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MINERAL RESOURCE POTENTIAL OF THE SAN GORGONIO WILDERNESS, SAN BERNARDINO COUNTY, CALIFORNIA

SUMMARY REPORT

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting 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, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and submitted to the President and the Congress. This report presents the results of a mineral resource survey of the San Gorgonio Wilderness, San Bernardino National Forest, San Bernardino County, California. The area was established as a wilderness by Public Law 88-577, September 3, 1964.

SUMMARY

Geologic, geochemical, and geophysical evidence, together with a review of historical mining and prospecting activities, suggests that most of the San Gorgonio Wilderness has low potential for all types of mineral and energy resources—including precious and base metals, construction stone and aggregate, fossil fuels, radioactive minerals, and geothermal resources. One small area within the drainage basin of the East Fork of Whitewater River has low to moderate potential for precious- and base-metal resources.

INTRODUCTION

The San Gorgonio Wilderness is located in the southeastern San Bernardino Mountains (fig. 1) approximately 75 miles east of Los Angeles, Calif. The wilderness includes an area of about 35,250 acres of mountainous terrain within the San Bernardino National Forest. The boundary of the wilderness generally coincides with the 7,000-ft topographic contour and encompasses the summits and flanks of 11,500-ft San Gorgonio Mountain and several slightly lower peaks to the northwest. Streams within the wilderness drain north into the Santa Ana River, east and southeast into tributaries of Mission Creek and the Whitewater River, and south into Mill Creek. State Highway 38 skirts the west and north sides of the area, but accessibility in the interior of the wilderness is restricted by rugged topography. The wilderness contains several foot trails but no roads or jeep trails.

Geologic setting

The San Bernardino Mountains and San Gorgonio Wilderness are situated in the eastern part of the Transverse Ranges of southern California, a geologic province that trends east-west athwart the predominant northwest-southeast structural grain of California (Bailey and Jahns, 1954). The structural setting of the San Bernardino Mountains reflects an active late Cenozoic tectonic history. The range is bounded on the south by major strike-slip faults of the San Andreas fault system, and on the north by a system of south-dipping thrust and reverse faults. Vertical movements on these and intervening faults have elevated the San Bernardino Mountains with respect to the Peninsular Ranges to the south and the Mojave Desert to the north (Dibblee, 1975; Sadler, 1982).

Geologic features of the San Gorgonio Wilderness that are described herein are based on mapping by Morton and others (1980, and additional unpublished mapping); a simplified version of their map is shown in figure 2 and on the accompanying mineral resource potential map. Earlier regional studies of the eastern San Bernardino Mountains were published by Vaughan (1922) and Dibblee (1964). The wilderness is underlain by two lithologically distinct terranes of gneissic rocks and by several varieties of granitoid rocks that have intruded the gneiss.

Southwestern and northern areas of the wilderness are underlain by relatively homogeneous, dark-gray biotite-rich gneiss and schist that exhibit conspicuous compositional layering. Discontinuous thin layers and lenses of pegmatitic granite and quartz-feldspar segregations are abundant in the gneiss, and locally it contains minor amounts of amphibolite and impure metaquartzite. The dark gneiss resembles biotite-rich parts of the Precambrian Baldwin Gneiss of Guillou (1953), for which Silver (1971) obtained a radiometric age of 1,750 m.y. The Baldwin Gneiss crops out on the north side of the Santa Ana River only 2 mi north of the San Gorgonio Wilderness. On the basis of a tentative lithologic correlation with that unit, we believe that the biotite-rich gneiss terrane in the study area is also Precambrian in age.

The southeastern part of the wilderness is underlain by a terrane of heterogeneous crystalline rocks. Much of this terrane consists of light-gray to moderate-gray quartzofeldspathic granitic gneiss with diffuse, wispy compositional layering. Lenses and irregularly shaped small bodies of texturally massive to foliated leucocratic and mesocratic granitoid rocks are intermingled with the gneiss. Small masses of metaquartzite, marble, skarn, and biotite-rich gneiss are present locally as inclusions in both the granitic gneiss and the associated granitoid rocks. These masses include several small bodies of skarn near San Gorgonio Mountain that were described by Shay (1975).

The granitic gneiss probably consists mostly of deformed plutonic igneous rocks. The intrusive age of the igneous protolith is uncertain, but we suspect that the terrane includes both Precambrian and Mesozoic plutons. A Mesozoic age is particularly likely for the less intensely deformed bodies of massive to foliated granitoid rocks that are interspersed with the granitic gneiss, but much of the gneiss itself may also consist of deformed Mesozoic plutons.

The small bodies of metasedimentary rock that are locally present as inclusions in the granitic gneiss are poorly dated. Large masses of quartzite and marble that crop out a few miles north of the San Gorgonio Wilderness have been correlated with upper Precambrian and Paleozoic strata of the Great Basin (Stewart and Poole, 1975; Cameron, 1982). The small bodies of metaquartzite and marble in the study area also may be late Precambrian and (or) Paleozoic in age, but we have not found evidence directly supporting this or any other age for these rocks.

