annual snowfall at Homer is 98.7 inches, and at Red Mountain is very heavy, ranging from 10 feet in Windy River Valley to more than 40 feet at altitudes of 2,500 feet or more. Except at lower altitudes, the snow remains on the ground until well into the summer. Sea-level temperatures range from zero to 80° F. but rarely remain below freezing for more than a few days at a time. Above 600 feet, freezing weather and heavy snowfall are the rule from October to May.

Relief at Red Mountain ranges from 1,000 feet in Windy River Valley to more than 3,400 feet at the peak. The area is drained by the Seldovia River, which flows into Seldovia Bay; Fish Creek, which flows into Cook Inlet near Barbara Point; and Windy River, which flows north 2⅓ miles and then east and south into Rocky Bay on the Gulf of Alaska.

LABOR AND LIVING CONDITIONS

Because of war conditions, labor was scarce and wage rates high. In 1944 the following hourly rates prevailed for a 40-hour week: Skilled, $1.50 to $2.00; semiskilled, $1.25 to $1.50; unskilled, $1.015. Time and a half is paid for time over 40 hours a week and double time for the seventh day.

Both Red Mountain Chromite, Inc., and the Chrome Queen Mining Co. furnished board and lodging for employees without charge.

Local labor is scarce during the fishing season, which is from June until September; consequently, labor must be imported during that period.

HISTORY

Many claims were staked in 1917 and 1918, but with the exception of the Star No. 4 and the Juneau Nos. 1 and 2, which were patented by Lass and Whitney, they were allowed to lapse during subsequent years. No production is on record from the Red Mountain area during this period, although 2,000 long tons was produced from Claim Point under the stimulus

of wartime prices. The unpatented claims evidently have been held by restaking, as only a small amount of assessment work is evident. Activity was resumed in 1937, and a trail was built by Guy P. Kearns and associates from the head of Jakolof Bay to the area.

The holdings of Kearns & Cooper were leased by the Chrome Queen Mining Company.

The holdings of Lass and Whitney were acquired by John W. Blodgett, Jr., who started building a road from the head of Jakolof Bay in July 1941. The name of the operator was changed later to Red Mountain Chromite, Inc. The road was completed as a pioneer trail in December 1941. Construction on this part of the road was suspended during the winter, but work continued on the $2\frac{1}{2}$ mile section along the south shore of Jakolof Bay to the dock site on Kasitsna Bay. Only enough work to maintain the road for tractor and sled travel was done until September 1942, when active construction was resumed by Red Mountain Chromite, Inc. The truck road was completed and graveled by the Alaska Road Commission.

PROPERTY AND OWNERSHIP

The location of the principal deposits and claims is shown on figure 3. The patented and unpatented claims covering the deposits under exploration by Red Mountain Chromite, Inc., were purchased or located by John W. Blodgett, Jr., Grand Rapids, Mich.

Ownership of the claims covering the principal known deposits at Red Mountain is as follows:

Patented claims	Holder	Deposit No.
Star No. 4	John W. Blodgett, Jr.	2
Juneau No. 1	do	8
Juneau No. 2	do	11
Unpatented claims		
Edith No. 1	John W. Blodgett, Jr.	25
Edith No. 2	do	1/
Edith No. 3	do	24
Edith No. 4	do	2/
Edith No. 5	do	10
Edith No. 7	do	17
Edith No. 8	do	
Edith No. 9	do	2/
Edith No. 10	do	2/
Edith No. 11	do	3/
Edith No. 12	do	3/
Letha No. 1	do	
Horseshoe Claim (placer)	do	5
Charles Francis Placer	do	

1/ Part of 24 overlapped by Edith No. 3.
2/ Part of 1.
3/ Part of 4.

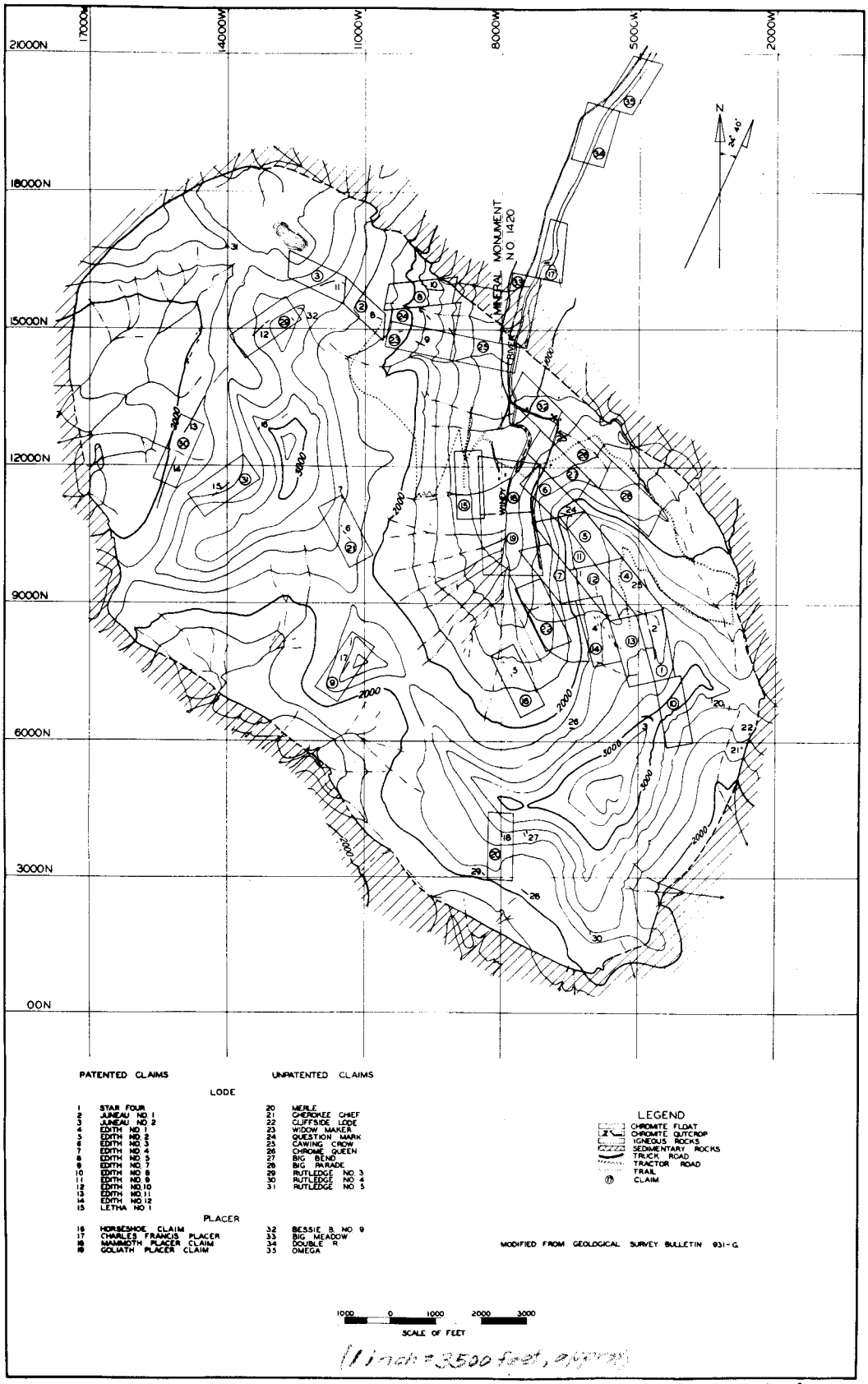


FIGURE 3.- Geologic and topographic map, Red Mountain, Alaska.

Unpatented claims - Continued	Holder	Deposit No.
Mammoth Placer Claim	John W. Blodgett, Jr.	
Goliath Placer Claim	do	
Merle	Kearns & Cooper	18
Cherokee Chief	do	6
Cliffside Lode	do	
Widow Maker	do	9
Question Mark	do	4/
Cawing Crow	do	
Chrome Queen	do	23
Big Bend	do	
Big Parade	do	
Bessie B. No. 9 (placer)	do	
Big Meadow (placer)	do	
Double R. (placer)	do	
Omega (placer)	do	
Rutledge No. 3	R. E. L. Rutledge	12
Rutledge No. 4	do	5/
Rutledge No. 5	do	15

4/ Extension of 9.
5/ Parts of 13 and 14.

Red Mountain Chromite, Inc., was organized under the laws of Michigan on October 21, 1941. Its principal place of business was 1103 Peoples National Bank Building, Grand Rapids, Mich.

The officers of Red Mountain Chromite, Inc., were: John W. Blodgett, Jr., president; Sarah Reed Blodgett, vice president; Samuel H. Martin, vice president; and Oscar E. Waer, secretary-treasurer. Red Mountain Chromite, Inc., was dissolved as of July 25, 1944.

Kearns & Cooper is a partnership between Guy P. Kearns, Seldovia, Alaska, and Dawson Cooper, Fairbanks, Alaska. The holdings of Kearns & Cooper have been leased by the Chrome Queen Mining Co.

The Chrome Queen Mining Co. was a partnership composed of Herbert Miller, Robert Heath, and Ray Sharp, of Seldovia, Alaska. After termination of operations in 1943, Robert Heath's interest was obtained by the other two partners. The company now consists of Herbert Miller and Ray Sharp.

R. E. L. Rutledge, Anchorage, Alaska, holds several claims in the area. Although Rutledge at one time held seven lode claims on the dunite intrusive, only the three claims shown (fig. 3) have been retained. Among the deposits covered by these claims are 12, 15, and part of 13 and 14.

ORE DEPOSITS

General Geology

Chromite deposits occur at the south end of Kenai Peninsula, Alaska, in two areas - Claim Point and Red Mountain. They are contained in masses of ultramafic rocks (those with unusually large contents of magnesium and iron), which are intrusive into a complex series of graywackes, slates, and cherts of Paleozoic(?) age. Dunite is the predominant intrusive; pyroxenite, garnet pyroxenite, and serpentine derived from the alteration of dunite also are present.

Chromite grains are distributed in small quantity throughout the dunite; the ore deposits are parts of the dunite and serpentine masses in which chromite has been concentrated by magmatic segregation. These deposits are tabular, strongly banded bodies, which range in size from stringers to bodies containing more than 50,000 tons and in grade from a few percent to 50 percent of chromic oxide (Cr_2O_3).12/

Dunite and the serpentine derived from it comprise perhaps 90 percent of the Red Mountain intrusive, and pyroxenite most of the remainder. The pyroxenite layers are parallel to one another and to the chromite-rich layers in the dunite. They are best exposed in the high ridge west of Windy River, but their apparent abundance there as compared with other parts of the area is due in part to a favorable combination of attitude and relief.13/

Banding is so conspicuous in the Red Mountain intrusive as to give it a stratified appearance. The layers strike parallel to the contact around three sides of the mass, and change in dip from almost vertical near the contact to horizontal near the pyramidal peak between the two low passes from Windy River into Seldovia River. The structure is essentially an elongate basin whose major axis trends north-northwest.14/

The deposits of the Kenai Peninsula, Alaska, have been studied with unusual care by Gill;15/ and his description, with the accompanying maps, is perhaps the best of an occurrence of flowbanded chromite within ultrabasic masses whose original boundaries are known and mapped and the structural relations of the chromite recorded.16/

12/ Guild, P. W., p. 139 of work cited in footnote 6.
13/ Same, p. 147.
14/ Same, p. 149.
15/ Gill, A. C., Chromite of Kenai Peninsula, Alaska: Geol. Survey Bull. 742, 1922, 52 pp.
16/ Sampson, Edward, professor of geology, Princeton University, Oct. 19, 1939.

Deposits 2 and 25 (fig. 3) are assumed to be in one zone and 9, 8, and 11 in another, or possibly in the same zone continued on the west side of Windy River Valley. Deposits 32, 12, 13, and 14 assume the same relationship. At first it was thought that possibly these deposits were all in the same zone, but a low-grade chromite body, deposit 32, was discovered in this zone that paralled the pyroxenite banding and obviously was higher in the series of bands than deposits 8, 9, and 11. Deposits 10 and 23 occur in lower series which offer further possibilities for prospecting. These deposits occur in the center of the wider dunite bands. The larger known deposits seem to occur in the steeply dipping part of the formation. Another characteristic of the ore bodies drilled is that the strike length is usually greater than the dip length. The occurrences of ore bodies at fairly even intervals along the strike of a zone and also of long strike length compared to dip have been observed in other deposits of this type at John Day, Oreg.[17/]

Mineralogy

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 its range in the deposits under discussion is small and the percentage of Cr_2O_3 near 58.[18/]

The chromium:iron ratio of the Red Mountain chromite ore ranges from 2.5:1 to 3.3:1, with the exception of deposit 10. In general, analyses indicate that 40-percent shipping ore from most of the Red Mountain deposits will have a ratio of approximately 2.7:1. The chromium: iron ratio of the first 1,500 long tons produced by the Chrome Queen Mining Co. was 2.63:1. The average analysis was 43.0 percent chromic oxide. Concentrates from detrital material from Claim Point and Red Mountain indicate that the iron content will be higher. A concentrate produced from the talus material in Windy River Valley had a chromium: iron ratio of 1.65:1 and contained 46.44 percent chromic oxide.

Chromite in the Red Mountain area contains about 58 percent chromic oxide and has a specific gravity of 4.4; that of the dunite is 3.3. The specific gravity of 40 percent chromic oxide ore is calculated to be 4.06, or 8.82 cubic feet to the long ton. The specific gravity of 20-percent ore is 3.68, or 9.74 cubic feet a long ton.

17/ Metzger, O., Chromite Deposits of Grant County, Oreg.: Bureau of Mines unpublished rept.

18/ Guild, P. W., Chromite Deposits of Kenai Peninsula, Alaska: Geol. Survey Bull. 931-G, 1942, p. 150.

Recent analyses by the Bureau of Mines of samples of olivine from Red Mountain show the presence of 0.25 percent nickel and 0.03 percent cobalt.

Description of Deposits

The principal deposits, numbering about 30, have been described by Gill[19] and Guild.[20] Deposits from which there was a prospect of early production were described in more detail in the order of their accessibility in War Minerals Report 191, Red Mountain Chromite Deposits, Kenai Peninsula, Alaska. Several of these deposits are redescribed in this report on the basis of new information. A number of additional deposits are also described.

CHROME QUEEN MINING CO.

Deposit 23

Deposit 23 is on the Chrome Queen claim just above the floor of the Windy River Valley, on the east slope, at an elevation of 1,150 feet (see figs. 3, 4, 5 and 6). It is 700 feet east of the double bend in Windy River and just south of the smaller and most southerly of two streams that flow northwesterly into the river. Large boulders of high-grade chromite float in the talus led to the discovery of this deposit by G. P. Kearns, who trenched and exposed the ore at one location. A trenching program by the Bureau of Mines in 1941 revealed a lenticular body of high-grade chromite striking N. 30° W. and dipping from 50° to 70° southwesterly. Owned by Kearns & Cooper, it has been leased to the Chrome Queen Mining Co.

Ten diamond-drill holes, Nos. 31 to 40, inclusive, were drilled by the Bureau of Mines to explore this deposit. Figure 4 is a plan map of the Chrome Queen deposit, including development through September 1944. The lens is offset by numerous faults. Apparently the displacement along these faults was small except in the case of the No. 1 fault, where the vertical movement was normal. The lower block is near the edge of the lens and pinches within a short distance (fig. 5, sections A-A', B-B', C-C', and D-D'). This is well-exposed in chutes 1 and 2.

Mine Operations

During 1942 and 1943, 4,972 long tons of chromite ore was produced. Analyses of the composite samples indicated the following composition of the ore:

19/ Gill, A. C., Chromite of Kenai Peninsula, Alaska: Geol. Survey Bulletin 742, 1922, 52 pp.

20/ Guild, P. W., Chromite Deposits of Kenai Peninsula, Alaska: Geol. Survey Bull. 931-G, 1942, pp. 139-175.

