UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

AEROMAGNETIC INTERPRETATION MAPS OF THE AMBLER RIVER QUADRANGLE, ALASKA

(Discussion to accompany sheets 1, 2 and 3)

By Steve W. Hackett

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INTRODUCTION

A 1:250,000-scale total-intensity magnetic anomaly map (sheet 1) of the Ambler River quadrangle was compiled from regional aeromagnetic surveys flown in 1974 and 1975 on contract for the State of Alaska Department of Natural Resources (DNR). The magnetic data were released by the Alaska Division of Geological and Geophysical Surveys (ADGGS) in 1:63,360-scale aeromagnetic maps during 1975 (western half) and 1976 (eastern half).

The airborne surveys were flown at 300 m (1,000 ft) above ground level (AGL) along north-south flight paths spaced about 1.6 km (1.0 mi) apart in the west and 1.2 km (0.75 mi) apart in the east. Flightline navigation and position, which were controlled by preliminary 1:63,360 topographic mapping, may contain some errors that affect the magnetic anomalies. Altimetry data were continuously recorded for each flight path. A regional magnetic trend of 3.45 gammas/mile north and 2.25 gammas/mile east (a negative southwestward gradient of about 4 gammas/mile) was removed by using the 1965 International Geomagnetic Reference Field updated to the time of the 1974 and 1975 aeromagnetic surveys. The magnetic data were processed and contoured on 1:63,360-scale maps and subsequently compiled (Hackett, 1977) to form the 1:250,000-scale aeromagnetic map. Contour intervals and labels are at 10, 50, and 100 gammas.

To obtain a constant mean terrain clearance the aeromagnetic survey was flown by a "drape flying" technique, i.e., at a nominal 300 m above the ground surface. This procedure minimizes the loss of resolution and attenuation of anomalies that might have occurred with an increased flying height at a constant barometric altitude, i.e., a constant height above sea level rather than a common height above ground level. Rugged topography and marginal of the magnetic masses, and possibly reverse remanent magnetism can cause, or in part accentuate, the magnetic lows in some regions.

The major geologic features in the Ambler River quadrangle generally correlate with the magnetic trends at a 1:250,000 scale, even though some discrepencies are evident between the regionally mapped surface geology and the 1:63,360-scale (ADDGS, 1974, 1975) aeromagnetic data. The geologic mapping within areas of the quadrangle is probably not detailed enough to explain some of the subtle and correlatable trends indicated on the magnetic lineament and anomaly trend map (sheet 2). However, the aeromagnetic data probably define some of the bedrock geology at depth. They may also identify unmapped structural features and should aid in testing suspected geologic trends.

Sheet 3, the geological interpretation map of the aeromagnetic data, shows the major magnetic-lithologic units and their boundaries. The boundaries were identified and integrated from a spectrally colored copy of the aeromagnetic map (sheet 1) and from the lineament and anomaly trend map (sheet 2). The units were cross-correlated with generalized geologic maps (Brosgé and Pessel, 1977; Mayfield and Tailleur, 1978), detailed geologic maps (Fritts, 1969, unpub. data; Pessel and others, 1973) and observations by the author during the 1975, 1976, 1977 field seasons. Identification of major types of geologic trends has been attempted by using the relative magnetite content of the lithologic units and the characteristic magnetic anomaly patterns and amplitudes of 1:63,360-scale aeromagnetic maps. Relative magnetizations and implied lithology of the magnetic anomalies are assigned to prominent areas. Some large asymmetric magnetic lows are thought to be caused by natural reversed remanent magnetism (indicated by the letter "R"). Other negative anomalies adjacent to positive anomalies are probably caused by

