Mineral Resources of the Pine Mountain Primitive Area, Arizona

GEOLOGICAL SURVEY BULLETIN 1230-J

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By F. C. CANNEY *and* W. L. LEHMBECK, U.S. GEOLOGICAL SURVEY, *and*
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STUDIES RELATED TO WILDERNESS

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An evaluation of the mineral potential of the area

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1967

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

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Washington, D.C. 20402 - Price 65 cents (paper cover)

STUDIES RELATED TO WILDERNESS

The Wilderness Act of 1964 (Public Law 88-577, Sept. 3, 1964) and the Conference Report on Senate Bill 4, 88th Congress, direct the U.S. Geological Survey and the U.S. Bureau of Mines to make mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe," when the act was passed, were incorporated into the National Wilderness Preservation System. Areas classified as "primitive" were not included in the Wilderness System, but the act provided that each primitive area should be studied for its suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This bulletin reports the results of a mineral survey in the Pine Mountain primitive area, Yavapai County, Ariz. The area discussed in the report corresponds to the area under consideration for wilderness status. It is not identical with the Pine Mountain Primitive Area as defined because modifications of the boundary have been proposed for the area to be considered for wilderness status. The area that was studied is referred to in this report as the Pine Mountain primitive area.

This report is one of a series of similar reports on primitive areas.

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By F. C. CANNEY and W. L. LEHMBECK, U.S. Geological Survey, and FRANK E. WILLIAMS, U.S. Bureau of Mines

SUMMARY

The Pine Mountain primitive area is in the southeast corner of Yavapai County' near the center of Arizona. Part of the area is in the Prescott National Forest and part is in the Tonto National Forest.

The primitive area is characterized by rather diverse types of topography and vegetation, but in general it is rugged and mountainous. It forms the southeast end of the Black Hills, a northwest-trending range that bounds Verde Valley on the southwest, rises 1,000–4,000 feet above the valley, and extends northwestward to the Jerome mining district. A long ridge divides the Pine Mountain area into two parts roughly equal in size but different in character. The part west and northwest of the ridge is mesalike, whereas the part east of the ridge is extremely rugged and is dissected by many moderately deep canyons. Altitudes in the area range from 6,281 feet on Pine Mountain to slightly less than 4,000 along the southeast border.

Rocks within the Pine Mountain area range in age from Precambrian to Cenozoic. The Precambrian rocks—mostly medium- to coarse-grained granite and closely related types, migmatite, gneiss, and metavolcanic and metasedimentary rocks—underlie most of the eastern and southern part and are also well exposed along parts of Bishop and Sycamore Creeks in the western part. Unconformably overlying the Precambrian rocks in part of the area are nearly flat-lying sedimentary strata of the Cambrian Tapeats(?) Sandstone and the Devonian Martin Limestone. Overlying the Paleozoic strata in the northwestern part of the area are nearly flat-lying basalt flows of Cenozoic age. In much of the southwestern part, the Paleozoic rocks are not present, and the volcanic rocks rest directly on Precambrian granite.

Vertical to high-angle faults are the principal structural features in the Pine Mountain area. The well-known Verde fault, which is the eastern boundary fault of the Black Hills, closely parallels the northeastern boundary of the primitive area. Another major fault strikes northeastward and closely parallels the rather straight southeast border of the area. Along both faults Tertiary volcanic rocks are downdropped to the east. Numerous other high-angle faults of lesser displacement roughly parallel the major structural features.

Geochemical prospecting was the principal method employed to evaluate the mineral potential of the area. A total of 186 samples of active stream sediment and 24 samples of heavy-mineral concentrates was collected. These samples were analyzed by chemical and spectrographic methods for metallic elements. Nearly all the metal contents measured fall in or are close to the normal background ranges expected in stream sediments derived from unmineralized rocks. No anomalies that might be considered indicative of the presence of near-surface metallic mineral deposits of economic importance were found.

Iron-stained zones, bleached areas, quartz-jasper stringers and veins, minor shear zones, and other miscellaneous types of altered rock are common in the metamorphic rocks of the primitive area. These occurrences were examined, and from many of them samples were collected for analysis. Only insignificant traces of metallic minerals were revealed by the analytical data and field studies. The presence of economically important near-surface mineral deposits in the area therefore is considered unlikely.

No nonmetallic deposits of commercial value are known in the primitive area.

GEOLOGY AND MINERAL RESOURCES

By F. C. Canney and W. L. Lehmbeck, U.S. Geological Survey

INTRODUCTION

LOCATION AND ACCESSIBILITY

The Pine Mountain primitive area, in southeastern Yavapai County, is near the center of Arizona (fig. 1). The existing primitive area comprises about 26 square miles; however, the area proposed for inclusion into the Wilderness System—the area that was studied—comprises about 31 square miles and is roughly rectangular—about 8 miles long and 4 miles wide (fig. 2). The proposed wilderness area excludes four small tracts of the original primitive area and includes five additional tracts of land. These proposed additions and exclusions are all relatively small (less than 0.5 sq. mi. each) except for the proposed addition of about 5 square miles on the southeast side of the primitive area.

The primitive area is between the Black Canyon Highway (Arizona Route 69 and Interstate Highway 17) and the Verde River. It is about 40 miles east-southeast of Prescott, the county seat of Yavapai County, and about 20 miles south of Camp Verde. The area is at the extreme southeast end of the Black Hills, a northwest-trending range that bounds Verde Valley on the southwest, rises 1,000–4,000 feet above the valley floor, and extends northwestward to the Jerome mining district. Streams in the Prescott area drain westward into the Agua Fria River and those in the Tonto area drain eastward into the Verde River.

The borders of the Pine Mountain primitive area can be reached or closely approached by four-wheel-drive vehicles at several points. A graded dirt road (Dugas Road), which leaves the Black Canyon Highway (Interstate 17) about 6 miles north of Cordes Junction

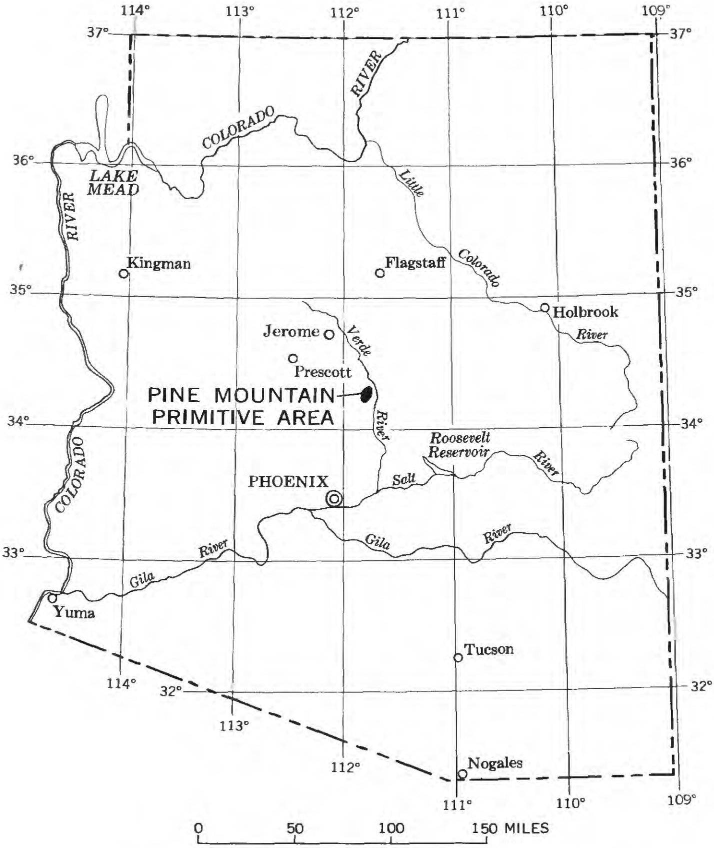

FIGURE 1.—Map of Arizona showing location of the Pine Mountain primitive area.

(junction of Interstate 17 and Arizona Route 69), is the only access to the northern part of the Prescott area. During most of the year it is traversable by passenger car as far as the Double T Ranch (fig. 2), a distance of about 18 miles, and by four-wheel-drive vehicle to the Nelson Place on the primitive-area boundary. The southwest border just north of 1M Peak can be reached by four-wheel-drive vehicle over the 22 Mesa Road, a U.S. Forest Service road which branches off the Dugas road about 8 miles west of the Double T Ranch. A point on Bishop Creek, about 1 mile from the extreme southwest edge of the area, can be reached fairly easily by a mining road that leaves the Bloody Basin Road south of Rugged Mesa. Within the Prescott area a good network of horse and foot trails permits relatively easy access to much of the area.

The Tonto area is somewhat more difficult of access. The north boundary can be reached by a road that goes to the MT Ranch

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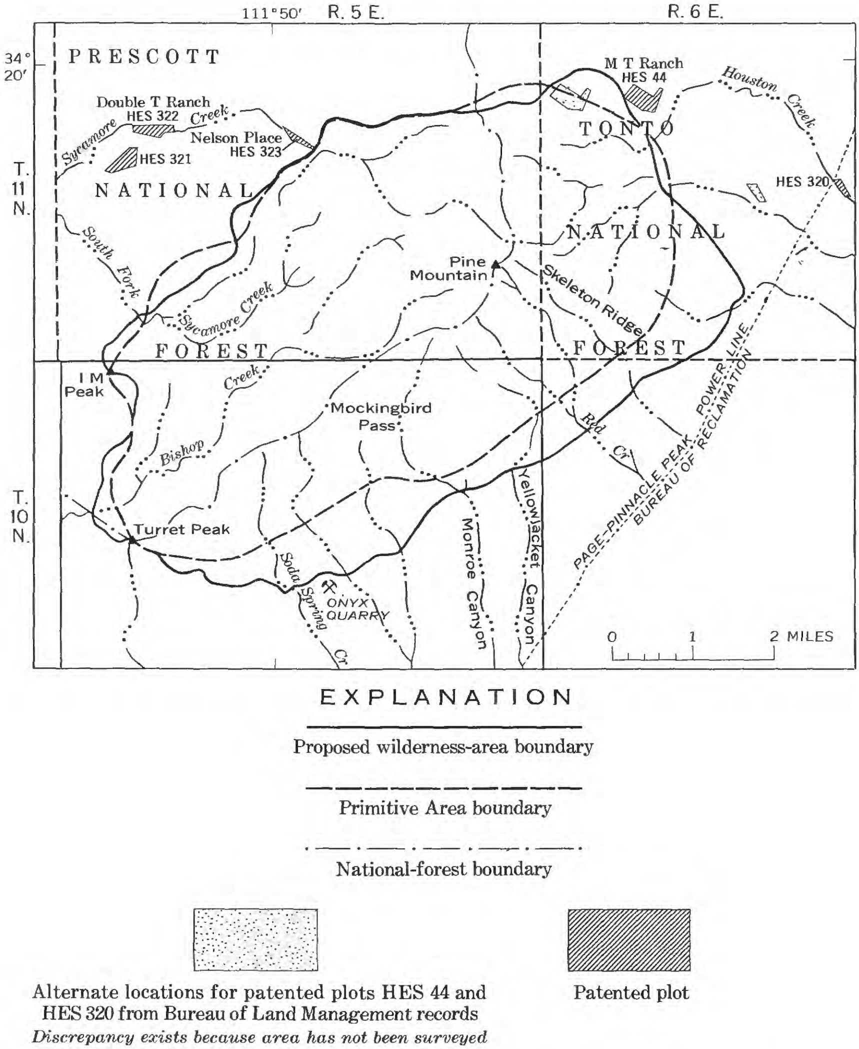

FIGURE 2.—Map of Pine Mountain primitive area, Yavapai County, Arizona. Compiled from a U.S. Forest Service map dated February 1966.

(fig. 2). A tortuous graded dirt work road that follows generally the new Page-Pinnacle Peak powerline provides the best access to most of the southeastern part of the primitive area. The powerline road can be reached from the Black Canyon Highway by taking the Bloody Basin Road 2 miles south of Cordes Junction. The south border can be nearly reached by way of the onyx-quarry road that branches off the powerline road. In the Tonto area travel is possible only by foot and is generally extremely difficult owing to the complete lack of trails and to thick vegetative cover.

PHYSICAL FEATURES, VEGETATION, AND CLIMATE

The Pine Mountain primitive area includes rather diverse topography and vegetation, but in general it is very rugged and mountainous (fig. 3). Physiographically, the Black Hills, which contain the Pine Mountain area, lie in a transitional belt between the Colorado Plateaus and Basin and Range provinces. The Colorado Plateaus consist of nearly flat-lying sedimentary rocks that are partly covered by extensive basic lava flows. Its southern edge is marked by the Mogollon Rim, an erosional scarp ranging from 1,000 to 2,000 feet in height. This great scarp lies east of the Pine Mountain area on the east side of the Verde River, and striking views of it can be obtained from the top of the escarpment in the primitive area. The transitional belt as defined by Wilson and Moore (1959, p. 89) includes those mountain ranges where the strata are still relatively flat although faulted and locally folded. The sedimentary rocks in the Pine Mountain area generally dip 10° or less and are cut by many high-angle faults.

A long northeast-trending ridge divides the Pine Mountain primitive area into two parts roughly equal in size but very different physiographically. The Prescott area, west and northwest of the ridge, is mesalike because of the nearly horizontal attitude of the Tertiary lava flows, and moderately deep canyons have been cut into it by Bishop and Sycamore Creeks (fig. 4). The Tonto area,

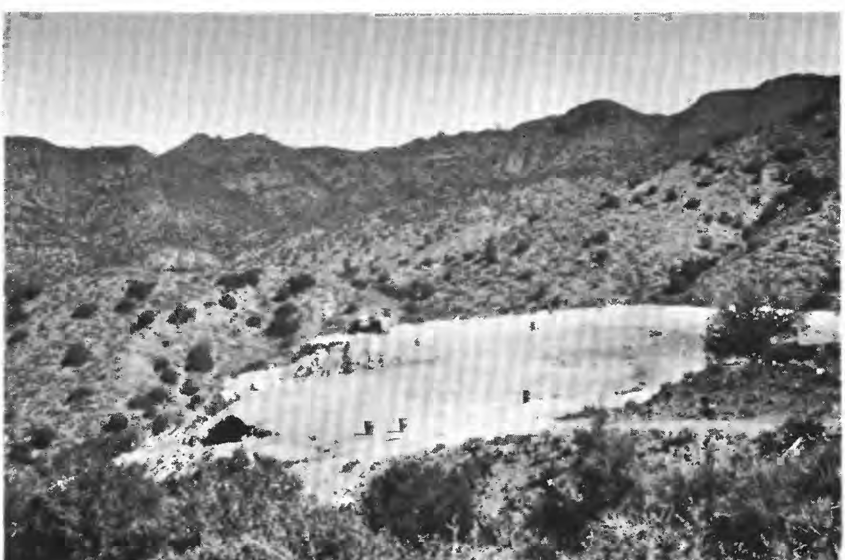

FIGURE 3.—View north-northwest from onyx quarry just outside primitive area showing rugged topography in southern part of area.

