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PROPERTY EXAMINATION REPORT

MAGNETIC EXPLORATION OF THE RED MOUNTAIN CHROMITE DEPOSITS, KENAI PENINSULA

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by

JAMES A. WILLIAMS
Associate Mining Engineer

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INTRODUCTION

The Territorial Department of Mines maintains a staff of mining engineers who are available to prospectors and mine operators for consultation, examinations, and other types of assistance with a view toward helping create new and increased mining production in Alaska. In line with this program, the Department did some geophysical exploration work for the Kenai Chrome Company, who are starting a chrome mining operation at Red Mountain on the Kenai Peninsula. The work was a magnetometer survey for the purpose of locating additional ore reserves for the company's future mining. The survey was done during July 25 to July 30, 1953, by James A. Williams and Martin W. Jasper, Associate Mining Engineers of the Department of Mines. The instrument used was a vertical Askania magnetometer of the Schmidt magnetic field balance type.

Since this report is concerned primarily with the geophysical work, other sections of the report are not so detailed as they would be if it were written on an examination of the property for its geological and economic possibilities. Further details on most of the subjects treated here with the exception of the magnetic work can be obtained from various U. S. Geological Survey Bulletins, Bureau of Mines R. I. 3885 by F. A. Rutledge on a drilling and sampling project there, and a Territorial Department of Mines report titled Some Chromite Occurrences at Red Mountain, Alaska written by J. C. Roehm, former Department engineer, as a result of his investigation there in 1941.

SUMMARY

The Territorial Department of Mines conducted a magnetic survey in July of 1953 at Red Mountain, Kenai Peninsula, in an attempt to locate extended ore reserves for the Kenai Chrome Company, who were starting mining operations on the Star No. 4 chromite deposit in that area. The area is a layered dunite intrusive containing numerous chromite bands or deposits. Although dunite has a relatively high order of magnetic susceptibility, chromite usually has a higher one because of its higher concentration of iron.

The survey was conducted by traversing with a magnetometer normal to the strike of the structures, taking readings nearly always at ten-foot intervals. The results are plotted on Plates III and IV in the form of profiles above the traverse lines. No anomalies were obtained in the vicinity of the Star No. 4 body that indicated an extension of the known structure or other independent chromite structures. Magnetic work was also done on the Juneau No. 1 deposit, and it was apparently successful, resulting in the finding of anomalies that indicate more chromite beyond the presently known limits of the body as shown on Plate IV. The probable reason for the success on this deposit is its greater width. It is recommended that more magnetic work be done around this deposit before further physical exploration is attempted. A third survey at Deposit No. 31 (staked as the Chrome Maverick Claim) failed because of highly magnetic serpentine in that vicinity.

Because of the uniform magnetic field over the Red Mountain dunite, it is considered that further magnetic exploration there for suspected chromite bodies of suitable size and grade would be conclusive if conducted where talus or float anomalies are not sufficiently large so as to obscure the chromite body anomalies.

ACKNOWLEDGMENTS

Acknowledgment and appreciation are due Mr. Mike Seiler and Mr. Norman Crooks, superintendent and foreman, respectively, of the Kenai Chrome Company mining operation, for their very courteous hospitality at the camp and their cooperation in assisting the exploration work. The writer also wishes to acknowledge the large-scale maps of the area and deposits made available by the Bureau of Mines which helped in planning and plotting the magnetic traverses.

LOCATION

Red Mountain is in the southwestern part of Kenai Peninsula and in the Seldovia Quadrangle at 151°29' west longitude and 59°22' north latitude. It is on the south side of Kachemak Bay, 8 or 10 miles inland from Jakolof Bay. Seldovia lies 10 airline miles to the northwest, and Homer is 20 airline miles north. The district is known as the Homer District. Recording for the precinct is done at Seldovia. The location can be seen on Plate I.