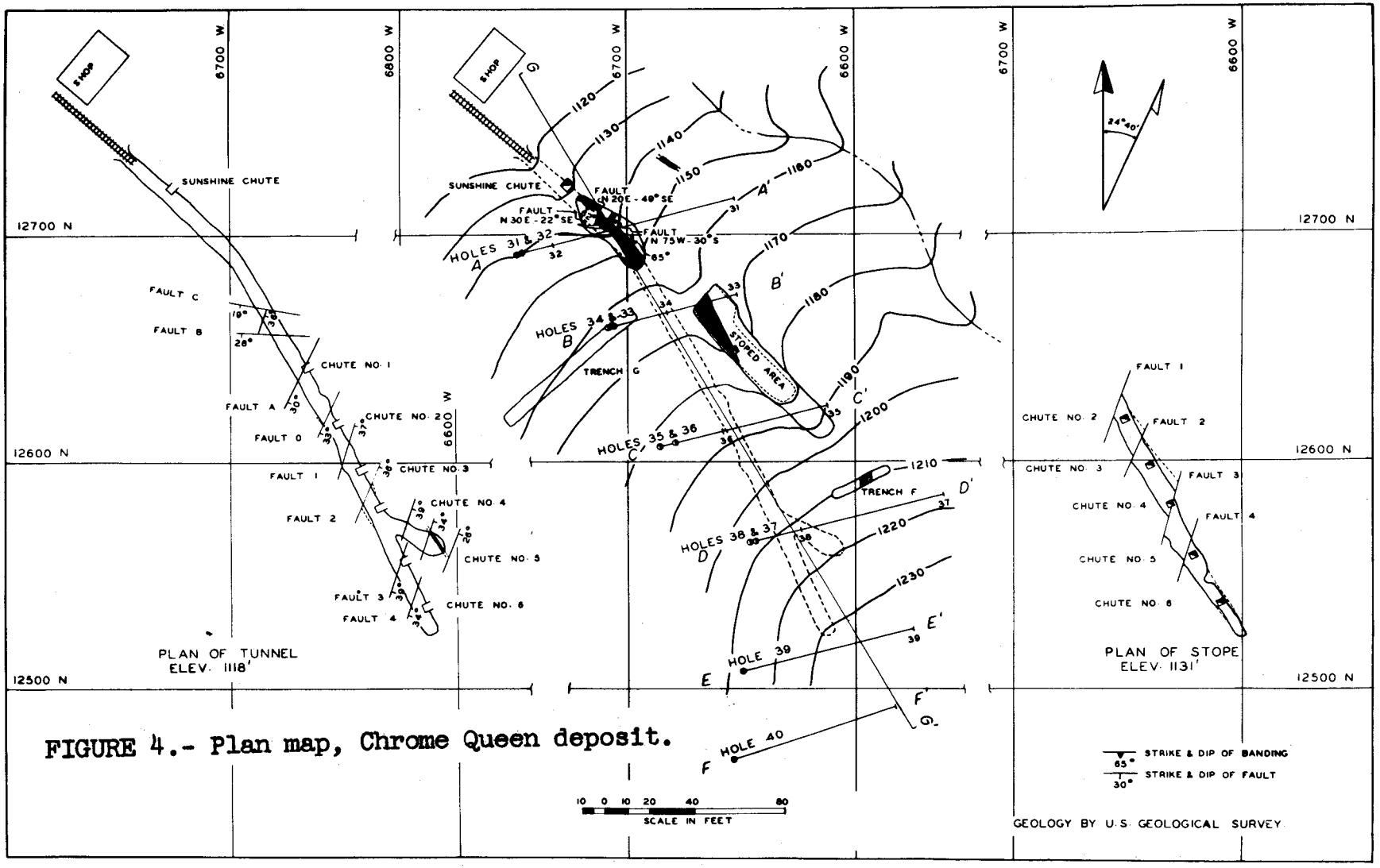


FIGURE 4.- Plan map, Chrome Queen deposit.

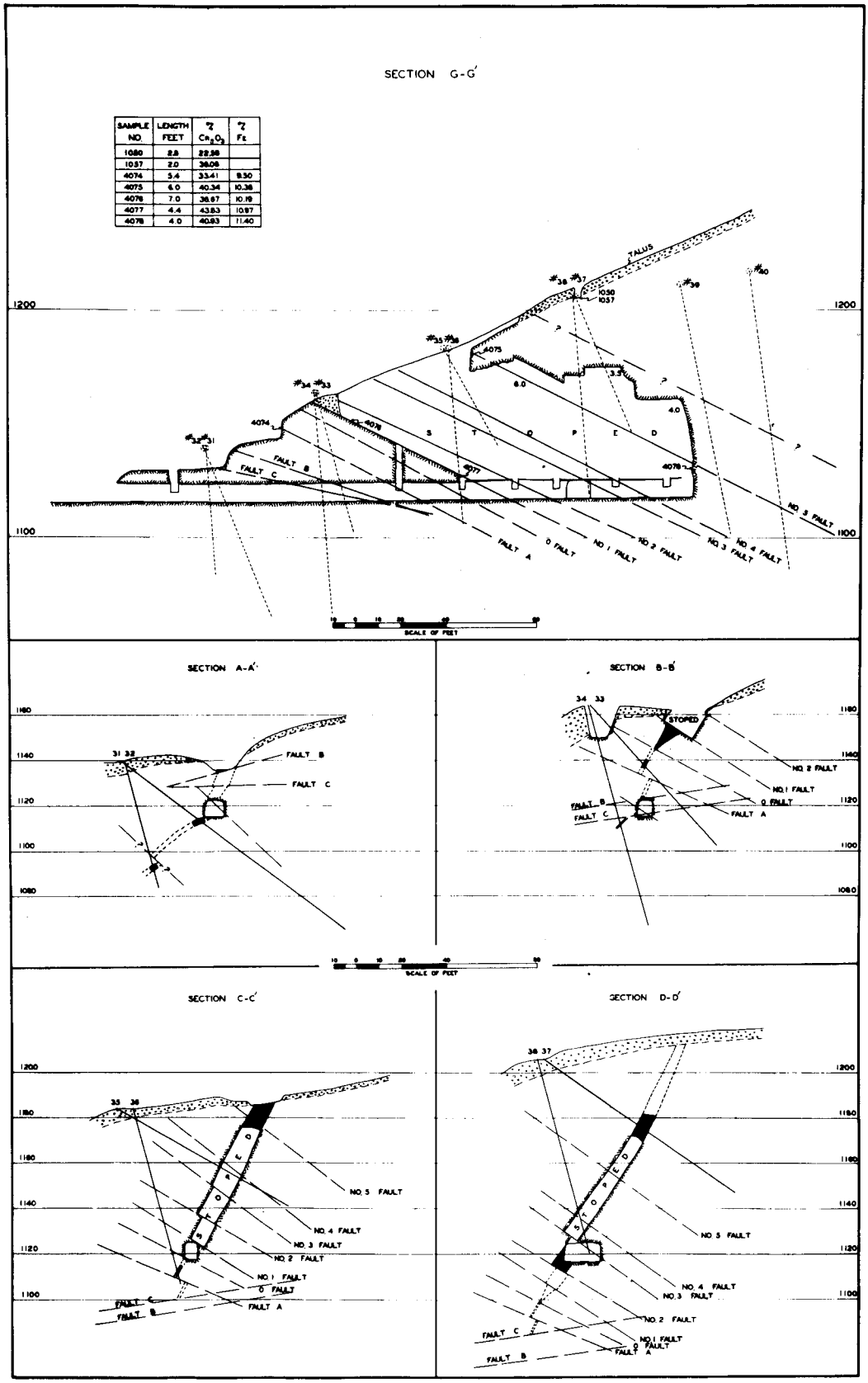
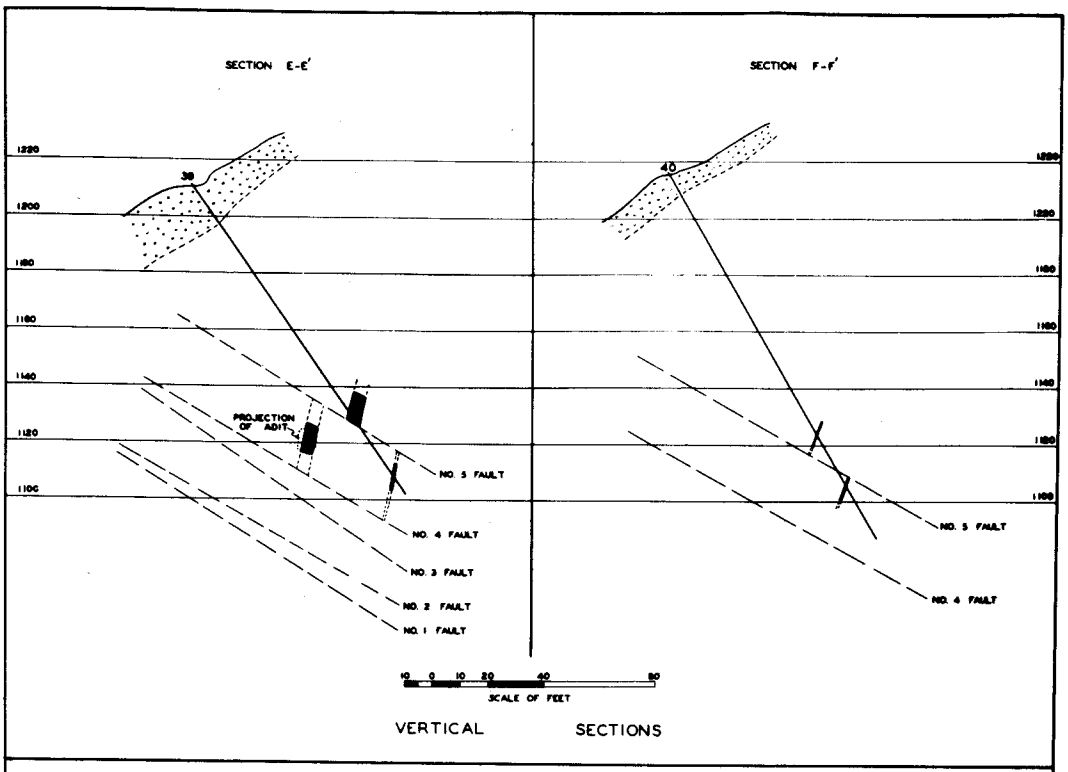
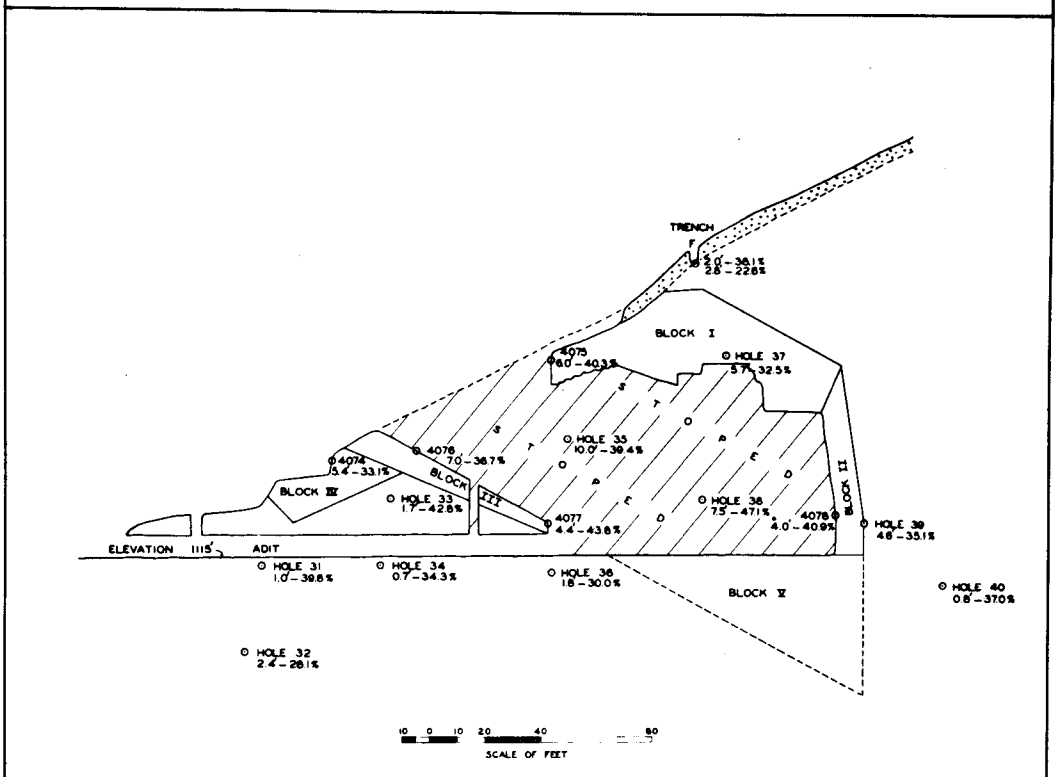


FIGURE 5.- Vertical sections, Chrome Queen deposit.



VERTICAL SECTIONS



SECTION IN PLANE OF VEIN, DEPOSIT 23

FIGURE 6.- Sections, Chrome Queen deposit.

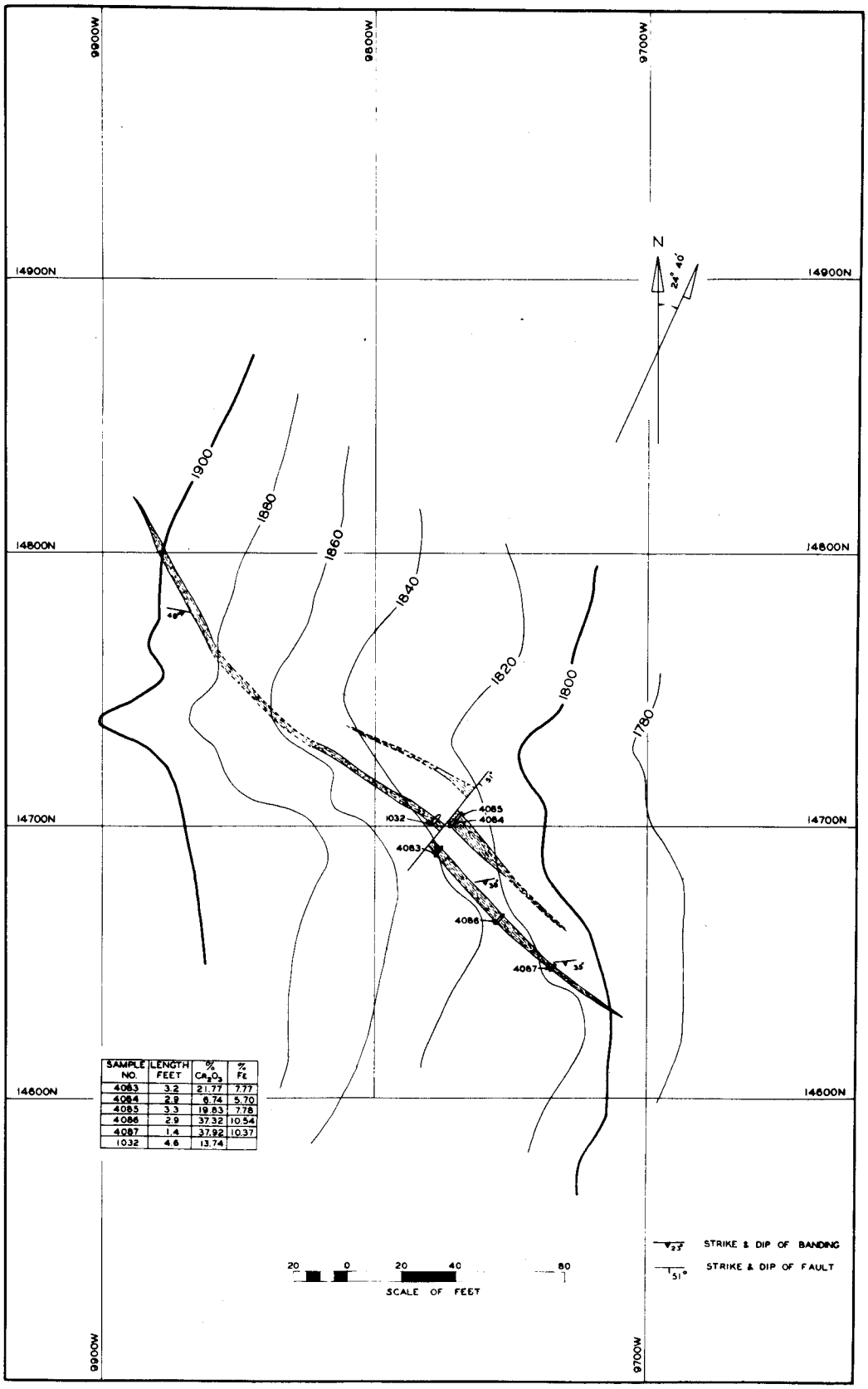


FIGURE 7.- Deposit 9, Widow Maker claim, Red Mountain, Alaska.

