DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1644-B

Base from U.S. Geological Survey 1:62,500: Woods Canyon, Young, 1961; 1:24,000: Buzzard Roost Mesa, Gisela, Sheep Basin Mountain, 1972; Diamond Butte, Diamond Point, McDonald Mountain, Payson North, Payson South, Promontory Butte, 1973

SCALE 1:48 000

CONTOUR INTERVAL 40 AND 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Data flown and compiled by Geodata International, Inc., under contract to the U.S. Geological Survey, in 1981. Regional field, IGRF 1975 (Barraclough, 1978) updated to month flown, removed. Datum arbitrary

Geology from Conway (1976) and mapping by C. M. Conway, 1980-81

AEROMAGNETIC MAP OF THE HELLS GATE ROADLESS AREA, GILA COUNTY, ARIZONA

By

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EXPLANATION OF SYMBOLS ON AEROMAGNETIC MAP

MAGNETIC CONTOURS--Showing total intensity of the Earth's magnetic field, in nanoteslas. Contour interval 20 nanoteslas. Hachures indicate closed areas of low magnetic intensity

C1 ANOMALY--Letter and number referred to in text

FLIGHT LINE--Flight level 1,000 ft above ground level, flight line spacing 0.5 mi

[Note: the following correlation and description of map units are for the geologic base map shown in gray]

CORRELATION OF MAP UNITS

- QTg — QUATERNARY AND TERTIARY — CENOZOIC
- Unconformity
- Pzs — PALEOZOIC
- Unconformity
- Ya — MIDDLE PROTEROZOIC
- Unconformity
- Xgp, Xir, Xg, Xq, Xer, Xsv, Xd — EARLY PROTEROZOIC

DESCRIPTION OF MAP UNITS

QTg GRAVEL AND SAND (QUATERNARY AND TERTIARY)--Unconsolidated and unsorted to moderately well-bedded and well-sorted gravel and sand

Pzs SEDIMENTARY ROCKS (PALEOZOIC)--Sandstone, limestone, dolomite, and shale of the Cambrian Tapeats Sandstone, Devonian Martin Formation, Mississippian Redwall Limestone, and Pennsylvanian Naco Formation

Ya APACHE GROUP (MIDDLE PROTEROZOIC)--Conglomerate, sandstone, and siltstone of the Pioneer Formation and Dripping Spring Quartzite

Xgp GRANOPHYRE (EARLY PROTEROZOIC)--Intrusive, micrographic, commonly miarolitic porphyry similar to intrusive rhyolite except for granophyre texture. Occurs as sills between granite and overlying units

Xq QUARTZITE (EARLY PROTEROZOIC)--Medium- to coarse-grained, thin- to thick-bedded, cross-stratified quartz arenite and minor basal siltstone and shale

Xir INTRUSIVE RHYOLITE (EARLY PROTEROZOIC)--Intrusive porphyritic alkali rhyolite. Occurs mostly as concordant sheets between the granophyre and overlying extrusive rhyolite

Xer EXTRUSIVE RHYOLITE (EARLY PROTEROZOIC)--Extrusive porphyritic alkali rhyolite and minor interbedded conglomerate, shale, graywacke, and mafic volcanic rocks. Rhyolite is largely ash-flow tuff

Xg GRANITE (EARLY PROTEROZOIC)--Fine- to coarse-grained leucocratic alkali-biotite granite

Xsv SEDIMENTARY AND VOLCANIC ROCKS (EARLY PROTEROZOIC)--Lithic arenite, graywacke, quartz arenite, conglomerate, shale, and mafic and felsic volcanic rocks

Xd DIORITE AND GABBRO (EARLY PROTEROZOIC)--Fine- to coarse-grained diorite and gabbro with minor granodiorite and quartz monzonite. Includes pendants composed of mafic and felsic volcanic and volcaniclastic rocks

CONTACT--Arrow shows direction and amount of dip

FAULT--Dashed where approximately located, dotted where concealed. Arrows show direction of offset; bar and ball on downthrown side

