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GRISCOM—AEROMAGNETIC SURVEY—BAKER—CYPRESS INSTANT STUDY AND TIMBERED CRATER FURTHER PLANNING AREAS, CALIF.

1:62 500

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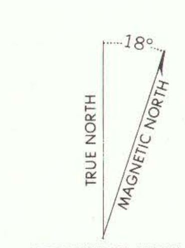
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MF-1214-C

Base from U.S. Geological Survey
Fall River Mills, Pondosa, 1961

SCALE 1:62500



APPROXIMATE MEAN DECLINATION, 1981

AREA OF MAP

Geology mapped by J. A. Peterson and L. M. Martin, 1979

Aeromagnetic survey flown by L K B Resources, Inc., 1978-1979

MAP SHOWING AEROMAGNETIC INTERPRETATION OF THE BAKER-CYPRESS BLM INSTANT STUDY AREA AND TIMBERED CRATER FOREST SERVICE FURTHER PLANNING AREAS, MODOC, SHASTA, AND SISKIYOU COUNTIES, CALIFORNIA

By
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1981

EXPLANATION

Geologic map

(Generalized from Peterson and Martin, 1980)

Qba — Basalt and alluvium, undivided — Quaternary

Tbu — Basalt — Tertiary

Contact

Fault

Outline of study area

Aeromagnetic map

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 intervals 20 and 100 gammas

x51820 MAXIMUM OR MINIMUM INTENSITY - Location measured within closed high or closed low

FLIGHT PATH - showing location and spacing of data

Flight path altitude is 1370 m (4500 ft) above sea level

A constant value of 53500 gammas is added to data

Observed total field reading (gammas) x53731

The regional field removed is IGRF 1975 updated to the month flown.

The grid interval for computer contouring is 175 m E-W and 400 m N-S.

Aeromagnetic data

The data for the aeromagnetic map of the Baker-Cypress and Timbered Crater areas were collected in 1978 and compiled at a scale of 1:62,500 (U.S. Geological Survey, 1979). East-west traverses were spaced at 0.8-km intervals at a constant altitude of 1370 m (4500 ft) above sea level. Contour interval is 20 and 100 gammas, depending upon the steepness of local gradients in the Earth's magnetic field. A regional magnetic field (the International Geomagnetic Reference Field - 1975, updated to the month flown) of approximately 5-6 gammas/km was removed from the data before contouring.

The local topographic relief for this area is commonly only a few tens of meters except for the steep slopes of Timbered Crater, which display 100 m of relief. Accordingly, the topography cannot be a significant source for magnetic anomalies with the possible exception of the small magnetic high of about 100 gammas on the magnetic traverse that crosses the south edge of the crater.

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 sources of the magnetic anomalies in this map area are volcanic rocks, both at the surface and also at substantial depth. Because these volcanic rocks are young and unaltered (Peterson and Martin, 1980), the remanent magnetization of the rocks will in general far exceed the induced magnetization. The magnetic anomalies on the aeromagnetic map are thus probably caused for the most part by remanent magnetization.

Geologic discussion

The geology of this area is described by Peterson and Martin (1980). The oldest rocks are Tertiary basalt (Gay and Aune, 1958) exposed along the north and east borders of the map. The remaining part of the mapped area is underlain by basalt, predominantly lava flows. These volcanic rocks are locally covered by alluvium and also overlie basin deposits (lacustrine and fluvial sedimentary rocks) exposed to the south near Tule River and Big Lake. The basin deposits in turn overlie the Tertiary basalt. The youngest lava flows form a small shield complex, 10 to 12 km across, that erupted from vents in the general vicinity of Brushy Butte at the center of the map; judging from local relief, the complex may be only 100 to 200 m thick. The various rock units are in general flat lying; unconformities separate the major groups of flows. Northwest-trending faults cut all rock units.

Aeromagnetic interpretation

Examination of the aeromagnetic map patterns indicates a major irregular magnetic high extending from the south border of the map area up through the north-central part. Surrounding this high are several magnetic lows: a major low on the east side, two lows at the north edge of the map area, and a low in the southwest corner. Such irregular patterns of highs and lows are characteristic of thick sections of flat-lying volcanic rocks.

In order to interpret these magnetic anomalies, it is helpful to decide upon the zero datum or local background level of the data. As stated on the map, a constant of 53,500 gammas was added to the data set, implying that this latter value is the background level (zero datum) of the map. The geomagnetic reference field originally subtracted from the data set is an extremely smoothed regional average, and such a reference field will thus not necessarily provide an accurate local zero datum level for such a small area. A better estimate of the zero datum level can be obtained by examination of a regional aeromagnetic map covering the same and adjacent areas (California Division of Mines and Geology, 1979).

My interpretation of the regional map places the zero datum level in the vicinity of 3300-3400 gammas. Hence, of the four substantial magnetic lows within the Baker-Cypress map area, only the northern low with a minimum value of 53,184 gammas is sufficiently low to be caused probably by rocks with reversed remanent magnetization. This low is located over Tertiary basalt. The remaining three lows are more likely areas underlain by weakly magnetic rocks. The major irregular magnetic high extending north through the central part of the Baker-Cypress area can be seen on the regional map to be an extension of a magnetic high farther south that trends northwest across the area of presumably nonmagnetic basin sedimentary rocks. Accordingly, the high is probably caused for the most part by the underlying Tertiary basalt, and it is likely that all the various large magnetic features of the regional map in this area are predominantly caused by the Tertiary basalt that underlies the entire area.

