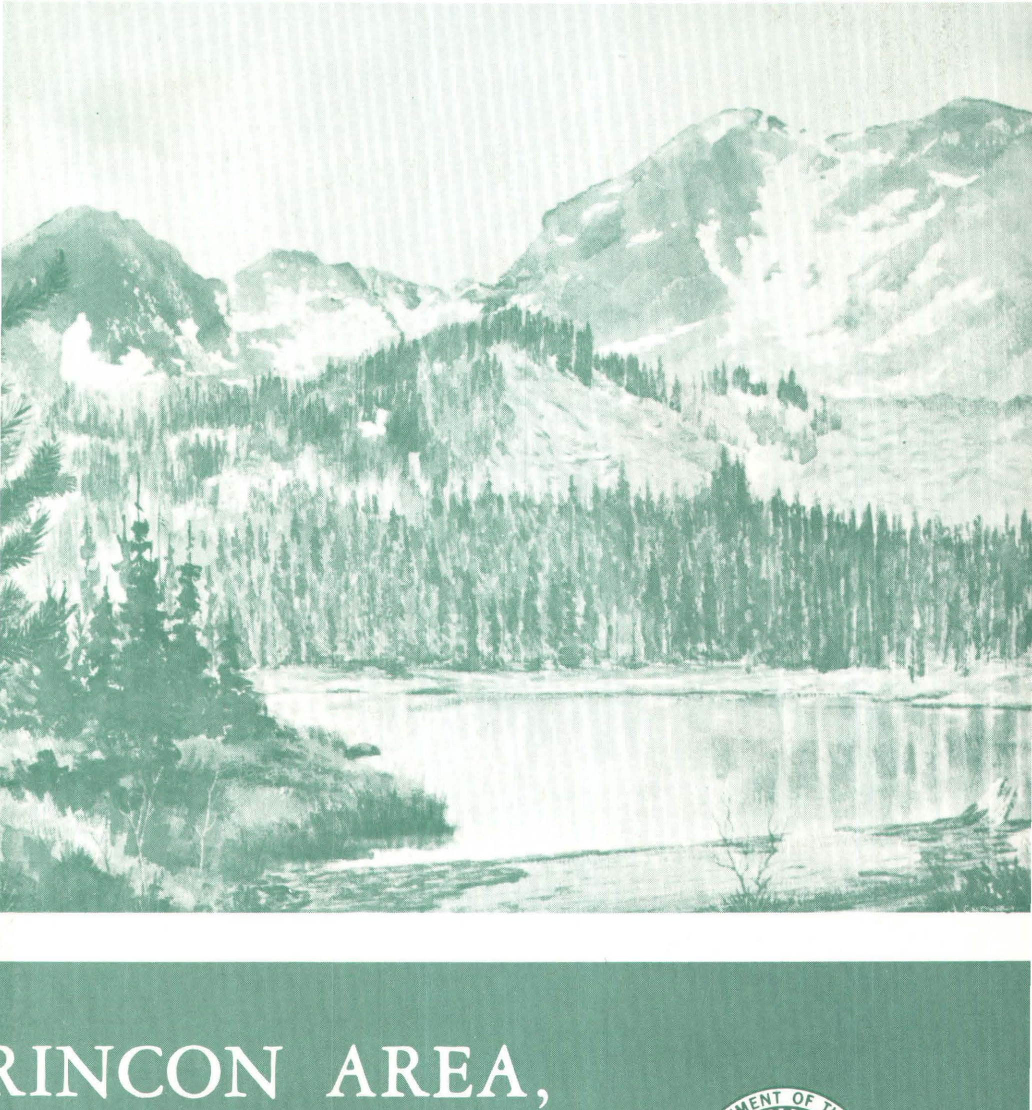
STUDIES RELATED TO WILDERNESS



RINCON AREA, PIMA COUNTY, ARIZONA

GEOLOGICAL SURVEY BULLETIN 1500

Mineral Resources of the Rincon Wilderness Study Area, Pima County, Arizona

A. Geology of the Rincon Wilderness Study Area, Pima County, Arizona

By CHARLES H. THORMAN
and HARALD DREWES, U.S. GEOLOGICAL SURVEY

B. Mines, Prospects, and Mineralized Areas of the Rincon Wilderness Study Area, Pima County, Arizona

By MICHAEL E. LANE, U.S. BUREAU of MINES

STUDIES RELATED TO WILDERNESS

GEOLOGICAL SURVEY BULLETIN 1500

An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

In accordance with the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964), the Joint Conference Report on Senate Bill 4, 88th Congress, and Public Law 94-567, the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. Areas officially designated as "wilderness," "wild," or "canoe" when the Act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The Acts provide that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This report discusses the results of a mineral survey of some national forest lands in the Rincon wilderness study area, Arizona, that is being considered for wilderness designation. The area studied is in Pima County in the southeastern part of Arizona.

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STUDIES RELATED TO WILDERNESS

MINERAL RESOURCES OF THE RINCON WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA

By U.S. GEOLOGICAL SURVEY and U.S. BUREAU of MINES

SUMMARY

The Rincon wilderness study area comprises about 254 km^2 (98 mi^2) of the Rincon Mountains 15–30 km (10–20 mi) east of Tucson, Ariz. The area lies within the Coronado National Forest and forms a belt around the north, east, and south sides of the Saguaro National Monument (fig. 1). In 1977 the U.S. Geological Survey and the U.S. Bureau of Mines made a mineral resource survey of the area, which indicated that the potential for finding metallic or nonmetallic mineral deposits, petroleum, coal, or geothermal energy in the study area is low. This appraisal is based on geologic and geochemical investigations and on examination of all mineralized prospects. A geologic map was made of the area and its immediate surroundings. Chemical and spectrographic analyses were made of 130 stream-sediment samples and of 143 rock samples. The locations of mining claims were compiled, and samples from most of the claims were assayed. No mineral production has been recorded within the study area.

The geology of the Rincon Mountains is complex. The core of the Rincon Mountains, lying mainly within the Saguaro National Monument, is underlain by igneous and metamorphic rocks chiefly of Precambrian and Tertiary ages. The study area lies on the flanks of the mountains in a terrain of sedimentary, metamorphic, and igneous rocks mainly of Precambrian through mid-Tertiary age. The rocks of this area are cut by many faults, with low-angle or bedding-parallel faults abundant. The distribution of these faulted rocks around the flanks of the Rincon Mountains is the result of a doming in the core area, the sliding of rock masses from the high part of the dome down its flanks, and the effects of erosion.

The potential for economic metallic mineral deposits is considered low because the known areas of anomalous concentrations of metals are small and the concentration of metals weak and erratic. The surface signs of mineralization are largely restricted to four locales in which some prospects exist (fig. 1): (1) east of Colossal Cave, southwest of the Rincon Mountains, (2) north of Happy Valley, east of the mountains, (3) between Roble and Youtcy Canyons, northeast of the mountains, and (4) near Italian Trap, north of the mountains. Very little primary sulfide mineralization is present, and signs of alteration are restricted to narrow zones along faults and fractures. The geochemical anomalies are weak; sites at which anomalous values of copper, molybdenum, or silver were obtained are mainly controlled by faults.

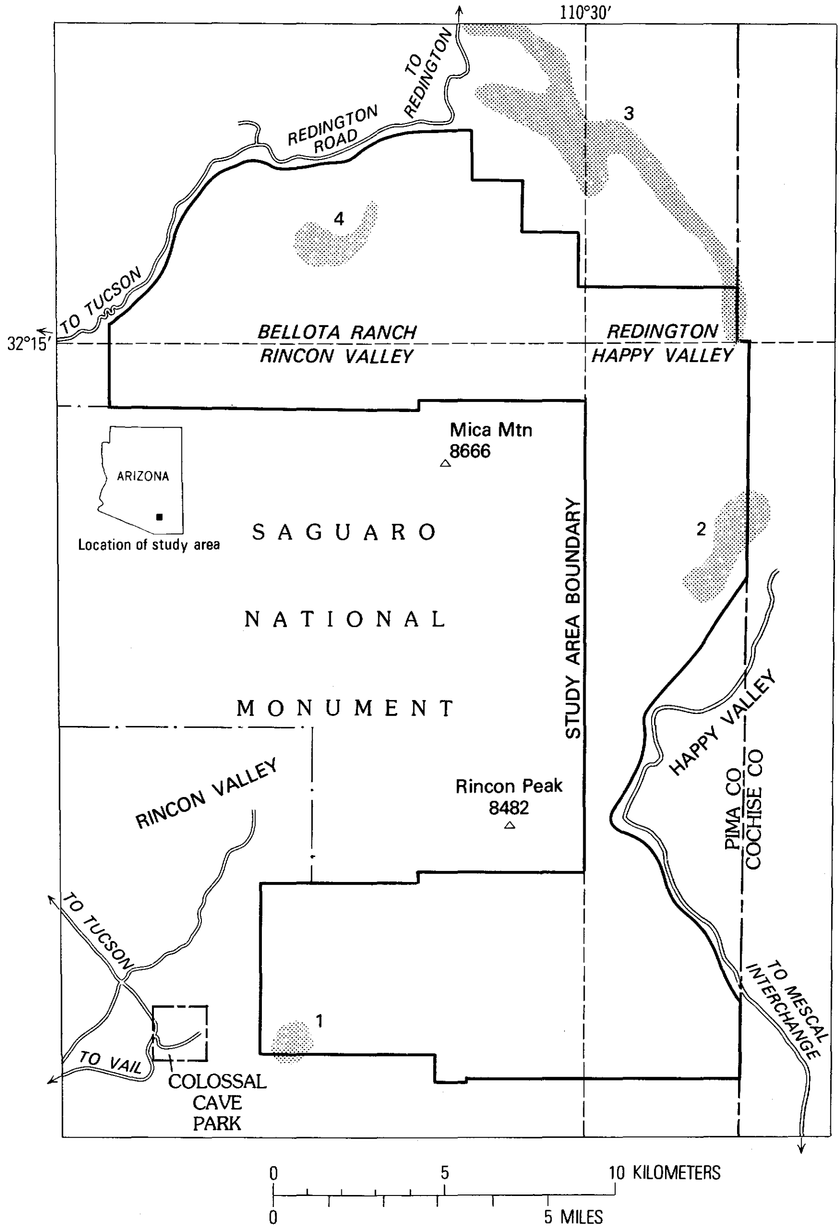

FIGURE 1.—Main access roads and weakly mineralized localities of the Rincon wilderness study area (heavy outline). 1, Colossal Cave locality; 2, Happy Valley locality; 3, Roble-Youtcy Canyon locality; 4, Italian Trap locality. Base from U.S. Geological Survey 1:62,500 Rincon Valley, Redington, Bellota Ranch, 1957; Happy Valley, 1958.

Nonmetallic mineral resources occur in deposits that are too small and too remote to be economically attractive. Sand and gravel deposits in the main drainages are similar to larger deposits that occur closer to nearby highways and cities. Limestone and marble present in some of the metamorphic rocks are too impure and too broken for use as dimension stone. Use of this marble as decorative rock is limited by remote markets. Limestone suitable for making cement is not likely to be found in large quantities within the Rincon wilderness study area. Closely spaced fractures in the granitic rocks make them of little value for building stone.

The likelihood of discovering sources of energy in the study area is remote. The abundant granitic rocks of the core area and the intense faulting of the cover rocks leave the study area with a completely unfavorable situation for oil and gas accumulations, and a history of late thermal activity in the study area further reduces the chances for the preservation of such accumulations. The kinds of rocks in which coal deposits could occur are not known in the Rincon Mountains. Although uranium mineralization occurs 2-3 km (1-2 mi) northeast of the study area, such mineralization is unlikely within the study area. Known deposits occur along or close to low-angle faults that strike and dip away from the study area. The geothermal potential of the study area is believed to be low. No hot springs or evidence of ancient hot springs occurs in the Rincon Mountains. The youngest volcanic rocks are too old to be viewed as signs of available heat at shallow depths.

Geology of the Rincon Wilderness Study Area, Pima County, Arizona

By CHARLES H. THORMAN
and HARALD DREWES, U.S. GEOLOGICAL SURVEY

MINERAL RESOURCES OF THE RINCON WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA

GEOLOGICAL SURVEY BULLETIN 1500-A

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GEOLOGY OF THE RINCON WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA

By CHARLES H. THORMAN and HARALD DREWES,
U.S. GEOLOGICAL SURVEY

INTRODUCTION

The Rincon wilderness study area, located east of Tucson, Ariz., includes about 245 km^2 (98 mi^2) of the Coronado National Forest in the Rincon Mountains. The area is horseshoe-shaped and open to the west, and it lies on the north, east, and south sides of the Saguaro National Monument (fig. 1). Much of the area lies on rugged flanks of the mountains, but it extends to less rugged terrain to the south, along Happy Valley to the east, and into the broad saddle between the Rincon and Santa Catalina Mountains to the north (fig. 2). The area covers parts of the Bellota Ranch, Redington, Rincon Valley, and Happy Valley 15-minute quadrangles.

A mineral resource survey of the wilderness study area was made in 1977 by the U.S. Geological Survey and the U.S. Bureau of Mines as part of a broader study by the U.S. Forest Service to determine the suitability of the area for inclusion in the National Wilderness Preservation System. A geologic map was prepared, stream-sediment samples were collected from the main drainage systems, and rock samples were taken from prospect pits and other mineralized sites to help evaluate the observed mineralization. The following description of the geology is based on the new field study as well as on recently completed studies of the Bellota Ranch quadrangle by Creasey and Theodore (1975), the Rincon Valley quadrangle by Drewes (1977), the Happy Valley quadrangle by Drewes (1974), and a map of the Mineta Ridge area of the Redington quadrangle by Chew (1962). Information gained in regional mapping by Drewes (1979) has also assisted evaluation of mineralization. The highlights of the geologic history, and descriptions of those rock types and faults related to the local mineralization are given in this chapter.

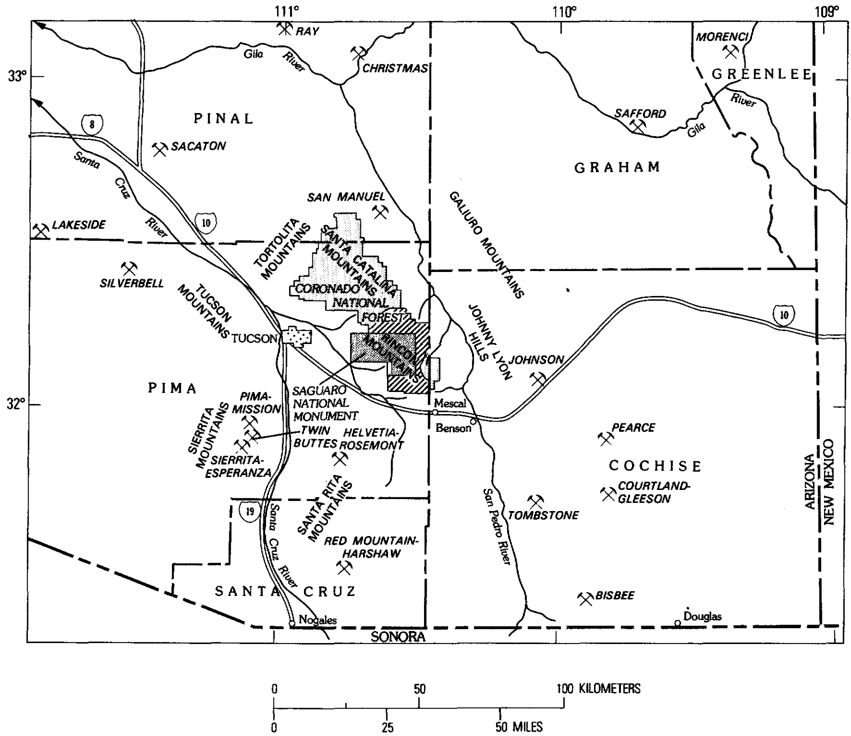


FIGURE 2.—Location of Rincon wilderness study area (diagonal line pattern) and surrounding mining districts (crossed pick and hammer).

GEOLOGY

GEOLOGIC SETTING

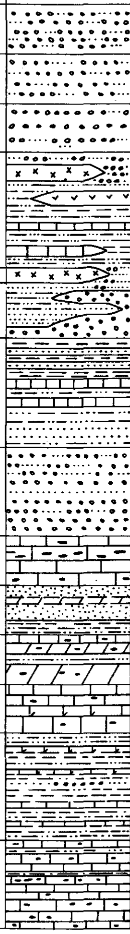
The Rincon Mountains lie within the present-day Basin and Range geologic province, about 160 km (100 mi) south of the Colorado Plateaus province. The Basin and Range province is characterized by northerly trending valleys and mountain ranges that typically are bounded by normal faults and by voluminous rhyolitic volcanic fields.

During the Precambrian the region was the site of clastic deposition. These rocks, the Pinal Schist, were intruded and metamorphosed during and after the Mazatzal Revolution, about 1.6 billion years ago. Together these rocks are commonly referred to as Precambrian basement. Major uplift and erosion caused the region to be beveled to a broad surface of low relief. This was followed by another episode of clastic deposition, represented by the Apache Group. Another period of uplift and erosion, less severe than the previous one, removed much of the Apache Group from southeastern Arizona. It was over this surface that Paleozoic seas transgressed.

During Paleozoic to early Cenozoic time, the Rincon Mountains were situated within the Cordilleran geosyncline and orogenic belt. This part of south-central Arizona lay on the southwest side of the stable part of the North American continent, or craton. From early Paleozoic to late Mesozoic time numerous marine transgressions occurred. Early and middle Paleozoic formations are thin and widespread, whereas late Paleozoic ones are considerably thicker (fig. 3). Deposits of late Paleozoic and Mesozoic age indicate a change in the region from dominantly marine sedimentation to continental accumulations. Volcanic activity became important in Mesozoic time in nearby areas. A major regional orogenic event that lasted from Late Jurassic to early Tertiary time, referred to as the Laramide or Cordilleran orogeny, terminated these depositional conditions. Deformation included high-angle block faulting, possible strike-slip faulting, large-scale thrust faulting with folding, magmatic activity, and local metamorphism and mineralization.

Cenozoic time saw a continued change away from the widespread, fairly uniform depositional conditions of the Paleozoic and early Mesozoic. After the late Mesozoic-early Cenozoic orogenic activity had died down, the region was the site of large-scale volcanic activity, continental deposition, and block faulting. Volcanic activity was especially pronounced in mid-Cenozoic time, when numerous individual outpourings of rhyolitic ash-flow tuffs covered up to several hundred square miles. Concurrently the Basin and Range province began to take form, with individual mountains and valleys being formed. In some instances early basins filled with material from adjacent uplifts reversed their downward movements and became major mountain ranges; such is the case of the Rincon Mountains.

