Aeromagnetic interpretation

of the Big Delta quadrangle, Alaska

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AEROMAGNETIC DATA AND INTERPRETATION

The aeromagnetic map of the Big Delta quadrangle was flown in 1973 and subsequently released by the State of Alaska (Alaska Div. Geology and Geophysics, 1973) at a scale of 1:250,000. The data were collected along north-south traverses spaced at 1.2-km intervals and flown at an altitude of 300 m above the ground. The data were originally compiled on 30- by 15-minute quadrangles at a scale of 1:63,360; these quadrangles have been combined and reduced to form the present map. Contour interval is 10, 20, 100, or 500 gammas, depending upon the steepness of local gradients in the Earth's magnetic field. A regional field of approximately 2.7 gammas/km was removed by computer from the data before contouring using a value of 56,934 gammas at the center of the map, and 5000 gammas was added arbitrarily to all values in order to avoid negative contours.

The local topographic relief for much of this area frequently attains values of 750 to 1250 m. The valleys generally are rather narrow and steep-sided. Accordingly the fixed-wing aircraft that performed the survey was not able to maintain a reasonably constant altitude of 300 m above ground and was probably 500 to 1000 m above the valley floors. Continuous recording altimeter data are available for each traverse but were not examined. Where an area of high relief is composed of magnetic rocks, a local magnetic anomaly is generated by the topography. However, comparison of the magnetic map with the topographic map indicates very little correlation between magnetic anomalies and topography so that in general the variations in aircraft altitude are not very important. The major loss in information will be the failure of small magnetic rock masses in the valleys to be detected by the magnetometer because of their increased distance from the aircraft.

The magnetic anomalies and patterns on the magnetic map are caused by variations in the amount of magnetic minerals, commonly magnetite, in the various rock units and are therefore closely related to geologic features. The magnetic anomalies in this map area are caused by igneous rocks, plutonic and volcanic, by serpentinized ultramafic rocks, by the contact-metamorphosed rocks in the metamorphic aureoles of plutons, and by regionally metamorphosed rocks.

The aeromagnetic interpretation map (sheet 2) was compiled by the following procedure: a preliminary interpretation map was constructed using only the magnetic map and not referring to the geologic map, then the interpretation was compared with the geologic map (Weber and others, 1978) and refined by modification of boundaries and by addition of a few more anomaly boundaries. At these high magnetic latitudes, boundaries between magnetic and relatively nonmagnetic rock units are in general located on the flanks of the magnetic anomaly, approximately at the steepest gradient. The aeromagnetic interpretation map contains many such interpreted boundaries drawn around characteristic magnetic anomalies. Some of these interpreted boundaries correspond approximately to mapped geologic contacts shown on the generalized geologic map. More detailed geologic mapping may eventually explain other boundaries. In addition, many of the boundaries are concealed by extensive Quaternary alluvial deposits, particularly in the southwestern and western portions of the map. These boundaries are believed to be exposed at the top surface of the bedrock. Long linear magnetic boundaries, which may truncate other linear magnetic features, are interpreted as faults and are so indicated on the interpretation map. Minor discrepancies between mapped geology and aeromagnetic interpretation are to be expected at this map scale; they may arise from errors in aircraft location, from the semiquantitative nature of the magnetic interpretation, and from the reconnaissance nature of the geologic mapping.

Certain magnetic lows on the map are interpreted to be the result of reverse remanent magnetization of the associated rock units and are indicated by a capital letter "R". These lows are relatively isolated and are considered to be below the local background level of the magnetic field, which on this map is set arbitrarily at 5000 gammas. As discussed below, these lows are caused by volcanic, plutonic, and metamorphic rocks in different parts of the map area. Other magnetic lows, in particular those on the sides of major magnetic highs, are the result of edge effects and have nothing to do with reverse remanent magnetization.

In the following sections the magnetic expression of the various rock units is discussed in sequence from oldest to youngest. The geologic information is taken from Weber and others (1978).

MAGNETIC EXPRESSION OF ROCK UNITS

Metamorphic rocks

Complex irregular patterns of small-amplitude magnetic anomalies less than 100 gammas in amplitude characterize the regionally metamorphosed rocks (quartzite, phyllite, schist, gneiss, and marble) that occupy the great majority of the quadrangle. Some of the more prominent of these anomalies have been outlined on the interpretation map but are not labeled. The specific rock units causing individual anomalies have not been identified but may include amphibolite layers. Anomaly trends are generally east-west, approximately parallel to regional geologic structure.

Paleozoic(?) ultramafic rocks (Pzu)

The Paleozoic(?) ultramafic rocks are foliated and occur in the southern portions of the quadrangle "infolded with amphibolite facies gneiss and schist" (Weber and others, 1978). Southeast of the Shaw Creek fault the magnetic anomalies (U) associated with the ultramafic rocks form narrow curvilinear patterns with closely associated magnetic minima on the flanks of the anomalies. Such anomaly patterns suggest folded thin sheets of magnetic material. Many of the small sharp magnetic anomalies with unidentified source rocks may be caused by ultramafic rocks. One anomaly located at lat 64°15'N, long 145°00'W and associated with ultramafic rocks is reversed and also is near the contact of a granitic pluton. Reversed anomalies caused by ultramafic rocks are very rare and perhaps this case is the result of contact metamorphism.

Two ultramafic bodies (labeled U_1) in the center of the quadrangle are expressed by magnetic anomalies which are significantly wider and have wider marginal gradients than the other anomalies (U) caused by ultramafic rocks. Judging by their form, these anomalies represent larger masses of magnetic material, having significant vertical extent, probably greater than 1 km.