The locations of the individual deposits within the Red Mountain intrusive area can be seen on Plate II. Vicinities of Deposits Nos. 2 (Star 4), 8 (Juneau No. 1), and 31 (Chrome Maverick) were the areas investigated.

OWNERSHIP

The two lode claims presently under lease to Kenai Chrome Company are the Edith No. 11 and Star No. 4. They are patented and are owned by Union Carbide and Carbon Corporation. The Juneau No. 1 Claim is also patented and was owned by John W. Blodgett, Jr. in 1949, according to the latest available records. Since Union Carbide and Carbon are

reported to have acquired several claims in the area in addition to the two mentioned above, they may possibly own the Juneau No. 1 now also.

The claims Star No. 4, Edith No. 11, and Juneau No. 1 were surveyed for patent in U. S. Mineral Surveys Nos. 1421, 2155, and 1420, respectively.

PHYSICAL FEATURES

Rugged and precipitous mountain slopes rising to elevations of around 3000 feet are the main feature of the area. The dunite area, within which the chromite deposits occur, is immediately distinguishable by its lack of trees or vegetation in an otherwise heavily wooded country. The cutoff of vegetation at the dunite contact is sudden. By far the largest portion of the dunite area is covered with slide or talus, and some of the talus is quite large. Exposed bedrock as shown in the accompanying photographs is more of the exception than the rule.

The Star No. 4 and Juneau No. 1 deposits are located on relatively level ground, the former being on a shoulder of Red Mountain proper, and the latter on a bench about 400 feet below the top of the ridge running along the west side of the Windy River Valley. Deposit 31 is on the narrow crest of a steep-sided saddle in the northwest end of the intrusive area.

A well maintained road connects the old Chrome Queen workings at the base of Red Mountain (elevation about 1100 feet) with Jakolof Bay, a distance of 8 or 10 miles. This road follows up Jakolof Creek from the bay, goes over a low pass to Windy River, then up the Windy to Red Mountain. Good stands of spruce are located along the road. The road from the base of the mountain to the elevation of 2500 feet where the Star 4 deposit is located is very rough and steep, but can be negotiated

slowly with trucks. An aerial tram will carry the ore over this portion of the route. At the time of the survey, a permanent camp was being built at the upper elevation. The Juneau No. 1 Claim, about the same elevation on the west side of the valley, is connected with the road by a steep foot trail only. Since the time of writing, a tractor trail has been bulldozed up Fish Creek to Deposit 31 from the Seldovia cat trail.

Jakolof Bay is serviced regularly by the mail boat "Iliamna", which operates between Homer and Seldovia. A very small flight strip is located on a tide flat at Jakolof Bay that can handle only the smallest of planes. A larger strip was being constructed along the road in the Windy River Valley. Flights will be made from Homer on request by the Inlet Flying Service.

Two or three cabins exist at Jakolof Bay in which shelter may be had in case of an emergency.

CLIMATE

The climate in the vicinity of Red Mountain is rather wet, particularly at the higher elevations. An annual rainfall of about 60 inches could probably be expected. Snowfall is very heavy at the higher elevations, being sufficient to crush earlier buildings on the Edith No. 11 Claim flat to the ground. As is evident in the pictures, considerable snow was still on hand in late July, apparently a normal condition. Although winters in that part of the country are reportedly comparatively mild at sea level, they are cold and windy above 1000 feet. All earlier reports on the area that the writer has seen agree that no permanent camp can be successfully maintained above 1000 feet, but it is believed that subsequent operations will disprove this point.

GEOLOGY

Red Mountain proper is only a portion of the dunite area carrying the chromite bodies, all of which are referred to as the Red Mountain chromite deposits. The mass of dunite is roughly elliptical in plan, as shown in Plate II, and about 2 by 3½ miles in size with the major axis trending northwest-southeast. The rocks into which the dunite intruded are a series consisting of graywackes, slates, cherts, limestones and interbedded volcanics. 1/ Some pyroxenite is included in the dunite, and in a few limited places near the contact with the graywacke series, the dunite has altered to serpentine.