THRUST FAULT--Sawteeth on upper plate

STRIKE AND DIP OF BEDDING
- Inclined
- Overturned

STRIKE AND DIP OF FLOW FOLIATION IN VOLCANIC ROCKS
- Inclined
- Vertical

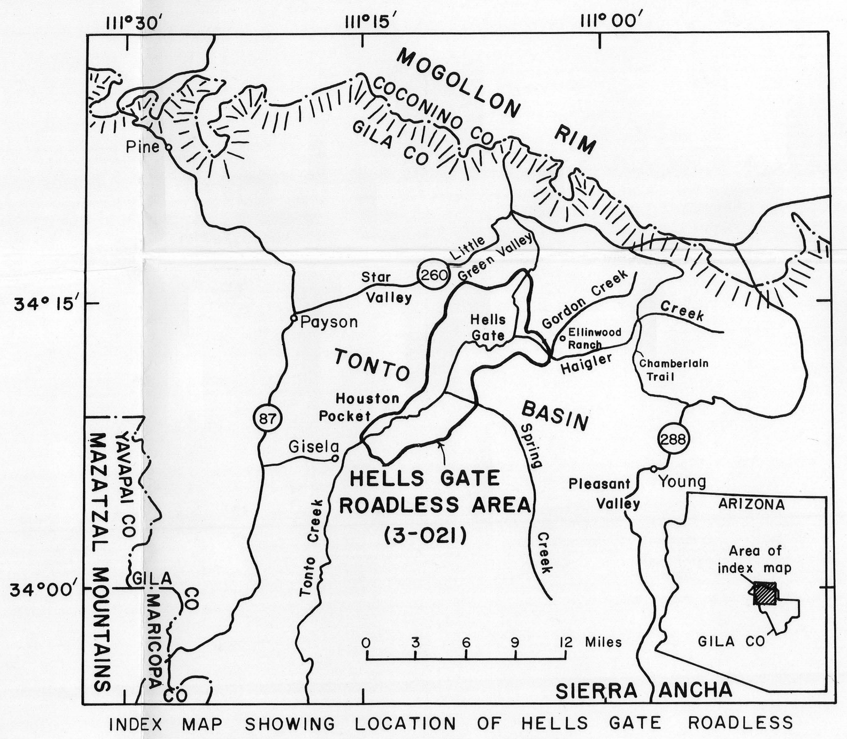
STRIKE AND DIP OF TECTONIC FOLIATION

BEARING AND PLUNGE OF COLUMNAR JOINTS

ANTICLINE--Dotted where concealed

SYNCLINE
- Normal--Dotted where concealed
- Overturned--Dotted where concealed

APPROXIMATE BOUNDARY OF ROADLESS AREA



INDEX MAP SHOWING LOCATION OF HELLS GATE ROADLESS AREA, NORTHERN GILA COUNTY, ARIZONA

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 Congress. This report presents the interpretation of an aeromagnetic survey of the Hells Gate Roadless Area in the Tonto National Forest, Gila County, Arizona. The Hells Gate Roadless Area (03021) 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 Hells Gate Roadless Area comprises about 31,200 acres in the northern part of the Tonto National Forest. It lies beneath the Mogollon Rim between the communities of Payson and Young. The area is roughly a 4 by 15 mi strip along the deeply incised segment of Tonto Creek and along a 2 mi segment of Haigler Creek at its intersection with Tonto Creek. Elevations range from 2,960 ft in the lower Tonto Creek gorge near Gisela, in the southeastern part of the area, to 6,200 ft in the Green Valley Hills, in the northern part of the area. Local relief in the deep canyon of Tonto Creek is commonly greater than 1,000 ft. Hells Gate is the geographic name for the canyon at the confluence of Tonto Creek and Haigler Creek. Foot trails cross Tonto Creek at Hells Gate and between Houston Pocket and McDonald Pocket. Descent into Tonto Creek elsewhere is extremely difficult.

The Hells Gate area lies in the central part of the Tonto Basin, which consists of Tonto Creek and tributaries draining the Mogollon escarpment and the northern Sierra Ancha. These streams dissect a tableland which is the unconformable surface at the base of the Paleozoic section and the Mogollon Rim. This tableland is a part of the Colorado Plateau margin, which has been slightly structurally disrupted by late Cenozoic faulting and from which most of the Middle Proterozoic and Paleozoic strata have been stripped by subsequent erosion. Early Proterozoic rocks constitute about ninety percent of the exposed rocks in the roadless area and are composed of granite, granophyre, and intrusive and extrusive rhyolite (Conway, 1983).

AEROMAGNETIC INTERPRETATION

An aeromagnetic survey with one-half mile line spacing was drape-flown at 1,000 ft above the ground in an east-west direction (nearly perpendicular to the strike of mapped geologic trends) in an effort to detect boundaries between the rock units and to define geologic features that might be associated with buried mineral deposits. Survey data show generally low magnetic relief across the Hells Gate Roadless Area and vicinity, which indicates minimal magnetic susceptibility contrast between the exposed rock units. Although the aeromagnetic survey was flown only 1,000 ft above ground, effects of topographic relief are not dominant in the data, but a northeast-trending magnetic grain conforms to the strike of the rock units and to topographic trends. The magnetic grain is mainly formed by two magnetic high trends composed of anomalies A1, A2, A3, and B1, B2, and B3 and two magnetic low trends composed of anomalies C1, C2, C3, and D1, D2, and D3.

