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GEOLOGIC AND MAGNETIC SURVEY OF CHROMITE DEPOSITS, CLAIM POINT, ALASKA*

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Abstract

On Claim Point, a small peninsula near the tip of Kenai Peninsula in SW Alaska, a number of chromite deposits occur in an intrusion of dunite that consists almost entirely of olivine with accessory chromite. In the richer deposits the chromite is a product of late magmatic segregation, while in the lean ore and in the dunite the chromite crystallized earlier than the olivine. In the main ore zone and probably in others as well, the emplacement of the ore was controlled by shearing stresses which were apparently operative both before and during the introduction of the chromite-rich magma, and which continued after final consolidation.

A magnetic survey demonstrated that moderately large positive anomalies exist over the shallow-lying deposits, while the magnetic field over the surrounding dunite is relatively uniform and of lower intensity. A magnetic survey of the whole area underlain by dunite would therefore be of value in any search for additional chromite deposits, especially where the surface is covered by overburden.

Introduction

For many years chromite deposits have been known to exist on Claim Point, a small peninsula near the tip of Kenai Peninsula in southwest Alasma (Fig 1). During 1917 and 1918 about 2000 tons of shipping grade ore was mined from one of the larger deposits on Claim Point. Since then the deposits have lain idle except for occasional prospecting and development work.

In 1918 and again in 1940 the area was examined and mapped, and estimates were made of ore reserves based on surface samples.[1] In December, 1941, a new camp was built and preparations

[1]References are at the end of the paper

were made for renewed development and mining. Early in 1942 a surface sampling and core drilling program was conducted by the U. S. Bureau of Mines.[2] Following this the writer was invited to examine the deposits and conduct a magnetometer survey to determine if unknown orebodies, or extensions of known ones, could thereby be indicated. The examination and magnetic survey were made during the period June 8-17, 1942. Plans to extend the magnetic survey to adjoining areas were abandoned when mining development was discontinued in July, 1942.

Although the primary purpose of this paper is to describe the results of the magnetic survey, some features of the mineralogy, structure and paragenesis of the deposits are also discussed briefly, since the writer's views differ in a few respects from those already published.

Description of Deposits

The chromite deposits occur in an intrusion of dunite, which to the north is in contact with slates and graywackes (Fig 2). Dunite probably forms the bedrock of all of Claim Point, but it is exposed only in the higher parts and along the shore. Glacial till, gravel and dense vegetation cover the lower parts of the peninsula.

Mineralogically the dunite is simple; it consists essentially of olivine and sparsely disseminated chromite, together with a very small amount of magnetite and minor alteration products of olivine. Occasional thin seams of olivine and augite cut the dunite and the chromite ore. Except near the contact with the graywacke, where it has in part altered to serpentine, the dunite is relatively uniform in appearance and composition. A composite sample taken from near the ore contained: 1.8 percent Cr_2O_3, 5.5 percent Fe, and 44.5 percent MgO. Farther from the ore the chromite content decreases slightly, while the iron and magnesium oxide contents are approximately 6 percent and 40 percent, respectively.[2]

Two generations of olivine, each containing disseminated chromite, are present in the dunite. The early olivine grains are relatively large - up to six mm long - and are considerably strained and fractured, but are little altered to serpentine. Most of the chromite disseminated in this olivine crystallized at an early period from the magma, as rounded to euhedral grains about 0.5 mm in diameter.

The later olivine was deposited as fine grains in irregular veinlets and cracks around the coarser olivine crystals. These grains are less strained, but are somewhat more serpentinized than the older olivine. The chromite associated with the later olivine is generally fine-grained and irregular. It is later than the second generation of olivine and is apparently contemporaneous with the serpentinization.

Chromite and olivine are practically the only constituents of the ore; thus it differs from the dunite mainly because of its higher chromite content. The ore occurs in steeply dipping sheets and irregular lenses, which range in size from thin streaks in the dunite to bodies several feet wide and perhaps 100 feet long, and in tenor from a few percent to over 50 percent Cr_2O_3.

Most of the individual deposits are found in groups of varying size, in which higher grade lenses and sheets are separated by lean and nearly barren material. Thus, while parts of these composite orebodies are high-grade, the bulk of the material is below shipping grade. The largest composite orebody has a maximum width of 80 feet and a length of about 300 feet.

Only two orebodies of commercial size are known; they are the Reef deposit at the southeast tip of Claim Point, and Bluff No. 1 deposit about 2000 feet northwest (fig 2). Bluff No. 1 and a number of smaller deposits strike N50-60°E - slightly divergent from the more easterly strike of the dunite layering - and are arranged en echelon in an east-west trending zone. The Reef and most of the remaining deposits may be similarly arranged in zones, but exposures were insufficient to permit detailed examination. In general they lie parallel to the steeply dipping dunite layers.

Most attention was paid to the Bluff No. 1 ore zone, where bedrock was exposed in a number of trenches. Drag folds and small, healed, steep faults are conspicuous in this zone. Many of the drag folds pitch northeast at 15-25°, and some of the ore lenses are elongated parallel to the axes of the folds. Some of the small dikes that cross the ore are displaced by healed faults. Facing northeast, their displacements are to the right. These features are mainly associated with the richer ore; they are less noticeable in the lean ore and are generally absent in the adjoining chromite. In addition, the richer individual ore bodies strike more to the north than the lean ore and the dunite (Fig 3 and 4).

A number of steeply dipping, unhealed faults also cross the ore zone. Along any single fault the horizontal displacement is seldom more than a few feet, but since it is usually in the same direction as that of the healed faults, the aggregate displacement along the ore zone may be considerable.

All of these features; the echelon position of the orebodies, their drag folds and healed faults, and their elliptical shape in vertical-longitudinal section, indicate that shearing occurred along Bluff No. 1 ore zone prior to the consolidation of the chromite-rich magma. Similarly, the lack of these features in the lean ore and in the adjoining dunite indicates that they were sufficiently consolidated to transmit the shearing stresses.

Conceivably, the ore could have been emplaced before the shearing occurred; a more likely explanation, however, is that it was introduced into shear joints during movement along the zone, and that additional movement produced the flow features and the post-consolidation faults.

Thin sections of rich ore show chromite occurring in grains and in aggregates surrounded by olivine. The olivine is considerably strained and cracked, but is little altered to serpentine. Some of it has been replaced by chromite, and many of the chromite grains enclose partly replaced grains of olivine. Most of the chromite in the rich ore is therefore later than the associated olivine. It is largely a product of late magmatic segregation, although a minor amount was apparently deposited by still later hydrothermal solutions. In the dunite and in some of the lean ore, on the other hand, the chromite formed earlier than, or was contemporaneous with the olivine.

