MINERAL RESOURCE POTENTIAL OF THE WHITEWATER WILDERNESS STUDY AREA, RIVERSIDE AND SAN BERNARDINO COUNTIES, CALIFORNIA

SUMMARY REPORT

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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 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 Whitewater Wilderness Study Area, California Desert Conservation Area, Riverside and San Bernardino Counties, California.

SUMMARY

Geological, geochemical, and geophysical evidence, together with a review of historical mining and prospecting activities, suggests that most of the Whitewater Wilderness Study Area has low potential for all types of mineral and energy resources—including precious and base metals, building stone and aggregate, fossil fuels, radioactive-mineral resources, and geothermal resources. One small area in the southern part of the study area shows evidence of gold and silver mineralization, and this locality has a low to moderate potential for the discovery of low-grade gold and silver resources.

INTRODUCTION

The Whitewater Wilderness Study Area is located about 45 miles east of Riverside and about 15 miles northwest of Palm Springs, Calif. (fig. 1). The study area comprises approximately 18 square miles (11,500 acres) that adjoin the San Bernardino National Forest in the southeastern San Bernardino Mountains. The area consists of rugged mountainous terrain as well as foothills of the California high desert, and is traversed by the Whitewater River, a major perennial stream that flows south and east into the Salton Sea. Access to the study area from the south is via dirt roads that lead from U.S. Interstate 10 and a paved road that follows Whitewater River canyon. Access from the east is via a dirt road that leaves State Highway 62 and follows Mission Creek.

GEOLOGY

The Whitewater Wilderness Study Area is underlain by crystalline bedrock, by Tertiary sedimentary and volcanic rocks, and by Quaternary deposits of sand and gravel. The area lies between several strands of the San Andreas fault system: on the south the Banning fault zone, and on the north the Mill Creek and Mission Creek fault zones, two strands of the San Andreas system that parallel each other closely but have had separate fault-movement histories. During the past 5 million years, many miles of right-lateral displacement on these faults have carried rocks in the Whitewater area northwestward from their original location in the southern Salton Trough to their present location.

The Mill Creek and Mission Creek fault zones separate two distinct terranes of crystalline bedrock, one occurring north of the fault zones and one occurring to the south. The Whitewater Wilderness Study Area is underlain by the southern terrane. Here, the crystalline rocks consist of a lithologically monotonous assemblage that includes granitoid rocks, gneissic granitoid rocks, and compositionally layered granitic gneiss. The granitoid rocks and their gneissic equivalents include hornblende-biotite granodiorite and quartz diorite, and leucocratic biotite granodiorite. The layered granitic gneiss ranges from granodiorite to quartz diorite in composition. Locally, a distinctive body of mafic, chloritized and saussuritized porphyritic monzogranite occurs within the layered gneiss complex. This crystalline terrane has been affected by one or more regional deformations that have crushed and sheared the rocks and have produced pervasive planar fabrics that include textural foliation, cataclastic and mylonitic foliation, and gneissic compositional layering.

North of the Mill Creek and Mission Creek fault zones, the crystalline bedrock consists of a lithologically heterogeneous assemblage that includes leucocratic to mafic, compositionally layered granitic gneiss. These rocks mainly are biotite-bearing to biotite-rich, although bodies of hornblende diorite occur locally. This terrane also has been affected by regional deformation that has produced pervasive shearing, textural foliation, and compositional layering.

In the eastern part of the Whitewater Wilderness Study Area the crystalline bedrock is overlain depositionally by Miocene and Pliocene sedimentary and volcanic rocks. The Miocene rocks consist of cobble conglomerate and pebbly sandstone interlayered locally with flows and intrusions of basalt, basaltic andesite, and rhyolite. Allen (1957) assigned these rocks to his Coachella Fanglomerate. This sequence is overlain unconformably by marine sedimentary rocks that we assigned to the Imperial Formation and by Pliocene nonmarine sedimentary rocks that we assign to the Painted Hill Formation of Allen (1954; 1957). These rocks consist of siltstone, sandstone, and pebble-cobble conglomerate.