Cr_2O_3.....	percent	41.42
Cr:Fe ratio.....		2.59
P.....	percent	0
S.....	do.	Tr.
SiO_2.....	do.	11.0
Al_2O_3.....	do.	6.3
MgO.....	do.	23.8

Beyond the development necessary for extraction of the measured ore body, the company did not engage in any exploration or prospecting. The company recessed operations for the winter early in November 1943. Operations were resumed in May 1944, but only 1,647 tons was delivered before termination of the contract as production was hampered by inclement weather. The average grade of the ore produced was 42.0 percent chromic oxide. The average chromium:iron ratio was 2.64:1.

Kearns & Cooper, Deposit 9

Deposit 9 is one of several ore bodies that outcrop on the steep west wall of the Windy River cirque 750 to 1,500 feet south of the contact of the Red Mountain intrusive mass. These ore bodies are on the Widow Maker and Question Mark claims, and the outcrops range in altitude from 1,400 to 2,100 feet. Only the largest, highest-grade deposit was sampled and mapped (fig. 7). This deposit is on the Widow Maker claim, approximately 1,400 feet south of the dunite contact at an elevation of 1,800 to 1,900 feet. It consists of two parallel lenses of banded and disseminated chromite striking approximately east and west, the strike changing from S. 80° W. to N. 80° W., and dipping from 35° to 49° to the south. A fault striking N. 39° E. and dipping 51° to the southeast displaces the lenses about 7 feet.

Samples 4083, 4086, and 4087 were cut from the segment of the south lens east of the fault. This segment has the highest grade of the deposit and is 3.2 feet thick at the fault. It extends 95 feet to the east before pinching out. Spalling off of the evenly disseminated ore in this segment has formed a notch in the cliff. Both the western segment of this lens and both segments of the other lens are of lower grade. No samples were taken of the western segments at this time, but previous Bureau of Mines samples have been used. Samples 4084 and 4085 were taken from the eastern segment of the north lens. Other parallel bands, noted but not sampled, are estimated to contain 10 percent chromic oxide. This deposit has not been developed.

RED MOUNTAIN CHROMITE, INC., PROPERTIES

Five deposits (Nos. 2, 8, 10, 11, and 24) have been explored by the Bureau of Mines and are described as follows:

Deposit 2

A high-grade chromite deposit is on the Star No. 4 claim on the comparatively level plateau north of Red Mountain at an altitude of 2,600

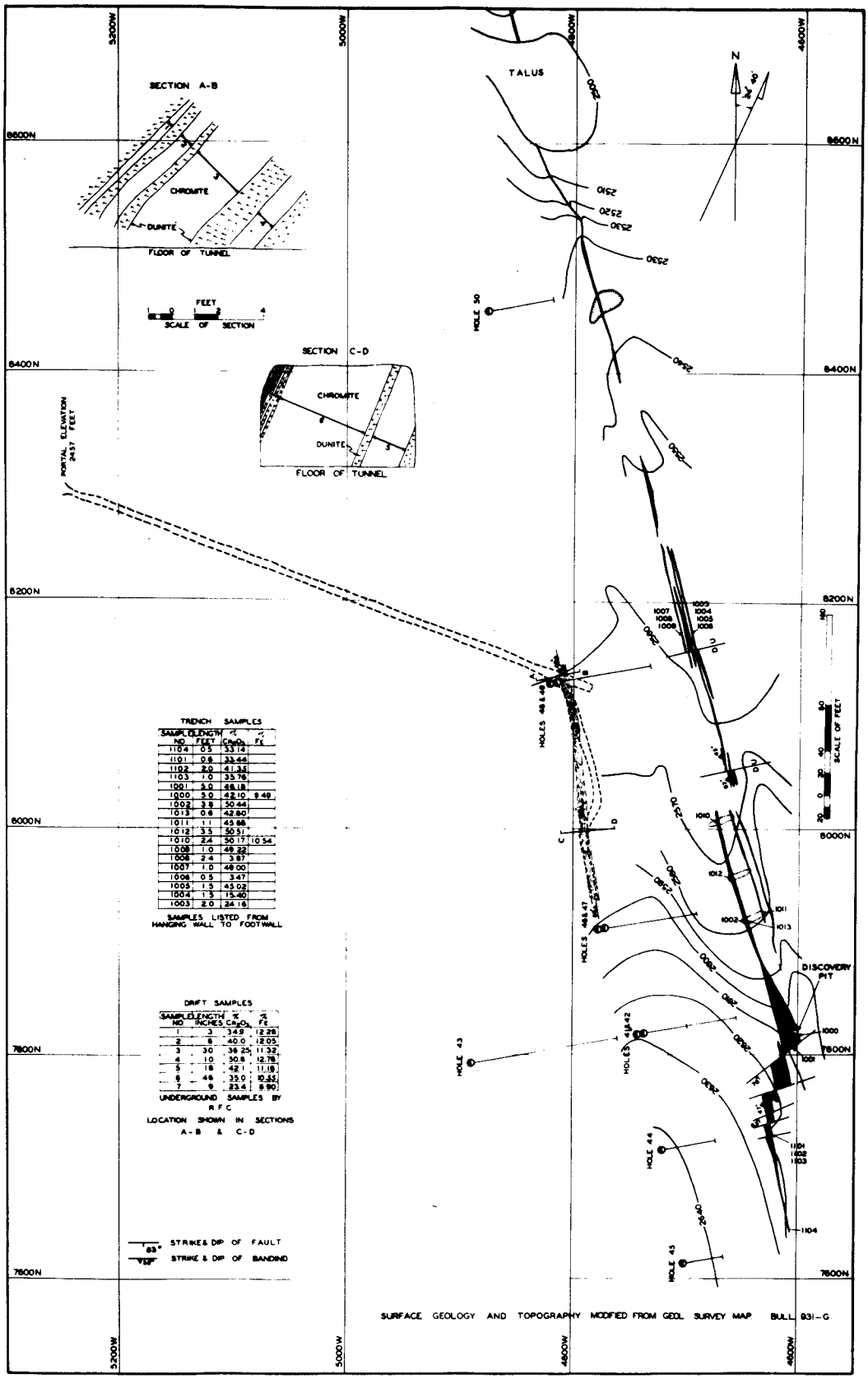
feet. It is a tabular ore body, the main part of which is 622 feet long with a maximum width of 10 feet at the outcrop. It strikes N. 10° W. and dips 40° to 68° west. The outcrop is seen as a stringer of chromite 180 feet south of the discovery pit, which gradually widens to the north to a maximum thickness of 10 feet of high-grade chromite at the discovery pit and tapers to 2.5 feet in thickness at a point 220 feet farther north. Two narrow footwall veins outcrop 80 feet north of the pit and extend to the same point. Although the vein is thought to be continuous beyond this point, intense folding makes it difficult to measure the thickness again until a point is reached 360 feet from the discovery pit, where the outcrop consists of four high-grade bands separated by dunite. These bands extend 100 feet north, where chromite appears in a 1-foot lenticular vein 80 feet in length. From a point on the line of the outcrop 590 feet northwest of the discovery pit another 1-foot vein extends 300 feet in the same direction. The total length of the outcrop is 1,100 feet. South of the discovery pit are numerous transverse faults that dip steeply to the south. The maximum horizontal movement is 10 feet. Nine holes were drilled and numbered from 41 to 49, inclusive. Drill hole 41 indicates that the ore body increases in width from 10 feet at the surface to 12.2 feet at a point 75 feet below the widest part of the outcrop. Below this point, the vein decreases in width and tapers off into low-grade stringers. Figures 8, 9, 10, 11, 12, and 13 show plan and sections of this deposit and analyses of the samples.

At the No. 2 deposit, a 490-foot adit (portal elevation, 2,457 feet) was driven, which intersected the ore body at an elevation of 2,461 feet. Before the operation was recessed, 195 feet of drifting was completed along the vein (fig. 8). The camp at the Star No. 4 deposit was dismantled in October 1943, and the material was hauled down the 2.2-mile tractor road to the Windy River Valley and stored.

Deposit 8

Deposit 8, on the patented Juneau No. 1 claim owned by John W. Blodgett, Jr., is 1,600 feet southwest of the dunite contact on a narrow plateau 3,000 feet west of Windy River. The deposit outcrops at an elevation of 2,300 feet.

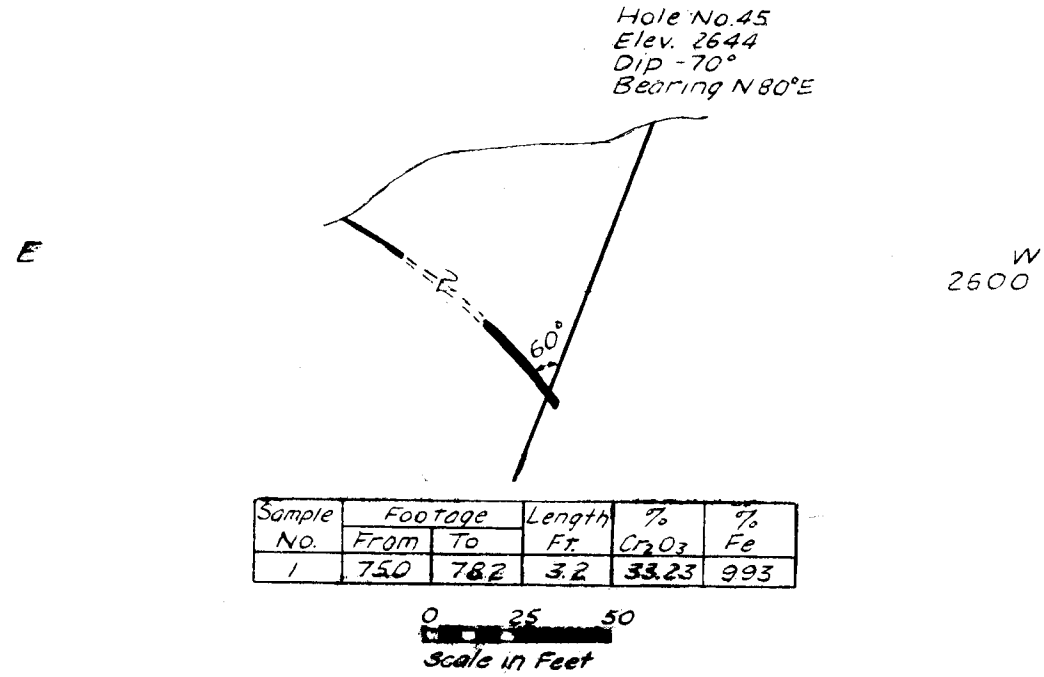
The general trend of the ore body is in an east-west direction, but the ore body is warped and changes in strike from S. 70° W. on the east end to N. 75° W. on the west. The ore is terminated on the west by a fault (fig. 14). The dip of this fault could not be determined, but it is believed to dip to the west as there was no offset of such magnitude encountered in holes 3 and 4 (section A-A', fig. 15). The ore body has been explored by six trenches and averages 7.3 feet wide over a strike length of 100 feet. An additional trench on both extensions failed to find the chromite zone. Analyses of trench samples are given in table 1, and their locations are shown on figure 14.



SAMPLE NO	LENGTH FEET	% Cr_2O_3	% Fe
1104	0.5	53.12	
1101	0.8	33.44	
1102	2.0	41.35	
1103	1.0	35.76	
1001	3.0	46.18	
1000	3.0	42.10	9.49
1002	3.8	50.44	
1013	0.6	42.80	
1011	1.1	45.88	
1012	3.5	50.51	
1010	2.4	50.17	10.54
1008	1.0	49.22	
1006	2.4	3.87	
1007	1.0	48.00	
1006	0.5	3.47	
1005	1.5	45.02	
1004	1.3	15.40	
1003	2.0	24.16	

SAMPLE NO	LENGTH INCHES	% Cr_2O_3	% Fe
1	3	34.9	12.28
2	8	40.0	12.05
3	30	36.25	11.32
4	10	50.8	12.78
5	18	42.1	11.18
6	48	35.0	10.35
7	9	23.4	8.90

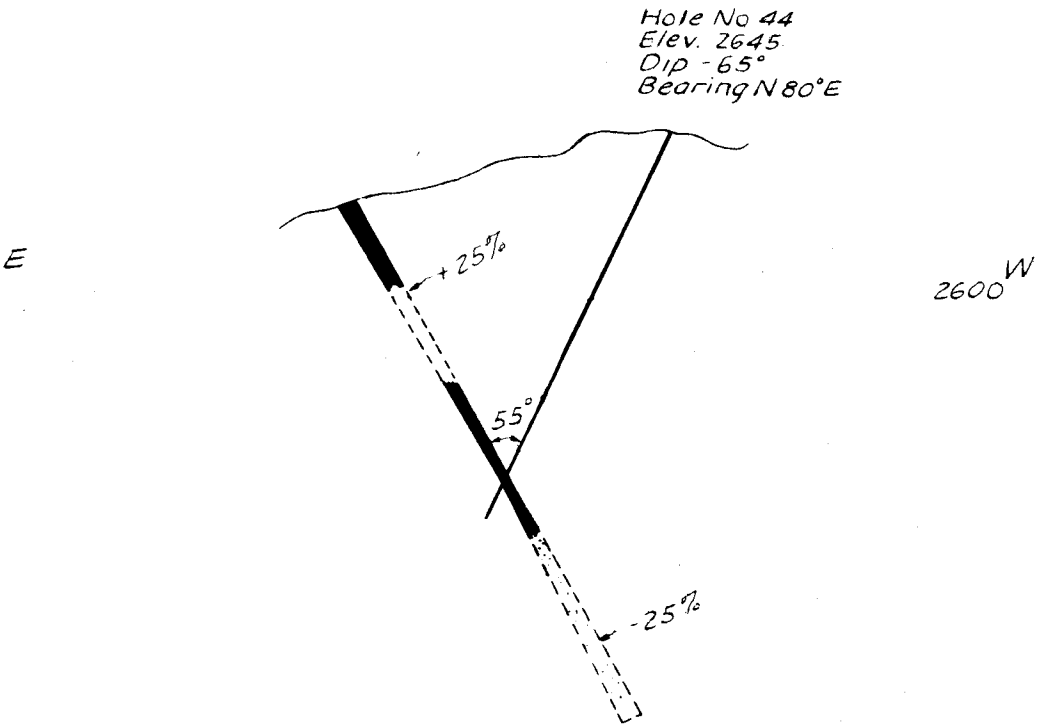
FIGURE 8.- Deposit 2, Star No. 4 claim, Red Mountain, Alaska.



