CORRELATION OF MAP UNITS

Unit	Age	Era
Tv	Pliocene? and Miocene	CENOZOIC
Td	Pliocene? and Miocene	CENOZOIC
Tb	Pliocene? and Miocene	CENOZOIC
Unconformity		
Pzs		PALEOZOIC
Unconformity		
Pim		PROTEROZOIC

DESCRIPTION OF MAP UNITS

Tv VERDE FORMATION (PLIOCENE AND MIOCENE)--Poorly consolidated basin-fill deposits; largely mantled bv alluvial deposits; volcanic rocks, mainly basalt, interbedded in lower part

Td DACITE FLOWS, TUFFS, AND BRECCIAS (MIOCENE)--Intrusive in part; some interlayered basalt

Tb BASALT FLOWS AMD VENT DEPOSITS (MIOCENE)--Includes a basalt sill in the Chasm Creek area; minor interbedded silicic tuff

Pzs SEDIMENTARY ROCKS (PALEOZOIC)--Includes Tapeats Sandstone, dolomitic siltstone of the Chino Valley Formation, dolomite of the Martin Formation, Redwall Limestone, and minor siltstone of the Supai Group

Pim IGNEOUS AND METAMORPHIC ROCKS (PROTEROZOIC)--Including volcanic and metavolcanic rocks and tonalite

CONTACT

FAULT--Dashed where approximately located or inferred; dotted where buried; U, upthrown side; D, downthrown side

ANTICLINE--Dashed where approximately located; dotted where buried

APPROXIMATE BOUNDARY OF ROADLESS AREA

LIMIT OF GEOLOGIC MAPPING

MAGNETIC CONTOURS--Showing residual total intensity magnetic field of the earth in gammas. Regional magnetic field (International Geomagnetic Reference Field, 1975, updated to month of flight) removed. Hachures indicate closed magnetic lows. Contour intervals 20 and 100 gammas

FLIGHT PATH

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. 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 President and the Congress. This report presents the results of an aeromagnetic survey of the Arnold Mesa Roadless Area (U.S. Forest Service number 03092) in the Prescott and Tonto National Forests, Yavapai County, Ariz. The Arnold Mesa Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The Arnold Mesa Roadless Area, Yavapai County, Ariz., is within the transition zone between the Colorado Plateaus to the northeast and the Basin and Range province to the southwest. The transition zone is a belt about 70 mi (120 km) wide that extends diagonally from northwest to southeast across central Arizona and parallels the topographic margin of the plateaus. The study area is underlain by Precambrian rocks and gently dipping Paleozoic strata that are largely covered by basaltic lavas and pyroclastic deposits of Miocene age (McKee and Anderson, 1971). Dacite breccia and tuff are locally interbedded with the basaltic rocks. Sedimentary deposits of late Cenozoic age are dominant in the Verde Valley from about Chasm Creek north; they accumulated in a depositional basin bounded on the west by the Verde fault.

The area includes the west side of the Verde River valley, the Black Hills, and the adjacent rolling upland terrain on the southwest. Steep slopes characterize the east flank of the Black Hills, which are incised by the gorges of Chasm and Gap Creeks. The Black Hills, with maximum elevations ranging from 5,200 to 6,700 ft (1,600 to 2,000 m) rise about 4,000 ft (1,200 m) above the lowland along the river. Crest altitudes are somewhat lower to the southwest, where the local topographic relief is on the order of less than 1,000 ft (300 m).

Numerous high-angle faults, predominantly of northwest trend, exist from the general vicinity of the Black Hills north to the southern edge of the Colorado Plateaus. The Verde fault in the northern part of the map area is a conspicuous, single, steep, normal fault. About a kilometer or so north of Chasm Creek, however, the single fault splays southward into several high-angle faults, most of relatively small displacement. These subsidiary faults become unrecognizable within the volcanic rocks south of Chasm Creek. The easternmost strand is distinct for 1.2 mi (2 km) southeast of Chasm Creek where it separates basin deposits from basalt, but it also becomes unrecognizable within the basalt southeast of Rodeo Flat.

MAGNETIC FEATURES AND INTERPRETATION

An aeromagnetic survey of the Arnold Mesa Roadless Area was flown in 1980 by Airmag Surveys, Inc., for the U.S. Geological Survey. Total magnetic intensity data were obtained along east-west flight lines about 0.5 mi (0.8 km) apart and flown approximately 1,000 ft (300 m) above ground. Intensity measurements were made with a Mark IV fluxgate magnetometer. A regional magnetic field (the International Geomagnetic Reference Field, 1975, updated to month flown) was removed from the data and a constant of 50,800 gammas was added to the adjusted total field intensity values.

