UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Interpretation of the aeromagnetic pattern of the San Juan primitive area, Colorado

by

Peter Popenoe and T. A. Steven

Open-file report

1969

69-211

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

U.S. GEOLOGICAL SURVEY
Released to open file
September 29, 1969

Contents

Illustration

Table

Interpretation of the aeromagnetic pattern of the San Juan primitive area, Colorado

By Peter Popenoe and T. A. Steven

Introduction

As part of the wilderness areas investigation program the U.S. Geological Survey flew an aeromagnetic survey of the San Juan primitive area in 1968. Traverses were flown in an east-west direction at 14,500 feet above sea level, and the total intensity magnetic field was recorded with an ASQ-10 flux-gate magnetometer. The results of the aeromagnetic survey of the proposed primitive area and some of the surrounding area are shown on plate 1.

The geology and mineral resources of the San Juan primitive area have been described by Steven, Schmitt, Sheridan, and Williams (1969), and the geologic map from that report should be used as an underlay for plate 1 of this report.

The complex aeromagnetic pattern shown on plate 1 of this report can be divided into three major areas that correspond to the Precambrian crystalline, the Paleozoic and Mesozoic sedimentary, and Tertiary volcanic terranes shown on the geologic map of Steven and others (1969). Of primary concern to the San Juan primitive area are the Precambrian metamorphic and granitic rocks in the Needle Mountains and a broad area to the east underlain by younger volcanic rocks. Specific aeromagnetic anomalies within these major areas are discussed individually, and, in addition, the mineralized areas in the vicinity of Whitehead Gulch, Beartown, and Trout Creek-Middle Fork-Piedra River areas are discussed separately.

Acknowledgments

We thank P. W. Lipman for information on the magnetic polarity of rock units, G. D. Bath for rock susceptibility measurements, and F. G. Barker for valuable discussions on the geology of the Needle Mountains area.

1969

Needle Mountains area

The Eolus Granite has the greatest areal distribution of any of the Precambrian rocks in the Needle Mountains area. This granite, the Tenmile Granite, and the Trimble Granite produce broad low-amplitude magnetic anomalies (shown at areas marked 1, pl. 1) which reflect a low magnetic susceptibility. Measured susceptibilities on two samples of Eolus Granite bear this out (table 1), as the susceptibilities were 1.62 and 0.54 x 10^{-4} cgs (centimeter gram seconds) units. The magnetic pattern suggests that the granite extends at a shallow depth beneath the Uncompahgre Formation in area 1A, and beneath the sedimentary cover in area 1B. Exposures of Eolus Granite, which have been mapped (Larsen and Cross, 1956) along the Piedra River south of area 1B, substantiate this interpretation.

Superimposed on the rather expressionless pattern of the Eolus Granite are a sharp anomaly of 982 gammas at area 2 (pl. 1) and a broader high centered over an outcrop of intrusive Tertiary rock at area 3. The anomaly at area 2 is located over a mapped body of Precambrian quartz diorite and reflects the relatively mafic composition of these rocks. The anomaly at area 3 is centered over a mineralized intrusive plug of quartz monzonite of probable Tertiary age in the Needle Mountains mining district.

The amplitude, size, and character of the anomaly at area 3 indicate that a relatively large area may be underlain by rocks of higher magnetic susceptibility than is demonstrated by Eolus Granite elsewhere; this supports the suggestion of Steven and others (1969) that the distribution of veins and metal values in the Needle Mountains mining district indicate a larger underlying intrusive body. Estimations on depths of gradients on the east side of the anomaly (Vacquier and others, 1951) along the flight line which passes through the anomaly maxima suggest that the source lies at about 1 mile below the flight elevation or at about 10,000 feet in this area. This is slightly below the elevation of the outcrop of quartz monzonite along Needle Creek. The source of the anomaly deepens to the west. The rocks in the vicinity of the Tertiary intrusive plug are highly altered with an accompanying destruction of magnetic minerals, and therefore no magnetic susceptibilities were measured of the intrusive quartz monzonite.

Other anomalies that reflect hypabyssal Tertiary intrusive masses are shown at the Grizzly Peak (anomaly 5) and Sultan Mountain stocks (anomaly 4), north of the proposed wilderness area; these exhibit very strong magnetic highs, which reflect a high magnetite content of the intrusive rocks. A strong magnetic high is developed also over the Precambrian Electra Lake Gabbro (anomaly 6) to the west of the primitive area.

Large magnetic highs are developed in areas 7 over the Precambrian Irving Formation. These highs reflect the relatively high magnetite content of the mafic metavolcanic rocks in the formation and are most strongly developed over the area containing the outcrops of "iron formation" which have been described (Steven and others, 1969). In contrast to these highs, deep aeromagnetic lows are developed over the Vallecito Conglomerate and areas of the Uncompahgre Formation (areas 8), probably reflecting the fact that these rocks are almost wholly nonmagnetic and are at least several thousand feet thick in the areas of the magnetic lows.

Whitehead Gulch area

The Whitehead Gulch area lies on the southern gradient of large aeromagnetic highs associated with the Sultan Mountain stock (anomaly 4) of Tertiary age, the San Juan Formation and Burns Quartz Latite (anomaly 9), which are normally polarized volcanic units of Tertiary age that cap Whitehead Peak and Kendall Mountain, and the Irving Formation (anomaly 10), a mafic Precambrian unit. The extent of the magnetic buildup throughout the area of Grizzly Peak, Sultan Mountain, and Whitehead Peak strongly suggests that this entire area may be underlain by a large Tertiary stock of relatively mafic material that reaches the surface only in the Sultan Mountain and Grizzly Peak stocks. The northern third of the Whitehead Gulch area may overlie the southern edge of this postulated stock.