Four lithologically distinct varieties of texturally massive to slightly foliated granitoid rocks form plutons of moderate size which have intruded the biotite-rich gneiss and the terrane of heterogeneous crystalline rocks. Leucocratic muscovite-biotite monzogranite (termed quartz monzonite by Morton and others, 1980) underlies the highest peaks near the center of the wilderness (plutonic rock terms used herein follow the usage of Streckeisen, 1973). Units of biotite granodiorite, hornblende-biotite granodiorite, and porphyritic hornblende quartz monzodiorite crop out near the west end of the wilderness. Judging from regional geologic relations, all four intrusive units are Mesozoic in age, and probably were emplaced during Jurassic and (or) Cretaceous time.

The igneous and metamorphic bedrock terranes are locally overlain by surficial deposits of unconsolidated sand and gravel of Pleistocene and Holocene age. These deposits include bouldery morainal debris deposited by ancient alpine glaciers (Sharp and others, 1959; Herd, 1980), dissected alluvium of stream terraces and older alluvial fans, and active alluvium of modern stream channels and alluvial fans.

An important strand of the San Andreas fault system, termed the Mill Creek fault by Allen (1957), follows Mill Creek Canyon along the southern edge of the San Gorgonio Wilderness. The magnitude and timing of strike-slip movements are uncertain, but many miles of right-lateral displacement probably have accumulated on this fault during late Cenozoic time. We found excellent exposures of the fault near the head of Mill Creek directly east of its confluence with High Creek. A zone of fault gouge and crushed rock at that location is as much as 600 ft wide and contains shear planes that dip moderately to steeply southward. Immediately southeast of the head of Mill Creek Canyon, the fault is overlain by older alluvial deposits of Pleistocene age which contain no fault scarps or other geomorphic evidence of Holocene faulting. Therefore, this strand of the San Andreas fault system apparently has been inactive during Holocene time.

GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS PERTAINING TO MINERAL RESOURCE ASSESSMENT

Geology

Within the San Gorgonio Wilderness, geologic environments potentially favorable for the occurrence of mineral deposits generally are small, scattered, and lack conclusive evidence that significant mineralization has actually occurred. The combination of rock types in the wilderness is different from that occurring in nearby mining districts where economic ore deposits have been discovered. In the Holcomb Valley and Tip Top Mountain areas 10 mi north and 10 mi northeast of the wilderness, gold and tungsten occur primarily in large bodies of Paleozoic metasedimentary rock that are intruded by undeformed Mesozoic plutons. By comparison, only a few bodies of metasedimentary rock and skarn, each too small to warrant being mapped, occur in the San Gorgonio Wilderness. These small bodies occur in the southeastern part of the wilderness, particularly on the south and east flanks of San Gorgonio Mountain, and most of them are surrounded by highly deformed granitic gneiss rather than undeformed plutonic rocks. We did not observe any significant evidence of mineralization associated with these bodies of metasedimentary rock and skarn.

Other geologic environments potentially favorable for mineralization include quartz veins and pegmatitic segregations that are found within both gneissic rock terranes. We found no evidence of mineralization associated with the pegmatitic segregations and found only superficial mineralization of the quartz veins. Green copper stains occur in quartz veins on Shields Peak, and quartz veinlets containing pyrite and arsenopyrite are present within brecciated rock along the Mill Creek fault in the saddle at the head of Mill Creek.

Limonitic iron-oxide stains occur within quartz veins and within gneiss at numerous localities, and are particularly common south of San Gorgonio Mountain along the East Fork of Whitewater River. We did not find evidence of significant mineralization in any of the areas of stained rock. However, the iron-stained granitic gneiss along the East Fork of Whitewater River marks a potential area for small-scale metallic mineralization, as suggested by chemical analyses of bedrock and stream sediment in this area that show anomalous concentrations of precious and base metals.

Geochemistry

A reconnaissance geochemical survey of the San Gorgonio Wilderness (Cox and Matti, 1983) was conducted for 33 major, minor, and trace elements in order to determine spatial variations in chemistry that might reflect local concentrations of ore minerals. Analyses were performed on 14 bedrock samples and on 40 stream-sediment samples composed of sandy alluvium. The sample locations are shown both on figure 2 and on the accompanying mineral resource potential map. Bedrock samples were collected only where staining or alteration suggested some potential for mineralization. The stream-sediment samples were collected at sites on all the major streams that drain the wilderness. Each stream-sediment sample was processed to yield three fractions for analysis: a minus-80-mesh fraction; a plus-80-mesh fraction; and a panned concentrate rich in heavy minerals.

