MINERAL RESOURCE POTENTIAL OF THE PLEASANT VIEW ROADLESS AREA, LOS ANGELES 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 discusses the results of a mineral survey of the Pleasant View Roadless Area (5008), Angeles National Forest, Los Angeles County, California. The area was originally classified as nonwilderness during the Second Roadless Area Review and Evaluation (RARE II) by the U. S. Forest Service, January 1979, but was reclassified as a further planning area during April 1979.

SUMMARY

A mineral resource survey of the Pleasant View Roadless Area included geologic mapping, a geochemical survey of rocks and stream sediments, and a study of mines, prospects, and mineralized areas. There are no known mineral deposits and there is no evidence of past mineral production from the study area. Although gold has been produced 2 mi southeast of the study area and minor amounts of gold were detected in samples of vein quartz from one prospect in the study area, gold was not detected by the geochemical survey of stream sediments. This limited evidence suggests that the entire study area has low potential for gold resources. Stream-sediment samples slightly enriched in tungsten and containing grains of the tungsten mineral scheelite cluster in an 8.5-mi^2 zone at the east end of the study area. However, evidence of tungsten mineralization was not observed in the crystalline rocks exposed within this zone. Judging from the small amounts of tungsten detected in the stream sediments, from the lack of historical tungsten mining or other conclusive evidence of tungsten mineralization in the study area, and from the limited scale of tungsten mineralization in neighboring areas, any bedrock or placer concentrations of tungsten that may be present in the study area probably are small and (or) low grade. Thus, there is low to moderate potential for tungsten resources within the designated 8.5-mi^2 zone at the east end of the study area. Evidence of resource potential was not observed for any mineral other than gold and tungsten.

INTRODUCTION

Geographic setting

The Pleasant View Roadless Area is located on the north slope of the San Gabriel Mountains (fig. 1) directly south of the western Mojave Desert region and approximately 25 mi northeast of Los Angeles, Calif. The study area encompasses 26,700 acres of rugged mountainous terrain in the Angeles National Forest. Elevations in the study area range from nearly 4,000 ft on Little Rock Creek at the west end of the area, to approximately 8,400 ft at Mount Lewis near the east end of the area. Pleasant View Ridge, which includes several summit elevations near 8,000 ft, trends northwestward across the western half of the study area and forms the drainage divide between Little Rock and Big Rock Creeks. Angeles Crest Highway (State Highway 2) skirts the south boundary of the study area, providing access to neighboring ski resorts on Waterman Mountain and Kratka Ridge. Two foot trails cross the study area, connecting Angeles Crest Highway with campgrounds near Big Rock Creek.

Geologic setting

The study area lies in the northern San Gabriel Mountains south of the San Andreas and Punchbowl faults (fig. 2). Ehlig (1981) has summarized the geology of the San Gabriel Mountains. Published geologic maps by Noble (1954), Dibblee (1967), Barrows (1980), and Evans (1982a,c) cover parts of the study area, and unpublished mapping within the study area and vicinity by T. W. Dibblee and by P. L. Ehlig has been incorporated in the geologic map of the San Bernardino 1° by 2° quadrangle (Rogers, 1967). Cox and Powell (unpub. map, U.S. Geological Survey, Menlo Park, 1982) mapped the study area to provide data for the present report; a simplified version of their geologic mapping is shown on figure 2 and on the accompanying mineral resource potential map. Crystalline bedrock is exposed throughout most of the study area. The main bedrock units include Precambrian gneiss, several assemblages of late Paleozoic(?) and Mesozoic plutonic rocks, and poorly dated schist and mylonitic rocks. Cenozoic units locally present in the study area consist of Tertiary sedimentary rocks, Tertiary rhyolite, and Quaternary alluvial deposits. The crystalline bedrock and Tertiary rock units are cut by numerous minor faults and by three regionally prominent structures: the Vincent thrust, and the Fenner and Punchbowl faults.