Several features disclosed by the brief geologic examination aided in planning the magnetic survey and in interpreting results. Thus, the uniform nature of the dunite and the absence of large faults indicated that relatively small magnetic variations would be associated with the dunite in spite of its paramagnetic character. In addition, the position and shape of the orebodies indicated that any associated magnetic variations would be found nearly directly over them.

Magnetic Survey

Field Measurements

In order to learn something of the magnetic properties of the dunite and the chromite, and of the magnitude of the anomalies to be encountered, several field tests were made before the magnetometer survey was run.

Tests with an alnico magnet fitted with pole pieces showed that although both materials are paramagnetic, the permeability of the ore is considerably higher than that of the dunite. Fragments of chromite 1-2 mm in size were readily attracted by the magnet, while similar fragments of dunite were only slightly attracted. In addition, 10-pound specimens of ore, held alternately above and below the magnetometer, produced deflections roughly proportionate to the grade of the ore. A maximum deflection equivalent to a change of 70 gammas was produced by high-grade ore. Similar specimens of dunite produced deflections of only a few gammas. A dip needle, sat normal to the magnetic field when held over dunite, was deflected up to four degrees over high-grade chromite lenses, indicating positive anomalies up to 1500-2000 gammas. Little increase in dip was noted over small and low-grade orebodies.

A vertical field balance with a sensitivity of 40 gammas per scale division was used for the magnetometer survey. Traverses were run over most of the orebodies, but a more detailed survey was made only of the Bluff No. 1 ore zone, where ample sampling data were available. A total of 192 stations were occupied in four and one-half days. Two days were lost because of magnetic disturbances. A forecast of probably magnetic conditions, supplied by the College Observatory of the Carnegie Institution, was of considerable aid in planning the survey. Since only one magnetometer was available, diurnal and other corrections were determined by hourly checks at base stations.

Results

Positive vertical anomalies, varying between a few hundred and 1800 gammas, were found over all of the larger and higher grade individual orebodies. The areal extent of these anomalies corresponded closely to that of the ore exposed at the surface of bedrock. Magnetic profiles across composite orebodies thus consist of a series of highs, located directly over the high-grade lenses or sheets, separated by lows, located over the low-grade material.

Some typical profiles are shown in Figs. 5-11, together with the corresponding chromic oxide and iron contents[2] of ore and dunite at the top of bedrock. Only those samples taken directly beneath their corresponding magnetometer stations were used in this comparison. Where stations were located between two adjoining samples, the mean of the two analyses was used; and in a few cases where stations were offset several feet from any samples, weighted mean values of several analyses were used. In order to extend the comparison to the adjoining dunite, where detailed sampling data were not available, the chromic oxide and iron contents of a composite sample were used.

As might be anticipated, the anomalies are determined largely by the tenor of the near-surface ore, although other factors are of course effective. Profiles over some deposits with abnormal chromium-iron ratios indicate that the anomalies are more closely related to the iron than to the chromium. This distinction, however, is of little importance, since with a few exceptions the iron content increases with increased chromium, although the iron-chromium ratio decreases with increased chromium.

Figs 12 and 13 indicate that in general the vertical intensity anomalies are proportionate in magnitude to the chromic oxide and iron contents of the material at the top of bedrock. The scatter in these graphs is a measure of the influence on the anomalies of factors other than are tenor, the most important of which are size, shape and position of the deposits. Thus the presence of ore-bodies that do not outcrop at the surface may be anticipated where positive anomalies are encountered over areas of low surface tenor. The parabolic trend of the points is probably a function of the size of the orebodies rather than of their tenor.

Fig. 14, a magnetic contour map of the Bluff No. 1 ore zone, shows the region of high but irregular intensity over the ore, and the lower and more uniform field over the dunite. To show in addition the correlation of magnetic anomalies with the individual deposits would require a smaller contour interval than was convenient to use here, as well as some method of indicating the position and tenor of these deposits without introducing confusing detail.

Summary and Conclusions

The Claim Point chromite deposits are magmetic segregations in which hydrothermal processes played a minor part. The chromite in the lean ore formed earlier than, or contemporaneous with the olivine; while the richer ore formed at a late magmatic stage, after the partial consolidation of the enclosing dunite.

At least one ore zone, the Bluff No. 1, is coincident with a zone of strain which was probably established before the emplacement of the ore and which therefore governed its emplacement. Drag folds and faults along this zone show that movement continued after the introduction of the ore; and unhealed step faults show that additional movement took place after its consolidation.

Other small, near-surface chromite deposits doubtless remain undiscovered in this known mineralized area. Whether or not additional ones exist outside this area cannot be determined from geologic evidence alone. It is apparent, however, that if the zone of strain that controlled the emplacement of ore along the Bluff No. 1 zone continues westward, additional large deposits are more likely to exist here than in undisturbed areas. Similarly, other deposits might be anticipated along the strike of the Reef deposit, but unfortunately they would lie under water.

Over the dunite the vertical magnetic field is relatively uniform, while over the chromite it is considerably higher and is approximately proportionate to the tenor and size of the deposits. Because of the large anomalies encountered over known deposits, it should be possible to indicate the presence of similar near-surface deposits even when covered by considerable thicknesses of overburden. Deeper lying deposits could also be indicated, provided their magnetic fields are not masked by overlying ore. Close spacing of magnetometer stations would be necessary in any complete survey of the area, because of the small areal extent of anomalies associated with near-surface deposits.

Excluding deposits underlying known ore, any new deposits must be sought in areas covered by thick overburden. For this reason additional prospecting should be preceded by a magnetic survey in order to eliminate some of the relatively slow and expensive trenching and diamond drilling. However, since on the whole the ore is of marginal grade, the present economic feasibility of additional work is doubtful.

In the writer's experience the Claim Point dunite is unique among ultrabasic intrusions in that a large part of it is magnetically uniform. It is unlikely that similar favorable conditions for magnetic exploration exist in many other chromite-bearing areas.

Acknowledgements

The writer is indebted to the staff of the Red Mountain Chromite Co. for their hospitality and cooperation during his stay at Claim Point; to R. S. Sanford, District Engineer of Alaska, U. S. Bureau of Mines, for sampling data; and to E. H. Bremhall and S. L. Seaton of the Carnegie Institution of Washington, for forecasts of magnetic conditions and for daily magnetograms.

