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PRELIMINARY GEOLOGIC INTERPRETATION OF AEROMAGNETIC DATA IN THE NIXON FORK DISTRICT, ALASKA

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ABSTRACT

An aeromagnetic map covering 480 square miles was compiled for the Nixon Fork district, which is located approximately 35 miles northeast of McGrath, Alaska. The survey was flown in search of concealed intrusive rocks which may have produced contact metamorphic deposits in limestone similar to the known lode deposits which have been the principal source of gold in the district.

The exposed quartz monzonite stocks with which the lode deposits are associated produce negative magnetic anomalies. Slight to moderately strong positive anomalies correlate with granitic intrusives in contact with Upper Cretaceous rocks in the Iditarod-Nixon Fork fault zone. No significant mineral deposits have been found in conjunction with these granitic bodies.

Positive anomalies, delineating buried intrusives, occur near the east and west boundaries of the mapped area. The nature of the westernmost intrusive is unknown.

An area of possible economic interest lies between Limestone Mountain and Whirlwind-Canyon Creeks in the eastern sector of the mapped area. An elliptical positive anomaly is superimposed on an elongate, slightly negative anomaly. This negative anomaly may represent an intrusive similar to the quartz monzonite with which the lode deposits are affiliated. The positive anomaly may be a near-vertical mafic dike intruded to within 50 feet of the surface of a limestone ridge. Limestone in the vicinity of the dike may be a favorable area for prospecting for lode deposits similar to the known gold-producing deposits of the district.

INTRODUCTION

In 1968, an aeromagnetic survey was made of a 480-square-mile area lying between Nixon Fork and the North Fork Kuskokwim River in Alaska, in conjunction with heavy metal investigations concurrently being conducted by the U.S. Geological Survey (fig. 1). The survey was flown by Lockwood, Kessler, and Bartlett, Inc., and compiled by the U.S. Geological Survey. The objectives were (1) to determine the magnetic characteristics of the intrusive rocks in the vicinity of the Nixon Fork mine, and (2) to delineate other areas where concealed intrusive rocks may occur.

The Nixon Fork district, located approximately 35 miles northeast of McGrath, is a region of rugged hills ranging in elevation from 400 to 2,800 feet above sea level. Gold placers were discovered in the area in 1917, but lode deposits soon became the chief source of gold. The gold lodes at the Nixon Fork mines occur as small contact metamorphic deposits in limestone, generally within a few hundred feet of the quartz monzonite contact. The chief ore minerals are auriferous pyrite and chalcopyrite. Locally, extensive oxidation has resulted in the release of gold from the sulfide minerals and consequent enrichment in the oxidized zone. Although the data are incomplete, the total production, through 1942, from the several lodes in the area was valued at approximately $1.3 million (Herreid, 1966). The mines have been virtually inactive since 1942, although limited operations were attempted in 1960.

GEOLOGIC SUMMARY

A reconnaissance geologic map of the Nixon Fork area, based on the early work of Brown (1926) and supplemented by aerial-photograph interpretation, is shown on figure 1. The geology of the Nixon Fork area and descriptions of the lode and placer deposits are given in reports by Martin (1921), Brown (1926), Mertie (1936), White and Stevens (1953), Jasper (1961), and Herreid (1966). A brief summary, based largely on the above reports, is given below.

The oldest and most common rock type in the area is complexly folded Paleozoic limestone. The limestone, 5,000-7,000 feet thick, is white to dark gray, thin to thick bedded, and contains thin interbeds of shale, chert, and calcareous sandstone. Near contacts with quartz monzonite the limestone is metamorphosed to a calc-silicate marble. Most of the higher hills in the mapped area are limestone.

Cretaceous rocks consist of a monotonous sequence of medium- to dark-gray graywacke sandstone, shale, and siltstone, and local beds of conglomerate. These rocks are at least 5,000 feet thick, have a conspicuous slaty cleavage, and are hornfelsed near contacts with granitic stocks.

