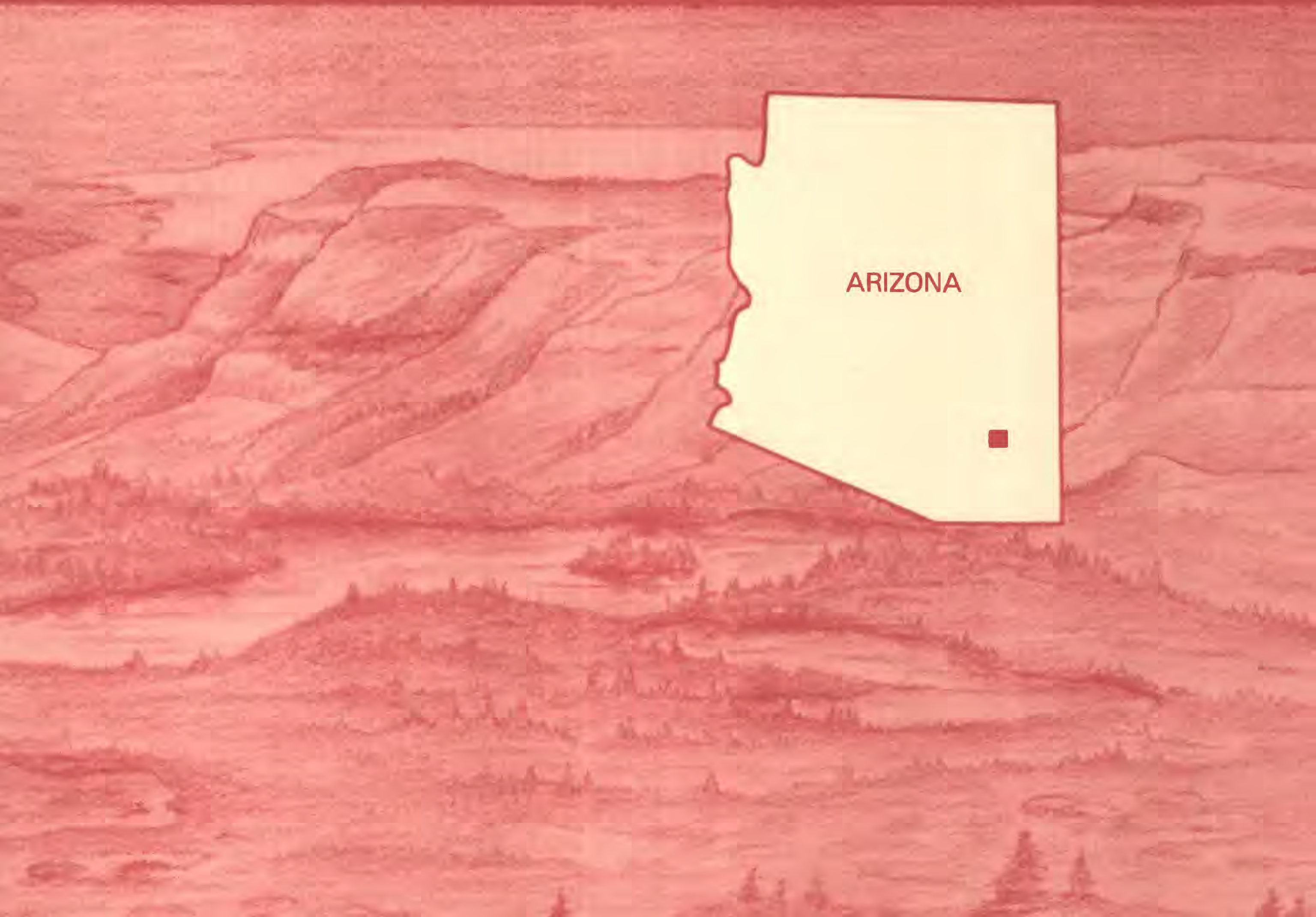
Mineral Resources of the Fishhooks Wilderness Study Area, Graham County, Arizona