The Rincon Mountains are in a region geologically favorable for mineral deposits, as is shown by the several major mining camps within 100 km (60 mi) of the study area: San Manuel, 50 km (30 mi) to the north; Safford, 100 km (60 mi) to the northeast; Tombstone, 50 km (30 mi) to the southeast; Patagonia, 100 km (60 mi) to the south; Sierrita, 50 km (30 mi) to the southwest; and Silverbell, 80 km (50 mi) to the northwest (fig. 2). These nearby districts have certain rock types, structural features, and aspects of geologic history similar to the wilderness study area; yet marked differences in the geologic history occurring between about 75 and 25 million years ago may explain the barren aspect of the Rincon Mountains and a few other ranges to the northwest compared to the mineral-rich condition of parts of most other nearby ranges. Many rock formations such as Paleozoic limestone, Cretaceous shale and sandstone and Tertiary granitic masses occur at Silverbell, San Manuel, or Tombstone, as well as in the Rincons. Low-angle faults are also reported from the Sierrita, Tombstone, and San Manuel areas, and high-angle faults are common everywhere. But the Rincon Moun-



AGE: Era, period	AGE: Era, period, and epoch	ROCKS: Group	ROCKS: Group, formation, and member	LITHOLOGY AND REMARKS	THICKNESS, METERS (FEET): Projected in from undisturbed areas	THICKNESS, METERS (FEET): Estimated present in Rincon Mountains
QUATERNARY	Holocene and Pleistocene		Unnamed	Gravel and sand—Deposits of drainageways and stream terraces		0–15+ (0–50+)
QUATERNARY	Pleistocene and Pliocene		Unnamed	Gravel and some sand—Light-gray to pale-brownish-gray; only locally indurated; clasts derived from core and cover rocks		0–300+ (0–1000+)
TERTIARY	Pliocene and Miocene		Unnamed; may be correlative with the Nogales Formation	Gravel, conglomerate, and some sand—Poorly indurated, light-gray to pale-reddish-gray; clasts derived from core and cover rocks		0–150+ (0–500+)
TERTIARY	Miocene to Oligocene		Pantano Formation	Conglomerate, sandstone, siltstone, and some limestone, sedimentary breccia, claystone, and gypsum—Pale-red, reddish-gray, or brownish-gray. Limestone light-gray, fine-grained. Clasts subrounded to angular pebbles to boulders and some blocks tens of meters in diameter, derived from sedimentary rocks and granitic rocks of the cover suite. Moderately indurated	2000 (6400)	600–2000 (2000–6400)
TERTIARY	Miocene to Oligocene		Unnamed volcanic formation	Andesite—Greenish-gray, fine-grained lava and dikes Andesite porphyry—Dark-brown coarsely porphyritic lava and dikes, locally called "turkey-track porphyry" Rhyolite—Pale-yellowish-brown to pale-reddish-gray tuff and welded tuff, and some dikes		
CRETACEOUS	Early Cretaceous		Bisbee Formation	Siltstone; shale, sandstone, and some limestone and conglomerates—Clastic rocks olive-gray, gray, reddish-gray, or pale-yellowish-gray. Clasts in conglomerate mainly subrounded pebbles of limestone, chert, and other Paleozoic rock types. Some limestone units laminated, medium gray; others have fossils, including clams	1560 (5200)	0–1500? (0–5000?)
CRETACEOUS	Early Cretaceous		Bisbee Formation: Glance Conglomerate Member	Conglomerate and some sandstone and siltstone—Clasts subrounded pebbles and cobbles mainly of limestone, dolomite, quartzite, and chert, of Paleozoic rock types. In some places thin; in others thick and gradational with overlying finer clastic rocks	0–120+ (0–400+)	0–240? (0–800?)
PERMIAN	Early Permian	Naco Group	Concha Limestone	Limestone—Medium-gray, fine-grained, cherty, and fossiliferous. Fossils include productid brachiopods	40–100 (130–332)	0–30 (0–100)
PERMIAN	Early Permian	Naco Group	Scherrer Formation	Sandstone, quartzite, and some dolomite and siltstone—Light-gray to pinkish-gray, fine-grained quartzitic sandstone, thin light-gray dolomite, and thick reddish-gray siltstone	170–208 (560–690)	0–90 (0–300)
PERMIAN	Early Permian	Naco Group	Epitaph Dolomite	Dolomite, limestone, and marlstone—Light- to dark-gray, cherty; dolomite coarse- to medium-grained; limestone fine-grained	0–362 (0–1189)	0–215 (0–700)
PERMIAN	Early Permian	Naco Group	Colina Limestone	Limestone—Dark-gray, fine-grained, locally slightly dolomitic, sparsely cherty and fossiliferous. Fossils include gastropods and large echinoid spines	55–135 (180–440)	0–125 (0–400)
PERMIAN / PENNSYLVANIAN	Early Permian and Late Pennsylvanian	Naco Group	Earp Formation	Shale, marlstone, and some sandstone, limestone, dolomite, and conglomerate—Commonly reddish-gray, locally greenish-gray or purplish-gray. Sandstone brown, conglomerate pale-red, and limestone and dolomite light-gray and fine-grained. Conglomerate of chert pebbles and chips. Fossils include fusulinids	219–340 (724–1130)	0–150 (0–500)
PENNSYLVANIAN	Late and Middle Pennsylvanian	Naco Group	Horquilla Limestone	Limestone and siltstone—Limestone light-pinkish-gray, thin- to medium-bedded, sparsely cherty. Siltstone reddish-gray, in units that increase in thickness toward top of formation, to 3 m thick. Fossils include corals, brachiopods, and fusulinids	305–485 (993–1600)	150–450 (500–1500)

FIGURE 3.—Stratigraphic diagram, showing normal sequence and thickness of bedded rocks, their unmetamorphosed lithologies, and their formation names and ages. Likely range of local thickness also shown. Graphic description indicates the approximate relative thickness and position of units within formations.

tains, along with the Santa Catalina and Tortolita Mountains, had a magmatic and metamorphic history unique to the region at least for its extended duration, if not also for its problematic magma conditions.

A widely scattered range of age values obtained from dating various minerals of single samples and between samples from various parts of a single formation is a feature of the Rincons but not of most of the nearby areas. Because radiometric and fission-track age determinations

Continued

AGE (Era, period, and epoch)	ROCKS (Group, formation, and member)	GRAPHIC DESCRIPTION	LITHOLOGY AND REMARKS	THICKNESS, METERS (FEET): Projected in from undisturbed areas	THICKNESS, METERS (FEET): Estimated present in Rincon Mountains
Mississippian	Escabrosa Limestone		Limestone—Medium-gray, thick- to thin-bedded, medium- to coarse-grained, bioclastic, and, in part, crinoidal; contains large chert nodules. Shale and limestone at top may be the Black Prince Limestone of Late Mississippian or Early Pennsylvanian(?) age. Fossils include horn corals	170–270 (557–900)	0–215 (0–700)
DEVONIAN — Late Devonian	Martin Formation		Dolomite, limestone, and some shale and sandstone—Medium-bedded and cherty. Dolomite brown and coarse-grained. Limestone gray and dolomitic. Shale reddish-brown. Fossils include corals and brachiopods	62–97 (205–320)	0–90 (0–300)
CAMBRIAN — Late and Middle Cambrian	Abrigo Formation		Shale, sandstone, and some limestone—Shale brownish-gray, brown, or olive-gray. Sandstone medium- to fine-grained. Limestone light-gray, thin-bedded; some beds are bioclastic, some have silty partings and crinkly bedding, and others have edgewise intraformational conglomerate. Some beds are dolomitic. Fossils include trilobites	215–265 (700–867)	0–240 (0–800)
CAMBRIAN — Middle Cambrian	Bolsa Quartzite		Quartzite, sandstone, and some shale and conglomerate—Light- to dark-gray, purplish-gray, or brownish-gray; medium- to thick-bedded	136–145 (450–480)	0–60 (0–200)
Precambrian Y	Apache Group — Dripping Spring Formation		Arkose, sandstone, and some quartzite and siltstone—Banded light-colored and reddish-brown, medium-bedded	90 (300)	0–90 (0–300)
Precambrian Y	Apache Group — Barnes Conglomerate Member		Conglomerate—Clasts of round pebbles of white quartz and quartzite	1–20 (3–60)	0–9 (0–30)
Precambrian Y	Apache Group — Pioneer Formation		Siltstone and shale—Shale hard, or argillite. Reddish-brown	45–90 (150–300)	0–90 (0–300)
Precambrian Y	Apache Group — Scanlan Conglomerate Member		Conglomerate—Clasts of angular pebbles of light-colored quartz and quartzite	0–9 (0–30)	0–3 (0–10)
Precambrian X	Pinal Schist		Schist, phyllite, and some quartzite and conglomerate—May include limestone and rhyolite. Everywhere metamorphosed. Gray, greenish-gray, or brownish-gray. Conglomerate clasts of white quartz or quartzite	6000? (20,000?)	3000+ (10,000+)

EXPLANATION

- Gravel, conglomerate, and sedimentary breccia
- Sand, sandstone, arkose, and quartzite
- Claystone, shale, argillite, and marlstone
- Siltstone
- Limestone
- Dolomite
- Dolomitic limestone
- Shaly limestone
- Sandy limestone
- Chert
- Gypsum and anhydrite
- Volcanic rocks

reflect the latest time of cooling past a known temperature threshold, which varies for specific minerals, the age determinations do not favor an explanation of a single simple plutonic emplacement about 25 m.y. ago, but indicate that the cooling history was drawn out, perhaps varied from place to place, and only ended about 25 m.y. ago. Under such conditions, mineral matter that may have been emplaced at the close of an initial period of stock emplacement could have been flushed out subsequently.

ROCK UNITS

The Rincon wilderness study area is underlain by granitic, sedimentary, and metasedimentary rocks that range in age from Precambrian to Holocene. In the following discussion the rocks are divided into "core rocks" and "cover rocks" according to their mode of occurrence. Core rocks are chiefly granitic rocks that have a gneissic or layered texture, lesser amounts of Pinal Schist intruded by the granitic rocks, and other granitic stocks cited later. Core rocks are so designated because they underlie the rugged central part of the mountains and form a domical structure. Cover rocks are both sedimentary and metasedimentary in origin and also contain granitic rocks without gneissic texture. The cover rocks are in low-angle fault contact with the core rocks and form the lower part of the flanks of the Rincon Mountains; they occur near the northern, eastern, and southern margins of the study area. Several granitic bodies are not properly parts of either the core or cover rock assemblages because they intrude, and thus are younger than, both the core and cover rocks. These include granodiorite of the Happy Valley, a non-gneissic rock that formed two small stocks, and a faintly gneissic unnamed quartz monzonite pluton near Youtcy Ranch. These plutonic rocks will be discussed with the rocks of the core assemblage, as they are believed to be genetically related to parts of it.

Small parts of the Rincon area are underlain by weakly indurated conglomerate that is younger than core or cover rocks. These deposits occur mainly along drainageways and locally form stream terraces.

Brief descriptions of all of the rock units of the Rincon wilderness study area are given on the explanation of the geologic map (pl. 1). More detailed information is provided later on formations of special interest to mineral-resource assessment. A composite stratigraphic section of Precambrian to mid-Tertiary sedimentary rocks is presented in figure 3. The original thickness and normal sequence of these formations was reconstructed in part from regional geologic information, particularly from areas such as the Johnny Lyon Hills 20 km (12 mi) to the east, where the layered sequence is less faulted (Cooper and Silver, 1964). Because of the abundant low-angle faulting in the Rincon Mountains, the thickness of formations is commonly reduced. Locally some formations are completely missing, whereas elsewhere formations are repeated.

CORE ROCKS

The core rocks are chiefly gneissic granitic rocks of several kinds and ages—the Continental Granodiorite, the Johnny Lyon Granodiorite, the Wrong Mountain Quartz Monzonite, the quartz monzonite of Sanmaniego Ridge (Creasey and Theodore, 1975), and an unnamed quartz monzonite that forms a stock at Espiritu Canyon. The core rock assemblage also contains Pinal Schist that is the host rock for certain granitic intrusives, the faintly gneissic quartz monzonite of the stock at Youtcy Ranch, and the non-gneissic granodiorite of Happy Valley. The Continental Granodiorite, Wrong Mountain Quartz Monzonite, quartz monzonite of the Espiritu Canyon stock, and quartz monzonite of Sanmaniego Ridge of Theodore and Creasey (1975) form plutons that occur over a wide area. Commonly the boundaries between these plutons and the rocks they intrude are gradational over a distance of tens of meters, but locally sharp contacts are also found. Where the smaller stocks cut the cover rocks, the contacts are sharp.

The Pinal Schist occurs mainly in the core rock assemblage, though it also occurs in several fault slices in the cover rocks. Much of this unit is phyllite or quartz-mica schist; some of it is quartzitic schist or quartzite, and in a few places it includes beds of quartzite conglomerate. It also includes rocks that may be metarhyolite. The Pinal Schist in the Little Dragoon Mountains 30 km (20 mi) east of the wilderness area has been radiogenically dated as 1,715 m.y. old (Cooper and Silver, 1964).

The Continental Granodiorite intrudes the Pinal Schist. It typically is a dark-gray coarse-grained rock with large crystals of light-colored feldspar. Where the rock is little deformed these crystals are blocky phenocrysts, but where deformation is moderate they are crushed and elongate, and where deformation is strong the porphyritic texture has been nearly obliterated. The dark color of the rock, produced by abundant biotite, magnetite, and sphene, persists regardless of the amount of deformation. The rock is dated as at least 1,450 m.y. old in the Santa Rita Mountains 30 km (20 mi) to the southwest (Drewes, 1971, 1976b, and Marvin and others, 1973); it is probably older than the Johnny Lyon Granodiorite.

In the Rincon wilderness study area, the Johnny Lyon Granodiorite forms only a peripheral part of the granitic core rocks, though it forms a body of batholith size to the east. Immediately below the faulted cover rocks east of Happy Valley, this granodiorite is sheared and weakly chloritized. The batholith to the east is made up of undeformed rock that generally is unfoliated or non-gneissic. Southeast of Happy Valley it intrudes rocks assigned to the Continental Granodiorite (Drewes, 1974), and in the Johnny Lyon Hills, 25 km (15 mi) to the east, it is radiometrically dated as 1,625 m.y. old (Cooper and Silver, 1964, and modified by L.T. Silver, oral commun., 1977).

All other kinds of granitic core rocks, including the younger cross-cutting masses, seem to be related. They are typically moderately coarse grained, nonporphyritic, and pale yellowish gray to light gray in color. They usually contain abundant feldspar and quartz, both biotite and muscovite, and small amounts of garnet. The granodiorite of Happy Valley, however, contains little or no muscovite and garnet. The age of this suite of granitic rocks is incompletely known, in part because their structure and texture suggest unusual complications of successive magma remobilization and emplacement, and in part because the youngest thermal event in this area destroyed much of the evidence for an older age. Nevertheless, several radiometric and fission-track dates of the Wrong Mountain Granodiorite (Drewes, 1977) suggest that at least some of this unit formed as a Precambrian pluton or from

Precambrian material. The quartz monzonite of Sanmaniego Ridge is assigned a Cretaceous or Tertiary age by Creasey and Theodore (1975), and we believe that the quartz monzonite of the stock at Espiritu Canyon has a similar age. Possibly most of the older core rocks were reheated and at least partly remobilized during Late Cretaceous to Paleocene time. Certainly, the cross-cutting rocks of the core rock have young emplacement ages, for the stock at Youtcy Ranch cuts low-angle faults that probably are of latest Cretaceous age, and stocks in Happy Valley cut similar faults and even younger high-angle faults that break the low-angle faults.

Rocks of the core are characterized by a microscopic fabric indicative of crushing and shearing, and many have a strong foliation and (or) lineation. Generally the older rocks of the core are more deformed than the younger. Foliation is fainter, for instance, in quartz monzonite of the Espiritu Canyon stock than in Wrong Mountain Quartz Monzonite, and lineation is not recognizable in the outcrop. Foliation is nearly unrecognizable in the stock at Youtcy Ranch and neither foliation nor lineation is found in the Happy Valley stocks, except for some primary mineral alinement. The suspected magma remobilization and internal deformation of the core rocks are apparently related, but attempts to explain their development are beyond the scope of this study.

In assessing the resource potential of the area, the following points are noteworthy, for they indicate some important differences between the study area and nearby areas of major mineralization. First, the core rocks finally cooled about 26 m.y. ago, about 20 m.y. younger than the time of major mineralization in nearby mining districts. Second, the intense structural deformation of the core rocks is not a common feature in nearby mining districts. Third, the contacts of the younger granitic rocks with the Precambrian rocks are commonly gradational through a broad zone, suggesting intrusion into a hot country rock, whereas the contacts of stocks in nearby mining districts are sharp, generally indicating thermal contrast. These features of the core rocks are not common in southeastern Arizona, but they are found in the Santa Catalina and Tortolita Mountains (fig. 2), 10 and 35 km (6 and 25 mi), respectively, to the northwest of the study area, and at other widely scattered localities elsewhere in the Cordilleran orgenic belt. They are apparently nowhere closely associated with large mineral deposits.

COVER ROCKS

The cover rocks comprise chiefly Paleozoic, Cretaceous, and mid-Tertiary sedimentary units and metasedimentary Paleozoic and Cretaceous units, with subordinate Precambrian igneous, metamorphic, and sedimentary units. These rock units occur in discontinuous fault slivers in the outer portions of the wilderness study area and underlie a more extensive belt outside the area. Numerous low- and high-angle faults cut the cover rocks; rock units of diverse ages lie against each other in a wide variety of relationships, but commonly younger rocks rest on older ones. Because of this structural complexity of the cover rock assemblage, no single complete stratigraphic section remains. Many units shown on the diagrammatic stratigraphic section of figure 3 locally are partially or completely cut out by faulting.

Precambrian rocks present in the cover assemblage include the Pinal Schist, Continental and Rincon Valley Granodiorites, and the Apache Group. These units are generally present in separate fault slivers that are relatively small in areal extent. The Pinal Schist and Continental Granodiorite are foliated, and the Continental Granodiorite is lineated. In contrast, the Rincon Valley Granodiorite is neither foliated nor lineated and is present only in the cover rock assemblage. Apache Group rocks comprise arkose, sandstone, quartzite, siltstone, shale, and conglomerate, and are the oldest unmetamorphosed unit in the study area.

Paleozoic and Mesozoic formations of the cover rock assemblage include Cambrian, Devonian, Mississippian, Pennsylvanian, Permian, and Lower Cretaceous units. The dominant lithologies are limestone, dolomite, shale, sandstone, and conglomerate. An estimated total thickness for an undisturbed succession of Paleozoic and Mesozoic rocks is on the order of 3.5 km (11,500 ft). All of these units are shown in figure 3; thicknesses are given as measured in nearby undisturbed areas and as estimated for the Rincon Mountains. Units that are commonly mineralized, as seen in many mining camps in southeastern Arizona, include the Upper and Middle Cambrian Abrigo Formation, the Upper Devonian Martin Formation, and the Lower Cretaceous Bisbee Formation.

Several of the Paleozoic formations, and the Lower Cretaceous Bisbee Formation, are metamorphosed in places to marble, metaquartzite, phyllite, and a tactite-marble-argillite mixture. Nearly all are foliated and banded rocks that were synkinematically metamorphosed to the upper greenschist facies or to higher grades. These rocks occur in separate discontinuous fault slivers, bounded above and below by low-angle faults. Thus the cover rocks include some unmetamorphosed and some metamorphosed formations of the same age. The areal distribution of the metamorphic rocks is closely related to major low-angle faults rather than to present proximity to plutons. The distribution of metamorphosed rocks resembles that in some nearby mining camps, where large areas of metamorphosed rock appear unrelated to exposed instrusive bodies.

The mid-Tertiary Pantano Formation, the youngest unit of the cover rock assemblage, is mainly composed of conglomerate, sandstone, and siltstone that is well to poorly indurated. South of the mountains the Pantano contains much coarse sedimentary breccia and landslide debris, and in limited areas it includes unindurated clay beds and lenses of limestone, gypsum, and anhydrite. No sedimentary breccia occurs northeast of the mountains, but rather more beds of clay, limestone, and gypsum. The beds to the northeast were informally called the "Mineta beds" in thesis studies (Chew, 1962). Later (1962) Chew published a formal definition and description of the Mineta Formation. The clasts in the conglomerate and breccia were derived from the sedimentary and metasedimentary rocks of the cover rock assemblage. Typically the Pantano is separated from these rocks by faults, but in the Happy Valley area it rests unconformably on the older rocks.

Volcanic rocks are found within the Pantano Formation at several localities. Dikes and intrusive pipes of rocks resembling these volcanics occur near these localities as well as in other parts of the Rincon Mountains. The volcanic rocks include welded and nonwelded rhyolitic tuff, andesite, and a distinctive coarsely porphyritic andesite locally known as "turkey-track porphyry" (Cooper, 1961). Within the study area, and near Pantano Wash a few kilometers south of the study area, several bodies of volcanic rock have been radiometrically dated as 35-25 m.y. old, and hence formed in late Oligocene and earliest Miocene time. Fossil rhinoceros remains in layers from near the top of the formation northeast of the mountains are designated as early Miocene in age by John Lance, but may be as old as late Oligocene according to Lindsay and Tessman (1974).

GRAVEL DEPOSITS

A thick sequence of very gently to moderately dipping gravel deposits is faulted against the cover rocks in the northeast corner of the map area and rests unconformably on them south of the mountains. The gravels were derived from the mountains and deposited in the adjacent basins. These weakly consolidated deposits are considered to be late Tertiary to Holocene in age. Though these deposits are faulted against older units, they are not considered to be part of the cover rock assemblage.

STRUCTURES

The two-fold subdivision of the rocks into core rock and cover rock assemblages is based principally on their mode of structural occurrence. The core rocks are primarily igneous and are only locally cut by faults. In marked contrast, the cover rocks are dominantly sedimentary and are profusely cut by four types of faults. These rocks form a belt about the core rocks that form the main mountain mass. The cover rocks have been removed from the higher uparched core by erosion and gravity sliding. The few mineralized areas lie on the flanks of the Rincons in the structurally controlled zone of the cover rocks. The areal association of cover rocks and mineralized areas is probably related to the many faults that cut the cover rocks. The faults provided permeable zones used by mineralizing fluids; these zones are not present in the core rocks.