Unconsolidated to consolidated Quaternary sedimentary units occur throughout the Whitewater Wilderness Study Area. The oldest unit is a steeply dipping deformed sequence of gravel and pebbly sandstone (unit of older gravel deposits) that rests unconformably on the Miocene units and on the crystalline basement complex, and that depositionally overlaps much of the Mission Creek fault zone. The deformed gravel unit in turn is overlain unconformably by gently dipping gravel deposits (unit of younger gravel deposits) that are perched high above the present Whitewater River and that also occur in outcrops buttressed against the walls of Whitewater canyon. The two gravel units represent deposits of the ancestral Whitewater River. The modern Whitewater River and its tributaries are transporting and depositing loose, unconsolidated alluvial sediment.

The three strands of the San Andreas fault system in the Whitewater Wilderness Study Area have had a complicated movement history. The Mission Creek and Mill Creek faults both are marked by zones of crushed, sheared, and altered crystalline rock, but the crush zone of the Mission Creek fault is much wider than that of the Mill Creek fault. Major displacements on the Mission Creek fault occurred prior to the accumulation of the steeply dipping deformed gravel unit because these gravels have been deposited over much of the wide crush zone. By contrast, the deformed gravels are faulted extensively by the Mill Creek fault. These relations suggest that displacements on the Mill Creek fault occurred after major displacements on the Mission Creek fault had terminated. The history of the Banning fault zone has been summarized by Matti and Morton (1982), who recognize latest Miocene and earliest Pliocene episodes of right-lateral displacements as well as Quaternary episodes of right-lateral and thrust displacements.

GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS PERTAINING TO MINERAL RESOURCE ASSESSMENT

Geology

Geologic evidence suggests that the Whitewater Wilderness Study Area generally has low potential for the discovery of mineral resources. During our geologic field studies we observed localized zones of mineralized rock, but geologic environments favorable for the occurrence of economic mineral deposits have not produced extensive zones of mineralization.

Crystalline rock types in the study area are different from those that occur elsewhere in the San Bernardino Mountains where economic mineral deposits have been found. For example, in areas like the Mineral Mountain, Bear Valley, and Holcomb Valley districts 20 to 30 miles northwest of the study area, precious metals have been discovered mainly in Paleozoic quartzite, metaquartzite, and marble that are intruded by Mesozoic plutons. This geologic setting is not developed in the Whitewater Wilderness Study Area where the suite of deformed granitic and gneissic rocks lacks metasedimentary pendants and contains no evidence of extensive alteration and veining. Locally, shear zones within the crystalline rocks show minor traces of gold, silver, and iron and copper oxides and sulfides, as in the Bonanza prospect in Cottonwood Canyon (fig. 2). However, the mineralized shear zones are limited in areal extent and they are not abundant in the crystalline rock.

Miocene sedimentary and volcanic rocks do not provide geologic environments favorable for the occurrence of economic mineral deposits. Pebbles and cobbles of detrital magnetite occur as clasts in some sedimentary layers; although these clasts locally are abundant, their concentrations are not great enough to warrant placer or mining operations. We did not observe significantly mineralized or alterated zones associated with the Miocene volcanic rock. Except for their possible use as gravel resources, Pliocene and Quaternary sedimentary rock units also do not provide geologic environments favorable for the occurrence of economic mineral deposits.

Geochemistry

A reconnaissance geochemical survey of stream sediments in the Whitewater Wilderness Study Area was conducted for 32 major, minor, and trace elements in order to determine spatial variations in stream-sediment chemistry that might reflect local concentrations of ore minerals. The locations of 28 geochemical sample localities and the tabulated analytical results for stream sediments and panned concentrates are shown in tables 1 and 2 on the accompanying mineral resource potential map.

Stream-sediment geochemistry can be a useful tool in reconnaissance mineral-resource evaluation because anomalously high concentrations of a specific element or group of elements in an alluvial deposit can reflect mineralization upstream in the drainage basin. However, the chemical composition of alluvium is influenced by numerous factors in addition to the mineral content of the source rocks (Rose and others, 1979, p. 383-427), and local geochemical anomalies often are unrelated to economic mineralization. Therefore, the stream-sediment geochemistry survey is strictly a reconnaissance technique producing results that must be evaluated within the context of geological and geophysical data and follow-up geochemical studies.

The patterns of chemical composition determined from the stream-sediment geochemical survey of the Whitewater Wilderness Study Area do not indicate economic mineralization within the study area. Most of the analyses fall within ranges that are reasonable for nonmineralized crystalline rocks and derivative stream sediments; few values exceed this geochemical background. Moreover, for all elements the maximum concentrations that were measured are low in comparison to values that generally have been reported in stream-sediment geochemical studies for districts where significant mineral deposits are present.