U.S. GEOLOGICAL SURVEY BULLETIN 1703–A



DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

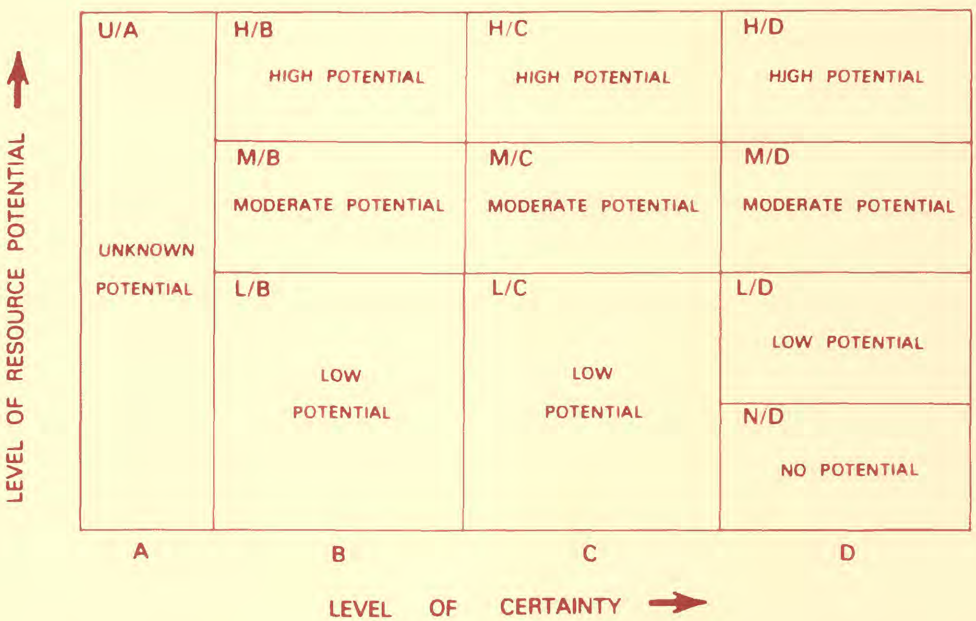
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty



A. Available information is not adequate for determination of the level of mineral resource potential.

B. Available information suggests the level of mineral resource potential.

C. Available information gives a good indication of the level of mineral resource potential.

D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

Taylor, R. B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

Taylor, R. B., Stoneman, R. J., and Marsh, S. P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40–42.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–0787, p. 7, 8.

Chapter A

Mineral Resources of the Fishhooks Wilderness Study Area, Graham County, Arizona

By FRANK S. SIMONS, PAUL K. THEOBALD,
RONALD R. TIDBALL, JAMES A. ERDMAN,
THELMA F. HARMS, and ANDREW GRISCOM
U.S. Geological Survey

GEORGE S. RYAN
U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1703

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
SOUTHEASTERN ARIZONA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1987

For sale by the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center
Box 25425
Denver, CO 80225

Library of Congress Cataloging in Publication Data

Mineral resources of the Fishhooks Wilderness Study Area, Graham County, Arizona.

(Mineral resources of wilderness study areas—Southeastern Arizona; ch. A) (U.S. Geological Survey bulletin ; 1703–A)
Bibliography: p.
1. Mines and mineral resources—Arizona—Fishhook Wilderness. 2. Geology—Arizona—Fishhooks Wilderness. 3. Fishhooks Wilderness (Ariz.)
I. Simons, Frank S. (Frank Stanton) 1917– . II. Series. III. Series: U.S. Geological Survey bulletin ; 1703–A.

QE75.B9 no. 1703–A 557.3 s 86–600165
[TN24.A6] [553'.09791'54]

STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. 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 a part of the Fishhooks (AZ-040-014) Wilderness Study Area, Graham County, Arizona.

RESOURCE / RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from U. S. Bureau of Mines and U. S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U. S. Geological Survey Circular 831, p. 5.