The Rincon Mountains dome is a broad structure with gentle flanks sloping not more than 20°, which is defined by the foliation of the core rocks and bedding of the cover rocks. (See structure sections, Drewes, 1974, 1977, and 1979). The Rincon dome is the southeastern most of three such features; the central one lies in the Santa Catalina Mountains and the northwestern one in the Tortolita Mountains. The simple domical form of the Rincon Mountains is modified by several subordinate domes, anticlines, and synclines, and by a north-trending normal fault on the west side of Happy Valley that downdrops the east flank of the dome some hundreds of meters.

The four types of faults that occur in the cover rocks are distinguished in part by their relation to bedding and in part by their age. Faults of two of these types are generally parallel to bedding: one type, containing faults here designated as thrust faults, is inferred to be of Late Cretaceous age; the other type, containing faults herein referred to as glide faults, is of Oligocene or younger age. The faults of the other two types commonly cut abruptly across bedding: one kind of fault, herein referred to as a disharmonic fault, is probably of Late Cretaceous age and genetically related to the thrust faults; faults of the other type, herein referred to as normal faults, are of Oligocene or younger age but not related to the glide faults. Although these names have a genetic significance to the structural interpretation favored by us, the four types of faults are generally distinguishable on descriptive grounds, and the chosen names—thrust, glide, disharmonic, and normal—are convenient designations even if alternative structural interpretations are chosen. The following descriptions focus on the thrust and disharmonic faults because they are the structures most commonly found in and near mineralized ground in the Rincon wilderness study area.

The thrust faults form a belt that is generally subparallel to the gently dipping bedding of the Paleozoic and Cretaceous sedimentary and metasedimentary cover rocks. The structurally lowest thrust fault in the belt separates the cover rocks from the core rocks. Younger rocks locally conceal these faults, and stocks intrude them. Some thrust faults are conspicuous and extensive structures marked by a zone of sheared, mylonitized, lineated, and locally brecciated rock many meters thick. Other thrust faults are shorter structures that commonly branch off the main thrust faults and are marked by less conspicuous zones of broken rock. The intensely mylonitized rock at the base of the metasedimentary rocks overlies incipient mylonitized (protomylonitized) and mylonitized features that are widespread in the granitic core rocks. Where thrust faults do cut across underlying or overlying beds, they generally do so gradually; they commonly follow shaly units, cut out parts of formations, and bring younger rocks over older ones. However, along some thrusts older rocks are faulted over younger ones. Throughout an extensive area northeast of Happy Valley lie two thrust plates of Paleozoic rocks, separated by an intermediate plate of Precambrian Rincon Valley Granodiorite. The rocks above a particular thrust fault may be folded even though those beneath are not. In places, sets of small drag folds with a plastic style of deformation lie near a thrust fault. Rocks near the lower faults are likely to be metamorphosed.

Regional considerations indicate that the thrust faults are about 75 m.y. old (Drewes, 1972, 1978). This relatively old age is based on the following lines of evidence: The thrust faults are intruded (1) by stocks of Oligocene age, and (2) by turkey-track porphyry of late Oligocene age. (3) They are locally unconformably overlain by the Oligocene-Miocene Pantano Formation. (4) They are associated with a style of deformation and degree or intensity of metamorphism that require a much thicker cover than could have been provided by the Pantano Formation. Indeed, glide faults of a much younger age formed when rock masses gradually slid off the rising Rincon dome. These glide faults postdate the deposition of the clay, limestone, and gypsum beds in the Pantano Formation, which were deposited in basins that could not have been part of the dome. (5) The abundance of Rincon Valley Granodiorite clasts in parts of the Pantano Formation indicate that the granodiorite was already faulted into the Rincon area by Pantano time. (6) A preglide faulting event of a thrust-fault nature is required to explain the large horizontal movement of thrust plates, as evidenced by duplicated Paleozoic formations (Drewes, 1973, 1976a), and the absence of a source of the Rincon Valley Granodiorite in the Rincon Mountains. This type of multiple faulting is also typical of other areas in the Basin and Range province where the earlier event is of late Mesozoic age.

The glide faults are structures subparallel to bedding and formed during or after latest Oligocene time. They formed by gravity sliding when rock masses slid off the flanks of the Rincon dome as it was rapidly (geologically speaking) uparched. Glide faults cut or underlie much of the Pantano. Locally, gliding movements reactivated segments of the already existing thrust-fault surfaces. Where the Pantano Formation occurs along glide faults, its rocks are shattered, smeared, or squeezed in the manner of a structurally incompetent rock bearing very little load. Where glide faults utilized the older thrust surfaces, the intensely sheared and mylonitized rock below the fault surface is brecciated, generally along a zone less than 1-2 m thick. Some glide-fault plates form shingled masses of little-deformed Pantano Formation that are offset from each other some hundreds to a few thousand meters. Other plates are surrounded by inward-dipping fault planes typical of oversized slump masses but retain an internal structural coherency.

Disharmonic faults commonly cut bedding abruptly along their entire length. Most of them are short and the offset along them is small. Their attitudes, relative displacements, and small-scale structures indicate that disharmonic faults can have normal, reverse, or strike-slip movement. A few of the strike-slip faults are several kilometers long and may have large offsets. Disharmonic faults as here defined occur only within thrust plates. Examples of the disharmonic faults occur on the east and west sides of Happy Valley. Some of the disharmonic faults near Colossal Cave were reactivated during the time of glide faulting because they bound infaulted blocks of Pantano Formation.

Locally, disharmonic faults can be seen to terminate downward or upward against thrust faults. The disharmonic faults end abruptly and at a high angle against the thrusts, and they do not tend to merge with them. Apparently the disharmonic faults formed as adjustments to stresses within the thrust plates during thrust movement. Thus, the age of these thrust faults is inferred to be Late Cretaceous, the same as the thrust faults.

The normal faults, the fourth type of faults referred to in this report, are structures of late Oligocene or younger age. Many of them occur on the east side of the Rincon Mountains, where they are many kilometers long, dip steeply, and produce large displacements. They all cut the Pantano Formation, or younger units, and terminate against the glide faults. The normal-fault group is probably younger than all mineralization in this area and is related to the development of Basin and Range geologic province features.

On a regional scale, the Basin and Range faulting south of the Rincon Mountains strikes nearly north, but north of the mountains the faults trend northwest. This important change seems to reflect a group of major northwest-trending faults in the crystalline basement rocks (Drewes, 1978).

GEOLOGY OF THE MINERALIZED LOCALITIES

Four sparsely mineralized areas, marked by clusters of prospect pits, occur near Colossal Cave, north of Happy Valley, between Roble and Youtcy Canyons, and near Italian Trap (fig. 1). Anomalous amounts of beryllium, copper, lead, molybdenum, silver, tin, tungsten, and zinc were detected in chip-samples collected from the prospect pits at the four locales. Values for these metals from the various prospects are shown in table 2 and in figures 4-10. The Roble-Youtcy Canyon locality is primarily outside the wilderness study area and has two different types of mineralization, one characterized by the metals mentioned above and a second by uranium. The following discussion applies to the non-uranium mineralization; the nature of the uranium deposits will be discussed separately at the end of this section.

The dominant factor localizing mineralization is the "plumbing system" along which mineralizing fluids migrated. In this case it follows the major thrust faults and genetically related disharmonic faults. Within the cover rock assemblage nearly every prospect pit and mineralized outcrop is on or very near one of these faults. The distribution of prospect pits and mineralized outcrops in the core rocks is likewise strongly influenced by the thrust faults. Though the several prospects in core rock are as much as 3 km (1.8 mi) from the present trace of a thrust fault, the faults are low-angle structures and their projection brings them very close above these prospects (structure sections A-A′, pl. 1, this report; D-D′, Drewes, 1977). The distribution of the mineralization at individual prospects or outcrops is primarily controlled by fault and joint surfaces, and to a lesser extent by bedding in the sedimentary rocks or shear foliation in the granitic rocks. Two prospect pits north of Youtcy Ranch, numbers 329 and 330, are in metasedimentary rocks near the margin of the quartz monzonite of Youtcy Ranch. Two other prospects south of the ranch, numbers 327 and 328, are associated with quartz veins in the quartz monzonite.

Mineralization is mainly in metasedimentary Paleozoic strata and subordinately in unmetamorphosed Paleozoic strata and sheared gneissic Precambrian rocks. The host rocks are chiefly marble and recrystallized Horquilla Limestone with some metaquartzite, shale, and impure carbonate rocks of the Bolsa Quartzite and Abrigo and Martin Formations. Gneissic host rocks include sheared and mylonitized Wrong Mountain Quartz Monzonite and Continental Granodiorite. The most common mineralization in Paleozoic rocks is in small pods or sheets of tactite or skarn, epidote- and garnet-rich rock derived from metamorphosed impure carbonate rock, or in small, irregular pods of iron-stained rock or jasperoid. The most common type in the sheared granitic rocks is in small iron-stained silicified pods. The ore minerals and silicified pods and sheets are not sheared or brecciated. Visible mineralization is generally secondary iron oxides, copper carbonates and oxides, quartz, and calcite, and rarely pyrite and chalcopyrite. The primary mineralization is believed to have been mainly sulfides of copper and iron; oxidation and some remobilization occurred subsequently.

The age of the primary sulfide mineralization is inferred from the age of the thrust and disharmonic faults that provided the structural control. These faults formed during Late Cretaceous or younger time and before final recrystallization of the granitic core rocks. The Pantano Formation, which is not mineralized except for some uranium, is underlain by a gravity fault; but this fault probably is younger than the regional sulfide mineralization. These inferences suggest that the thrust and disharmonic faults formed prior to mineralization and served as conduits for the fluids that deposited iron and copper sulfides in fractured rocks of suitable composition. Primary mineralization is thus of late- or post-Laramide age. Oxidation and local remobilization of the metals took place at a later time. Glide faulting and normal faulting occurred later than the primary mineralization and probably after most, if not all, of the oxidation and remobilization.

The uranium mineralization in the Roble-Youtcy Canyon locality occurs in the northeastern part of the belt of faulted cover rocks. The uranium occurs in metasedimentary Paleozoic and Cretaceous rocks, in sheared granitic rocks, and in the mid-Tertiary Pantano Formation. Granger and Raup (1962, p. A34-A37) discussed the mineralization. They identified autunite and uranophane at sites A and D and pyrite, chalcocite, and purple fluorite at site B. Sites B and D are in the Pantano Formation. Brief accounts appeared in U.S. Atomic Energy Commission (1970a and 1970b) and in written communications by consulting geologists on the geology of the several prospects, to which various names are given that reflect changes of ownership since the intermittent prospecting for uranium began in 1949. Site A is known as Blue Rock 1-16 claims or Sure Fire claim; site B (approximately located on pl. 2) is the North Chance 1-3 claims; site C is the Center Chance claim and may be the same as West Chance 1-3 claims; site D (approximately located, pl. 2) is the East Chance 1-22 claims or Van Hill No. 7 and 8 claims. Sites 161 and 162 have been called the Roble spring deposit, and sites 154 and E are the South Chance 1-6 claims. Site 161 is the adit shown by Granger and Raup (1962) in their figure 2, and site 162 covers the two "radioactive horses" shown in that figure.

Uranium mineralization appears to have been controlled by faulting, as were the other metals. However, the Pantano Formation contains uranium, indicating that at least part of the mineralization process, be it primary or secondary, is mid-Tertiary or younger. Autunite and uranophane are typically formed under near-surface conditions in the zone of ground-water circulation. These conditions probably were not developed until well after the time of thrust faulting, subsequent stock emplacement, and final thermal metamorphism. Such conditions date from the beginning of glide faulting in post-Pantano time. Uraniferous waters could have moved along faults to levels well below the level of active glide faults or thrust faults reactivated as glide faults.

GEOCHEMICAL INVESTIGATION

A reconnaissance geochemical survey was made of the wilderness study area in order to determine whether any parts of the area might be mineralized, and to provide information on introduced elements. One hundred twenty-two stream-sediment samples were collected from major drainages, and 43 rock-chip samples were taken from prospect pits in mineralized ground and from outcrops of granitic rocks. Both sample suites were spectrographically analyzed for 30 or 31 elements.

The minus 80-mesh portion of the stream-sediment samples was analyzed after being finely ground. The rock-chip samples were crushed to about 6 mm (0.25 in.), split through a Jones splitter, and ground to minus 150 mesh (0.1 mm) on ceramic plates in a vertical crusher in preparation for analysis.

The samples were analyzed by R. T. Hopkins and J. M. Motooka of the U. S. Geological Survey for 30 or 31 elements, using the semiquantitative emission spectrographic technique described in Grimes and Marranzino (1968). This technique identifies four common rock-forming elements in percent and the other elements in ppm (parts per million). These elements and their lower limits of detection are, in percent: iron, 0.05; magnesium, 0.02; calcium, 0.05; and titanium, 0.002; and in parts per million: manganese, 10; silver, 0.5; arsenic, 200; gold, 10; boron, 10; barium, 20; beryllium, 1; bismuth, 10; cadmium, 20; cobalt, 5; chromium, 10; copper, 5; lanthanum, 20; molybdenum, 5; niobium, 20; nickel, 5; lead, 10; antimony, 100; scandium, 5; tin, 10; strontium, 100; vanadium, 10; tungsten, 50; yttrium, 10; zinc, 200; zirconium, 10; and thorium, 100. Thorium was tested for in only some rock-chip samples. Many of these elements were too sparse to be detected; in other cases their abundance exceeds the lower limit of detection but is in the range of values typical of the unmineralized rocks of the Rincon Mountains and of stream-sediment samples derived from such unmineralized rocks. These analyses define background values. Tables 1 and 2 list only those values in stream-sediment and mineralized rock-chip samples that exceed background values sufficiently to be anomalous. Beneath each element in the tables is listed the lower limit of detection as described above, the common range of values, and the lower limit of what we judge to be anomalous values. Typically an anomalous value is two to three times the background value for each element, except for copper and molybdenum, for which a lesser increase may be significant in locating mineralized ground.

GEOCHEMISTRY OF STREAM-SEDIMENT SAMPLES

Analyses of stream sediments collected from the major drainages provide an overview of the rocks from which the sediments were derived. In principle, the composition of the stream sediments from a drainage area underlain by a single rock type gives a close approximation of the chemistry of that rock, allowing for modification chiefly by chemical weathering. Where the rock is not mineralized, the analyses of the sediments provide background values for the elements tested. In areas of extensive rock alteration, such as are not found in the Rincon Mountains, rocks may be enriched or impoverished in certain elements, resulting in either positive or negative geochemical anomalies. Where a stream drainage is underlain by more than one rock type, allowances must be made for the compositional variations and relative abundance of the different rocks. When substantial anomalies are detected through reconnaissance sampling, additional more closely spaced sampling is commonly needed to outline and evaluate the anomaly. Such follow-up collecting was not deemed necessary for this study.

Each of the stream-sediment samples consisted of about 0.75-1.0 kg (about 1-2 cups) of silt, in places admixed with some sand or clay, taken as a composite from several spots across the drainage. Where stream sediments contained some local concentration of dark minerals, commonly biotite or hornblende, efforts were made to take samples representative of the whole unit. Sediment rich in organic material was avoided. Samples were collected preferentially above, rather than below, the site of man's activity, such as roads, fences, windmills, or corrals. Where prospect pits occurred along drainages, samples were taken above the pits or no less than 0.5 km (about ⅓ mi) below the pit avoid possible local contamination. Finally, to avoid contamination by wi: dblown dust, the top layers at each collection spot were brushed aside.

In the Rincon Mountains wilderness study area, some anomalous amounts of beryllium, copper, manganese, molybdenum, lead, and silver were detected in the stream-sediment samples (table 1). The distribution of these samples and amounts of a particular anomalous element are shown in figures 4-9.

In most instances samples having anomalous values of an element are interspersed with samples containing only background values of that element; in a few small areas, however, samples with anomalous values are clustered. Where samples with anomalous values are widely scattered, the source of the element of concern probably comes from local sites of mineral enrichment, such as veinlets too small or dispersed to be easily located.

Anomalous copper values barely exceed the anomaly threshold of ≥100 ppm, being only 100 or 150 ppm (fig. 4). Most of the anomalous values are in the Italian Trap and Roble-Youtcy Canyon locales. The other locales each have only one or two anomalous samples.

Anomalous molybdenum values (fig. 5) range from 7 to 20 ppm; many of these samples are from the Italian Trap locale, some are from the Roble-Youtcy Canyon locale, and the other locales have only one or two samples containing anomalous amounts of molybdenum. Of the 26

TABLE 1.—*Semiquantitative spectrographic analyses of stream-sediment samples*

[Analysts: R. T. Hopkins and J. M. Motooka. Anomalous values taken at 2-3 × common range of values, except for Cu and Mo, for which a slightly lesser increase in values may be significant in locating mineralized ground. <, less than; ≥, equal to or greater than; leaders (- - -), element present in common range of values, as shown below]

Elements	Ag	Be	Cu	Mn	Mo	Pb
Lower limit of detection	0.5	1	10	10	5	10
Common range of values	<0.5	1.5-2	30-70	1,000-2,000	<5	50-70
Anomalous values	≥0.5	≥3	≥100	≥5,000	≥7	≥100
Sample No.						
102	---	---	---	---	---	150
103	---	---	---	---	7	---
109a	---	---	100	---	7	---
128	---	3	---	---	---	---
129	---	---	---	---	7	---
131	---	3	---	---	---	---
136	---	---	---	---	10	---
144	---	---	100	5,000	---	---
147	---	---	100	---	---	---
148	---	3	---	---	---	---
152	---	---	100	---	---	---
153	---	---	100	---	7	---
156	---	3	---	---	---	---
158	---	---	100	---	---	---
164	---	3	---	---	---	---
166	---	3	---	---	---	---
167	---	---	100	---	7	---
169	---	3	---	---	10	---
171	---	5	100	---	7	---
172	---	3	---	5,000	---	---
173	---	3	---	---	7	---
174	---	---	---	---	---	100
176	---	3	150	---	---	100
177	---	---	---	---	---	100
178	---	3	---	---	---	---
179	---	3	100	---	---	100
180	---	3	100	---	---	---
181	---	---	100	---	10	---
183	1.5	---	150	---	15	---
184	---	---	100	---	---	---

samples that contain anomalous amounts of molybdenum, 16 contain 7 ppm each or the lowest concentration given particular attention.

Copper and molybdenum are commonly associated in mining districts of southeastern Arizona, as well as in the Rincon Mountains wilderness study area, as shown in figure 6, particularly in the Italian Trap locale.

TABLE 1.—*Semiquantitative spectrographic analyses of stream-sediment samples*—Continued

Elements	Ag	Be	Cu	Mn	Mo	Pb
Lower limit of detection	0.5	1	10	10	5	10
Common range of values	<0.5	1.5-2	30-70	1,000-2,000	<5	50-70
Anomalous values	≥0.5	≥3	≥100	≥5,000	≥7	≥100
Sample No.						
185	---	---	150	---	---	---
186	---	3	100	---	---	---
188	---	3	---	---	---	100
189	---	---	---	---	---	100
192	---	---	150	---	---	100
193	---	---	---	---	---	100
194	---	---	100	---	7	---
195	---	---	150	---	20	100
196	---	---	100	---	---	100
197	---	---	---	---	7	100
198	---	---	---	---	15	---
199	---	---	150	---	15	---
200	---	---	100	---	7	---
203	---	---	150	---	15	100
204	---	---	---	---	7	---
206	---	---	---	---	7	---
207	---	---	---	---	7	---
208	---	---	---	---	---	100
210	---	---	---	---	15	---
211	---	---	---	---	7	---
214	---	---	150	---	10	100
216	---	---	100	---	7	---
219	---	---	100	---	---	---
220	---	---	100	---	---	---
221	---	---	---	---	7	---

Beryllium anomalies fall in the 3-5 ppm range (fig. 7) and are scattered in the Roble-Youtcy Canyon locale.

Lead anomalies are in the 100-150 ppm range (fig. 8) and occur mostly in the Italian Trap or northwestern part of the Roble-Youtcy Canyon locale.

