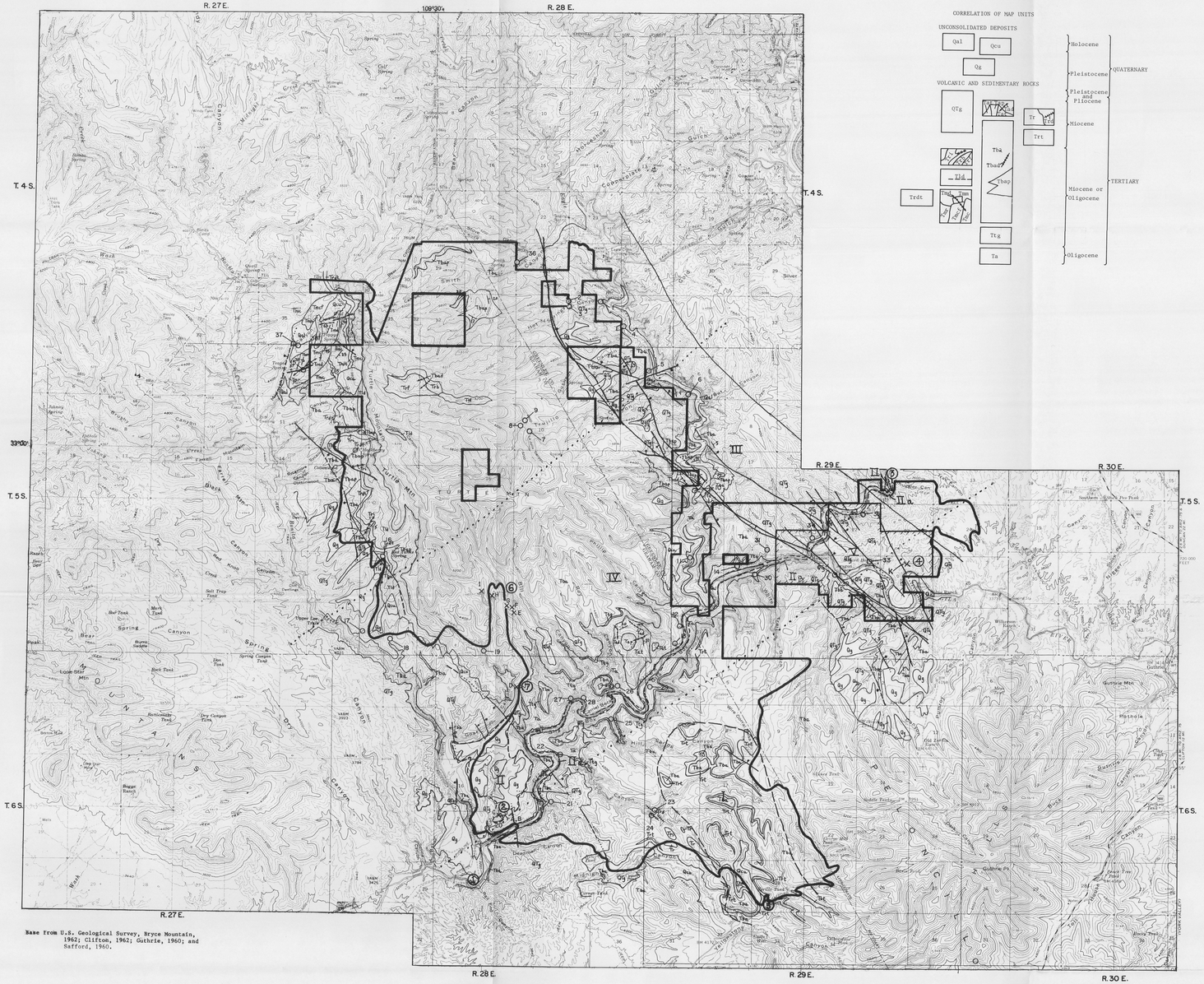
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED BY THE U.S. GEOLOGICAL SURVEY AND THE
U.S. BUREAU OF MINES FOR THE U.S. BUREAU OF LAND MANAGEMENT

MISCELLANEOUS FIELD STUDIES
MAP MF-1315-B



CORRELATION OF MAP UNITS

EXPLANATION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Qal ALLUVIUM (HOLOCENE)

Qcu COLLUVIUM, UNDIVIDED (HOLOCENE AND PLEISTOCENE)

Qg TERRACE DEPOSITS (PLEISTOCENE)