Sample No.	Footage From	Footage To	Length Ft.	% Cr_2O_3	% Fe
1	75.0	78.2	3.2	33.23	9.93

0 25 50
Scale in Feet

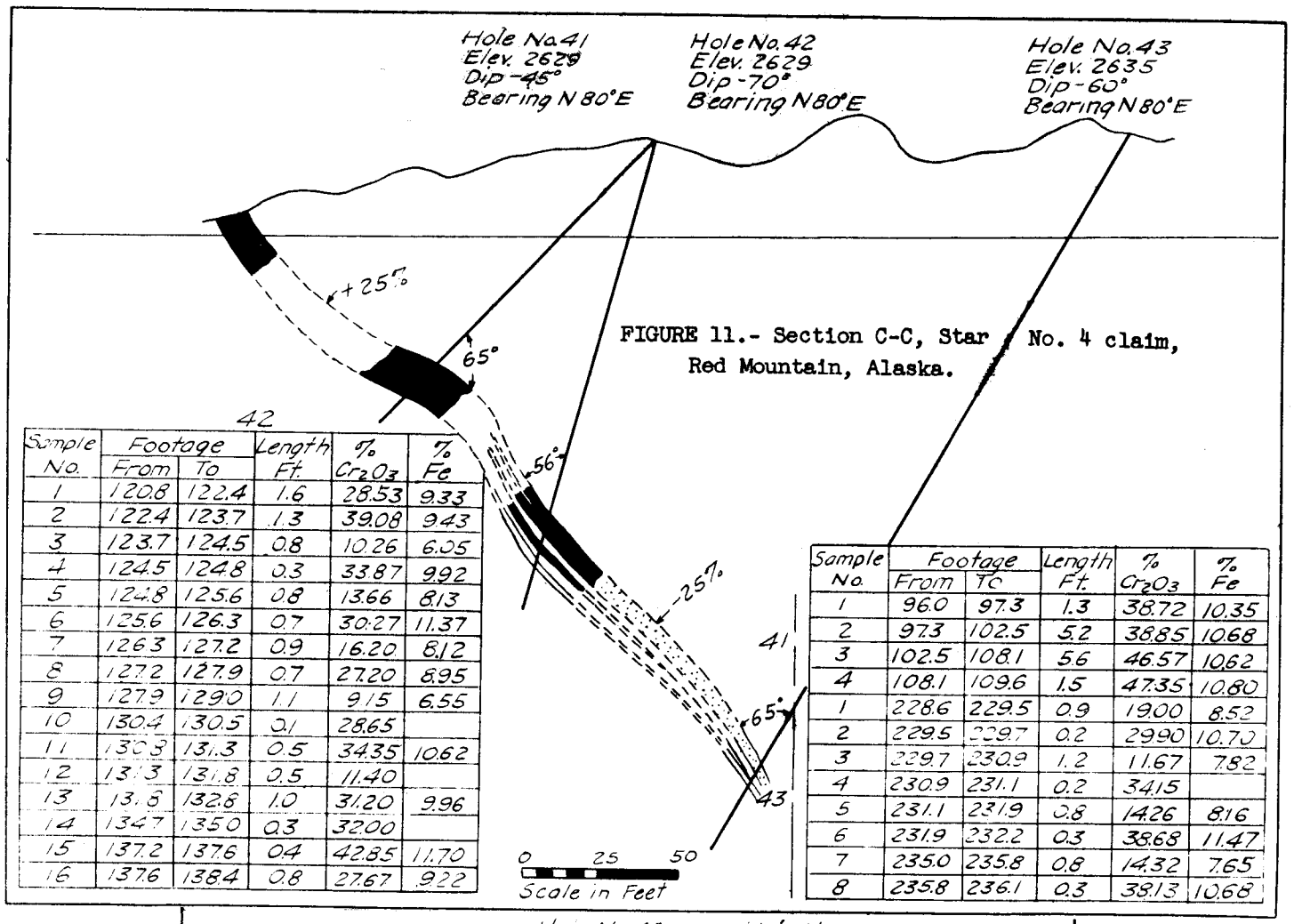
FIGURE 9.- Section A-A, Star No. 4 claim, Red Mountain, Alaska.



Sample No.	Footage From	Footage To	Length Ft	% Cr_2O_3	% Fe
1	98.6	101.5	2.9	43.04	10.83

0 25 50
Scale in Feet

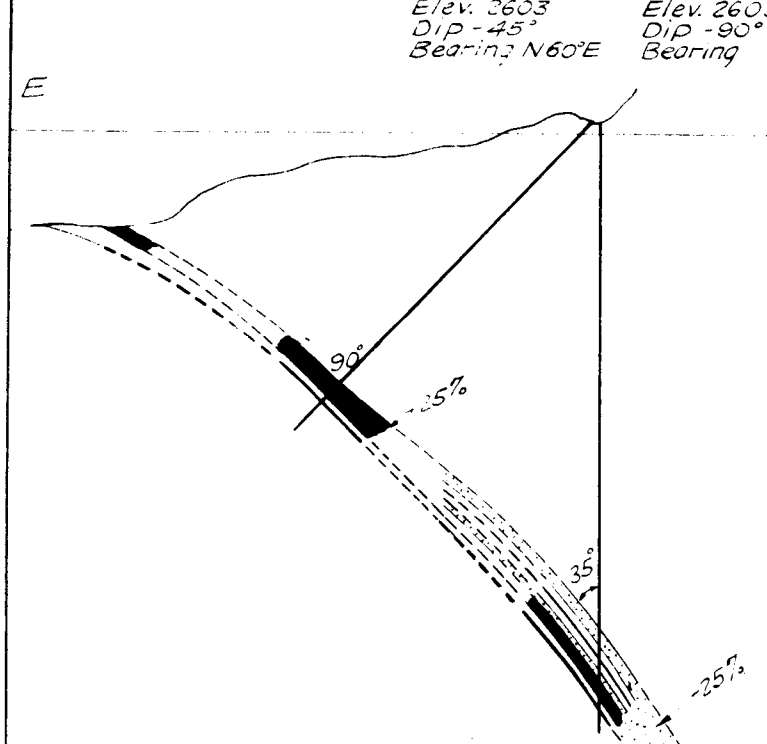
FIGURE 10.- Section B-B, Star No. 4 claim, Red Mountain, Alaska.



Sample No.	Footage From	Footage To	Length Ft.	% Cr_2O_3	% Fe
1	120.8	122.4	1.6	28.53	9.33
2	122.4	123.7	1.3	39.08	9.43
3	123.7	124.5	0.8	10.26	6.05
4	124.5	124.8	0.3	33.87	9.92
5	124.8	125.6	0.8	13.66	8.13
6	125.6	126.3	0.7	30.27	11.37
7	126.3	127.2	0.9	16.20	8.12
8	127.2	127.9	0.7	27.20	8.95
9	127.9	129.0	1.1	9.15	6.55
10	130.4	130.5	0.1	28.65	
11	130.3	131.3	0.5	34.35	10.62
12	131.3	131.8	0.5	11.40	
13	131.8	132.8	1.0	31.20	9.96
14	134.7	135.0	0.3	32.00	
15	137.2	137.6	0.4	42.85	11.70
16	137.6	138.4	0.8	27.67	9.22

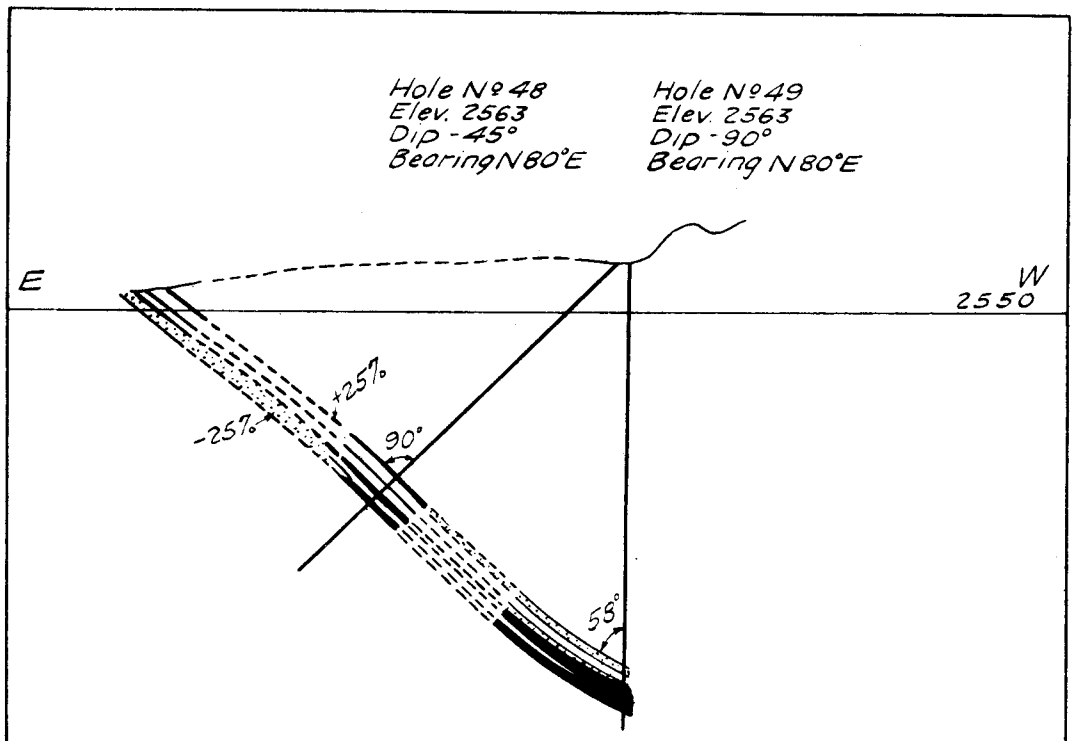
Sample No.	Footage From	Footage To	Length Ft.	% Cr_2O_3	% Fe
1	96.0	97.3	1.3	38.72	10.35
2	97.3	102.5	5.2	38.85	10.68
3	102.5	108.1	5.6	46.57	10.62
4	108.1	109.6	1.5	47.35	10.80
1	228.6	229.5	0.9	19.00	8.52
2	229.5	229.7	0.2	29.90	10.70
3	229.7	230.9	1.2	11.67	7.82
4	230.9	231.1	0.2	34.15	
5	231.1	231.9	0.8	14.26	8.16
6	231.9	232.2	0.3	38.68	11.47
7	235.0	235.8	0.8	14.32	7.65
8	235.8	236.1	0.3	38.13	10.68

FIGURE 11.- Section C-C, Star No. 4 claim, Red Mountain, Alaska.



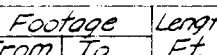
	Sample No.	Footage From	Footage To	Length Ft.	% Cr_2O_3	% Fe
46	1	100.5	101.0	0.5	40.73	
	2	101.0	104.3	3.3	44.89	10.35
	3	104.3	106.1	1.8	48.56	11.61
	4	107.0	108.6	1.6	48.64	11.35
47	1	139.5	145.1	5.6	11.69	8.25
	2	145.1	148.2	3.1	11.89	7.75
	3	149.9	151.4	1.5	22.24	11.32
	4	151.4	152.7	1.3	12.36	9.93
	5	152.7	153.5	0.8	25.92	12.60
	6	153.5	154.9	1.4	12.99	9.12
	7	154.9	160.0	5.1	27.14	10.08
	8	160.0	162.4	2.4	26.07	9.98
	9	163.6	164.5	0.9	25.69	9.98

FIGURE 12.- Section D-D, Star No. 4 claim, Red Mountain, Alaska.



	Sample No.	Footage From	Footage To	Length Ft.	% Cr_2O_3	% Fe
48	1	81.0	82.5	1.5	43.98	10.87
	2	84.0	84.5	0.5	48.07	
	3	87.3	88.1	0.8	49.21	10.70
	4	88.6	89.1	0.5	47.46	11.55
	5	89.1	89.6	0.5	20.40	8.62
	6	89.6	90.0	0.4	49.79	11.93
	7	90.0	92.0	2.0	12.53	8.17
49	1	108.8	110.2	1.4	20.68	9.86
	2	110.3	110.8	0.5	32.25	11.13
	3	111.5	112.0	0.5	19.57	8.79
	4	112.4	115.5	3.1	26.28	9.70
	5	115.9	116.1	0.2	32.25	
	6	116.6	117.9	1.3	38.73	10.88

FIGURE 13.- Section E-E, Star No. 4 claim, Red Mountain, Alaska.



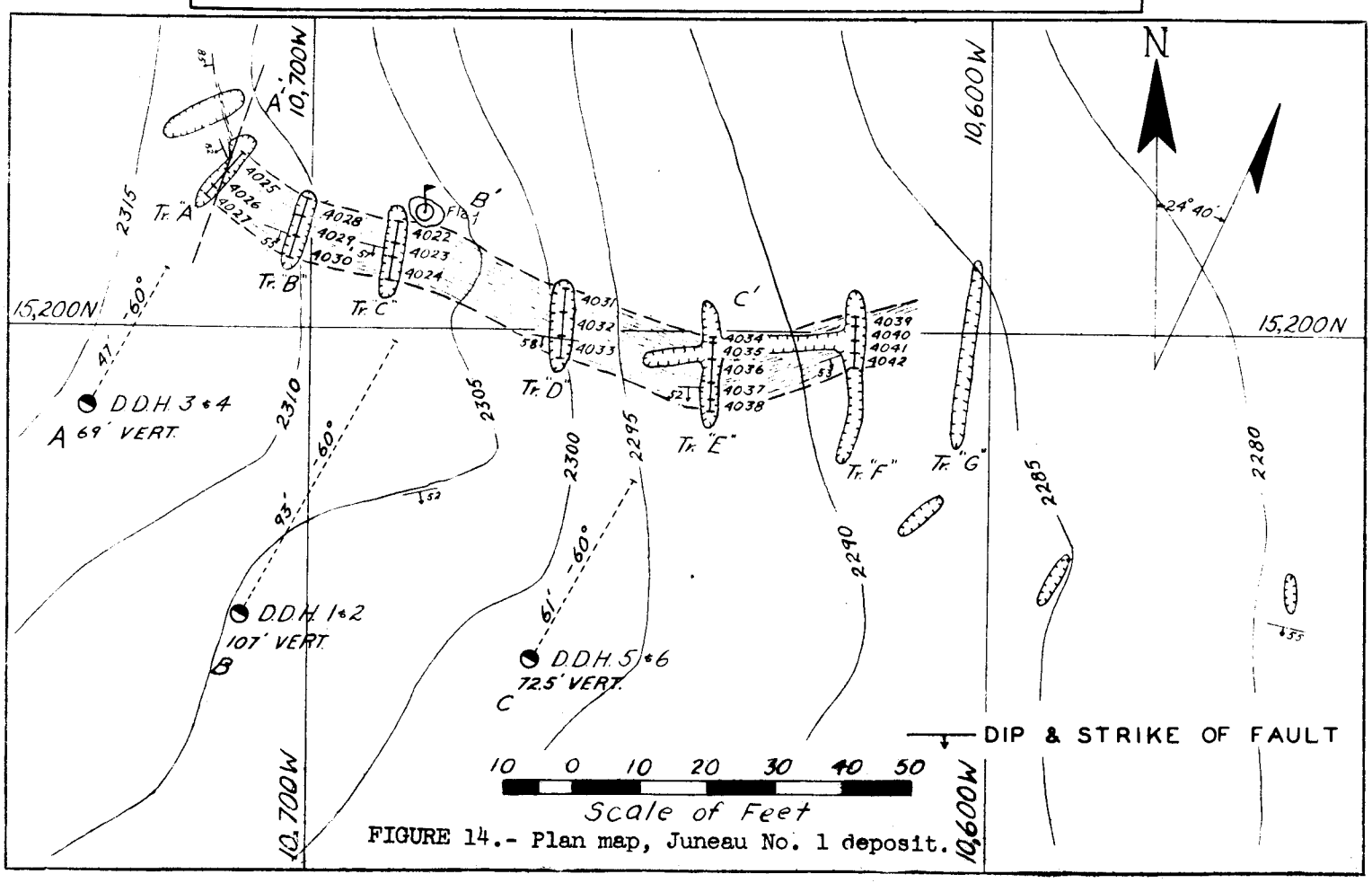
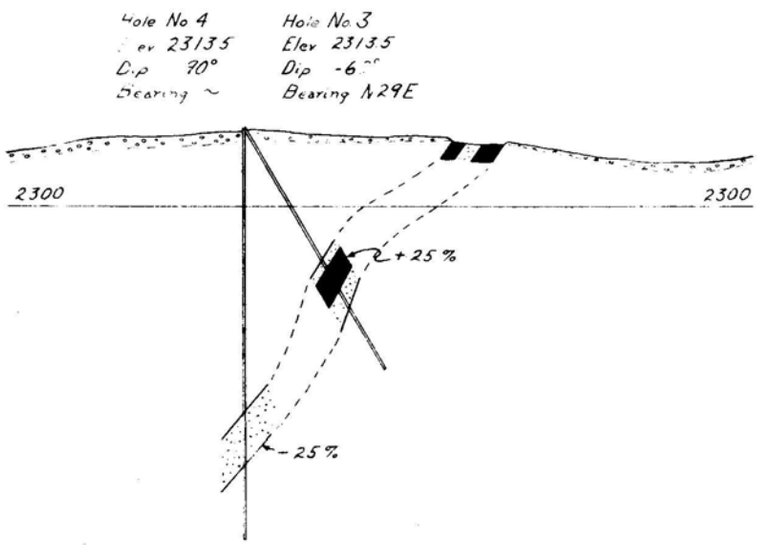
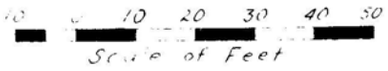