The patterns of chemical composition determined by the geochemical survey suggest that most areas of the San Gorgonio Wilderness have not been sites of significant mineralization. Most of the analyses fall within ranges that are reasonable for nonmineralized crystalline rocks and their derivative stream sediments. However, the magnitude and distribution of scattered geochemical anomalies indicate that incipient mineralization has occurred locally in some parts of the San Gorgonio Wilderness. The clustering of several geochemical anomalies along the East Fork of Whitewater River indicates that this drainage basin could be a possible target for future mineral exploration.

Metallic elements

Chemical analyses of bedrock samples provide evidence of incipient metallic mineralization by deep-seated hydrothermal processes. In the western part of the study area, quartz veins that cut biotite-rich gneiss locally contain trace amounts of barium, chromium, cobalt, copper, iron, lead, and tungsten, and anomalous amounts of tin (10 ppm, site WX-03) and molybdenum (50 ppm, site WX-13). More persuasive evidence of incipient mineralization is seen south of San Gorgonio Mountain in the vicinity of the East Fork of Whitewater River (site WX-07), where samples of limonite-stained gneiss contain anomalous amounts of barium (1,500 ppm), copper (150 ppm), lead (150 ppm), and molybdenum (7 ppm). Several miles northeast of San Gorgonio Mountain, quartz veins that cut granitic gneiss contain trace amounts of gold (0.05 ppm, site WX-24).

In the southern and eastern parts of the wilderness, evidence of incipient metallic mineralization related to contact metamorphism is provided by analyses of small bodies of skarn and marble that are embedded in granitic gneiss. These analyses reveal anomalous amounts of several metallic elements: iron, greater than 20 percent; gold, 0.6 ppm; molybdenum, 15 and 70 ppm; t' 30 ppm; tungsten, 700 ppm; and zinc, 300 ppm. Most of these anomalies refer to samples from sites WX-04 and WX-11 on the ridge directly west of the East Fork of Whitewater River.

The evidence for incipient metallic mineralization provided by bedrock samples is reinforced by stream-sediment geochemical anomalies. Stream-sediment anomalies for molybdenum and tungsten occur locally throughout the San Gorgonio Wilderness, particularly in analyses of the panned-concentrate samples. The largest panned-concentrate molybdenum anomaly (150 ppm) was measured southwest of San Gorgonio Mountain (site SG-01). The second largest molybdenum anomaly (20 ppm, site SG-33) was identified in the East Fork of Whitewater River, in the same drainage basin where we have inferred incipient mineralization on the basis of geochemical anomalies in skarn, marble, and iron-stained gneiss. Smaller molybdenum anomalies ranging from 5 to 10 ppm were determined for both panned-concentrate and bulk-sediment samples scattered over a large part of the wilderness. Tungsten values in the panned-concentrate fraction range as high as 400 ppm. The largest tungsten anomalies mainly occur in the eastern part of the wilderness, in samples collected north, south, and east of San Gorgonio Mountain. These include a value of 250 ppm from the East Fork of Whitewater River (site SG-33). Several other above-average tungsten values are located in streams that drain the north and southwest sides of the wilderness.

Anomalies for chromium, cobalt, nickel, and copper occur in panned-concentrate samples and to a lesser degree in bulk-sediment samples from streams that drain the south and west flanks of the wilderness. A particularly anomalous sample collected from Skinner Creek, near the west end of the wilderness, contains 700 ppm chromium, 50 ppm cobalt, and 500 ppm nickel in the minus-80-mesh fraction (site SG-08). Small copper anomalies (300 ppm) were detected in panned-concentrate samples from two small streams near Skinner Creek (sites SG-05 and SG-07). Elsewhere, an isolated 5,000-ppm panned-concentrate anomaly for chromium occurs northwest of Anderson Peak (site SG-37), and anomalies for cobalt (150 ppm), copper (500 ppm), and nickel (150 ppm) occur together in a panned-concentrate sample from the East Fork of Whitewater River (site SG-33).

The prominent anomalies for chromium, cobalt, and nickel in the sample from Skinner Creek suggest a mafic or ultramafic igneous source. Mafic and ultramafic igneous rocks are rare or absent within the San Gorgonio Wilderness, but numerous dikes of fine-grained mafic rock intrude quartz monzodiorite near Skinner Creek, just beyond the western end of the wilderness. These dikes are prominently exposed in roadcuts along Highway 38, and some of them crop out upstream of the stream-sediment sample site on Skinner Creek. These dikes were not studied in detail, but it is possible that they contain disseminated chromite and sulfide minerals and are thus responsible for the chromium-cobalt-nickel anomaly on Skinner Creek as well as for the small copper anomalies in adjacent watersheds. Preliminary observations suggest that the swarm of mafic dikes lies mostly or entirely outside the wilderness and consequently has no bearing on the mineral resource potential of the San Gorgonio Wilderness.