Precambrian gneiss

The oldest rocks in the study area are amphibolite-facies gneissic rocks that form scattered remnants intruded by late Paleozoic(?) and Mesozoic plutonic rocks. The gneissic rocks comprise three distinct varieties that are combined in a single map unit on figure 2. In the eastern half of the area, the gneiss generally is biotite rich, locally contains sillimanite and garnet, and less commonly contains staurolite. Most of the remnant bodies of gneiss in the western half of the area are quartzofeldspathic, composed of alternating leucocratic and mafic layers. The third type of gneiss is homogeneous coarse-grained augen gneiss, which locally occurs within the largest body of layered quartzofeldspathic gneiss on Pleasant View Ridge. Silver (1971) determined Precambrian uranium-lead ages on similar quartzofeldspathic gneiss and augen gneiss in the Soledad Basin region directly northwest of the San Gabriel Mountains (also see Ehlig, 1981).

Late Paleozoic(?) and Mesozoic plutonic rocks

The gneissic rocks of the study area are intruded by numerous plutonic rock units (plutonic rock terminology used herein follows Streckeisen, 1973). The oldest plutonic unit consists of mafic diorite and gabbro of probable Late Permian or Triassic age. These mafic rocks are intruded by a unit of foliated quartz monzodiorite and quartz diorite that has been correlated (unpublished mapping of T. W. Dibblee, compiled by Rogers, 1967) with the Mount Lowe Granodiorite of Miller (1926, 1934) (equivalent to the Lowe Granodiorite of other workers). The main body of the Mount Lowe Granodiorite located west of the study area has yielded Triassic radiometric ages (Silver, 1971; Joseph and others, 1978).

An assemblage of three younger plutonic units underlies a large part of the study area south of the Punchbowl fault. These units consist of the following: a unit of porphyritic quartz monzodiorite; a unit of heterogeneous plutonic rocks consisting of quartz diorite, tonalite, and granodiorite; and a unit of leucocratic biotite monzogranite that intrudes the other two younger plutonic units. On the basis of regional geologic relations, we assign a Jurassic(?) age to the quartz monzodiorite unit and a Cretaceous age to both the heterogeneous plutonic rocks unit and the monzogranite unit.

Two additional plutonic rock units are exposed north of the Punchbowl fault. The Pinyon Ridge Granodiorite (Noble, 1954) crops out north of the Fenner fault. This unit consists mostly of biotite-hornblende quartz diorite to quartz monzodiorite. The second unit consists of a single small body of biotite monzogranite located east of the study area near Vincent Gap, where it may either intrude or be faulted against the Pelona Schist, described below. Noble (1954) assigned the Pinyon Ridge Granodiorite a Jurassic(?) age; however, because there are no radiometric ages for the unit, the more general age of Mesozoic is used in this report. The biotite monzogranite near Vincent Gap may be Cretaceous, but alternatively could be Miocene, for similar granitic rocks exposed 13 mi southeast of the study area have yielded potassium-argon ages of 14 to 19 m.y. (Miller and Morton, 1977).

Schist and mylonitic rocks

Schist and mylonitic rocks are exposed near the east end of the study area. The Pelona Schist (Hershey, 1902) consists of greenschist-facies metamorphic rocks derived from sandstone, siltstone, shale, basalt, and chert (Ehlig, 1981; Evans, 1982a,c). Exposures of the schist are present between the Punchbowl and Fenner faults (Noble, 1954) and southeast of the study area, structurally beneath the Vincent thrust fault (Evans, 1982c). Precambrian gneiss and late Paleozoic(?) and Mesozoic plutonic rocks that structurally overlie the Pelona Schist in the upper plate of the thrust are mylonitized in a thick zone adjacent to the thrust surface. Rubidium-strontium ages from the Pelona Schist and structurally overlying mylonitic rocks suggest that both rock units were metamorphosed and deformed during and (or) before Paleocene time (Ehlig, 1981, Evans, 1982c); however, the depositional age of the Pelona Schist protolith is uncertain.