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1. A. C. Gill: Chromite of Kenai Peninsula, Alaska: U. S. Geological Survey, Bulletin 742, (1922)

   P. W. Guild: Chromite Deposits of Kenai Peninsula, Alaska: U. S. Geological Survey, Bulletin 931-G (1942)

2. Claim Point Chromite Deposit, Kenai Peninsula, Alaska; U. S. Bureau of Mines War Minerals Report 253 (1943)

(After P. 4)

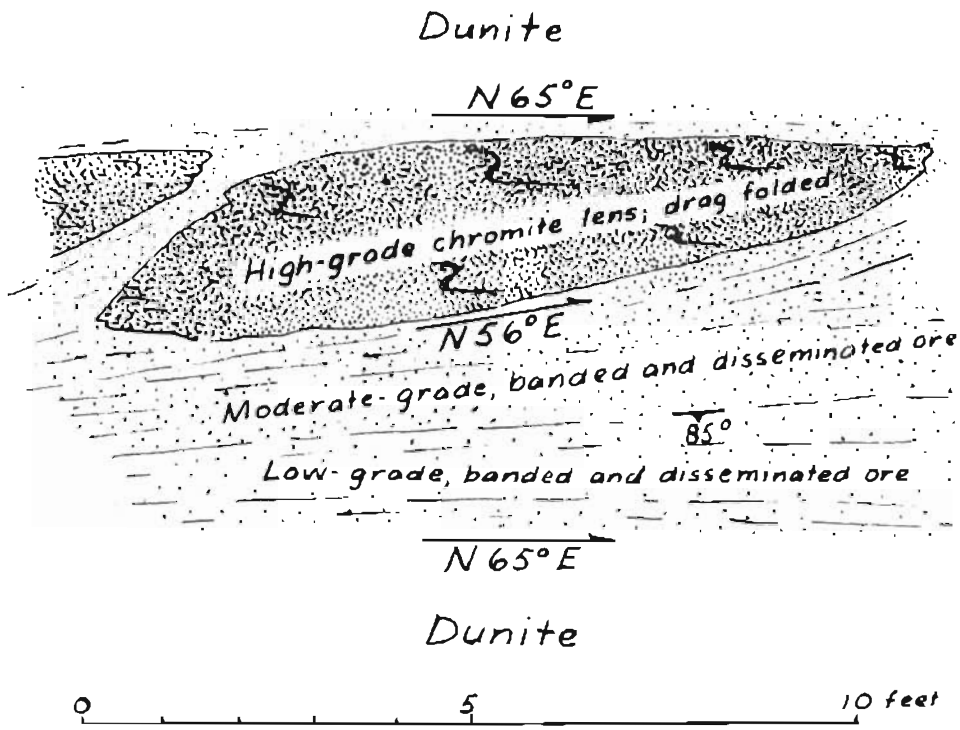

FIG. 4. — SKETCH SHOWING DIVERGENCE OF STRIKE OF HIGH-GRADE ORE LENS FROM THAT OF LOW-GRADE ORE AND DUNITE.

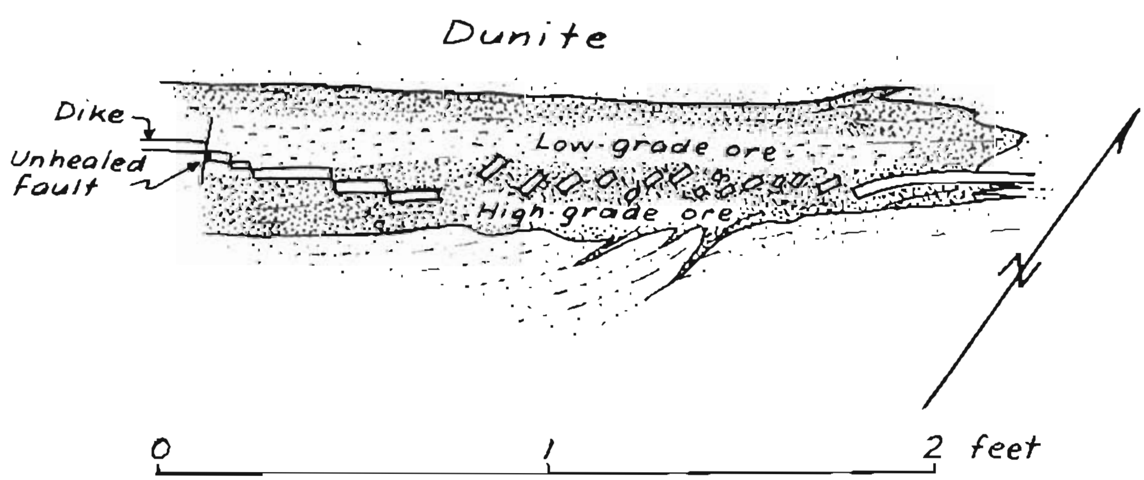

FIG. 3. — SKETCH SHOWING HEALED STEP FAULTS AND DRAG IN RICH ORE.

(After P.7)

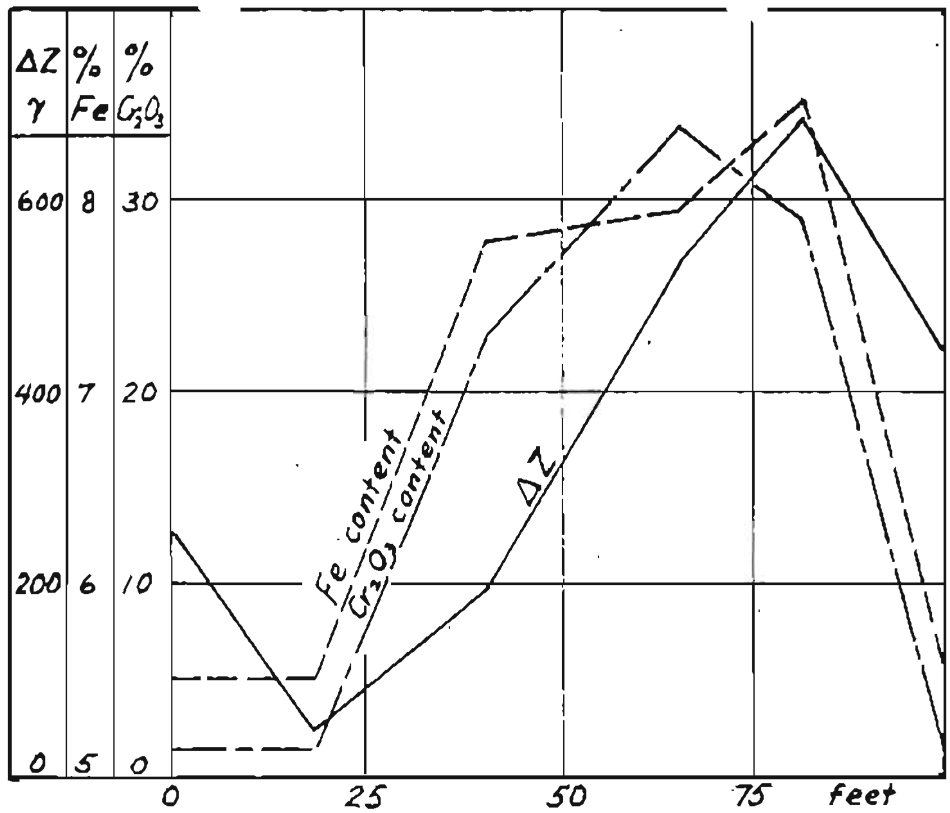

FIG. 5. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH 10 B.

