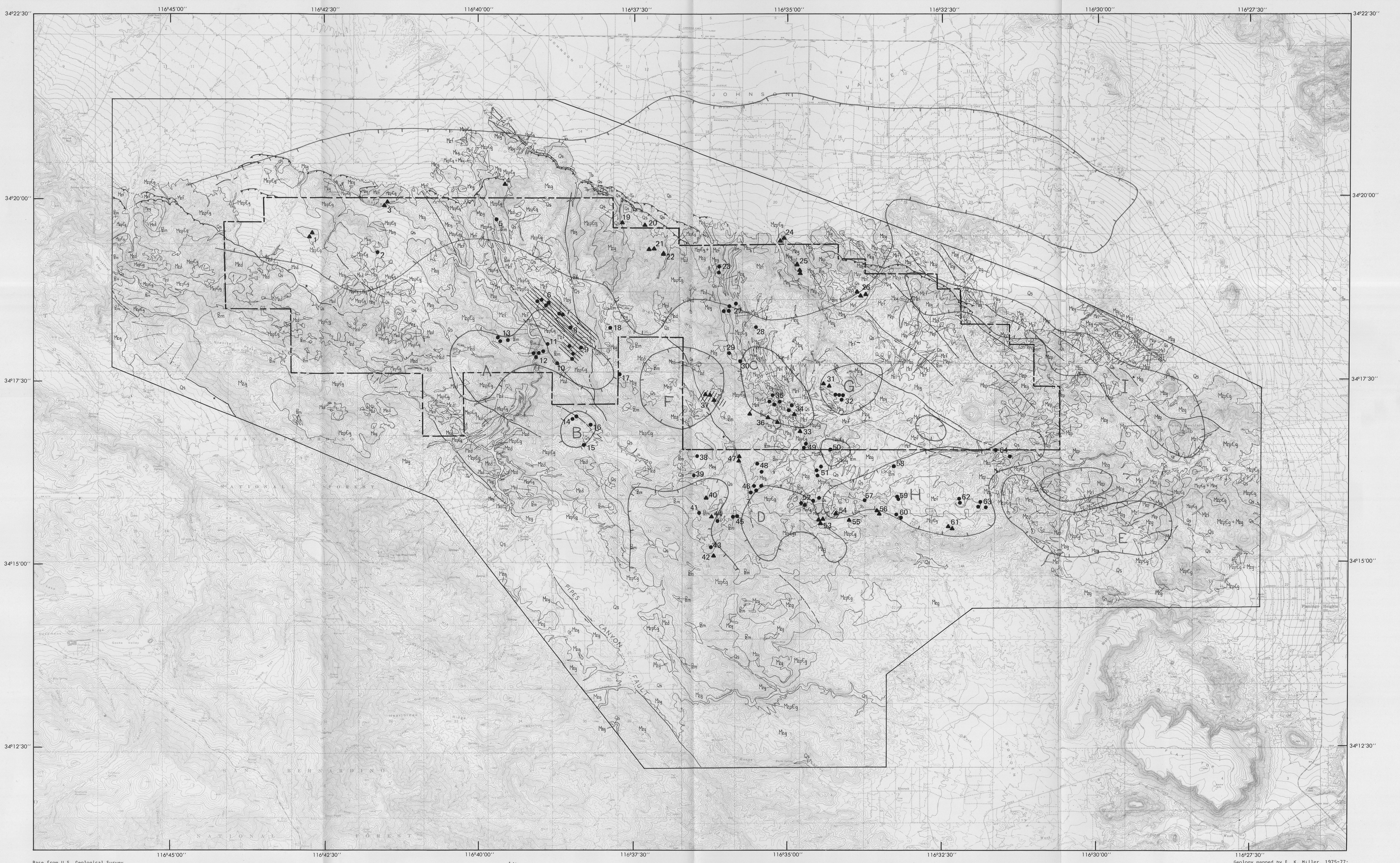
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

MISCELLANEOUS FIELD STUDIES
MAP MF-1493-A



Base from U.S. Geological Survey Moonridge, 1970; Big Bear City, 1971; Bighorn Canyon, Landers, Onyx Peak, Rattlesnake Canyon, Rimrock, Yucca Valley North, 1972

Geology mapped by F. K. Miller, 1975-77; J. C. Matti, B. F. Cox, 1980-81; J. C. Matti, R. E. Powell, 1982

STUDIES RELATED TO WILDERNESS
Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys in certain areas to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Bighorn Mountains Wilderness Study Area (CDCA-217), California Desert Conservation Area, San Bernardino County, California.

SUMMARY

Geological, geochemical, and geophysical evidence, together with a review of historical mining and prospecting activities, suggests that most of the Bighorn Mountains Wilderness Study Area (CDCA-217) has low potential for the discovery of all types of mineral and energy resources--including precious and base metals, building stone and aggregate, fossil fuels, radioactive-mineral resources, and geothermal resources. Low-grade mineralization has been documented in one small area in the vicinity of Rattlesnake Canyon, and this area has low to moderate potential for future small-scale exploration and development of precious and base metals. Thorium and uranium enrichment have been documented in two small areas in the eastern part of the wilderness study area; these two areas have low to moderate potential for future small-scale exploration and development of radioactive-mineral resources.

INTRODUCTION

The Bighorn Mountains Wilderness Study Area is located in southern California in the Bighorn Mountains and in adjacent areas of the northeastern San Bernardino Mountains (fig. 1). The study area lies about 15 mi northwest of Yucca Valley, and encompasses an area of approximately 35 mi^2 (22,400 acres) that adjoins the San Bernardino National Forest. The study area mainly occupies low mountains and high plateaus of the California high desert, and is traversed by Rattlesnake Canyon creek, an ephemeral stream that flows northward into Johnson Valley in the Mojave Desert. Rugged, mountainous terrain occurs in the southwestern part of the study area in the vicinity of the 7,500-ft-high Granite Peaks. Access to the study area is gained by numerous unimproved dirt roads that lead southward and westward into the area from State Highway 247, and northward from New Dixie Mine Road and Viscera Spring Road.

GEOLOGY

The Bighorn Mountains Wilderness Study Area is underlain mainly by crystalline bedrock. We group these rocks into a prebatholithic suite of Paleozoic metasedimentary schist and paragneiss, a deformed plutonic suite of early(?) Mesozoic intrusive rocks, and an undeformed plutonic suite of late Mesozoic intrusive rocks. Tertiary and Quaternary sedimentary deposits fringe the mountains.