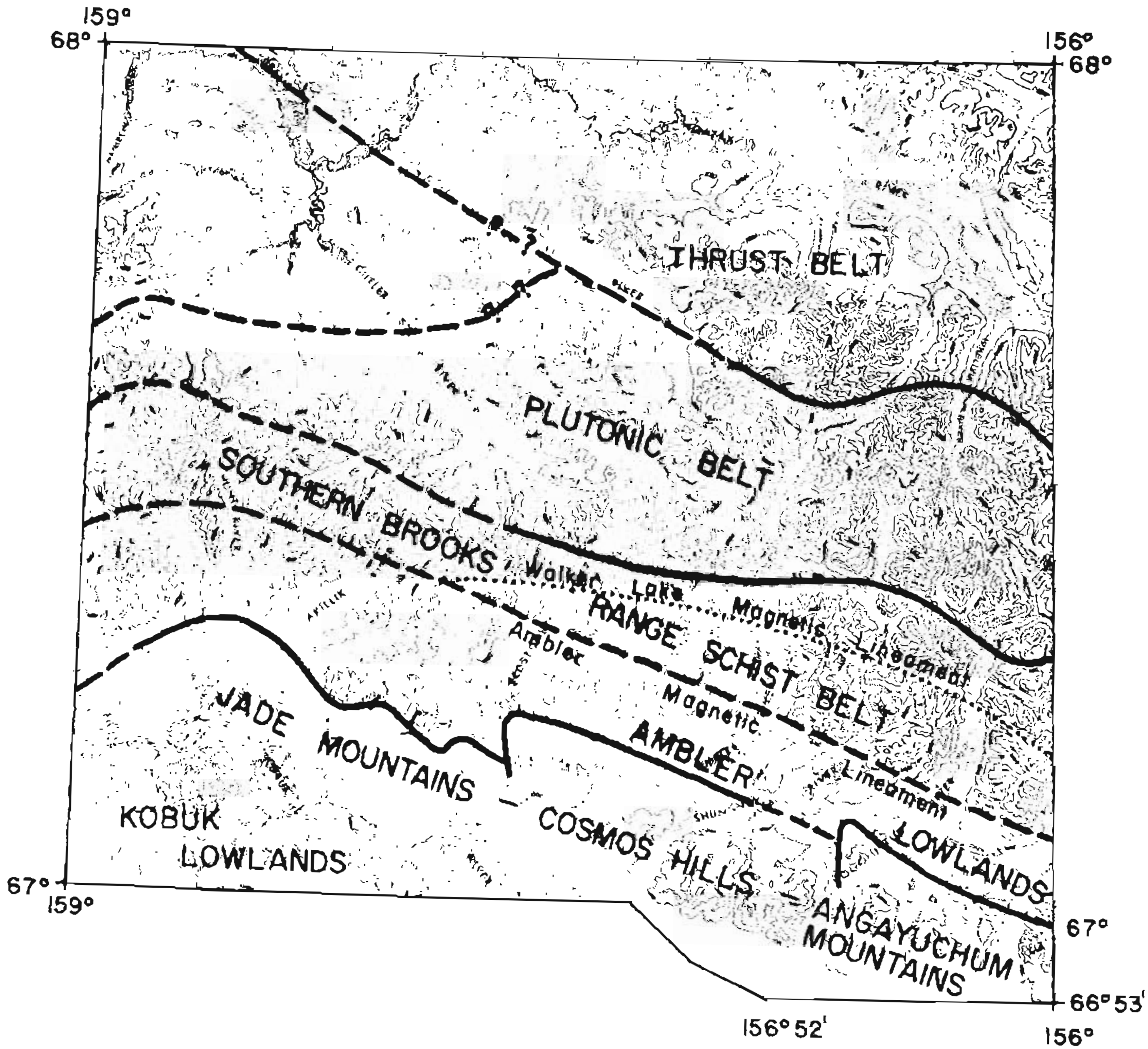

Figure 1.--Aeromagnetic terranes of the Ambler River quadrangle.

Roeder and Mull, 1978). This regionally identified geologic and geophysical feature is interpreted to represent a major boundary between oceanic and continental crust that was juxtaposed possibly in Late Jurassic and Early Cretaceous time during the Brooks Range orogeny. Structural mixing of rocks from both sources has probably occurred over a wide area associated with this geologically and geophysically outlined boundary. This major magnetic feature suggests a south-dipping boundary that, although locally broken, extends many kilometers both within and east of the Ambler River quadrangle along the southern margin of the Brooks Range (Hackett, 1977, 1980 in press).