In some panned concentrates (table 2), elements that were detected in amounts exceeding background values may point to the existence of local mineralized point sources. Three panned concentrates have high concentrations of arsenic and detectable antimony (sites 9, 18, and 20), and one sample shows anomalous values for bismuth, silver, cobalt, and tungsten (site 13). Bismuth and cobalt show elevated values in panned concentrates from sites scattered throughout the Wilderness Study Area. However, any potential metallic sources for these geochemical anomalies probably are limited in size and distribution because the anomalies do not show systematic patterns or clustering. For example, samples collected adjacent to sites 9, 13, 18, and 20 do not contain detectable concentrations of metals. The origin of metallic anomalies in tables 1 and 2 is unknown. However, the anomalies probably are insignificant and probably represent a localized geologic source such as small quartz veins or quartz-feldspar segregations in the layered gneiss. Our geologic investigations did not identify extensive zones of quartz veining, although quartz-feldspar segregations locally are common in the layered gneiss units.

Manganese and boron concentrations also are high in panned concentrates from several sites within the study area. Some of the elevated manganese values probably are related to concentrations of piedmontite (a manganese epidote mineral) that occur in localized narrow belts within the granitoid rock and granitic gneiss (Allen, 1957; Smith and Albee, 1967). Manganese and boron also may be traceable to epidote and tourmaline disseminated in the gneiss or concentrated in metamorphic segregations.

We believe that the values designated as anomalous in tables 1 and 2 probably have no economic significance. The stream sediments were derived from a mainly granitic terrane that has been crushed, sheared, recrystallized, locally laced with quartz-feldspar metamorphic segregations, and locally altered to produce zones of saussuritized, chloritized, and epidotized rock. Locally-elevated metallic values can be expected in rocks having granitic parentage and having this style of metamorphism and deformation, and we believe the anomalous values for elements in the Whitewater Wilderness Study Area represent reasonable geochemical variability. Because of the isolated nature of the metallic-element anomalies and the lack of evidence for large-scale mineral deposits, mineralization in the study area most likely has resulted in small, scattered mineralized zones. Therefore, the results of the geochemical survey are compatible with the geologic evidence: the geochemistry suggests a low mineral resource potential for the Whitewater Wilderness Study Area.

Geophysical surveys

An aerial magnetic survey of the Whitewater Wilderness Study Area was flown in 1981, and the data have been analyzed by Andrew Griscom (unpub. data, 1981). The magnetic anomalies and patterns on magnetic maps are caused by variations in the amount of magnetic minerals (commonly magnetite) in the rock units. Because they are closely related to geologic features, the magnetic-intensity contours can indicate economic concentrations of iron-rich minerals as well as terranes where these minerals are deficient.

The sources of most of the major magnetic anomalies within the Whitewater Wilderness Study Area are probably volcanic rocks or their associated intrusive sources, some of which probably are concealed beneath young sediments in the valley of Whitewater River. Because these volcanic rocks are unaltered and relatively young (Miocene), the remanent magnetization of the rocks may far exceed the induced magnetization. Depending upon whether the Earth's magnetic field at the time of extrusion and emplacement was normal or reversed, the remanent magnetization of the volcanic rocks accordingly is normal or reversed, and the rocks correspondingly display either a magnetic high or low on an aeromagnetic map. In the study area both magnetic highs and magnetic lows of this sort are observed, and they seem to be associated with the volcanic rock units. However, none of the volcanic units was tested for magnetic susceptibility or polarity of magnetization. There is no aeromagnetic evidence of mineralization within the Whitewater Wilderness Study Area.

MINING DISTRICTS AND MINERALIZATION

Methods and previous studies

In the present study, the U.S. Bureau of Mines reviewed literature pertaining to geology and mining activity in the vicinity of the Whitewater Wilderness Study Area. Records on file with the U.S. Bureau of Land Management and Riverside County mining records were searched to locate mining claims in or near the study area, and all known claims and prospects within the area were examined. Mineralized areas were sampled and mapped where warranted.

Mines and mineral deposits in the vicinity of the Whitewater Wilderness Study Area were systematically described most recently by Saul, Gray, and Evans (1968).