CONTENTS

PLATE

FIGURE

Mineral Resources of the Fishhooks Wilderness Study Area, Graham County, Arizona

By Frank S. Simons, Paul K. Theobald,
Ronald R. Tidball, James A. Erdman,
Thelma F. Harms, *and* Andrew Griscom,
U.S. Geological Survey, *and*
George S. Ryan,
U.S. Bureau of Mines

SUMMARY

The Fishhooks (AZ-040-014) Wilderness Study Area is on the crest of the Gila Mountains in northern Graham County, Arizona (fig. 1). The U.S. Bureau of Land Management requested a mineral survey on 10,883 acres (about 16 square miles) of this area. A mineral survey of the area was made in 1983 and 1984. No mining has been done in the area and no prospects were found. The area is underlain entirely by volcanic rocks of Tertiary (63-1.6 m.y. or million years; see geologic time chart on the last page of this report) age in which no evidence of mineralization was seen. Gravity and aeromagnetic anomalies southeast of but near the study area are interpreted to indicate a caldera and an associated concealed pluton; no mineralization related to these anomalies has been observed in the study area. Geologic and geochemical information indicates that the area has a low mineral resource potential for metals, nonmetals, and fuels.

The Fishhooks Wilderness Study Area is bordered to the northeast by the San Carlos Indian Reservation. The study area ranges in altitude from about 3,900 ft in lower Diamond Bar Canyon to 6,629 ft on Gila Peak near the southern end of the area. It is underlain entirely by gently dipping varicolored layered volcanic rocks and rhyolitic plugs that intrude the volcanics. The volcanic rocks are dissected by deep canyons whose walls display cliff-and-bench topography; the canyons are the predominant geographic features of the study area, and its name derives from Upper, Middle, and Lower Fishhook Canyons that together constitute the headwaters of McKinney Canyon.

No mineral reserves or identified resources were found in the study area (fig. 1). No geochemical anomalies suggestive of mineralization were found, and the mineral resource potential is low for both metals and nonmetals, with certainty level C. No sedimentary rocks are exposed in the area, and the resource potential for oil and gas is low, with certainty level C; as of January 1985, there were no oil and gas leases or lease applications in or near the area. Drilling has revealed the existence of a low-temperature (<100 °C) geothermal pool in the Day mine area several miles south of the study area (Witcher and others, 1982), but inasmuch as no deep holes have been drilled inside the study area, it is not known whether the geothermal zone extends into it.

INTRODUCTION

The Fishhooks Wilderness Study Area (AZ-040-014) is a northwest-trending tract on the crest of the Gila Mountains in northern Graham County, southeastern Arizona, about 30 mi northwest of Safford and 45 mi east-southeast of Globe. The U.S. Geological Survey and the U.S. Bureau of Mines studied 10,883 acres (about 16 square miles) of the Fishhooks Wilderness Study Area, which is bordered to the northeast by the San Carlos Indian Reservation. In this report, the studied area is called the "wilderness study area" or just "study area."

Access to the study area is from U.S. Highway 70, either from Geronimo or from Fort Thomas, on an unpaved graded road that ends at the Diamond Bar ranch. Various places along the southwestern edge of the study area may be reached over rough jeep roads. The northeastern side of the study area may be reached in a few places via roads that branch off the graded road across Ash Flat on the reservation.

The study area ranges in altitude from about 3,900 ft in lower Diamond Bar Canyon to 6,629 ft on Gila Peak near the southern end of the area (fig. 1). It is underlain entirely by gently dipping varicolored layered volcanic rocks and rhyolitic plugs that intrude the volcanics. The northeastern side of the study area is approximately the southwestern edge of Ash Flat, and southwestward-flowing streams eroding headward into Ash Flat have cut deep canyons whose walls display cliff-and-bench topography carved onto the layered volcanic rocks. The canyons are the predominant geographic