Jade Mountains-Cosmos Hills-Angayuchum Mountains

Within the Jade Mountains-Cosmos Hills-Angayuchum Mountains terrane (fig. 1), the magnetic signature is characterized by sharp, high-amplitude anomalies that are related to exposures and subcrops of mafic and ultramafic igneous rocks. Large, high-amplitude anomalies reflect the exposed serpentinite bodies, and adjacent magnetic patterns indicate additional ultramafic bodies beneath the alluvium or Cretaceous sedimentary rocks. Some moderate and broad magnetic lows are associated with the phyllites, carbonates, and related rocks in the area. In the Jade Mountains, anomaly patterns suggest south-southwestward-dipping, layered slabs of volcanic and ultramafic rocks. The large asymmetric negative anomalies associated with the mafic and ultramafic rocks indicate that reversed remanent magnetization might be present in addition to normal polarization effects of these southward-dipping magnetic bodies. Because magnetic property measurements (NRM may be present) from outcrops are not available, the dip of these magnetic layers with depth is not quantitatively documented. However, geologic attitudes taken from selected outcrops (Patton and others, 1968; and Fritts, 1969, 1970, and 1971; Pessel

Southern Brooks Range Schist Belt

Metamorphic rocks in the southern Brooks Range schist belt (fig. 1) have subtle and variable magnetic responses but show strongly developed regional magnetic anomalies and gradients subparallel to structural and stratigraphic trends. Some magnetic anomalies are locally associated with a chloritic schist unit (Pzcq, sheet 2) in the central and northern part of the schist belt. Relatively high susceptibility contrasts are in part associated with a magnetite-rich quartzite unit (Pzmq, sheet 2). The regional aeromagnetic data indicate that magnetic anomalies greater than 40 gammas are absent over most of the known zinc, copper, lead, gold, and silver deposits within the schist belt. This important metallogenic trend, the southern Ambler District mineral belt, can be magnetically characterized only in terms of its association with other regional geologic features on the 1:250,000-scale aeromagnetic map. Truncation of magnetic anomalies suggests basement faults or near-vertical contacts at depth between the schist-belt rocks, the Ambler Lowlands, and the rocks in the Cosmos Hills-Angayuchum Mountains trend.

Variable and inconsistent anomalies occur over felsic intrusive rocks that are also numerous in the south and central parts of the Ambler River quadrangle (Mayfield and Tailleur, 1978). Small granitic bodies have been mapped near the Walker Lake fault (Pessel and others, 1975) and within the schist belt (Pessel and Brosgé, 1977). A small stock crops out in the core of the arch of the Cosmos Hills, just south of the quadrangle boundary (Fritts, 1970, 1971). A small skarn that may have resulted from granitic intrusion at depth or localized thermal metamorphism crops out near the core of the Kalurivik Arch in the schist belt (Wiltse, 1975; Tailleur and Pessel, oral commun.). Some mafic lenses (mi) within the schist belt (Pessel and Brosgé, 1977) that have important structural significance cause localized positive central part of the Ambler River quadrangle (Gilbert and others, 1977) and may be truncated by the Ambler magnetic lineament. The Kalurivik Arch, a major antiformal structure that extends for at least 62 km along and within the southern Brooks Range schist belt (Pessel and others, 1973) occurs between the Walker Lake and Ambler magnetic lineaments. The convergence of these lineaments outlines the western boundary of this important anticlinal trend. Other reconnaissance-mapped bedrock units appear to have subtle convergent structural trends in the central and western part of the quadrangle. The southern and westward termination of magnetic features associated with geologic trends may reflect a southwesterly convergent structural style for the western Brooks Range schist belt.