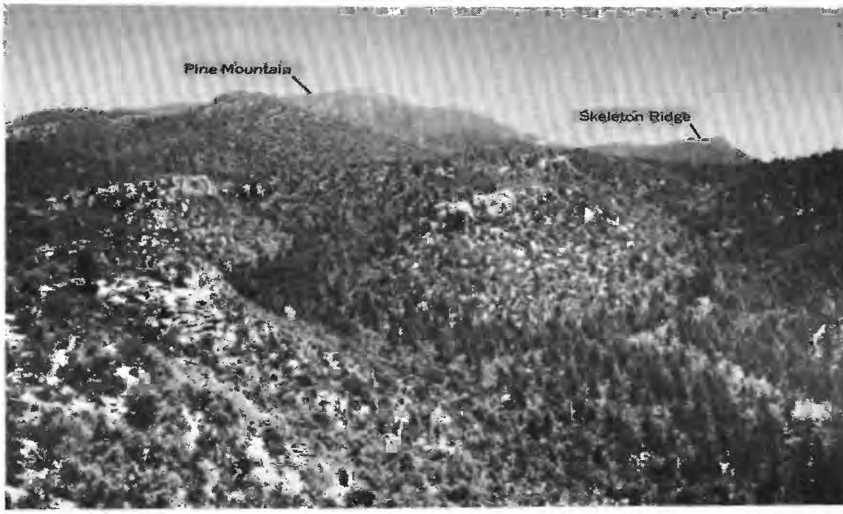

FIGURE 4.—Prominent exposures of gently dipping Tapeats(?) Sandstone in headwaters of Bishop Creek. Small downdropped block of Tapeats(?) Sandstone shown near picture center.

east of the escarpment, has very rugged topography because many eastward- and southeastward-flowing streams have carved moderately deep canyons in the granitic and metavolcanic rocks that compose most of the bedrock. Nearly all these streams head against a prominent line of cliffs composed of Tertiary lava flows and the Paleozoic sedimentary rocks.

Altitudes in the Pine Mountain area range from 6,821 feet on Pine Mountain to slightly less than 4,000 feet at several points on the southeast border. Turret Peak (alt 5,848 ft) and 1M Peak (alt 5,988 ft) are prominent and easily recognizable landmarks in the southern part of the area.

Streams in the area are intermittent although some, such as Sycamore and Bishop Creeks, are undoubtedly perennial in local stretches except in drought years. Ample evidence suggests that most streams become raging torrents in the spring runoff, whenever a substantial depth of winter snow accumulates at higher altitudes.

No climatological data are available for the area, but climatic records for some relatively nearby points (summarized by Anderson and Creasey, 1958, p. 5, and by Twenter and Metzger, 1963, p. 11–13) suggest that the average annual precipitation ranges from 10 to 20 inches, with May and June being the driest months and July and August the wettest. In this part of Arizona precipitation is in the form of rain during much of the year although snow is common during the winter at altitudes of more than 5,000 feet.

The vegetation is extremely varied both in type and amount, as would be expected from the rather large differences in altitude between various parts of the area. It ranges from plant communities composed of various species of shrubs and cactuses characteristic of the Sonoran Desert to relatively open stands of ponderosa pine. Broadly speaking, three general types are present: open grasslands, chaparral, and pine forest. Chaparral is used here loosely to mean any dense thicket of stiff or thorny shrubs or dwarf trees. The heaviest growth of chaparral is on the slopes and ridges in the Tonto area, especially north of Skeleton Ridge. In many parts of this area the vegetative cover is so dense that to travel any distance is an extremely difficult, painful, and time-consuming operation. Chaparral, very dense in many places, is also present in the southwestern part of the area along the sides of the major valleys.

In the northwestern part of the area, pine forest is very common at altitudes of more than 6,000 feet, and some pine is present at lower altitudes along the larger watercourses. Some of the flat-topped upland surfaces are relatively open grasslands that contain scattered stands of pinyon pine and juniper.

ACKNOWLEDGMENTS

We thank M. H. Krieger and F. R. Twenter of the U.S. Geological Survey who made available to us unpublished sketch maps and other data that had a bearing on the geology of the Pine Mountain area. Also, we acknowledge the cordial cooperation of Mr. Barry Peterson, U.S. Forest Service District Ranger for the Cave Creek District of the Tonto National Forest, who allowed use of a Forest Service cabin in Bloody Basin during part of the investigation. Mr. Brad Stewart, owner of the Double T Ranch, kindly permitted the field party to stay at his ranchhouse while working in the Prescott area.

INVESTIGATIONS

No detailed geologic studies of the Pine Mountain primitive area had been made prior to the present investigation, but reconnaissance data coupled with detailed geologic knowledge of the Jerome and Verde Valley areas to the north suggested that deposits of base and precious metals could possibly exist in the area, especially in igneous and metamorphic rocks of Precambrian age. However, the absence of mines and the nearly complete absence of physical indications of past prospecting activity (such as prospect pits, adits, claim monuments) suggest that the area probably does not contain deposits of valuable minerals.

PREVIOUS STUDIES

We found no references in the geologic literature to any geological or geochemical investigations in the area. However, some of the gross geologic features are shown on the geologic map of Yavapai County, Arizona (Arizona Bureau of Mines, 1958). Twenter and Metzger (1963), who mapped the geology in Verde Valley, north of the Pine Mountain primitive area, also did some generalized geologic mapping based principally on a study of aerial photographs, of the Turret Peak 30-minute quadrangle, which includes the Pine Mountain area. Mrs. Medora H. Krieger, of the U.S. Geological Survey, also made a brief reconnaissance of the western and northwestern part of the Turret Peak quadrangle in 1955–57 during reconnaissance for revision of the State geologic map of Arizona.

PRESENT STUDY

The present study of the Pine Mountain primitive area and bordering areas was made during a 6-week period in April and May 1966 by F. C. Canney, W. L. Lehmbeck, and G. H. Van Sickle. Mr. Adolpho Mezzetti of the National Institute of Mining and Geology in Argentina also participated in some of the fieldwork.

Because the objective of the study was to evaluate the mineral potential of the area, geochemical prospecting, supplemented by reconnaissance geologic mapping, was the principal method of investigation (pl. 1). Geologic data obtained in a preliminary photogeologic study were useful in planning and controlling to some degree the extent and density of the geochemical sampling program by indicating those areas where the rocks were judged most likely to contain mineral deposits.

Sampling and analysis of stream sediments was the principal geochemical reconnaissance method employed. Very large areas can be scanned for their mineral potentialities by drainage surveys because of the fairly great distances over which the weathering products of mineral deposits are carried by ground and surface waters. Such surveys are useful both in the location of individual deposits and of entire mineralized districts, as well as in the appraisal of prospects and favorable geological features. This technique was judged particularly suitable for this evaluation study because the topography was generally very rugged and hence the rocks were being actively eroded. In, and just outside, the Pine Mountain area, 186 samples of active stream sediment, 24 samples of heavy-mineral concentrate, and 46 samples of soil, altered rock, fault gouge, and mineralized zones and veins were collected. The sample localities are shown on plate 2.

The reconnaissance geologic map (pl. 1) was prepared principally by study of the aerial photographs coupled with geological observations in the field. The ease with which the gently dipping layered Tertiary lava flows and the conspicuous cliff-forming Tapeats (?) Sandstone could be recognized in the photographs greatly facilitated photogeologic interpretation (fig. 4).

A small amount of work was also done outside the primitive area. This consisted principally of examining several nearby mines and prospects for the purpose of gaining an insight into the type of mineral deposit that might be expected to occur in similar host rocks in the Pine Mountain area.

The only known resource of valuable nonmetallic minerals in or near the Pine Mountain area is a small occurrence of white onyx marble just outside the south boundary of the proposed wilderness. Because this deposit was being worked as a source of terrazo aggregate at the time fieldwork was underway, we studied it briefly to see whether similar deposits might exist in the proposed wilderness.

The possibility that the area might contain limestone pure enough for use in making cement was considered. This was based on the possibility that the Redwall Limestone of Mississippian age, from which raw material for cementmaking is obtained elsewhere in Yavapai County, might be present in the Pine Mountain primitive area.

The possible value of the rocks in the Pine Mountain area as sources of construction and road material was not considered owing to the remoteness of the area from centers of population.

The reconnaissance geological data and the known structural setting of the Pine Mountain area also indicated that petroleum need not be considered as a potential resource.

COLLECTION AND ANALYSIS OF GEOCHEMICAL SAMPLES

The standard stream sediment sample was a composite sample of the finer material taken at several points in the streambed. About 50–75 grams of material was usually taken and stored in a waterproof paper envelope. The samples generally were of material in the fine- to coarse-sand sizes; sediment in the clay-size fraction was generally very scarce, and apparently most of this kind of fine sediment had been flushed out of the drainage system by the raging torrents that are reported to have flowed in most of these stream courses a few months earlier. The density of sampling averaged about six samples per square mile, but it varied greatly. In general, more samples were collected in areas underlain by igneous and metamorphic rocks of Precambrian age, which were considered most likely to contain mineral deposits, and fewer samples were collected in areas underlain by Paleozoic strata and Tertiary lavas.

In addition, 24 heavy-mineral concentrates were taken by panning out one pan of stream gravel. The availability of water generally dictated where this type of sample was taken. These crude heavy-mineral concentrates were later purified with heavy liquids, and the heavier-than-bromoform fraction (specific gravity 2.89) was saved for analysis.

All stream-sediment samples, except the crude heavy-mineral concentrates, were sieved to minus 250 microns, and the fines were saved for analysis. Quick colorimetric tests for cold-extractable copper and citrate-soluble heavy metals were run on these samples in a mobile chemical laboratory near the field area. These preliminary data were needed to determine quickly whether or not anomalous amounts of such common base metals as copper, lead, and zinc were present. The analytical methods used in the field laboratory have been described by Ward, Lakin, and Canney (1963).

All stream sediment samples, heavy-mineral concentrates, and samples of altered and mineralized rocks were analyzed by a semi-quantitative spectrographic method, from which the results can be considered as being within 30–50 percent of the correct value. Gold was determined by use of a sensitive colorimetric chemical procedure described by Lakin and Nakagawa (1965). The analytical data (tables 1, 2, and 3, beginning on p. J34) are in parts per million (ppm); 1 ppm equals 0.0001 percent, or the equivalent of 0.029 ounce per ton.

GEOLOGY

Rock formations exposed in the Pine Mountain primitive area range in age from Precambrian to Cenozoic (pl. 1). The Precambrian rocks underlie most of the Tonto area and are also exposed in the lower reaches of Bishop and Sycamore Creeks in the Prescott area. They consist of medium- to coarse-grained igneous rocks of acidic to intermediate composition, migmatitic rocks, and highly deformed and altered metavolcanic and metasedimentary rocks. Unconformably overlying the Precambrian rocks in part of the area are sedimentary strata of the Cambrian Tapeats(?) Sandstone and the Martin Limestone of Devonian age. Paleozoic rocks younger than the Martin Limestone were not recognized although the mapping was not done in sufficient detail to preclude positively the possible presence of some Mississippian Redwall Limestone. Overlying the Paleozoic strata in the northwestern part of the area are volcanic rocks, principally basalt flows, of Cenozoic age. In much of the southwestern part of the area, however, erosion apparently stripped the Paleozoic strata prior to the beginning of Tertiary volcanic activity, for many basalt flows there rest directly on Precambrian granite.

GEOLOGIC SETTING

The Pine Mountain area is at the south end of the Black Hills, a north- to northwest-trending elevated and slightly tilted fault block that extends northwestward to the Jerome area. The geology in the north half of the Black Hills is well known from the detailed mapping in the Jerome area by Anderson and Creasey (1958) and from the studies in the adjoining Verde Valley by Twenter and Metzger (1963). Metamorphosed volcanic and sedimentary rocks and intrusive quartz-bearing granitoid rocks, all of Precambrian age, are the oldest rocks in the northern Black Hills. They are unconformably overlain by Paleozoic sedimentary rocks which range in age from Cambrian to Permian. In the Jerome area the Paleozoic strata present are, in ascending order, the Cambrian Tapeats(?) Sandstone, the Devonian Martin Limestone, the Mississippian Redwall Limestone, and the basal or Pennsylvanian part of the Supai Formation.

Anderson and Creasey (1958, p. 46) placed the lowermost Paleozoic rocks in the Cambrian with reservation, for they considered it possible that they may be Devonian rocks rather than equivalent to Tapeats of the Grand Canyon area. They measured an aggregate thickness of about 1,200 feet of Paleozoic rocks in the Jerome area. Rocks younger than the Pennsylvanian and Permian Supai Formation were completely stripped from the Black Hills range by erosion before Tertiary volcanism.