One sample collected a short distance downstream from a silver-bearing prospect contains a barely anomalous amount of 1.5 ppm silver (fig. 9).

Two samples, Nos. 144 and 172, contain anomalous amounts of manganese, one each from the Happy Valley and Roble-Youtcy Canyon locales. No surface explanation for these concentrations is available.

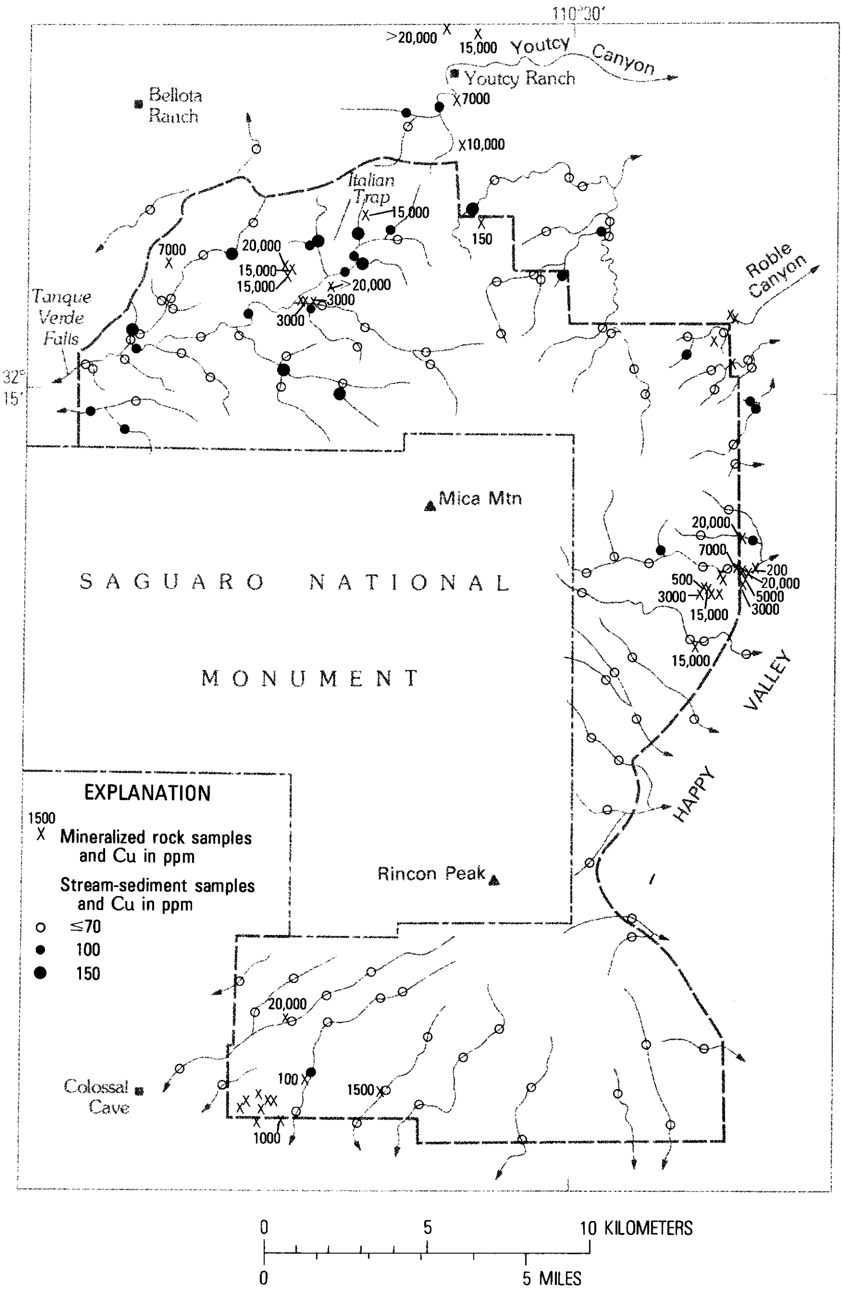


FIGURE 4.—Distribution of copper in stream-sediment and mineralized rock samples.

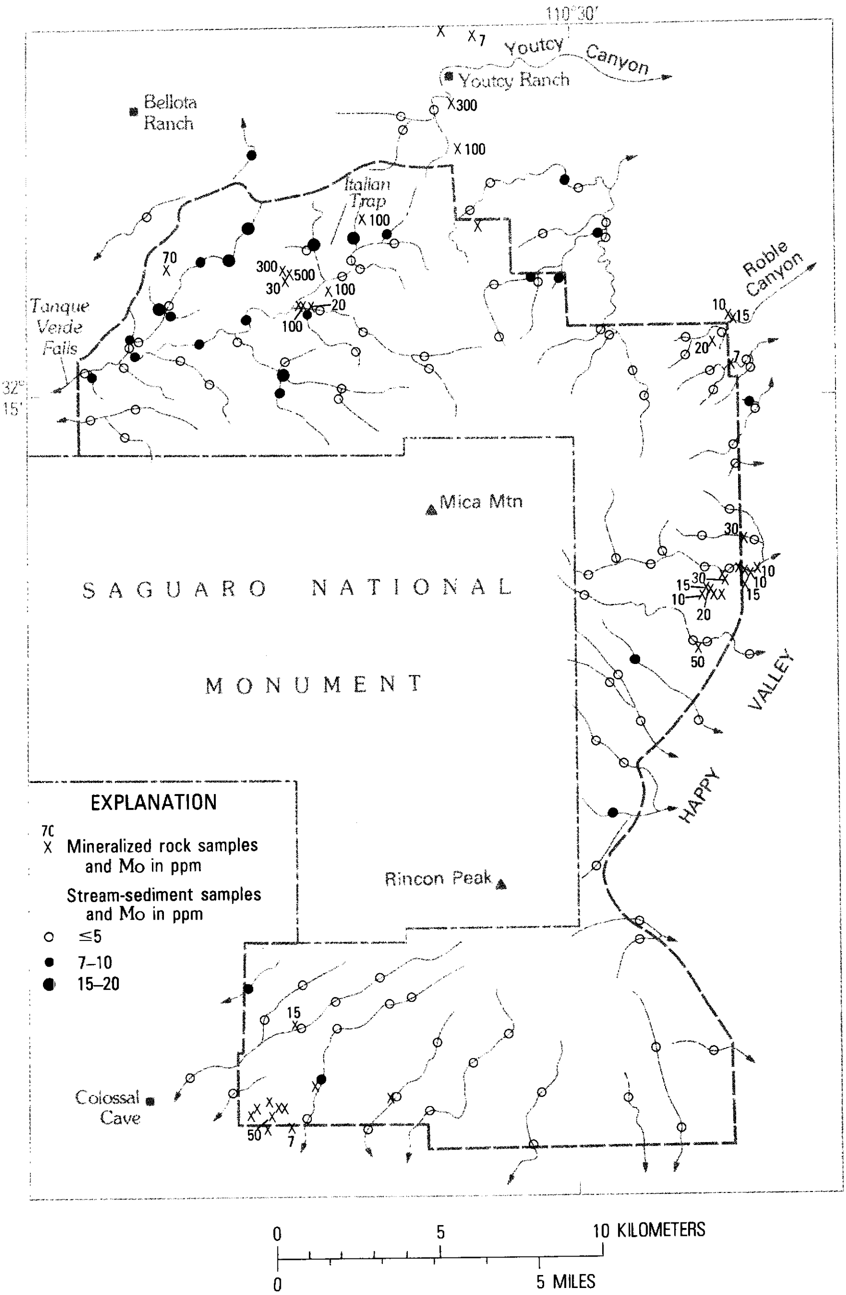


FIGURE 5.—Distribution of molybdenum in stream-sediment and mineralized rock samples.

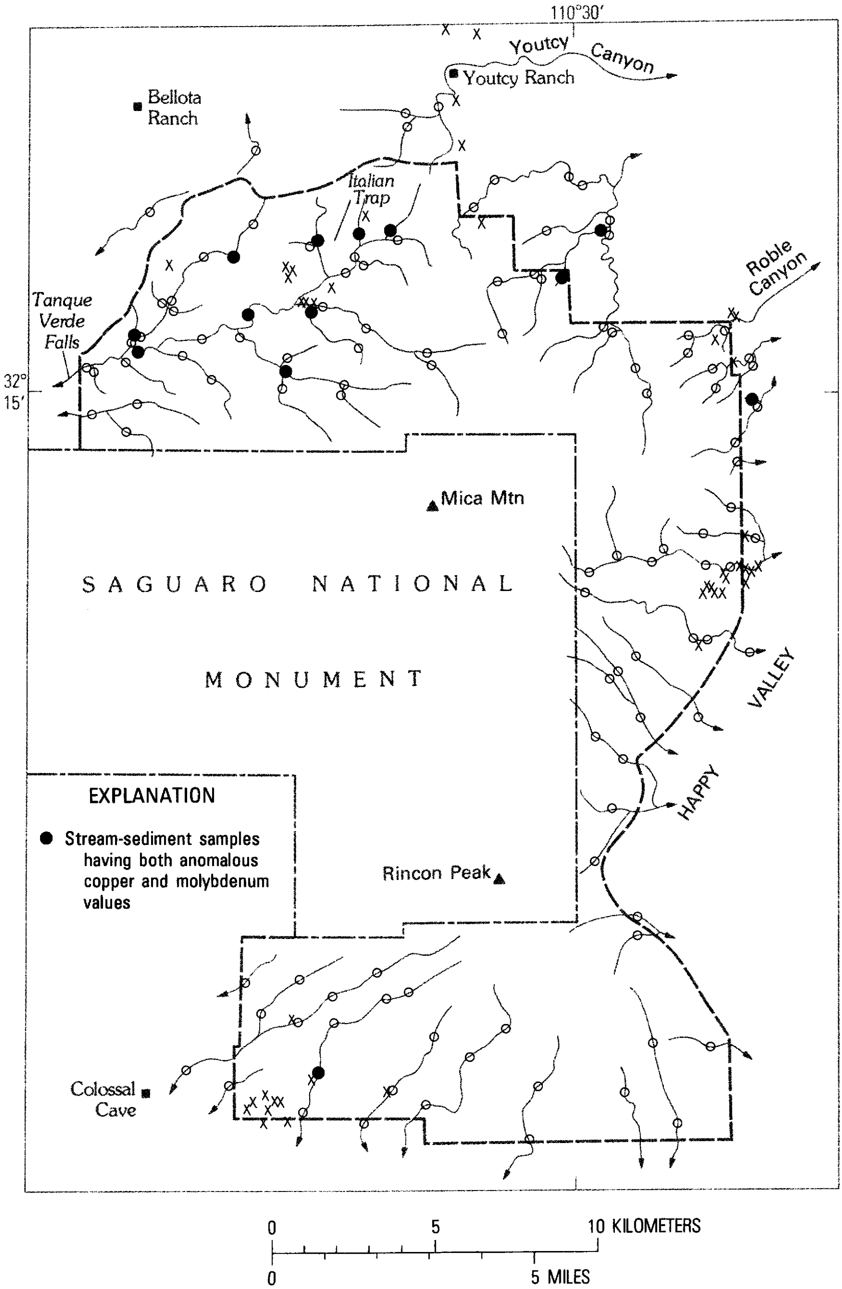


FIGURE 6.—Distribution of stream-sediment samples (solid circles) that have both anomalous copper and molybdenum values.

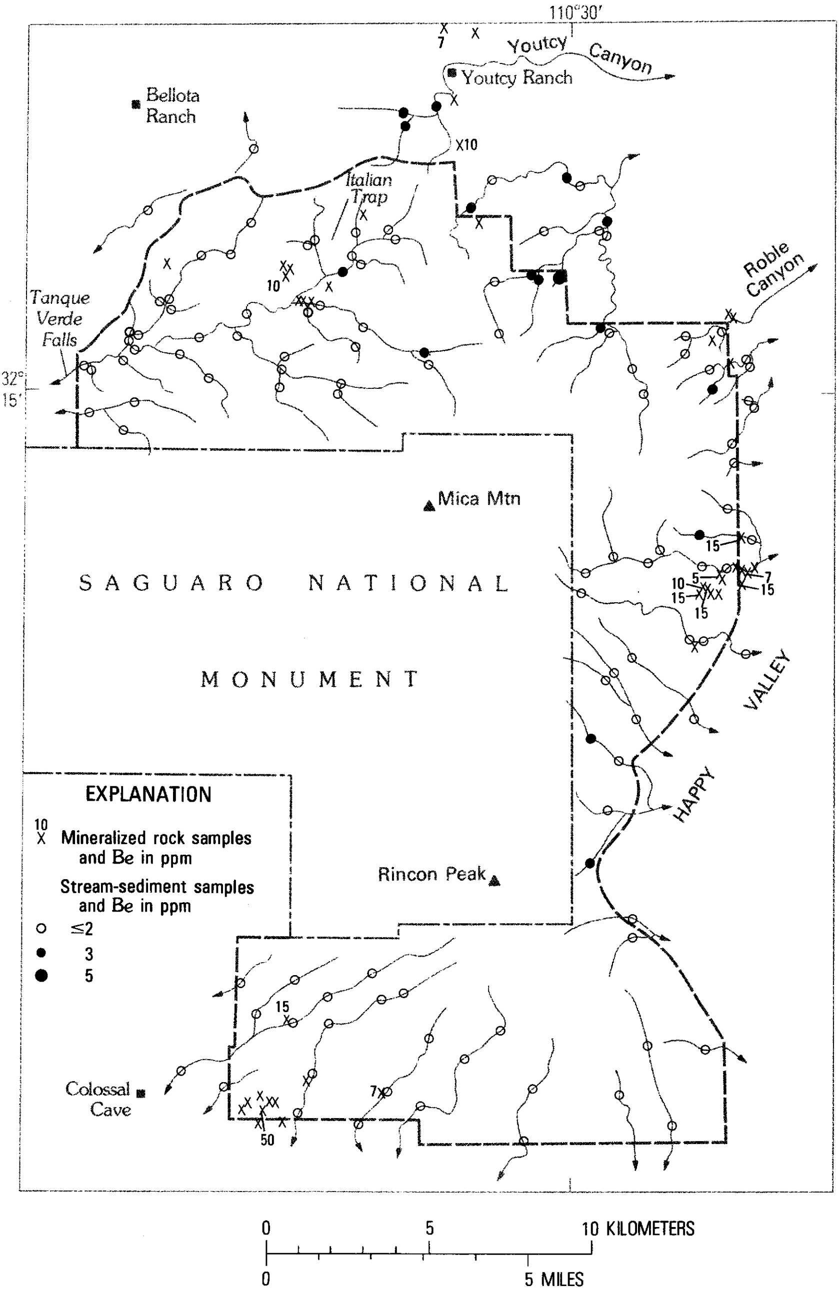


FIGURE 7.—Distribution of beryllium in stream-sediment and mineralized rock samples.

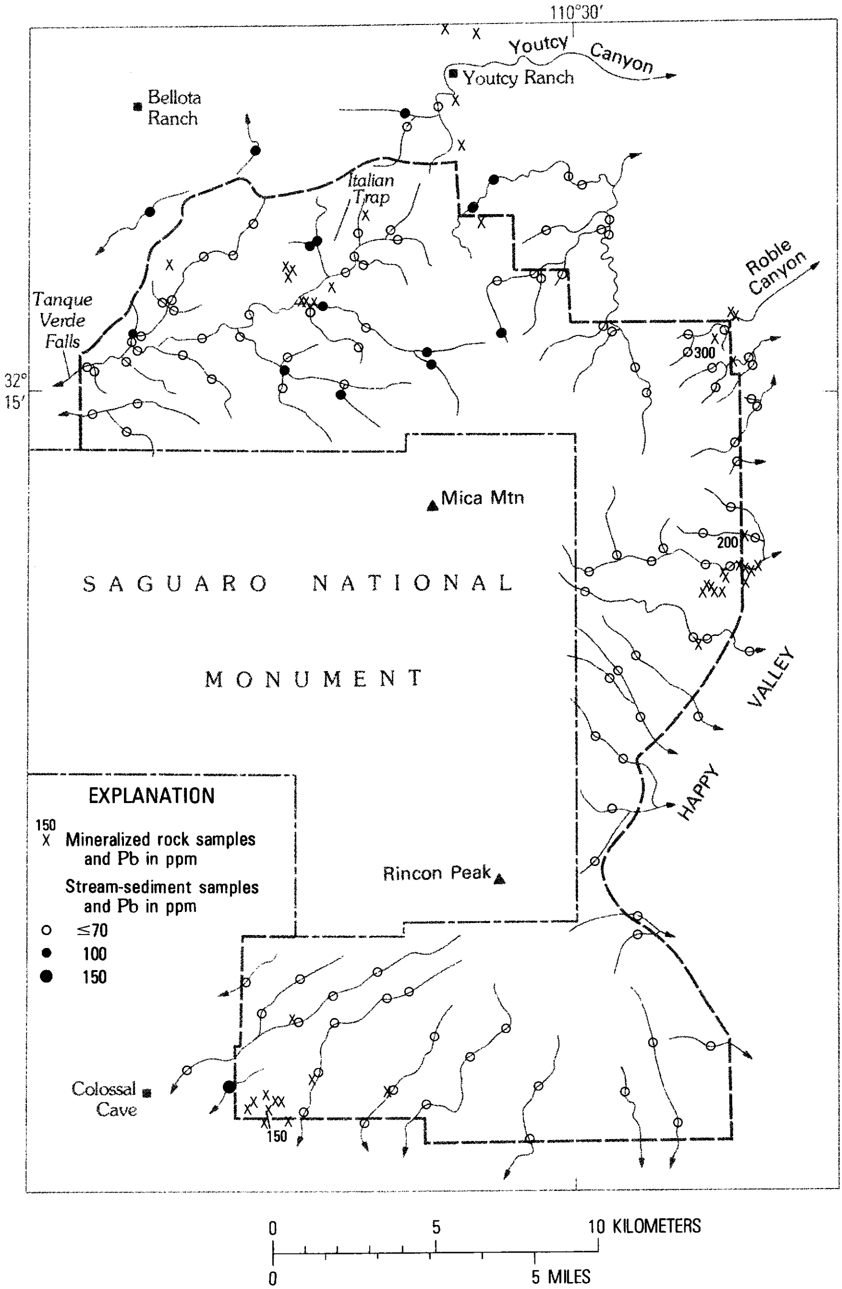


FIGURE 8.—Distribution of lead in stream-sediment and mineralized rock samples.

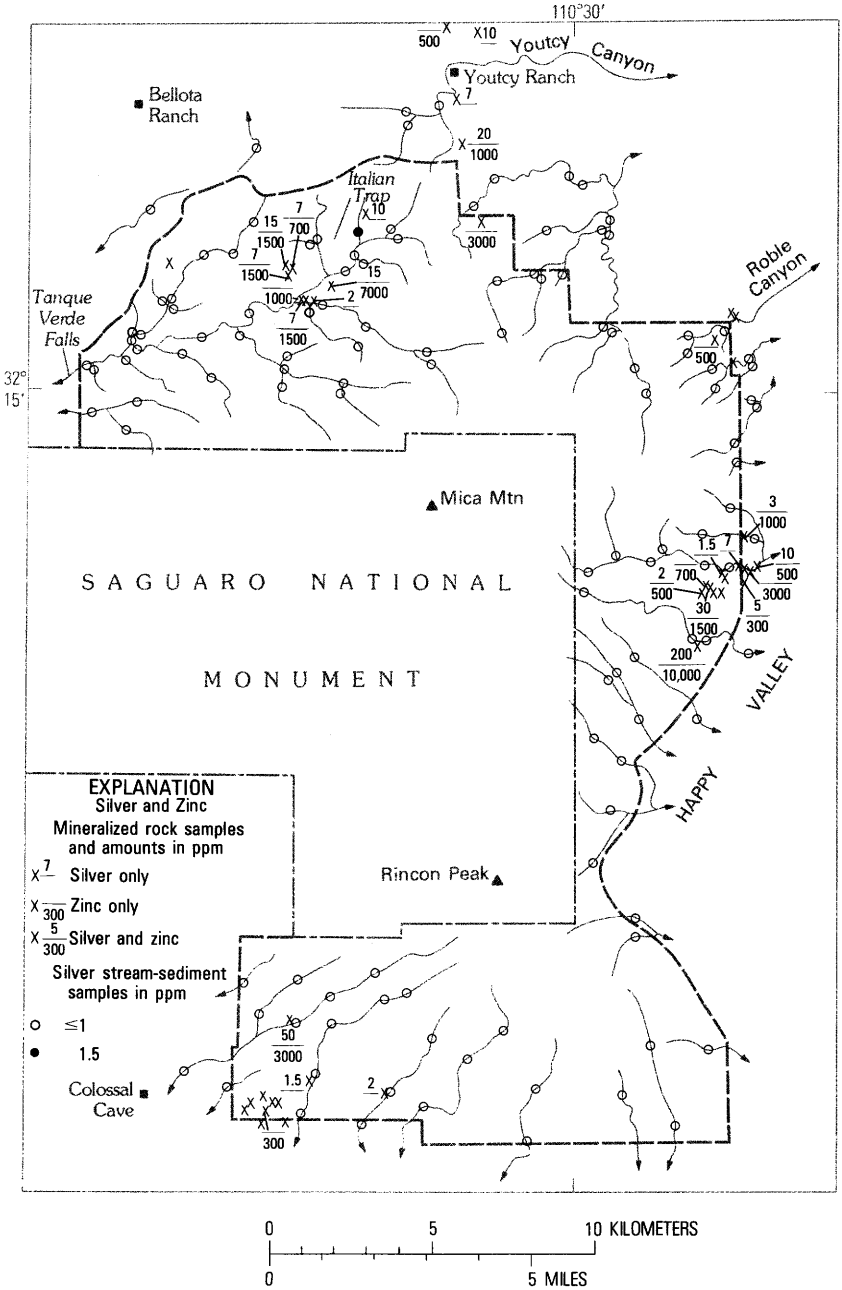


FIGURE 9.—Distribution of silver and zinc in stream-sediment and mineralized rock samples.