Cenozoic units

Tertiary sedimentary rocks nonconformably overlie crystalline rocks north of the Punchbowl fault. These sedimentary rocks consist of two formations which are combined in a single map unit on figure 2: Paleocene marine shale, sandstone, and conglomerate (San Francisquito Formation: Dibblee, 1967; Kooser, 1980); and upper Miocene and lower Pliocene continental sandstone and conglomerate (Punchbowl Formation: Noble, 1953, 1954; Woodburne and Golz, 1972). A large dike of rhyolite intrudes the Mount Lowe Granodiorite and Cretaceous monzogranite near the south side of the study area north of Kratka Ridge. The rhyolite may be genetically related to late Oligocene and Miocene intrusive rocks that have been described in neighboring areas (Miller and Morton, 1977; Ehlig, 1981). The youngest unit in the study area consists of poorly consolidated sand and gravel of Quaternary age. Deposits of these materials are present within major stream canyons in the study area, particularly tributaries of Big Rock Creek, and also form large alluvial fans that lie mostly outside the study area north of Pleasant View Ridge.

Structure

Three major faults are present near the northern and eastern boundaries of the study area (fig. 2). The oldest of these faults is the westward-dipping Vincent thrust, exposed 1 mi southeast of the study area. During Paleocene time, and perhaps earlier, the Precambrian gneiss and late Paleozoic(?) and Mesozoic plutonic rocks in the upper plate of the Vincent thrust were faulted on top of the Pelona Schist (Ehlig, 1981). During thrusting, both the schist and upper-plate rocks were deformed and metamorphosed. Deformational effects to the upper-plate rocks include the zone of mylonitic rocks adjacent to the thrust and a broader zone of less intense ductile and brittle deformation, including pervasive foliation and localized fracturing, that extends westward into the study area as far as the drainage divide west of the South Fork of Big Rock Creek.

The Fenner and Punchbowl faults are major steeply dipping Cenozoic structures that formed after the Vincent thrust, probably as ancestral strands of the San Andreas fault system. The Fenner fault is truncated by the younger Punchbowl fault, on which nearly 30 mi of right-lateral displacement may have occurred during late Pliocene or Pleistocene time (Dibblee, 1967, 1968). North of Pleasant View Ridge, the Punchbowl fault locally has caused slight vertical separation of Pleistocene or lower Holocene alluvium (Noble 1954), apparently indicating minor movement during Holocene time. Numerous steeply dipping minor faults of Cenozoic age cut basement rocks south of the Punchbowl fault. Movement on these faults probably has been predominantly vertical, but separations between bedrock units suggest lateral displacements of 1,000 ft or more have accumulated on some of these faults.

GEOLOGY AND GEOCHEMISTRY PERTAINING TO MINERAL RESOURCE ASSESSMENT

Geology

Concentrations of ore minerals were not observed within rock units, or along fractures, veins, faults, or intrusive contacts while mapping the geology of the study area; neither are there any special lithologic or structural features that would seem to provide an ideal geologic setting for any particular type of mineralization. However, southeast of the study area, veins and placer accumulations containing subeconomic resources of gold and tungsten occur near the Vincent thrust fault in a geologic setting generally similar to that present in the eastern part of the study area (Evans, 1982b; Ridenour and others, 1982; Zilka and Schmauch, 1982). Gold-bearing veins occur in both the upper and lower plates of the Vincent thrust, whereas tungsten-bearing veins are almost entirely restricted to the upper plate of the thrust.

The apparent localization of vein-related occurrences of gold and tungsten near the Vincent thrust suggests that the thrust or related structures may have influenced the generation or migration of mineralizing hydrothermal fluids in the eastern San Gabriel Mountains. A broad zone of heterogeneous brittle and ductile deformation extends away from the

Vincent thrust westward into the study area as far as the drainage divide west of the South Fork of Big Rock Creek. This zone of fractured and foliated rocks could have provided an access route for mineralizing fluids that may have originated near the Vincent thrust. This idea is supported by the geochemical survey (following section), which detected anomalous concentrations of tungsten and several other elements in stream sediments derived from the zone of deformed rocks; however, gold was not detected by the survey.

Geochemistry

A reconnaissance geochemical survey of stream sediments and crystalline bedrock was conducted for 31 major, minor, and trace elements to identify any spatial variations in chemistry that might reflect local concentrations of ore minerals. Emission-spectrographic analyses were performed on stream-sediment samples collected at 57 sites and on samples of nonmineralized bedrock collected at 62 sites. The stream sediments were the main target of the survey. Stream-sediment geochemistry provides useful information for reconnaissance mineral resource evaluation because anomalously high concentrations of a specific element or group of elements in alluvium can indicate the presence of mineralized bedrock upstream in the drainage basin.