Prebatholithic suite

A distinctive assemblage of prebatholithic metasedimentary rocks is exposed in the southwestern part of the study area in the vicinity of Granite Peaks. This assemblage consists mainly of biotite schist and biotite-quartz paragneiss, but also includes minor phyllite, laminated metaquartzite, and marble. Lithologically similar pods of biotite schist and gneiss that crop out in the central and eastern parts of the study area most likely are extensions of these metasedimentary rocks. We believe that the schist and paragneiss assemblage is Paleozoic in age. In the Rattlesnake Canyon area, we have grouped bodies of metasedimentary gneiss and schist together with associated biotite-rich porphyrytic granodiorite and augen gneiss of unknown age.

Deformed plutonic suite

The deformed plutonic suite comprises a heterogeneous assemblage of orthogneiss and foliated to compositionally layered plutonic rocks that includes a variety of leucocratic, mesocratic, and mafic lithologies. In the eastern two-thirds of the wilderness study area, this suite is represented by strongly foliated plutonic rock and diffusely layered to well-layered granitic gneiss and subordinate porphyritic granodiorite orthogneiss. To the west, in the Granite Peaks area, the deformed plutonic suite is characterized by leucocratic biotite granodiorite and gneissic granodiorite that have been mylonitized. Here, the granitic gneiss represents plutonic rocks that have invaded the metasedimentary rocks which are preserved as bodies and xenoliths of schistose biotite gneiss and metaquartzite within the gneissose granitoid rocks. During or following their emplacement, the plutonic rocks were deformed and mylonitized. Locally within the study area, large bodies and small lenses of mafic plutonic rocks occur as inclusions within the granitic gneiss. These mafic rocks consist of hornblende gabbro, hornblende diorite, hornblende quartz diorite, and amphibolite. Plutonic protoliths for granitic gneiss of the deformed plutonic suite most likely are Mesozoic in age, and possibly are early Mesozoic or even late Paleozoic based on outcrops in the Granite Peaks area where plutonic protoliths for the mylonitized granitic gneiss have intruded Paleozoic metasedimentary rocks of the prebatholithic suite. The deformed plutonic suite in turn is intruded by undeformed plutons that probably are late Mesozoic.

Undeformed plutonic suite

The undeformed plutonic suite consists of texturally massive to slightly foliated late Mesozoic plutonic rocks. On the simplified geologic map, we have grouped several plutonic lithologies into a single unit of leucocratic biotite-bearing granitoid rocks that consists mainly of granodiorite and lesser amounts of monzogranite, quartz monzonite, granite, and distinctive garnetiferous muscovite-biotite leucogranite and granodiorite. Older rocks include a large body of foliated, sphene-bearing biotite-hornblende quartz diorite that has engulfed elongate arcuate bodies of mafic hornblende-biotite quartz diorite. In the eastern part of the study area, the undeformed plutonic suite is cut by latite, aplite, and quartz porphyry dikes that parallel joint patterns in the late Mesozoic granitoid units. All units of the undeformed plutonic suite intrude the granitic gneiss of the deformed plutonic suite.

Tertiary and Quaternary units

In the eastern part of the mapped area, bodies of olivine basalt occur as intrusions and small flows. Localized outcrops of basalt also occur at the northern base of the Bighorn Mountains, where the volcanic rocks have been overridden by gneiss and granite along thrust faults. Localized outcrops of sandstone and cobbly sandstone occur marginal to the north boundary of the study area. Dibblee (1967) and Sadler (1982a, b) assign these units to the Old Woman Sandstone. On the simplified geologic map, we have grouped alluvium deposited and transported by active streamflows together with older deposits of dissected Pleistocene alluvium. These surficial deposits consist of unconsolidated to well-consolidated gravel and sand.

Geology related to mineral resource potential

Although geologic environments that commonly are favorable for the occurrence of mineral deposits occur in the Bighorn Mountains Wilderness Study Area, except for a few small areas these environments have not produced economic deposits of precious or base metals and energy minerals. Favorable sites for mineralization might be expected in the following generalized geologic environments: metasedimentary pendants and xenolith swarms; the deformed plutonic suite, especially compositionally layered granitic gneiss containing quartz veins and quartz-feldspar segregations; late Mesozoic intrusive rocks of the undeformed plutonic suite; and zones of faulting and fracturing, where the rocks may have been altered by hydrothermal fluids.

Paleozoic metasedimentary rocks of the prebatholithic suite and late Mesozoic intrusive rocks of the undeformed plutonic suite do not appear to be mineralized extensively in the study area. Granitoid rocks of the late Mesozoic undeformed plutonic suite do not exhibit extensive alteration or quartz-vein networks except locally in the vicinity of contact zones, where the plutonic rocks have engulfed and partly assimilated bodies of biotite-rich prebatholithic rock. We did not observe obvious signs of mineralization or alteration along these contacts, although some contact zones locally are enriched in thorium-bearing monazite.

Gneissic granite and granitic gneiss of the deformed plutonic suite also do not show evidence of significant mineralization. In these rocks, zones of alteration and zones of injection pegmatites and crosscutting quartz veins are not common, although quartz lenses and pegmatitic quartz-feldspar segregations parallel to foliation and layering occur in some places. Biotite-rich stringers associated with these pegmatitic segregations locally yield high thorium values and modest uranium values, and commonly are enriched in monazite. However, the segregations are common only where compositional layering is well developed, and so they are sparse in much of the gneiss terrane where the rocks mainly are diffusely layered or are foliated.

GEOCHEMISTRY

A reconnaissance geochemical survey of stream sediment in the Bighorn Mountains Wilderness Study Area was conducted for 32 major, minor, and trace elements to identify any spatial variations in stream-sediment chemistry that might reflect local concentrations of ore minerals. Two samples of stream alluvium were collected from each of 316 sampling sites in the wilderness study area and vicinity: (1) a bulk-sediment sample and (2) a panned concentrate rich in heavy minerals. The patterns of chemical composition determined by this geochemical survey do not indicate any economic mineralization within the study area. Most of the analyses fall within ranges that are reasonable for nonmineralized crystalline rocks and derivative stream sediment; few elemental values are anomalous with respect to the average geochemical background.