Many of the samples with anomalous amounts of copper, molybdenum, beryllium, and lead occur near the clusters of prospect pits in the Italian Trap locale. Some samples also come from the Roble-Youtcy Canyon locale. The Colossal Cave and Happy Valley locales are not identified by stream-sediment anomalies.

GEOCHEMISTRY OF MINERALIZED ROCK-CHIP SAMPLES

Analysis of rock-chip samples collected from mineralized ground gives a basis for determining the elements that were introduced during mineralization. Significant elements may be economically interesting, such as gold or silver; or as in the case of arsenic, antimony, or bismuth, they may be indicators of a nearby occurrence of economic deposits of other metals.

Typically a suite of 5-10 chips of mineralized rock and gossan, each chip a few centimeters across and the total weighing up to about 1 kg (2.2 pounds), was collected from a prospect, from its dump, and also from an adjacent area within about 10 m (30 ft) of the prospect where visible mineralization was found. Where the workings were inaccessible, only the dump was sampled, and in a few places samples were collected from mineralized ground where no workings were found. A deliberate effort was made to include a variety of rock types, rather than only ore minerals, but ore minerals were included even if sparse.

Anomalous concentrations of 13 elements were detected in 34 of the 40 rock-chip samples (table 2). Anomalous concentrations of 7-9 elements appeared in 5 of these samples and of 2-6 elements in another 27 of these samples. Copper and molybdenum occur in anomalous amounts in 27 or more of the samples, and silver and zinc in 20 or more of them.

Copper concentrations that range from 100 to more than 20,000 ppm were detected in each of the slightly mineralized locales (fig. 4). Copper occurs in most of the prospects in the Italian Trap and Happy Valley locales and in the northwestern part of the Roble-Youtcy Canyon locale, but is found in less than half of the prospects of the other locales. The wide range in values is in part due to sampling procedures and is of relatively little significance.

Molybdenum in concentrations of 7-500 ppm is uniformly disseminated in the mineralized locales (fig. 5). Consistently higher concentrations (70 ppm or more) are found near Italian Trap and Youtcy Canyon than in the other areas.

Silver concentrations of 1.5-15 ppm are fairly randomly distributed in prospects of the four locales (fig. 9). Sample 308 from the Colossal Cave locale contains as much as 50 ppm, and samples 311 and 314 from the

Happy Valley locale have 200 and 30 ppm, respectively, and are associated with anomalous concentrations of other metals (table 2).

Anomalous zinc values range from 300 to 10,000 ppm and occur less widely dispersed in the four locales than copper, molybdenum, or silver. The highest values of zinc are from a few sites near Italian Trap and from sample 311 in Happy Valley (fig. 9).

Beryllium concentrations range from 5 to 15 ppm, with one sample having 50 ppm. Half of the sites of anomalous concentrations of beryllium are in the Happy Valley locale and the others are uniformly dispersed in the other locales. A slightly higher concentration of beryllium in rocks than in stream-sediment samples (5 instead of 3 ppm) may be of significance because most rocks contain 3 ppm or more in this area and there is an apparent loss of detected beryllium in corresponding alluvium.

Anomalous amounts of tungsten (70-300 ppm) occur chiefly in Happy Valley and at two prospects near Colossal Cave (fig. 10). Tin, lead, and cadmium are present in anomalous amounts in only a few scattered samples. Arsenic occurs at three sites in Roble Canyon, where it is associated in two of the sites that also contain anomalous concentrations of antimony. Most of the samples containing high values of bismuth and manganese are from Happy Valley.

POTENTIAL FOR MINERAL RESOURCES

The potential for economic deposits of metallic minerals, fuels, and nonmetallic materials from the Rincon wilderness study area is considered to be very low. This assessment is based on the combined results of direct observation in the field, placed in regional perspective, and the geochemical reconnaissance investigation of the study area. The known areas of anomalous concentrations of metals are small, the degree of concentration of metals weak and generally erratic, and the controlling factors of those mineral concentrations are mostly of a kind that suggest exploration targets either to be of very limited extent or to lie outside the study area. Only the Italian Trap locale lies wholly within the study area; the others lie on the borders of the area, and the Roble-Youtcy Canyon locale is almost entirely outside the area. The surface signs of mineralization are largely restricted to four locales in which only a few prospects and small exploratory mines exist. Very little primary sulfide mineralization is present, and rock alteration is absent or restricted to narrow zones along faults and fractures. All told, the geochemical anomalies are weak and their geologic setting and restricted occurrences along and near low-angle thrust faults suggest that they are not indicative of major hidden mineral deposits. The sites at which some high values of copper, molybdenum, or silver were ob-

TABLE 2.—*Semiquantitative spectrographic*

[Analysts: R. T. Hopkins and J. M. Motooka. Common range of values obtained from unmineralized rock samples and crease in values may be significant in locating mineralized ground. <, less than; >, greater than; ≥, equal to or greater tions of copper (Lovering and others, 1970; Banks, 1974). Leaders (- - -), element present in common range of values, as

Elements	Ag	As	Be	Bi	Cd
Lower limit of detection	0.5	200	1	10	20
Common range of values	0.5-0.7	<200	1.5-2	<10-10	<20-20
Anomalous values	≥1.5	≥300	≥5	≥30	≥50
Sample No.					
304	---	---	50	---	---
307	---	---	---	---	---
308	50	---	15	50	50
309	1.5	---	---	---	---
310	2	---	7	---	---
311	200	---	---	30	---
312	2	---	15	100	---
313	---	---	10	---	---
314	30	---	15	---	---
315	5	---	15	100	---
316	---	---	---	---	---
317	---	---	---	---	---
318	1.5	---	5	---	---
319	7	---	---	100	---
320	10	---	7	---	---
321	3	---	15	150	---
322	---	---	---	---	---
323	---	1,500	---	---	---
324	---	3,000	---	---	---
325	---	2,000	---	---	---
326	---	---	---	---	---
327	20	---	10	---	---
328	7	---	---	---	---
329	10	---	---	---	---
330	---	---	7	---	---
331	10	---	---	---	---
332	15	---	---	---	---
333	2	---	---	---	---
334	7	---	---	---	---
335	---	---	---	---	---
336	7	---	10	---	50
337	7	---	---	---	---
338	15	---	---	---	---
339	7	---	---	---	---
343	---	---	---	---	---

analyses of mineralized rock samples, in ppm

alluvium. Anomalous values taken at 2-3 × common range of values except for Cu and Mo, for which a slightly lesser in-
than; ≤, equal to or less than. Sample 343 collected as unmineralized rock, some of which contains moderate concentra-
shown below]

Cu	Mn	Mo	Pb	Sb	Sn	W	Zn
5	10	5	10	100	10	50	200
30-70	500-2,000	<5	10-50	<100	<10	<50	<200?
≥100	≥5,000	≥7	≥100	≥100	≥20	≥70	≥300
---	---	50	150	100	---	150	300
1,000	5,000	7	---	---	---	---	---
20,000	>5,000	15	---	---	---	300	3,000
100	---	---	---	---	---	---	---
1,500	---	---	---	---	---	---	---
15,000	5,000	50	---	---	---	---	10,000
3,000	---	10	---	---	100	70	500
500	>5,000	15	---	---	---	---	700
15,000	---	20	---	---	---	---	1,500
3,000	>5,000	15	---	---	---	70	300
5,000	---	10	---	---	---	---	---
200	---	---	---	---	---	---	300
1,500	---	30	---	---	---	---	---
7,000	---	---	---	---	---	---	---
20,000	---	10	---	---	---	100	500
20,000	---	30	200	---	---	70	1,000
---	---	7	---	---	---	---	---
---	---	20	300	300	---	---	500
---	---	15	---	300	---	---	---
---	---	10	---	---	---	---	---
150	>5,000	---	---	---	---	---	3,000
10,000	>5,000	100	---	---	20	---	1,000
7,000	---	300	---	---	---	---	---
15,000	---	7	---	---	---	---	---
>20,000	---	---	---	---	---	---	500
15,000	---	100	---	---	---	---	---
>20,000	5,000	100	---	---	20	---	7,000
3,000	---	20	---	---	---	---	---
3,000	---	100	---	---	---	---	1,500
---	---	---	---	---	---	---	1,000
15,000	---	30	---	---	---	---	1,500
15,000	---	500	---	---	---	---	700
>20,000	---	300	---	---	---	---	1,500
7,000	---	70	---	---	---	---	---
150	---	---	---	---	---	---	---

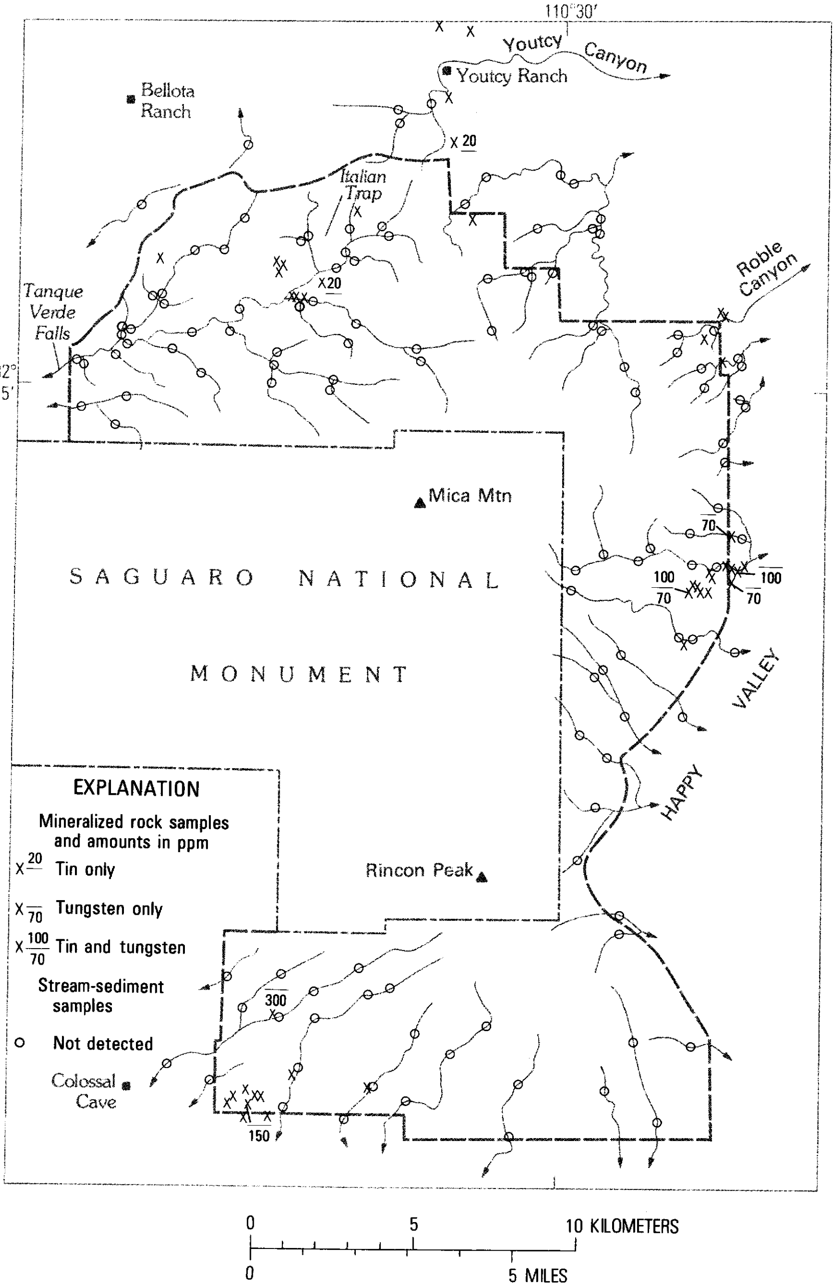


FIGURE 10.—Distribution of mineralized rock samples showing amounts of tin and tungsten ≥20 and 70 ppm, respectively.

tained are very small, mostly scattered within the locales, and are seen to be mainly controlled by faults. These structures are part of a nearly flat lying system at Italian Trap. At the other locales these structures strike and dip away from the study area. Projections of potentially mineralized ground are thus restricted in depth or lie chiefly outside the study area.

The likelihood of discovering economic deposits of fuels in the study area is also remote. The abundant granitic rocks of the core area and the intense faulting of the cover rocks leave the study area with a situation completely unfavorable for oil and gas accumulation, and the late thermal activity further reduces the chances for the preservation of such accumulations. The clastic rocks of Cretaceous age in which coal deposits could conceivably be found are not known in the Rincon Mountains.

Uranium mineralization is known 2-3 km (1-2 mi) northeast of the study area, but such deposits are unlikely to occur within the study area. These deposits occur along or close to low-angle faults that strike and dip away from the northeast border of the study area; therefore, even should a minable deposit be found, it would extend away from the study area. This mineralization is thought to be late Tertiary or Quaternary and related to mineral-bearing waters circulating near the surface, a condition most compatible with the upper cover rocks that occur mainly outside the study area away from the gneissic dome.

The geothermal potential of the study area is considered to be low. Neither existing hot springs nor deposits of past hot springs are known within or near the Rincon Mountains. The youngest volcanic rocks are probably too old and too sparse to be viewed as encouraging signs of available heat at shallow depths.

Nonmetallic mineral resources, while present, occur in locations too remote to be competitive, and are too small to be economically attractive. Sand and gravel are present along the main drainages, but similar deposits occur in vastly greater abundance closer to places where they are needed. A clay that may be suitable for brick making and small amounts of gypsum are known in the Pantano Formation several kilometers northeast of the study area, but the rocks strike and dip away from the study area. Marble present in some of the metamorphosed cover rocks is too impure and too much faulted to be attractive building material, and is too remote from markets to be a likely source of roofing material. Because of the strong internal structures—the foliation and lineation—it is also unlikely that the granitic rocks of the core would be suitable for building stone. Although carbonate rocks are present, limestone suitable for cement rock is also not likely to be found in economic quantity within the Rincon wilderness study area.

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Mines, Prospects, and Mineralized Areas of the Pima County, Arizona Rincon Wilderness Study Area,

By MICHAEL E. LANE, U.S. BUREAU of MINES

MINERAL RESOURCES OF THE RINCON WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA

GEOLOGICAL SURVEY BULLETIN 1500-B

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MINES, PROSPECTS, AND MINERALIZED AREAS OF THE RINCON WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA

By MICHAEL E. LANE, U.S. BUREAU of MINES

INTRODUCTION

The U.S. Bureau of Mines conducted a mineral survey in 1977 of the Rincon wilderness study area, Pima County, Ariz. (pl. 2). The study area, consisting of 25,466 ha (62,900 acres) in the Coronado National Forest, is under consideration by the U.S. Forest Service for inclusion in the National Wilderness Preservation System. It is located on the north, east, and south flanks of the Rincon Mountains, 32 km (20 mi) east of Tucson and 30 km (18 mi) northwest of Benson, Ariz. The study area includes part of the east end of the Saguaro National Monument.

Prior to the field investigation, I reviewed literature pertinent to the study area and examined U.S. Bureau of Land Management records for information about patented mining claims and Federal mineral leases, which reveals no patented mining claims or Federal mineral leases in the study area at the time of the investigation. Also, I checked courthouse records of Pima and Cochise Counties to determine locations of unpatented claims. About 200 unpatented mining claims are recorded that may have been located in or near the study area. However, most of the descriptions of these claims were vague and their exact locations could not be determined. Those claims with adequate descriptions are shown on plate 2. The records of the U.S. Bureau of Mines show no mineral production from within the study area.

During the field investigation all known mines, prospect workings, and mineralized areas in or near the Rincon study area were examined. A general reconnaissance was made of the study area and a peripheral zone. Previously unknown prospects and mineralized areas found were also examined. A total of 108 samples, including 8 stream-sediment samples, were collected during the field investigation. The eight stream-sediment samples were taken in drainages, and the other samples were taken from mineralized veins, zones, outcrops, and dumps at mines and prospect workings. All the samples were analyzed spectrographically for 42 elements and fire-assayed for gold and silver (table 3). Some samples were further analyzed for specific elements or chemical compounds by other analytical methods. Those samples with anomalous and significant values are discussed later.

ACKNOWLEDGMENTS

The fieldwork, done in 1977, was assisted by J. Gersic, J. Brown, and R. C. Smith of the U.S. Bureau of Mines, and by R. Pickard and P. Mesard, who were part-time student employees. The cooperation and assistance of officials of the U.S. Forest Service, Bureau of Land Management, and Pima and Cochise Counties are gratefully acknowledged. Stan Keith of the Arizona Bureau of Mines and A. K. Doss and John Kellogg of the Arizona State Land Department contributed valuable information about mineral activity. I greatly appreciate the cooperation of local residents, especially Ollie Barney, Lloyd Clopton, and Mrs. J. Lewis, who have permitted access through their property to the study area and provided information about location of prospects.

MINING HISTORY AND PRODUCTION

The Rincon study area contains no mines that have had any known production. Most of the mining activity has been limited to small workings such as pits and short adits of exploratory nature; however, small amounts of high-grade ore may have been packed out and not recorded.

Some minor production has come out of the Blue Rock property, about 2.4 km (1.5 mi) northeast of the wilderness study area.[1] In 1956, 58 tons (52.7 t) of uranium ore reportedly were shipped to Cutter, Ariz., by the Tucson Uranium Company. In 1977, 102 tons (92.5 t) of uranium ore were shipped to Canon City, Colo., by Nuclear Energy Ltd. from the same property.

MINES, PROSPECTS, AND MINERALIZED AREAS

COLOSSAL CAVE LOCALITY

Eleven small prospects were examined in the southwest corner of the study area approximately midway between Colossal Cave and Hidden

[1]Production figures are reported here primarily in the units in which production was originally measured, and then converted to a metric equivalent.

Spring in secs. 1, 2, 10, and 12, T. 16 S., R. 17 E. (pl. 2, samples 1-11). The prospects are in Paleozoic sedimentary rocks and Precambrian quartz monzonite (Wrong Mountain Quartz Monzonite). The major limestone unit is Horquilla Limestone with Escabrosa Limestone and the Martin Formation occurring as fault blocks.

One select and two grab samples collected from the dumps at prospect pits in the Horquilla Limestone (samples 5, 6) and in the Wrong Mountain Quartz Monzonite (sample 9) contained relatively high silver and copper values. Grab sample 5 assayed 2.7 troy oz silver (93 g/t) and a trace of gold per ton. [2] Select sample 6 assayed 0.1 oz silver per ton (3.4 g/t) and 5.9 percent copper. Grab sample 9 contained 0.7 oz silver (24 g/t) and a trace of gold per ton and 0.7 percent copper. No mineralized structures are exposed in the pits, but malachite and chalcopyrite are visible in the dump at sample site 6.