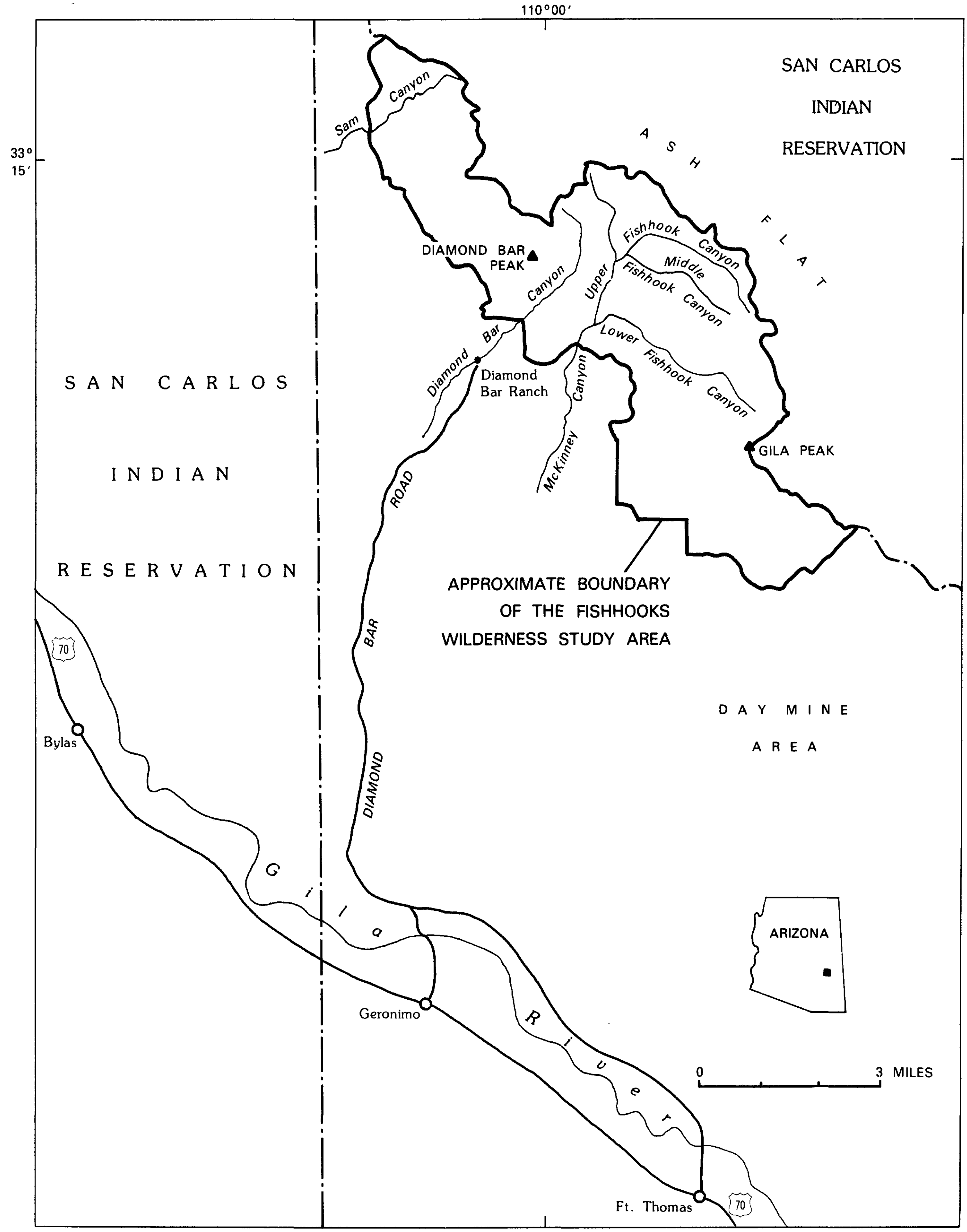


Figure 1. Mineral resource potential map of the Fishhooks Wilderness Study Area, Graham County, Arizona. The entire area has low mineral resource potential for all metals, nonmetals, and energy resources, with certainty level C.

features of the study area, and indeed the name derives from Upper, Middle, and Lower Fishhook Canyons that together constitute the headwaters of McKinney Canyon. The upper parts of the canyons are the most rugged; for instance, the vertical distance from Gila Peak to upper Dutch Pasture Canyon is nearly 2,000 ft in a horizontal distance of 1 mi.