Prospecting history

The locations of known prospects in the vicinity of the Whitewater Wilderness Study Area are shown on figure 2. Mining claims in the vicinity were staked as early as 1888. No production has been reported from mines in or adjacent to the wilderness study area, although stone, limestone, and sand and gravel deposits 1.5 to 7 mi from the area have been worked. No mining claims were recorded within the study area in 1981.

Mineralized areas

No deposits of potentially mineable metallic minerals have been discovered within the Whitewater Wilderness Study Area. However, shear zones within the granitic and gneissic crystalline rocks locally are mineralized. The shears generally strike northwest and dip northeast. In places the shear zones are stained by limonite, and pyrite and chalcopyrite are disseminated locally through the zones. Manganese oxides, magnetite, and epidote also are common in places. The zones sporadically contain gold, silver, and copper.

At the Bonanza prospect in Cottonwood Canyon (fig. 2), a sheared, limonite-stained zone associated with a fault in compositionally layered gneiss is exposed across several hundred feet of outcrop. The limonitic zone parallels foliation, and is penetrated by a 124-ft-long adit. One sample from the adit contained 1.6 oz/ton silver; a second sample from an outcrop of limonitic gneiss contained 0.22 oz/ton gold. However, geochemical analyses of two stream-sediment samples (WW-26 and WW-27) from streams that drain the limonitic gneiss zone of the Bonanza prospect did not show detectable concentrations of gold or silver in their analyses, and metal content of other bedrock samples in the vicinity of the Bonanza prospect was negligible. Based on the demonstrated occurrence of gold and silver in some of the bedrock analyses, the area of the Bonanza prospect is assigned a low to moderate potential for the discovery of low-grade gold and silver resources.

Metallic concentrations of economic significance were not found in mineralized zones elsewhere within the Whitewater Wilderness Study Area. Outside the study area, samples from two current claim groups (Desert Gold and Desert Rainbow, loc. 7 and 8, fig. 2) contained as much as 0.031 oz/ton gold and 0.3 oz/ton silver. However, most samples from the claims had negligible metal content.

Migmatitic gneiss on the west side of Mission Creek, just outside the study area, is sheared and altered near a contact with basaltic tuff breccia. Pyrite, chalcopyrite, and secondary copper minerals are scattered through the altered gneiss. Two of four samples from the area contained gold and copper, averaging 0.028 oz/ton gold and 0.32 percent copper.

Twenty-four reconnaissance heavy-mineral-concentrate samples were taken from drainages throughout the study area. Two of the samples contained small amounts of gold.

Energy and industrial resources

No deposits of potentially mineable energy minerals have been discovered within the Whitewater Wilderness Study Area. Torbernite and other secondary uranium minerals at the DBL Claims (loc. 4, fig. 2)) were reported by Barrett (1955). The occurrence was not verified in 1981, and scintillometer traverses detected no anomalous radioactivity in the area.

The Whitewater Wilderness Study Area lies within an area considered prospectively valuable for geothermal resources (U.S. Geological Survey, 1978). However, no geothermal springs or evidence of hydrothermal alteration are known in the study area.

Several exploratory oil wells were drilled within 6 mi of the study area from 1918 to 1957 (Proctor, 1968, p. 39). However, the wells were nonproductive.

Sand and gravel deposits occur within the Whitewater Wilderness Study Area, but the development of these deposits for construction stone is unlikely because similar deposits outside the study area are more extensive and are closer to present markets.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Geological, geochemical, and geophysical evidence, together with a review of prospecting and mining activities, suggest that most of the Whitewater Wilderness Study Area has low to insignificant potential for economic development of all types of mineral resources and energy resources. This mineral-resource assessment is based on the following consideratons: (1) geological mapping indicates that geologic environments favorable for the occurrence of mineral deposits have not produced extensive zones of mineralization within the study area; (2) generally low concentrations of specific elements as determined by chemical analyses of stream-sediment and panned-concentrate samples from 28 localities indicate that elemental abundances generally fall within expected background ranges; (3) aeromagnetic patterns suggest that anomalous magnetic highs that occur within the study area most likely are associated with volcanic rocks and do not point to the existence of concentrations of economic magnetic minerals; and (4) historic prospecting activities have been limited and unsuccessful by comparison with mining operations that occur in different geologic terranes elsewhere in the San Bernardino Mountains. Therefore, we believe that most of the Whitewater Wilderness Study Area has a low to insignificant potential for development of metallic and radioactive minerals, construction materials, fossil fuels, and geothermal resources. One small area in the southern part of the wilderness study area (fig. 2) shows evidence of gold and silver mineralization, and this locality has a low to moderate potential for the discovery of low-grade gold and silver resources.