The aeromagnetic contour pattern is related in part to the magnetic intensities of the various rock units. Because of their greater content of magnetic minerals, mainly magnetite, the basaltic rocks generally possess strong intensities of magnetization. The more silicic volcanic rocks commonly have much lower magnetization intensities. Sedimentary rocks and unconsolidated sedimentary deposits give little or no magnetic response and are considered to be essentially nonmagnetic. Accordingly, a zone of low magnetic intensity and gentle magnetic gradients extends from Chasm Creek north and is coincident with exposed Precambrian intrusive and metamorphic rocks, Paleozoic sedimentary rocks, and Cenozoic basin-fill deposits of the Verde Formation. High magnetic intensities and steep magnetic gradients occur for the most part over areas where basalt, commonly hundreds of feet thick, is exposed. Most of the magnetic anomalies shown on the map are bounded by high magnetic gradients whose limited horizontal extent indicates that their magnetic sources are exposed or lie near the ground surface.

In the southeastern part of the Black Hills, a prominent magnetic high with two maxima lies over Tule Mesa, which includes the highest terrain in the study area and is bounded on the northeast by extreme topographic relief. The mesa is underlain by the greatest known thickness of basalt in the map area, 2,000 ft (600 m) or more. The comparatively high amplitude of the anomaly suggests that the rocks beneath the magnetic maxima possess greater magnetization intensities than those of most near-surface flows. A substantial thickness of basaltic rocks that have moderate to strong magnetization is considered to be the source of the anomaly. Magnetic expression of the rocks may be enhanced by the effect of topography. Low magnetic intensity that is a counterpart of the anomaly occurs at the northwest end of the feature. The nonmagnetic response of sedimentary rocks in the upper reaches of Gap Creek contributes to the low intensity.

A magnetic low also occurs over the northeast flank of Tule Mesa. This feature is probably produced by the edge effects of basalt flows on the mesa and by sedimentary rocks exposed in a fault zone along the northeast edge of the low. Very likely, the anomaly is enhanced by the effect of variation in height of the magnetometer above ground because of the difficulty of maintaining a constant aircraft altitude over such steep terrain.

In the central part of the map area, a broad zone of high magnetic intensity lies over the Black Hills and Arnold Mesa, which form a broad basalt-capped, drainage divide. Thicker parts of the basalt cap occur in the eastern and southeastern parts of this central upland region. Local magnetic maxima within the zone coincide approximately with peaks and ridges. The more pronounced anomalies lie in the southeastern part of the zone and are attributed to the basalt underlying Horner Mountain and peaks near the head of Horner Gulch. Comparison of anomaly amplitudes suggests that the intensity of magnetization in the basalt of Horner Mountain is much greater than elsewhere in the zone. In the eastern part of the high intensity zone, small magnetic highs are associated with peaks west of the headwaters of Chasm Creek. Owing to insufficient data and the position of flight lines, these anomalies do not fully represent the volume and magnetization of the basalt accumulations. Northwest of Horner Mountain, magnetic highs lie over basalt flows on high points near the west edge of the mesa. The anomalies occur over the thinnest part of the volcanic rock sequence and extend over the eroded windows of relatively nonmagnetic Paleozoic sedimentary rocks and Precambrian tonalite. The magnetic highs are attributed to local zones of higher magnetic intensity that occur near the southern ends of the flows and are caused by magnetic induction in the basalt.

Magnetic anomalies that seem to be associated with basalt flows of normal magnetization intensity and may be augmented by topographic effects lie over Yellow Jacket Mesa and Bald Hill west of the central upland and over Table Mountain south of Chasm Creek. To the east, a magnetic high of moderate amplitude correlates with dacitic rocks and intercalated basalt on a hill southeast of Rodeo Flat.

In the west part of the low magnetic intensity zone north of Chasm Creek, a small magnetic minimum occurs over basalt on Squaw Peak. This feature was recorded along a single flight line that passed north of the peak. The anomaly probably represents the negative end effect of flows on the northern flank of the mountain, or, perhaps, may be caused by abnormally directed remanent magnetization in the underlying basaltic rocks.