Sandy alluvium was collected from all the main drainages in the study area. Each stream-sediment sample was processed to yield two fractions for spectrographic analysis: (1) a minus-80-mesh fraction and (2) a nonmagnetic heavy-mineral concentrate produced by hand panning in the field followed by bromoform immersion and electromagnetic separation in the lab. A split of each heavy-mineral concentrate was also examined microscopically to determine the mineralogy of the heavy-mineral grains. The bedrock samples were collected from visibly unweathered, nonmineralized outcrops in order to determine the normal or background abundances of elements in crystalline rock units, thereby facilitating interpretation of the stream-sediment geochemistry.

When compared to worldwide-average geochemical abundances (for example, see Turekian, 1977), the compositions determined for most bedrock samples are normal for the rock types involved. However, the analytical data show that the Mount Lowe Granodiorite and the mafic diorite and gabbro unit contain unusually large amounts of strontium (as much as 1000 ppm). These strontium concentrations are anomalous for plutonic rocks, but are not high enough to have any mineral resource significance. The bedrock survey also revealed some minor geochemical variations in the eastern half of the study area that apparently are unrelated to rock type or to mapped faults: minor anomalies were determined for silver (4 anomalies, 0.5 to 1.5 ppm; background less than 0.5-ppm spectrographic detection limit), boron (8 anomalies, 15 to 20 ppm; background 10 ppm or less), and molybdenum (1 anomaly, 5 ppm; other determinations below 5-ppm detection limit). The slight enrichment of metallic elements in these bedrock samples has no direct mineral resource significance, but nevertheless is consistent with stream-sediment geochemistry that suggests vein-related mineral occurrences are localized near the east end of the study area.

The stream-sediment geochemistry indicates that most elements were derived from areas of nonmineralized crystalline rocks. Notable exceptions were found for tungsten, barium, strontium, boron, and bismuth, all of which were detected in anomalous amounts in heavy-mineral concentrates from sample sites clustered near Mt. Lewis at the east end of the study area (patterned area on fig. 2). Grains of scheelite and (or) elevated concentrations of tungsten (100 to 300 ppm; background less than 100-ppm spectrographic detection limit) were observed in 11 out of 12 heavy-mineral concentrates from tributaries of Dorr Canyon and the South Fork of Big Rock Creek and from one minor drainage on the north flank of Mt. Lewis. Grains of barite and (or) anomalous concentrations of barium (5000 to 10,000 ppm; background 50 to 500 ppm) were observed in 11 of these same 12 samples. The same group of heavy-mineral concentrates contains abnormally high values of strontium (500 to 3000 ppm; background 200 ppm and below) and boron (30 to 150 ppm, background less than 20-ppm detection limit). The distribution of bismuth anomalies (4 anomalies, 50 to 700 ppm; background mostly less than 20-ppm detection limit) overlaps with the cluster of tungsten anomalies, but extends westward as far as the central part of the study area, where there are also two isolated 100-ppm anomalies for tungsten. No gold was detected by the survey; however, the apparent absence of gold may be deceiving and may be attributable to the low sensitivity of the emission-spectrographic method (detection limits: 20 ppm for heavy-mineral fraction, 10 ppm for minus-80-mesh fraction.

Geochemical data for the minus-80-mesh sediment fraction are less informative, but generally reinforce the pattern shown by the heavy-mineral fraction. Boron anomalies (12 anomalies, 50 to 100 ppm; background 10 to 20 ppm) were recorded for the same cluster of stream-sediment sample sites near Mt. Lewis. However, neither tungsten nor bismuth was detected (detection limits 50 ppm and 10 ppm, respectively), and no prominent anomalies were found for either barium or strontium.