What, then, is the magnetic expression of the Quaternary basalt that covers almost the entire surface of the study area? Measurements of magnetic properties were made on eight samples of Quaternary basalt from sample sites widely distributed across the area: three from the flows of the shield complex, two from the flows associated with Timbered Crater, and 3 from other flows. The measured values are those commonly found in young terrestrial basalt flows. Average magnetic susceptibility is 7.04×10^{-3} emu/cm^3 (range from 1.59 to 22.10 $\times 10^{-3}$); average remanent magnetization (direction unknown) is 5.53×10^{-3} (range from 1.37 to 16.50×10^{-3}). The ratio (Q) between the remanent magnetization and the induced magnetization of these rocks (for a local field of 53,400 gammas) is 1.5, a value rather close to 1.0, which means that if any of the rock units possess reversed remanent magnetization, their two magnetizations will be in opposite directions and nearly equal in amplitude, thus substantially canceling each other out. Rocks of this sort will produce relatively small aeromagnetic anomalies, but in general most Quaternary rocks do not possess reversed remanent magnetization.

An aeromagnetic survey over young basalt flows should produce a characteristic "birds-eye maple" pattern with anomaly wavelengths of about 1 km for a height of 300-350 m above the ground. Examination of the aeromagnetic map discloses numerous such small anomalies scattered over the map with amplitudes of 50-250 gammas. These anomalies are considered to be caused by the Quaternary basalt. Only two anomalies can be confidently associated with specific geologic features. One is the very small high associated with the south rim of Timbered Crater. The other is a circular high (maximum value 54670 gammas) in the center of the magnetic map. This circular high is centered 1 km west of Brushy Butte and is associated with the central vent area of the small shield complex. The anomaly may be caused by the basalt intrusions below the various vents.

The depth to the sources of these numerous small magnetic anomalies caused by Quaternary basalt may be calculated from the horizontal extent of the steepest gradients (Vacquier and others, 1951), this distance being a measure of the depth of the source below the surveying aircraft. In volcanic terranes such depth estimates tend to be somewhat shallower than the true source depth because flat-lying volcanic rock units have forms that do not meet the assumptions of the method. The widths of the magnetic gradients associated with the small anomalies are appropriate for sources about 300-350 m below the aircraft, thus confirming that they are indeed caused by Quaternary basalt. Similar steep narrow gradients bounding much larger magnetic anomalies are located over or adjacent to areas of the Tertiary basalt; this latter result provides a second reason for believing that the larger magnetic features are caused by the Tertiary flows. On the other hand, the much broader gradients associated with the west side of the major eastern low (6 by 8 km in size) indicate that the Tertiary source rocks here are deeply buried, being covered by both the Quaternary basalts and the underlying basin deposits.

The amplitudes of the magnetic anomalies caused by the Quaternary basalts are so small (50-250 gammas) that they provide significant constraints upon the thickness of these basalts, given the measured magnetic properties. Assuming a normal direction of remanent magnetization, the total magnetization of the basalt is the sum of the induced and remanent components, or approximately 9×10^{-3} emu/cm^3. Applying this magnetization to an east-trending, horizontal slab of rock 1830 m (6000 ft) long by 1220 m (4000 ft) wide and 76 m (250 ft) thick (Model A of plate 111 in Andreasen and Zietz, 1969) yields a computed magnetic anomaly of about 450 gammas measured 305 m (1000 ft) above the slab. This result is somewhat larger than the largest observed anomalies believed to be caused by the Quaternary volcanic rocks and implies that the rocks are in general probably not much thicker than 76 m (250 ft) and also that the measured average magnetization (from eight samples) may be somewhat larger than the true average magnetization of the rocks.

The apparent absence of local magnetic highs in the southeast quarter of the aeromagnetic map and the presence of at least five small closed lows (maximum amplitude about 60 gammas) suggest that the Quaternary basalts in this area may possess reversed remanent magnetization. If they are reversed, then the vector sum of the average measured induced and remanent magnetizations is about 1.8×10^{-3} emu/cm^3 in the reversed direction (up to the south). This result when used for the previously described model produces a local magnetic low of about 90 gammas, again a quantity somewhat larger than the amplitudes of the largest observed local magnetic lows in the southeast quarter of the map area. The implications concerning flow thickness and magnetic properties are thus the same for this latter area as in the previous example that assumed normal remanent magnetization.

References

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Studies Related to Wilderness

The Wilderness Act (Public Law 88-577, September 3, 1964) and related Acts, require the Geological Survey and the Bureau of Mines to survey certain areas on Federal Lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the Administration and the Congress. These maps and reports present the results of a geological and mineral survey of the Baker-Cypress BLM Instant Study Area and Timbered Crater Forest Service Further Planning Areas

Interior—Geological Survey, Reston, Va.—1981

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