VOLCANIC AND SEDIMENTARY DEPOSITS

QTg GILA CONGLOMERATE AND YOUNGER BASIN-FILL DEPOSITS, UNDIVIDED (PLEISTOCENE, PLIOCENE, AND MIOCENE)

YOUNG ANDESITE CONE OF GILA BOX (MIOCENE)

Tap Andesite plug breccia

Tat Andesite cinder cone

Tad Andesite dikes

Tr RHYOLITE FLOWS (MIOCENE)

Trd RHYOLITE(?) DIKES (MIOCENE)

ANDESITE AND BASALTIC ANDESITE OF TUKTLE MOUNTAIN–GUTHRIE PEAK (MIOCENE AND OLIGOCENE)

Tba Extensive unit of light- to dark-gray, medium-thick flows

Tbap Remnant cinder cones

Tbad Dark-gray dikes

Trt RHYOLITE PYROCLASTIC DEPOSITS (MIOCENE)

RHYOLITE OF SYCAMORE CANYON (MIOCENE OR OLIGOCENE)

Tri Rhyolite intrusive rocks

Trf Rhyolite flow

Trb Rhyolite breccia

Tld LATITE OR DACITE FLOWS (MIOCENE OR OLIGOCENE)

VOLCANIC ROCKS OF MIDNIGHT CANYON (MIOCENE OR OLIGOCENE)

Tmd Andesite dikes

Tmc Cone deposits

Tmcf Crater-fill deposits

Tmr Rhyolite

Tmm Megablocks

Trdt RHYODACITIC PYROCLASTIC DEPOSITS (MIOCENE OR OLIGOCENE)

Ttg PYROCLASTIC AIR-FALL AND VOLCANICLASTIC SEDIMENTARY DEPOSITS (MIOCENE OR OLIGOCENE)

Ta ANDESITE OF GILA RIVER (OLIGOCENE)

EXPLANATION

APPROXIMATE BOUNDARY OF STUDY AREA

CONTACT--Known, approximate, and inferred

FAULT, SHOWING DIP--Dashed where inferred; dotted where inferred; dotted where concealed. Ball bar on downthrown side

STRIKE AND DIP OF BEDS--Layering in volcaniclastic rocks
Inclined
Vertical
Overturned

SAMPLE LOCALITY
Stream sediment (U.S. Geological Survey)
Prospect (U.S. Bureau of Mines)

MINE OR PROSPECT--Number corresponds to number in table 1 and in text

AREAS OF MINERAL RESOURCE POTENTIAL--
Listing principal criteria used to assess favorability of occurrence and potential

I AREA I. PUMICE--Identified resource with low potential
Criterion: (1) Operating quarry outside study area producing small tonnage of pumice from ash-flow tuff
(2) Extension of pumice-bearing ash-flow tuff in study area

II AREA II. PLACER GOLD--Hypothetical resource with low potential
Criteria: (1) Known, minor past gold production in the study area and present gold mining development just outside study area
(2) Scattered occurrences of favorable old alluvial gravels preserved in part from Clifton-Morenci mining area

IIa AREA IIa. PLACER GOLD--Hypothetical resource with very low potential
Criterion: (1) Low gold values in modern alluvial gravels of the San Francisco and Gila Rivers

III AREA III. MANGANESE--Hypothetical resource with low potential
Criteria: (1) Known, small, epithermal deposit with minor production in study area
(2) Favorable structures (faults and fractures) to control and concentrate mineralizing solutions
(3) Known hot springs, suggesting presence of a shallow hydrothermal system

IV AREA IV. COPPER–Speculative resource
Criteria: (1) Possible favorable host terrane for porphyry copper deposits underlying study area
(2) NE–SW zone of structural weakness as inferred from geophysical investigations

V AREA V. GEOTHERMAL ENERGY--Gillard Hot Springs Known Geothermal Resource Area (KGRA)
Criteria: (1) Isolated thermal spring occurrence with calculated reservoir temperatures of 90–150°C

Geology mapped by D. H. Richter and V. A. Lawrence, 1978–1979.

SCALE 1:62 500

1 ½ 0 1 2 3 4 MILES

1 .5 0 1 2 3 4 KILOMETERS

MINERAL RESOURCE POTENTIAL MAP OF THE GILA-SAN FRANCISCO WILDERNESS STUDY AREA, GRAHAM AND GREENLEE COUNTIES, ARIZONA

By
Donald H. Richter, Douglas P. Klein, and Viki A. Lawrence, U.S. Geological Survey
and
Michael E. Lane, U.S. Bureau of Mines

1982

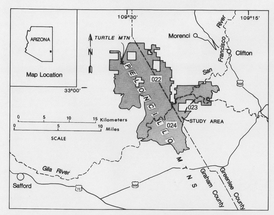


Figure 1.—Index map showing location of Gila-San Francisco Wilderness Study Area (AZ-040-022/023/024), Graham and Greenlee Counties, Arizona.