A few small anomalies for tin, lead, and gold occur in the stream-sediment samples. These anomalies are scattered and show no obvious systematic relation to anomalies for other elements. The two largest anomalies were detected in the panned-concentrate fraction: a tin value of 300 ppm from a small stream near the northwest edge of the wilderness (site SG-38); and a lead value of 700 ppm from a small side stream east of San Gorgonio Mountain (site SG-27). Gold was detected in trace amounts, below the nominal lower detection limit of the atomic absorption method, in the minus-80-mesh fraction of two adjacent drainage samples along the southwest side of the wilderness (sites SG-03 and SG-04). The potential significance of these various minor anomalies is unknown.

Radioactive and rare-earth elements

Elevated values for the rare-earth elements cerium and lanthanum are widespread in panned-concentrate samples from the eastern half of the wilderness, and are locally accompanied by high concentrations of the radioactive elements uranium and thorium. The concentrations of cerium and lanthanum commonly exceed 5,000 ppm and 2,000 ppm, respectively. The values for uranium range as high as 840 ppm, and those for thorium as high as 5,000 ppm, with the peak values for both elements occurring at a sample site east of San Gorgonio Mountain (site SG-27). We tentatively attribute the anomalous abundances of cerium, lanthanum, uranium, and thorium to resistant heavy minerals such as monazite, allanite, zircon, and sphene. The anomalies probably are inconsequential, because these minerals commonly are disseminated in minor amounts in rocks similar to the granitic gneiss and monzogranite of the San Gorgonio Wilderness, but they rarely form ore deposits in bedrock. Such heavy minerals may be concentrated as placer deposits in stream gravels. However, in the absence of extensive stream deposits, there is little potential for important placer deposits in the San Gorgonio Wilderness. Small placer accumulations might be present along the North Fork of Whitewater River east of San Gorgonio Mountain, where one of the larger deposits of stream gravel and some of the more prominent geochemical anomalies for uranium and rare-earth elements are localized.

At four sample sites (SG-17, -18, -38, -39), prominent uranium anomalies (maximum value: 31 ppm) in the minus-80-mesh fraction are accompanied by relatively low uranium concentrations in the panned-concentrate fraction. These four anomalies may represent hydromorphic enrichment (Rose, 1977, p. 330) of fine-grained sediments by adsorption or precipitation of uranium dissolved in stream water. Primary uranium ore minerals, particularly uraninite and its variety pitchblende, are highly soluble in aerated surface water and shallow ground water, and therefore they can give rise to hydromorphic stream-sediment anomalies downstream from sites of mineralization. The four anomalies in the minus-80-mesh bulk sediment may be stronger indicators of potential uranium mineralization than the uranium anomalies in the panned-concentrate fraction, but they are small compared to hydromorphic anomalies reported in regions of proven uranium mineralization, which commonly exceed 100 ppm in samples of fine-grained stream sediment. We attribute no special significance to any of the geochemical uranium anomalies in the San Gorgonio Wilderness.

It is noteworthy that no stream-sediment uranium anomaly was detected in Alger Creek (site SG-03) even though an occurrence of a uranium-bearing mineral (uranothorite) has been documented in that drainage basin (Hewett and Stone, 1957). The mineral occurrence (location 2 on figure 2 and on the accompanying mineral resource potential map) is located a short distance outside the wilderness, but nevertheless lies upstream from the stream-sediment sample site. The absence of a stream-sediment uranium anomaly in Alger Creek suggests that uranothorite-bearing rock such as that described by Hewett and Stone (1957) probably is not abundant in the Alger Creek drainage basin. The same conclusion is also indicated by the lack of an aerial gamma-ray anomaly in this area (Pitkin and Duval, 1981).

Significance of geochemical anomalies

Geochemical anomalies detected in bedrock samples and in drainage samples suggest that incipient mineralization has occurred in various parts of the San Gorgonio Wilderness. The anomalies for most elements are scattered and are generally of low magnitude compared to geochemical anomalies that have been reported in districts where significant mineral deposits have been proven. Therefore, most of the anomalies probably are not related to significant mineral deposits. The drainage basin of the East Fork of Whitewater River may merit future exploration for precious and base metals because numerous geochemical anomalies—including several of the largest anomalies for cobalt, copper, gold, molybdenum, and tungsten—were detected in bedrock and stream-sediment samples from this area. Geochemical evidence for metallic mineralization is supported by geologic evidence which suggests that small-scale mineralization may have occurred in this area: granitic gneiss in the watershed exhibits extensive iron-oxide stains, and the gneiss contains scattered small bodies of calc-silicate skarn that could provide sites for metasomatic deposits of tungsten, molybdenum, and other elements.

Geophysics

Aerial radioactivity and aerial magnetic surveys of the San Gorgonio Wilderness were flown in 1978 along east-west lines spaced 0.5 mi apart at about 400 ft above ground level. Pitkin and Duval (1981) presented the results of the radioactivity study, and the aeromagnetic data were interpreted by H. W. Oliver (unpub. data, 1978). In addition, 40 gravity measurements were made in the wilderness during 1981 to complete a larger gravity survey of the San Bernardino 1^{o} x 2^{o} quadrangle (Tang and Ponce, 1982; Biehler and others, 1983). The surveys of radioactivity, magnetism, and gravity do not show any indication of significant mineral deposits.