According to Anderson and Creasey (1958, p. 79), the greatest deformation in the Jerome area occurred in late Tertiary time after accumulation of most of the Tertiary volcanic and sedimentary rocks. At this time the Black Hills were uplifted along normal faults, probably part of the block faulting of the Basin and Range province. The present topography resulted from this uplift and subsequent erosion. The Black Hills are bordered along the east front by the Verde fault zone and along the west front by the Coyote fault zone. The Verde fault zone, which closely follows the northeastern edge of the Pine Mountain area, is a series of normal faults between which the blocks are progressively downdropped to the east. Near Tule Mesa, in the southern part of the Black Hills which lies just north of the area covered in this study, Twenter and Metzger (1963, p. 63) reported that as many as 25 fault segments are in a zone about 6 miles wide, and that displacement along the Verde fault in Cenozoic time was as much as, and probably more

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than, 3,000 feet. The block faulting that uplifted the Black Hills resulted in two distinct types of deformation: simple uplift marked by gentle tilting and faulting accompanied by mild to severe tilting (Anderson and Creasey, 1958, p. 78). The rocks apparently yielded by faulting and tilting rather than by folding.

Cenozoic rocks of volcanic and sedimentary origin are widespread throughout the Black Hills. The relative abundance of the sedimentary and volcanic facies varies widely. The volcanic rocks are composed chiefly of basaltic flows and subordinately of basaltic sediments and agglomerate. The physical character and mineralogic composition of the basalt appears to be typical of many plateau basaltic flows (Anderson and Creasey, 1958, p. 57). The sedimentary facies of the Cenozoic rocks range from fine silty sand and marl to coarse gravel and conglomerate.

PRECAMBRIAN ROCKS

Quartzose intrusive rocks, gneiss, migmatite, metamorphosed mafic extrusive rocks, and associated tuffaceous sedimentary rocks are the oldest and most widespread rocks in the primitive area. They constitute the exposed bedrock in more than half of the Pine Mountain area, principally in the Tonto area. The Precambrian rocks are exposed at altitudes ranging from less than 4,000 feet to at least 6,000 feet.

The quartzose intrusive rocks, principally granitic but with some facies that probably range to quartz diorite in composition, are by far the most common Precambrian rock type exposed. Some relatively small areas of highly deformed metamorphic rocks have been shown separately on plate 1. The areas underlain by gneissic and migmatitic rocks, however, were not mapped separately; in general, these types occur mostly in small poorly defined areas in a northeast-trending belt between the Pine Mountain–Turret Peak ridge and the westernmost of the two major northeast-trending faults shown in the Tonto area.

The metamorphic rocks are highly deformed volcanic and tuffaceous rocks of intermediate to mafic composition. Lava flows are the predominant type, but some intercalated tuffaceous beds are also present. Megascopically, these rocks are mostly dark gray to dark grayish green to greenish black on fresh surfaces; they generally weather to various shades of brown, commonly with a reddish tinge. In many places, notably near the contacts with the enclosing granite, these rocks are highly stained by iron and manganese oxides to various shades of red and black. Such staining is apparently caused by the oxidation of small amount of contained pyrite. The metamorphic rocks weather to a dark-brownish soil which supports a very dense brush cover which is much thicker than the cover on areas underlain by the granitic rocks.

Near some of the areas of metamorphic rocks are irregular zones and masses of migmatitic rocks where dark-grayish-green rocks very similar in appearance to the metavolcanic rocks contain abundant medium- to coarse-grained granitic material in stringers and irregular masses.

The Precambrian granite in the Pine Mountain area is fairly uniform in composition and appearance over wide areas. It is predominantly a medium- to coarse-grained equigranular massive rock with a typical igneous rock texture. The fresh rock is typically somewhat pinkish, although considerable color variations ranging from a rather dark brick red to a light pinkish brown are common. It weathers to various shades of brown and red. Megascopically, it is composed of potash feldspar (commonly mostly microcline), plagioclase, clear, vitreous quartz, and greenish-black hornblende. The relative proportion of light and dark minerals and of quartz and feldspar varies somewhat. In areas where the rock approaches quartz diorite in composition, many outcrops have a distinct greenish coloration. The hornblende is in part altered to chlorite. The rather appreciable amounts of magnetite found in the heavy-mineral concentrates from granitic areas indicate that considerable accessory magnetite is present. Epidote is also rather widely, but erratically, distributed; in many places it occurs as thin veinlets.

The granite in the northeastward-trending fault block along the southeastern boundary of the area is usually coarser grained and redder; it contains more microcline and less hornblende than the granitic rocks to the west, which are paler in color and in some parts probably approach granodiorite or quartz diorite in composition.

The granite weathers readily to a sandy aggregate composed mostly of pea-sized grains of quartz and feldspar. The greater amounts of brick-red microcline in the northeastward-trending fault block along the area's southeastern margin cause the overlying sandy soil and alluvium to have a much more distinct red-brown color than the adjoining areas. This vivid contrast causes the fault block to stand out clearly on the black and white aerial photographs of the area.

Quartz veins, stringers, and pods in narrow shear zones and joints are widely distributed in the granitic rocks. In general, they are narrow, ranging from less than an inch to a few feet wide. Very few can be traced for any distance; one outstanding exception is a quartz "reef" in the southeastern part of the area near Skeleton Ridge (pl. 1). This "reef" crops out for about 2½ miles and ranges in width from about 50 to 250 feet and averages about 100 feet. It consists principally of milky white quartz; minor amounts of hematite coats fractures and seams in the quartz. Its contact with the enclosing granite is gradational over about 10 feet, and this border zone contains many small quartz stringers. Presumably this quartz "reef" could mark the trace of an old fault zone.

The granitic rocks in the Pine Mountain area are of undoubted Precambrian age because the Cambrian Tapeats(?) Sandstone rests unconformably on an old erosion surface carved into these rocks.

PALEOZOIC ROCKS

Lower Paleozoic sedimentary rocks are exposed at several localities in the Pine Mountain primitive area and unconformably overlie the Precambrian rocks. The Tapeats(?) Sandstone of Cambrian age was deposited on an old erosion surface of granitic rocks. Overlying the Tapeats(?) Sandstone with apparent conformity is the Martin Limestone of Devonian age. The combined thickness of these two formations probably does not exceed about 500 feet at any place in the area, and the aggregate thickness appears to be extremely variable. Paleozoic rocks younger than the Martin Limestone have apparently been eroded from the Pine Mountain area although the possible presence of thin remnant patches of Mississippian Redwall Limestone cannot be ruled out completely by our fieldwork.

The Paleozoic rocks are well exposed in the east-facing cliffs along the Pine Mountain escarpment, between the northern boundary of the area and Mockingbird Pass; they are also well exposed in the upper reaches of Bishop Creek and its tributaries, and presumably they underlie the Tertiary volcanic rocks in much of the northwestern part of the area. Small fault-block areas near 1M Peak are also underlain by Paleozoic rocks. The Paleozoic formations have been eroded from almost the entire eastern part of the area; only a few scattered outliers are present as thin caps on some of the higher areas such as Skeleton Ridge. Paleozoic rocks are missing from large areas in the southwestern part of the primitive area; presumably they were eroded before Cenozoic time, for basalt flows rest directly on the granitic rocks in these areas. Thin wedges of Paleozoic rocks are also present in at least two localities along the major fault that closely parallels the southeastern boundary of the primitive area.

The base of the Paleozoic rocks in the Pine Mountain area generally ranges in altitude from 5,000 to 6,000 feet; the wide variation results from extensive block faulting.

The Tapeats(?) Sandstone, which is 50–75 feet thick, generally consists of a lower unit, composed of coarse-grained sandstone and conglomerate that form prominent cliffs, and a slope-forming upper unit, composed chiefly of dolomitic siltstone and shale moderately cemented with siliceous and calcareous cement. The lower unit, in which crossbedding and cut-and-fill channels are common, is buff to light reddish brown and is composed mostly of pebbles of quartz, chert, and jasper in a light ferruginous-siliceous cement. Some variation in thickness is caused by the uneven erosional surface on which the Tapeats was deposited.

The Martin Limestone, which overlies the Tapeats(?) Sandstone with apparent conformity, consists mostly of dolomite, but it also commonly contains dolomitic limestone, limestone, and minor interbeds of limy siltstone and sandstone. Beds range in thickness from a few inches or less to a few feet. Color varies depending partly on grain size and partly on the amount of impurities. Light shades of gray, generally with tinges of yellow or pink, are most common. The thickness of the Martin varies considerably owing to erosion.

CENOZOIC ROCKS

Cenozoic rocks, chiefly volcanic, are widespread in the Pine Mountain primitive area. They compose much of the exposed bedrock in the Prescott area, where they overlie both Paleozoic sedimentary strata and Precambrian granite. Except for three small pluglike masses of rhyolite that intrude the granite in the southern part of the area east of the Pine Mountain escarpment, the volcanic rocks consist almost entirely of basalt lava flows although very small deposits of cinders, breccia, and agglomerate are not uncommon. Except for a short stretch north of Mockingbird Pass, a prominent line of basaltic cliffs forms the ridge that marks the top of the escarpment in the Pine Mountain area. Where the basaltic lava sheet is well exposed, it consists of several rather massive flows, usually separated by a thin soil layer or pyroclastic deposit. Most flows have massive interiors but blocky-appearing tops. Columnar jointing is very common. Most of the lava is highly vesicular. On fresh surfaces the basalt is light to dark gray, but some has a reddish tinge; on weathered surfaces it is dark gray or brownish black. The basalt is porphyritic, with phenocrysts of olivine and augite set in a very fine grained groundmass. The physical character and mineralogic composition of the basalt appears typical of that of many plateau basaltic flows.

The thickness of the Tertiary basaltic rocks varies considerably, but it is possibly as much as 1,000 feet. These rocks are probably thickest northwest and west of Pine Mountain. The exact age of these basalt flows is not known, but similar rocks in the Verde Valley north of the Pine Mountain area were reported by Twenter and Metzger (1963, p. 44) to underlie the Verde Formation, which is probably Pliocene or Pleistocene in age; Anderson and Creasey (1958, p. 58–59) tentatively assigned the Tertiary volcanic rocks in the Black Hills to the Pliocene Epoch.

Three small pluglike masses of rhyolite are shown or plate 1 in the area of granitic rocks in the southern part of the map area. The rhyolite is fine grained and fresh in appearance; it consists of small phenocrysts of quartz and feldspar crystals set in a dense groundmass. It is white to light gray and weathers white; the outcrops contrast starkly with the brick-red granite that surround them. Vertical flow banding is also common near the edges of these masses. The southwesternmost rhyolite plug forms a spirelike mass that stands prominently above the surrounding granitic terrane.

Lack of stratigraphic relations with rocks younger than Precambrian prevents the assignment of a definite age to these rhyolitic rocks, but probably they are the youngest rocks in the Pine Mountain area and possibly are of Quaternary age. This conclusion is based on the fresh appearance of the rocks and on the fact that rhyolitic rocks unconformably overlie and, northeast of Squaw Peak, about 15 miles north of the area of this report (Twenter and Metzger, 1963, p. 58), penetrate the Verde Formation of Pliocene(?) or Pleistocene age.

Stream deposits of Recent or Pleistocene age occur in terraces principally along Bishop Creek, South Fork of Sycamore Creek, and some of the larger canyons draining the southeastern part of the area. They were not mapped separately, but in general they consist of a heterogeneous mixture of boulders, cobbles, and finer grained material. Their composition reflects rather closely the geology of the rocks in the immediate source area. The deposits are mostly unconsolidated and are generally not stratified. Coarse colluvial gravels also cover the bases of some of the steeper slopes in some areas.

STRUCTURE

Most of the Paleozoic sedimentary rocks and the Tertiary volcanic rocks have only slight dips. Where accurate measurement could be obtained, the Paleozoic strata strike between N. 20° W. and N. 70° W. and dip 5°–10° NE. The lava beds dips much more steeply in the downfaulted blocks southeast of 1M Peak.

No folds were recognized in the primitive area. Apparently the rocks reacted to the stresses during the period of Cenozoic deformation principally by simple uplift and gentle tilting.

Vertical to high-angle faults are the principal structural features in the area (pl. 1), and several periods of faulting were recognized. Although the great majority of faults cut all the rocks in the area, at least one fault cuts the granite and overlying Paleozoic strata but not the overlying lavas, and others cut the lower part of the lava flows but apparently not the upper part. These different periods of faulting are in agreement with observations made by others in nearby areas where structural disturbances are known to have occurred intermittently since the close of the Paleozoic. Two sets of faults are present, those that in general strike northwest to west, which are predominant, and those that strike northeast.

The well-known Verde fault zone, which extends for many miles and which is the eastern boundary fault of the Black Hills, closely parallels the northeastern boundary of the primitive area. It continues to the north on the west side of the Verde Valley to Bakers Pass, north of Jerome, and probably at least 10–15 miles to the southeast, as suggested by an unpublished photogeologic study by F. R. Twenter. The Verde fault zone comprises a main fault and many parallel and subparallel faults. The series of high-angle normal faults bound blocks that are progressively downdropped to the east. At the northeastern edge of the primitive area, Tertiary volcanic rocks are downdropped against Precambrian rocks along the Verde zone. The stratigraphic throw along this stretch of the fault is not known but is certainly in excess of 2,000 feet, as the altitude of the base of correlative volcanic rocks exposed in the escarpment at Pine Mountain is at least 6,000 feet and the base of the Tertiary in the downdropped block is less than 4,000 feet. According to Anderson and Creasey (1958, p. 147–149), the Verde fault represents an old zone of structural weakness, for movement in Precambrian time may have displaced Precambrian rocks as much as 1,000 feet. Most of the movement along this fault apparently occurred after deposition of most of the Tertiary volcanic rocks.

Another major structural feature is a fault that strikes northeastward and closely parallels the southeastern border of the Pine Mountain area (pl. 1). Tertiary volcanic rocks and sediments on the east side of the fault are downdropped against the pinkish Precambrian granite over much of its trace. There are, however, at least two small slices of Paleozoic rocks that occur between the granitic and volcanic rocks; one of these is at the site of the onyx quarry, just outside the primitive area. This boundary fault appears to have most of its displacement along one large break. Its rather straight trace indicates a nearly vertical dip. To the northeast, this fault appears to end against the Verde fault. To the southwest, outside the primitive area, the unpublished photogeologic studies of F. R. Twenter show that the fault assumes a more southerly trend and continues for many miles.