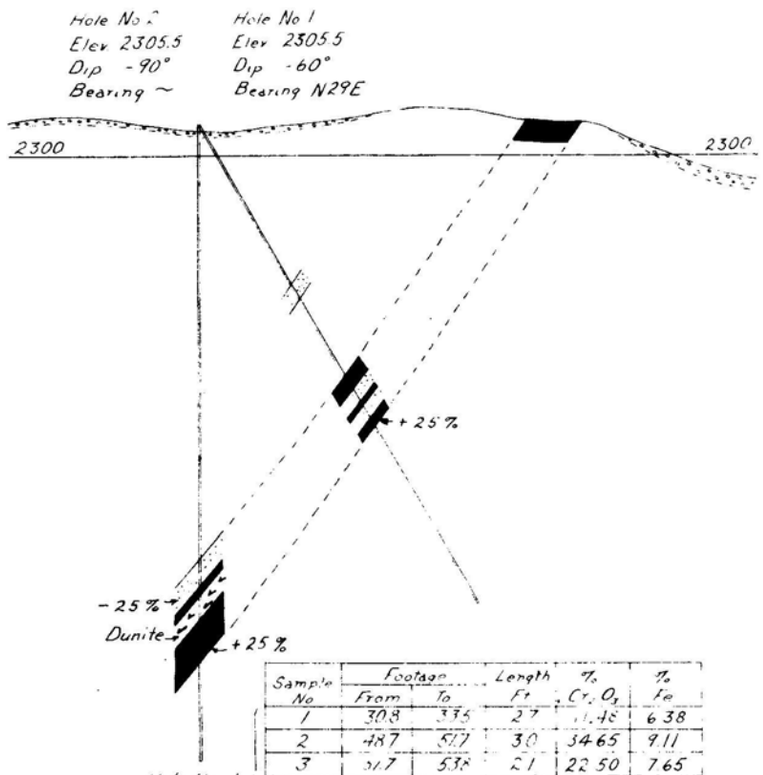
FIGURE 14.- Plan map, Juneau No. 1 deposit.



	Sample No	Footage From	Footage To	Length Ft	% Cr_2O_3	% Fe
Hole No. 3	1	256	274	18	24.45	7.80
	2	274	315	41	42.00	9.40
	3	315	350	35	23.70	7.92
Hole No 4	1	480	572	92	21.90	7.71

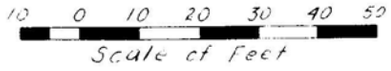
FIGURE 15.- Section A-A', Juneau No. 1 deposit, Red Mountain, Alaska.

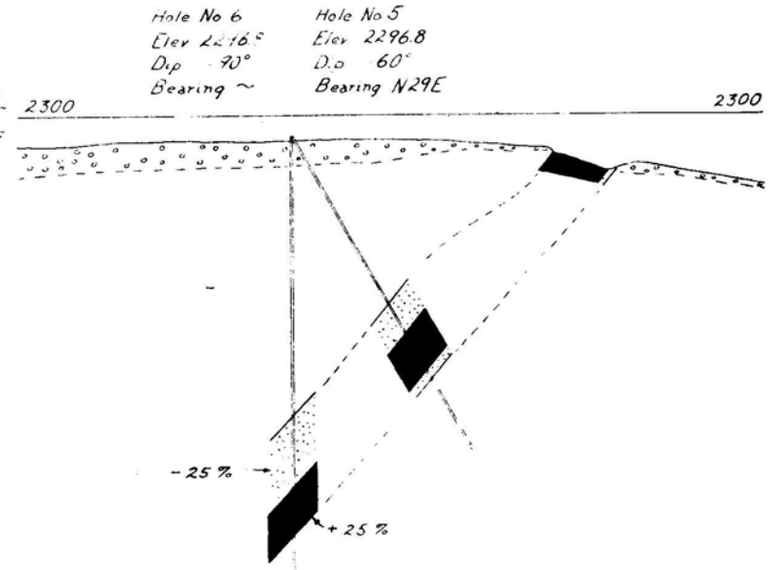




	Sample No	Footage From	Footage To	Length Ft	% Cr_2O_3	% Fe
Hole No 1	1	308	335	27	11.48	6.38
	2	487	517	30	34.65	9.11
	3	517	538	21	22.50	7.65
	4	538	550	12	38.70	9.65
	5	550	573	23	24.15	7.71
	6	573	586	13	38.30	9.37
Hole No. 2	1	735	780	45	14.67	6.80
	2	780	790	10	34.10	9.10
	3	834	905	71	38.50	9.25

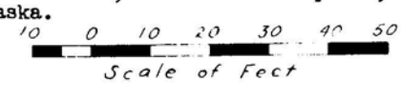
FIGURE 16.- Section B-B'. Juneau No. 1 deposit, Red Mountain, Alaska.





	Sample No	Footage From	Footage To	Length Ft	% Cr_2O_3	% Fe
Hole No 5	1	326	382	5.6	19.80	7.43
	2	382	403	2.1	35.70	4.10
	3	403	420	1.7	26.40	7.95
	4	420	455	3.5	42.50	9.96
	5	455	470	1.5	24.05	7.72
Hole No 6	1	300	475	17.5	6.95	5.48
	2	475	594	11.9	14.92	6.75
	3	594	673	7.9	30.60	8.45

FIGURE 17.- Section C-C', Juneau No. 1 deposit, Red Mountain, Alaska.



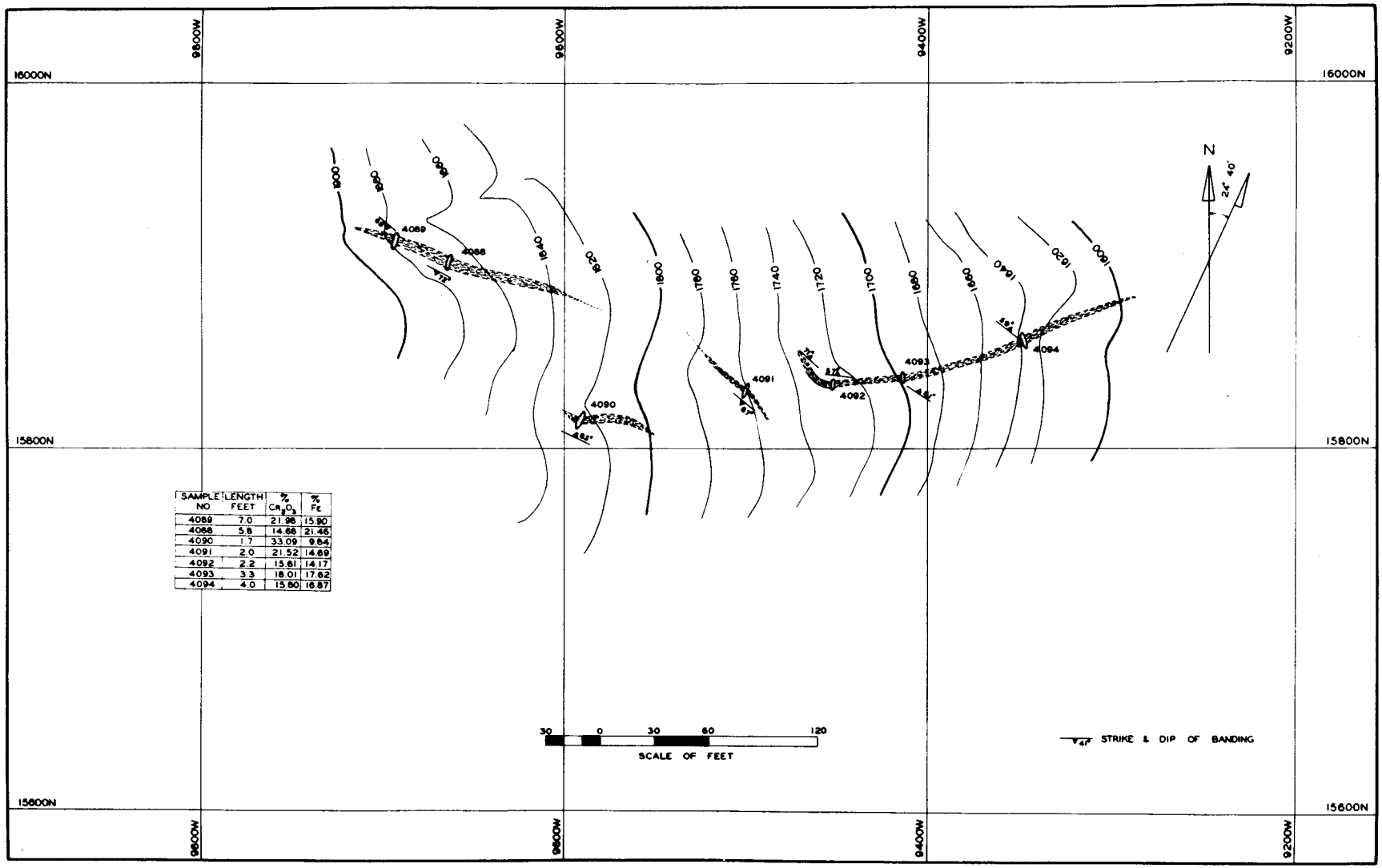


FIGURE 18.- Deposit 10, Edith No. V claim, Red Mountain, Alaska.

TABLE 1. - Juneau No. 1 trench samples

Trench No.	Sample No.	Length, feet	Cr_2O_3, percent	Fe, percent
A	4025	3.7	29.08	8.42
	4026	2.9	22.82	7.85
	4027	1.5	32.33	8.59
		8.1	27.44	8.25
B	4028	3.0	39.17	9.67
	4029	3.0	47.75	10.46
	4030	3.4	28.75	7.96
		9.4	38.14	9.30
C	4022	3.0	46.16	10.29
	4023	2.0	40.60	9.61
	4024	3.4	35.42	9.10
		8.4	40.49	9.65
D	4031	3.5	45.64	10.35
	4032	3.5	42.84	9.95
	4033	3.1	41.53	10.24
		10.1	43.41	10.18
E	* 4034	1.0	22.09	8.19
E	4035	2.3	41.13	9.70
	4036	3.6	41.81	9.78
	4037	2.3	44.80	10.24
	4038	1.8	31.97	9.04
		10.0	40.57	9.73
F	4039	1.4	35.68	9.22
	4040	2.0	37.81	9.50
	4041	2.1	41.61	9.72
	4042	2.2	46.23	10.42
		7.7	40.86	9.77

*Sample 4034 not included in average

Six diamond-drill holes, Nos. 1 to 6, inclusive, were drilled to explore this deposit at depth. Figures 15, 16, and 17 are vertical sections through these holes. Aside from trenching and core drilling, this deposit has not been developed.

Deposit 10

Two hundred and fifty feet south of the contact of the dunite intrusive on the west side of the Windy River Valley is a faulted deposit comprising two small and two medium-size lenses of chromite. This deposit, No. 10, is on the Edith No. V claim and ranges in altitude from 1,600 to 1,900 feet. The deposit has the most variable dips of any of the deposits investigated in the Red Mountain intrusive, dips having been recorded from 57° N. to 87° S., as shown on figure 18.

The ore appears to be high-grade but has a much lower chromic oxide content than was expected. According to Guild,[21] an unusual mode of origin is suggested both by the low tenor of the ore and by the fact that the trend of the ore body diverges at a small angle from that of the banding. This divergence is marked by narrow stringers of disseminated chromite grains. The body may have been formed in the fractured contact zone of the intrusive by late magmatic or hydrothermal action, or it may be the result of recrystallization. The first of these theories agrees with that of Sampson,[22] to whom the deposit appears to be a clear case of late chromite characterized by structural discordance, abnormal mineral association, and highly distinctive chemical composition.

The lowest and largest of the four lenses has been traced over a strike length of 180 feet. Samples 4092 to 4094, inclusive, were taken from this lens and have an average width of 3.2 feet. Though the general strike of the lens is N. 68° W. and the dip 59° northeast, the last 15 feet of the western end of the lens swings north with a strike of N.47° W. and a dip of 71° northeast.

Thirty-five feet west of the lowest lens is a small lens with a thickness of 2 feet at the widest point and a strike length of 50 feet. This lens has a strike of N. 51° W. and a dip of 87° southwest. Fifty feet southwest of the above is another small lens. Slightly warped, the average strike of this lens is N. 65° W. Although there is no large difference in strike between these deposits, the second lens dips 85° northeast and is exposed over a strike length of 50 feet.

Sixty-five feet north of the foregoing lens is the eastern end of the last of the series and second of the large lenses comprising deposit No. 10. Exposed over a strike length of 110 feet, this lens has an average thickness of 6.9 feet and an average strike of N. 55° W. and dips 68° southwest.

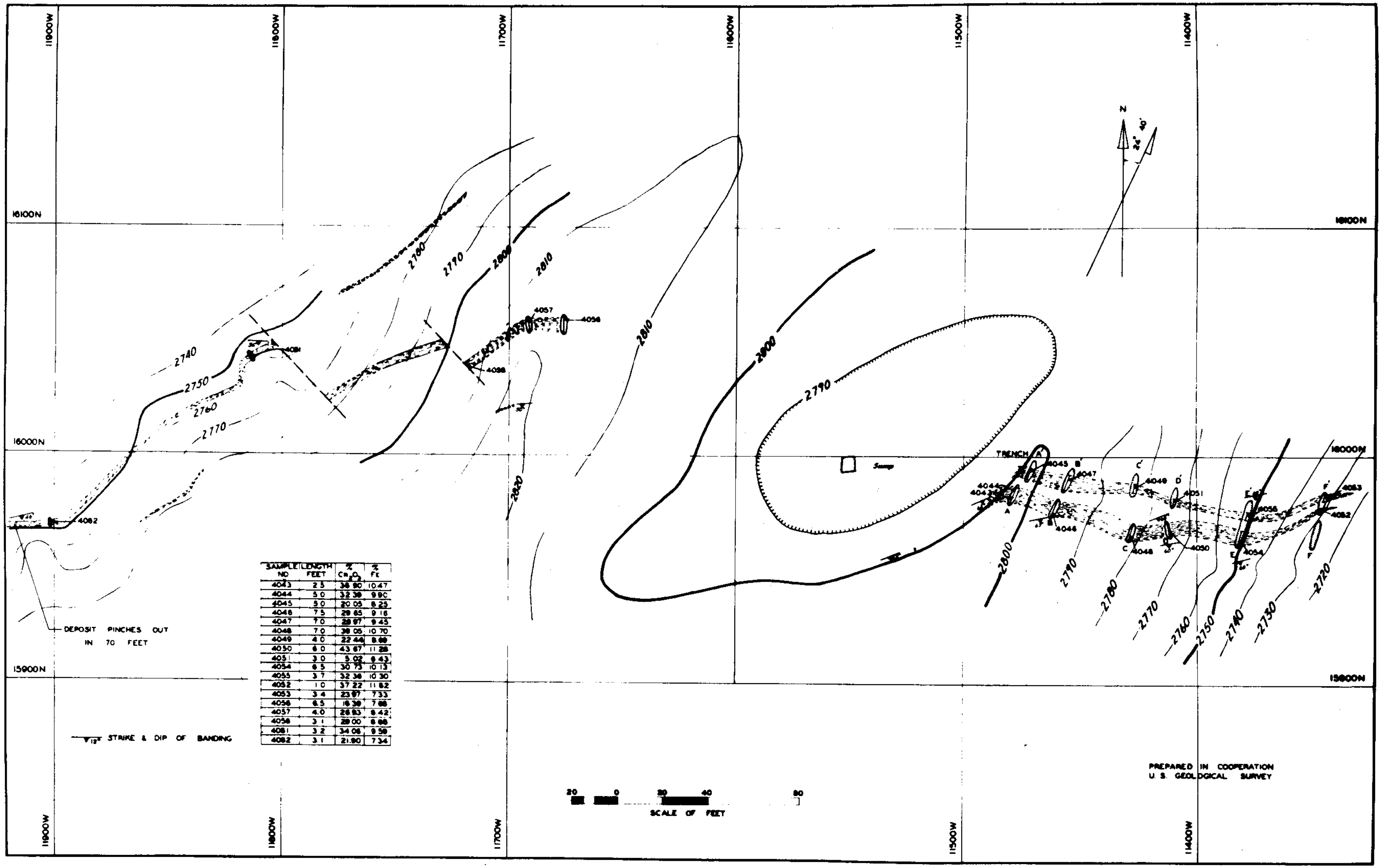
Deposit 10 is characterized by the steep, variable dips, low chromite content, and low chromium:iron ratio. This deposit has not been developed.