A rock unit consisting of peridotite, greenstone, and Permian quartzite (Pzu an Pgc) is found as an assemblage extending east-west through the north half of the quadrangle. Associated with the peridotite, which is partly serpentinized, are the most intense magnetic anomalies (U_2) in the quadrangle. The intensity is emphasized by the fact that these rocks form mountain tops and ridge crests, thus being close to the magnetometer. Anomalies of this magnitude (1000 to 1500 gammas) are common over serpentinized peridotite elsewhere and are not generally a sign of magnetic ore, rather being caused by disseminated magnetite in the serpentinite.

The greenstone associated with the peridotite is weakly magnetic with anomalies somewhat smaller in amplitude though not easily separable from those of the latter material.

The large minima associated with the flanks of these anomalies indicate contacts dipping away from the minima hence the magnetic masses have the form of synformal sheets bottoming at very shallow depth in agreement with the geologic mapping which shows them to be remnants of an eroded thrust sheet.

Diorite and gabbro

Small scarce plugs and stocks of diorite and gabbro are dotted around the central and eastern portions of the quadrangle and have been grouped with the granitic rocks (TMzg) on sheet 2. Most of these objects have no evident magnetic expression, including the single large intrusion (Weber and others, 1978) at lat 64°15'W, long 145°08'W.

Two magnetic highs (D) and a low (D,R) in the north center of the map area are believed to be caused by these mafic rocks, as also is another high at lat 64°10'N, long 145°05'W. The reversal (R) is assumed to be caused by remanent magnetization in the mafic rocks rather than in the small adjacent patch of ultramafic rock.

Granitic plutonic rocks and contact-metamorphosed rocks

Large plutons of granodiorite, quartz monzonite, and granite of Cretaceous and Tertiary age are found throughout the quadrangle. These plutons are non-magnetic without apparent exception but can be identified by the very flat magnetic low (P) associated with them. Fourteen such areas have been identified on the interpretation map. Those flat areas are surrounded by broad smooth low-amplitude magnetic highs which trend parallel to the contacts and which are considered to be the result of contact metamorphism of adjacent country rocks. The metamorphism has presumably developed a small amount of extra magnetite in these rocks for distances of up to 6 km from the pluton contacts. Locally, even wider magnetic highs suggest the possibility that the pluton contacts are dipping outwards beneath the country rocks at relatively low angles. In one case, the very large east-west trending magnetic high at lat 64°30'N on the west border of the map, a pluton may underlie the magnetic anomaly at relatively shallow depth of only a few kilometers thus having caused contact metamorphism of the overlying rocks and development of a small additional amount of magnetite.

Extending east-west across the top of the quadrangle at approximately lat 64°57'N is a discontinuous belt of granitic plutons and associated east-west magnetic anomalies caused by contact metamorphism. This belt of rocks contains a number of occurrences of sulfides and has been designated a "tract permissive for mineral deposits" (Menzie and Foster, 1979).

Felsic igneous rocks (Tf)

A few patches of fine-grained felsic lavas and hypabyssal rocks are found along the east margin of the quadrangle, the largest areas lying near lat 64°30'N. A few sharp local magnetic anomalies may be caused by these volcanic rocks and are labeled with the letter "V". One broad reversed anomaly in this same area may also be caused by these rocks.

FAULTS

The aeromagnetic map displays well the Shaw Creek fault which extends from southwest to northeast across the center of the map. The fault is expressed as linear interruptions of magnetic anomaly patterns on each side of the fault. Three parallel strands (sheet 2) appear to be indicated in the center of the quadrangle, although topographic effects of the linear fault valley may be confusing the magnetic patterns. The aeromagnetic data provide information on the possible offset of this fault although it should be kept in mind that the results are somewhat equivocal. Firstly, the writer believes that the sense of drag on the more linear magnetic anomalies striking into the northwest side of the fault is left-lateral. Secondly, it is suggested that the magnetic pattern associated with the granitic pluton (Kg) on the southeast side of the fault at lat 64°32'N matches with the magnetic pattern on the northwest side of the fault at lat 64°15'N where a concealed granitic pluton is interpreted from the magnetic data. If these two patterns represent the same granitic pluton, then a left-lateral offset of 50 ± 4 km can be measured. Testing this offset against the geologic map of Weber and others (1978), it can be observed that a sequence of 4 rock units (from east to west: Pzsg, Pzs, Pzp€g, and Pzg) strike about north-south, intercepting the southeast side of the fault at approximately lat 64°40'N and intercepting the northwest side of the fault at lat 64°24'N for a measured offset of 51 km ± 3 km. The belt of Permian greenstone and peridotite (U_2 on sheet 2) striking across the north portion of the quadrangle intercepts the fault approximately at lat 64°55'N (or the westernmost splay at 64°45'N). An assemblage of serpentinized peridotite and greenstone of uncertain age (Foster, 1976; Foster, oral communication, 1979) is located in the Eagle quadrangle 43 km east of this intercept and strikes northwest such that if projected to the Shaw Creek fault the ultramafic rocks would have a left-lateral offset of about 30 km with those of the Big Delta quadrangle (or 50 km including the splay faults). It seems very possible that these two rock units, containing both serpentinized peridotite and greenstone, are the same age (Permian) and thus may confirm the left-lateral offset on this major fault.

Other faults shown on the geologic map are not clearly expressed on the magnetic map except possibly the one associated with the axis of the northeast-trending magnetic low in the left center of the quadrangle (sheet 2) at lat 64°30'N, long 145°50'W. In general the magnetic map does not contradict the faults on the geologic map with the possible exception of the northeast-trending fault that intercepts the west border of the map at lat 64°20'N. This latter fault cuts across a major east-west magnetic anomaly interpreted as caused by contact metamorphosed rocks. Either the fault does not have significant offset or it predates the granitic intrusion which presumably caused the metamorphism.

<u>References</u>

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