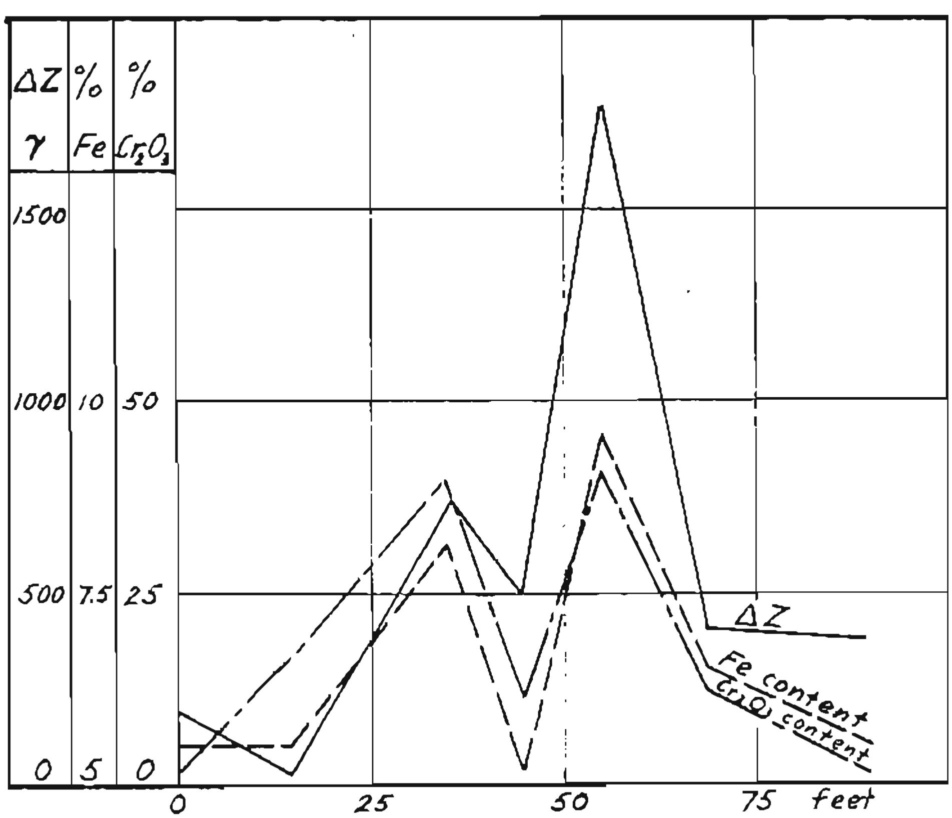

FIG. 6. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH 10 C.

(After P. 8)

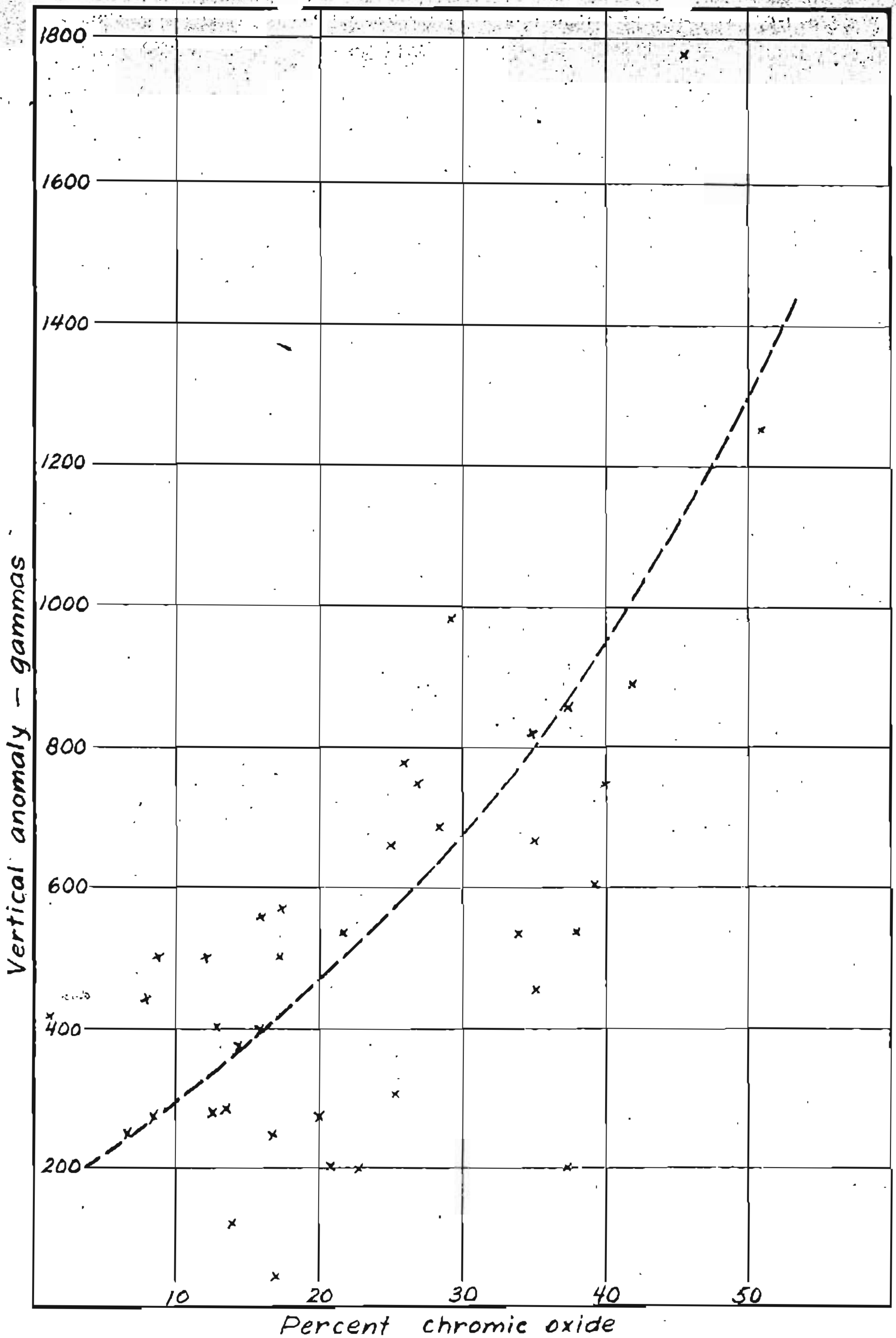

FIG. 12. -- VARIATION IN VERTICAL INTENSITY WITH CHROMIC OXIDE CONTENT OF MATERIAL AT TOP OF BEDROCK.