The dunite intrusive is of the layered type, probably formed by successive subsurface flows, with the chromite deposits formed as layers or bands parallel to and intercalated between the layers of dunite. The mineralization was no doubt a result of magmatic segregation, the chromite concentrating to greater or lesser degrees in the dunite to form the enriched layers. The chromite bodies are irregularly located and of various sizes from less than a foot to 12 or 15 feet thick and lengths up to hundreds of feet long. From observation, the grades also appear to vary from very slight concentrations to bands of nearly solid chromite.

The dunite layers, and hence the chromite deposits, usually strike parallel to the nearest contact and dip from very steep near the contact to nearly flat near the center of the mass. This gives a basin-like structure to the intrusive. It appears that there was a downwarping of the center after the flows. No large faults have been found. Roehm goes quite deeply into a detailed theory explaining the causes of the

1/ Philip W. Guild, Chromite Deposits of the Kenai Peninsula, Alaska: U.S. Geological Survey Bull. 931-C, 1942, p. 142.

structural features mentioned above. 2/ He also recommends that the talus-covered slopes be covered with a magnetometer survey to detect probable underlying deposits.

Of the three chromite bodies investigated for magnetic anomalies, the Star No. 4 deposit is the only one well exposed at the surface. It is in an area from which overburden has been fairly well eroded. The Juneau No. 1 deposit is mostly covered with a relatively thin layer of overburden consisting of fine talus, float, and soil through which a few outcrops protrude. Deposit No. 31 was completely covered at the time with relatively fine talus, and there was only small chromite float to indicate its presence. Some alteration of dunite to serpentine occurred in this vicinity. The four photographs are views of the Star No. 4 and Juneau No. 1 deposits.

MINERALOGY

Chromite is a chromium-iron oxide expressed chemically as $FeCr_2O_4$ or $FeO \cdot Cr_2O_3$. It is more or less magnetic, depending mostly on the iron content. The iron is an impurity, and the chromium:iron ratio must be at least $2\frac{1}{2}$:1 for a commercial grade ore or concentrate in addition to a required 45% Cr_2O_3 content to be accepted by purchasers without penalties. As a result of many assays by the Territorial Department of Mines on the Star No. 4 chromite for the Kenai Chrome Company, it appears that with fluctuations of the chromium content, the Cr:Fe ratio fluctuates in the same direction. These corresponding fluctuations of ore grade and Cr:Fe ratio do not alter the fact that the total iron content increases with richer ore. Hence, in this particular locality, at least, the better

2/ J.C. Roehm, "Some Chromite Occurrences at Red Mountain, Kenai Peninsula, Alaska": Territorial Department of Mines unpublished report, August 15, 1941, pp. 2-8.

Figure 1. Star No. 4 Deposit at Discovery Shaft, looking north. Magnetometer Station 0/00 this side of shaft. Contact between dunite and sedimentary series on far side of Windy River Valley seen in right background.

Figure 2. Star No. 4 Deposit near Traverse Line 0, looking north.

Figure 3. Star No. 4 Deposit near north end of Star 4 Claim, looking north.

Figure 4. Outcrops and float of Juneau No. 1 Deposit, looking west from about the western end of known deposit.

the ore, the higher is its magnetic susceptibility.

Dunite, which composes the mass of material enclosing the ore bodies at Red Mountain, is relatively magnetic as compared to most other rocks, but less so than the chromite. Pyroxenite, of which there are a few occurrences locally, is also a relatively magnetic rock. Serpentine has been reported by some geophysicists to have a slight magnetic susceptibility, but the serpentine encountered near Deposit 31 on the Chrome Maverick Claim proved to be roughly twice as magnetic as the chromite there. Probably its iron content was higher than usual.