Tertiary stocks of quartz monzonite and granite composition cut the Paleozoic carbonates and Cretaceous rocks. Quartz-latite porphyry is found within and along the borders of the quartz monzonite stock at the Nixon Fork mine. These porphyry phases are believed to represent chilled border zones (Brown, 1926) or late differentiates of the magma (Herreid, 1966).

Brown (1926, p. 120-123) proposed that the Paleozoic limestones have been thrust northwestward over Cretaceous rocks. The thrust was subsequently folded and pierced by granitic stocks, and therefore the possibility of a mineralized thrust plate occurring at the base of the limestone near intrusive contacts should, at least, be considered. Erosion has exposed fensters of Cretaceous rocks below the thrust plate (fig. 1), and the thrust plate appears to be terminated to the north by the Iditarod-Nixon Fork fault zone--a major fault zone in south-central Alaska with probable right-lateral movement (Grantz, 1966).

AEROMAGNETIC SURVEY

The aeromagnetic survey consisted of 40 northwest-southeast traverses approximately 12 miles long and spaced 1 mile apart. The traverses were flown at a barometric flight elevation of 2,500 feet, except where topography required higher flight elevations. A Gulf fluxgate magnetometer was used to obtain a total intensity magnetic profile along each traverse.

The magnetic data were contoured at 10- and 20-gamma intervals, the larger interval used in the areas of high magnetic gradients. The contoured data superimposed on geology are shown in figure 1. The magnetic values are total intensity relative to a datum of 56,000 gammas and have not been corrected for the earth's normal total magnetic field intensity, which in this area increases approximately 5.0 gammas per mile in a northeasterly direction.

DISCUSSION OF AEROMAGNETIC DATA

Magnetic anomalies are produced by near-surface intrusive rocks and by deep-seated igneous masses. The absence of magnetic anomalies related to topography indicates that the sedimentary country rock is nonmagnetic. Magnetic anomalies are produced by all of the larger intrusive bodies, and other magnetic anomalies may possibly be produced by intrusives unknown prior to this survey. Although each exposed magnetic body has been mapped as quartz monzonite and granite, a marked difference in the magnetic properties is indicated by the variety of magnetic expression.

The known gold lodes and prospects in the district are related to the quartz monzonite stocks at the Nixon Fork mines and 7 miles southwest at the headwaters of Eagle Creek (Brown, 1926; White and Stevens, 1953). The quartz monzonite shows little alteration (Herreid, 1966) and is thought to have no magnetic expression. Although the quartz monzonite stock at the Nixon Fork mines is delineated by a negative anomaly, the local magnetic field is considered to be influenced mainly by a rock unit at depth. Where the intruded stock has replaced a more magnetic rock unit at depth, the magnetic field has been distorted so as to lessen the relative magnetic intensity over the area of the stock.

A positive anomaly occurs immediately south of the Eagle Creek stock, but the magnetic field over the stock is depressed. The magnetic properties of the quartz monzonite are thought to be similar to that of the Nixon Fork mines stock although the magnetic high and low can conceivably be caused by the exposed quartz monzonite. However, a depth estimate, determined from the profile crossing the stock, indicates that the source of the positive magnetic anomaly is approximately 1,500 feet beneath the ground surface. The depth to the source and the location of the magnetic high and low suggest that the stock may therefore be either more magnetic at depth or that a magnetic rock unit occurs along the south flank of the stock.

A third negative magnetic anomaly is located immediately southwest of the Nixon Fork mines stock. The anomaly lies over the valley of Hidden Creek which is underlain by limestone. This anomaly may correlate with a cupola of the main stock located within the ridge which parallels Holmes Gulch. The intensity of the anomaly suggests that it is not deeply buried.

The two most prominent positive magnetic features are located at the northeast corner and near the southwest boundary of the area of figure 1. The northeast anomaly, located at the intersection of Canyon and Whirlwind Creeks, is caused by an elongate body of exposed granite and quartz monzonite (Brown, 1926, p. 117). This intrusive forms the southwest extension of Whirlwind Ridge and can also be traced north of the mapped area to the quartz monzonite stock comprising the Von Frank Mountain.