(After P. 8)

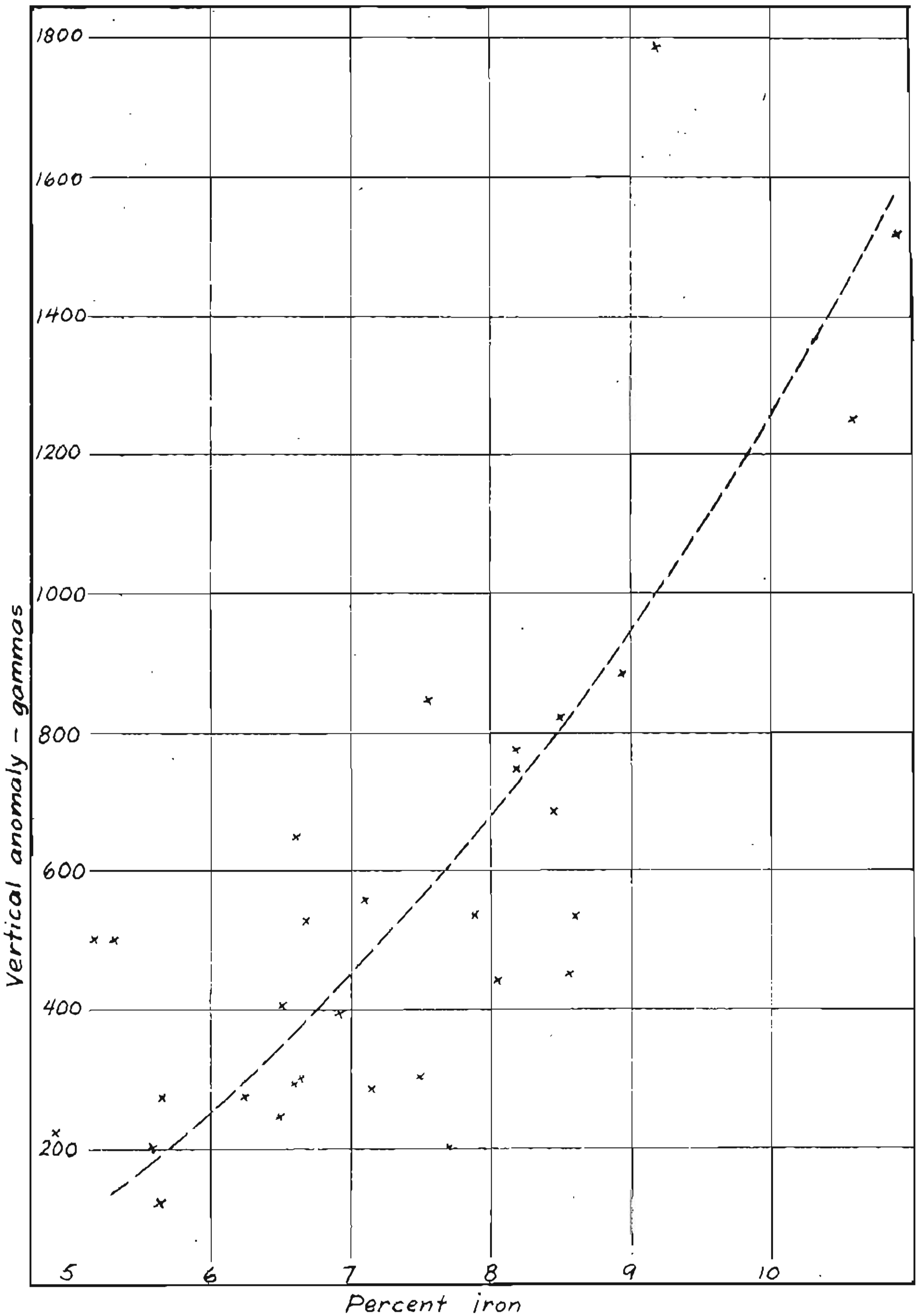

FIG. 13. — VARIATION IN VERTICAL INTENSITY WITH IRON CONTENT OF MATERIAL AT TOP OF BEDROCK.

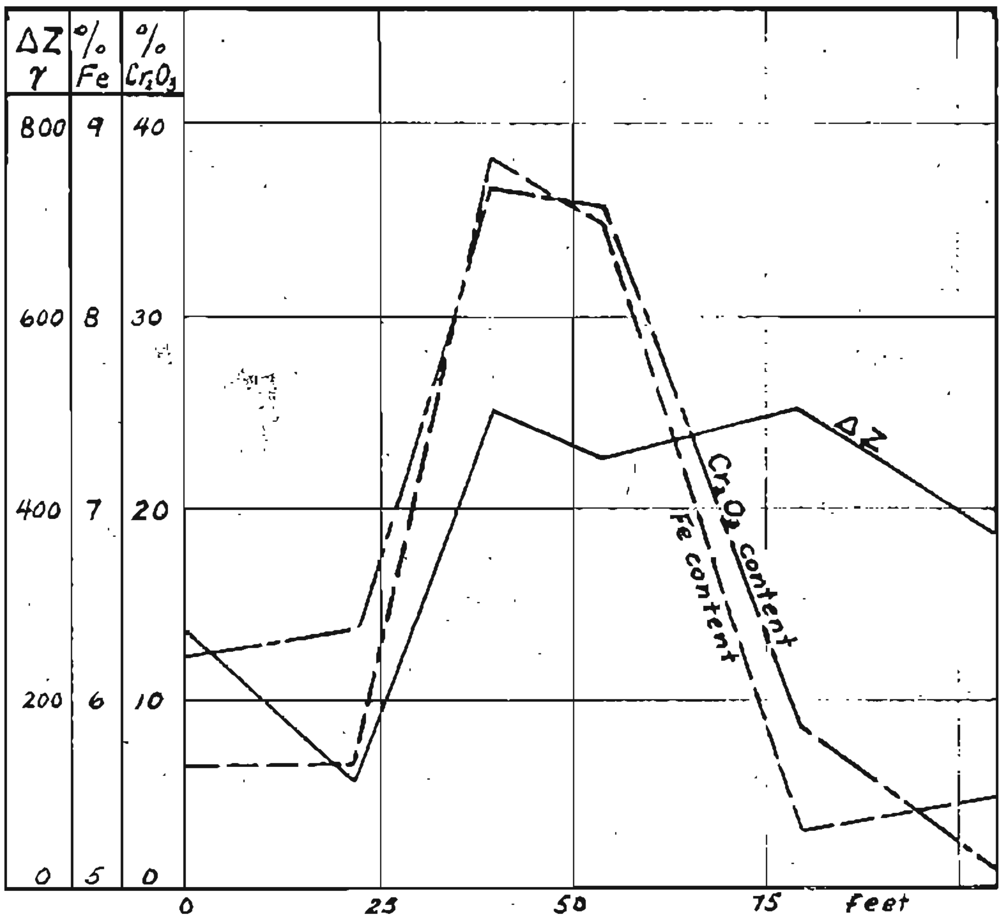

FIG. 7. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH 10 D.