Nonmetallic elements

Panned concentrates at many localities contain high concentrations of thorium, the rare-earth elements lanthanum and yttrium, and the transition metals niobium and scandium. Elevated values of these elements generally occur together in samples collected throughout the area, and we believe that the detected concentrations reflect higher-than-average background concentrations of these elements in the plutonic and gneissic rocks of the district. In bulk sediment, uranium values range from 0.2 to 6 ppm, with a mean concentration of 1.0 ppm. Most of the higher uranium concentrations (greater than 2.0 ppm) were detected in samples from the eastern part of the wilderness study area. In the same general area where uranium values are elevated, many panned concentrates contain greater than 2,000 ppm zirconium, accompanied by lanthanum ranging from 300 to greater than 2,000 ppm (the upper limit of detection by emission spectrography). The zirconium-uranium-lanthanum association possibly reflects high concentrations of zircon that may occur in rocks of the undeformed plutonic suite. Higher-than-average amounts of zircon may be present in granodiorite and muscovite-biotite leucogranite that crop out extensively in the eastern part of the wilderness study area and in areas to the southeast; alternatively, high concentrations of zircon may occur in aplitic and quartz porphyry latite dikes that cut the late Mesozoic plutons in this area.

Metallic elements

In panned concentrates, the approximate average concentrations for metallic elements include: copper, 35 to 50 ppm, with a few values as high as 200 ppm; tin, 50 to 70 ppm, with a few values of 100 to 150 ppm and one value of 300 ppm; tungsten, about 100 to 200 ppm, with a very few samples ranging from 500 to 2,000 ppm; lead, about 200 to 300 ppm, with a few values ranging from 1,000 to 5,000 ppm and one value each of 10,000 and 20,000 ppm; molybdenum, most values below the limit of detection (10 ppm), with a few values ranging from 50 to 200 ppm; bismuth, 50 to 100 ppm, with a range of from less than 20 to 200-300 ppm, and with three values between 1,000 and 2,000 ppm. In almost all the bulk-sediment samples, concentrations of tin, tungsten, molybdenum, and bismuth are below detection limits (10, 50, 5, and 10 ppm, respectively). The mean value for lead is about 30 to 50 ppm, with very little variation. The mean value for copper averages about 50 ppm, with a few values of 100 ppm. The similarity of the mean values for copper in both panned-concentrate and bulk-sediment samples suggests that 50 ppm copper represents a general background level for copper in the study area.

Anomalous metallic concentrations are scattered throughout the study area. Higher-than-average concentrations of lead, in some samples accompanied by higher-than-average concentrations of copper, occur in a few isolated localites both within and outside of the wilderness study area. Some anomalous lead and copper concentrations occur in the vicinity of mineral prospects inspected by the U.S. Bureau of Mines in the Rattlesnake Canyon area; other anomalous values are scattered elsewhere throughout the crystalline-bedrock terranes. Higher-than-average concentrations of tungsten, molybdenum, and bismuth also are scattered throughout the area, and in some samples are associated with mineral prospects. Higher-than-average concentrations of tin occur mostly in the eastern part of the wilderness study area and vicinity, and these elevated values may be related to muscovite-biotite leucogranite and granodiorite of the undeformed plutonic suite. Chromium concentrations, ranging from 20 to 700 ppm in the panned concentrates, occur mostly in the western part of the study area where mesocratic to leucocratic granitic gneiss of the deformed plutonic suite has intruded mafic plutonic rocks.

The anomalous concentrations of metallic elements occur in isolated sample sites throughout the study area. None of the anomalous values are clustered tightly together within a geographic area or areas that might be the sites of large- or small-scale metallic mineralization. Most of the high metallic concentrations probably reflect isolated mineralized point sources, such as quartz veins or pegmatitic quartz-feldspar segregations in the gneissic rocks. Tin may be an exception: higher-than-average tin concentrations in the eastern part of the study area may be explained by tin disseminated in muscovite-biotite leucogranite and granodiorite of the undeformed plutonic suite. We believe that the anomalous metal concentrations in the geochemical data represent expectable geochemical variation within the plutonic and gneissic crystalline rocks, and are not significant indicators of mineral resource potential.

GEOPHYSICS

Aeromagnetic and gravity maps of the Bighorn Mountains Wilderness Study Area were prepared as a geophysical contribution to the mineral-resource evaluation. These data were analyzed by Andrew Griscom (unpub. data, 1981).

An aerial magnetic survey of the wilderness study area was flown in 1981. The trend and distribution of major magnetic highs and lows are illustrated in simplified form on the mineral resource potential map. Our unpublished aeromagnetic-contour map indicates that most of these magnetic anomalies and irregularities in magnetic patterns occur over rocks of the prebatholithic suite and the deformed plutonic suite; the magnetic expression of the late Mesozoic undeformed plutonic suite generally is one of low-amplitude anomalies and relatively smooth magnetic field. Although some of these aeromagnetic patterns locally are associated with areas of known mineral occurrence, they do not provide any additional information about the occurrence of metallic- or nonmetallic-mineral resources.

Our unpublished gravity map indicates that in the western two-thirds of the study area, an irregular high of 8- to 10-mGal amplitude is associated with mafic rocks of the prebatholithic suite and the deformed plutonic suite. In general, the small apparent density contrast between granitic gneiss of the deformed plutonic suite and granitoid rocks of the undeformed plutonic suite may explain the relatively featureless gravity map. The gravity data provide no evidence for possible economic mineralization.

MINING DISTRICTS AND MINERALIZATION

The Bighorn Mountains Wilderness Study Area and surrounding lands are pocked by over 140 prospect pits, 11 shafts, and nine adits; these workings reflect a long but sporadic history of mining activity. However, no production is reported from the area. The locations of workings are shown on the mineral resource potential map; tables 1 and 2 summarize geologic, mineralogic, and geochemical data from these workings.

Radioactive minerals

Radioactivity exceeds twice the local background level in 24 prospecting areas (table 1). The thorium content of 66 samples ranges from 30 to 6,780 ppm, with an arithmetic mean of 300 ppm. Uranium (as U_3O_8) ranges from 1.2 to 150 ppm, with an arithmetic mean of 8.8 ppm. Monazite is the principal thorium-bearing mineral.

Monazite concentrations occur in three types of deposits: pegmatite veins and segregations, igneous contacts, and placers. (1) The largest and richest concentrations are developed in granitic gneiss of the deformed plutonic suite, where the monazite occurs in ovoid to lenticular pegmatitic quartz-feldspar intergrowths and segregations separated by thin biotite-rich stringers. The Martin prospects (loc. 37) and prospects at locality 54 represent monazite occurrences of this type. (2) The largest number of radioactive prospects occur in small mafic pods of biotite paragneiss and metadiorite associated with intrusive bodies of quartz monzonite, granodiorite, or pegmatite. Typically, the monazite is concentrated in biotite-rich layers in the gneiss or in thin zones along intrusive contacts. Although locally rich, monazite concentrations in these contact-zone deposits generally are small and spotty. (3) Concentrations of monazite also occur as small pockets in stream sediment in the drainages of Bighorn Canyon and Ruby Canyon, and in some drainages in the Black Mountain area.

