DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOPHYSICAL INVESTIGATIONS
MAP GP-881

AEROMAGNETIC SURVEY OF THE WEST-CENTRAL PART OF THE SEWARD PENINSULA, ALASKA

In 1968, an aeromagnetic survey was made in the Kougarok-Serpentine area of the Seward Peninsula, Alaska, covering about 1,150 square miles. (See index map.) The survey was flown and compiled by Lockwood, Kessler, and Bartlett, Inc. Fifty-five east-west traverses, 1 mile apart, were flown at a barometric altitude of 2,500 feet. A fluxgate magnetometer was used to obtain a continuous total-intensity magnetic profile along each traverse from which the total field map was contoured as shown.

The area surveyed is largely tundra covered; therefore, the stratigraphic and structural relationships are difficult to define, and for this reason it was felt that an aeromagnetic map would be useful in the interpretation of the bedrock geology. Of especial interest is an area surrounding the granite intrusive shown in the north-central part of the map, because many of the surrounding faults are hydrothermally altered and contain anomalous amounts of metals that are associated with veined quartz (Sainsbury and others, 1969, p. 33). Many of the streams in the area, notably the Kougarok River, have been mined extensively for placer gold, but few lodes have been found.

GENERAL GEOLOGY

The bedrock of the area covered by the aeromagnetic survey consists mainly of Precambrian metamorphic rocks, Paleozoic carbonate rocks, and a granite stock of Late Cretaceous or Tertiary age. The rocks assigned to the Precambrian comprise two main map units: (1) a great thickness of carbonaceous to graphitic siltite composed principally of silt-sized quartz grains, minor phengitic mica, and various amounts of carbonate cement, and (2) a great expanse of schist composed principally of magnesian chlorite, albite, epidote, garnet, amphibole (locally glaucophane), sphene, and quartz. The graphitic siltite is correlated with similar rocks that crop out widely over the Seward Peninsula and is assigned to the "slate of the York region," an informal name given by Collier (1902). The graphitic siltite, which crops out in a broad north-south belt through the center of the mapped area, has a generally flat magnetic expression, but with scattered magnetic highs over inferred bodies of metamorphosed intrusive rocks of mafic to intermediate composition.

The chloritic schist which forms a belt on the west side of the mapped area is the northern continuation of similar rocks which extend from the Nome area, more than 70 miles south, around the west end of the Kigluaik Mountains and across the east end of the Teller 1:250,000 quadrangle (Sainsbury, 1972) directly west of the area of this report. Within the chloritic schist are numerous dikes and pluglike bodies of mafic rocks ranging from garnet-glaucophane to relict titaniferous augite and labradorite. All have a high content of iron and magnesium and a low content of silica. Numerous magnetic features lie along this belt of chloritic schist, which is either a metamorphosed volcanic sequence thrust eastward over the graphitic siltite or a series of mafic intrusive rocks emplaced along a major structural zone and subsequently metamorphosed during the intense eastward thrusting that affected the entire Seward Peninsula in Early to mid-Cretaceous time (Sainsbury, 1972).

The Paleozoic carbonate rocks, mostly of Silurian or Ordovician age, are in thrust-fault contact above the graphitic siltite. They form a narrow belt characterized by low magnetic response in the central part of the mapped area; in the eastern part of the area, they are intimately intermixed with the graphitic siltite along a tectonic belt, mapped as a thrust melange exhibiting various magnetic properties.

The granite stock in the northern part of the mapped area intruded the graphitic siltite and the potassium-rich gneiss which is thought to be older than the siltites.

GEOLOGIC STRUCTURE

Reconnaissance geologic mapping of the Seward Peninsula by Sainsbury has now been completed. It shows that present distribution of older rocks is a consequence of imbricate thrust faulting of Precambrian and Paleozoic rocks. Thrust plates moved east, producing north-trending folds, schistosity, and cleavage. Many mafic bodies may have been emplaced during the thrusting. However, the complete absence of large mafic intrusives in the Paleozoic carbonates suggests that the mafic rocks are either metavolcanics intercalated in the graphitic siltite or mafic intrusives that followed well-defined zones of complex structure developed before or during the early part of the thrusting. After the thrusting, stocks and batholiths of granite and quartz monzonite, ranging in age from about 100 m.y. to 74 m.y., were emplaced in the thrust sheets.

MAGNETIC MAP

Several pronounced magnetic features are shown on the aeromagnetic map. The most extensive feature, trending north along the west-central part of the map, is a series of anomalies over the chloritic schist outcrop. Apparently the magnetic rock producing these anomalies occurs as a sheet 30 miles long from north to south in the mapped area. Depth estimates made on several of these magnetic highs by techniques developed by Peters (1949) indicate that the magnetic source rock is at or close to the surface. Sainsbury (1972) reported that the chloritic schist contained abundant iron before metamorphism, and, on the assumption that the schist plate is reasonably thick, it should still be sufficiently magnetic to produce these anomalies.