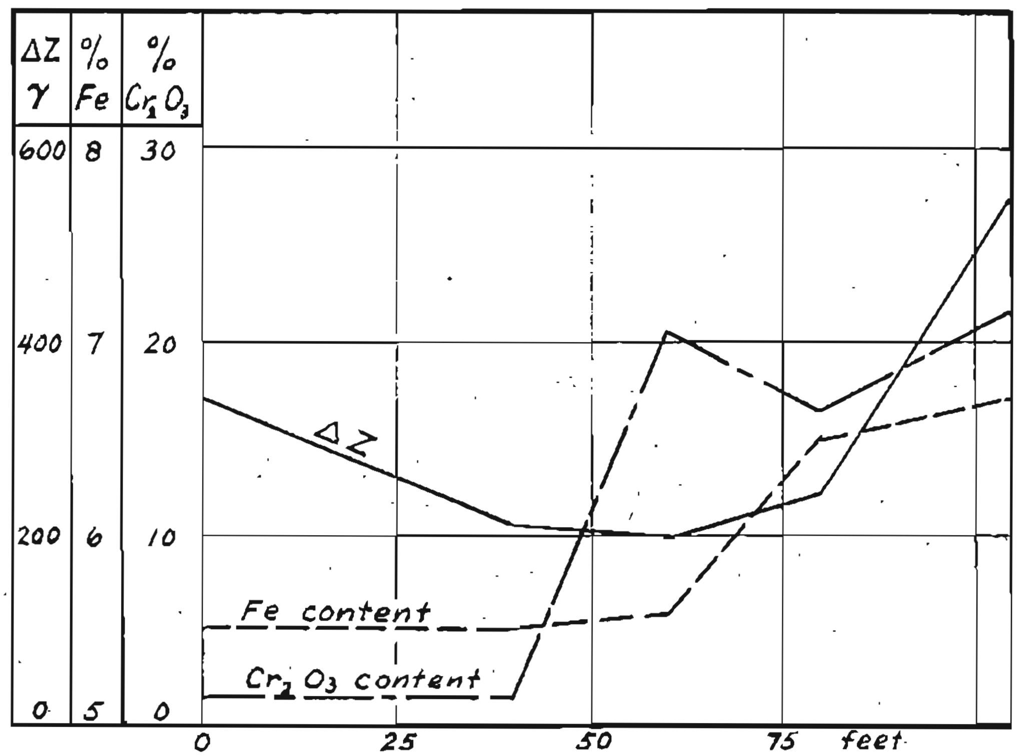

FIG. 8. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH 16 E.

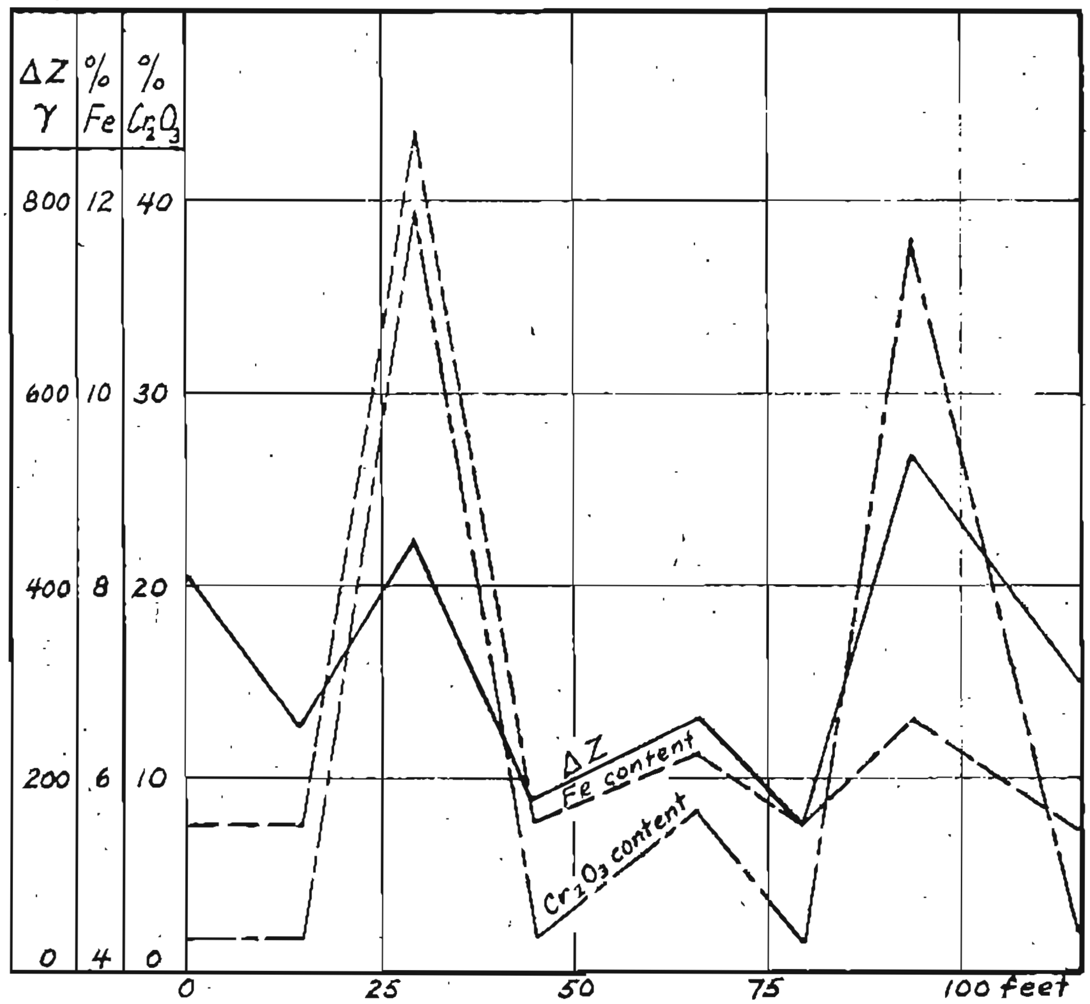

FIG. 9. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH 10 F.