MAGNETIC MEASUREMENTS

The magnetic measurements taken were of the vertical component only of the magnetic field at each station or point. The magnetometer used was a vertical Askania Schmidt-type field balance equipped with a temperature-compensated magnetic system. Its sensitivity was earlier calibrated and found to be 25.0 gammas per scale division.

During the course of the survey, hourly check readings were taken at one station used as a base to detect changes in the earth's magnetic field and in the instrument. When fluctuations in the magnetic intensity were found to have occurred, they were treated in the field-note calculations as linear with time, and readings taken in the interim were adjusted accordingly. The vertical intensity in gammas of the base station was chosen arbitrarily, and the intensity values of all other stations (except the Juneau No. 1 survey) were calculated relative to the arbitrarily-chosen value of the base station. Another base was chosen on Juneau No. 1 claim. Because of the distance involved, no "tie-in" in magnetic values was made between the base stations of the Star No. 4 and Juneau No. 1 surveys. Therefore, the heights of the profiles are not necessarily relative between the two widely-separated areas.

PROCEDURE

The problem was to locate anomalies indicating extensions of known chromite bodies or undiscovered deposits. Because of the magnetic nature of the Red Mountain chromite, it was considered probable that if traverses were run over chromite structures not seen at the surface, the resulting magnetic profiles of the traverses would indicate the presence of the chromite. The method of attacking the problem was to run the magnetometer traverses perpendicular to the strike of the formations so as to cross over as many structures as possible within the Star No. 4 and Edith No. 11 Claims. Stations were at close intervals because of the narrow bands. Sufficient traverses were surveyed so as to obtain profiles over a crossection of the two claims except where the terrain was too steep or the snow probably too deep for practical results. Several of the traverses were run over the outcrops of the Star 4 orebody to learn what anomalies would result from the known structure as an aid to interpreting the results over unknown structures. Also, four parallel traverses were run fairly closely adjacent (Lines 5.5N to 7N inclusive) to determine if the resulting profiles would reveal similarities that could be interpreted as having any bearing on the problem. Traverse Line 7N was interrupted in the vicinity of the camp because of probable interfering anomalies from equipment. These traverses are seen on Plate III.

It was intended to keep the Star 4 vicinity survey within the two claims leased by the Kenai Chrome Co., Star No. 4 and Edith No. 11. However, no claim posts or lines could be found on the ground, and their approximate locations were not known. For the purposes of plotting the claim lines on Plate III, the mineral survey plats on file at the Bureau of Land Management were later consulted, and it was found as shown on this plate that considerable of the traverses were run on Claims Edith Nos. 1 and 10.

Results in the vicinity of the Star No. 4 deposit not being favorable, it was decided to attempt to locate probable extensions of the Juneau No. 1 deposit, since it appeared the next most likely to cause large anomalies, even though no plans were in existence to mine it. One traverse was surveyed perpendicularly across the deposit to ascertain if a definite anomaly existed. When a definite increase in readings was obtained over the deposit, parallel traverses were run across the projected strike beyond the known extremities of the deposit as shown on Plate IV. Traverse profiles here indicate extensions of the known deposit.

At the request of Bill Lyons and Dallas Newell, recent locators of the Chrome Maverick Claim covering Deposit 31, a magnetic survey was started on their claim, but was soon abandoned because of highly-magnetic serpentine existing there.

Exclusive of the work on Deposit 31, magnetic measurements were taken over a total of 2545 feet of traverses, practically all of which readings were taken at ten-foot intervals. Notes were kept by Jasper, and Williams operated the magnetometer. The physical surveying was done by chain and Brunton. Values of the readings in gammas are plotted as profiles along the traverse lines on Plates III and IV. Readings, results of calculations, and other observations are recorded in Field Book No. M-3. Results are discussed in the next section.