Investigations by the U.S. Bureau of Mines

Investigations by the U.S. Bureau of Mines were done in 1983 by G. S. Ryan and included a review of available published material on mineral resources and mining activity in and around the area, a check of U.S. Bureau of Land Management files for mining claims, an aerial reconnaissance, and foot traverses (Ryan, 1985).

Investigations by the U.S. Geological Survey

The study area was mapped geologically in reconnaissance for the geologic map of Graham and Greenlee Counties (Wilson and Moore, 1958), but no other geologic studies have been published. Geologic field work in the area was done by F. S. Simons during 21 days in the fall of 1983 and of 1984, and 60 rock samples were collected. The geochemical study was done in 1984 and is based on 24 stream-sediment samples and heavy-mineral concentrates of stream sediments collected by P. K. Theobald, R. R. Tidball, and T. F. Harms, and 28 plant samples collected by J. A. Erdman. Spectrographic and chemical analyses were done by T. F. Harms, L. A. Bradley, J. M. Motooka, and N. M. Conklin. Interpretation of gravity and aeromagnetic data was by Andrew Griscom.

APPRAISAL OF IDENTIFIED RESOURCES

By George S. Ryan, U.S. Bureau of Mines

Mining and Mineral-Exploration Activity

No mines, prospects, or alteration zones were found by aerial reconnaissance or foot traverses, and no samples were collected. The owner of the Diamond Bar ranch (fig. 1) stated that he did not know of any prospecting or of any mining claims being staked in the study area in the past 60 years. As of January 1985, records of the Bureau of Land Management indicate that, although many claims were located in the Day mine area, 3 mi (miles) south of the study area, none were staked in the study area itself.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Frank S. Simons, Paul K. Theobald, Ronald R. Tidball, James A. Erdman, Thelma F. Harms, and Andrew Griscom, U.S. Geological Survey

Geology

The Fishhooks Wilderness Study Area is underlain by Tertiary volcanic rocks ranging in composition from rhyolite to basalt and comprising lava flows and flow breccias, welded ash-flow tuffs, tuff breccia, and tuff (pl. 1). The layered rocks are intruded by rhyolitic plugs that constitute a northwesterly trending group of intrusions extending the entire length of the study area.

Samples of 24 rocks ranging in composition from rhyolite to olivine basalt and representing six major rock units were analyzed by the six-step optical-emission semiquantitative spectrographic method of Grimes and Marranzino (1968) for 31 minor elements that might be significant in evaluating the mineral resource potential of the study area (analyses by D. E. Detra, M. J. Malcolm, and P. H. Briggs, U.S. Geological Survey). Most samples contained only expectable amounts of minor elements, but a few contained anomalous amounts of one or more elements, and the localities of these samples are shown on plate 1. Three of the six samples from rhyolite intrusions (unit Trp, pl. 1) contained traces of silver (0.5 ppm (parts per million) or less, samples 1, 2, and 4), and two of them, sample 2 from Diamond Bar Peak and sample 1 from the intrusion north of it, contained 10 ppm molybdenum. These three samples, as well as sample 3, also contained 100–150 ppm lead; such amounts of lead are anomalous, inasmuch as rhyolites normally contain only about 20 ppm lead. Sample 5, of rhyolitic tuff, contained a trace of silver (less than 0.5 ppm). No other evidence of mineralization was recognized in the rhyolitic rocks. Sample 6, of a dacite lava from unit Ta (pl. 1) in the northern part of the study area, contained 150 ppm copper, and sample 7, of biotite latite from unit Tsl (pl. 1) in the southern part, contained 200 ppm copper; these amounts are marginally anomalous, but no other suggestion of mineralization was found in these rocks.