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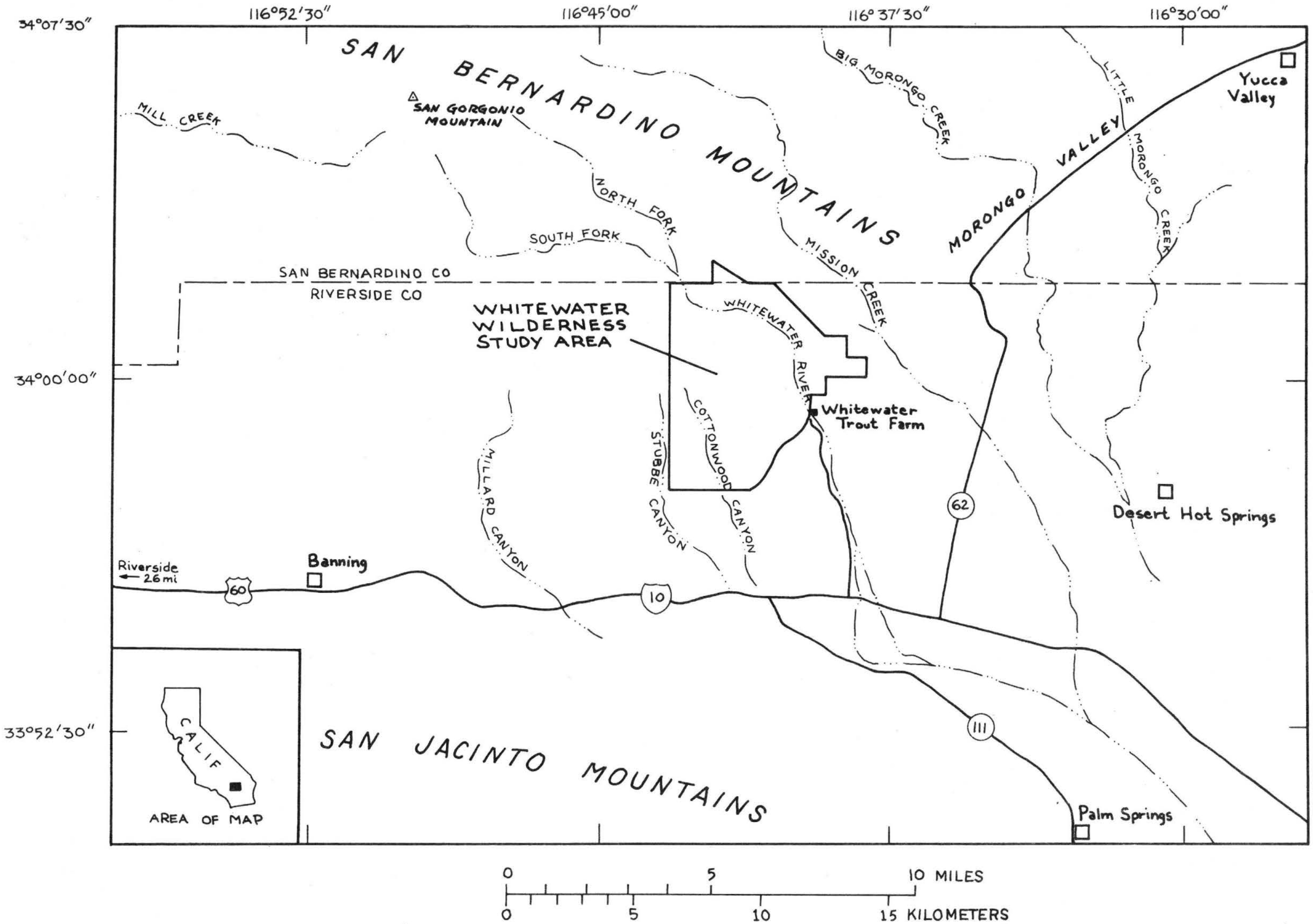

Figure 1.--Index map showing location of the Whitewater Wilderness Study Area, Riverside and San Bernardino Counties, Calif.