Precious and base metals

Forty-one prospect areas were sampled for precious and base metals (table 2). The metallic content is negligible in most of the 126 samples; however, significant values were obtained from prospects at the Black Rattler (loc. 6), the Big Bucks (loc. 9), and the Plata (loc. 32).

The Black Rattler and Big Bucks claims both are developed in granitoid rocks of the undeformed plutonic suite. Biotite-rich paragneiss of the prebatholithic suite and mesocratic granitic gneiss of the deformed plutonic suite occur nearby, and all the rocks have been broken by high-angle faults. Samples of pyritic quartz veins from surface workings and dumps at the Black Rattler contain significant amounts of gold, silver, lead, and copper. Underground workings, said by the owner to be extensive, were inaccessible. Samples from the Big Bucks yielded as much as 19.1 ppm gold and 1.15 percent copper, but limited exposure and inaccessible workings did not permit resource evaluation. Pyritic quartz lenses at the Plata contain as much as 11.2 ppm silver. Distribution of the silver is spotty, however, and the lenses appear to be small and not very widespread.

Industrial resources

Low-grade talc, mixed with clay, silica, and feldspars, occurs in an altered contact zone between granitic rocks and a mafic pendant at the Kermodi claims (loc. 63). A near-horizontal zoned pegmatite (loc. 28) is similar in lithology and structure to the pegmatite at the Pomona tile quarry, a former producer of quartz and feldspar located northeast of the project area. Occurrences of biotite, phlogopite, and vermiculite are present in the E1/2 sec. 13, T. 2 N., R. 3 E. Sand and gravel deposits occur sparsely within the study area; however, the development of these resources for construction stone is unlikely because the deposits are limited and because similar deposits outside the study area are more extensive and closer to present markets.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Geological, geochemical, and geophysical investigations, together with a review of prospecting and mining activities, suggest that most of the Bighorn Mountains Wilderness Study Area has low potential for economic development of all types of mineral resources and energy resources. This mineral-resource assessment is based on the following considerations. (1) Geologic mapping indicates that although geologic environments potentially favorable for mineralization occur within the study area, except for a few small areas these environments have not produced large deposits of precious and base metals and energy minerals. (2) Generally low concentrations of metallic and radioactive elements determined by chemical analyses of 316 stream-sediment and panned-concentrate samples indicate that elemental abundances generally fall within expected background ranges, although the background values for radioactive elements, certain rare-earth elements, and zirconium appear to be higher than normal for crustal rocks. (3) Aeromagnetic patterns and gravity data do not point to the occurrence of economic concentrations of magnetic minerals. (4) Although prospecting activities have occurred sporadically over a long period, no production has been reported and no large deposits of metallic or radioactive minerals have been discovered. Therefore, we believe that most of the Bighorn Mountains Wilderness Study Area has low potential for the discovery of metallic and radioactive minerals, construction materials, fossil fuels, and geothermal resources.

Radioactive-mineral resources

Although thorium-bearing monazite is abundant and widespread in the Bighorn Mountains Wilderness Study Area, occurrences generally are small and spotty. Two small areas within the wilderness study area have low to moderate potential for the discovery of thorium resources. Deposits at the Martin prospects (loc. 37) and prospect 54 might be large enough to support small-scale mining operations. Monazite concentrates could be produced easily and cheaply by simple crushing, sizing, and density separation; these concentrates then could be sold and refined for their thorium and rare-earth content. However, under existing market conditions and given the existing and future availability of easily developed monazite deposits elsewhere, development of the thorium-bearing monazite deposits at the Martin prospects and at prospect 54 is unlikely. These deposits would have greater potential for development with the advent of a large open market for monazite, but such a market is not likely in the foreseeable future. In northeastern Florida, monazite presently can be recovered economically as a byproduct from Pleistocene beach sand that is mined for its titanium content. This source is expected to meet anticipated demand in the near future (Kirk, 1980). The United States has more than ample monazite reserves in vein deposits, carbonatites, and placers in Idaho, Colorado, California, and North and South Carolina to meet any unanticipated demand that might arise from construction of thorium-fueled nuclear reactors and from other new technologies (Staatz and others, 1979, 1980). Because of these considerations and because the monazite deposits of the individual prospects have limited extent, the potential for future development of the two largest radioactive-mineral prospects in the Bighorn Mountains Wilderness Study Area is low to moderate.

Precious- and base-metal resources

Sample results suggest that the vicinity of the Black Rattler and Big Bucks mines (locs. 6-9) has low to moderate potential for future small-scale exploration and development of precious- and base-metal resources. However, inaccessibility of the underground workings precluded thorough examination, sampling, and estimation of these resources. Silver values from the Plata claim (loc. 32) are significant, but the quartz lenses are too small to have economic potential.

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EXPLANATION

AREAS OF LOW TO MODERATE POTENTIAL FOR FUTURE SMALL-SCALE EXPLORATION AND DEVELOPMENT

Radioactive-mineral resources

Precious- and base-metal resources

PROSPECT OR MINERALIZED AREA--Numbers refer to localities described in tables 1 and 2

1 ▲ Radioactive-mineral prospect

11 ● Precious- or base-metal prospect

BOUNDARY OF MAGNETIC HIGH OR LOW--Hachures point in direction of lower magnetic-field intensity. Letters A to I refer to discussion in accompanying pamphlet. Boundaries estimated by Andrew Griscom (unpub. data, 1981)

APPROXIMATE BOUNDARY OF WILDERNESS STUDY AREA

CORRELATION OF MAP UNITS

Qs — QUATERNARY — CENOZOIC
Unconformity
To, Tb (Pliocene and late Miocene) — TERTIARY — CENOZOIC
Undeformed plutonic suite: Mzl, Mzg, Mzf, Mzq — MESOZOIC
Deformed plutonic suite: Mzp, Mzd — MESOZOIC
Prebatholithic suite: Pzm — PALEOZOIC
Deformed plutonic suite / Prebatholithic suite: Mzp€g — MESOZOIC AND PRECAMBRIAN(?)