Deposit 11

Deposit 11 outcrops on the patented Juneau No. 2 claim 1,500 feet south of the dunite contact. Here a chromite-bearing zone is exposed on both sides of the high ridge forming the divide between Windy River and the headwaters of Fish Creek. At this point, the ridge has two crests, about 200 feet apart, divided by a shallow, talus-filled basin. Because of the depth of water-filled talus, it was impossible to trace either of the outcrops across the basin, but from the geologic evidence they are not believed to be one continuous lens (see fig. 19).

21/ Guild, P. W., Chromite Deposits of Kenai Peninsula, Alaska: Geol. Survey Bull., 931-G, 1942, pp. 170-171.

22/ Sampson, Edward, professor of geology, Princeton University, Oct. 19, 1939.



SAMPLE NO	LENGTH FEET	% Cr_2O_3	% Fe
4043	2.5	38.90	10.47
4044	5.0	32.38	9.90
4045	5.0	20.05	8.25
4046	7.5	28.65	9.16
4047	7.0	28.97	9.45
4048	7.0	38.05	10.70
4049	4.0	22.44	8.69
4050	6.0	43.67	11.28
4051	3.0	5.02	8.43
4054	6.5	30.73	10.13
4055	3.7	32.38	10.30
4052	1.0	37.22	11.82
4053	3.4	23.97	7.33
4056	6.5	16.38	7.88
4057	4.0	26.93	8.42
4058	3.1	29.00	8.88
4081	3.2	34.06	9.58
4082	3.1	21.90	7.34

FIGURE 19.- Deposit 11, Juneau No. 2 claim, Red Mountain, Alaska.

The chromite-bearing zone on the east slope consists of two parallel lenses, one high- and one low-grade, separated by an average of 6 feet of barren dunite. This zone has been exposed over a horizontal distance of 150 feet and vertical distance of 80 feet. Seven samples, 4043, 4044, 4046, 4048, 4050, 4052, and 4054, were taken from the higher-grade lens having an average width of 5.1 feet. Both the high- and low-grade lenses strike S. 75° W. and dip 61° S.

The parallel low-grade lens has been exposed and sampled by six trenches (fig. 19). An average width of 4.4 feet is indicated for this deposit by samples 4045, 4047, 4049, 4051, 4053, and 4055. These chromite-bearing lenses are composed of alternate bands of chromite and barren dunite, or dunite containing various amounts of disseminated chromite grains. The lower-grade lens, though continuous, contains a section near the middle where the higher-grade bands pinch out. A trench sample (4051) from this section contained only 5.02 percent chromic oxide over a width of 3.0 feet.

The west slope of the ridge is covered with large blocks of talus material; and, although exposures are poor, a low-grade lens cut by two faults was traced over a strike length of 313 feet. The average strike and dip of this lens is S. 80° W. and the dip 40° S. The first faulted segment of this lens has an average width of 4.5 feet over a strike length of 45 feet. The second segment has a strike length of 58 feet, and the remainder of the lens can be traced along the slope over a strike length of 210 feet. The width of this last segment averages 3.0 feet. This deposit has not been developed.

Deposit 24

This deposit is on the Edith No. 3 claim and outcrops at 2,040 to 2,330 feet altitude near the top of the cliffs south of the Chrome Queen mine and about 3,000 feet northwest of deposit 2 on the Star No. 4 claim. It consists of bands of high-grade and low-grade chromite separated by barren dunite. The chromite bands are cut by three faults, as shown on figure 20. To the east of the first fault, one band of chromite is exposed over a strike length of 230 feet, with an average thickness of 0.7 feet. Two samples, 4100 and 4101, were taken from this segment, which strikes N. 30° W. and dips 50° southwest.

Two bands of chromite are exposed in the second segment: First, a 1-foot band of high-grade chromite; second, 5 feet of barren dunite; and third, a band of low-grade chromite 0.8 foot thick. This segment has a strike length of 65 feet.

The third segment, with a strike length of 30 feet, is composed of three bands of chromite. The chromite-bearing zone is folded; and this, combined with a dip slope, gives an erroneous impression of the quantity of ore. Section A-B, (fig. 20) is a diagrammatic section showing the effect of the fault and folding on the ore zone.

The remainder of this deposit has a strike length of 190 feet. Striking N. 30° W. and dipping 40° southwest, this segment is composed of three bands of chromite, two high-grade and one low-grade. The middle lens splits near the eastern end of this segment to form the two high-grade bands in the previous section (see fig. 20). The lower and low-grade band on the north extends 125 feet westward from the fault with an average width of 1.0 foot. The upper, or southern lens is exposed over a strike length of 95 feet and has a thickness of 2.9 feet.

RUTLEDGE PROPERTIES

Three deposits (Nos. 12, 13, and 14), that are all or in part covered by claims held by R. E. L. Rutledge, have been explored by the Bureau of Mines and are described as follows:

Deposit 12

This deposit is on the Rutledge No. 3 claim 3,000 feet southwest of the dunite contact. The chromite-bearing zone outcrops along the west flank of the pyramidal peak on the divide south of deposit No. 11 (fig. 3). Composed of alternate bands of chromite and dunite, the chromite-rich zone is continuous but the individual bands of chromite are lenticular. Sections taken across the deposit at the sample locations show various numbers and thicknesses of the chromite bands (sample sections, fig. 21). The chromite bands are warped by folding while the magma was still plastic and cut by numerous faults showing small displacement.

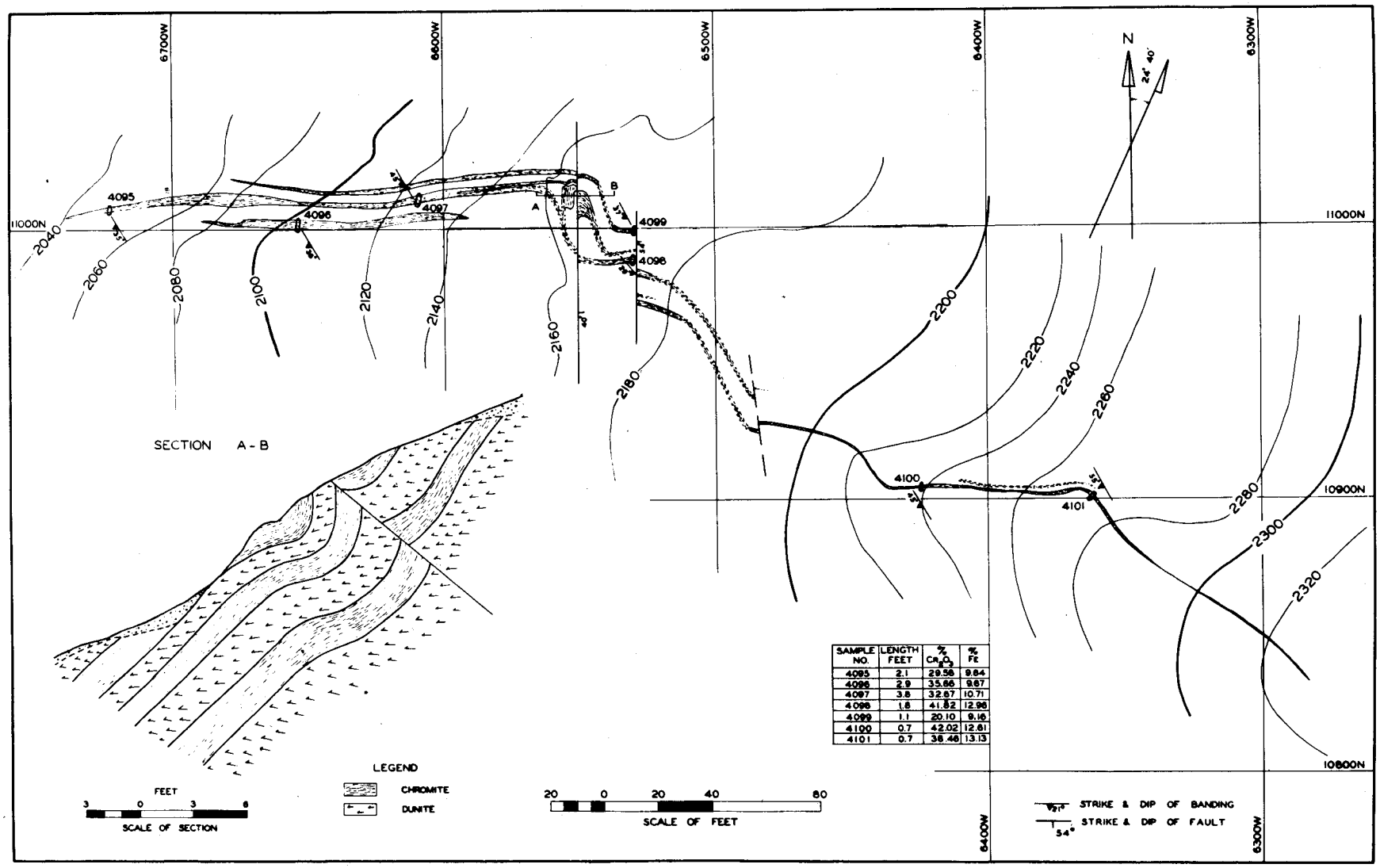
Six samples, 4059 to 4064, inclusive, were taken from this deposit striking S. 55° W. and dipping 43° southeast. The deposit ranges in altitude from 2,660 to 2,840 feet and is exposed for an average width of 2.2 feet over a strike length of 380 feet. This deposit has not been developed.

Deposit 13

Deposit 13 outcrops in the cliffs north of the south branch of Fish Creek 870 feet southwest of deposit 12 (fig. 3). This deposit consists of three zones of banded and disseminated chromite ranging in altitude from 1,980 feet to 2,320 feet (fig. 22). Sharp folding and numerous cross faulting have occurred, but the general strike of the deposit is S. 30° W. and the dip 45° southeast.

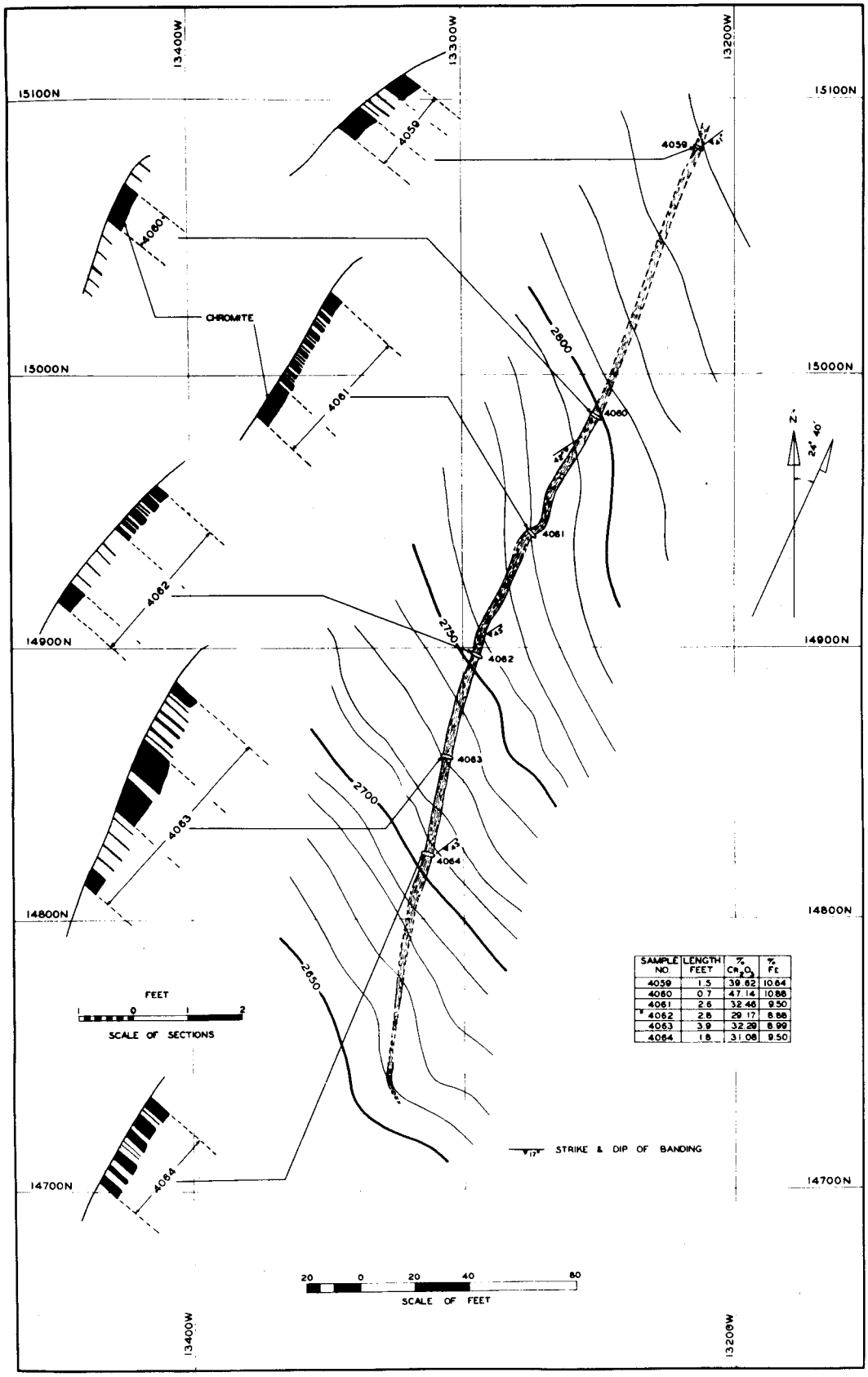
Sample 4065 was taken from the two 0.2-foot bands of high-grade chromite separated by 1.4 feet of barren dunite comprising the northern zone. Numerous narrow bands of chromite are also exposed in a parallel 1.2-foot zone beneath the bottom high-grade band. The banded phase of this zone is exposed over a strike length of 100 feet. At the south end of the banded zone, the individual bands pinch out, but the mineralized zone continues 300 feet southwest with the chromite occurring as disseminated grains in the dunite.