Near the east edge of sec. 34, T. 15 S., R. 17 E., the dump of a caved prospect pit contains silicified shear-zone material in quartz monzonite. The material sampled was fine-grained, limonite-stained, highly altered rock including crystalline epidote, copper mineralization, and lesser amounts of pyrite and garnet. Grab sample 12 collected from the dump contained 2.6 percent copper, 2.4 oz silver (82 g/t) and a trace of gold per ton. Excessive cover prevented delineation of the zone.

The Heavy Boy workings consisting of an inaccessible adit and some pits dug in the hillside, are about 0.8 km (½ mi) southeast of Colossal Cave and 2.4 km (1.5 mi) west of the study area in the NE¼ sec. 8, T. 16 S., R. 17 E. According to Stewart and Pfister (1960), major exploration work had been confined to a brecciated, barite-bearing fault zone in Paleozoic limestone. Sample 13, taken from stockpiled material, contained 54.1 percent barium. The fault zone was not visible for mapping and in-place sampling.

HAPPY VALLEY LOCALE

BEAR CREEK

Several small pits and trenches clustered mainly in the south half of sec. 25, T. 14 S., R. 18 E. along Bear Creek were excavated in the Rincon Valley Granodiorite and the Horquilla Limestone, both associated with small outcrops of the Martin Formation. Marbleization and epidotization have occurred in the Horquilla Limestone, indicating limited metamorphism. Six chip samples (16-19, 21 and 22) taken at the prospects assayed from 1.7 to 5.8 percent copper and from 0.3 to 2.1 troy oz silver per ton (10-72 g/t). Three of the six contained lead and cobalt values of interest (table 4). No continuity of structure was observed along or between the workings.

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[2] Assay values in this section are reported primarily in the inch-pound units in which originally computed, and then converted to metric equivalent.

TABLE 3.—*Analyses of samples from localities in and near the Rincon study area, Arizona.*

[Fire assays, semiquantitative spectrographic, and atomic absorption analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. In addition to the elements in the table, some samples showed values of the following elements and are listed following the table: As, B, Ba, Bi, Cd, Co, La, Nb, P, Sb, Sc, Sn, Te, W. The following elements were detected but not considered significant and are not listed: Al, Ca, Fe, Ga, Li, Mg, Mn, Na, Si, Ti. Elements not found above the detection limits: Be, K, Pd, Re, Ta, Ti. Asterisk (*), additional data given by sample number at end of table; Tr, trace amount; leaders (--), not detected; <, less than amount shown; >, greater than amount shown; ( ), values in percent by other analyses. Assay values for Au and Ag in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample No.	Fire assay (oz/ton)		Semiquantitative spectrographic analyses, in percent										Remarks on provenance and collection of samples
	Au	Ag	Cr	Cu	Mo	Ni	Pb	Sr	V	Y	Zn	Zr	
1	Tr	--	<0.001	<0.001	<0.002	<0.001	<0.03	0.005	<0.001	<0.005	<0.001	<0.001	Pit-dump-grab, 1.5-m (5-ft) grid.
2	--	--	<.001	< .001	<.002	<.001	<.03	.009	<.001	<.005	<.001	<.001	Pit-dump-grab, 0.9-m (4-ft) grid.
3	--	0.1	<.001	< .001	<.002	<.001	<.03	<.001	<.001	<.005	<.001	<.001	Pit-chip, 61 cm (24 in.).
* 4	--	Tr	<.001	< .001	<.002	<.001	<.03	<.001	<.001	<.005	<.001	<.001	Do.
5	Tr	2.7	.002	< .001	<.002	<.001	<.03	<.001	<.001	<.005	<.001	<.001	Pit-dump-grab-random.
* 6	--	.1	.001	4	<.002	<.001	<.03	<.001	<.001	.005	.05	.001	Pit-dump-select.
7	Tr	.1	.001	< .001	<.002	<.001	<.03	.002	.001	.005	.001	.001	Pit-dump-grab, 1.8-m (6-ft) grid.
* 8	Tr	.1	<.001	< .001	<.002	<.001	<.03	.02	<.001	<.005	.008	<.002	Shaft-dump-grab, 0.6-m (2-ft) grid.
* 9	Tr	.7	<.001	.7	<.002	<.001	<.03	.02	<.001	<.005	.01	<.002	Pit-dump-grab-random.
* 10	Tr	Tr	<.001	< .001	<.002	<.001	<.03	.009	<.001	<.005	<.001	<.002	Adit-dump-grab 0.9-m (3-ft) grid.
* 11	--	.1	<.001	< .001	<.002	<.001	<.03	.03	<.001	<.005	.01	<.002	Pit-dump-select.
* 12	Tr	2.4	<.001	.3	<.002	<.001	<.03	<.001	<.001	<.005	.2	<.002	Pit-select.
* 13	Tr	.1	<.001	.001	<.002	<.001	<.07	2	<.001	<.005	<.001	<.001	Adit-dump-select.
14	Tr	--	<.001	.001	<.002	<.001	<.03	<.001	<.001	<.005	.001	.02	Outcrop-chip 0.9 m (3 ft).
* 15	Tr	--	.001	.2	<.002	.02	.7	<.001	<.001	<.005	<.001	<.002	Outcrop-select.
* 16	--	.2	.005	>1.0	.001	.002	.011	.001	.005	.02	>1.0	<.002	Pit-chip, 46 cm (18 in.) long.
* 17	--	.7	.004	>1.0	.001	.002	<.008	.002	.005	.020	.016	<.002	Pit-chip, 31 cm (12 in.).
* 18	--	1.7	.005	>1.0	.003	.008	.25	.003	.006	.023	>1.0	<.002	Pit-chip, 61 cm (24 in.).
* 19	--	1.0	.004	>1.0	.002	.009	.11	.012	<.004	.009	.59	<.002	Trench-chip, 46 cm (18 in.).
20	--	.02	.005	.75	<.001	.003	<.008	.004	<.004	.007	.01	.003	Pit-chip, 46 cm (18 in.).
* 21	--	2.1	.004	>1.0	.002	.009	<.008	.003	.008	.011	.07	.003	Trench-chip, 53 cm (21 in.).

* 22	--	.03	<.005	>1.0	.002	.009	<.008	.006	.004	.020	.11	.011	Pit-chip, 46 cm (18 in.).
23	--	.2	.005	.056	.001	.004	<.008	.001	<.004	.013	.003	<.002	Pit-chip, 61 cm (24 in.).
* 24	--	.6	.004	>1.0	.005	.02	<.008	<.001	.005	.029	.039	.009	Adit-dump-select.
25	--	.2	.004	.33	.002	.002	<.008	.002	.005	.021	.019	<.002	Pit-chip, 46 cm (18 in.).
26	--	.1	<.002	.005	<.001	<.002	.02	.005	<.004	<.007	.003	<.002	Pit-dump-grab, 0.6-m (2-ft) grid.
* 27	--	.1	.004	>1.0	.002	.003	<.008	.002	.005	.026	.13	<.002	Adit-chip, 46 cm (18 in.).
28	Tr	--	<.001	< .001	<.002	<.001	<.03	.006	<.001	<.005	<.001	<.001	Outcrop-select.
29	--	.1	.008	.063	<.001	.003	<.008	.003	<.004	<.007	.005	.005	Trench-chip, 46 cm (18 in.).
30	--	.1	.009	.011	<.001	.004	<.008	.003	<.004	<.007	.003	.008	Trench-select.
31	--	.2	.003	.044	<.001	<.002	<.008	.003	<.004	.010	<.001	<.002	Trench-dump-grab-random.
32	--	Tr	<.002	.018	<.001	<.002	<.008	.002	<.004	<.007	<.001	<.002	Adit-chip, 1.2 m (4 ft).
* 33	Tr	Tr	.008	>1.0	.004	.019	<.008	.026	.008	.037	.021	.004	Adit-dump-select.
34	Tr	--	<.001	.4	<.002	.001	<.03	.01	<.001	<.005	<.001	<.001	Shaft-dump-grab, 1.8-m (6-ft) grid.
* 35	Tr	--	<.001	< .09	<.009	.002	<.03	.005	.009	<.005	.05	<.001	Do.
* 36	Tr	.2	<.002	>1.0	<.001	<.002	<.008	<.001	.004	.009	.011	<.002	Adit-chip, 31 cm (12 in.).
* 37	Tr	.2	.016	>1.0	.004	.023	.010	.003	.008	.021	.024	.013	Do.
38	--	.1	.002	.070	.001	<.002	.008	.003	<.004	.012	.003	.002	Adit-chip, 0.8 m (2.5 ft).
* 39	--	.1	.002	.054	.002	<.002	.008	.006	.009	.008	.003	.014	Pit-chip, 0.8 m (2.5 ft).
* 40	Tr	.4	.006	>1.0	.001	.007	<.008	.002	.006	.021	.011	.006	Adit-chip, 1.2 m (4 ft).
* 41	--	--	<.001	< .001	<.002	<.001	<.03	.01	<.001	<.005	<.001	<.001	Pit-dump-grab, 1.8-m (6-ft) grid.
42	--	.1	<.002	.084	<.001	<.002	<.008	.002	<.004	<.007	.005	<.002	Adit-dump-grab, 0.6-m (2-ft) grid.
* 43	--	.1	<.002	>1.0	<.001	<.002	<.008	.003	<.004	<.004	<.001	<.002	Adit-chip, 1.4 m (4.5 ft).
44	--	.1	.004	.010	<.001	<.002	<.008	.002	<.004	<.007	.025	<.002	Adit-chip, 1.7 m (5.5 ft).
* 45	Tr	--	<.002	5	<.004	<.002	<.04	<.001	<.007	<.007	<.05	<.003	Pit-chip, 15 cm (6 in.).
46	Tr	--	.01	< .09	<.004	<.006	<.04	<.001	.007	<.007	<.001	<.005	Pit-dump-select.
47	Tr	--	<.001	< .001	<.002	<.001	<.03	.003	<.001	<.005	<.001	<.001	Outcrop-select.
48	--	--	.010	.048	.001	.003	<.008	.004	.004	.010	.006	.013	Adit-chip, 61 cm (24 in.).
49	--	Tr	.006	.26	.001	.003	<.008	.004	.007	.021	.021	<.002	Adit-chip, 76 cm (30 in.).
50	--	.3	.006	.13	.001	.003	<.008	.003	.007	.016	.010	.005	Adit-chip, 46 cm (18 in.).
51	--	.2	.003	.066	.001	<.002	<.008	<.001	<.004	.013	.006	<.002	Adit-chip, 38 cm (15 in.).
* 52	Tr	--	<.001	>1.0	.002	<.001	<.008	.001	.008	.028	.04	<.020	Adit-chip, 61 cm (24 in.).
* 53	Tr	--	.005	>1.0	.003	.012	.064	<.001	.011	.027	.047	.007	Adit-chip, 1.1 m (3.5 ft).
* 54	Tr	--	.006	>1.0	.002	.004	.013	<.001	.007	.026	.028	<.002	Adit-chip, 1.2 m (4 ft).
* 55	Tr	--	.007	>1.0	.003	.008	.021	<.001	.009	.034	.042	<.002	Adit-chip, 0.8 m (2.5 ft).
* 56	Tr	--	<.002	>1.0	.001	<.002	<.008	.035	<.004	.010	<.001	<.002	Shaft-dump-grab-random.
* 57	Tr	.1	.004	.61	.002	.003	<.008	.001	.004	.022	.003	.007	Pit-chip, 31 cm (12 in.).
* 58	Tr	--	<.002	1.0	.002	<.002	<.008	.003	<.004	<.007	.005	<.002	Adit-chip, 31 cm (12 in.).

TABLE 3.—*Analyses of samples from localities in and near the Rincon study area, Arizona*—Continued

Sample No.	Fire assay (oz/ton)		Semiquantitative spectrographic analyses, in percent										Remarks on provenance and collection of samples
	Au	Ag	Cr	Cu	Mo	Ni	Pb	Sr	V	Y	Zn	Zr	
* 59	--	--	.003	>1.0	.003	.013	<.008	.003	<.004	.026	.011	.002	Adit-dump-select.
* 60	--	.1	.004	>1.0	.003	.015	.008	.003	<.004	.021	.008	<.002	Pit-chip, 46 cm (18 in.).
61	--	.2	<.002	.12	.002	.004	<.008	.002	<.004	.013	.005	<.002	Pit-chip, 46 cm (18 in.).
* 62	Tr	Tr	<.002	.85	.003	<.002	<.008	.004	<.004	.009	.006	<.002	Pit-chip, 0.9 m (3 ft).
* 63	Tr	Tr	.003	>1.0	.001	.004	<.008	.003	<.004	.014	.007	.010	Pit-chip, 46 cm (18 in.).
* 64	.04	.3	.007	>1.0	.003	.007	.93	.001	.007	.032	.15	.032	Pit-chip, 31 cm (12 in.).
65	--	.01	.003	.005	.001	.003	<.008	.004	<.004	<.007	.003	.008	Adit-chip, 1.2 m (4 ft).
* 66	--	.1	.007	.004	.002	<.002	<.008	.002	.005	.010	<.001	.013	Adit-chip, 50 cm (20 in.).
* 67	--	Tr	<.004	.010	.002	.003	<.008	<.001	.004	.027	<.001	.012	Trench-chip, 109 cm (43 in.).
* 68	--	Tr	<.006	< .004	.002	.003	<.008	.005	.004	.016	<.001	.005	Trench-chip, 1.8 m (6 ft).
* 69	--	.1	.007	< .004	.002	.007	<.008	.001	.006	.05	.004	.007	Trench-select.
70	Tr	--	<.001	.002	<.002	<.001	.03	.05	<.001	<.005	<.001	.002	Outcrop-select.
71	--	.2	.003	.11	.003	<.002	<.008	.004	<.004	<.007	.012	.011	Adit-chip, 20 cm (8 in.).
72	--	.1	.004	.037	.002	<.002	<.008	.005	<.004	<.007	.006	.008	Adit-dump-grab, 1.8-m (6-ft) grid.
73	--	.1	.004	.029	.001	.003	<.008	.004	<.004	.008	.004	.003	Stockpile-dump-grab-random.
74	--	.1	.005	.049	.002	.004	<.008	.004	<.004	.013	.005	.011	Do.
75	--	.1	.005	.031	.002	.004	<.008	.003	<.004	.013	.007	.009	Do.
76	--	.1	.006	.026	.002	.009	<.008	.004	.007	.020	.006	.013	Adit-chip, 0.6 m (2 ft).
* 77	--	.1	.010	.006	.002	.009	.011	.003	.005	.023	.001	.009	Adit-chip, 50 cm (20 in.).
* 78	Tr	.2	<.001	2	<.002	<.001	<.03	<.001	<.001	.005	.04	<.002	Trench-dump-select.
79	--	.1	.004	< .08	<.002	<.006	<.03	.001	.01	<.005	.04	<.005	Pit-dump-grab-random.
* 80	--	.1	.002	< .03	.02	<.001	<.03	.02	<.001	<.005	.007	.02	Do.
81	Tr	.1	<.001	< .001	<.002	<.001	<.03	.006	<.001	<.005	<.001	<.002	Do.
* 82	Tr	--	.02	< .001	<.002	.002	<.03	.001	<.001	<.005	.001	<.002	Pit-chip, 109 cm (43 in.).
83	--	--	<.001	.01	<.002	<.001	<.03	.007	<.001	<.005	.01	<.002	Adit-chip, 90 cm (35 in.).
* 84	--	--	<.001	< .001	<.002	<.001	<.03	.03	<.001	<.005	.07	<.002	Adit-chip, 36 cm (14 in.).
85	--	.2	<.001	.02	<.002	<.001	<.03	.004	<.001	<.005	.06	<.002	Adit-dump-grab, 1.8-m (6-ft) grid.
* 86	--	Tr	<.001	.9	<.002	<.001	<.03	<.001	<.001	<.005	.4	<.002	Adit-chip, 89 cm (35 in.).
* 87	--	Tr	<.002	2	.02	<.001	<.04	<.001	<.002	<.007	.3	<.003	Shaft-ship, 114 cm (45 in.).
* 88	Tr	.4	.005	4	.05	<.001	<.03	<.001	.002	<.005	<.05	.005	Adit-chip, 99 cm (39 in.).

TABLE 3.—*Analyses of samples from localities in and near the Rincon study area, Arizona*—Continued

* 89	Tr	.2	<.001	3	<.002	<.001	<.03	<.001	<.001	<.005	.3	<.002	Adit-chip, 33 cm (13 in.).
* 90	--	--	<.001	2	.05	<.001	<.03	<.001	<.001	<.005	.08	.02	Adit-chip, 50 cm (20 in.).
* 91	Tr	--	<.001	.9	.006	<.001	<.03	<.001	<.001	<.005	.1	<.002	Adit-dump-grab, 1.8-m (6-ft) grid.
* 92	Tr	Tr	<.001	2	<.002	<.001	<.03	<.001	<.001	<.005	.3	<.002	Pit-chip, 99 cm (39 in.).
* 93	--	.1	<.001	1	<.002	<.001	<.03	<.001	<.001	<.005	.5	<.002	Pit-dump-grab, 1.8-m (6-ft) grid.
* 94	Tr	--	<.001	1	<.002	<.001	<.03	<.001	<.001	<.005	.2	<.002	Adit-dump-grab, 1.8-m (6-ft) grid.
* 95	--	--	<.001	1	<.002	<.001	<.03	<.001	<.001	<.005	1	<.002	Pit-chip-random.
* 96	Tr	--	<.001	1	<.002	<.001	<.03	<.001	<.001	<.005	.1	<.002	Pit-dump-grab-random.
* 97	--	--	<.001	.3	<.002	<.001	<.03	<.001	<.001	<.005	5	<.002	Pit-chip, 130 cm (51 in.).
* 98	Tr	.2	<.001	2	<.002	<.006	<.03	<.001	<.001	<.005	2	<.005	Pit-dump-grab-random.
* 99	Tr	.2	<.001	2	.03	<.001	<.03	<.001	<.001	<.005	.001	<.002	Outcrop-grab-random.
*100	Tr	Tr	.004	3	.07	<.001	<.03	<.001	.003	<.005	.001	.009	Outcrop-chip, 0.9 m (3 ft).

SAMPLE NUMBERS AND FURTHER ANALYSIS

4. 0.08 Te.
6. (5.9) Cu.
8. 0.05 Ba, 0.09 Te.
9. 0.08 Ba, 0.09 Te.
10. 0.04 Ba, 0.07 Te.
11. 0.09 Ba.
12. (2.6) Cu, (0.11) Zn.
13. 54.1 Ba, (0.92) Sr.
15. 0.03 B, 0.2 Bi, (0.007) Cu, (0.03) Pb, 0.01 Sn.
16. (3.4) Cu, (0.002) Y, (3.5) Zn.
17. (1.7) Cu.
18. 0.038 Co, (3.1) Cu, (0.96) Zn.
19. (2.5) Cu, 0.19 P, 0.12 Sb.
21. (5.8) Cu, 0.69 Sb.
22. 0.031 Co, (1.9) Cu, (0.002) Y.
24. (0.63) Cu, 0.002 Sc, 0.19 W.
27. 0.005 Co, (5.1) Cu, (0.17) Zn.
33. (0.4) Cu, 0.002 Sc, 0.055 Sb.
35. 0.003 Co.
36. (0.56) Cu.
37. 0.004 Co, (1.7) Cu, 0.30 P, 0.16 Sb, 0.002 Sc, 0.012 Sn.
39. 0.04 Co.
40. (1.1) Cu.
41. 0.05 Ba.
43. (0.47) Cu.
45. (7.5) Cu.
52. (0.08) Cu, 0.08 Te.
53. 0.014 Co, (0.55) Cu, 0.062 Sb.
54. 0.005 Co, (2.0) Cu.
55. 0.008 Co, (2.2) Cu, 0.022 La.
56. (1.2) Cu.
57. (0.26) Cu.
58. (0.37) Cu.
59. (0.58) Cu.
60. (0.47) Cu, 0.086 P, 0.052 Sb.
62. (0.44) Cu.
63. (0.48) Cu.
64. (3.8) Cu, 0.23 La, (1.4) Pb, 0.003 Sc, 0.11 Se, (0.57) Zn.
66. 0.12 As.
67. 0.13 As, 0.09 Sb.
68. 0.002 Sr.
69. 0.082 As, 0.001 Sc.
77. 0.056 Sb.
78. 0.02 Ba, (1.1) Cu.
80. 1 Ba, 0.2 Te.
82. 0.01 B, 0.02 Ba, 0.08 Te.
84. 0.1 Ba.
86. (0.68) Cu, (0.4) Zn.
87. (1.3) Cu, (0.038) Mo, 0.06 W, (0.28) Zn.
88. (1.7) Cu, (0.075) Mo.
89. (1.7) Cu, 0.002 Nb, (0.3) Zn.
90. (2.9) Cu, (0.033) Mo, 0.09 Te.
91. (0.41) Cu, (0.09) Zn.
92. (1.5) Cu, (0.65) Zn.
93. (0.54) Cu, (0.83) Zn.
94. (0.52) Cu, (0.19) Zn.
95. (2.3) Cu, (0.19) Zn.
96. (0.24) Cu, (0.64) Zn.
97. 0.04 Cd, (0.19) Cu, (9.9) Zn.
98. (1.8) Cu, (1.5) Zn.
99. (2.2) Cu, 0.09 Te.
100. (3.5) Cu, 0.03 La, (0.033) Mo, 0.1 Te.