Strata are not available to permit the exact assessment of the displacement. However, altitude at the base of the Tertiary volcanic rocks on the downthrown side of the fault is less than 4,000 feet; and the correlative volcanic rocks along the escarpment between Turret Peak and Mockingbird Pass are generally more than 5,000 feet in altitude; therefore, the combined stratigraphic throw of this and the paralleling fault to the northwest is at least 1,000 feet and probably much more.

Another major fault zone parallels the southeast boundary fault, where it appears mostly as a single break; elsewhere, such as south and southwest of Mockingbird Pass, it occurs as several subparallel subordinate faults. Most of the Precambrian metamorphic rocks of the area occur between the minor and major faults along this zone of faulting. The zone extends almost the entire length of the primitive area, but it cannot be traced across Skeleton Ridge. In general, the faults along this zone have vertical to very steep southeasterly dips.

Numerous smaller faults are also present in the primitive area, many of which are shown on plate 1. Most are high-angle normal faults that roughly parallel the trend of the major structural features. Displacements, where they could be estimated, range from a few tens of feet to several hundred feet or more. In general, the area is complexly faulted, and there are many more faults than were mapped. The Tertiary volcanic rocks probably conceal many faults related to the earlier period of deformation between the end of the Paleozoic and the beginning of volcanism in Tertiary time.

MINERAL RESOURCES

SETTING

The Verde mining district, on the east slope of the northern part of the Black Hills, 30–40 miles northwest of the primitive area, has produced significant amounts of gold, silver, copper, and zinc. Two famous mines in this district, the United Verde and the United Verde Extension, both at Jerome, have contributed more than 99 percent of the total production of the district, and commonly the district is called the Jerome district (Anderson and Creasey, 1958, p. 100). Many mineral deposits of various sizes also occur in a belt of Precambrian igneous and metamorphic rocks south and southwest of Jerome for a distance of about 50 miles. According to Creasey (1952, p. 26), the distribution of these mines suggests a mineral belt; in this belt 16 mines each have had a metal production valued at more than $1 million.

Precambrian massive sulfide deposits, Precambrian fissure veins, and Quaternary gold placer deposits are the principal types of ore deposits in the Black Hills and in Bradshaw Mountains to the southwest. The massive sulfide deposits consist principally of pyrite, with variable amounts of other sulfides, especially chalcopyrite, tennantite, sphalerite, and galena. These deposits are considered to be replacements of schistose rock. They generally exhibit sharp margins with the host rock, which commonly shows silicification and sericitization (Anderson and Creasey, 1958; Krieger, 1965).

The fissure veins, generally found along shear zones, have been mined chiefly for gold quartz and copper-silver-gold ore. The veins were formed mostly by fissure filling, although wallrock replacement is not uncommon along some of them. Although veins of this type are very common in the Precambrian terrane, very few are of economic importance, and production from them has been small and sporadic.

Because nearly all the ore deposits in Yavapai County are in Precambrian rocks and were probably formed in Precambrian time, it seems unlikely that significant mineralization would be found in the Paleozoic and younger rocks in the primitive area although a few minor prospects in younger rocks prove the existence of mineralizing solutions of post-Paleozoic age (Krieger, 1965, p. 107–108).

Although the Pine Mountain area lies a considerable distance from the mineral belt mentioned above, the fact that Precambrian igneous and metamorphic rocks are exposed in more than 50 percent of the area indicated that the possible presence of mineral deposits of the types just mentioned could not be ruled out on geologic considerations alone. On the other hand, much prospecting has been done south and north of Jerome in the hopes of finding ore bodies like those of the United Verde and United Verde Extension; so, it could be assumed that the Pine Mountain primitive area has been thoroughly prospected and that surface indication of important mineralized areas such as large gossan zones were probably absent, at least in the areas of exposed Precambrian rocks. We found nothing in our field studies to nullify this assumption.

METALLIC MINERALS

There is no record of any mineral production in the primitive area. Some possible production probably came from the Copper Queen, United Arizona, and Rosalie mines, about 6 miles southwest of Turret Peak. The Copper Queen and the United Arizona were examined briefly. The Copper Queen apparently was little more than a prospect; the United Arizona probably had a small production, as suggested by the size of the dump, but its underground workings were not accessible for inspection. The country rock at both properties consists of tan to pink medium- to coarse-grained granite. At the Copper Queen a narrow shear zone contains oxi-

244–284 O—67——4

dized copper minerals in silicified stringers in shallow underground workings. At the United Arizona the dump material indicates a similar type of occurrence.

Three small prospects, in shear zones in the medium-grained granite, were also noted near Bishop Creek, slightly more than a mile outside the southwest boundary of the primitive area (pl. 2). Oxidized copper minerals and very sparse primart sulfides, principally chalcopyrite, occur in narrow quartz veins and lenses and pods of silicified granite along the zone. Abundant chlorite was noted in some of the altered rock in the shear zones. None of the deposits appeared to be of economic importance.

PROSPECTS

The U.S. Bureau of Mines section of this report notes that 96 claims, in three groups, are in the Pine Mountain area or adjoining areas. Only the Frances Young group of 18 claims are believed to be in the primitive area. We did not positively identify any discovery pits or monuments on these claims although a small prospect about half a mile south of the MT Ranch (site 104, pl. 2) may be on this claim group, for it appeared to have been worked fairly recently. This prospect consists of a 15-foot adit driven into a vertically dipping shear zone that strikes N. 70° W. The shear zone is about 3–4 feet wide and consists mostly of brecciated and kaolinized Precambrian granite. Minor amounts of secondary copper minerals occur in the altered granite at the adit mouth, but none were seen beyond. Sparse specimens of silicified rock on the dump contain limonitic boxworks and a few traces of unoxidized pyrite and chalcopyrite. On the hillside above the adit the zone appears to be very weak and could not be traced for more than about 20–25 feet; its surface expression is mostly the presence of slightly more altered and iron-stained float. Four samples of mineralized rock and material from the shear zone (table 2, samples 104M, 104M2, 104M3, 104M4) contained negligible amounts of precious metals. The prospect appears to be similar to those previously described and has insignificant economic potential.

Another small prospect (site 107, pl. 2) is about half a mile south-southwest of the above prospect. A discovery notice on this claim is dated 1942. A 4-foot-deep pit on the claim exposes small amounts of secondary green and blue copper minerals coating fracture surfaces in granite. The occurrence is apparently an isolated pocket, for no trend was apparent. The analysis of a sample (table 2, sample 107M) of the copper-stained granite showed the highest silver content found in any of the Pine Mountain samples (22 ppm, or 0.6 oz per ton). This prospect is of no economic significance.

Another prospect is on a tributary to Red Creek less than one-quarter of a mile inside the primitive area and not far from the major fault that separates the Precambrian rocks from the Tertiary volcanic rocks (site 142, pl. 2). A mineralized shear zone in a narrow belt of Precambrian metamorphic rocks is explored by old workings that consist of a 20-foot adit and two small pits. The zone trends about N. 65° E. and can be traced for about 1,000 feet. The exact width of the zone is difficult to determine, but it is possibly 10–20 feet at the adit; the width appears to vary considerably along the strike. There is no trace of the zone on the hillside to the southwest. Fragments of a dense grayish-green rock containing pyrite and arsenopyrite were found on the dump, and similar rock is exposed in the creek bottom. No copper-stained rock was seen.

Analyses of samples 142M, 142S, 142M3, 142M4, 142M5, and 142-M6 (table 2) show that the metal content of the zone is of no economic interest. Slightly anomalous, though very low, contents of copper and zinc were found in most of these samples. Negligible amounts of gold and silver also were found.

OTHER MINERALIZED AREAS

Iron-stained zones, bleached areas, quartz-jasper stringers and veins, and other miscellaneous types of altered rock are common in the Precambrian metamorphic rocks of the primitive area. These rocks were briefly examined but were not sampled unless the intensity of staining and alteration appeared to be considerably above average. The more highly altered zones generally are at or near fault zones that separate Precambrian metamorphic rocks from the granitic rocks. Commonly, a distinct increase in the redness of the granite can be observed as a major fault is approached. Although no prospect pits or other workings were noted in these slightly altered areas, a few old claim corners were occasionally noted nearby. In the following descriptions of some of these areas, sample-site numbers referred to are shown on plate 2 and the analytical data are given in table 2.

Along a stream tributary to Soda Spring Creek, at the southern boundary of the primitive area, a narrow mineralized shear zone in granite is exposed (site 163). The zone is compoesd of approximately 6 inches of brick-red rather soft material bordered by 3–4 inches of bleached and silicified granite; numerous narrow quartz stringers are also present. Analysis of a composite chip sample of the zone (163R) showed no metal values of economic interest.

About 0.3 mile upstream from site 163 and just east of the fault contact between the granite and metamorphic rocks, the granite on both banks of the stream is appreciably more altered and iron stained. In places it appears to be a gossan, is highly silicified, and is colored rather dark shades of red and black. This alteration is very pervasive over a fairly large area, but no discrete veins or other structural features were detected. Two samples of the more highly altered and stained rock (164R2 and 164R3), one from either side of the stream, contained anomalous amounts of lead and slightly anomalous amounts of molybdenum and zinc. These metal contents are extremely low compared with metal contents of gossans associated with most base-metal deposits. It is highly unlikely that more than mere traces of base-metal minerals are present in the fresh rock. The lack of any anomalous concentrations in the downstream-alluvium samples also tend to confirm this conclusion.

Quartz veins and pods are widely distributed in the Precambrian rocks. They generally are less than a few inches wide, but some are as much as a foot or more wide. The largest silicified zone, the quartz "reef" (pl. 1), has been described in a previous section. In general, the quartz veins consist principally of milky white quartz; metallic minerals are scarce.

In the upper reaches of Soda Spring Creek, near sites 173 and 174, small veins are more abundant than at most places. One of the larger veins which trends N. 65° E. to N. 35° E. and dips steeply, is 2–3 feet wide and at least 500 feet long. No sulfides were seen, but thin seams of jasper and limonite in a matrix of milky quartz are common. Analysis of a composite chip sample of the vein (173R) at a point where it contained appreciable amounts of jasper and limonite revealed no metal concentrations of economic interest.

The highest gold content of any rock sample (176R1) taken in the primitive area was from a 10-inch quartz vein containing sparse pyrite near site 176. The value of 0.75 ppm, however, represents only about 0.02 ounce per ton of gold and is of no economic interest. The quartz vein is in a major fault zone that consists of about 30–40 feet of brecciated rock that includes about 4–5 feet of finely pulverized material. A 20-foot channel sample of material from the fault zone (176R2) contained no metal content of economic interest.

Three-tenths of a mile upstream from site 176 in an area shown as granite on plate 1 are several areas of metavolcanic rocks (sites 177 and 178) that are appreciably altered and iron stained. The rocks are rather highly fractured and bleached in localized areas and also contain small seams of jasper and quartz. The extent of these areas of altered basic lavas was not determined; however, some small faults can be observed on the aerial photographs, and it is probable that these areas represent small down-faulted blocks.

The analyses of samples (177S, 177R, and 178R) collected from the area and the overall appearance of these altered rocks suggest only that silica and minor pyrite have been introduced. It is extremely unlikely that this area has any economic significance. Anderson and Creasey (1958, p. 43) noted that many sheared zones in the Precambrian metamorphic rocks northwest of the area were sufficiently mineralized with quartz and jasper and at places with pyrite and presumably chalcopyrite to encourage the prospector into fruitless exploration. To the best of their knowledge, no jasper vein in that area ever yeilded sufficient ore to justify the exploration.

Another area of iron-stained and altered basic volcanic rocks, site 188, contains much jasper, as thin films on joints and as thin seams along fractures, and numerous small quartz stringers and lenses. This area is just west of the major fault shown on plate 1; at this point the fault is very tight, and no appreciable amount of gouge or shattered rock is present. Analysis of a composite sample of the iron-stained volcanic rock (188R) revealed no anomalous metal contents.

Two other areas of altered and mineralized rock were detected during a reconnaissance of Monroe Canyon. One of these (site 247) is a poorly defined zone of shearing in fine- to medium-grained pinkish granite. It is marked principally by an increase in the intensity of iron staining and bleaching and by the presence of many more thin seams of quartz and jasper. An alinement of notches in the ridgetops may represent the strike of this zone. One distinct vein in this generalized zone of shearing, which strikes N. 50°–60° E. and dips about 60° S., is composed of seams of quartz, jasper, and barite and contains much reddish-black gossany material. Analyses of a composite chip sample of the vein (247R) and of a composite sample of colluvial soil taken across the zone reveal nothing of economic significance.

Three-tenths of a mile upstream from the zone just described is an iron-stained zone in siliceous grayish-green metavolcanic rocks exposed in the banks of the stream. The zone strikes about N. 60°–70° E. and dips steeply. Much of the float on the steep hillside above the zone is highly stained to various shades of red and black with iron and manganese oxides. This zone appears to be in a thin slice of metamorphosed volcanic rocks that occur just west of the major fault shown on plate 1 and east of an area of predominantly granitic and migmatitic rocks. The geology in this general area is, however, very complex, and detailed mapping would be necessary to adequately understand the structure and geological relations. The mineralized zone appears, though, to be very similar to those in metavolcanic rocks that have been previously described, especially the prospect on a tributary to Red Creek (site 142). No prospect pits or other signs of exploratory workings were seen in the iron-stained zone although one old claim cairn was noted. In some of the more siliceous areas, abundant to sparse pyrite was noted, and the analytical data also suggest that minor arsenopyrite is undoubtedly present. A narrow barite vein striking N. 25° W. was also noted. Analysis of a sample of the mineralized rock showed no more than a trace of copper and only 0.08 ppm gold, a negligible content. The copper content of 200 ppm is not unusual for pyrite-bearing rock and has no economic significance. Two samples of colluvial soil (249S, 254S) were taken from locations where their metal contents should reflect the tenor of the zone, but data from these samples show no metal contents that are significantly above background.