The aggregate drainage area represented by the cluster of stream-sediment geochemical anomalies for tungsten (fig. 2) covers approximately 12 mi^2, including 8.5 mi^2 within the study area and 3.5 mi^2 outside the area. The presence of the tungsten ore mineral scheelite in the heavy-mineral concentrates indicates that mineral-concentrating processes have occurred within the bedrock of this drainage area. Carbonate rocks, such as are hosts to metasomatic tactite deposits of scheelite elsewhere in southern California (Bateman and Irwin, 1954), were not observed in the study area. The scheelite probably occurs instead within hydrothermal veins that cut gneissic and plutonic rocks, although no veins were observed in the course of reconnaissance geologic mapping. The association of scheelite and barite with geochemical anomalies for strontium, boron, and bismuth is consistent with a vein origin. Barite is a common gangue mineral in vein-type ore deposits and commonly contains strontium substituted for barium in the crystal lattice. Boron and bismuth both are highly mobile in hydrothermal systems and commonly serve as pathfinders for vein-related deposits of tungsten (Levinson, 1980).

The occurrence of tungsten anomalies and scheelite at the east end of the study area is noteworthy because vein-related subeconomic resources of scheelite have recently been described in similar geologic settings 10 to 12 mi southeast of the study area (Ridenour and others, 1982; Zilka and Schmauch, 1982). It should also be noted that the largest amounts of tungsten determined by our geochemical survey (300 ppm in heavy-mineral concentrates) are small compared to tungsten anomalies as great as 2000 ppm and 10,000 ppm that have been reported for panned-concentrate samples collected 6 to 10 mi southeast of the study area (Evans, 1982b). However, the modest magnitudes of the tungsten anomalies are partly compensated by their pronounced clustering in association with the anomalies for barium, boron, and bismuth.

MINES, PROSPECTS, AND MINERALIZED AREAS

The Bureau of Mines inspected mines, prospects, and mineralized areas in and near the Pleasant View Roadless Area in 1981 and reviewed documents and reports pertaining to historical mining and prospecting activities. U.S. Forest Service and U.S. Bureau of Land Management records were examined to determine claim locations, and field examinations were conducted at all known claims and prospects. There is no active mining and there are no patented claims or mineral leases in the study area. The area contains no known mineral deposits and no evidence of past production of metallic mineral resources, industrial mineral resources, coal and hydrocarbons, or geothermal energy.

Three prospects are located within or directly adjacent to the study area. The Sycamore prospect (fig. 2, loc. 1), located at the northwest end of the study area, consists of one 37-ft adit and an open cut measuring 13 ft long, 6 ft wide, and 10 ft deep. The prospect explores a zone of ductile shearing along the contact between Jurassic(?) quartz monzodiorite (unit Jqm) and Cretaceous monzogranite (unit Km). A quartz vein at the site is 0.5 to 0.7 ft thick and has an exposed length of over 10 ft. Two chip samples of the vein rock were collected for analysis. One contained 0.5 oz silver per ton; the other contained 0.028 oz gold per ton. Judging from the low metal content and small size of the vein, the Sycamore prospect contains no identified mineral resources.

The Donaldson prospect (fig. 2, loc. 2), located at the south side of the study area, consists of a single pit measuring 8 ft wide, 8 ft long, and 4 ft deep. The prospect is located in a small lens of gneissic rocks that is intruded on the north by the Mount Lowe Granodiorite of Miller (1926, 1934) and is truncated on the south by a fault. The gneiss is pulverized and brecciated adjacent to the fault but contains no evidence of metallic minerals.

The Fenner Canyon prospect (fig. 2, loc. 3), located just outside the eastern boundary of the study area, contains two caved adits. The workings are in limonite-stained schist that contains no evidence of significant mineralization.