The double-peaked southwestern anomaly, approximately 6 miles northwest of Halfway Mountain (fig. 1), coincides with a pair of rounded, isolated hills having a relief of about 1,000 feet. The hills are extensively covered by vegetation and the bedrock geology is not known. The intensity of the anomaly is similar to the Whirlwind-Canyon Creek anomaly, suggesting the presence of an igneous mass like that found on Whirlwind Ridge.

Southeast of the Whirlwind-Canyon Creeks anomaly along Soda Creek, a very broad, deep-seated magnetic feature is present. This feature is estimated to be about 2,000 feet beneath the surface.

Approximately 5 miles northeast of Limestone Mountain, a small, elliptical magnetic high, outlining a previously unknown magnetic body, occurs over a northeast-trending ridge. The ridge, labeled C-C' on figure 1, is thought to consist of steeply dipping limestone as determined from inspection of aerial photographs. The gradient of the magnetic anomaly indicates that the intrusive is not deeply buried. To test this observation, a theoretical magnetic body was constructed using a two-dimensional magnetic profile computer program to simulate the principal magnetic anomaly observed along the portion of the flightline labeled C-C' on figure 1. A model which generates a profile similar to the observed profile is shown in figure 2. The theoretical magnetic body is 250 feet wide, dips 70° NW, and extends to an infinite depth. The magnetic susceptibility contrast was chosen to be 6.4×10^{-3} cgs units. Relating the model structure to a physical counterpart, the high susceptibility suggests that the body is mafic in composition and dikelike in form. The top of the dike lies near the surface of the limestone ridge.

The distortion of the regional magnetic contours south of the elliptical anomaly and southwest of the Whirlwind-Canyon Creeks anomaly may indicate the existence of a large elongate intrusive similar to the quartz monzonite at the Nixon Fork mine. The inferred intrusive causes a slight depression in the observed total magnetic field and may be related to the postulated near-surface dike. If this relation exists, the limestone in the vicinity of the dike provides a favorable environment for lode deposits similar to those found at the Nixon Fork mine (Brown, 1926, p. 135).