A barite-fluorite vein was found in Monroe Canyon at site 238, just outside the primitive area boundary. It occurs in medium- to coarse-grained pinkish granite and consists of a 2–3-inch core of reddish-brown bladed crystals of barite bordered by a selvage of coarsely crystalline bluish-green fluorite. Some specular hematite and a few minor flecks of a mineral that might be pyrite were seen. The granite wallrock of the vein appears fresh although in an adjoining zone, which is 1 inch wide or less, the feldspars have been partly kaolinized. An analysis of the vein material is given in table 2 (sample 238R). Yttrium content of the sample is greater than 200 ppm, but yttrium is known to be a common minor constituent of fluorite, and contents up to about 500 ppm are not uncommon; the sample contained about 20 percent calcium, which suggests a fluorite content of 40–50 percent. Although this was the only barite-fluorite vein noted, other similar veins may be present in the primitive area, but these reddish-brown veins are difficult to detect in a matrix of reddish granite.

Table 2 contains analytical data on samples other than those described in the previous paragraphs. The samples are described briefly in the table but are not otherwise discussed, for no anomalous metal contents were found.

The analytical data in tables 1 and 3 provide no indications that any exposed or near-surface mineral deposit of significant size and economic interest is present in the Pine Mountain primitive area. With rare exceptions, for example, 23 ppm cold-extractable copper in sample 63A (table 1), all the metal contents fall in or are close to the normal background ranges expected in stream sediments derived from unmineralized rocks. Significant anomalies that might indicate exposed or near-surface deposits were not detected in this survey. Although additional minor zones of mineralized rock may be present, the presence of economically important near-surface mineral deposits of base, ferrous, or precious metals is unlikely.

The analytical data on samples from this area, when considered in the light of the geologic framework, permit several generalized observations. A stream-sediment sample represents the relatively insoluble products of weathering of a rock mass. In areas of steep terrain where mechanical erosion predominates, as in the Pine Mountain area, the dominant constituents of a sediment sample are the resistant primary minerals, such as quartz, the heavy accessory minerals, and partially weathered rock and rock-mineral fragments. The metal content of a sediment sample, then, will tend to reflect the average metal content in the various rock types present in the drainage basin of the stream although a complex interplay of various chemical and mechanical factors that influence the sample during weathering and transport permits large variations. Likewise, the mineralogical composition of a heavy-mineral concentrate will reflect the relative abundance of the heavy-accessory minerals.

The normal abundance of many major and minor elements differs appreciably in the two principal rock types present in the Pine Mountain primitive area, the basaltic lavas and the granitic rocks. Mafic rocks, such as basalt, are characteristically higher than granitic rocks in their content of copper, nickel, cobalt, chromium, and other elements. Acidic rock, however, contains more lead, barium, yttrium, and zirconium. Broadly speaking, these differences are principally responsible for the major variations noted in elemental abundances in the stream-sediment and heavy-mineral concentrates. The influence of parent rock type is especially pronounced in the suite of heavy-mineral concentrates (table 3). On the basis of the heavy-mineral concentrate data, samples from streams draining predominantly granitic rocks (for example, 162P, 187P, 236P, 239P) contain on the average more zinc, lanthanum, lead, zirconium, yttrium, molybdenum, and tin but less nickel, cobalt, and chromium than do samples from streams that contain basaltic rocks in their drainage basin (for example, 214P, 215P, 217P).

The same crude correlation between rock type and elemental suites is present in the analytical data for the alluvium samples (table 1). The great range in content of zirconium and chromium is especially notable. Initially, the fact that a few of these samples (79A, 159A,1 95A, 196A) contain above-average amounts of zinc, zirconium, yttrium, tin, and molybdenum suggested they could be considered slightly anomalous. However, owing to the similarity between the analytical data on these samples and the analytical data on heavy-mineral concentrates from granitic terrane, these samples were examined mineralogically and were found to contain quantities of magnetite and other accessory minerals that were much higher than normal. Apparently these streams were sampled at points where stream action had performed a partial natural concentration of the heavy minerals. On samples that contain 200 ppm zinc or greater, the ratio of very low cold-extractable heavy metal to total zinc indicates that the zinc is present in the lattice of one or more minerals, possibly an amphibole or magnetite.

Although no complex pegmatites were seen in the granite rocks, the rather large number of quartz veins and certain other features suggest that at least part of the granite was affected by late pneumatolytic and hydrothermal solutions. Accordingly, the sparse very slight enrichment noted for molybdenum and tin in certain samples is not considered indicative of the presence of mineral deposits of these metals because both tin and molybdenum are known to be rather strongly enriched in late crystallates during magmatic differentiation.

NONMETALLIC MINERALS

There is little likelihood that any nonmetallic deposits of commercial value are present in the Pine Mountain primitive area. In north-central Arizona apparently only the Redwall Limestone of Mississippian age is pure enough in certain areas to be used as a source of lime and cement raw material, and this formation was not recognized in the primitive area. The Martin Limestone is present but it is mostly an impure clastic and dolomitic limestone, and all indications are that it contains no appreciable quantity of commercial-quality limestone. A few very old prospect pits were found in outcrop areas of the Martin Limestone just outside the primitive area boundary near the Nelson Place. The pits are in the dense lithographic unit of the Martin; so, possibly rough building stone or lithographic block was the commodity sought.

Deposits of onyx marble occur at two points just outside the south boundary of the primitive area The principal quarry is shown in figure 2, and a general view of the occurrence and workings is shown in figure 3. The quarry, which was being operated in April and May 1966 by the U.S. Marble Co., produces a white coarsely crystalline calcite which is pulverized for use as an aggregate in the manufacture of terrazzo. This is obviously a high-cost operation owing to the remoteness of the deposit and the necessity to do much hand sorting to obtain material of sufficient purity. However, the miners said that only material from this deposit met the manufacturers' specifications Because this quarry occurs outside the primitive area, it was only briefly examined to determine its geological and structural setting so that the probability of similar occurrences in the Pine Mountain area could be assessed.

The deposit, which is a roughly rectangular wedge of rock composed mostly of calcium carbonate of varying degrees of purity, occurs in the major fault zone that follows the east boundary of the primitive area. It is roughly 2,000 feet long parallel to the fault and is no more than 100–150 feet wide. It is bounded on the southeast by the Tertiary basalts in the down dropped block and on the west by Precambrian granite. The deposit is composed of stringers, lenses, crosscutting veins, and irregularly shaped masses of very pure coarsely crystalline white calcite in a mass of carbonate rock of lesser purity. Several discrete blocks of a tan limestone appeared to resemble some of the limestone of the Martin. Tentatively, we consider this occurrence to represent a type of hot-spring deposit. Possibly the faulting dragged up a brecciated mass of Martin Limestone along the fault zone, and later thermal waters ascending along the fault dissolved some of this material and reprecipitated it upon cooling. The presence of many calcite veins as much as 6 inches wide in the basic volcanic rocks exposed in the canyon of Soda Spring Creek to the southwest tend to substantiate this hypotheses.

No similar deposits were seen in the primitive area although a detailed examination of the entire length of the fault zone was not made. Small slices of brecciated Martin Limestone do occur, however, at several points along the bordering faults, but those examined showed no evidence of having been affected by anything but physical brecciation during faulting. If other similar deposits of onyx marble are present in the primitive area, they most likely will be found along the major fault zones that parallel the eastern boundaries. Our field studies coupled with the inspection of aerial photographs indicate little probability of finding additional deposits.

ECONOMIC APPRAISAL

By Frank E. Williams, U.S. Bureau of Mines

INTRODUCTION

This report describes the work done by the U.S. Bureau of Mines, in the fall of 1965, to determine land status and mineral resources of the Pine Mountain primitive area (referred to on U.S. Forest Service maps as the proposed Pine Mountain Wilderness area), Yavapai County, Ariz. Records of county, State, and Federal agencies were scanned and personnel of these agencies and other individuals acquainted with the area were interviewed.

The examination of the primitive area consisted of checking sites of known claim locations and exploration, seeking surface evidence of mineral occurrencies, and obtaining any information as to possible mining activities of the past.

ACKNOWLEDGMENTS

Acknowledgment of assistance is made to Frank Knight, Director, Arizona Department of Mineral Resources, Phoenix; R. E. Wilson, U.S. Forest Service, geologist, Phoenix; Hoyt Harvel, U.S. Forest Service, Prescott National Forest; Ray Page, U.S. Forest Service, Prescott National Forest; Barry Peterson, U.S. Forest Service, Tonto National Forest; Carl Adams, U.S. Bureau of Sport Fisheries and Wildlife; J. H. Courtwright, geologist, American Smelting and Refining Co., Tucson; Jack Still, mining engineer consultant, Presscott, Ariz.; Paul Edwards, prospector who filed mining claims in the vicinity; U.S. Bureau of Land Management, Phoenix; and the Arizona State Land Department.

MINING CLAIMS

The Pine Mountain primitive area comprises about 17,430 acres of the public domain in Prescott and Tonto National Forests.

The only evidence of recent mining interest in or adjoining the Pine Mountain area is 96 claims, in three groups, filed in August 1965 by Mr. Paul Edwards and associates (fig. 5). These claims,

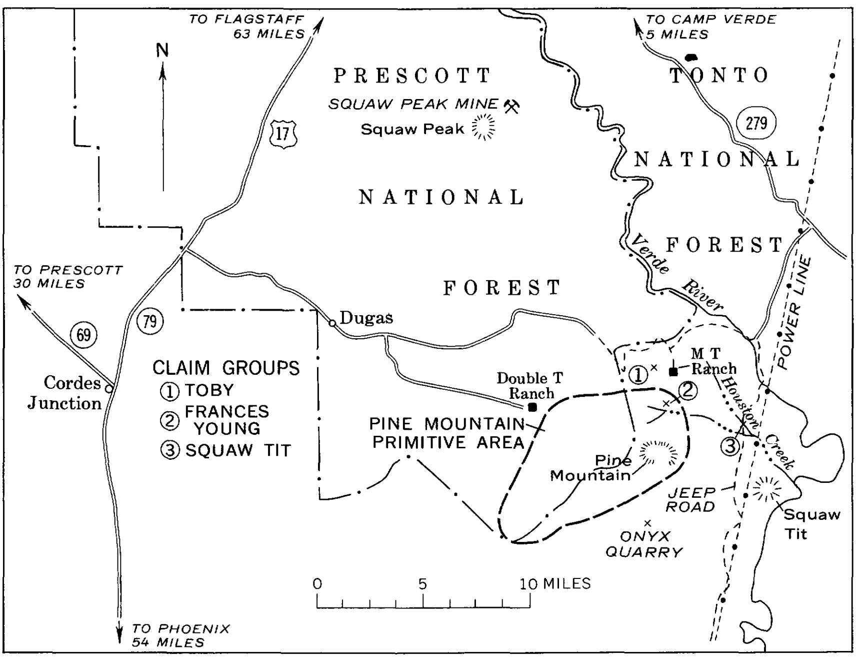

FIGURE 5.—Location of mining claims in and near Pine Mountain primitive area, Yavapai County, Arizona.

which are recorded in the Yavapai County courthouse in Prescott, are: the Frances Young group of 18 claims 1½ miles south of the M. T. Ranch; the Squaw Tit group of 66 claims adjacent to Houston Creek, 2 miles west of the Verde River; and the Toby group of 12 claims about 1 mile west of the M. T. Ranch and 1 mile south of the jeep road.

The position of the claim groups in relation to the primitive-area boundary has not been established. In the absence of a survey to determine the boundary, it is difficult to position the claims with respect to it. The Frances Young group is believed to be just within the primitive area, and the other two just outside. No location monuments, other staking devices, or evidence of the occurrence of valuable minerals was seen on the ground.

Probably there is no patented ground in the Pine Mountain primitive area. However, there are five patents (including mineral rights) adjoining or near the area, which are shown in figure 2 and listed in the following table. Positive location of the patented land parcels cannot be established until the area is surveyed.

Patented land near the Pine Mountain primitive area

Township north	Range east	Sec.	Homestead Entry Survey No. HES—	Acres
11	5	19	321	35.6
11	5	19, 20 (Double T Ranch)	322	40.6
11	5	21, 22 (Nelson Place)	323	17.87
11	6	20 (or 16 and 21) [1]	44	55.08
11	6	22, 27 (or 23 and 26) [1]	320	15.26

[1] The section numbers in parentheses are those shown on the U.S. Forest Service records; those outside parentheses are those given on the U.S. Bureau of Land Management records. The discrepancies exist because this area is not surveyed. If HES 44 is in sec. 20, then, according to the latest U.S. Forest Service map, it is within the primitive-area boundary.

ECONOMIC APPRAISAL

A search of the records and examination of the ground did not show any evidence of petroleum or other mineral production, the occurrence of any valuable minerals, or any mineral potential within the Pine Mountain primitive area. However, sampling by the Geological Survey indicates minor copper mineralization in the adit on the Frances Young group of claims.

The Frances Young group was visited, in the company of Mr. Edwards, and an outcrop designated by him as the "best exposure" was examined. No evidence of valuable mineral occurrence was seen. The claims cover what the locators apparently thought to be gossan, but according to the Geological Survey, this material is iron stained weathered granite. There is a 15-foot adit on one of the claims that antedates the location of the Frances Young group.

The only other reference to possible claim locations in the Pine Mountain primitive area was contained in a letter from the Regional Forester, U.S. Forest Service, to Frank Knight, Director, Arizona Department of Mineral Resources, dated March 30, 1962, regarding an estimated 260 acres located under the general mining laws of 1872, amended. There is no record in the Yavapai County courthouse of these claims ever having been filed. The area cannot be definitely identified but may be in the primitive area and might possibly have been marked by the prospect adit on the Frances Young claim.

The Squaw Tit group of claims and the northern edge of the Toby group were visited in company with Mr. Edwards. The so-called gossan on the Squaw Tit group was similar to that on the Frances Young group. No minerals of economic importance were found.

POTENTIAL OF AREAS ADJOINING PINE MOUNTAIN PRIMITIVE AREA

The field investigation was extended beyond primitive-area boundaries to provide information on known mineral deposits in the general area as a guide to possible similar occurrences in the primitive area.

METALS

A copper-molybdenum deposit at Squaw Peak 13 miles north of the Pine Mountain primitive area was mined on a very small scale during World War II but is not being worked at present. It has no resemblance to exposures in the primitive area.