STUDIES RELATED TO WILDERNESS
Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, Oct. 21, 1976), requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas 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 a mineral survey of the Gila-San Francisco Wilderness Study Area, which includes the Gila Box (AZ-040-022/023/024A) and Turtle Mountain (AZ-040-022/023/024B) areas, Graham and Greenlee Counties, Arizona.

SUMMARY

The mineral resource potential of the Gila-San Francisco Wilderness Study Area (AZ-040-022/023/024) is low. Although favorable geologic environments for placer gold deposits and manganese vein deposits are present in the study area, the probability of discovering economically exploitable deposits of these metals is low, and not encouraging. Even more speculative is the study area's porphyry copper potential which is based solely on the possibility of favorable host terranes underlying the study area at depth. The study area does contain substantial deposits of pumice, but their economic significance is probably minor. A part of the study area has been previously designated a Known Geothermal Resource Area (KGRA).

INTRODUCTION

The Gila-San Francisco Wilderness Study Area includes about 44,200 acres (18,700 ha) at the northern end of the Peloncillo Mountains in Graham and Greenlee Counties in southeastern Arizona. Elevations in the study area range from a low of about 3,200 ft (975 m), where the Gila River emerges from a picturesque gorge and flows into the Safford basin, to a high of 7,004 ft (2,135 m) on top of Turtle Mountain, a broad, prominent topographic feature in the north part of the study area.

The northern Peloncillo Mountains occur in a transitional zone between the Colorado Plateau province to the north and the Basin and Range province to the south and west. The study area is underlain by middle Tertiary to Pleistocene (about 2–30 m.y. old) volcanic and volcaniclastic rocks that are locally mantled by Quaternary alluvium and colluvial deposits. Northwest-trending normal faults, related to Basin and Range extensional tectonism, bound both sides of the study area.

Mining activity in the study area has been limited to a few small and intermittently operated placer gold deposits along the Gila and San Francisco Rivers and a small manganese vein deposit. No mining activity was observed during investigations in 1979 and 1980. A geothermal energy resource exists near Gillard Hot Springs along the Gila River in the eastern part of the study area.

GEOLOGY

A brief resumé of the geology and geologic history of the Gila-San Francisco Wilderness Study Area is presented below, and the generalized geology is portrayed as a base for the accompanying mineral-resource potential map. For more detailed aspects of the geology, the reader is referred to the companion geologic map of this study (Richter and Lawrence, 1981).

More than 3,900 ft (1,200 m) of volcanic and volcaniclastic rocks ranging from Oligocene (about 30 m.y. old) to Pleistocene (about 2 m.y. old) in age underly the study area. The apparent oldest rock unit is comprised of a series of massive andesite flows and flow breccias that is exposed along the bottom of the Gila Box and the lower canyon of Eagle Creek. A thin discontinuous unit of rhyolitic air-fall tuffs and volcaniclastic rocks locally separates these older andesites from an overlying sequence of generally more mafic flows that constitute the bulk of the volcanic rocks in the study area. These flows and associated pyroclastics are chiefly olivine-bearing andesites and basaltic andesites that were erupted during a relatively long span of time, concurrent with silicic volcanic activity to the south and west of the study area. Thick, local accumulations of cinder and scoria and short rootless flows, exposed along Eagle Creek, near Smith Canyon, and between Red Tanks Spring and Lines Canyon along the west edge of the area, are remnants of cones that mark some of the vent areas for the extensive andesite and basaltic andesite flows.

A variety of silicic volcanic rocks are intercalated with the andesite and basaltic andesite flows. Southeast of the Gila Box a rhyolite ash-flow and air-fall unit occurs in the upper part of the andesite and basaltic andesite sequence. These deposits and a few rhyolite dikes and extrusive bodies, which cut and overlie andesite, are apparently related to a major 20-m.y.-old eruptive center 4 mi (6.5 km) south of the study area. In the northwest corner of the study area, the complex Midnight Canyon eruptive center is overlain by younger flows of andesite and basaltic andesite, but may also be the source for some of the older flows of the sequence. Two, thick, hornblende-bearing dacite flows exposed along the mountain front south of Midnight Canyon are also probably related to the Midnight Canyon Center. In the same area, two silicic air-fall units within the andesite and basaltic andesite sequence are from a large stratovolcano, about 25 m.y. old, centered about 6 mi (10 km) west of the study area.