Radioactivity survey

The aerial radioactivity survey measured gamma radiation emitted from radioactive materials in order to estimate the apparent abundances of ^{40}K, ^{232}Th, and ^{238}U at the ground surface. Pitkin and Duval (1981) concluded that the apparent abundances of radioactive elements detected by the survey do not exceed those expected for nonmineralized granitic and metamorphic rocks of the types present in the San Gorgonio Wilderness. The radioactivity survey provides no indication of significant concentrations of radioactive elements in the study area.

Magnetic survey

The aeromagnetic survey measured variations in the total intensity of the magnetic field over the San Gorgonio Wilderness and adjacent areas. The survey was conducted as a means of identifying concentrations of certain iron-rich minerals or other minerals that may be associated with occurrences of iron ore. Small magnetic highs of about 300 to 500 gammas were revealed along the south flanks of most east-west-trending ridges, and magnetic lows of about 200 to 400 gammas occur over north flanks of the ridges and adjacent valleys. To aid in the interpretation of these data, magnetic susceptibilities of about 50 typical rock samples from the wilderness were measured, and the effect of topography was computed for several assumptions of magnetization. Comparisons between magnetic and geochemical anomalies were also studied.

The results of this work indicate that the observed magnetic field results primarily from a rather uniform induced magnetization of both gneissic and granitoid rocks of about 1.5×10^{-3} emu/cm^{3}. This induced magnetization is caused by the occurrence of finely disseminated magnetite (Fe_3O_4) in concentrations of about 1 percent or less in these rocks. This concentration is similar to that in igneous and metamorphic rocks throughout California. No correlation between magnetic and geochemical anomalies was found. Thus, the magnetic survey did not reveal any significant magnetic anomalies and we conclude that there are no significant concentrations of iron ore in the wilderness.

Gravity survey

Gravity measurements from the San Gorgonio Wilderness were corrected for latitude, elevation, and terrain. The resulting Bouguer gravity data show two noteworthy features: 1) a general decrease in gravity values to the north; and 2) a local gravity high with amplitude of about 5 mGal located in the western part of the wilderness near Anderson Peak. The northward decline in gravity values is related to a regional gravity low that is centered near the northern edge of the San Bernardino Mountains (Biehler and others, 1983). This regional gravity low is consistent with seismological evidence for a deep mountain root beneath the San Bernardino Mountains and adjacent high Mojave Desert (Oliver, 1980, p. 15-17; Lamanuzzi, 1981). The local gravity high is associated with a body of granodiorite that is exposed on Anderson Peak. The gravity data provide no evidence for significant mineralization.

MINING DISTRICTS AND MINERALIZATION

The locations of known mines and prospects in or immediately adjacent to the San Gorgonio Wilderness are shown on figure 2 and on the accompanying mineral resource potential map. Sites of early mining activities known from official records were examined and evaluated for their economic potential. We also checked for evidence of early mining activities reported by long-time local residents.

Little mineral production has come from the San Gorgonio Wilderness, and only a few prospects occur in the area. U.S. Forest Service records, which cover only the past 35 years, show that claims have been located on Mill Creek, Alger Creek, and on the East Fork of Barton Creek (fig. 2, sites 1, 2, and 3). Records for earlier periods, when prospecting activity was greatest, are available in the San Bernardino County courthouse but are mixed with a large volume of general records. A mine shaft located in a topographic saddle about 0.7 mi north-northeast of the summit of San Gorgonio Mountain (fig. 2, site 4) probably dates to these earlier prospecting activities.

Evidence of mining and prospecting activities in and immediately adjacent to the wilderness is limited to metallic and radioactive minerals and marble. There apparently has been no activity involving fossil fuels, geothermal energy, or construction materials other than marble. Glacial moraines on the north and east flanks of San Gorgonio Mountain contain a large volume of loose sand and gravel, and granitic rocks of a quality suitable for general construction purposes are extensively exposed near the west end of the wilderness. However, these occurrences of potential construction materials have not attracted any commercial interest, probably because they are relatively inaccessible in comparison to deposits of equal or better quality that are widespread in southern California.

Marble workings in Mill Creek Canyon

Marble has been quarried at the Mill Creek mine on the north wall of Mill Creek Canyon about 2.7 mi southwest of San Gorgonio Mountain (fig. 2, site 1). The workings are located in the largest and easternmost of three lenticular marble bodies enclosed by granitic gneiss. The size of an open cut on the lower end of the marble lens suggests that about 13,600 tons have been removed. The three lenses are 27, 48, and 64 ft thick and 500, 1,100, and 1,800 ft long. The marble is fractured into blocks averaging 2 ft on a side. Prominant fracture sets strike N. 65^{o} E., N. 60^{o} E., and N. 35^{o} W., and dip 74^{o} SE., 40^{o} NW., and vertically, respectively. Several other small lenticular bodies of marble occur as inclusions in granitic gneiss on the south and east flanks of San Gorgonio Mountain. All of the marble bodies, including those in Mill Creek Canyon, are of little interest now because much larger, more accessible deposits of marble and limestone are available elsewhere in southern California.