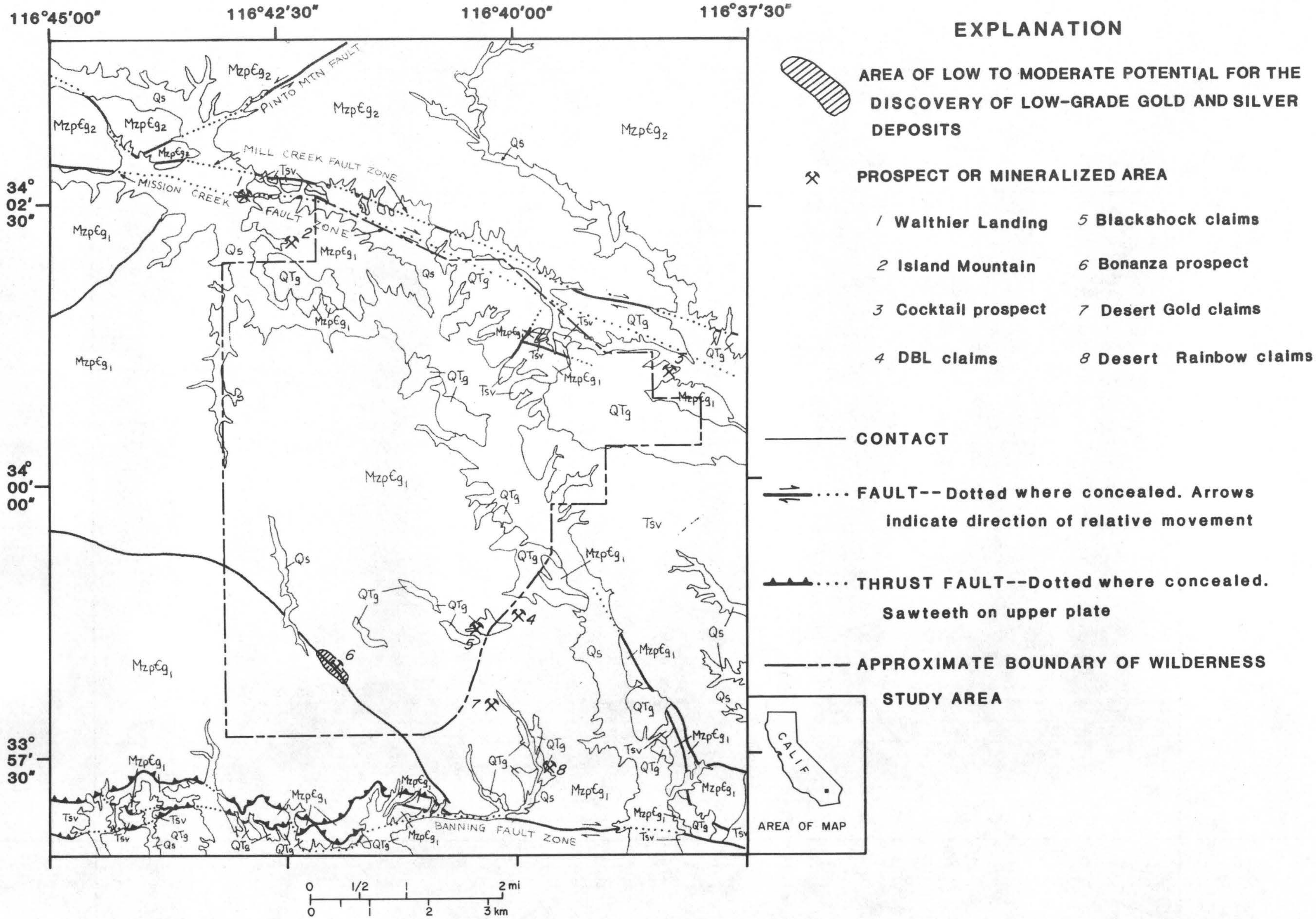

Figure 2.--Whitewater Wilderness Study Area showing zone with mineral resource potential and location of mines and prospects. Geology simplified from accompanying mineral resource potential map. Qs = surficial sedimentary deposits; QTg = older gravel deposits; Tsv = Tertiary sedimentary and volcanic rocks; Mzp€g$_1$ = granitic gneiss south of the Mill Creek-Mission Creek fault zones; Mzp€g$_2$ = heterogeneous granitic gneiss north of the Mill Creek-Mission Creek fault zones.