The inactive Big Horn mine (fig. 2, loc. 4), located 2 mi east of the study area, has been the only mineral producer in the near vicinity (Ridenour and others, 1982). The mine was owned by the Siskon Corporation in 1975. Minerals containing gold, silver, copper, and lead occupy veins within chlorite schist and carbonaceous schist directly beneath the Vincent thrust fault. Ten adits at the mine contain more than 6,100 ft of workings. Bureau of Mines records indicate that the property has produced 31,000 tons of ore containing 3,701 oz gold, 2,430 oz silver, 1,357 lb copper, and 1,296 lb lead. According to a 1975 estimate, the mine contains approximately 1.2 million tons of subeconomic mineral resources averaging 0.15 oz gold per ton (Ridenour and others, 1982). At 1983 gold prices ($400 per troy ounce), the mine probably contains at least marginal reserves of gold.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The Pleasant View Roadless Area lacks identified mineral and energy resources, and there has been no recorded mineral production from the area. Deposits of sand and gravel might be used for concrete aggregate or road fill, and some of the gneissic and plutonic rocks within the roadless area could be used for crushed stone or riprap. These occurrences of potential construction materials have not attracted any commercial interest, however, probably because they are relatively inaccessible in comparison to deposits of equal or better quality that are available in nearby regions (see Goldman, 1968). No evidence of resource potential was observed for geothermal energy, coal and hydrocarbons, radioactive minerals, and most metallic minerals with the exception of gold and tungsten.

The study area as a whole has low potential for lode gold resources. This conclusion is based on the minor amounts of gold that were detected in a quartz vein at the Sycamore prospect, and on the proximity of an historic gold producer, the Bighorn mine, located 2 mi southeast of the study area. No supporting evidence is provided by the stream-sediment geochemical survey. The available evidence for gold is too meager to indicate either a specific geologic environment or particular geographic zone within the study area where gold occurrences are most likely to be present.

Grains of scheelite and geochemical anomalies for tungsten in stream sediments suggest that tungsten-bearing veins are present within an 8.5-mi^2 zone near the east end of the study area (fig. 2). The zone of geochemical anomalies corresponds with a structural zone of foliated and fractured rocks west of the Vincent thrust; this zone of deformed rocks might have provided avenues for the migration of tungsten-bearing hydrothermal fluids. However, veins, metallic minerals, or other evidence of mineralization were not observed in this part of the study area, nor has historical prospecting revealed any placer or bedrock concentrations of tungsten ore in the study area. With maximum values of 300 ppm, the tungsten geochemical anomalies are modest in size compared to anomalies reported elsewhere in areas with significant tungsten mineralization; however, tungsten is not always detected in fine-grained alluvium in areas with significant tungsten mineralization. Overall, the available evidence suggests that tungsten concentrations near the east end of the study area probably are limited to small and (or) low-grade occurrences comparable to those found in similar geologic settings 10 to 12 mi southeast of the study area. Thus, there is a low to moderate potential for tungsten resources in the 8.5-mi^2 zone near the east end of the study area.