The middle zone is 370 feet southwest and along the same strike as the previous zone. Samples 4066 and 4067 were taken from this section composed of banded chromite and dunite. The bands are cut by several faults,



SAMPLE NO.	LENGTH FEET	% Cr_2O_3	% Fe
4095	2.1	29.56	9.84
4096	2.9	35.66	9.87
4097	3.8	32.67	10.71
4098	1.8	41.82	12.96
4099	1.1	20.10	9.16
4100	0.7	42.02	12.61
4101	0.7	38.46	13.13

FIGURE 20.- Deposit 24, Edith No. III claim, Red Mountain, Alaska.



SAMPLE NO.	LENGTH FEET	% Cr_2O_3	% Fe
4059	1.5	39.62	10.64
4060	0.7	47.14	10.88
4061	2.6	32.46	9.50
4062	2.8	29.17	8.88
4063	3.9	32.29	8.99
4064	1.8	31.08	9.50

FIGURE 21.- Deposit 12, Rutledge No. 3 claim, Red Mountain, Alaska.

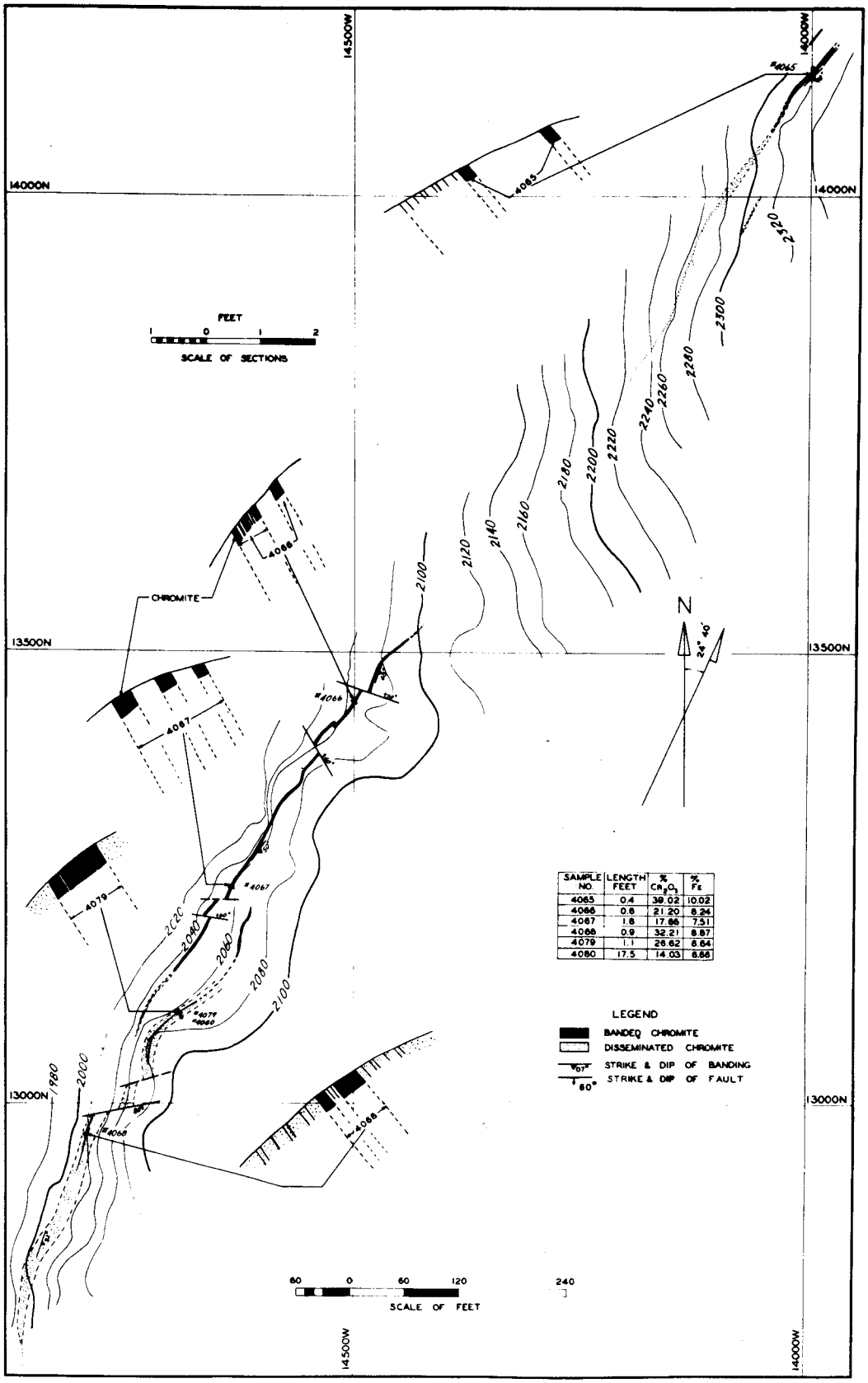


FIGURE 22.- Deposit 13, Rutledge No. 4 claim, Red Mountain, Alaska.

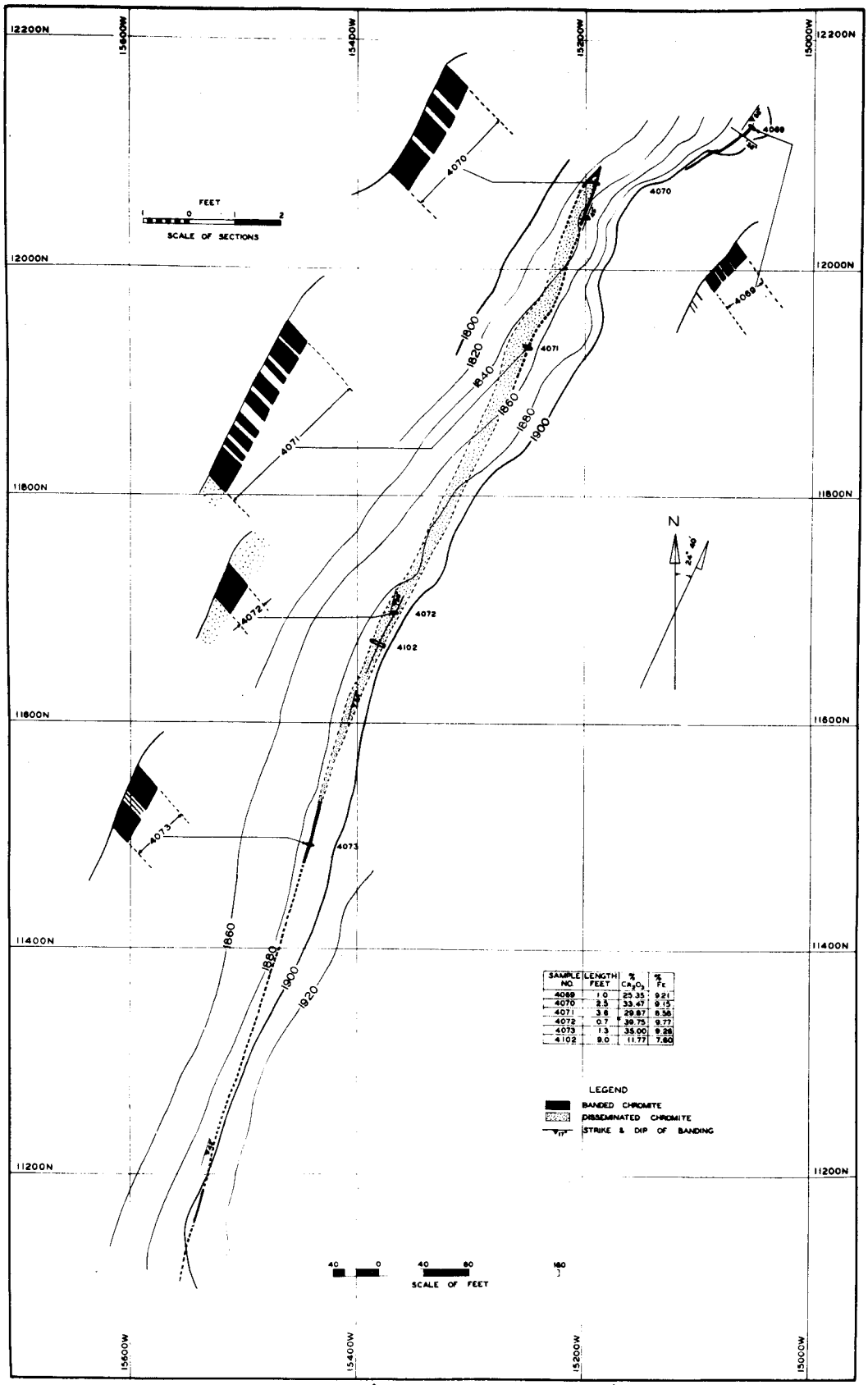


FIGURE 23.- Deposit 14, Rutledge No. 4 claim, Red Mountain, Alaska.

but the largest measured displacement is 8 feet. The average width indicated by sampling of this banded zone is 1.6 feet. The chromite bands are not uniform in thickness or continuous along the strike. The total length of this zone is 550 feet.

The third and southernmost chromite-bearing zone parallels the middle zone for 150 feet. This zone is composed mainly of disseminated chromite, though along part of the 540-foot strike length, it contains bands of chromite as well as disseminated chromite grains. Samples 4068 and 4079 were taken from banded occurrences of chromite within the disseminated zone. The average width of the banded chromite samples was 1.0 foot averaging 29.4 percent chromic oxide. One sample, No. 4080, was taken across the entire mineralized zone and contained 14.03 percent chromic oxide over a width of 17.5 feet.

Deposit 14

Along the same general strike of deposit 13, but 550 feet southwest and on the south side of Fish Creek, a chromite-bearing zone outcrops near the base of the cliff, as shown in figure 3. The deposit ranges in altitude from 1,820 feet to 1,900 feet and is composed mainly of disseminated chromite grains but contains some banded chromite (fig. 23).

Sample 4069 was taken from a 70-foot segment of banded chromite at the north end of the deposit that has either been faulted from the main deposit or is in a slightly higher horizon. This segment strikes S. 35° W., dips 55° southeast, and contains 25.35 percent chromic oxide over a width of 1.0 foot.

The strike of the main deposit is S. 16° W. and the dip 48° southeast, the mineralization consisting mostly of disseminated chromite grains. At the north end of the main deposit, a zone of banded chromite splits and forms two banded zones separated by disseminated chromite (fig. 26). The eastern banded zone can be traced over a strike length of 210 feet. Samples 4070 and 4071 were taken from this zone with an average width of 3.0 feet. The disseminated zone can be traced for 600 feet with an average width of 10 feet. Several small bands of chromite occur within the disseminated zone but these bands are not continuous. The mineralized zone continues to the south as banded chromite for 450 feet with an average width of 1.0 foot. There has been no development at this deposit.

TALUS IN WINDY RIVER CIRQUE

A large talus slope has accumulated in the Windy River cirque, at the base of Red Mountain, extending from the Chrome Queen claim almost to the head of Windy River. The material, ranging in size from fine sand to huge boulders, contains some high-grade chromite float.

Twenty test pits were dug. The first 8 pits were cut along the side of the truck road leading to the site of the adit proposed by Red Mountain Chromite, Inc. Only the samples from the first 3 pits contained chromite

in excess of that found in the normal dunite. Of the 12 test pits along the toe of the slope, samples from the last 8 pits were higher in grade than the normal dunite.

Figure 24 is a sketch map showing location of test pits, analyses of samples, and limits of the talus material. The limits of that portion of the talus containing chromite in excess of that contained in the normal dunite is also shown.

The test pits indicated that only a portion of the talus slope adjacent to a section of the cliff carrying a larger amount of chromite than the normal dunite can be considered. This area is 2,000 feet long and will average 500 feet in width. Of this 2,000 feet, 1,200 feet is covered by the Cliffside Lode claim, and the remaining 800 feet adjoins the claim on the north (see fig. 24).

Test pits were carried as deep as possible without excessive blasting of the larger blocks of dunite encountered in the talus. The depth of test pits therefore, is not indicative of the total thickness of the talus material. An average thickness of at least 6 feet is indicated for the talus material.

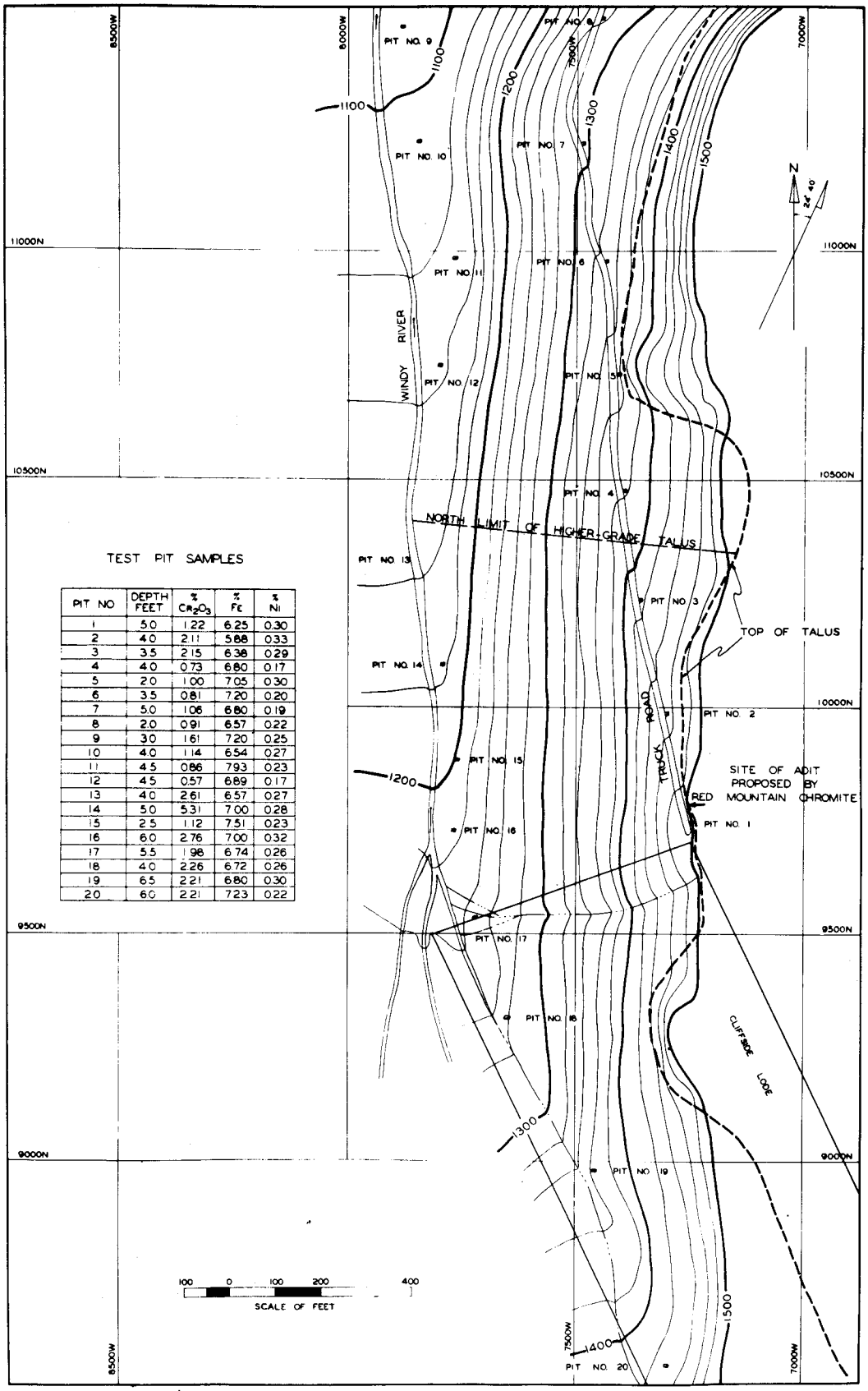
PLACER DEPOSITS

There are extensive deposits of gravel, composed principally of dunite from the Red Mountain intrusive, in the Windy River, Seldovia River, and Fish Creek Valleys. Panning tests were made of these deposits to investigate the possibility of concentration by stream action of the chromite from the dunite intrusive. None of these tests was indicative of a segregation of chromite-bearing gravel. The specific gravity of the chromite and dunite is 4.4 and 3.3, respectively. This difference in specific gravity is too small for any appreciable concentration to take place, especially in an unsized material.