Uranothorite occurrence near Alger Creek

Three lenticular masses of reddish-brown coarse-grained microcline-rich pegmatite containing disseminated uranothorite are exposed in an open cut near Alger Creek, just south of the San Gorgonio Wilderness (fig. 2, site 2). The uranium potential of this rock was investigated because similar pegmatitic lenses are common in the two terranes of gneissic rocks in the wilderness. A quantity of ore totalling less than 10 tons was shipped from the Alger Creek area in 1954 (Hewett and Stone, 1957), at about the same time that other small uranium deposits, including the Thum Bum claim near Big Bear Lake (Troxel and others, 1957, p. 671), were being developed elsewhere in the eastern San Bernardino

Mountains.

The uranothorite-bearing lenses near Alger Creek follow a zone of fracturing and shearing that parallels the foliation of surrounding granitic gneiss. The lenses are en echelon and are a maximum of 3.5 ft thick and 48 ft long. In addition to uranothorite, the pegmatite contains disseminated biotite, magnetite, allanite, and zircon (Hewett and Stone, 1957, p. 106). Samples of the pegmatite analyzed by us contain from 0.01 to 0.08 percent U_3O_8 (average of 0.02 percent). By comparison, most commercial uranium deposits being mined today contain at least 0.1 percent U_3O_8.

Due to their small size and low grade, the lenses of uranothorite-bearing rock near Alger Creek cannot be considered a significant source of uranium or thorium either now or in the near future. The low radioactive-mineral potential inferred for the Alger Creek area is corroborated by the airborne radiometric survey (Pitkin and Duval, 1981) which did not detect abnormal levels of gamma radiation in this vicinity.

Additional observations on mining activity

We checked other known claims as well as mining activities mentioned by local residents and made the following observations:

(1) A prospect pit at the claim on the East Fork of Barton Creek exposes a barren quartz vein in gneiss (fig. 2, site 3).

(2) Bedrock samples collected along the Mill Creek fault near the head of Mill Creek contain pyrite and arsenopyrite, but these samples assayed only trace amounts of silver and copper. We did not observe any evidence of past mining activities in this area, despite remarks by local residents that $28,000 in silver was produced from this area in 1911.

(3) The mine shaft northeast of San Gorgonio Mountain (fig. 2, site 4) is collapsed; no conspicuous mineralization is present at the surface in the granitic country rock. Samples of dump material contain only traces of gold, silver, and lead.

(4) Local residents stated that claims once were staked on gold-bearing veins along Fish Creek. We analyzed samples of vein quartz collected near Fish Creek and found traces of gold but no metal concentrations of significance.

(5) Despite remarks by local residents, there is no evidence that building stone was ever obtained at the head of Hatchery Creek.

(6) A tunnel near Dobbs cabin was driven to convey water and did not involve mining operations.

Significance of historical mining activities

All known occurrences of metallic and radioactive materials within and immediately adjacent to the San Gorgonio Wilderness are insignificant because of their small size and low grade. Construction materials (marble, granitic rocks, sand, and gravel) in the area have little potential because of their relative inaccessibility and greater distance to markets compared to similar deposits elsewhere in southern California. Finally, in view of widespread past mining activities in surrounding areas of the eastern San Bernardino Mountains, we suspect that the absence of significant historical workings within the vicinity of the San Gorgonio Wilderness reflects the low mineral resource potential of the rocks within this area.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Geologic, geochemical, and geophysical investigations conducted within the San Gorgonio Wilderness suggest that few significant targets for mineral resource exploration exist within the area. Historic mining activity in the wilderness and adjacent areas has been limited, small scale, and short lived compared to mining operations in nearby districts to the north and east. Therefore, we believe that most of the San Gorgonio Wilderness has low potential for metallic and radioactive minerals, construction materials, fossil fuels, and geothermal resources. Geochemical anomalies in bedrock samples and in stream-sediment samples, together with the occurrence of iron-stained gneiss and small bodies of contact-metasomatized metasedimentary rock, suggest that the drainage basin of the East Fork of Whitewater River south of San Gorgonio Mountain may be the site of small-scale base- and precious-metal mineralization. Accordingly, we infer a low to moderate potential for base- and precious-metal resources in the watershed of the East Fork of Whitewater River (fig. 2).