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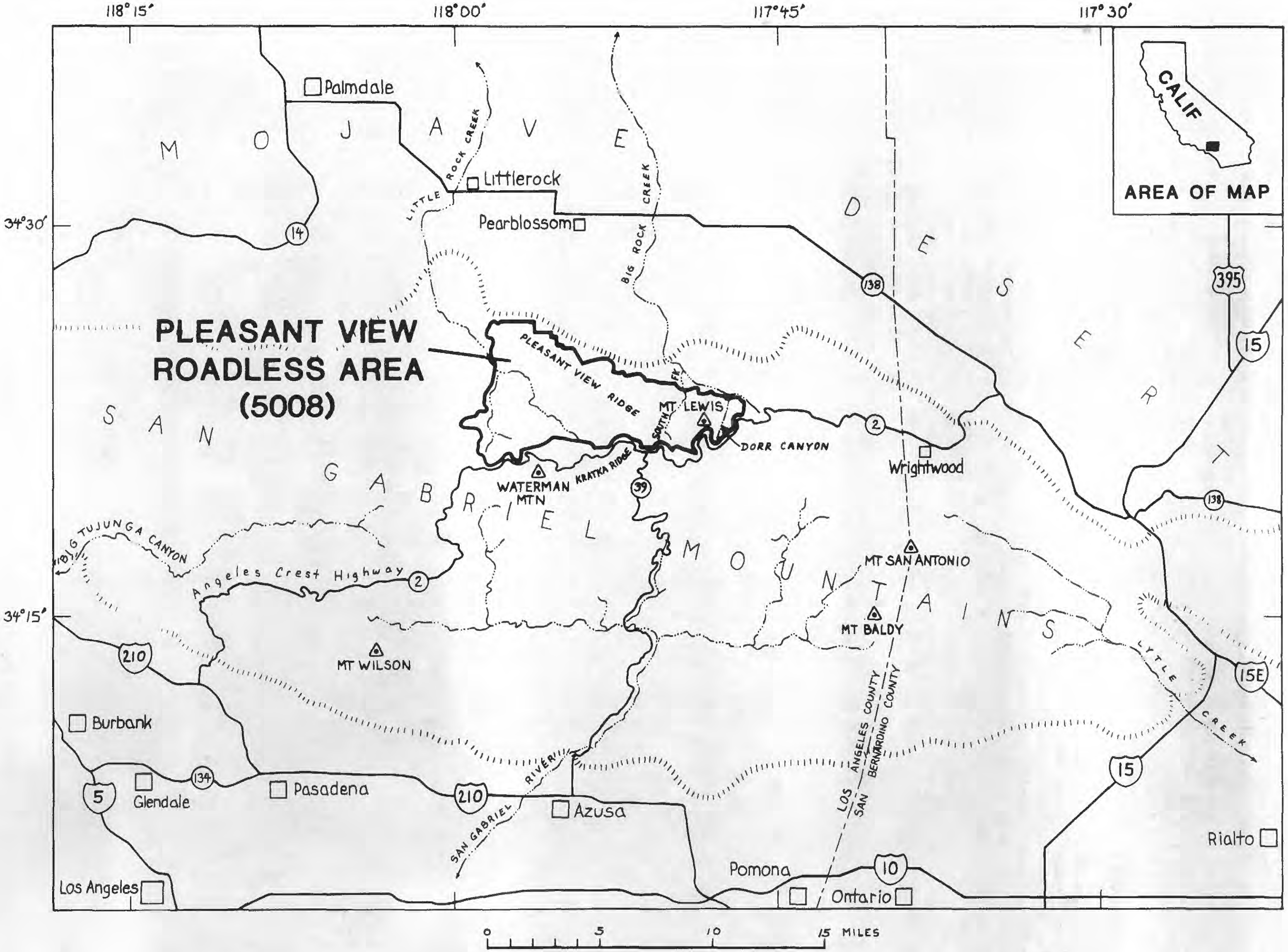
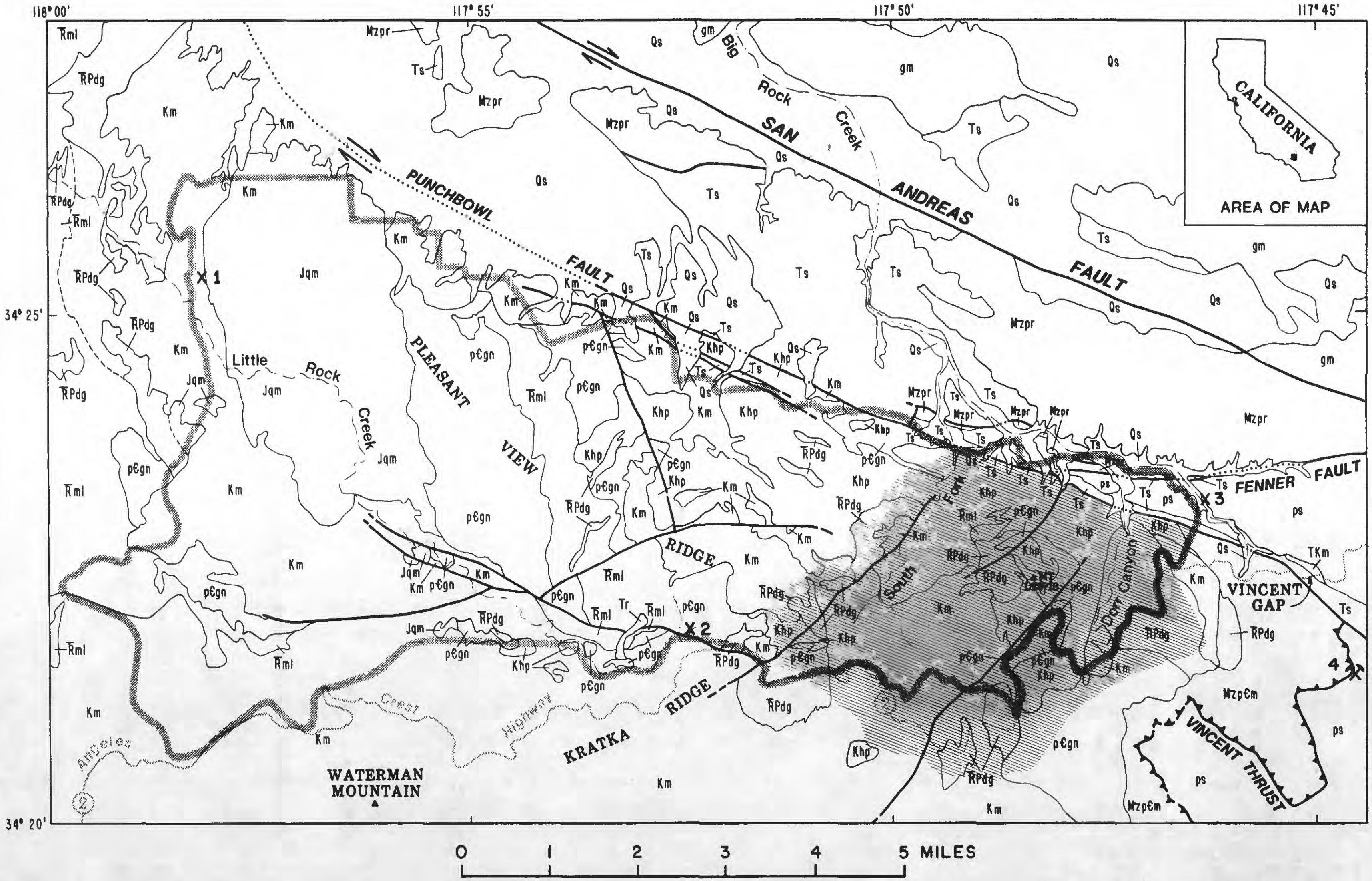