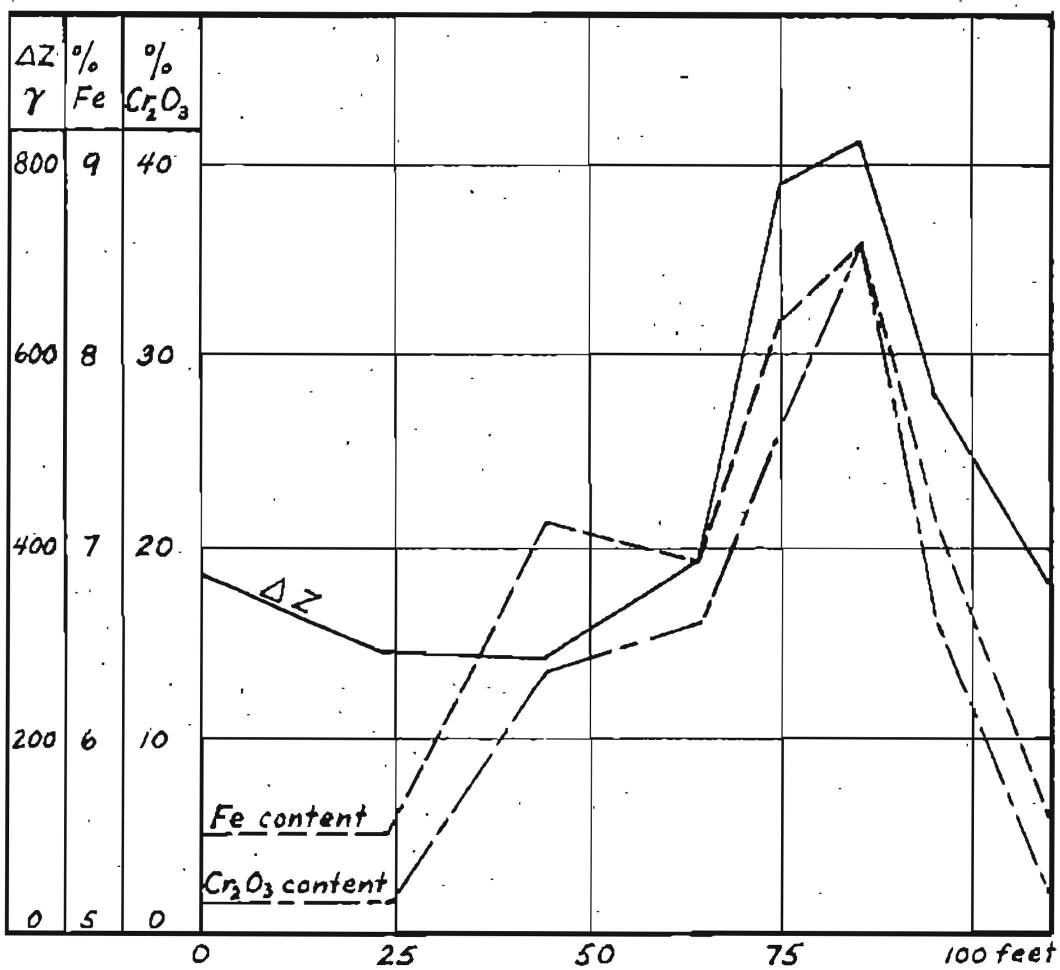

FIG. 10. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHROMIC OXIDE AND IRON CONTENTS AT TOP OF BEDROCK ALONG TRENCH C.

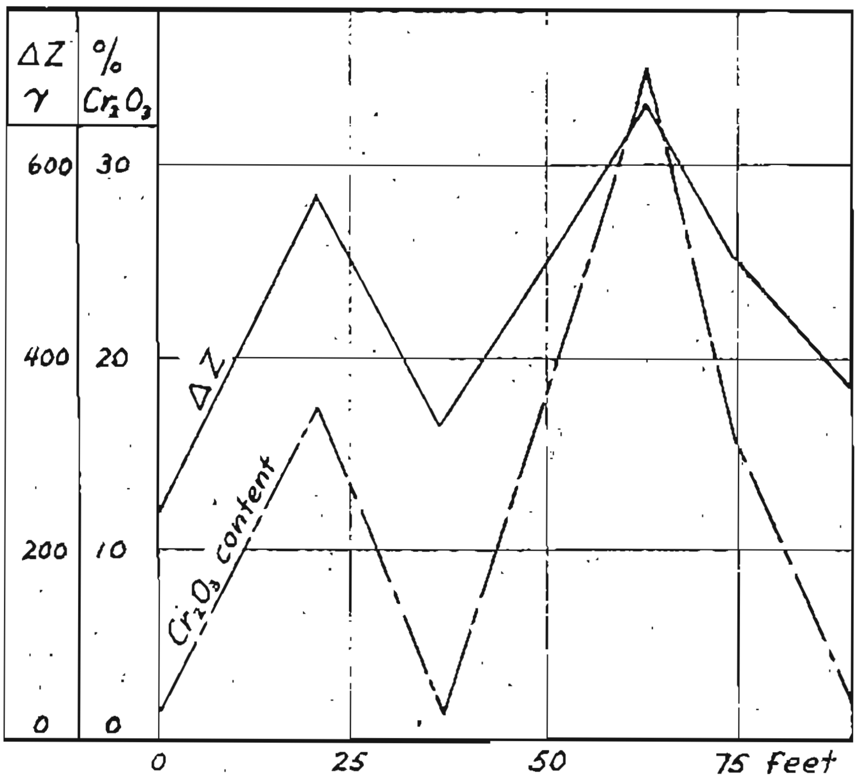

FIG. 11. — COMPARISON OF VERTICAL INTENSITY ANOMALY WITH CHOMIC OXIDE CONTENT AT TOP OF BEDROCK ALONG TRENCHES H AND I.