In the event that future mineral resource studies are conducted in the San Gorgonio Wilderness, we recommend the following approaches: (1) detailed mapping and geochemical studies of skarn deposits on the south and east flanks of San Gorgonio Mountain in relation to potential occurrences of molybdenum and tungsten; (2) detailed mapping and geochemical studies of iron-stained gneiss along the East Fork of Whitewater River in relation to possible vein occurrences or disseminated occurrences of base and precious metals; and (3) further geochemical and mineralogic studies to evaluate the significance of widespread high concentrations of the rare-earth elements cerium and lanthanum determined by our geochemical survey of stream sediments.

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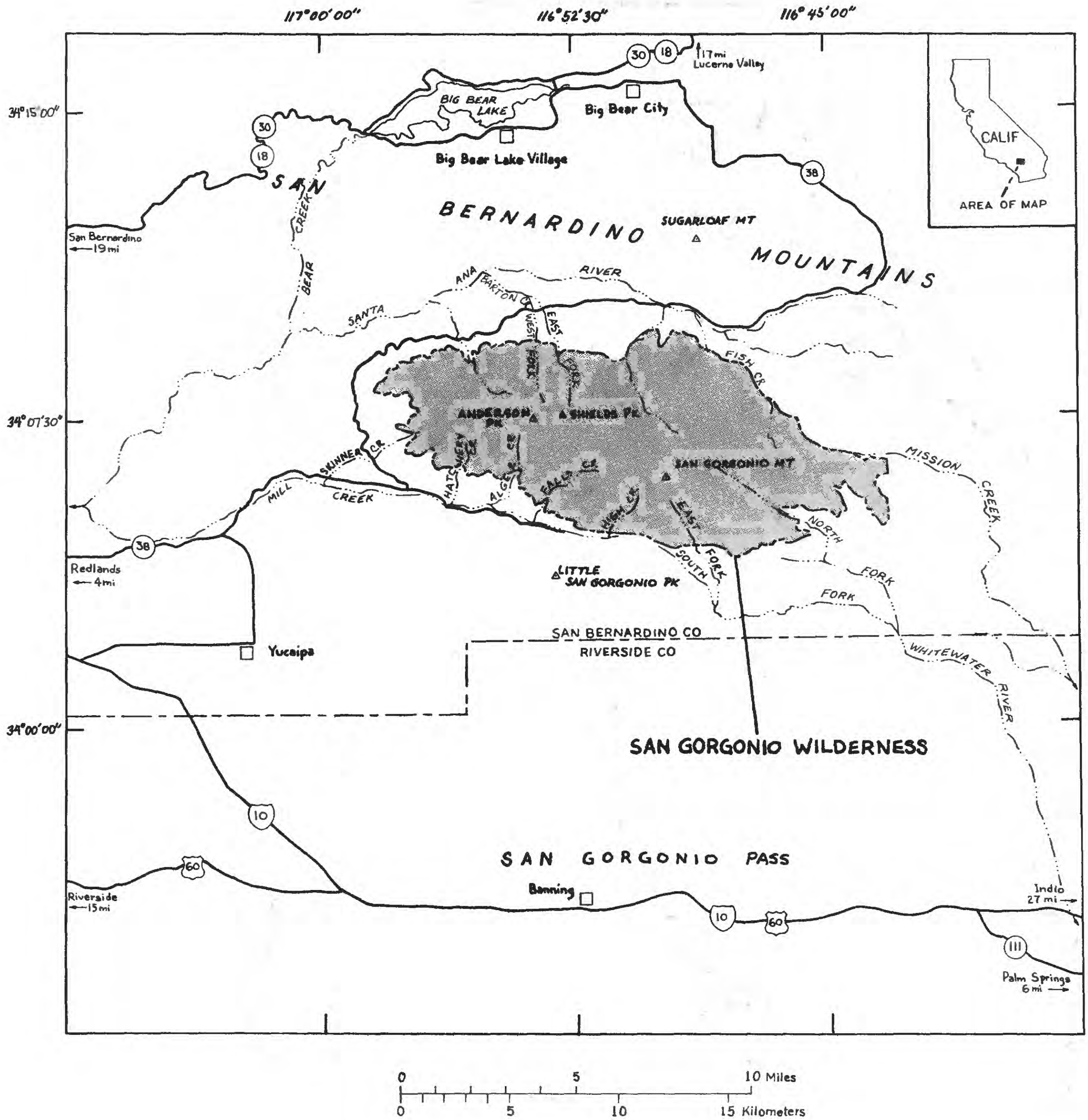
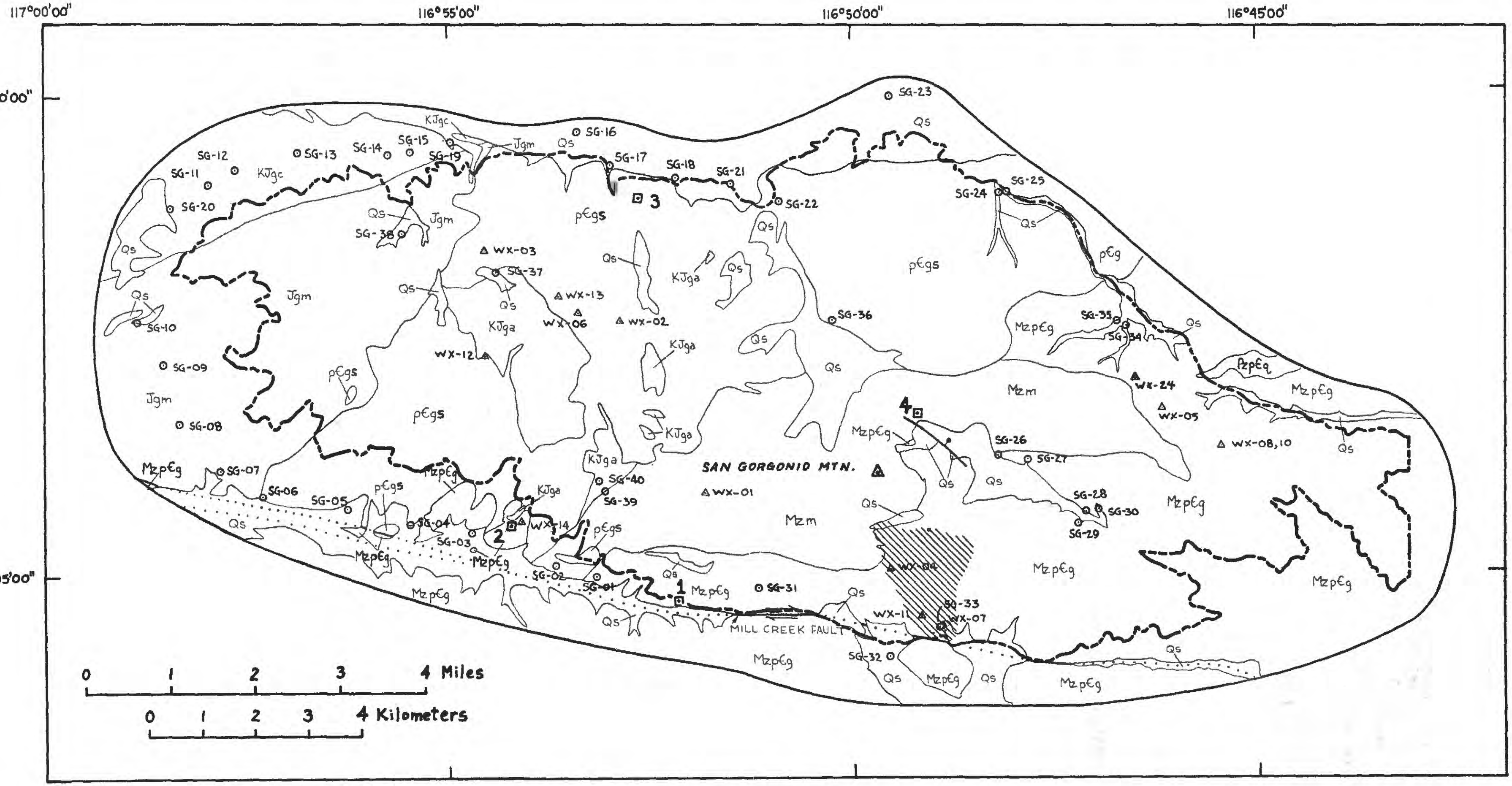