Figure 1.--Index map showing the location of the Pleasant View Roadless Area (5008), Los Angeles County, California.



(See page 8 for figure caption and explanation)

Figure 2.--Pleasant View Roadless Area, showing simplified geology, mines and prospects, and area with low to moderate potential for vein-related tungsten resources. Geology north of Punchbowl and Fenner faults is modified from Rogers (1967) and Kooser (1980); geology near Vincent thrust southeast of study area is modified from Evans (1982a,c). For detailed description of geologic units see accompanying map sheet. Qs, surficial deposits (Quaternary); Ts, sedimentary rocks (Tertiary); Tr, rhyolite (dike) (Tertiary); TKm, biotite monzogranite near Vincent Gap (Miocene? or Cretaceous?); ps, Pelona Schist (age uncertain); Km, leucocratic biotite monzogranite (Cretaceous); Khp, heterogeneous plutonic rocks (quartz diorite, tonalite, and granodiorite) (Cretaceous); Mzpr, Pinyon Ridge Granodiorite (quartz diorite and quartz monzodiorite) (Mesozoic); Jqm, porphyritic quartz monzodiorite (Jurassic?); TRml, Mount Lowe Granodiorite of Miller (1926, 1934) (quartz monzodiorite and quartz diorite) (Triassic); TRPdg, mafic diorite and gabbro (Triassic or Permian); Mzp€m, mylonitic rocks (Mesozoic, late Paleozoic?, and Precambrian); p€gn, gneissic rocks (Precambrian). In addition, unit gm (not shown on accompanying map sheet) consists of undifferentiated granitic and metamorphic rocks (age uncertain) north of San Andreas fault.

EXPLANATION

AREA WITH LOW TO MODERATE POTENTIAL FOR VEIN-RELATED TUNGSTEN RESOURCES

MINES AND PROSPECTS

- X 1 Sycamore prospect
- X 2 Donaldson prospect
- X 3 Fenner Canyon prospect
- ⚒ 4 Bighorn mine

CONTACT--Dashed where approximate

FAULT--Dashed where approximate; dotted where concealed. Arrows indicate relative lateral movement

THRUST FAULT--Dashed where approximate. Barbs on upper plate

ROADLESS AREA BOUNDARY