Aeromagnetic high anomaly A1 occurs over granite (Xg) terrain and high topography. The anomaly is caused by the thick section of granite; however, the low amplitude and broad magnetic gradient of the anomaly indicate the low magnetic susceptibility of the granite.

Steep-gradient magnetic highs--anomalies A2 and A3--occur over a fault block bounded by northeast-trending faults in the intrusive rhyolite (Xir) terrain. Where anomalies have steep gradients, their sources lie near the surface. The rhyolite shows very little magnetic contrast in other places; however, geologic cross-sections (Conway, 1976) across the fault block show numerous sills of various rock types in the rhyolite. Possibly the crosscutting Star Valley and Spring faults have positioned blocks of sill rock with high magnetic susceptibility against rhyolite with low magnetic susceptibility near, but not coincident with, the topographic highs. Magnetic contours generally outline the topographically high terrain, but the apexes of the magnetic anomalies are not in all places over the topographic peaks.

The northeast-trending line of magnetic highs--anomalies B1, B2, and B3--is over the upthrown side of a northeast-trending fault and over extrusive rhyolite (Xer) and sedimentary and volcanic rocks (Xsv). The magnetic highs are probably caused by volcanic rocks with high magnetic susceptibilities in the Xsv and Xer sequences. The magnetic highs extend northeastward beyond the extrusive rhyolite (Xer) outcrop suggesting that those rocks continue in the subsurface beneath the gravel and sand (QTg) cover).

An elongate magnetic low--anomalies C1, C2, and C3--occurs over a thick section of intrusive rhyolite (Xir), quartzite (Xq), and extrusive rhyolite (Xer), which have low magnetic susceptibilities. These rocks lie in a syncline, the base of which is more than 8,000 ft deep beneath anomaly C2 (Conway, 1976). Closed magnetic lows at C1, C2, and C3 are over topographic highs indicating that the lows are not caused by the surface rock, but are caused by the basement rocks; the closed lows occur where the magnetometer was farthest from the basement rocks. A steep magnetic gradient (about 200 nanoteslas per mi) occurs over surface outcrops of steeply dipping rhyolite (Xer) and volcanic rocks (Xsv) at the east edge of the syncline, between anomalies C1 and C2 and anomaly B1. The steeply dipping contact between the two units extends about 7,000 ft deep (Conway, 1976), and the contrasting magnetic susceptibilities of the two units cause the steep magnetic gradient.

A line of northeast-trending magnetic lows--anomalies D1, D2, and D3--is outside the southeast border of the roadless area. The trend is probably caused by extrusive rhyolite (Xer), which has low magnetic susceptibility, in a downdropped fault block. The broad low northeast of anomaly D3 at the east margin of the aeromagnetic map is over rhyolite that goes about 7,000 ft deep (Conway, 1976).

The intense magnetic high--anomalies E1, E2, and E3 (about 1,000 nanoteslas)--outside the roadless area at the west-central border of the aeromagnetic map is caused by intrusive diorite and gabbro (Xd). The northwest-trending intrusive contact between the diorite and gabbro (Xd) with high magnetic susceptibility and the granite (Xg) with low magnetic susceptibility is marked by a northwest-trending magnetic gradient. Diorite and gabbro (Xd) are exposed at the southwest corner of the study area and possibly underlie the rock units in the southwest corner of the map (anomaly E4). The steepened northwest-trending magnetic gradient outside the south end of the study area may indicate a high-angle contact between the diorite and gabbro (Xd) and granite (Xg) in the subsurface.

REFERENCES CITED

Barraclough, D. R., and Fabiano, E. B., 1978, Grid values and charts for the IGRF [International Geomagnetic Reference Field] 1975.0: International Association of Geomagnetism and Aeronomy Bulletin No. 38, 131 p.; available from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22151 as PB-276 630.

Conway, C. M., 1976, Petrology, structure, and evolution of a Precambrian volcanic and plutonic complex, Tonto Basin, Gila County, Arizona: Pasadena, California Institute of Technology, Ph.D. dissertation, 460 p.

Conway, C. M., McColley, R. A., Marsh, S. P., Kulik, D. M., Martin, R. A., and Kilburn, J. E., 1983, Mineral resource potential map of the Hells Gate Roadless Area, Gila County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1644-A, scale 1:48,000.

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