TABLE 4.—*Assay results of silver, copper, lead, and cobalt in some samples from the Bear Creek area*

[Leaders (- - -), not detected. Silver determined in inch-pound units, 1 oz/ton = 34.285 g/t]

Sample			Assay data				
No.	Type	Length	Ag (oz/ton)	Cu (percent)	Pb (percent)	Co (ppm)	Remarks
16	Chip	46 cm (18 in.)	0.2	3.4	3.5	---	Pit; brecciated zone in limestone; some malachite, azurite, and chrysocolla.
17	-do-	31 cm (12 in.)	.7	1.7	---	---	Pit; siliceous breccia zone with fractures filled with malachite, azurite, and chrysocolla.
18	-do-	61 cm (24 in.)	1.7	3.1	.96	380	Pit; contact zone of marble and aplite(?); some malachite, azurite, chrysocolla, limonite, hematite, and epidote.
19	-do-	46 cm (18 in.)	1.0	2.4	---	---	Trench; siliceous vein with malachite, azurite, and chrysocolla.
21	-do-	53 cm (21 in.)	2.1	5.8	---	---	Trench; contact of light-colored igneous intrusive (aplite?) and a dark fine-grained altered rock (schist?) with malachite, azurite, and chrysocolla.
22	-do-	46 cm (18 in.)	.3	1.9	---	310	Pit; highly altered fault zone in Horquilla Limestone; some malachite and azurite as fracture fillings in fault zone.

FRESNO SPRING

The examined workings consist of prospect pits and short adits about 0.4 km (¼ mi) west of Fresno Spring and 4.0 km (2.5 mi) north of Watkins Ranch. Two adits and two pits within the study area in unsurveyed sec. 24, T. 14 S., R. 19 E. had relatively high metal values as indicated by samples 24-27, although all appeared to be associated with minor, isolated pods of mineralization (pl. 2).

Sample 24, a select sample of iron-rich material from the dump of a caved 2.4-m (8-ft) adit driven along the contact between Horquilla Limestone and aplite(?), contained 0.6 oz silver per ton (21 g/t), 0.63 percent copper, 0.039 percent zinc, and 0.19 percent tungsten.

Sample 25, chipped 46 cm (18 in.) across a contact zone of limestone and aplite in a small pit, contained 0.20 oz silver per ton (6.8 g/t), 0.33 percent copper, and 0.019 percent zinc. Where exposed in the pit, the zone dips 30° west, is as much as 61 cm (24 in.) wide, and contains chrysocolla and an abundance of yellow-green crystalline epidote. Locally, the limestone is altered to marble.

Sample 26, a grab sample taken on a 0.6-m (2-ft) grid of a dump of a prospect pit in a pod of highly fractured iron-stained aplite in Horquilla Limestone, contained 0.1 oz silver per ton (3.4 g/t), 0.005 percent copper, and 0.02 percent lead.

Sample 27, chipped 46 cm (18 in.) across an indistinct contact of Horquilla Limestone and aplite(?) exposed in a 1.8-m (6-ft) adit, contained 0.1 oz silver per ton (3.4 g/t), 5.1 percent copper, and 0.17 percent zinc. Chrysocolla, hematite, and epidote are visible along the contact within the adit where the mineralization appears to be an isolated pod.

PAIGE CREEK

The sampled prospects in the Paige Creek area are about 0.8 km (½ mi) outside the study area in secs. 19 and 30, T. 14 S., R. 19 E., about 1.6 km (1 mi) north of Driscoll Mountain and 1.6 km (1 mi) south of Barney Ranch. There are two prospects, which include an adit and a barren trench on the north side of Paige Creek.

The adit, which was 6.1 m (20 ft) long, is in aplite(?) containing quartz lenses. The prominent rock unit in the area is Horquilla Limestone associated with schist, quartzite, and marble. Select sample (33) from the dump contained 0.4 percent copper, 0.021 percent zinc, and traces of gold and silver. The sample was a hard, brittle, vesicular rock, dark brown to black in color with visible azurite, malachite, and chrysocolla.

A 1.2-m (4-ft) chip sample (32) taken vertically in the north rib 1.5 m (5 ft) from the face of the adit contained 0.018 percent copper and a trace of silver. It appeared that the adit explored a limited and isolated pod of mineralization.

DEER CREEK

Deer Creek, a major tributary of Paige Creek, is approximately 5.6 km (3.5 mi) north of Watkins Ranch and about 0.8 km (½ mi) southwest of Barney Ranch. Prospect pits, adits, and a shaft are in the Deer Creek area in sec. 19, T. 14 S., R. 19 E., and unsurveyed sec. 24, T. 14 S., R. 18 E. Those in unsurveyed sec. 24 are in the Rincon study area and those in sec. 19 are less than 0.8 km (½ mi) east of the study area (pl. 2).

Four chip samples (36, 37, 40, and 45) taken from prospect workings along Deer Creek assayed greater than 0.5 percent copper; however, the mineralization appears to be in isolated pods. Sample 36, a 31-cm (12-in.) chip sample, contained 0.56 percent copper, 0.2 oz silver per ton (6.8 g/t), and a trace of gold. This sample was taken in a zone of copper mineralization in dolomitic limestone 9.2 m (30 ft) inside the portal of a partially caved adit that was estimated to be 20 m (65 ft) long. The copper mineralization consists of chrysocolla, azurite, and malachite.

About 31 m (100 ft) north of the partially caved adit is a small adit and a trench that contains malachite, azurite, and chrysocolla as fracture fillings in country rock of dolomite and altered limestone. Exposed at the face of the adit is a 31-cm (12-in.) thick, horizontal zone of copper mineralization containing bands of malachite and azurite. A 31-cm (12-in.) chip sample (37) taken across this zone contained 1.7 percent copper, 0.2 oz silver per ton (6.8 g/t), and a trace of gold.

Sample 40, a chip sample taken across a 1.2 m (4 ft) mineralized zone in an adit, contained relatively high copper and silver values. Figure 11 is a plan of the adit.

Sample 45, a 38-cm (15-in.) chip sample taken across a mineralized vein in the north wall of a prospect pit contained 7.5 percent copper and a trace of gold. The pit is in a sandy and carbonaceous buff-colored breccia and exposes the vein, in which chrysocolla, malachite, and hematite are visible. The major rock unit in this area is limestone containing lenses of marble.

BARNEY RANCH

Barney Ranch is in the south half of sec. 18, T. 14 S., R. 19 E. About 0.4 km (¼ mi) west of Barney Ranch, just outside of the Rincon study area, is an adit which, according to Ollie Barney, owner of the Barney Ranch, was driven in 1901 for exploration purposes. Samples 48-55 were taken in the adit (fig. 12; pl. 2).

About 0.8 km (½ mi) east of the ranch is an inaccessible shaft in schist associated with quartz dikes. The shaft was estimated to be 6.1 m (20 ft) deep, having a mineralized zone about 46 cm (18 in.) wide just

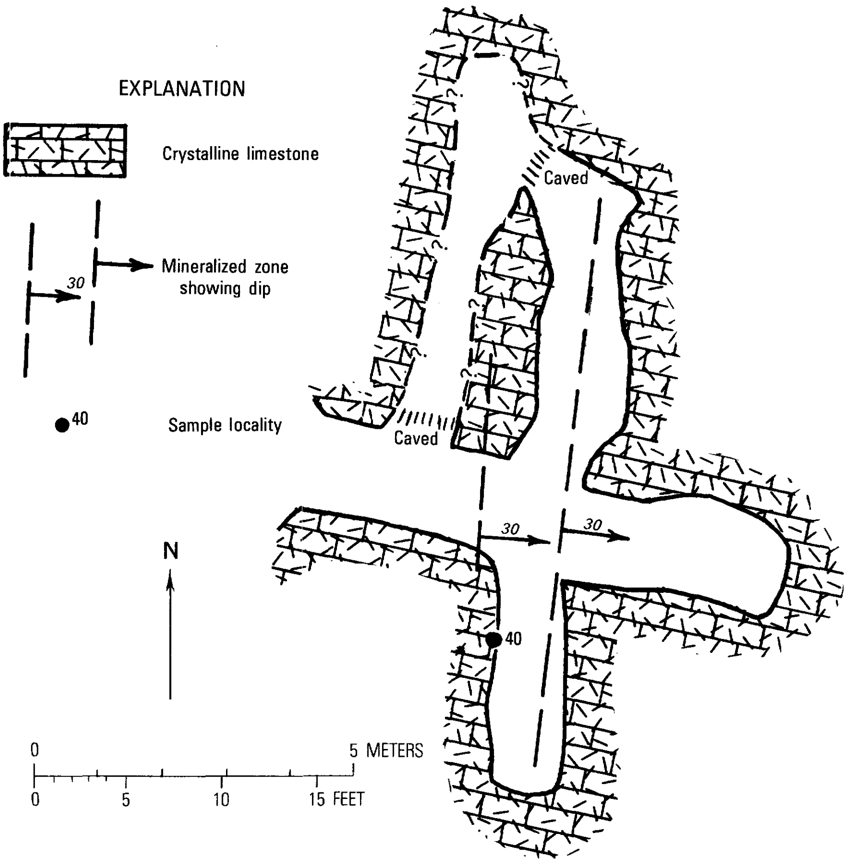

FIGURE 11.—Adit near Deer Creek.

[Assay data in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample			Assay data			
No.	Type	Length	Au (oz/ton)	Ag (oz/ton)	Cu (percent)	Remarks
40	Chip	1.2 m (4 ft)	Tr	0.4	1.1	Mineralized zone, some bands of chrysocolla and malachite.

below the collar. The dump at the shaft appeared to be segregated into waste and mineralized rock containing chrysocolla. A grab sample (56) taken of the mineralized part of the dump contained 1.2 percent copper and a trace of gold.

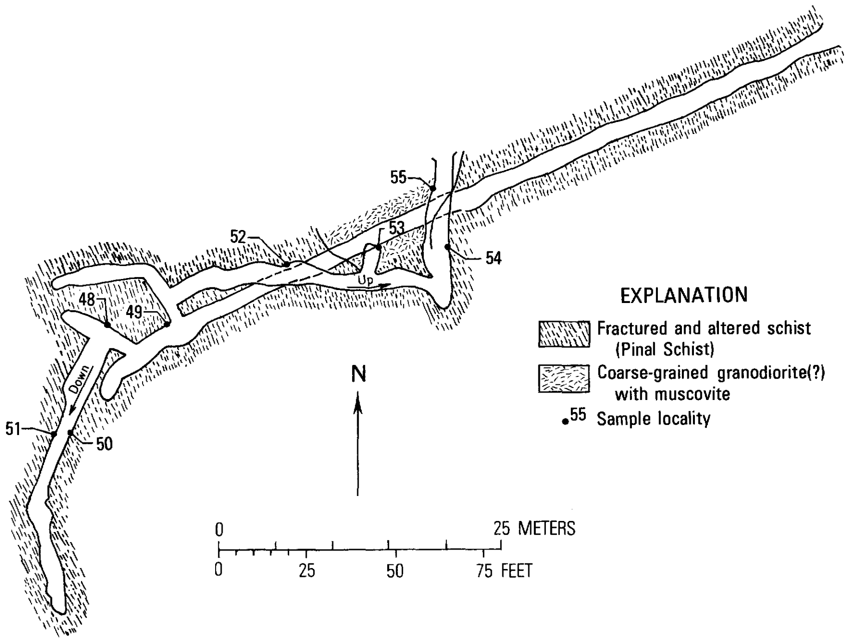

FIGURE 12.—Adit near Barney Ranch.

[All samples chip; Tr, trace; leaders (---), not detected. Assay data in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample		Assay data						
No.	Length	Au (oz/ton)	Ag (oz/ton)	Cu (percent)	Mo (percent)	Pb (percent)	Zn (percent)	Remarks
48	61 cm (24 in.)	---	---	0.048	0.001	0.008	0.006	Highly fractured and altered schist with copper staining.
49	76 cm (30 in.)	---	Tr	.26	.001	.008	.021	Altered schist with iron staining.
50	46 cm (18 in.)	---	0.3	.13	.001	.008	.010	Highly altered schist with limonite banding and copper staining.
51	38 cm (15 in.)	---	.2	.066	.001	.008	.006	Do.
52	61 cm (24 in.)	Tr	---	.08	.002	.008	.04	Brecciated zone in schist with limonite.
53	1.1 m (3.5 ft)	Tr	---	.55	.003	.064	.047	Highly fractured schist; chrysocolla in fractures.
54	1.2 m (4 ft)	Tr	---	2.0	.002	.013	.028	Chrysocolla and specularite in fractures and as crust.
55	0.8 m (2.5 ft)	Tr	---	2.2	.003	.021	.042	Do.

TABLE 5.—*Assay results of gold, silver, and copper in some samples from the Lechequilla Peak area*

[Tr, trace; leaders (- - -), not detected. Assay data in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample			Assay data			
No.	Type	Length	Au (oz/ton)	Ag (oz/ton)	Cu (percent)	Remarks
57	Chip--	31 cm (12 in.)	Tr	0.1	0.26	Pit; mineralized fractured zone in Bolsa Quartzite; some chrysocolla; chlorite alteration.
58	--do--	31 cm (12 in.)	Tr	---	.37	Adit; copper-stained fractured zone.
59	Select	---	---	---	.58	Adit, dump; copper-stained rocks.
60	Chip--	46 cm (18 in.)	---	.1	.47	Pit, highly fractured, weathered, mineralized zone.
63	--do--	46 cm (18 in.)	Tr	Tr	.48	Pit; mineralized contact between Pinal Schist and a white quartz dike.
[1]64	--do--	31 cm (12 in.)	0.04	.3	3.8	Pit; copper staining in fractured quartzite.

[1]64. Also 1.4 Pb, 0.57 Zn, 0.11 Se, in percent.

LECHEQUILLA PEAK

Lechequilla Peak is a prominent peak about 1 km (¾ mi) east of the study area in the southeast corner of sec. 7, T. 14 S., R. 19 E. The country rock of the Lechequilla Peak area is mostly Bolsa Quartzite and some Pinal Schist. Horquilla Limestone, Escabrosa Limestone, and the Martin Formation crop out on the east flank of the mountain. Major thrust faulting has taken place in this area (Drewes, 1974).

Six prospect workings lie southwest and two prospect workings lie east of the peak, and all are from 0.8 to 1.6 km (½ to 1 mi) east of the Rincon study area. The locations of three workings are shown on plate 2, and the locations of five workings are shown in figure 13. Six samples (57-60, 63, and 64) taken at some of the prospect workings have relatively high copper values; however, the mineralized zones are narrow and limited in extent. Sample and assay data are listed in table 5.

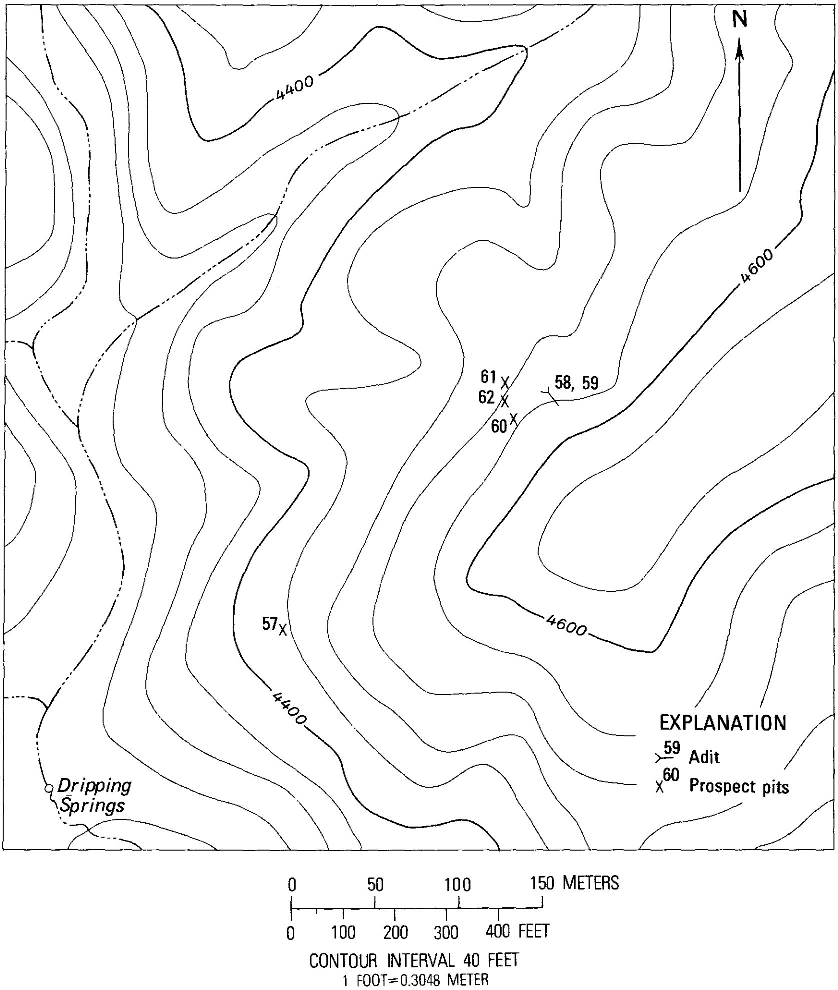

FIGURE 13.—Sample localities about 1.6 km (1 mi) southwest of Lechequilla Peak and outside the study area. Base from U.S. Geological Survey 1:24,000 Happy Valley NW, 1973.

ROBLE-YOUTCY CANYON LOCALE

ROBLE SPRING

Roble Spring is in a canyon in the SW¼ sec. 30, T. 13 S., R. 19 E., outside the study area. Massive limestone cliffs with a limestone conglomerate near the base make up the south side of the canyon, whereas the north side is part of a steep-sloping ridge consisting of schist. The Roble Spring area is adjacent to the northeast corner of the Rincon study area.

In a preliminary reconnaissance report (U.S. Atomic Energy Commission and U.S. Geological Survey, 1970), H. C. Granger reported on some uranium occurrences in sec. 30, T. 13 S., R. 19 E., at a property he called the Roble Spring deposit. On April 16, 1951, when he made his examination, a prospect pit and an adit that was 3.1 m (10 ft) long were on the property. He sampled two radioactive deposits in a nearly vertical, northwest-trending fault zone. On the southwest side of the fault zone was limestone and on the northeast side was schist. The larger deposit was 4.6 m (15 ft) long and 1.5 m (5 ft) wide and the smaller deposit was 3.1 m (10 ft) long and 1.2 m (4 ft) wide. The radiometric and chemical analyses of his sample of the larger deposit were 0.078 and 0.004 percent U_3O_8, respectively, and those of his sample of the smaller deposits were 0.006 and 0.005 percent U_3O_8, respectively. Granger and Raup (1962) in the discussion of the Roble Spring deposit mentioned that the difference between the radiometric and chemical analyses of the sample of the larger deposit suggest that some of the original uranium may have been removed by leaching.

A 3.1-m (10-ft) adit and a 20-m (65-ft) trench were examined near Roble Spring. Sample 66 was a 50-cm (20-in.) chip sample taken across an iron-rich shear zone in limestone in the adit. Samples 67-69 were taken in the trench in a shear zone between limestone and schist. The values range from 0.001 to 0.003 percent U_3O_8.

BLUE ROCK PROPERTY

The Blue Rock property is in the SW¼ sec. 15, T. 13 S., R. 18 E., about 2.4 km (1.5 mi) north of the Rincon study area. The country rock consists of gray-green, highly fractured and altered schist composed mostly of quartz and chlorite. Uranium mineralization occurs in fractures. Minor amounts of fluorite occur in small scattered veins.