Figure 1.—Index map showing location of the San Gorgonio Wilderness, San Bernardino County, Calif.



EXPLANATION

AREA OF LOW TO MODERATE POTENTIAL FOR PRECIOUS- AND BASE-METAL RESOURCES

2 ⊡ MINE OR PROSPECT—Numbers refer to discussion in text
1 Mill Creek mine 3 Barton Creek prospect
2 Alger Creek open cut 4 Collapsed mine shaft

SG-03 ⊙ STREAM-SEDIMENT SAMPLE SITE

WX-11 △ BEDROCK SAMPLE SITE

CONTACT

FAULT—Dotted where concealed. Arrows indicate direction of relative movement. Bar and ball on downthrown block

APPROXIMATE BOUNDARY OF WILDERNESS

BOUNDARY OF MAPPED AREA

Figure 2.—San Gorgonio Wilderness, showing simplified geology, geochemical sample sites, mines and prospects, and zone with inferred low to moderate mineral resource potential. For detailed description of geologic units see accompanying map sheet. Qs, surfical deposits (Quaternary); KJga, granodiorite of Anderson Peak (Cretaceous or Jurassic); KJgc, granodiorite of Camp Angelus (Cretaceous or Jurassic); Jgm, quartz monzodiorite and quartz monzonite of Manzanita Springs (Jurassic); Mzm, monzogranite of San Gorgonio Mountain (Mesozoic); Mzp€g, granitic gneiss (Mesozoic?, Paleozoic?, and Precambrian); Pzp€q, metaquartzite (Paleozoic? and (or) Precambrian); p€gs, biotite gneiss and schist (Precambrian).