If the layers of chloritic schist represent an ancient volcanic sequence and if the underlying basement rock is substantially nonmagnetic, then the magnetic anomalies produced by the schist would depend on its thickness. Thus, reasonable variations in thickness of the chloritic schist within short distances would produce significant anomalies which, however, could also be caused by variations in magnetic susceptibility of the schist owing to segregation of magnetic minerals during metamorphism. The magnetic anomalies, however, lie over a series of tundra-covered hills that have numerous outcrops of glaucophane-bearing mafic intrusives, several of which are large enough to give significant magnetic response. The anomalies may, in actuality, be due to the existence of a combination of these conditions.

North and east of the schist outcrop area the altitude is in general lower, and the increased distance from aircraft to ground resulted in a more subtle magnetic expression. In general also, the north-trending anomalies shown just west of center on the map reveal the presence of chloritic schist extending eastward beneath tundra. The typically elongate configuration of these anomalies and their paralleling the trend of the anomalies over the schist outcrop suggest that they are not the result of a deep-seated feature, such as a buried intrusive.

A pattern of north-trending magnetic anomalies also exists in the east-central part of the mapped area that coincides with the thrust melange of Paleozoic carbonate rocks and graphitic siltite. Here, as in the western part of the area, the topography seems to partly control the position of the magnetic highs. Estimates of the distance to magnetic rock are as much as 2,500 feet below the sensor; and if the average hilltop elevation is about 1,500 feet, the depth of magnetic rocks may be as much as 1,000 feet. The Paleozoic carbonate rocks apparently are not magnetic, as seen by the thrust sheet directly to the west which has no magnetic expression even where the terrain is only 700 feet below the sensing element. Similarly, the graphitic siltite is not sufficiently magnetic to produce the anomalies. The general alinement of the magnetic anomalies along the thrust melange and the elongation of the individual anomalies suggest that the well-defined smaller anomalies are related to unexposed mafic bodies emplaced along the tectonic belt, but the north-south elongation of larger, low-gradient features indicates the possibility of a thick, sheet-like mass of chloritic schist underlying the Paleozoic rocks.

Although the granite stock in the Serpentine Hot Springs area has little magnetic expression, a sharp magnetic low exists just south of the stock, and two similar, though smaller, anomalies occur south of this sharp anomaly. The shape, amplitude, and direction of polarization of these anomalies suggest that they are caused mainly by remanent magnetization rather than by the magnetic susceptibility of the rock. Hence, these anomalies are probably due to reversely polarized dikelike structures, without surface expression but shallowly buried as indicated by depth estimates computed on the highest amplitude anomaly.

The positive anomaly just east of the sharp negative anomaly may be partly due to topography inasmuch as it is coincident with an area of high elevation. However, the graphitic siltite in the vicinity of this feature is not sufficiently magnetic to produce an anomaly. Possibly an intrusive body, emplaced later than the granite and associated with the intricate fault system shown on the map, produces this positive anomaly. The irregularly shaped positive anomaly to the southwest may be related to the eastern magnetic feature and therefore would suggest a southwest trend of the inferred intrusive body; the negative magnetic features, therefore, perhaps represent dikes which may be integral to the intrusive.

Many of the veins in the area south of the exposed granite contain anomalous amounts of various metals as reported by Sainsbury, Hudson, Kachadoorian, and Richards (1970). Most geochemical sampling, however, was done in the vicinity of the northeast positive magnetic anomaly; therefore, detailed geochemical sampling of the faults near the west negative magnetic anomalies seems justified in view of the high metal content found in many of the sampled veins.

The magnetically anomalous area in the southern part of the mapped area lies within the graphitic siltite. Several important placer gold deposits, which have been mined intermittently for over 70 years, are nearby. East of these placers, Coffee Dome, a resistant hill of graphitic siltite, is faintly metamorphosed and is cut by numerous quartz veins, suggesting that an intrusive body of unknown composition is present at moderate depth.