According to unpublished records of the U.S. Department of Energy, Tucson Uranium Company made the following shipments from the property in 1956 to a buying station at Globe, Ariz.: 7.0 tons (6.4 t) containing 0.13 percent U_3O_8, 42.0 tons (38.1 t) containing 0.08 percent U_3O_8, and 9.0 tons (8.2 t) containing 0.06 percent U_3O_8.

At the time of the field investigation in the early part of 1977, a shaft, five adits, and three uranium ore stockpiles were on the property (fig. 14; pl. 2). The shaft and one adit were filled with water and another adit was caved. Seven samples (71-77) taken at the property contained from 0.002 to 0.135 percent U_3O_8.

In the latter part of 1977, Nuclear Energy, Ltd. did some drilling, reopened some of the workings, and shipped 102 tons (92.5 t) of ore containing 0.123 percent U_3O_8 to the Cotter Corp. uranium mill at Canon City, Colo. (R. Twiford, Jr., written commun., Dec. 1, 1977). The company was planning a joint venture with Aries Uranium Co. and El Portal Mining Co. to mine the property.

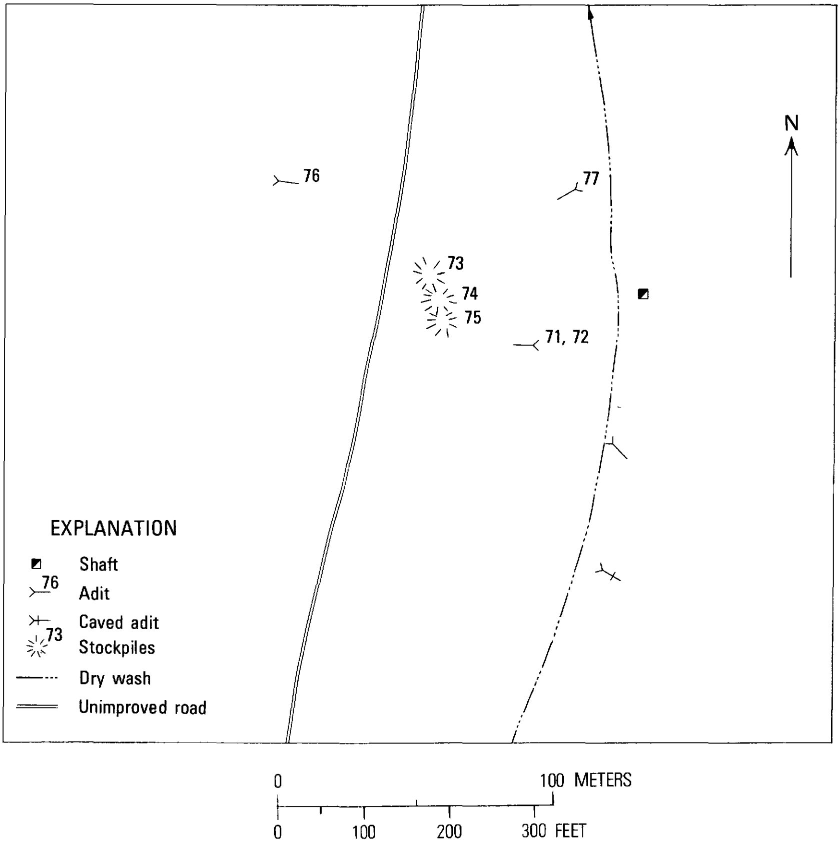

FIGURE 14.—Sample localities on Blue Rock property.

Sample No.	Type	Length	Assay data U_3O_8 (percent)	Remarks
71[1]	Chip	20 cm (8 in.)	0.0024	Highly fractured schist with minor copper specks.
72	Grab	1.8-m (6.0-ft) grid	.010	Dump.
73	-do-	Random	.135	Stockpile.
74	-do-	-do---	.115	Do.
75	-do-	-do---	.092	Do.
76	Chip	0.6 m (2 ft)	.0028	Fractured schist with calcite fillings and minor alteration.
77	-do--	50 cm (20 in.)	.047	Fractured schist with minor visible fluorite.

[1]71. Also 0.11 percent Cu.

ITALIAN TRAP LOCALE

Italian Trap is in unsurveyed sec. 23, T. 13 S., R. 17 E., in the northwest part of the study area. The prospect workings examined are southwest of Italian Trap in unsurveyed secs. 22, 23, 26, and 27, T. 13 S., R. 17 E. The locations of the prospect workings are shown on plate 2 and in figures 15, 16, and 17.

The two rock types present in the area are Horquilla Limestone (Pennsylvanian) and Wrong Mountain Quartz Monzonite (Precambrian). Locally the Horquilla Limestone is marbleized. As a result of thrust faulting or gravity sliding, the limestone-quartz monzonite contact is sheared. Most of the prospect workings are located along the shear zone.

Samples 78 and 86-98 have either high copper or zinc values or both. Sample 90 has the highest copper value, 2.9 percent, and sample 97 has the highest zinc value, 9.9 percent. Sample and assay data for samples 87, 88, and 94 are shown in figure 16, for samples 89-91 in figure 17, and for samples 78, 86, 92, 93, and 95-98 in table 6.

Samples 99 and 100 were taken about 60 m (200 ft) apart in a quartz vein that crops out in unsurveyed sec. 29, T. 13 S., R. 17 E., about 1.6 km (1 mi) west of Chiva Tank. No prospect workings appeared in the vicinity, but it appeared that some "scratching" had been done along the vein. The country rock is quartz monzonite. The vein, 0.9 m (3 ft) wide, is light gray in color and contains irregular copper mineralization. Sample 99 contains 2.2 percent copper, 0.2 oz silver per ton (6.8 g/t), and a trace of gold. A 0.9-m (3-ft) chip sample (100) taken across the vein contains 3.5 percent copper and traces of gold and silver.

LIMESTONE AND MARBLE SAMPLES

Two samples (15 and 47) of limestone and two samples (28 and 81) of marble were taken in or near the study area. Samples 28 and 47 are outside the study area. The samples of limestone were analyzed for lime (CaO) and magnesia (MgO). Sample 15 contains 42.7 percent CaO and 0.18 percent MgO, and sample 47 contains 46.0 percent CaO and 1.4 percent MgO. Based on these analyses, neither limestone can be considered as high calcium limestone and, therefore, neither is suitable for most chemical and metallurgical uses. They possibly could be used for agricultural purposes and for making crushed aggregate. Samples 15 and 47 of limestone and samples 28 and 81 of marble were subjected to some physical tests to help determine their suitability for use as dimension stone. It is doubtful that either the limestone or marble could be used as dimension stone because the rocks are highly fractured and occur in limited tonnage. The marble possibly could be used as decorative aggregate.

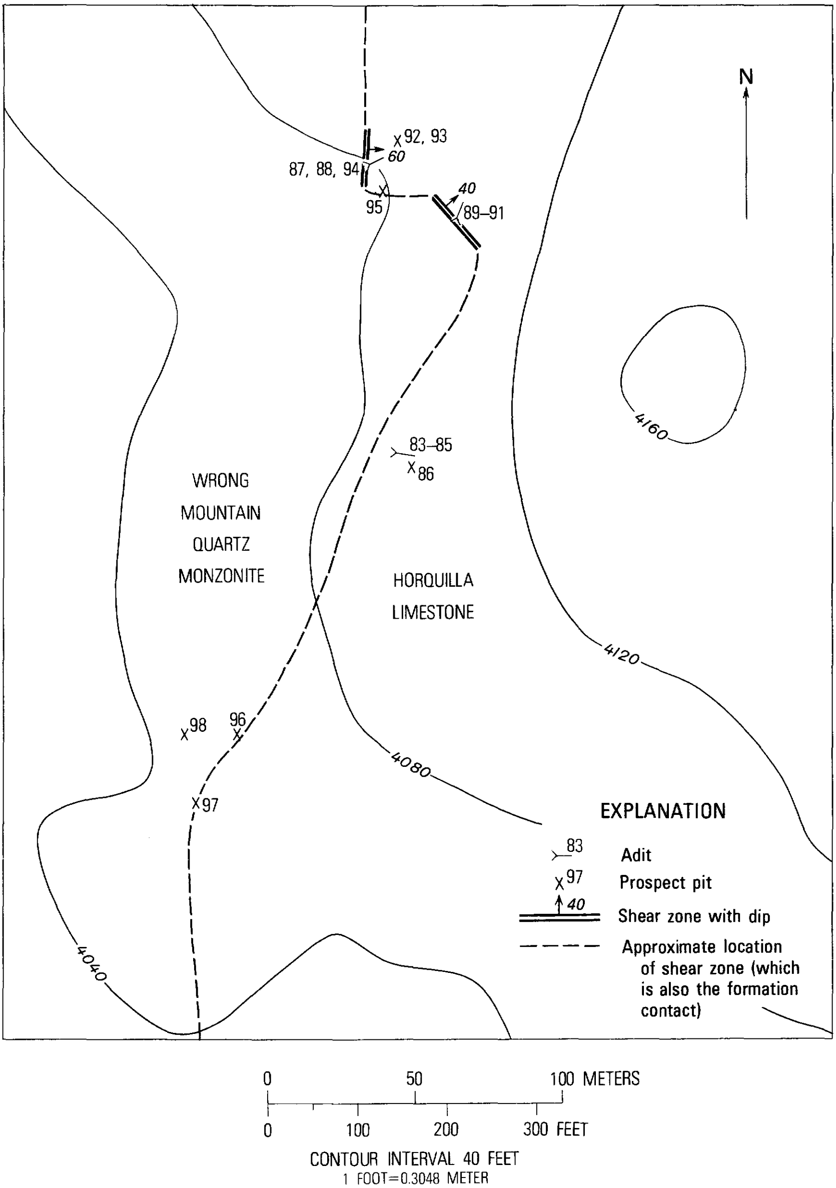

FIGURE 15.—Localities of samples 83-98 in the Italian Trap area. Base from U.S. Geological Survey 1:62,500 Bellota Ranch, 1957.

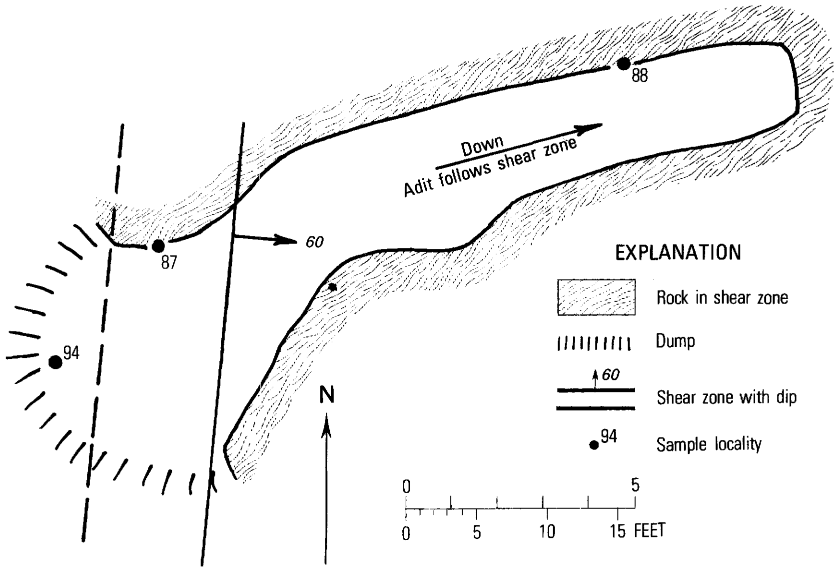

FIGURE 16.—Adit near Italian Trap where samples 87, 88, and 94 were taken.

[Tr, trace; leaders (---), not detected. Assay data in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample			Assay data				
No.	Type	Length	Au (oz/ton)	Ag (oz/ton)	Cu (percent)	Zn (percent)	Remarks
87	Chip	114 cm (45 in.)	---	Tr	1.3	0.28	Stringers of copper mineralization concordant with shear zone.
88	-do-	99 cm (39 in.)	Tr	0.4	1.7	.05	Chalcopyrite and malachite in quartz.
94	Grab	1.8-m (6-ft) grid	Tr	---	.52	.19	Dump material composed of material from shear zone.

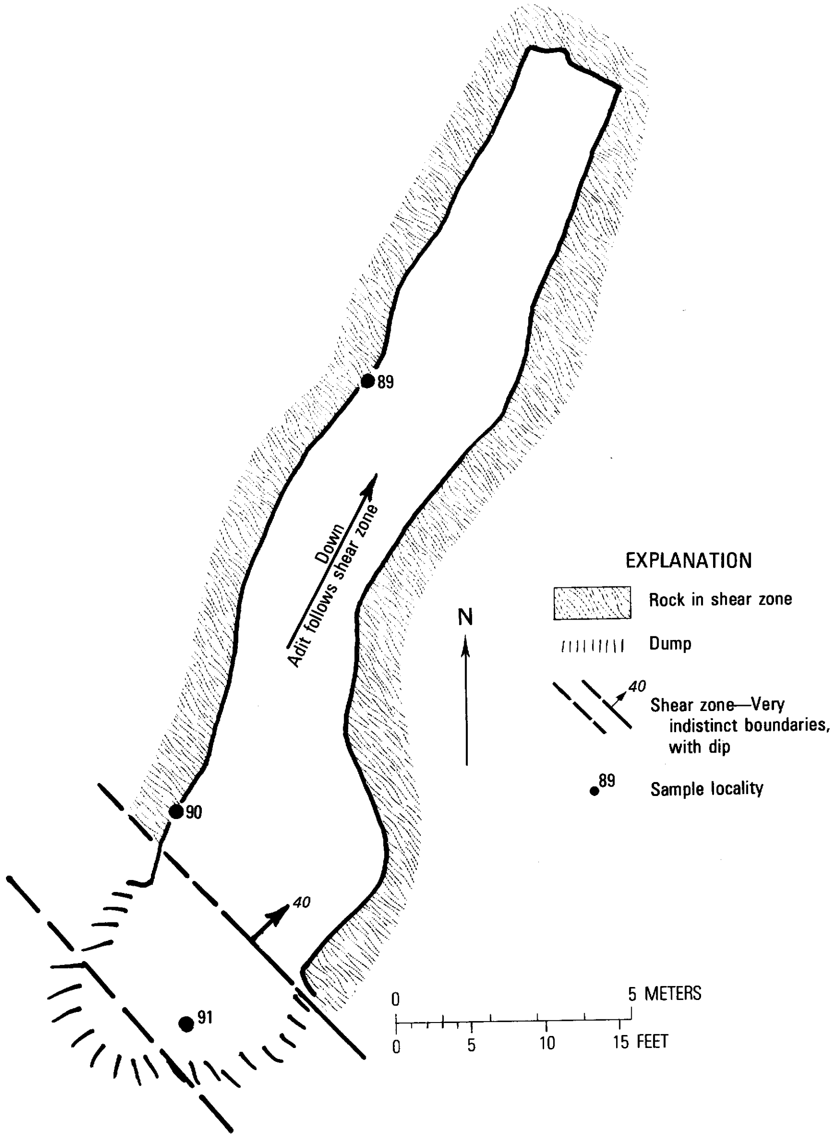

FIGURE 17.—Adit near Italian Trap where samples 89-91 were taken.

[Leaders (---), not detected. Data for Au and Ag measured in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample			Assay data				
No.	Type	Length	Au[1] (oz/ton)	Ag (oz/ton)	Cu (percent)	Zn (percent)	Remarks
89	Chip	33 cm (13 in.)	Tr	0.2	1.7	0.3	Banded iron mineralization with malachite.
90	-do-	50 cm (20 in.)	---	---	2.9	.08	Shear zone with malachite specs.
91	Grab	1.8-m (6-ft) grid	Tr	---	.41	.09	Malachite in dump material.

[1]Tr, trace.

PANNED STREAM-SEDIMENT SAMPLES

Eight panned stream-sediment samples were taken in or near the Rincon study area. Samples P4, P5, and P8 were taken just outside the study area boundary. The samples were taken in drainages by panning stream sediments until only the heavy material was left. Assay values are shown in table 7. Although various minerals were found in high concentrations, the limited amount of sediments in the drainages indicates a low potential for economic deposits.

CONCLUSIONS

The mineral potential of the Rincon wilderness study area is considered low. No recorded mineral production is known from within the study area.

Minor metallic mineralization occurs in several localities in the study area. Copper is the most common visible mineralization found and oc-

TABLE 6.—*Assay results of gold, silver, copper, and zinc for some samples at Italian Trap area*

[Tr, trace; leaders (- -), not detected. Assay data for Au and Ag in inch-pound units; 1 oz/ton = 34.285 g/t]

Sample			Assay data				
No.	Type	Length	Au (oz/ton)	Ag (oz/ton)	Cu (percent)	Zn (percent)	Remarks
78	Select	--	Tr	0.2	1.1	0.04	Trench; dark brown material with hematite and malachite.
86	Chip--	89 cm (35 in.)	--	Tr	.68	.4	Adit; copper mineralization in iron-stained limestone.
92	-do--	99 cm (39 in.)	Tr	Tr	1.5	.65	Pit; shear zone with banded chrysocolla.
93	Grab--	1.8-m (6-ft) grid.	--	.1	.54	.83	Pit, dump; dark, sheared material with chrysocolla.
95	Chip--	Random	--	--	2.3	.19	Pit; shear zone containing malachite.
96	Grab--	-do-	Tr	--	.24	.64	Pit, dump; sheared material with some copper mineralization.
97	Chip--	130 cm (51 in.)	--	--	.19	9.9	Pit; disseminated malachite in weathered shear zone.
98	Grab--	Random	Tr	.2	1.8	1.5	Pit, dump; sheared material with some malachite and azurite.

TABLE 7.—*Analyses of panned stream-sediment samples from in and near Rincon study area, Arizona*

[Fire assays and semiquantitative spectrographic analyses were performed at the Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, Nevada. The following elements were detected but not considered significant: Al, Ca, Fe, Mg, Mn, Si. Elements found below detection limits: Ag, As, B, Be, Bi, Cd, Co, Cu, Ga, K, Li, Mo, Na, Nb, N, Pb, Pd, Pt, Re, Sd, Sc, Sn, Te, Tl. In addition, values of Ba, Sr, and Ta were found in two samples and are footnoted below the table. <, less than amount shown]

Sample No.	Fire assay[3] Au (oz/ton)	Semiquantitative spectrographic analyses, in percent							
		Cr	La	P	Ti	V	Y	Zn	Zr
[1]P1	Tr	0.003	0.7	<0.2	12	0.05	0.7	0.1	0.2
P2	---	.005	<.01	< .2	6	<.004	.06	.07	<.003
P3	Tr	.01	<.01	2	16	.07	.9	.08	.1
P4	---	.001	.03	1	13	.03	.7	.09	.5
[2]P5	Tr	.03	.03	9	5	.2	.05	.1	.5
P6	---	.009	<.01	< .2	10	.04	.3	.07	.6
P7	---	<.001	<.01	< .2	13	.04	.8	.08	.3
P8	Tr	.008	.05	3	10	.04	.5	.06	.6

[1]P1. Also 0.003 percent Sr.

[2]P5. Also 2 percent Ba, 4 percent Ta.

[3]Tr, trace; leaders (---), not detected.

curs in all the areas except the Roble-Youtcy Canyon locale. Silver values were less than an ounce per ton in most samples, and all gold values, except for one sample that assayed 0.04 oz/ton (1.37 g/t), were a trace or not detected. Lead and zinc mineralization occur but not as widespread as that of copper. The majority of the metallic mineralization is contained in or associated with fracturing and faulting.

Uranium mineralization occurs at the Roble Spring area adjacent to the northeastern part of the study area and at the Blue Rock property about 2.4 km (1.5 mi) north of the study area. No evidence was found to indicate that such mineralization extends into or exists in the study area.

Samples of limestone and marble from the study area showed the rocks to be very strong but highly fractured, thus eliminating them for use as dimension stone. Based on chemical analyses, the limestone is not suitable for most chemical and metallurgical uses. The limestone possibly could be used for agricultural purposes and for making crushed aggregate and the marble could be used for decorative aggregate. However, similar limestones and marbles exist outside the study area nearer to potential markets for such uses.

Sand and gravel deposits inside the study area are relatively small. Much larger deposits outside the study area are more readily accessible.

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