Beartown area

Tertiary intrusive quartz monzonite and mafic quartz syenite of Precambrian age are exposed in an erosional window at Ute Creek east of the Beartown area, and probably are responsible for the magnetic high in area 11. This anomaly is not strongly developed, as the intrusives are exposed deep in Ute Creek canyon at the relatively low altitude of about 11,000 feet. These rocks are surrounded by a thick mass of Gilpin Peak Tuff, a tuffaceous volcanic unit with a magnetic susceptibility of 3.6×10^{-4} cgs units and a polarity probably in a reversed direction from the earth's normal field (table 1). The Gilpin Peak Tuff is more than 2,000 feet thick and is the cause of the aeromagnetic lows seen on the north side of anomalies 11 and 12 and north of anomaly 2.

Anomaly 12, near the head of Ute Creek, probably originates at the surface and is caused by andesite flows and breccias exposed in Ute Creek. The whole area lies along the strong magnetic gradient described in the Whitehead Gulch section, which probably indicates that it also may lie along the southern margin of a large stock containing strongly magnetized Tertiary intrusive material at depth.

Tertiary volcanic rocks

Approximately the eastern two-thirds of the San Juan primitive area is underlain by a varied sequence of volcanic rocks of Tertiary age. This area has a very complex magnetic expression, but it is amenable to reasonable interpretation if certain magnetic parameters are known. Table 1 lists the magnetic susceptibilities and polarities of the principal volcanic rocks.

The effect of moderately to highly magnetic rock units, modified by topography, is well shown in the central part of the volcanic area where a strong V-shaped magnetic high and a strong linear high are present (areas labeled 13 on pl. 1). These anomalies are generated by the normally polarized Huerto Formation which has a magnetic susceptibility of 1.3×10^{-3} cgs units, the highest susceptibility of any of the volcanic units measured. The maximum highs are developed over the topographic highs where the volcanic rocks were only about 1,500 feet below the magnetometer survey elevation.

In contrast to the strong magnetic highs just discussed, very deep magnetic lows are developed over certain reversely polarized rocks, chiefly the Carpenter Ridge Tuff and Wason Park Rhyolite (areas labeled 14, pl. 1). The susceptibility of the Carpenter Ridge Tuff, 5.4×10^{-4} cgs units, is moderately strong and is in a reverse direction; thus, where the Carpenter Ridge Tuff occurs beside normally polarized rocks of even moderate susceptibility, a spectacular contrast is produced.

Most of the area marked 15 on plate 1 is underlain by Fish Canyon Tuff, a normally polarized rock of relatively low susceptibility, 0.6×10^{-4} cgs units, which produces moderate highs. Where the Fish Canyon Tuff is in fault contact with a rock of even lower magnetic susceptibility, such as the Conejos Formation in the south-eastern part of the San Juan primitive area (areas labeled 16, pl. 1), a textbook example of an anomaly reflecting a uniformly magnetized block with vertical edges is produced.

Trout Creek-Middle Fork, Piedra River area

A strong magnetic high (area 17, pl. 1) occurs in this area, which cannot be explained by the exposed volcanic rocks. The anomaly occurs over Wason Park Rhyolite, tuff of Sevenmile Creek, and Carpenter Ridge Tuff, all of which are reversely polarized. The size and shape of the anomaly indicate a near-surface source which expands at depth. Geologic evidences, including the proximity to the sulfur beds along the east fork of Trout Creek, local hydrothermal alteration, and the nature of the volcanic rocks led to the geologic conclusion given by Steven and others (1969) that this area marks a local volcanic vent of the Huerto Formation. The

strong magnetic high reinforces the geologic evidence and may locate the position of the vent area more closely. The size of the anomaly would indicate that a stock about 3 miles across may be present at a shallow depth beneath the aeromagnetic high.

Table 1. Measured magnetic susceptibility, polarization, and density of rocks of the San Juan primitive area

Rock type	Susceptibility x 10^{-4} cgs units	Polarization	Density g/cm^3
Snowshoe Mountain Quartz Latite		Normal	
Wason Park Rhyolite		Reversed	
Mammoth Mountain Rhyolite (tuff of Sevenmile Creek)		Reversed	
Carpenter Ridge Tuff	5.45	Reversed	2.26
Rhyolite welded tuff		Normal	
Huerto Formation	13.13	Normal	2.58
Fish Canyon Tuff	.65	Normal	2.22
Gilpin Peak Tuff	3.57	Reversed ?	1.89
Eolus Granite	.54	Normal	2.63
Eolus Granite	1.62	Normal	2.55

References

Larsen, E. S., Jr., and Cross, C. W., 1956, Geology and petrology of the San Juan region, southwestern Colorado: U.S. Geol. Survey Prof. Paper 258, 303p.

Steven, T. A., Schmitt, L. J., Jr., Sheridan, M. J., and Williams, F. C., 1969, Mineral reccurces of the San Juan primitive area, Colorado: U.S. Geol. Survey Bull. 1261-F, 187 p.

Vacquier, Victor, Steenland, N. C., Henderson, R. G., and Zietz, Isidore, 1951, Interpretation of aeromagnetic maps: Geol. Soc. America Mem. 47, 151 p.