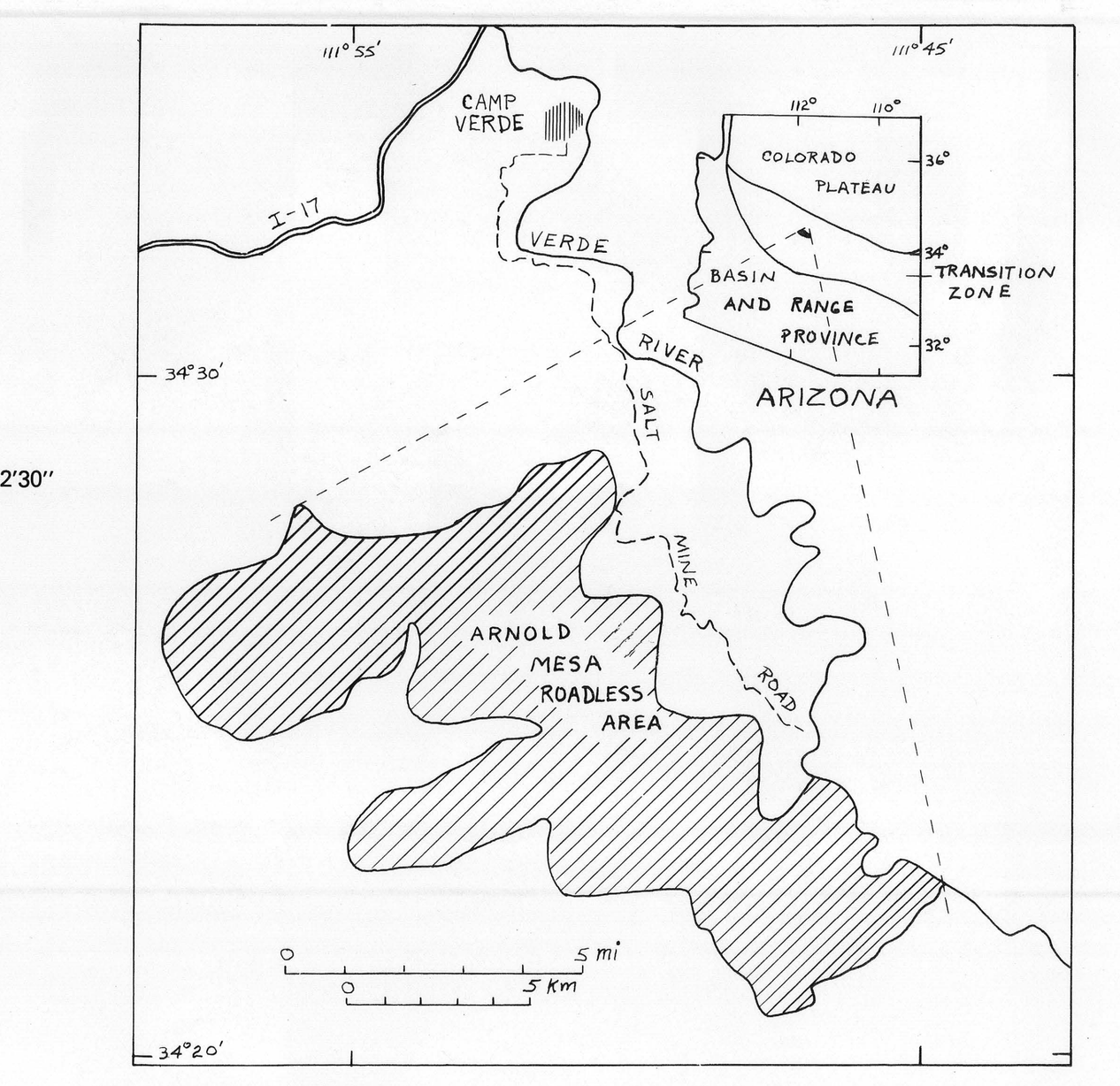
The magnetic contour pattern shows a general northwest trend that correlates with the trend of geologic structure. High magnetic gradients along the northeast side of the main anomalous zone coincide approximately with the southwest rim of the Verde Valley; the valley rim parallels the Verde fault. Narrow belts of low magnetic intensity represented by contour reentrants and steep gradients coincide with northwest-trending faults, such as the Verde fault north of Chasm Creek, fault segments in the west end of Rodeo Flat, and a major fault crossing the headwaters of Gap Creek and Cedar Bench. The northwest-trending belts of magnetic-gradient change, in combination with mapped faults and the strong topographic expression of the Verde Rim, suggest that the strong northwest-trending structural grain, of which the Verde fault is a conspicuous expression, continues southeastward to the southern map boundary. However, the major locus of Cenozoic faulting was on a trend parallel to the Verde fault but offset from it, en echelon, about 2.5 mi (4 km) to the southwest.

Tonalite that is host, north of the roadless area boundary, to a porphyry copper deposit (Roe, 1976) in the vicinity of the Squaw Peak Mine occurs in a belt of low magnetic intensity indicated by a reentrant in the magnetic contours. Alteration of the tonalite in the mine area may contribute to the low magnetic intensity. However, the low intensity belt continues south to southeast beyond the area of alteration and mineralization and is interpreted as a manifestation of the Verde fault. A similar reentrant in the magnetic contours occurs along the major fault that crosses Gap Creek and Cedar Bench.

REFERENCES

McKee, E. H., and Anderson, C. A., 1971, Age and chemistry of Tertiary volcanic rocks in north central Arizona and relation of the rocks to the Colorado Plateaus: Geological Society of America Bulletin, v. 82, p. 2767-2782.

Roe, R. R., 1976, Geology of the Squaw Peak porphyry copper-molybdenum deposit, Yavapai County, Arizona: Tucson, University of Arizona M.S. thesis, 102 p.



INDEX MAP SHOWING LOCATION OF ARNOLD MESA ROADLESS AREA, ARIZONA

AEROMAGNETIC MAP OF THE ARNOLD MESA ROADLESS AREA, YAVAPAI COUNTY, ARIZONA

By
Willard E. Davis and Edward W. Wolfe

1983

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

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