Geophysics

Gravity data (Andrew Griscom and Craig Erdman, unpub. data, station spacing 0.5–3 mi) were reduced to isostatic residual gravity values in order to nearly eliminate isostatic effects of high topography and thus to accentuate the effects of upper crustal rock units of differing densities. The study area trends generally northwest and is along or as much as 6 mi northeast of a linear northwest-trending gravity high that is believed to represent the axis of a broad basement antiform, many miles long, along which higher density Precambrian and Paleozoic rocks are intermittently exposed through the younger overlying volcanic rocks of lower density. In the extreme southeastern corner of the study area, a gravity gradient slopes down to the southeast into a circular gravity low about 5 mi in diameter but outside the study area. This gravity low is associated with a concealed pluton (inferred from the magnetic data described below) and is interpreted as a possible caldera filled with lower density material and having border faults that are expressed by the steeper gravity gradients around the gravity low. The extreme northwestern parts of these caldera faults may thus be at the southeastern end of the study area.

Aeromagnetic data (Andrew Griscom and Craig Erdman, unpub. data, flight-line spacing 0.5 mi, nominal flight altitude 1,000 ft (feet) above the ground) allow differentiation between rock units having differing magnetic properties. The northwestern half of the area is generally magnetically quiet, but the southeastern half has an irregular pattern typically associated with volcanic rocks. Small local highs are caused by sharp topographic highs. The southeasternmost 4 mi of the study area is associated with a magnetic high and a sharp, deep low that are the northwestern part of a major magnetic anomaly, a 1,500-gamma magnetic high outside the study area, that is interpreted to be produced by a large subsurface pluton. The inferred caldera described above is about 4 mi northeast of the pluton and is presumed to be associated with it. The large magnetic anomaly appears to have an extension on the northwestern side of the inferred caldera. This extension may be the expression of a partial ring dike that is inferred to be beneath the southeastern end of the study area. Little rock alteration and no signs of mineralization have been observed in the study area near the inferred ring dike, so the pluton may not be of economic interest.

Geochemistry

Three types of samples, stream sediments, heavy-mineral concentrates, and plants, were collected at each sample locality. In all, 24 samples of stream sediment, 24 heavy-mineral concentrates, 12 samples of mesquite, and 16 samples of Utah juniper were collected from the study area. Details of the sample collection, preparation, and analysis, together with the analytical data, are reported by Harms and others (1985).

Stream-sediment samples were sieved to pass a 30-mesh screen (approximately a 0.5-mm opening). These samples consist of weathered material mechanically transported to the sample site. A concentrate of the heavy minerals contained in stream sediment was prepared by panning, separating the heavy fraction in bromoform (specific gravity 2.8), and removing iron and magnesium oxides and silicates by electromagnetic separation. The concentrate contains heavy and resistant minerals, including some that commonly are associated with ore deposits. Pulverized splits of the stream-sediment samples and heavy-mineral concentrates were analyzed for 31 elements by six-step optical emission semiquantitative spectrography (Grimes and Marranzino, 1968).

None of the stream-sediment samples contained anomalous amounts of any element.

A few of the heavy-mineral concentrates contained anomalous amounts of copper, lead, thorium, or tin, and the localities of these samples appear on plate 1. Samples 1, 2, and 3, from upper Sam Canyon, contained more than 2,000 ppm tin, and from nearby, sample 4 contained 200 ppm tin. Samples 1 and 3 also contained 2,000 and 700 ppm thorium, respectively. These samples are believed to be derived from extensive outcrops of rhyolitic plugs that form the ridge and peaks along the northeastern boundary of the study area. Sample 4 has less rhyolite in its source area, which may explain its much lower tin content.

A group of concentrate samples from along the middle of the southwestern side of the area (samples 5, 6, 7, 8, 9, and 10) contained lead in amounts ranging from 30 ppm (sample 7) to 2,000 ppm (samples 8 and 9). Sample 9 also contained 2,000 ppm tin; some of the rhyolitic plug of Diamond Bar Peak is in the drainage basin above, as well as another small rhyolitic plug. These samples were derived largely from andesitic rocks, with some basalt and silicic tuff. Sample 11, about 0.5 mi west of the study area near McKinney Canyon (pl. 1), contained 1,500 ppm copper and 500 ppm zinc; the source rocks are largely lower silicic volcanic rocks (pl. 1). This group of samples indicates a low-level copper-lead-zinc anomaly, which could be on the edge of a possible lead anomaly that has been tentatively identified outside the study area to the west.