NONMETALLICS

An excavation a few miles south of Pine Mountain (fig. 6) marks a former quarrying operation on a "marble" occurrence. The material was mined and hauled by truck to Phoenix in 1963–64 for subsequent sale in the Los Angeles area for roofing aggregate. The material is slightly crystallized limestone. This limestone does not appear to be suitable for other uses such as cement making.

It is reported that little or no profit was realized in the operation. Though similar material may be present in the primitive area, it does not constitute an economic or strategic resource under any foreseeable conditions.

MINERAL FUELS

There is no evidence of the occurrence of hydrocarbon minerals in the immediate vicinity of Pine Mountain. Minor lignite seams have been reported in the Permian and Pennsylvanian Supai Formation east of the Verde River, but these sediments have been completely removed by erosion in the general area of Pine Mountain. The nearest, and to date unsuccessful, venture into oil prospecting is about 35 air-miles north-northwest of Pine Mountain in the Verde Valley. The Permian Coconino Sandstone and Kaibab Limestone were the exploration targets, but these formations are not present in the Pine Mountain primitive area.

CONCLUSIONS

Investigation of the Pine Mountain primitive area by the U.S. Bureau of Mines did not show evidence of oil and gas or other mineral potential except possible building materials. There is no economic justification for exploiting occurrences of construction materials. They are not unique and, because of their remote location, are not competitive.

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TABLES

TABLE 1.—*Geochemical analyses of stream sediments*

[Analyses by semiquantitative spectrographic procedure except as noted. Looked for but not detected number preceding the letter in the sample number is the site number shown on the sample-site map.

Sample	Semiquantitative spectrographic analyses (ppm)										
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y
5A	5,000	<200	1,000	100	100	30	70	50	10	10	10
6A	5,000	<200	1,000	100	100	30	50	70	10	10	10
10A	3,000	<200	1,000	70	50	20	20	20	10	20	10
11A	5,000	<200	1,000	70	150	20	10	20	10	20	20
12A	3,000	<200	1,000	50	150	20	5	20	10	10	10
13A	5,000	<200	1,000	150	100	<20	30	30	10	10	10
14A	3,000	<200	1,000	70	100	<20	7	20	10	10	10
15A	5,000	<200	1,500	100	150	<20	10	30	<10	10	15
16A	3,000	<200	500	10	200	50	2	10	<10	10	20
17A	5,000	<200	500	100	100	<20	5	20	10	10	10
18A	5,000	<200	1,000	100	150	<20	20	50	10	15	10
19A	3,000	<200	500	70	100	20	5	20	10	10	10
20A	5,000	<200	1,000	70	100	20	5	20	10	10	10
21A	5,000	<200	1,000	50	100	20	5	20	10	10	10
22A	5,000	<200	1,500	50	150	30	10	30	30	15	10
23A	3,000	<200	1,500	30	150	20	10	30	10	15	15
24A	3,000	<200	1,000	50	100	20	5	20	15	10	20
25A	2,000	<200	1,000	50	100	20	5	20	15	10	20
26A	3,000	<200	1,500	50	150	20	<2	30	15	10	20
27A	3,000	<200	1,500	70	50	20	15	50	15	10	15
28A	3,000	<200	1,000	50	100	20	5	30	10	10	15
29A	3,000	<200	1,000	30	100	20	2	10	5	10	10
30A	5,000	<200	700	50	100	<20	2	20	7	10	15
31A	1,000	<200	200	20	10	<20	<2	10	7	<10	5
32A	5,000	<200	700	70	50	20	20	30	10	10	15
33A	5,000	<200	500	70	70	20	10	30	10	<10	10
34A	5,000	<200	700	50	200	20	5	20	20	10	15
35A	3,000	<200	700	70	150	<20	2	15	15	10	15
36A	3,000	<200	1,000	70	50	<20	10	15	15	15	15
37A	3,000	<200	1,000	100	50	<20	15	50	15	10	10
39A	3,000	<200	1,000	70	100	<20	5	30	10	10	15
40A	3,000	<200	1,500	100	70	<20	10	30	10	10	15
43A	7,000	<200	700	50	200	100	15	20	10	10	50
44A	3,000	<200	1,000	70	100	50	10	20	20	100	20
45A	5,000	<200	1,000	70	50	20	10	70	15	300	10
46A	5,000	<200	500	70	200	70	10	20	20	70	50
47A	3,000	<200	1,500	100	150	20	20	50	15	30	15
48A1	5,000	<200	1,500	100	100	30	20	50	20	70	20
48A2	5,000	<200	1,000	100	100	20	20	30	20	10	20
48A3	2,000	<200	500	30	100	20	10	20	20	10	15
49A	5,000	<200	1,000	50	200	30	5	70	15	20	10
50A	5,000	<200	500	70	100	<20	100	70	10	<10	30
51A	5,000	<200	700	50	70	<20	50	50	10	<10	15
52A	3,000	<200	1,000	30	70	20	10	30	10	20	15
53A	3,000	<200	1,000	50	70	<20	20	50	10	20	10
54A	3,000	<200	500	50	50	20	5	30	10	15	15
55A	5,000	<200	500	50	50	<20	7	30	10	150	10
56A	5,000	<200	500	50	70	20	5	30	10	200	10
57A	5,000	<200	1,000	100	50	20	30	30	10	20	10
58A	5,000	<200	500	70	70	<20	30	30	10	50	15
59A	5,000	<200	1,000	100	70	30	50	50	20	10	30
60A	5,000	<200	1,000	100	70	50	30	50	10	10	20
61A	2,000	<200	500	50	70	50	20	30	15	20	50
62A	5,000	<200	500	70	100	70	20	50	15	15	70
63A	5,000	<200	1,000	70	100	50	20	70	10	20	50
64A	2,000	<200	700	50	50	20	20	30	10	20	15
65A	10,000	<200	1,000	150	50	<20	30	30	10	15	15
66A	2,000	<200	700	70	20	<20	20	20	10	20	10
67A	2,000	<200	700	70	30	<20	10	20	15	20	10
68A	2,000	<200	1,000	70	20	<20	20	30	10	20	10

from Pine Mountain primitive area, Arizona

(element and limit of sensitivity): Ag <1; As <500; Au[1] <0.2; Bi <10; Ce <20; Sb <100; W <50. The
Analysts: Elwin Mosier, G. A. Nowlan, W. L. Lehmbeck, G. H. Van Sickle, Adolpho Mezzetti]

	Semiquantitative spectrographic analyses (ppm)--Continued							Chemical analyses (ppm)	
Sample	Mo	Sn	Co	Be	Cr	Ba	Sr	cxHM[2]	cxCu[3]
5A	<1	<10	20	<1	200	500	200	1	4
6A	<1	<10	20	<1	150	500	200	1	4
10A	<1	<10	10	<1	20	500	100	2	3
11A	<1	<10	10	<1	10	500	400	1	4
12A	<1	<10	7	<1	5	500	<100	2	6
13A	1	<10	10	<1	100	300	<100	1	6
14A	<1	<10	7	<1	20	300	<100	2	6
15A	<1	<10	10	<1	50	200	100	2	6
16A	<1	<10	5	<1	<5	200	400	2	2
17A	<1	<10	7	<1	5	300	100	4	4
18A	1	<10	10	<1	150	500	200	.5	3
19A	<1	<10	5	<1	10	300	200	2	3
20A	<1	<10	10	<1	10	500	200	2	2
21A	<1	<10	10	<1	5	500	200	3	3
22A	<1	<10	10	<1	15	500	200	5	4
23A	<1	<10	10	<1	10	300	200	5	6
24A	<1	<10	10	<1	5	500	200	3	11
25A	<1	<10	10	<1	<5	500	200	2	4
26A	<1	<10	10	<1	<5	1,000	<100	2	6
27A	<1	<10	10	<1	30	500	<100	7	7
28A	<1	<10	10	<1	15	500	100	3	11
29A	<1	<10	7	<1	5	700	<100	3	6
30A	<1	<10	7	<1	<5	300	<100	3	4
31A	<1	<10	<5	<1	<5	100	<100	.5	4
32A	<1	<10	10	<1	70	500	150	2	4
33A	<1	<10	10	<1	30	500	200	.5	1.5
34A	<1	<10	5	<1	5	500	<100	4	4
35A	<1	<10	7	<1	10	500	100	1	4
36A	<1	<10	10	<1	30	1,000	150	2	3
37A	<1	<10	10	<1	50	500	150	1	6
39A	<1	<10	10	<1	10	700	100	2	4
40A	<1	<10	15	<1	100	1,000	300	.5	2
43A	<1	<10	5	1	30	1,000	<100	4	6
44A	<1	<10	7	1	20	1,000	200	2	3
45A	<1	<10	10	<1	100	1,000	300	1	4
46A	<1	<10	10	1	30	1,000	100	2	6
47A	<1	<10	10	1	50	700	100	2	6
48A1	<1	<10	15	<1	50	1,000	100	2	6
48A2	<1	<10	15	<1	50	1,000	100	1	6
48A3	<1	<10	<5	1	20	500	<100	3	1.5
49A	<1	<10	7	1	20	500	<100	3	4
50A	<1	<10	20	1	500	500	200	1	<.5
51A	<1	<10	15	<1	200	300	150	.5	1.5
52A	<1	<10	10	1	20	300	100		7
53A	<1	<10	15	1	50	500	100	2	4
54A	<1	<10	7	1	20	300	<100	1	1
55A	<1	<10	10	1	20	500	150	1	2
56A	<1	<10	7	1	10	300	100	2	2
57A	<1	<10	15	1	300	500	200	.5	2
58A	<1	<10	10	1	100	500	150	.5	1.5
59A	1	<10	20	1	100	500	200	4	2
60A	1	<10	15	1	70	500	200	1	2
61A	<1	<10	10	1	30	500	<100	2	7
62A	1	<10	10	2	50	500	<100	2	4
63A	1	<10	15	1.5	30	500	<100	5	23
64A	<1	<10	10	1	30	500	150	3	3
65A	1	<10	15	<1	100	500	150	1	4
66A	<1	<10	10	<1	50	500	100	1	1
67A	<1	<10	7	<1	30	500	200	2	1
68A	<1	<10	10	<1	50	300	100	2	7

See footnotes at end of table.

TABLE 1.—*Geochemical analyses of stream sediments from*

Sample	Semiquantitative spectrographic analyses (ppm)--Continued										
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y
69A	3,000	<200	500	70	50	20	20	20	<10	20	10
70A	3,000	<200	500	50	70	50	20	20	10	70	70
71A	3,000	<200	1,000	100	70	<20	20	20	15	50	15
72A	2,000	<200	500	50	100	30	10	20	10	10	15
73A	5,000	<200	1,500	150	200	50	30	20	20	100	30
74A	2,000	<200	200	20	200	70	2	10	20	10	50
75A	2,000	<200	500	30	150	20	7	20	<10	10	20
76A	3,000	<200	300	30	300	50	10	15	15	10	150
77A	3,000	<200	200	50	300	30	15	10	10	<10	70
78A	3,000	<200	200	50	200	30	30	15	<10	<10	70
79A	10,000	500	200	70	>1,000	30	30	20	15	10	>200
80A	5,000	<200	300	50	100	30	30	20	10	10	50
81A	2,000	<200	200	50	200	30	10	15	15	10	70
82A	2,000	<200	150	50	100	30	20	15	10	10	50
83A	2,000	<200	150	20	200	50	15	20	20	10	150
84A	2,000	<200	300	70	100	30	20	30	10	20	20
85A	3,000	<200	500	70	300	50	10	15	10	20	50
131A	2,000	<200	500	50	100	20	15	50	10	100	20
147A	2,000	<200	100	20	300	30	2	10	40	<10	50
148A	5,000	<200	300	50	1,000	100	5	20	10	10	200
149A	5,000	<200	200	70	200	50	5	15	10	10	100
150A	5,000	<200	200	200	1,000	70	30	70	30	10	200
151A	3,000	<200	200	50	500	70	20	10	15	10	200
152A	3,000	<200	200	70	300	100	20	20	20	10	70
153A	3,000	<200	300	150	200	20	20	30	10	10	20
154A	7,000	<200	1,000	150	700	50	20	30	30	20	100
155A	7,000	<200	1,000	200	1,000	50	20	20	30	10	200
156A	5,000	<200	1,000	100	500	70	30	15	20	10	150
157A	5,000	<200	700	50	>1,000	50	2	15	30	10	150
159A	7,000	300	700	100	>1,000	50	5	20	30	10	200
161A	5,000	<200	700	150	300	20	20	30	15	30	50
162A	5,000	<200	1,000	100	500	50	20	30	20	20	70
163A	5,000	<200	1,000	150	150	20	20	30	10	20	30
164A	5,000	<200	1,500	200	150	<20	20	50	20	30	20
165A	3,000	<200	1,000	100	50	<20	10	50	15	50	10
166A	5,000	<200	1,000	200	150	20	20	50	10	20	20
167A	5,000	<200	1,000	150	100	30	20	70	20	20	20
168A	5,000	<200	1,000	500	150	30	30	70	20	10	20
170A	5,000	<200	700	150	200	50	15	50	20	20	50
171A	5,000	<200	700	50	200	50	5	15	15	20	50
172A	5,000	<200	1,000	300	200	50	20	50	20	50	30
173A	5,000	<200	1,000	70	500	100	5	20	20	50	100
174A	5,000	<200	700	70	500	100	5	15	30	20	100
175A	5,000	<200	700	50	500	100	5	15	30	20	100
176A	5,000	<200	1,000	200	150	<20	20	30	15	30	20
177A	5,000	<200	1,000	200	300	20	10	30	15	20	20
177A1	5,000	<200	1,000	300	200	<20	20	50	10	20	20
179A	2,000	<200	700	30	30	<20	5	10	<10	15	7
180A	5,000	<200	1,000	100	50	20	20	50	10	<10	10
181A	3,000	<200	700	100	100	<20	20	100	20	20	15
183A	5,000	<200	500	100	70	20	30	50	<10	10	15
184A	5,000	<200	1,000	100	100	20	20	50	15	20	15
185A	5,000	<200	500	20	300	100	2	10	15	10	100
187A	5,000	<200	700	70	500	70	10	30	15	10	100
188A	3,000	<200	1,000	70	100	20	15	20	10	10	10
189A	3,000	<200	1,000	70	50	<20	15	50	10	15	10
190A	5,000	<200	1,000	100	200	20	20	50	20	20	15
191A	2,000	<200	700	50	50	20	5	15	<10	30	10
192A	3,000	200	1,000	200	200	20	7	50	20	50	15
193A	3,000	<200	700	100	150	20	5	50	20	50	20