RESULTS

A study of the magnetic profiles on Plate III reveals only two significant anomalies. These are on Lines 5S and 0 where the traverses crossed exposures of the Star No. 4 chromite body. The largest anomaly, about 1000 gammas, was found at Station 0/00 over the 8-foot outcrop near the Discovery Shaft in Line 5S. The negative anomaly immediately to the

east of the chromite is caused by the steep slope in that direction which caused the readings to be taken below the elevation of the outcrop, causing a negative attraction. As the horizontal distance from the outcrop increased, this negative effect decreased. The gentle slope of the magnetic profile down to normal on the west side of the peak is the result of the chromite dipping to the west and causing a gradually decreasing anomaly as it reaches greater depths below the instrument.

At Station 0+04W in Line 0, the traverse crosses the Star 4 deposit, and a small but significant anomaly of about 200 gammas is revealed. This anomaly also fades more gradually to the west because of the westward dip of the chromite layer. The deposit here is about 2 feet wide. Station 0+40W, Line 5.5N, shows no anomaly, although that station is on an 18" outcrop. It appears that the chromite band must be quite wide to cause a distinctive anomaly.

The disturbance on Line 3.5N was considered to be caused by remains of the earlier-mentioned crushed steel Quonset huts which littered this particular area. They apparently created a large negative anomaly, and then as the survey progressed down the slope below them, a small positive anomaly resulted.

Where parallel, the four Traverse Lines 5.5N to 7N, inclusive, show no significant similarities. No anomalies in the Star 4 area, other than the two mentioned, indicate chromite in interesting amounts.

Readings taken away from the chromite deposit and other disturbances were quite uniform, considering the magnetic nature of the dunite.

Results on the Juneau No. 1 Claim are encouraging. It appears that an extension of the chromite body beyond its known limits has been revealed. As mentioned earlier, this deposit is covered with overburden

except for occasional outcrops. Traverse Line 0 was run for a check on the known location of the deposit as determined by the Bureau of Mines, and the resulting anomalous readings at Stations 0/20N and 0/30N indicate the location of the deposit correctly. The anomaly is about 350 gammas.

Definite anomalies were found on Lines 0.4E, 0.9E, and 1.15E that indicate a continuing of the deposit beyond its known limit as shown by the profiles and dashed probable outline on Plate IV. There is a local change in strike between the known and indicated bodies, but the general trend of both is the same. The anomaly in Line 0.4E is small, about 200 gammas, but those in the next two lines are about 550 and 300 gammas respectively. The anomaly in Line 0.9E shows a definite increase of probably both width and grade of chromite from Line 0.4E. The Line 1.15E anomaly, being lower in intensity and having more gradual slopes on both sides than shown on Line 0.9E, indicates either a wider and lower grade section of the chromite, or else a thicker covering of overburden. In either case, the chromite deposit becomes too low-grade or too deeply buried to cause appreciable magnetic intensity at Line 1.4E, or ceases altogether before that line is reached. The apparent success of the Juneau No. 1 work is probably due to the greater width of this deposit. It averages 7 or 8 feet wide.

Beyond the west end of the known deposit, an anomaly of about 200 gammas (slightly larger than that of Line 0.4E) was detected on Line 1W that indicates probable chromite mineralization as shown on Plate IV. No appreciable extension of the anomaly was located on Line 1.25W however, so the mineralization either stops short of that line or is more deeply buried. The latter might be the case because the ground starts rising more rapidly in the vicinity of these two lines. On the other hand, the

Bureau of Mines' sampling shows a weakening of the grade of mineralization toward the western end of the known deposit. 3/

The indicated chromite body beneath Line 1W is offset to a fair degree from the general trend of the proven body. This may have been caused by the fault which is reported to terminate the chromite to the west. Further reflection on possibilities brings the opinion that it might be a small independent and isolated body, but the general geology of the area is not favorable to this sort of a deposit.