The final eruptive event in the study area was the development of a small andesitic cinder cone in the Gila Box. The cone is built on a very irregular erosion surface cut by the Gila River on older andesites.

Prior to the end of volcanism, thick deposits of volcaniclastic sedimentary rocks began to accumulate in basins flanking the volcanic highlands. Basal parts of the volcaniclastic sequence contain a number of intercalated andesite and basaltic andesite flows and silicic ash-flow and air-fall deposits. Development of the basins was initiated by basin and Range faulting, probably between 20 and 25 m.y. ago, when volcanic activity began to wane. Faulting continued concomitantly with deposition of the volcaniclastic rocks, probably until the end of the Tertiary.

GEOCHEMISTRY

The geochemical investigation of the Gila-San Francisco Wilderness Study Area is based on the analyses of 38 stream sediment samples collected at localities shown on the accompanying map. The minus 80-mesh fractions of the samples were analyzed semi-quantitatively for 31 elements by M. S. Erickson (U.S. Geological Survey) using emission spectroscopy techniques. Two samples were slightly enriched in molybdenum and are discussed in more detail below. The remaining 36 samples contained generally less than two times the average concentration of these elements in basaltic and andesitic rocks.

Molybdenum was detected in two samples (20 and 10 ppm in samples 23 and 29, respectively) from streams draining an area underlain by extensive andesite and basaltic andesite flows, with an interbedded rhyolite ash-flow tuff unit, and some small intrusive and extrusive rhyolite bodies. Spectrographic reanalyses of the two samples confirmed the anomalous molybdenum, but in lesser amounts (<5 and 7 ppm Mo). Examination of rock samples from the drainage areas on an activation analyzer (Cd^{109} source) revealed that the ash-flow tuff (map unit Trt) contains minor amounts of molybdenum and hence is the likely source of the weak anomalies. The ash-flow tuff is from a rhyolite eruptive complex centered about 4 mi (6.5 km) south of the study area.

GEOPHYSICS

Gravity and magnetic patterns in the region of the Gila-San Francisco Wilderness Study Area are significantly affected by severe elevation variations and a thick blanket of low density but highly magnetized volcanic rocks (Hay and others, 1981; U.S. Geological Survey, 1981). However, some large scale patterns that filter through suggest structural features that can be extended from mapped surface geological data. Also some northeast geological trends, not delineated from surface geology, are inferred from the geophysics.

The northwest-trending Basin and Range faults that bound Guthrie Peak and the Turtle Mountains, and which are mapped on the surface at numerous exposures, are fairly well marked by anomaly lineations and truncations in both gravity and magnetic data. These data allow extrapolation between and beyond exposures, but do not suggest any unusual changes of trend. The investigations by private industry (P. M Hopkins, oral communication, 1980) indicate the presence of about 800,000 yds^3 of old river gravels containing 0.02–0.002 oz Au/yd^3. Lithologically similar, old gravels are present in the study area between the confluence of Bonita Creek with the Gila River, but to our knowledge no reliable data concerning gold content are available. Although fire-assay analyses of three representative gravel samples collected by us in this area indicate less than 0.01 oz Au/ton, values comparable to that at the Smuggler Mine could still be present. In addition, Hopkins' states that the modern gravels of the San Francisco and Gila Rivers may contain as much as 0.001 oz Au/yd^3.

A few tons of hand-sorted manganese ore have been produced from a small epithermal vein-type deposit in the study area. The manganese (wad and pyrolusite) is associated with calcite and occurs in small irregular lenses along a fault cutting well-indurated Gila Conglomerate of Tertiary and Quaternary age. The presence of manganese oxides in the Gila Conglomerate together with known active hot springs along the northeast side of the study area suggests that other deposits of similar size and grade may be present.

The identified pumice resource in the study area is substantial, but like many construction-oriented commodities its exploitation depends largely on proximity to urban centers and the fluctuating demands of local industry. Present pumice production from the operating quarry just outside the study area will probably be sufficient to supply the needs of the Safford area for many years, hence the economic significance of the pumice-bearing deposits within the study area is probably minor.

The Gillard Hot Springs KGRA in the eastern part of the study area has been identified as a medium temperature (90°–150°C) hot-water, hydrothermal convection system. It has a mean reservoir thermal energy (resource) of about 1.1×10^{18} J (Brook and others, 1979) which could be utilized as a beneficial heat source (space heating), but is probably not adequate for electrical generation.