DESCRIPTION OF MAP UNITS

Qs SURFICIAL DEPOSITS (QUATERNARY)--Unconsolidated to consolidated alluvium, colluvium, and dissected older alluvium; deposits consist of sand, pebbly sand, and gravel

To OLD WOMAN SANDSTONE (TERTIARY)--Consolidated sandstone, pebble- and cobble-bearing sandstone, and conglomerate

Tb BASALT (PLIOCENE AND LATE MIOCENE)--Dikes and flows of olivine basalt

Mzl LATITE, APLITE, AND QUARTZ PORPHYRY DIKES (MESOZOIC)

Mzg LEUCOCRATIC GRANITOID ROCKS (MESOZOIC)--Coarsely crystalline, foliated to massive biotite-bearing granodiorite, monzogranite, quartz monzonite, granite, and garnetiferous muscovite-biotite granodiorite and leucogranite

Mzf FOLIATED BIOTITE-HORNBLENDE QUARTZ DIORITE TO GRANODIORITE (MESOZOIC)--Coarsely crystalline, sphene-bearing quartz diorite to granodiorite

Mzq HORNBLENDE-BIOTITE QUARTZ DIORITE (MESOZOIC)--Medium to coarsely crystalline, foliated to massive, sphene-rich quartz diorite

Mzp PORPHYRITIC GRANODIORITE (MESOZOIC)--Coarsely to very coarsely crystalline porphyritic granodiorite, strongly foliated through compositionally layered to massive; phenocrysts and augen of potassium feldspar

Mzd HORNBLENDE DIORITE, GABBRO, QUARTZ DIORITE, AND AMPHIBOLITE (MESOZOIC)--Finely to coarsely crystalline diorite, gabbro, quartz diorite, and amphibolite; lineated and folded through foliated to texturally massive

Pzm METASEDIMENTARY ROCKS (PALEOZOIC)--Schistose biotite paragneiss and minor phyllite, metaquartzite, and marble; in Rattlesnake Canyon, includes biotite-rich porphyritic granodiorite orthogneiss of unknown age

Mzp€g GRANITIC GNEISS (MESOZOIC AND PRECAMBRIAN?)--Heterogeneous gneissic granitoid rocks and granitic gneiss, foliated to diffusely layered to well-layered; pervasively mylonitized in the Granite Peaks area, locally mylonitized elsewhere; mainly granodioritic in composition

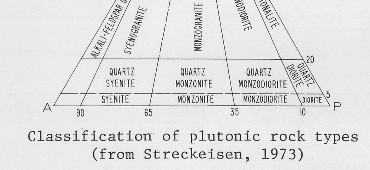
CONTACT

FAULT--Dashed where approximately located; dotted where concealed. Arrows indicate direction of relative movement. Bar and ball on downthrown block

THRUST FAULT--Dashed where approximately located; dotted where concealed. Sawteeth on upper plate

LANDSLIDE DEPOSIT--Arrows show inferred direction of movement

CRUSHED AND SHEARED ROCK IN FAULT ZONE



Classification of plutonic rock types (from Streckeisen, 1973)

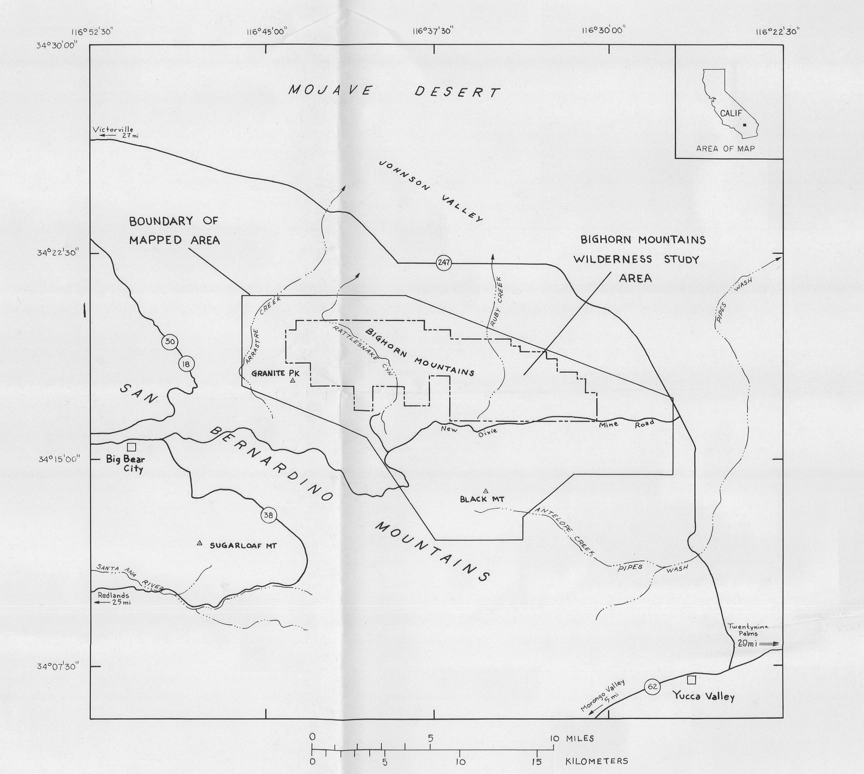


Figure 1.— Index map showing location of the Bighorn Mountains Wilderness Study Area (CDCA-217), San Bernardino County, Calif.