Pine Mountain primitive area, Arizona—Continued

	Semiquantitative spectrographic analyses (ppm)--Continued							Chemical analyses (ppm)	
Sample	Mo	Sn	Co	Be	Cr	Ba	Sr	cxHM[2]	cxCu[3]
69A	<1	<10	10	1	20	200	<100	7	4
70A	<1	50	10	2	50	200	<100	2	4
71A	<1	<10	15	2	50	300	<100	1	2
72A	<1	<10	7	1	10	300	150	5	4
73A	2	10	20	1	100	700	150	2	3
74A	<1	10	<5	1	5	300	<100	2	2
75A	<1	<10	7	<1	10	200	<100	4	4
76A	1	<10	7	1	10	200	<100	2	2
77A	1	<10	10	1	20	300	<100	1	.5
78A	1	<10	10	1	100	200	100	2	1
79A	10	50	5	2	20	150	<100	1	1
80A	<1	40	10	1	70	500	150	.5	<.5
81A	1	<10	5	1	20	200	<100	1	1
82A	<1	<10	7	1	20	200	<100	1	2
83A	1	10	<5	1	10	300	<100	1	2
84A	1	<10	10	1	30	300	<100	<.5	1
85A	2	<10	10	1	50	500	100	1	4
131A	<1	<10	10	<1	20	300	<100	7	4
147A	<1	<10	<5	1	5	150	<100	1	2
148A	1	10	5	1	20	700	<100	1	2
149A	1	10	5	1	20	300	<100	<.5	2
150A	2	10	15	1	50	700	<100	.5	2
151A	1	<10	5	2	<5	200	<100	1	1
152A	<1	<10	7	2	20	300	<100	5	4
153A	<1	<10	15	<1	30	500	200	.5	4
154A	5	<10	20	1	70	700	100	.5	2
155A	5	<10	15	1	70	700	<100	2	2
156A	2	<10	15	1	200	500	150	1	2
157A	2	<10	5	1	15	700	<100	1	1
159A	20	50	5	1	1,000	500	<100	1	1
161A	2	<10	30	<1	100	700	200	.5	1
162A	3	<10	20	1	50	700	150	1	2
163A	2	<10	30	<1	100	700	150	1	4
164A	3	<10	30	<1	200	700	200	1	4
165A	<2	<10	20	1	30	500	150	.5	6
166A	<2	<10	20	<1	100	700	200	.5	4
167A	<2	<10	20	<1	50	700	200	2	6
168A	5	<10	30	<1	150	700	300	2	4
170A	2	<10	20	1	50	500	200	1	2
171A	2	<10	10	1	20	500	<100	1	2
172A	<2	<10	30	<1	100	700	200	.5	2
173A	3	<10	20	1	20	700	100	.5	2
174A	2	<10	10	1	30	500	<100	3	2
175A	2	<10	10	1	20	500	<100	2	2
176A	3	<10	20	<1	70	700	200	.5	2
177A	2	<10	20	<1	50	700	200	.5	2
177A1	5	<10	20	<1	200	700	300	1	4
179A	<1	<10	<5	1	5	300	200	1	1
180A	1	<10	15	<1	50	500	200	1	4
181A	1	<10	15	<1	30	300	200	2	4
183A	1	<10	15	<1	50	500	200	1	4
184A	1	<10	15	<1	30	700	200	.5	3
185A	1	<10	5	2	5	500	<100	1	<.5
187A	2	<10	10	1	20	700	100	.5	1
188A	<1	<10	15	1	30	700	200	1	2
189A	<1	<10	15	<1	30	500	150	2	4
190A	1	<10	15	1	50	700	200	1	4
191A	<1	<10	10	1	<5	300	<100	4	4
192A	2	<10	20	1	70	3,000	200	1	2
193A	<2	<10	20	1	20	2,000	200	1	3

See footnotes at end of table.

TABLE 1.—*Geochemical analyses of stream sediments from*

Sample	Semiquantitative spectrographic analyses (ppm)--Continued									
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y
194A	5,000	200	700	50	1,000	100	5	15	20	30	>200
195A	5,000	200	1,000	100	>1,000	50	5	20	20	70	>200
196A	5,000	200	500	100	>1,000	100	5	15	15	30	>200
197A	5,000	<200	1,000	100	500	30	10	20	10	30	30
198A	5,000	200	700	100	1,000	50	5	20	20	50	100
199A	3,000	<200	1,000	150	300	20	70	30	15	70	30
200A	5,000	<200	1,000	150	100	<20	100	50	20	10	10
201A	7,000	<200	1,000	200	150	20	100	50	15	15	15
202A	5,000	<200	700	200	150	20	70	50	20	15	15
203A	7,000	<200	700	300	100	<20	100	50	10	10	15
205A	7,000	<200	1,000	200	200	20	70	50	20	20	20
206A	5,000	<200	700	200	200	20	70	30	15	20	20
207A	3,000	<200	700	70	100	20	30	20	10	20	10
208A	7,000	<200	1,000	200	150	20	70	70	20	20	15
209A	5,000	<200	1,000	100	200	20	70	50	20	20	20
210A	3,000	<200	700	70	200	20	30	30	30	50	20
211A	7,000	<200	700	150	150	20	70	50	20	30	20
213A	5,000	<200	1,000	200	150	20	100	50	10	20	20
214A	5,000	<200	1,000	200	200	20	100	50	10	20	20
215A	7,000	<200	700	300	200	20	100	50	10	20	20
216A	7,000	<200	1,000	150	300	20	50	50	15	50	20
217A	7,000	<200	1,000	300	200	20	100	70	20	30	20
218A	7,000	<200	1,000	300	150	20	100	70	15	30	20
221A	7,000	<200	500	70	100	20	50	70	10	<10	<10
222A	3,000	<200	700	100	150	20	50	30	30	20	20
224A	2,000	<200	700	50	150	20	5	30	30	30	30
224A1	3,000	<200	500	100	200	20	5	50	20	70	30
226A	5,000	<200	700	200	150	20	100	50	10	20	20
227A	5,000	<200	700	150	150	30	70	30	10	15	20
228A	5,000	<200	700	150	150	20	50	50	15	20	20
229A	7,000	<200	700	150	200	20	100	30	10	20	15
230A	5,000	<200	1,000	150	100	20	70	70	20	20	15
231A	7,000	<200	700	200	150	20	100	30	10	20	20
232A	5,000	<200	700	100	100	20	100	50	15	20	15
233A	5,000	<200	700	150	150	20	70	30	10	20	15
234A	5,000	<200	1,000	100	150	20	70	50	20	20	10
235A	5,000	<200	500	100	150	20	70	50	20	20	15
236A	5,000	200	700	70	700	50	5	20	20	50	100
237A	5,000	<200	500	50	1,000	100	5	10	10	20	200
239A	5,000	200	300	70	>1,000	30	5	20	20	15	>200
240A	7,000	200	500	100	>1,000	50	5	20	20	10	>200
241A	10,000	300	500	200	>1,000	20	5	20	20	10	100
242A	2,000	200	700	50	500	50	5	15	30	15	100
243A	3,000	<200	500	70	500	70	5	20	20	30	70
244A	3,000	<200	700	150	300	20	10	30	10	50	20
245A	2,000	<200	500	100	300	70	7	30	15	50	30
246A	3,000	<200	300	70	500	70	5	20	15	20	70
248A	5,000	<200	700	150	200	20	20	30	15	50	20
249A	2,000	<200	300	100	150	<20	10	30	15	70	15
251A	3,000	<200	700	100	200	20	20	20	20	100	20
252A	1,500	<200	500	50	20	<20	5	20	15	70	15
253A	2,000	<200	700	100	150	20	10	50	20	100	20
255A	3,000	<200	500	150	150	<20	10	30	15	70	20
257A	3,000	<200	700	100	100	20	30	50	20	30	15
258A	5,000	<200	700	100	200	30	70	50	20	20	20
301A	5,000	<200	700	100	100	20	70	50	10	20	20
303A	5,000	<200	1,000	150	100	<20	100	50	15	10	20
304A	5,000	<200	1,000	150	150	20	100	70	15	10	20
305A	5,000	<200	700	200	100	20	100	70	10	10	20
307A	5,000	<200	1,000	150	100	20	100	70	15	15	20

Pine Mountain primitive area, Arizona—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued							Chemical analyses (ppm)	
	Mo	Sn	Co	Be	Cr	Ba	Sr	cxHM 2/	cxCu 3/
194A	5	<10	10	2	15	1,000	<100	1	<0.5
195A	5	<10	15	1.5	20	3,000	200	.5	2
196A	5	<10	10	2	20	2,000	<100	1	2
197A	5	<10	20	1	50	3,000	100	.5	2
198A	5	<10	15	1.5	20	2,000	150	1	2
199A	2	<10	30	1	300	1,000	200	1	2
200A	2	<10	30	1	1,000	1,000	300	2	2
201A	2	<10	50	1	700	700	300	1	2
202A	2	<10	30	1	700	1,000	200	1	4
203A	2	<10	30	1	1,500	1,000	200	2	4
205A	2	<10	30	1	200	1,000	500	1	2
206A	2	<10	30	1	500	1,000	300	1	2
207A	<2	<10	20	1	200	700	300	1	2
208A	2	<10	30	1	700	1,000	300	2	4
209A	2	<10	30	1	700	1,000	200	1	4
210A	<2	<10	20	1	150	700	100	2	3
211A	<2	<10	30	1	300	1,000	200	1	4
213A	2	<10	30	1	700	1,000	300	1	2
214A	2	<10	30	1	500	1,000	300	1	4
215A	2	<10	30	1	700	1,000	200	.5	2
216A	<2	<10	20	1	300	1,000	300	1	2
217A	2	<10	30	<1	1,000	1,000	300	1	3
218A	2	<10	30	<1	700	1,000	300	1	2
221A	<2	<10	20	<1	700	2,000	300	1	4
222A	<2	<10	15	1	700	1,000	150	1	3
224A	<2	<10	10	1	20	1,000	150	3	4
224A-1	<2	<10	10	<1	30	1,000	150	1	2
226A	2	<10	30	<1	700	1,000	300	1	2
227A	2	<10	30	<1	300	1,000	300	1	2
228A	2	<10	30	1	150	1,000	500	2	4
229A	2	<10	30	<1	700	1,000	300	.5	2
230A	2	<10	30	1	200	1,500	500	2	4
231A	2	<10	30	<1	700	700	300	.5	2
232A	2	<10	30	<1	200	1,000	300	1	4
233A	2	<10	30	<1	200	1,000	300	.5	2
234A	<2	<10	30	1	150	1,500	300	1	4
235A	<2	<10	30	1	200	1,000	300	1	2
236A	5	<10	10	2	30	2,000	100	1	2
237A	5	<10	10	1	30	5,000	100	1	2
239A	20	<10	5	2	20	700	<100	.5	1
240A	30	<10	5	2	30	>5,000	<100	1	2
241A	10	<10	10	1	100	2,000	<100	1	2
242A	<2	10	5	1.5	15	1,000	<100	3	2
243A	2	<10	7	1.5	15	3,000	<100	1	4
244A	2	<10	15	1	100	1,500	200	1	7
245A	2	<10	15	1	30	1,500	100	3	4
246A	2	<10	5	1	30	5,000	100	1	11
248A	2	<10	20	1	150	2,000	300	1	2
249A	2	<10	15	<1	100	1,500	300	1	3
251A	2	<10	20	1	100	1,000	300	1	2
252A	<2	<10	10	<1	20	1,000	300	1	2
253A	2	<10	20	1	50	1,000	200	3	7
255A	2	<10	20	1	100	1,000	200	1	2
257A	<2	<10	20	1	500	700	300	1	4
258A	<2	<10	30	1	300	1,000	300	1	4
301A	2	<10	30	<1	500	700	300	1	2
303A	2	<10	30	<1	1,000	500	300	1	2
304A	2	<10	30	<1	1,000	700	300	3	4
305A	2	<10	30	<1	1,000	700	500	2	4
307A	<2	<10	30	1	700	1,000	300	3	4

See footnotes at end of table.

TABLE 1.—*Geochemical analyses of stream sediments from*

Sample	Semiquantitative spectrographic analyses (ppm)--Continued										
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y
310A	7,000	<200	700	200	150	20	100	70	10	15	20
311A	5,000	<200	1,000	150	100	20	70	70	20	15	15
312A	5,000	<200	1,000	200	100	20	100	50	20	20	20
313A	5,000	<200	700	100	150	20	70	20	20	20	15
314A	5,000	<200	1,000	150	100	20	100	50	20	15	20
315A	5,000	<200	1,000	150	150	20	100	70	20	15	20

Pine Mountain primitive area, Arizona—Continued

	Semiquantitative spectrographic analyses (ppm)--Continued							Chemical analyses (ppm)	
Sample	Mo	Sn	Co	Be	Cr	Ba	Sr	cxHM 2/	cxCu 3/
310A	<2	<10	30	<1	1,500	1,000	300	3	2
311A	<2	<10	30	1	1,000	1,000	300	3	4
312A	<2	<10	30	1	1,000	1,000	200	3	4
313A	<2	<10	20	1	500	700	200	1	2
314A	<2	<10	30	1	1,000	1,500	300	3	2
315A	2	<10	50	1	700	1,000	300	3	2

1/ Determined by a colorimetric field method.

2/ Cold-extractable heavy metals, principally undifferentiated copper, lead, and zinc, expressed as zinc equivalent. Determined by a colorimetric field method.

3/ Cold-extractable copper. Determined by a colorimetric field method.