Speculative geological and geophysical data suggests that porphyry copper deposits may underlie parts of the Gila-San Francisco Wilderness Study Area at depth. In the Gila Mountains, about 5 mi (8 km) to the southwest, Cretaceous volcanic rocks intruded by Laramide (52–60 m.y.) granitic plutons underlie middle Tertiary volcanic rocks, and in the Clifton-Morenci area, 3 mi (5 km) to the northeast, a Precambrian to Mesozoic terrane also intruded by Laramide plutons is exposed. In both areas the Laramide plutons are associated with large porphyry copper deposits. Similar pre-middle Tertiary rocks could underlie the study area; however, based on the regional northeast dip for the Cretaceous–middle Tertiary contact in the Gila Mountains, these economically potential rocks may be as much as 2,300 to 6,300 ft (700–1,900 m) below the surface in the study area.

Table 1.—Mineral deposits and prospects in and near the Gila-San Francisco Wilderness Study Area
[Inactive mines and prospects have had no development or exploration work since 1975]

Map No.	Name	Location	Resource	Deposit type	Development category	Description
1	Dorothy B	Sec. 28, unsurveyed, T. 6 S., R. 28 E.	Au	Placer	Mine, active	Poorly sorted old Gila River gravels.
2	Unknown	NW 1/4 sec. 22, unsurveyed, T. 6 S., R. 28 E	Au?	Placer	Prospect, inactive	Poorly sorted old Gila River gravels. Clasts chiefly of volcanic rock, locally cemented by caliche. Samples A–C assayed less than 0.0102 gold/ton
3	Smuggler	SW 1/4 sec. 14, T. 5 S., R. 29 E.	Au	Placer	Mine, inactive	Poorly sorted old San Francisco River gravels. Clasts chiefly of volcanic rock and locally abundant massive hematite. Sample J assayed less than 0.01 or gold/ton.
4	Gila Hot Springs (Gulf Pyrolusite)	NE1/4 sec. 26, T. 5 S., R. 29 E.	Mn	Vein	Mine, inactive	Wad and pyrolusite in fractures in Gila Conglomerate. Sample K contained 35 percent Manganese.
5	Gila Valley Block Company	SW 1/4 sec. 28, T. 6 S., R. 29 E.	Pumice	Volcanic	Quarry, active	Blocky, white pumice in nonwelded ash-flow tuff.
6	Unknown	Secs. 28 and 33, unsurveyed, T. 5 S., R. 28 E.	Unknown	Unknown	Prospects, inactive	Massive, andesitic volcanic flows. No mineralization or structure observed. Samples E–I contained no detectable anomalous metals.
7	Unknown	SE 1/4 sec. 33, unsurveyed T. 6 S., R. 28 E.	Unknown	Unknown	Prospect, inactive	Massive andesite flow. No mineralization or structure observed. Sample D contained no detectable anomalous metals.

REFERENCES

Brook, C. A., Mariner, R. H., Mabey, D. R., Swanson, J. R., Guffanti, Marianne, and Muffler, L. J. P., 1979, Hydrothermal convection systems with reservoir temperatures >90°C, in Muffler, L. J. P., ed., Assessment of geothermal resources of the United States, 1978: U.S. Geological Survey Circular 790, 163 p.

Burkhardt, H. E., Brook, C. A., and Smith, F. W., 1980, Selected administrative, land and resource data for known Geothermal Resources Areas in Arizona, California, Idaho, Nevada, Oregon, and Washington: U.S. Geological Survey Open-File Report OF-80-1290, 29 p.

Farnham, L. L., Stewart, L. A., and DeLong, C. W., 1961, Manganese deposits of eastern Arizona: U.S. Bureau of Mines Information Circular 7990, 178 p.

Hay, S. E., Klein, D. P., Boler, F. M., and Brickey, M., 1981, Principal facts of gravity observations in the Dragoon Mountains Further Planning Area (RARE II) and the Gila-San Francisco Wilderness Study Area, Arizona: U.S. Geological Survey Open-File Report OF-81-849, 24 p.

Richter, D. H., and Lawrence, V. A., 1981, Geologic map of the Gila-San Francisco Wilderness Study Area, Graham and Greenlee Counties, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1315-A, scale 1:62,500.

U.S. Geological Survey, 1981, Aeromagnetic map of an area north of Safford, Arizona: U.S. Geological Survey Open-File Report OF-81-97.

Wilson, E. D., 1961, Gold placers and placering in Arizona: Arizona Bureau of Mines Bulletin 168, 124 p.

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225