NICKEL

The identification of nickel in the olivine at Red Mountain and the presence of serpentine suggested the possibility of an occurrence of nickel similar to that of the garnierite of New Caledonia. Fourteen samples were taken of the chromite, dunite, pyroxenite, garnet pyroxenite, and serpentine for mineralogical investigation and analyses of the nickel. Location and description of the samples follow:

Sample No.	Type of rock, minerals present, nickel content, and location
1	Pyroxenite: Essentially augite, with a very small amount of serpentine. Nickel content, less than 0.05 percent. Sample from outcrop of band southeast of small lake on Star Four claim in line with center line of adit.
2	Banded chromite: Essentially chromite, with considerable olivine and lesser serpentine. Nickel content, 0.12 percent. Banded chromite taken along outcrop of Star Four deposit.



TEST PIT SAMPLES

PIT NO	DEPTH FEET	% Cr_2O_3	% Fe	% Ni
1	5.0	1.22	6.25	0.30
2	4.0	2.11	5.88	0.33
3	3.5	2.15	6.38	0.29
4	4.0	0.73	6.80	0.17
5	2.0	1.00	7.05	0.30
6	3.5	0.81	7.20	0.20
7	5.0	1.06	6.80	0.19
8	2.0	0.91	6.57	0.22
9	3.0	1.61	7.20	0.25
10	4.0	1.14	6.54	0.27
11	4.5	0.86	7.93	0.23
12	4.5	0.57	6.89	0.17
13	4.0	2.61	6.57	0.27
14	5.0	5.31	7.00	0.28
15	2.5	1.12	7.51	0.23
16	6.0	2.76	7.00	0.32
17	5.5	1.98	6.74	0.26
18	4.0	2.26	6.72	0.26
19	6.5	2.21	6.80	0.30
20	6.0	2.21	7.23	0.22

FIGURE 24.- Sketch map showing test pits on talus, Red Mountain, Alaska.

Sample No.	Type of rock, minerals present, nickel content, and location
3	Dunite: Essentially olivine, with a minor amount of antigorite. Chromite occurred in bands and in disseminated crystals. A band of olivine, augite, and hornblende, about one-quarter inch thick, occurred on an edge of one of the specimens. Nickel content, 0.21 percent. Sample of dunite wall rock of Star No. 4 deposit was taken near discovery shaft on north side.
4	Serpentine: The dark-colored specimens were almost entirely antigorite. Some of the lighter-colored pieces were essentially augite, with lesser antigorite. Nickel content, 0.06 percent. The sample was taken from outcrop along "cat" road to the Star No. 4 deposit on the bench above Chrome Queen mine. The serpentine was taken near the contact with the pyroxenite and along the same strike. It is believed that this serpentine has altered from the pyroxenite.
5	Pyroxenite: Essentially augite, with a considerable amount of antigorite. A trace of magnetite was present. Nickel content, less than 0.05 percent. The pyroxenite was taken in band adjacent to the above sample and contained a small amount of serpentine.
6	Serpentine: The dark pieces were composed entirely of antigorite. The lighter green-colored pieces were composed of antigorite, with considerable augite and lesser olivine. Nickel content, 0.23 percent. Sample from outcrop in creek northeast of the Chrome Queen mine near contact with the sediments on north side of creek.
7	Dunite: Essentially olivine, with a few thin bands of chromite. Antigorite was present, especially in the dark, more heavily fractured pieces. Nickel content, 0.24 percent. The sample consisted of dunite containing some chrome from the banded chromite of deposit 14. Deposit 14 is on the west side of the Red Mountain intrusive near the south fork of Fish Creek.
8	Dunite: Fractured dunite composed essentially of olivine, with considerable antigorite and a sparing amount of chromite. Nickel content, 0.22 percent. The dunite was taken from the wall rock of the above deposit (deposit 14).
9	Serpentine: Antigorite, with considerable olivine. The antigorite was dark green and was intermixed with the olivine. Nickel content, 0.06 percent. Sample from outcrop near west contact of the intrusive mass on the saddle south of lake.
10	Garnet pyroxenite: Essentially augite, with much pyrope garnet. Nickel content, 0.12 percent. Sample from outcrop of garnet pyroxenite northeast of lake near contact.

Sample No.	Type of rock, minerals present, nickel content, and location
11	Serpentine: Antigorite, with lesser olivine. Nickel content, less than 0.05 percent. Serpentine taken from west side of Juneau No. 2 ridge near the north contact of the dunite intrusion.
12	Dunite: Essentially olivine and antigorite, with a minor amount of chromite. The olivine and antigorite were very closely associated, the antigorite being an alteration product of the olivine. Nickel content, 0.26 percent. Dunite from wall rock of the Juneau No. 1 deposit.
13	Dunite: Sugary-textured dunite, composed almost entirely of olivine, with small amounts of antigorite and chromite. Nickel content, 0.32 percent. Sample from wall rock of deposit 9 - Widow Maker.
14	Chromite: Essentially chromite, with admixed olivine. Nickel content, 0.14 percent. Sample from the Chrome Queen deposit.

Mineralogical identification and analyses of the above samples indicate that the nickel occurs principally in the dunite, the olivine averaging 0.25 percent nickel. Samples of the banded chromite and olivine contained less nickel in proportion to the olivine. The pyroxenite bands in the intrusive were composed principally of augite and contained 0.05 percent nickel.

There has been no apparent concentration of the nickel in the serpentine in the Red Mountain area. Of the four samples taken of the serpentine, only one contained nickel in an amount approximating that in the original dunite. A sample of the garnet-pyroxenite, composed principally of augite and pyrope garnet, contained 0.12 percent nickel.

Visual examination of the surface of the Red Mountain intrusive and identification and analyses of samples of its components failed to disclose any apparent concentration of nickel.

OTHER LODE DEPOSITS

There are numerous outcrops of banded and disseminated chromite within the Red Mountain intrusive other than those described in the present report. These deposits were eliminated from the program of exploration on the basis of small size and low grade.

MAPPING, SAMPLING, AND ANALYSIS

The base geologic and topographic map of the Red Mountain intrusive was completed by the Federal Geological Survey in 1940. Location of claims belonging to John W. Blodgett, Jr., was taken from a copy of the map prepared by Red Mountain Chromite, Inc., from notes for patent by a licensed surveyor. Other locations were taken from the claim map prepared by the Geological Survey. Transit surveys were made of the Chrome Queen

deposit, including all development and the Juneau No. 1 deposit, by the Bureau of Mines in 1944. The plan map of the Star No. 4 deposit was compiled from a topographic and geologic map by the Federal Geological Survey, a transit survey by Red Mountain Chromite, Inc., of its underground development and location of the deposit's outcrop, and a Brunton survey by the Bureau of Mines. A Brunton and tape survey of the Juneau No. 2 deposit was made during 1944 by the Federal Geological Survey and the Bureau of Mines. All other deposits were mapped by the Bureau of Mines, using Brunton and tape, during 1944.

Four- by two-inch channel samples were cut from the trenches as indicated and at intervals along the outcrops of deposits 12, 13, and 14. All samples were crushed and reduced in size before shipment to Anchorage for analysis by the Territorial Department of Mines.

Diamond-drill samples were split and half retained at the project with the rest of the drill cores. The samples were crushed and shipped to the Territorial Department of Mines for analysis. All drill cores were later shipped to Anchorage for storage so that representative sections could more easily be secured for testing of physical properties. Because of the banded high-grade nature of the ore, core recovery was stressed rather than rate of drilling. Core recovery averaged 92.1 percent in the dunite and 96.3 percent in the chromite-bearing zones when an EX double-tube core barrel was used. Holes were started AX, but only 18.9 feet of AX casing was available. Therefore, most of the drilling was EX.

Twenty test pits were excavated in the talus slope along the right limit of the Red Mountain cirque. Eight of these pits were along the road near the upper limits of the talus and the other 12 along Windy River. Every tenth shovelful was saved and quartered to make up the sample. The sample from each pit was split and one-half crushed and reduced for analyses. A composite was then prepared from the pits containing more chromite than the normal dunite and shipped to the Rolla Station of the Bureau of Mines for metallurgical testing.

Because of the heavy overburden and suspicion of faulting, drilling of deposit 23 (Chrome Queen) was planned to intersect the ore body at 50-foot intervals along the strike and at 35-foot intervals in depth. Deposit No. 2 (Star No. 4) was more regular and continuous however, and drilling was planned to intersect the ore body at only 100-foot intervals along the strike of the wider portion and at greater intervals to the north where the outcrop is narrower but still persistent.

Trenching of deposit 8 (Juneau No. 1) had indicated an ore body 85 feet long averaging 8 feet in width. Drilling was planned to intersect the ore body at 35-foot intervals along the strike. The depth of snow (18 feet - July 12, 1944) precluded a preliminary program of trenching as extensive as desired. Two holes were drilled from each set-up to intersect the ore body at 35-foot intervals along the dip.

BENEFICIATION OF RED MOUNTAIN CHROMITE

Results of beneficiation tests conducted by the Bureau of Mines on a sample of similar ore from deposit 10, Claim Point,23/ indicate that the low-grade ore is amenable to concentration. The sample 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 liberation and separation of this gangue mineral were the chief problems in treating the ore. The particles of chromite occur in veinlets and disseminated through the olivine.

A concentrate meeting Metals Reserve specifications for high-grade ore was produced from a feed having the following chemical analysis: 28.2 percent chromic oxide, 7.7 percent iron, and 19.2 percent silica. A recovery of 89 percent of the chromite was made as a concentrate containing 45.1 percent chromic oxide and 11.4 percent silica, with a chrome:iron ratio of 2.71:1.

The ore, crushed to minus 10-mesh, was ground to minus 48-mesh, deslimed by decantation, and sized by screening. The products were then tabled, and the table middlings were combined and ground to minus 65-mesh before retabling. The slime was recovered by settling and mixed with the minus 200-mesh middling and table concentrates to yield the final product. The final concentrate constituted 55.4 percent of the feed. Rejects consisted of the plus 200-mesh middlings and table tailing containing 14.15 and 5.9 percent chromic oxide, respectively. Complete data on test are shown in table 3.

Additional tests with finer regrinding of the table middlings gave higher recoveries with only slight lowering of grade of the final product. In both cases, the table tailing contained close to 6 percent chromic oxide. Although close sizing of the ore pulp, before tabling and extensive regrinding of the table middlings, was employed in the test work, in actual practice the process, probably could be simplified by grinding slightly finer and taking more middling material directly into the concentrates.

Flotation tests were unsuccessful as an ore-dressing method. The dissemination of a small amount of fine chromite in the gangue particles was thought to be responsible for the poor separation obtained by flotation. In the flotation work, two general principles were investigated: (1) Flotation and recovery of chromite using fatty-acid type reagents to float the chromite, and (2) flotation and rejection of the siliceous gangue material using cationic reagents to float the gangue.

Magnetic concentration alone recovered 74.0 percent of the chromite in a combined product assaying 43.4 percent chromic oxide. Combined magnetic and table concentration yielded a product containing 39.1 percent chromic oxide and effected a recovery of 96.9 percent of the chromite. The best results, however, were obtained using tabling alone, which also has the advantage of simplicity.

23/ Bureau of Mines, Claim Point Chromite Deposit, Kenai Peninsula, Alaska: War Minerals Rept. 253, 1943, 34 pp.

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: 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	2.85:1
Table middling (minus 200-mesh)...	5.3	25.15	7.0	23.6	4.7	85.1	48.4	11.7	6.9	2.83:1
Slime.....	6.0	17.90	8.6	25.8	3.9	89.0	45.1	11.4	9.0	2.71:1
Table middling (plus 200-mesh)....	5.5	14.15	6.2	31.6	2.8	91.8	42.3	10.9	11.0	2.66:1
Table tailing.....	39.1	5.9	4.7	35.4	8.2	100.0	28.1	8.5	20.5	2.26:1
TOTAL.....	100.0	28.1	8.5	20.5	100.0	-	-	-	-	-

Beneficiation tests conducted by the Bureau of Mines on a sample of talus material from the right limit of the Windy River cirque indicate that an excellent recovery of the chromic oxide content is possible by grinding, classification, and tabling. Weathering has released a quantity of the chromite as free grains, and has altered the olivine gangue in the smaller fragments to a soft limonitic material from which the chromite is released easily by grinding. From a feed containing 2.5 percent chromic oxide, 67 percent of the chromic oxide was recovered in a concentrate containing 46 percent chromic oxide and 19 percent iron. The chromium:iron ratio of 2.4:1 classifies the concentrate as "low-grade B" worth $27 a long ton at the local purchasing depot on tidewater.

Although the talus material ranged in size from fine sand to huge boulders, the sample as taken was minus 8-inch. Screen tests on this sample did not indicate any appreciable segregation in the several sized products. The results are shown in table 4.

TABLE 4. - Screen Test

Talus material right limit, Windy River cirque

Screen size	Weight percent	Cr_2O_3, percent	Percent of total
Plus 4 inch.....	15.72	2.41	20.5
Minus 4 plus 2 inch.....	23.57	.77	9.8
Minus 2 plus 1 inch.....	14.52	2.63	20.7
Minus 1 inch plus 4-mesh...	28.70	1.88	29.3
Minus 4-mesh...	17.49	2.07	19.7
Composite.....	100.00	1.85	100.0

Previous screen tests on a different sample of the same material were made after it had been crushed to minus 3/4-inch for the head sample. These tests indicate that 35.5 percent of the total chromic oxide is contained in the products between 20- and 100-mesh, which represents 17.7 percent of the total material. This product contained 5.13 percent chromic oxide. These tests indicate a possible recovery of 0.6 unit a ton of mined material by crushing to minus 3/4-inch, screening, and milling 17.7 percent of the whole tonnage.

METALLURGICAL INVESTIGATION ON RECOVERY OF NICKEL

Chemical analyses of the products of table concentration of the chromite in the talus material indicated that the nickel was intimately associated with the gangue minerals, of which olivine is the chief constituent. Four methods of recovering the nickel from the composite of the gravity rejects have been tried, namely: Roasting and magnetic separation, flotation, leaching, and electric-arc smelting. The composite contained 0.24 percent nickel. Neither flotation nor roasting and magnetic separation of the composite reject sample gave appreciable concentration of the nickel. Matte smelting gave little promise of success because of the high melting point of olivine mineral (3,500°-4,000° C.), with which the nickel is presumably combined or intimately associated.

In preliminary smelting tests in an electric-arc furnace, a charge consisting of 90 percent composite table rejects and 10 percent coke gave a metallic button containing 70.2 percent iron, 5.04 percent chromium, and 2.4 percent nickel. Additional electric-arc smelting tests have been made; tests in an induction furnace are also in progress. It is anticipated that by proper regulation of test conditions a nickeliferous product may be obtained that will recover a large portion of the nickel in the composite of table rejects in a commercially usable form.

Several different leach solutions were tested. Saturated sulfur dioxide, 5 percent sulfuric acid, and ammonium bicarbonate solutions all failed to provide any appreciable extraction of the nickel, even when preceded by a one-half hour reducing roast. Stage leaching with hydrochloric acid gave promise of a method for recovery of the nickel. In a one-stage hydrochloric acid leach test a nickel sulfide product containing 15.08 percent nickel was precipitated from the leach solution with a nickel recovery of 53.7 percent. In a two-stage hydrochloric acid leach test 80.0 percent of the nickel was recovered in a nickel-iron precipitate, and 71.1 percent of the magnesium was recovered as magnesium chloride. In the three-stage hydrochloric acid leach test a nickel precipitate was prepared that contained 52.5 percent of the nickel. The precipitate contained 37.77 percent nickel. The iron precipitate contained 0.65 percent nickel which showed incomplete washing of the iron precipitate. The nickel and iron precipitates together contained 85.9 percent of the nickel. About 65 percent of the magnesium in the sample was recovered as magnesium chloride. The talus material contains an average of 45 percent magnesium oxide.

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