Table 1.--Mines and prospects of the Bighorn Mountains: radioactive minerals

Index No.	Name	Workings	Description
1	Sundown	Two prospect pits	Pegmatite in biotite-schist country rocks; pegmatite contains epidote in places. Two chip samples from pegmatite contained 150 and 100 ppm Th and 21 and 11 ppm U_3O_8, respectively.
3	The Cut No. 100	One 10-ft-long adit, one prospect pit about 300 ft SW. from adit.	Tabular pendant of biotite gneiss in quartz monzonite; pendant trends N. 50° E., extends more than 500 ft, and contains some pegmatite. Workings are on narrow radioactive zone along pendant. Zone was traced 100 ft northeast of adit and southwest as far as pit. Three chip samples from adit contained 90, 70, and 60 ppm Th and 6.0, 6.2, and 3.3 ppm U_3O_8, respectively; one chip sample from gneiss in pit contained 30 ppm Th and 3.0 ppm U_3O_8; one chip sample from pegmatite in pit contained 110 ppm Th and 3.0 ppm U_3O_8.
4	Red Boulder No. 1	One open cut in west canyon wall.	Biotite gneiss with 6- to 12-in.-wide argillic gouge zone and numerous biotite-rich clots. Site of Hewett's (1957) brannerite occurrence; no brannerite was observed in thin section. A few grains of thorium-bearing monazite were found. One chip sample from most radioactive part of gouge zone contained 190 ppm Th and 19 ppm U_3O_8.
19	Unknown	One bulldozer cut, approx 30 by 70 ft.	Gray to black siliceous quartz monzonite containing clots of biotite and spotty zones of limonite. One chip sample across quartz monzonite contained 270 ppm Th and 19 ppm U_3O_8; one chip sample from more radioactive biotite clot contained 520 ppm Th and 37 ppm U_3O_8.
20	Unknown	One bulldozer scraping.	Highly siliceous granitic gneiss with clots of 70 to 80 percent biotite. One chip sample contained 100 ppm Th and 4.1 ppm U_3O_8.
21	Unknown	Four prospect pits	One pit in biotite gneiss; three pits to the east along a northwest-trending contact between gneissic quartz monzonite and metadiorite, including tabular bodies of chloritic red granite and nodular pegmatite. Mafic streaks contain thorium-bearing monazite crystals, as much as 3 mm long. One chip sample from most radioactive zone in western pit contained 450 ppm Th and 7.7 ppm U_3O_8; four chip samples from various rock types in eastern pits contained from 520 to 780 ppm Th and from 5.6 to 12 ppm U_3O_8.
22	The Lords No. 2	One prospect pit	Biotite gneiss. One chip sample contained 200 ppm Th and 77 ppm U_3O_8.
24	Unknown	Two prospect pits about 100 ft apart.	Both pits in biotite gneiss; eastern pit is radioactive. One chip sample from western pit contained 810 ppm Th and 6.0 ppm U_3O_8.
25	Blackrock	Four bulldozer trenches.	Granodiorite containing clots of biotite and lenses of biotite shcist. Four chip samples contained 60, 190, 210, and 720 ppm Th and 1.2, 2.8, 2.1, and 5.9 ppm U_3O_8.
26	Draggin Nos. 1 & 2	Two prospect pits, two trenches	Contact between quartz monzonite and granodiorite. Quartz monzonite is siliceous and iron stained. Two chip samples across contact in trenches contained 140 and 220 ppm Th and 13 and 9.9 ppm U_3O_8, respectively; two chip samples from quartz monzonite in pits contained 250 and 180 ppm Th and 21 and 10 ppm U_3O_8, respectively.
31	Black Dog	One 13-ft-long shaft, four shallow prospect pits and cuts.	Elliptical east-trending body of leucocratic granite and granite pegmatite, 70 by 140 ft, intruding diorite. Thorium-bearing monazite is concentrated in biotite-rich zone a few inches thick along north and south contacts. Four chip samples from shaft and pits contained 30, 40, 50, and 70 ppm Th and 2.2, 2.5, 1.7, and 3.0 ppm U_3O_8, respectively; one sample from small area of extremely radioactive soil near shaft, evidently the site of a former ore stockpile, contained 730 ppm Th and 8.8 ppm U_3O_8.
33	Unknown	One prospect pit	Biotite gneiss and some limonite. One chip sample contained 130 ppm Th and 2.6 ppm U_3O_8.
34	Old Oasis	One 15-ft-long shaft	Siliceous gneiss with biotite clots and stringers. One chip sample contained 540 ppm Th and 17 ppm U_3O_8.
36	Unknown	Two prospect pits, one bulldozer trench.	Quartz monzonite and biotite gneiss with pegmatite veins and dikes. Chip samples from across pegmatite in each working contained 150, 170, and 220 ppm Th and 2.9, 2.6, and 2.9 ppm U_3O_8, respectively.
37	Martin prospects	One 80-ft-long trench, two prospect pits, one exposure 20 by 50 ft.	Deposit is in an east-trending pendant of diorite and biotite schist enclosed by quartz monzonite and granodiorite. Zone of nodular pegmatite, 10 to 15 ft wide, can be traced discontinuously for approximately 1,000 ft in outcrops, workings, and float. Thorium-bearing monazite and sparse allanite are concentrated in biotite-rich schist along margins, and in stringers within pegmatite. Seven samples of nodular pegmatite and associated biotite schist contained from 140 to 430 ppm Th, averaging 260 ppm; and from 1.3 to 4.3 ppm U_3O_8, averaging 2.4 ppm.
40	Unknown	One prospect pit	Biotite gneiss covered by alluvium. One grab sample of gneiss contained 40 ppm Th and 1.7 ppm U_3O_8.
42	Unknown	One bulldozer cut in hillside.	Biotite gneiss with stringers of pegmatite. One grab sample representing various rock types present contained 50 ppm Th and 1.6 ppm U_3O_8.
44	Hobbit Hole	One prospect pit	Northeast-trending pegmatite lens, 15 by 5 ft, along contact between gneiss and quartz monzonite. Pegmatite includes biotite-rich clots and stringers containing grains of thorium-bearing monazite. One grab sample of pegmatite contained 520 ppm Th and 14 ppm U_3O_8.
47	Desert Wind	One prospect pit	Biotite gneiss and quartz monzonite in pit. One grab sample from most radioactive spots contained 110 ppm Th and 27 ppm U_3O_8.
53	Unknown	Two prospect pits	Pegmatite containing weathered siliceous pod with potassium feldspar, biotite, and limonite. Two grab samples from areas having high scintillometer readings contained 970 and 380 ppm Th and 228 and 10 ppm U_3O_8, respectively.
54	Unknown	One 8- by 25-ft bulldozer cut, several smaller cuts.	Nodular pegmatite, 4 ft thick, in biotite, gneiss, and diorite pendant. Pegmatite extends 20 to 25 ft NW.-SE. and contains biotite-rich stringers with abundant monazite crystals. One chip sample from across pegmatite contained 100 ppm Th and 3.6 ppm U_3O_8, one sample of most radioacitve rock contained 6,780 ppm Th and 150 ppm U_3O_8--the highest values of any sample from the study area.
55	Unknown	One prospect pit	Highly weathered, slightly silicified granitic rock containing biotite schist inclusions. One grab sample contained 30 ppm Th and 1.2 ppm U_3O_8.
56	Unknown	Two prospect pits	Pegmatitic quartz monzonite and siliceous schist. Silica and biotite are concentrated along fractures in 1- to 2-in.-wide veins; some limonite. Two chip samples from across quartz monzonite contained 50 and 340 ppm Th and 3.0 and 5.6 ppm U_3O_8, respectively; one chip sample from schist contained 1,760 ppm Th and 80 ppm U_3O_8.
61	Unknown	Two prospect pits	Pegmatite with quartz-feldspar-biotite blebs. Two chip samples contained 50 and 170 ppm Th and 2.7 and 7.7 ppm U_3O_8, respectively.