The positive magnetic anomaly west of Coffee Dome is centered over an area of low relief, ground level being about 2,300 feet below the sensing element. Several depth estimates made on the central part of this anomaly and its adjuncts indicate that the magnetic rock causing the anomaly may be buried as deeply as 2,500-5,500 feet. An intrusive mass, buried at such a depth, would probably encompass the area immediately north of the magnetic high as evidenced by the negative anomaly being greater than that which would be normally expected north of a positive anomaly. The westerly trending magnetic low north of the positive anomaly is then due possibly to either a ridge of acidic rock or a hydrothermally altered zone related to a larger granitic mass. If the latter interpretation is true, the magnetite in the rock would have been removed by the hydrothermal action which would have resulted in the conspicuous negative anomaly, and the extent of the magnetic low probably would delineate the altered area concealed beneath the bedrock. Similarly, the negative anomaly centered over Coffee Dome, supported by the above evidence of a buried intrusive body, suggests the possibility of a zone of hydrothermal alteration. Such magnetic features as these are common in areas of hydrothermal alteration related to porphyry copper intrusives in the southwestern United States.

REFERENCES

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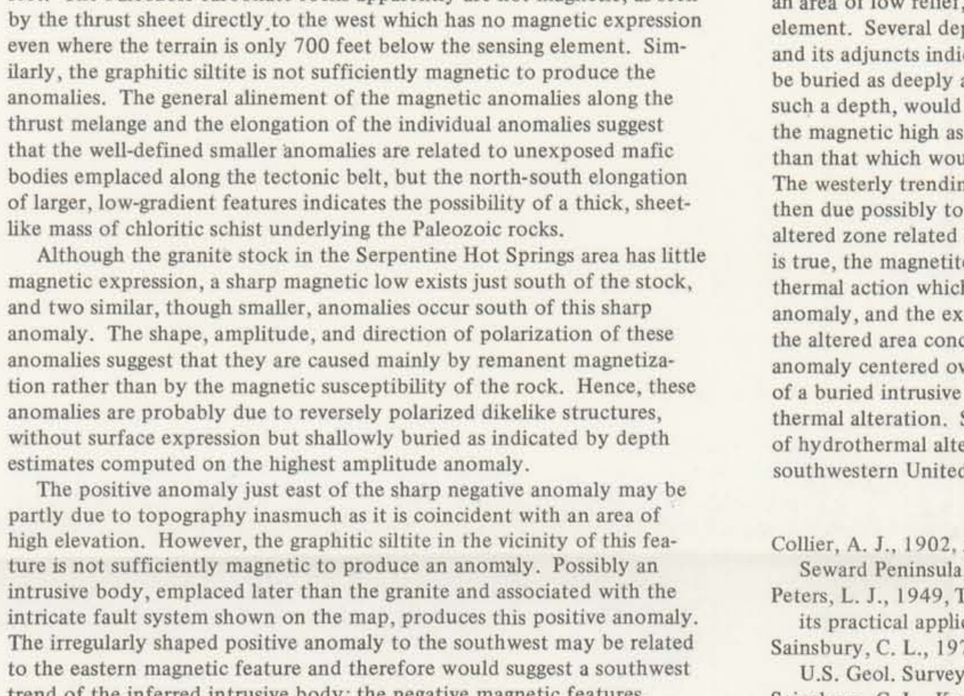
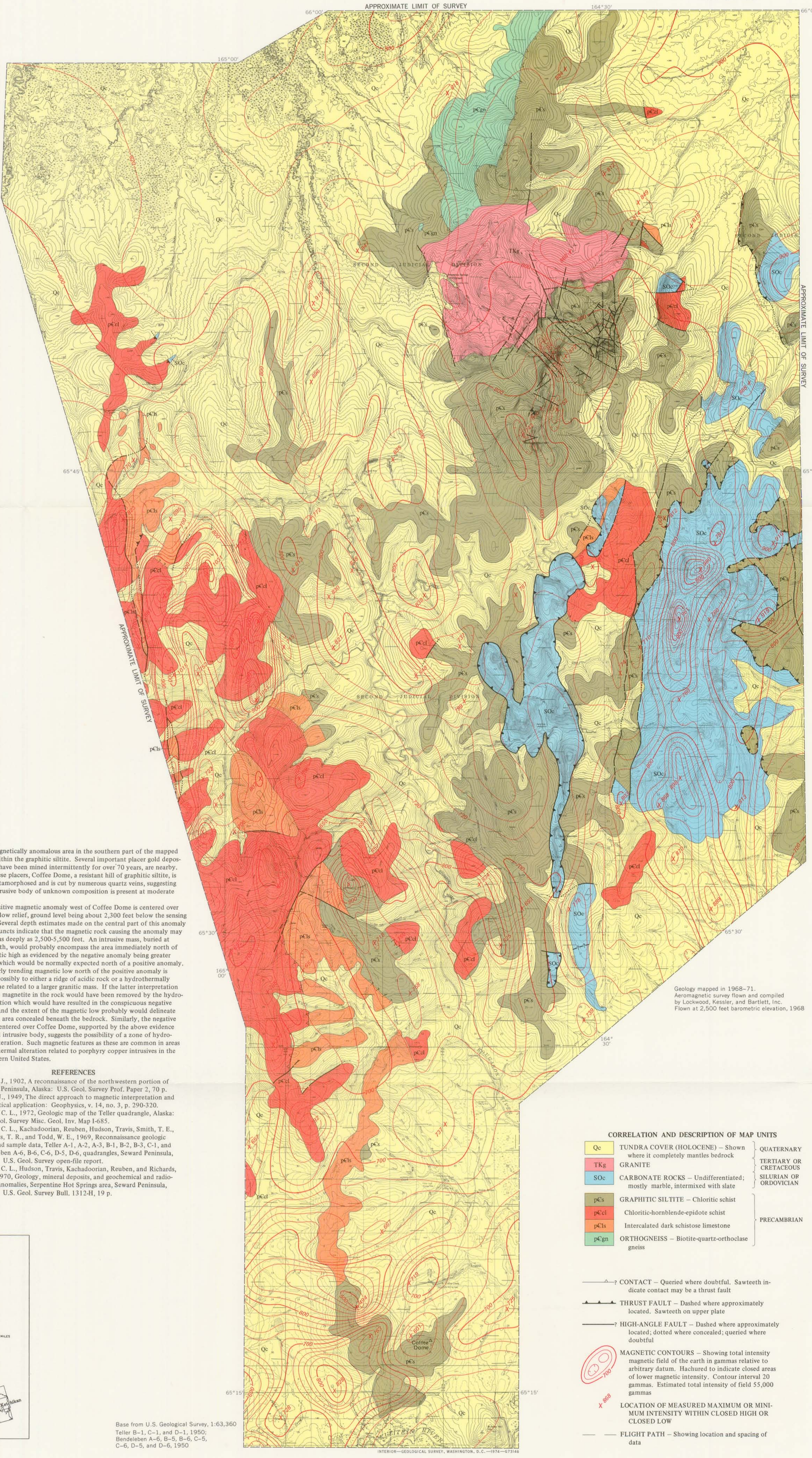
Sainsbury, C. L., Hudson, Travis, Kachadoorian, Reuben, and Richards, T. R., 1970, Geology, mineral deposits, and geochemical and radiometric anomalies, Serpentine Hot Springs area, Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 1312-H, 19 p.