Plutonic Belt

North of the Walker Lake magnetic lineament, a belt of plutonic rocks (fig. 1) intruding schists and carbonates is characterized by low-amplitude magnetic anomalies. There are large, asymmetric negative anomalies associated with the mid-Paleozoic and younger(?) intrusive rocks along this belt. The younger granitic rocks appear to have intruded a complexly folded and faulted series of metamorphic rocks and massive carbonates that show structural evidence of extensive thrust faulting. Rock alteration, which includes increased metamorphic grades (Mayfield, 1975), probably outlines contact metamorphic aureoles associated with and bordering some of the plutonic bodies which may be reflected by relatively high-intensity magnetic zones near the plutons. Many of the magnetic boundaries, which are associated with the contacts between the plutons and the country rock, are roughly concentric and elongate. These magnetic patterns suggest pretectonic emplacement and later tectonic infolding within the metamorphic (metasedimentary) basement.

to the complex aeromagnetic patterns and susceptibility contrasts within the quadrangle. Areas of intrusive rocks within the plutonic belt are outlined on the geologic interpretation map as curvilinear zones of steepened magnetic gradients and sharp magnetic discontinuities that persist for many kilometers in the central part of the quadrangle. These magnetic patterns and lineaments reflect major magnetic discontinuities within the basement rocks and probably indicate a fundamental tectonic pattern that is related to the emplacement of the plutons. The intense magnetic relief associated with magnetite-rich metamorphic and igneous terranes dominates the east-central and central parts in the Ambler River quadrangle. A subtle regional break in magnetic gradient in the northern parts of the plutonic belt outlines the possible westward extension of a south-vergent thrust belt (Mull, 1977). North of the axis of the regional intrusive rock belt a relatively thick sequence of Paleozoic carbonate clastic and pelitic rocks overlies deep magnetic basement.

Thrust Belt

North and northeast of the plutonic belt, the "thrust belt" (Mayfield and Tailleur, 1978) typically has a subdued magnetic signature, indicating that a magnetic basement lies at considerable depth under the carbonates and sediments of the Baird, Lisburne, and Endicott Groups of Paleozoic age. Some positive anomalous areas, such as within the Kavachurak Creek and Tunukuchiak Creek drainages, probably are associated with a shallowing magnetic basement and may reflect tectonic windows within the carbonate and clastic terranes. A broad magnetic high along the northern part of the Ambler River quadrangle indicates some deep and significant regional intrabasement contrasts toward the north. The relatively large positive magnetic anomalies over the Cutler River lowlands are probably associated with mafic rocks or magnetite-rich character to the south and continental rocks to the north. A narrow, composite magnetic high is associated with the Walker Lake fault (Fritts, 1970) and trends as a magnetic lineament from Walker Lake in the Survey Pass quadrangle to where the magnetic high broadens as a gradient westward across the Ambler River quadrangle. This magnetic trend, the Walker Lake magnetic lineament, is truncated by the Ambler magnetic lineament near the Redstone River, where the lineament outlines the western plunge of the Kalurivik Arch. Metamorphic and volcanic rocks of the southern Brooks Range schist belt have a subdued but variable magnetic signature and show strongly developed regional magnetic trends subparallel to geologic strike. Aeromagnetic lineaments and anomaly trends within the plutonic belt outline major magnetic zones within the basement rocks and probably indicate a fundamental tectonic pattern that is interpreted to be related to the emplacement of plutons. The thrust belt, a thick stratigraphic sequence of tectonically emplaced Paleozoic carbonate and clastic rocks, overlies deep magnetic basement in the east-central and northeast parts of the quadrangle.

Oriented rock samples from some of the major magnetic units are needed for a detailed interpretation of the aeromagnetic data. Detailed geological mapping, geophysical surveys, and rock-sampling programs to obtain physical rock properties would provide more definitive data for determining the metamorphic and petrophysical effects of buried plutonic bodies. A quantitative study of detailed aeromagnetic and ground magnetic data would provide additional evidence for the possible size, shape, and depth of burial of the magnetic units and for the configuration of selected metamorphic, igneous, and sedimentary terranes.

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