TABLE 2.—*Geochemical analyses of rocks, soils, and other*

[Analyses by semiquantitative spectrographic procedure except as noted. Looked for but not found in the sample number is the site number shown on the

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	As
	Semiquantitative spectrographic analyses (ppm)																
104M	2,000	200	5,000	20	300	20	15	>5,000	<10	30	70	2	<10	5	<0.5	<1	<200
104M2	1,000	<200	1,000	15	70	<20	3	1,000	<10	30	20	<2	<10	5	<0.2	1	<500
104M3	1,500	<200	100	30	50	<20	2	100	10	30	10	<2	<10	<5	<0.2	1	<500
104M4	100	<200	200	10	20	<20	3	>5,000	20	10	50	7	<10	5	0.7	<1	2,000
107M	100	200	200	30	<10	<20	2	>5,000	30	20	<10	30	<10	<5	20	<1	2,000
119R1	500	<200	50	<10	70	20	<2	5	<10	20	10	<2	<10	<5	<0.2	<1	500
120R	5,000	<200	2,000	300	50	<20	7	15	20	<10	30	2	<10	20	<0.2	<1	<500
121M2	500	<100	5,000	20	10	30	<2	70	<10	<10	150	<2	<10	<5	<0.5	<1	<200
123R	3,000	100	2,000	300	20	<20	15	70	30	15	20	3	<10	20	<0.5	<1	<200
129R	100	<100	50	<10	20	<20	5	5	<10	<10	<10	<2	<10	<5	0.5	<1	<200
133R	3,000	<200	500	100	70	<20	5	30	<10	50	15	<2	<10	10	<0.2	1	<500
134R	100	<200	50	<10	10	<20	<2	5	<10	<10	<10	<2	<10	<5	<0.2	<1	<500
138R	3,000	<200	700	150	50	<20	7	10	<10	100	15	<2	<10	20	<0.2	<1	<500
142M	200	500	1,000	100	15	<20	50	100	50	<10	20	5	<10	15	1.5	<1	>10,000
142M3	1,000	200	500	200	50	20	5	200	30	150	20	15	<10	5	1	1	5,000
142M4	500	500	5,000	70	20	<20	30	150	20	30	20	5	<10	30	0.5	<1	7,000
142M5	700	200	700	50	10	<20	30	70	20	<10	10	2	<10	20	0.5	<1	>10,000
142M6	1,500	300	1,500	200	20	20	50	200	30	20	30	10	<10	5	0.5	1	10,000
143R1	200	<200	150	<10	10	20	<2	15	<10	<10	<10	<2	<10	<5	<0.2	<1	500
146R	1,500	<200	500	30	150	70	2	<5	<10	50	70	<2	<10	5	<0.2	2	<500
154R	2,000	<200	700	50	200	50	100	50	<10	100	30	2	<10	30	<0.2	2	<500
154M	200	<200	1,500	20	10	<20	30	15	<10	<10	<10	<2	<10	20	<0.2	2	<500
158R	1,000	<200	300	15	200	100	5	20	10	100	50	<2	<10	<5	0.2	7	<500
160R	1,500	<200	700	50	50	50	100	20	<10	20	30	<2	<10	20	<0.2	2	<500
163R	1,000	<200	100	30	200	50	2	10	<10	30	30	<2	<10	<5	<0.2	5	<500
164R2	500	<200	200	50	200	20	2	30	150	30	30	3	<10	<5	<0.2	3	1,500
164R3	300	300	200	300	200	<20	7	20	500	100	30	30	<10	<5	<0.2	5	3,000
173R	150	<200	100	30	30	<20	<2	10	<10	10	10	<2	<10	<5	<0.2	1	<500
176R1	100	<200	50	20	10	<20	<2	20	<10	10	10	10	<10	<5	0.7	2	<500
176R2	1,500	<200	50	15	300	50	<2	10	<10	30	30	<2	<10	<5	<0.2	3	<500
177R	2,000	<200	150	70	70	20	5	20	<10	30	<10	2	<10	5	<0.2	2	<500
178R	1,500	<200	700	50	100	<20	2	50	<10	150	20	2	<10	10	<0.2	1	<500
186R	2,000	<200	50	20	300	70	5	<5	<10	30	30	<2	<10	<5	<0.2	2	<500
188R	7,000	200	1,000	200	70	<20	50	50	20	70	10	2	<10	30	<0.2	1	<500
219R	1,500	<200	100	30	150	<20	2	7	<10	70	15	<2	<10	7	<0.2	1	<500
220R	3,000	<200	700	150	100	20	5	10	<10	30	20	<2	20	20	<0.2	1	<500
238R	50	<200	10	10	<10	<20	<2	70	<10	<10	>200	<2	<10	<5	<0.2	1	<500
247R	1,000	<200	100	15	200	<20	<2	20	<10	30	20	<2	<10	<5	<0.2	2	<500
249R1	1,500	200	200	100	30	<20	30	200	50	<10	20	10	<10	20	1	1	1,000
142S	2,000	300	5,000	200	100	20	50	200	50	100	30	10	20	20	1	<1	5,000
177S	5,000	<200	1,000	150	100	20	30	70	20	20	20	2	<10	30	1	<1	<500
219S	3,000	<200	500	70	200	20	10	20	20	100	20	<2	<10	10	<0.2	1	<500
247S	3,000	<200	1,000	50	200	100	10	30	20	30	30	<2	<10	15	<0.2	1	<500
249S	3,000	<200	1,500	100	100	<20	30	70	20	20	20	2	<10	20	<0.2	1	<500
254S	2,000	<200	1,000	70	150	20	15	50	30	50	30	2	<10	15	<0.2	1	<500
256S	5,000	<200	700	70	500	50	10	30	20	30	50	3	<10	20	0.2	2	<500

materials from Pine Mountain primitive area, Arizona

(element and limit of sensitivity): Cd <20; Bi <10; Sb <100; W <50. The number preceding the letter sample-site map. Analysts: Elwin Mosier, G. A. Nowlan]

	Semiquantitative spectrographic analyses (ppm)--Continued			Chemical analyses (ppm)			
Sample	Cr	Ba	Sr	Au[1]	cxHM[2]	cxCu[3]	Sample description
104M	5	1,000	<100	<0,2	--	--	Rock, primary and secondary copper minerals.
104M2	5	700	100	.08	--	--	Granite, sheared and altered, mouth of adit.
104M3	30	300	700	.10	--	--	Granite, sheared and altered, back of adit.
104M4	5	200	300	.10	--	--	Quartz-jasper rock, gossany.
107M	<2	1,500	<100	<.2	--	--	Granite, sheared, secondary copper minerals.
119R1	<5	700	100	.05	--	--	Granite, bleached.
120R	20	500	2,000	<.05	--	--	Granite, altered.
121M2	<2	100	<100	<.2	--	--	Calcite vein.
123R	50	200	500	<.2	--	--	Gabbro.
129R	2	70	<100	<.2	--	--	Quartz-rich rock ("quartz reef").
133R	20	1,000	100	.05	--	--	Rock, iron-stained and altered.
134R	<5	1,000	<100	.08	--	--	Quartz-rich rock ("quartz reef").
138R	70	500	150	.08	--	--	Granite, sheared.
142M	10	100	<100	<.2	--	--	Rock metavolcanic, with sulfides.
142M3	50	300	<100	.08	--	--	Rock, altered, composite of zone.
					--		
142M4	10	100	<100	.05	--	--	Rock, siliceous, with minor sulfides.
142M5	10	50	<100	.01	--	--	Rock, altered, composite of zone.
142M6	150	70	<100	<.05	--	--	Do.
143R1	<5	700	<100	.08	--	--	Granite, silicified.
146R	10	500	1,500	.05	--	--	Granite, sheared.
154R	1,000	1,000	300	<.05	--	--	Fault gouge.
154M	10	100	1,00	.08	--	--	Calcite vein.
158R	10	1,000	150	.05	--	--	Granite, sheared.
160R	700	700	300	.05	--	--	Fault gouge and sheared zone.
163R	5	300	<100	.05	--	--	Granite, iron-stained and bleached.
164R2	5	700	<100	.05	--	--	Rock, metavolcanic, altered.
164R3	5	500	<100	<.05	--	--	Rock, highly altered and iron-stained.
173R	<5	200	<100	.05	--	--	Quartz vein.
176R1	<5	200	<100	.05	--	--	Quartz vein.
176R2	<5	700	<100	.05	--	--	Sheared rock and fault gouge.
177R	15	500	<100	<.05	--	--	Rock, altered and iron-stained.
178R	5	1,000	100	<.05	--	--	Fracture coatings.
186R	5	1,000	<100	.05	--	--	Fault gouge.
188R	70	500	<100	<.05	--	--	Rock, metavolcanic, iron-stained.
219R	5	3,000	<100	<.05	--	--	Granite, iron-stained.
220R	15	1,000	200	.05	--	--	Granite, sheared.
238R	<5	M	>5,000	.08	--	--	Barite-fluorite vein.
247R	5	M	5,000	.08	--	--	Vein, with quartz, jasper, and barite.
249R1	20	2,000	<100	.10	--	--	Rock, gossany.
142S	50	200	<100	<.2	11	11	Soil.
177S	70	300	<100	<.2	5	15	Do.
219S	70	1,000	200	<.2	2	2	Do.
247S	50	2,000	200	<.2	7	4	Do.
249S	150	300	100	<.2	9	15	Do.
254S	70	700	100	<.2	9	2	Do.
256S	50	700	100	<.2	2	2	Do.

[1] Determined by a colorimetric field method.

[2] Cold-extractable heavy metals, principally undifferentiated copper, lead and zinc, expressed as zinc equivalent. Determined by a colorimetric field method.

[3] Cold- extractable copper.

TABLE 3.—*Geochemical analyses of heavy-mineral*

[Analyses by semiquantitative spectrographic procedure except for Au. Looked for but not detected
letter in the sample number is the site number shown on the

Sample	Semiquantitative spectrographic analyses (ppm)									
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B
7P	10,000	200	1,500	500	150	<20	200	70	100	<10
38P	>10,000	200	1,500	500	300	<20	50	70	100	10
41P	10,000	200	1,500	300	500	50	<10	70	70	10
59P	7,000	<200	1,500	200	500	30	150	70	50	20
80P	>10,000	<200	1,000	150	>1,000	70	50	50	50	15
161P	7,000	300	1,500	300	700	70	10	70	70	10
162P	10,000	200	700	200	1,000	50	<10	30	30	10
187P	>10,000	300	700	300	>1,000	100	<10	30	50	10
199P	5,000	<200	200	200	500	30	200	100	70	50
206P	10,000	<200	1,000	300	200	<20	150	50	<10	10
209P	10,000	<200	1,000	500	500	<20	200	50	50	10
213P	7,000	<200	1,000	300	50	<20	500	50	10	<10
214P	7,000	<200	1,000	200	50	<20	300	30	<10	<10
215P	10,000	200	1,000	300	200	20	200	50	10	<10
217P	10,000	200	700	500	100	<20	200	70	<10	10
218P	10,000	200	1,000	500	150	<20	300	50	<10	<10
224P	7,000	300	1,000	300	>1,000	<20	<10	20	100	50
225P	7,000	<200	700	500	300	<20	100	50	10	20
229P	7,000	<200	1,500	300	200	<20	150	50	15	10
231P	10,000	<200	1,000	300	200	<20	100	50	10	<10
235P	7,000	<200	1,000	300	200	30	100	70	15	<10
236P	5,000	200	300	100	>1,000	20	<10	20	50	15
239P	>10,000	300	700	150	>1,000	70	<10	20	70	15
252P	5,000	<200	300	500	500	<20	20	50	50	15

concentrates from Pine Mountain primitive area, Arizona

(element and limit of sensitivity): Ag <1;Bi <10; Cd <20; Sb <100; W <50. The number preceding the sample-site map. Analysts: Elwin Mosier, G. A. Nowlan]

Semiquantitative spectrographic analyses (ppm)--Continued

Sample	Y	Mo	Sn	Co	Be	As	Cr	Ba	Sr	Au[1]
7P	10	5	<10	50	1	<500	3,000	200	100	<0.05
38P	70	20	<10	30	1	<500	2,000	1,000	200	<0.05
41P	50	15	<10	50	1	<500	200	5,000	200	<0.05
59P	200	10	<10	30	1	<500	1,000	1,000	200	<0.05
80P	>200	15	20	30	1	<500	500	1,000	<100	<0.10
161P	200	20	<10	30	1	<500	500	2,000	150	<0.05
162P	>200	20	<10	20	1	<500	150	700	<100	<0.05
187P	>200	30	50	15	1	<500	150	3,000	<100	<0.05
199P	200	7	<10	30	<1	<500	5,000	150	<100	<0.05
206P	50	5	<10	50	<1	<500	3,000	100	100	<0.05
209P	30	5	<10	30	<1	<500	3,000	150	150	<0.10
213P	20	3	<10	50	<1	<500	3,000	200	150	<0.05
214P	10	2	<10	50	<1	<500	5,000	300	200	0.05
215P	30	5	<10	50	<1	<500	3,000	150	150	<0.05
217P	20	2	<10	50	<1	<500	3,000	150	150	1.0
218P	10	5	<10	50	<1	<500	3,000	100	<100	<0.05
224P	70	20	<10	20	<1	<500	100	200	20	0.3
225P	20	5	<10	30	<1	<500	1,500	100	100	0.15
229P	30	2	<10	30	<1	<500	2,000	300	300	0.4
231P	20	3	<10	50	<1	<500	2,000	150	200	<0.05
235P	30	2	<10	30	<1	<500	1,000	200	200	<0.10
236P	>200	50	70	10	1	<500	50	5,000	<100	<0.05
239P	>200	70	50	7	1	<500	70	1,000	<100	<0.10
252P	30	10	<10	20	<1	<500	150	2,000	150	<0.05

[1] Determined by colorimetric field method.

U.S. GOVERNMENT PRINTING OFFICE : 1967—O-244-284

Studies Related To Wilderness

GEOLOGICAL SURVEY BULLETIN 1230

This volume was published as separate chapters A–J

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

Library of Congress catalog-card No. GS 67-203

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