INDEX MAP SHOWING AREA OF AEROMAGNETIC SURVEY GP-881



Geology mapped in 1968–71.
Aeromagnetic survey flown and compiled by Lockwood, Kessler, and Bartlett, Inc.
Flown at 2,500 feet barometric elevation, 1968

CORRELATION AND DESCRIPTION OF MAP UNITS

Unit	Description	Age
Qc	TUNDRA COVER (HOLOCENE) – Shown where it completely mantles bedrock	QUATERNARY
TKg	GRANITE	TERTIARY OR CRETACEOUS
SOc	CARBONATE ROCKS – Undifferentiated; mostly marble, intermixed with slate	SILURIAN OR ORDOVICIAN
p€s	GRAPHITIC SILTITE – Chloritic schist	PRECAMBRIAN
p€cl	Chloritic-hornblende-epidote schist	
p€ls	Intercalated dark schistose limestone	
p€gn	ORTHOGNEISS – Biotite-quartz-orthoclase gneiss	

CONTACT – Queried where doubtful. Sawteeth indicate contact may be a thrust fault

THRUST FAULT – Dashed where approximately located. Sawteeth on upper plate

HIGH-ANGLE FAULT – Dashed where approximately located; dotted where concealed; queried where doubtful

MAGNETIC CONTOURS – Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum. Hachured to indicate closed areas of lower magnetic intensity. Contour interval 20 gammas. Estimated total intensity of field 55,000 gammas

LOCATION OF MEASURED MAXIMUM OR MINIMUM INTENSITY WITHIN CLOSED HIGH OR CLOSED LOW

FLIGHT PATH – Showing location and spacing of data

Base from U.S. Geological Survey, 1:63,360
Teller B–1, C–1, and D–1, 1950;
Bendeleben A–6, B–5, B–6, C–5, C–6, D–5, and D–6, 1950

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SCALE 1:125 000

2 0 2 4 6 8 10 MILES

2 0 2 4 6 8 10 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED OR DASHED LINES REPRESENT 25-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

1974, APPROXIMATE MAGNETIC DECLINATION AT CENTER OF MAP AREA IS 17½° EAST

AEROMAGNETIC AND GENERALIZED GEOLOGIC MAP OF THE WEST-CENTRAL PART OF THE SEWARD PENINSULA, ALASKA

By
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1974

For sale by U.S. Geological Survey, price $1.00