Attention is now called to the gentle rise of magnetic intensity values at the north end of Line 1W. This could possibly indicate that the chromite body to the west of the fault passes under Line 1W to the north of the end of the magnetic traverse. A small indication of mineralization beyond the fault mapped by the Bureau of Mines helps this possibility. Line 1W should have been traversed further to the north to settle the question.

It will be noticed in the Juneau No. 1 profiles that in at least three of the anomalies, the shape is typical of that of a rather gently-dipping ore body. Also, the readings away from the chromite were quite uniform, as before.

Upon commencing the magnetic measurements for Mr. Lyons and Mr. Newell at the Chrome Maverick deposit (No. 31), extremely high and erratic readings shortly made it clear that here was something entirely different than before encountered. In addition to the numerous small chromite float scattered around, serpentine was also present. Approximately equal-sized specimens of each of the two minerals were alternately and

3/ F.A. Rutledge, Exploration of Red Mountain Chromite Deposits, Kenai Peninsula, Alaska: U.S. Bureau of Mines R.I. 3885, April 1946, p. 13.

separately moved over and then under the magnetometer while reading the free-swinging magnetic system to note the amounts of deflection. It was found by this method that the magnetic susceptibility of the serpentine is roughly twice that of the chromite. Obviously, magnetic exploration for the chromite in this locality was out of the question, so that particular project was abandoned. (It has since been reported that Mr. Lyons has excavated at this location and found a good chromite structure, some of the best ore being below where the highest readings were obtained. Thus it appears that it was not the serpentine alone causing the abnormally high anomalies).

CONCLUSIONS

The magnetometer survey failed to reveal any anomalies in the vicinity of the Star No. 4 deposit that indicate extensions of that body or other chromite bands nearby. An apparently successful survey was conducted, however, at the Juneau No. 1 deposit that indicates extensions beyond the limits of the presently known body as shown on Plate IV. The third portion of the magnetic work on Deposit No. 31 failed because of a highly magnetic serpentine in that area that causes a greater anomaly per unit than the chromite.

The reason for the greater success at the Juneau No. 1 Claim is considered by the writer to be because of the greater width of that deposit. It appears that in the case of chromite bands dipping 40° or more, an exposed and fairly high-grade deposit of less than two feet in width will not cause a distinctive anomaly. Other factors being equal, higher grade deposits of the Red Mountain type will create larger anomalies. Greater widths at the same depth and grade will give higher anomalies. It

follows that exploration for extensions of narrow chromite bodies with a magnetometer in this district is not practical unless they are more flat-lying.

If mining or development should ever be proposed for the Juneau No. 1 deposit, it is recommended that further magnetic exploration in the vicinity be performed in advance. Other deposits of a similar nature and situation should be investigated for significant anomalies also, if further magnetic work is to be done in the area.

The magnetic field over the dunite intrusive at Red Mountain was found to be remarkably uniform for a material of its high magnetic susceptibility, as opposed to the Red Bluff Bay dunite for example. 4/ Because of this uniformity, a magnetic survey at Red Mountain where the talus or overburden is not too coarse nor too deep is very likely to be successful in locating chromite deposits of the qualifications discussed above. A sharp watch for the magnetic serpentine would of course be advisable at all times.

As to Roehm's recommendation that slopes covered with talus be explored by magnetometer 5/, the steeper slopes where the talus is large would be very difficult to traverse, and the terrain and float anomalies would be large. Stations would of necessity have to be spaced at not more than five-foot intervals in an attempt to smooth out the float anomalies, and the resulting profiles would probably still be too erratic to successfully locate any but abnormally large deposits. It

4/ J.A. Williams, "Magnetic Investigation of Chromite Deposits at Red Bluff Bay, Baranof Island": Territorial Department of Mines unpublished report, October 1953, p. 2.

5/ Roehm, op, cit., p. 15.

would possibly be worth the time and expense, however, to try it in a limited selected area if someone were sufficiently interested.

James A. Williams
Associate Mining Engineer