Table 2.--Mines and prospects of the Bighorn Mountains: metallic minerals

Index No.	Name	Workings	Description
2	Unknown	One prospect pit	Argillized and chloritic muscovite schist, 7 ft thick, with purplish discoloration. One chip sample from across schist contained 0.03 ppm Au, 1.4 ppm Ag, and 3 ppm Cu.
5	Old Woman No. 9	One small prospect pit on hillside.	Quartz lens, 8 in. thick, in biotite schist. Zones of iron-stained mica schist, 1.5 ft thick, above and below lens; small amounts of malachite. One chip sample contained 0.03 ppm Au, 0.9 ppm Ag, and 190 ppm Cu.
6	Black Rattler Nos. 1 & 2	Three shafts, three adits, one trench, one prospect pit. Main shaft is said to be 200 ft deep with drifts on three levels, but these workings are inaccessible. Longest adit is 100 ft.	Medium- to coarse-grained quartz monzonite and granodiorite cut by argillized and silicified fracture zones trending N. 84° W., dipping 90°; fractures are locally filled with pyrite-bearing quartz veins. Nine chip samples from mineralized structures exposed at surface and in adits averaged 2.05 ppm Au and 2.62 ppm Ag, and contained as much as 600 ppm Cu and 1.68 weight percent Pb.
7	Black Rattler No. 3	One 26-ft-long trench trending N. 72° W., and a 30-ft-long adit driven east from end of trench. About 300 ft east is a cut in hillside and dicovery monument.	Trench and adit explore two limonite-stained argillized zones, each 2 ft thick, in biotite gneiss and quartz monzonite. Cut is on a 10-ft-wide zone of clay and silicified quartz monzonite along contact of quartz monzonite and aplite. One chip sample from across face of adit contained 0.03 ppm Au and 0.7 ppm Ag; one chip sample from across clay zone in cut contained 0.07 ppm Au and 1.2 ppm Ag.
8	Unknown	One 16-ft-long adit with an 8-ft vertical winze.	5- to 6-ft wide silicified zone at winze, with iron stains and chrysocolla on fractures. Wallrock is biotite gneiss on north side, and siliceous granite gneiss and biotite schist on south side. One chip sample from silicified zone contained 0.07 ppm Au, 1.8 ppm Ag, and 0.22 weight percent Cu.
9	Big Bucks Nos. 1-3	Two shafts, 27 and 50 ft deep, inaccess-ible; 25-ft-long adit, five prospect pits.	Shafts explore contact between biotite schist and granodiorite; chrysocolla coats fractures in schist. Lower workings to the southwest explore limonitic quartz veins. Two samples from around shafts contained 2.7 and 0.63 ppm Au, 1.1 and 4.7 ppm Ag, and 0.12 weight percent Cu, respectively; a grab sample from a stockpile near shafts contained 19.1 ppm Au, 3.3 ppm Ag, and 1.15 weight percent Cu; four samples from quartz veins and altered rock in lower workings averaged 0.05 ppm Au, 0.8 ppm Ag, and 38 ppm Cu.
10	Unknown	One 15-ft-long adit, 15- to 20-ft inclined winze at face of adit.	Gneiss with alternating mafic and iron-stained siliceous bands. Adit and winze follow strike and dip of siliceous bands. One chip sample from face of adit contained 0.03 ppm Au and 1.4 ppm Ag.
11	Unknown	One 35-ft-long north-south-trending bulldozer trench.	Iron-stained quartz vein, 5 ft wide, trending east-west. Wallrock is biotite schist cut by granitic and pegmatitic dikes. One chip sample from across quartz vein contained 0.4 ppm Au, 0.9 ppm Ag, and detectable Cu, Mo, and Pb.
12	Weaner No. 14	One 75-ft adit, one 38-ft adit, three prospect pits	Workings over a distance of 500 ft explore zone of quartz veins and lenses, as thick as 8 ft, and limonitic argillized zones. Veins follow foliation of enclosing biotite schist. Traces of chrysocolla in one adit. A total of 10 chip samples averaged 0.10 ppm Au (range, 0.03-0.5 ppm), 1.1 ppm Ag (range, 0.5-1.8 ppm), and 113 ppm Cu.
13	Weaner No. 1	Two inclined shafts 89 and 21 ft deep; one 52-ft-long cross-cut adit, one trench, three prospect pits.	Thin iron-stained quartz stringers in biotite gneiss. A total of 10 samples from workings and dumps averaged 0.57 ppm Au (range, 0.03-4.1 ppm) and 1.02 ppm Ag (range, 0.4-3.4 ppm).
14	Unknown	One 12-ft trench; one prospect pit 200 ft NE.	Rock at trench is mostly hornblende diorite and some quartz monzonite. Pit is in weathered limonitic slightly silicified quartz monzonite. One chip sample from trench and one from pit both contained 0.03 ppm Au and 0.3 ppm Ag.
15	Unknown	One prospect pit in streambank mostly destroyed by flash flood	Streambank composed of partial cemented greenish-gray micaceous alluvium. Two samples both contained 0.03 ppm Au and 0.3 ppm Ag.
16	Unknown	One prospect pit	Quartz vein, 3 ft thick, trends N. 85° W. for 200 ft in argillized quartz monzonite. Vein contains pockets of black and red iron oxides. One random chip sample contained 0.03 ppm Au and 0.7 ppm Ag.
17	Unknown	One prospect pit	Highly altered very coarse grained granite containing chlorite and limonite. One select grab sample contained 0.03 ppm Au, 1.1 ppm Ag, and 7 ppm W.
18	Unknown	One prospect pit	Biotite gneiss with clots of quartz and sparse limonite; horizontal layering. One chip sample contained 0.03 ppm Au and 0.3 ppm Ag.
23	Unknown	One 20-ft adit, one prospect pit.	Quartz monzonite with quartz lenses containing sulfides and iron stain. Strike due north-south, dip 58° E. One chip sample from across quartz vein on back of adit contained 0.06 ppm Au and 2.1 ppm Ag; one chip sample from across quartz lens in pit contained 0.03 ppm Au and 1.0 ppm Ag.