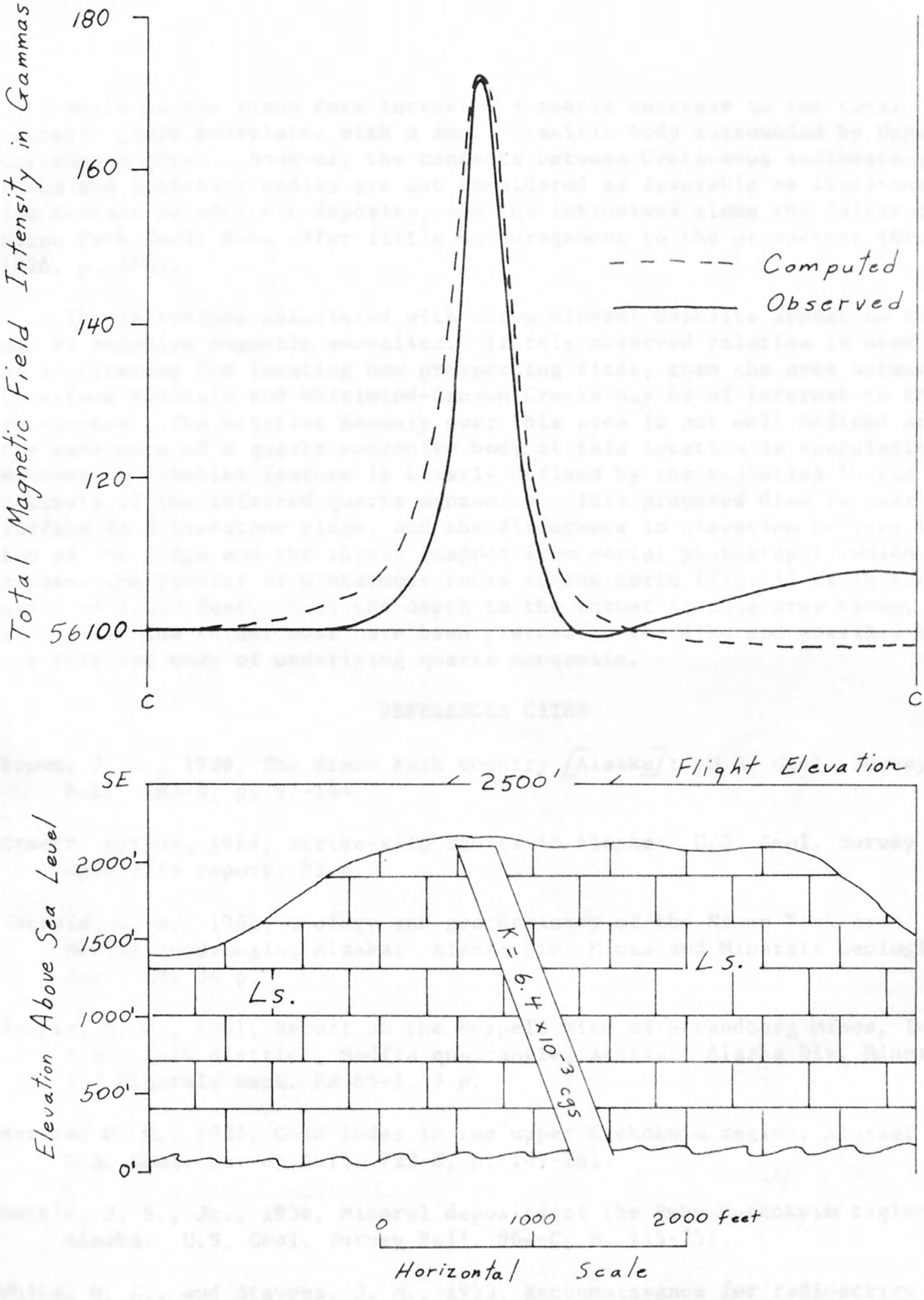

Figure 2.--Observed and computed magnetic profiles over an assumed dike of infinite depth extent.

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North of the Nixon Fork intrusive a subtle increase in the total magnetic field correlates with a small granitic body surrounded by Upper Cretaceous rocks. However, the contacts between Cretaceous sedimentary rocks and intrusive bodies are not considered as favorable as limestone for contact metamorphic deposits, and the intrusives along the Iditarod-Nixon Fork fault zone offer little encouragement to the prospector (Brown, 1926, p. 140).

The intrusives associated with known mineral deposits appear on the map as negative magnetic anomalies. If this observed relation is used as a criterion for locating new prospecting sites, then the area between Limestone Mountain and Whirlwind-Canyon Creeks may be of interest to the prospector. The negative anomaly over this area is not well defined and the existence of a quartz monzonite body at this location is speculative. However, a dikelike feature is clearly defined by the magnetics in the vicinity of the inferred quartz monzonite. This proposed dike is near the surface in a limestone ridge, and the difference in elevation between the top of the ridge and the thrust (mapped from aerial photographs) which exposes the fenster of Cretaceous rocks to the north (fig. 1) is in the order of 1,000 feet. Thus the depth to the thrust in this area cannot be great, and the thrust must have been pierced by the dike and possibly by the inferred body of underlying quartz monzonite.

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FIGURE 1

EXPLANATION

Surficial deposits — QUATERNARY

IGNEOUS ROCKS

Quartz monzonite and granite — TERTIARY

SEDIMENTARY ROCKS

Graywacke, sandstone, shale, and siltstone — CRETACEOUS

Chiefly carbonate rocks — ORDOVICIAN, SILURIAN, AND DEVONIAN(?)

Contact
Dashed where approximately located, queried where inferred

Thrust fault
Dashed where approximately located, queried where inferred. Sawteeth on upper plate

Lineament
Traced from aerial photographs

Boundaries of Iditarod-Nixon Fork fault zone
Queried where inferred or covered

Mine workings

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