The leaves of honey mesquite (*Prosopsis juliflora*) were sampled at lower altitudes, whereas branch tips (stems and needles combined) of Utah juniper (*Juniperus osteosperma*) were sampled at higher altitudes where mesquite was not available or where its leaves were not fully developed. Data from these samples were compared to those from other samples of similar materials in adjoining areas.

Plant samples provide information on soluble metals that are transported from the drainage basin and that are available at depth. Roots of mesquite, for example, are reported to extend laterally as much as 50 ft and to depths of as much as 165 ft (Simpson, 1977). The plant samples were ashed and digested in nitric and hydrochloric acids, and 30 elements were determined in the solutions by inductively coupled plasma spectroscopy. Neither mesquite nor juniper samples showed any unusual element occurrence in the study area.

Mineral and Energy Resources

No mines, prospects, evidence of rock alteration or mineralization, or significant geochemical anomalies were found in the study area. A minor tin anomaly is indicated by heavy-mineral concentrates in the upper part of Sam Canyon, and a diffuse copper-lead-zinc anomaly is suggested in the area between Steer Springs Canyon on the north and McKinney Canyon on the south. Porphyry copper deposits like those around Lone Star Mountain northeast of Safford may lie beneath the cover of young volcanic rocks in the study area, but rocks commonly associated with such deposits are not exposed in the area, and exploration for them would require geophysical exploration methods and drilling. Exploration drilling from the Day mine area south to the Gila River revealed only minor copper mineralization. The mineral resource potential for copper in porphyry deposits is low in the wilderness study area. Drilling in the Day mine area has defined a low-temperature (<100°C) geothermal zone, but because no deep holes have been drilled in or near the study area, it is not known whether the geothermal zone extends into the study area. The geothermal-energy resource potential is assessed as low. No sedimentary rocks favorable for the accumulation of oil and gas occur in or near the study area, and no oil and gas leases or lease applications have been filed. The potential for undiscovered oil and gas resources is low for the entire study area.

The low mineral resource potential of the study area is assigned a certainty level of C (Goudarzi, 1984; see inside front cover of this report) because the geologic, geophysical, and geochemical data give a good indication of resource potential.

REFERENCES CITED

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84-787, 42 p.

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Harms, T. F., Bradley, L. A., Tidball, R. R., Motooka, J. M., and Conklin, N. M., 1985, Analytical results and sample locality maps of stream sediments, heavy-mineral concentrates, and plant samples from Black Rock, Fishhooks, and Needles Eye Wilderness Study Areas: U.S. Geological Survey Open-File Report 85-462, 52 p.

Ryan, G. S., 1985, Mineral investigation of the Fishhooks Wilderness Study Area, Graham County, Arizona: U.S. Bureau of Mines Open File Report MLA 17-85, 8 p.

Simpson, B. B., ed., 1977, Mesquite—its biology in two desert ecosystems: Stroudsburg, Pa., Dowden, Hutchinson, and Ross, Inc., 250 p.

Wilson, E. D., and Moore, R. T., 1958, Geologic map of Graham and Greenlee Counties, Arizona: Tucson, Arizona Bureau of Mines, University of Arizona, scale 1:375,000.

Witcher, J. C., Stone, Claudia, and Hahman, W. R., Sr., 1982, Geothermal resources of Arizona [map]: U.S. National Oceanic and Atmospheric Administration, National Geophysical and Solar-Terrestrial Data Center, scale 1:500,000.

GEOLOGIC TIME CHART

Terms and boundary ages used by the U. S. Geological Survey, 1986

EON	ERA	PERIOD		EPOCH	BOUNDARY AGE IN MILLION YEARS
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late	96
				Early	138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~ 240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~ 330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~ 570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				3800?
pre-Archean[2]					4550

[1] Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

[2] Informal time term without specific rank.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1987—773-047/46,015 REGION NO. 8