27	Gold Basin No. 2, Wheeler Springs	Two adits, 70 and 30 ft long, on ridge. Two crossout adits driven into west wall of Bighorn Canyon. Southern adit, 285 ft long; northern adit caved. Prospect pit, 800 ft northeast of crosscuts on Wheeler Springs claim.	Adits on ridge explore northwest-trending quartz veins and altered zones, 1 to 1.5 ft thick, in quartz monzonite and gneiss. Veins are limonitic and contain minor chrysocolla. Southern crossout adit was driven through biotite gneiss and schist, diorite, quartz monzonite, granite, and pegmatite without penetrating mineralized or altered rock. Wheeler Springs prospect is on a limonitic quartz vein. Four chip samples from upper adits averaged 0.32 ppm Au (range, 0.04-1.15 ppm), 2.1 ppm Ag (range, 1.0-4.3 ppm), and 200 ppm Cu (range, 23-390 ppm); four chip samples from southern crossout averaged 0.075 ppm Au (range, 0.03-0.13 ppm) and 1.0 ppm Ag (range, 0.7-1.4 ppm); one chip sample from Wheeler Springs prospect contained 0.03 ppm Au and 0.6 ppm Ag.
28	Unknown	One prospect pit	Zoned quartz-feldspar pegmatite, 100 by 185 ft, highly fractured; general trend, N. 70° E., gentle dip. One chip sample each from feldspar and quartz zones both contained 0.03 ppm Au and 0.6 and 0.4 ppm Ag, respectively.
29	Neptune	One cut in north wall of canyon.	Quartz lens, 2 to 8 in. thick, in banded iron-stained quartz monzonite and granodiorite. Pockets of cellular limonite and red iron stain in quartz. One chip sample contained 0.03 ppm Au, 0.3 ppm Ag and detectable Bi, Cu, and Mo.
30	Alaska	One shaft, approximately 40 ft deep, steeply inclined S. 70° E.	Rock at collar of shaft is argillized iron-stained biotite gneiss. One chip sample at collar contained 0.03 ppm Au, 1.0 ppm Ag, and detectable Cu and Mo.
32	Plata claims	Two shafts, 20 and 40 ft deep, six prospect pits.	Three isolated lenses of silicified pyritic quartz monzonite separated by several hundred feet of unaltered quartz monzonite. A total of 11 chip samples averaged 0.05 ppm Au (range, 0.03-0.15 ppm) and 3.8 ppm Ag (range, 1.5-11.2 ppm).
35	Unknown	Five prospect pits, four bulldozer cuts, two shafts, one trench.	Workings are scattered over terrane of biotite gneiss, granitic rocks, pegmatite dikes, and some quartz veins. A total of 11 samples averaged 1.36 ppm Au (range, 0.03-3.75 ppm), and 1.61 ppm Ag (range, 0.6-4.4 ppm).
38	Unknown	One open cut in hillside.	Biotite gneiss, augen gneiss, schist, and quartz monzonite. One chip sample contained 0.03 ppm Au and 0.8 ppm Ag.
39	Unknown	One prospect pit	Contact between diorite and weathered quartz monzonite. One chip sample contained 0.03 ppm Au and 0.3 ppm Ag.
41	Unknown	One prospect pit	Biotite gneiss cut by pegmatite veins and dikes. One grab sample contained 0.03 ppm Au and 0.9 ppm Ag.
43	Unknown	One open cut in hillside.	Dark-gray to black mafic schist and gneiss. One grab sample contained 0.03 ppm Au and 0.5 ppm Ag.
44	Hobbit Hole	One prospect pit	Weathered gray diorite cut by pegmatite dike, 1 ft thick. One grab sample contained 0.03 ppm Au and 0.4 ppm Ag.
45	Unknown	Two prospect pits, 150 ft apart.	Western pit exposes a white dike of leucogranite, 5 ft wide, in quartz monzonite. Eastern pit is in a body of gneiss surrounded by quartz monzonite. Random chip sample from western pit contained 0.03 ppm Au and 0.4 ppm Ag; random chip sample from eastern pit contained 0.03 ppm Au and 0.3 ppm Ag.
46	Unknown	Two prospect pits, two bulldozer cuts.	Pits and cuts are in quartz monzonite. Quartz vein and minor argillic and sericitic alteration at southwestern working. One chip sample from each working contained 0.03 ppm Au and from 0.4 to 0.6 ppm Ag; minor Cu in sample from quartz vein.
48	Unknown	Two prospect pits	Northern pit is in weathered quartz monzonite; southern pit is on contact of diorite inclusion in quartz monzonite. One random chip sample from each pit both contained 0.03 ppm Au and 0.5 and 0.9 ppm Ag, respectively.
49	Unknown	Two prospect pits	One pit is in iron-stained silicified granite; other is in amphibolitic gneiss containing veinlets of limonitic quartz. One chip sample from across gneiss contained 0.03 ppm Au and 0.5 ppm Ag; one chip sample from across granite contained 0.14 ppm Au and 0.4 ppm Ag.
50	Unknown	One prospect pit	Pegmatite, 6 to 8 in. thick, consisting predominantly of feldspar and quartz with sparse limonite. One chip sample from across pegmatite contained 0.03 ppm Au and 0.6 ppm Ag.
51	Unknown	One 50-ft trench, two bulldozer cuts.	Biotite gneiss and quartz monzonite with quartz stringers. Four chip samples contained 0.03 ppm Au and from 0.3 to 0.6 ppm Ag.
52	Blackrock	Three prospect pits	Biotite schist and granitic country rock. Shear zones with quartz and iron staining. One chip and one grab sample from two pits averaged 0.03 ppm Au, 0.8 ppm Ag, and 30 ppm Cu; one chip sample from across a shear zone contained 0.03 ppm Au, 2.4 ppm Ag, and 235 ppm Cu.
57	Unknown	One prospect pit	Friable biotite schist with quartz blebs. One chip sample contained 0.03 ppm Au and 0.3 ppm Ag.
58	Unknown	One prospect pit	Iron-stained biotite pegmatite in quartz monzonite. Two chip samples contained 0.04 and 0.03 ppm Au and 0.4 and 0.5 ppm Ag, respectively.
59	Unknown	Two prospect pits	Granitic gneiss with pegmatite and quartz veins. One chip sample contained 0.03 ppm Au and 0.3 ppm Ag.
60	Unknown	Two prospect pits	Biotite schist with bands of pegmatite, 2 to 6 in. thick, along foliation. One sample from each pit both contained 0.03 ppm Au and 0.4 and 0.5 ppm Ag, respectively.
62	Unknown	One trench	Partially cemented friable caliche containing limonite. One chip sample contained 0.4 ppm Au and 0.6 ppm Ag.
63	Unknown	Six trenches, three prospect pits.	Altered contact zone between a mafic pendant and granitic rocks. Iron-stained siliceous zone contains cubic crystals of pyrite. Alteration products include talc, clay, and calcite; talc is mixed with quartz, feldspar, and clay. Two chip samples from pyritic siliceous zone both contained 0.03 ppm Au and 0.4 ppm Ag.
64	Unknown	Two prospect pits	Granodiorite and quartz monzonite with minor pegmatite. One chip sample from each pit both contained 0.04 ppm Au and 0.4 ppm Ag.

MINERAL RESOURCE POTENTIAL MAP OF THE BIGHORN MOUNTAINS WILDERNESS STUDY AREA (CDCA-217), SAN BERNARDINO COUNTY, CALIFORNIA

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