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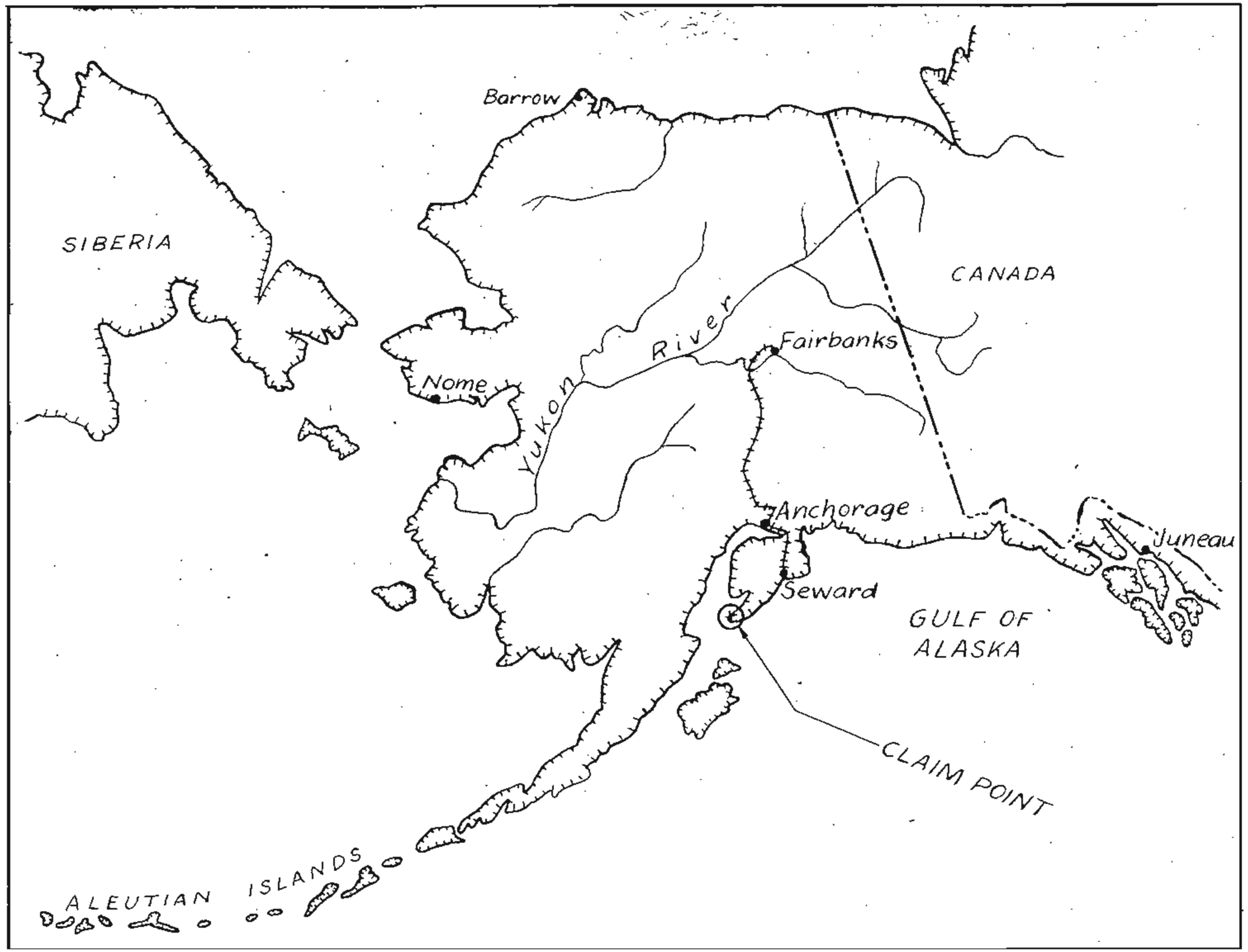

FIG. 1.— MAP OF ALASKA SHOWING LOCATION OF CLAIM POINT

(After P. 2) Fig. 2

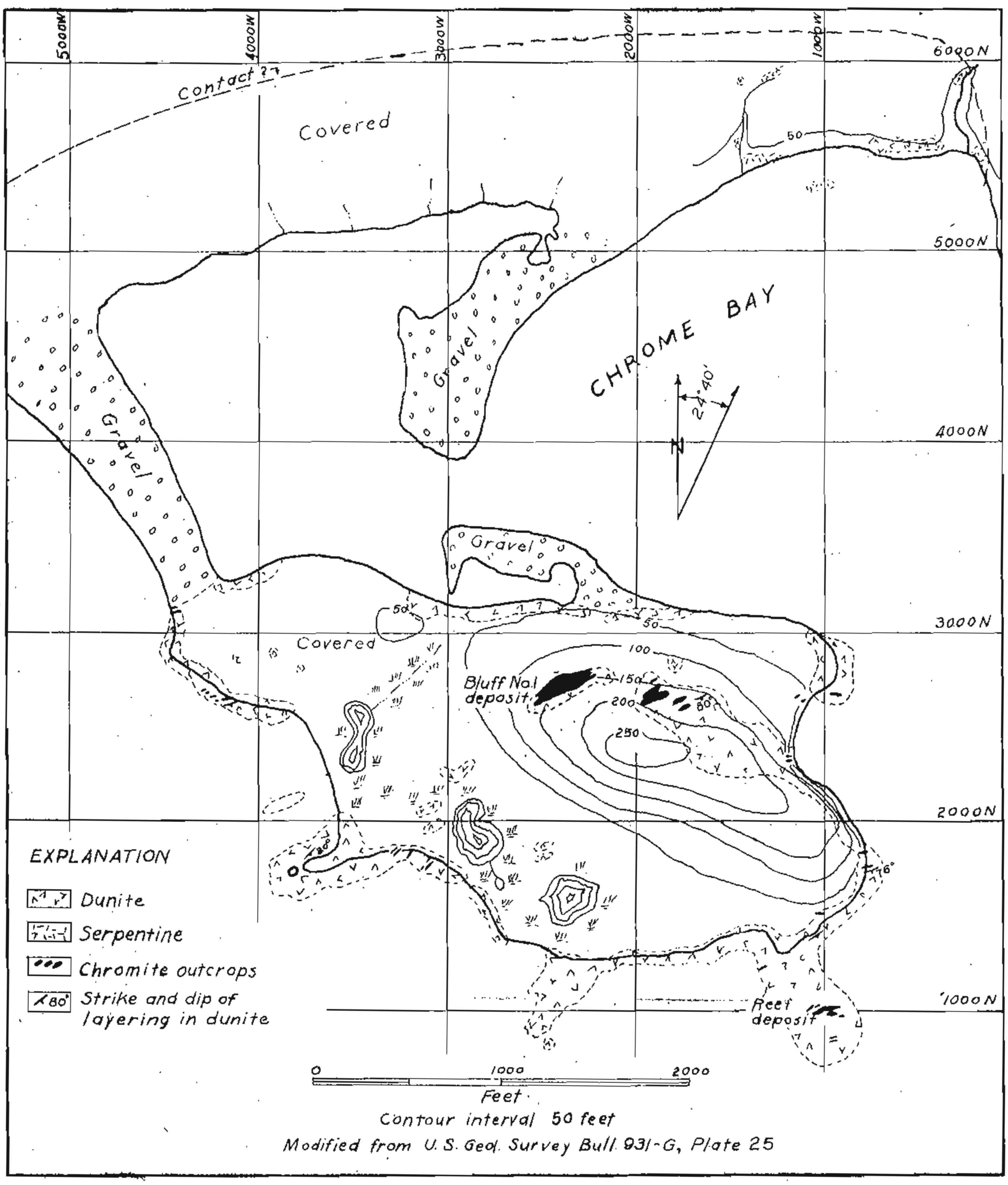

FIG. 2.— GEOLOGIC MAP OF CLAIM POINT