UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MINERAL RESOURCES OF THE SHEEP MOUNTAIN WILDERNESS STUDY AREA AND THE CUCAMONGA WILDERNESS AND ADDITIONS, LOS ANGELES AND SAN BERNARDINO COUNTIES, CALIFORNIA

OPEN-FILE REPORT 77-251

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature

Menlo Park, California

1977

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STUDIES RELATED TO WILDERNESS

In accordance with 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 U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. 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 currently 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. This report discusses the results of a mineral survey of some national forest lands in the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions that are being considered for wilderness designation.

MINERAL RESOURCES OF THE SHEEP MOUNTAIN

WILDERNESS STUDY AREA AND

THE CUCAMONGA WILDERNESS AND ADDITIONS,

Los Angeles and San Bernardino Counties, California

A. Geology of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions, Los Angeles and San Bernardino Counties, California

By James G. Evans, U.S. Geological Survey

B. Aeromagnetic study of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness area and additions, Los Angeles and San Bernardino Counties, California

By Leroy Pankratz, U.S. Geological Survey

C. A geological and geochemical evaluation of the mineral resources of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions, Los Angeles and San Bernardino Counties, California

By James G. Evans, U.S. Geological Survey

D. Economic appraisal of the Sheep Mountain Wilderness study area, Los Angeles and San Bernardino Counties, California

By James Ridenour, Steven W. Schmauch, *and* Nicholas T. Zilka, U.S. Bureau of Mines

E. Economic appraisal of the Cucamonga Wilderness area and additions, San Bernardino County, California

By Nicholas T. Zilka *and* Steven W. Schmauch, U.S. Bureau of Mines

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SUMMARY

A mineral survey of the Sheep Mountain Wilderness study area and Cucamonga Wilderness area and additions by the U.S. Geological Survey and Bureau of Mines in 1975 covered about 66,500 acres (26,500 ha) of the San Bernardino and Angeles National Forests in southern California. The two study areas are separated by San Antonio Canyon. The mineral resource potential was evaluated through geological, geochemical, and geophysical studies by the Geological Survey and through evaluation of mines and prospects by the Bureau of Mines.

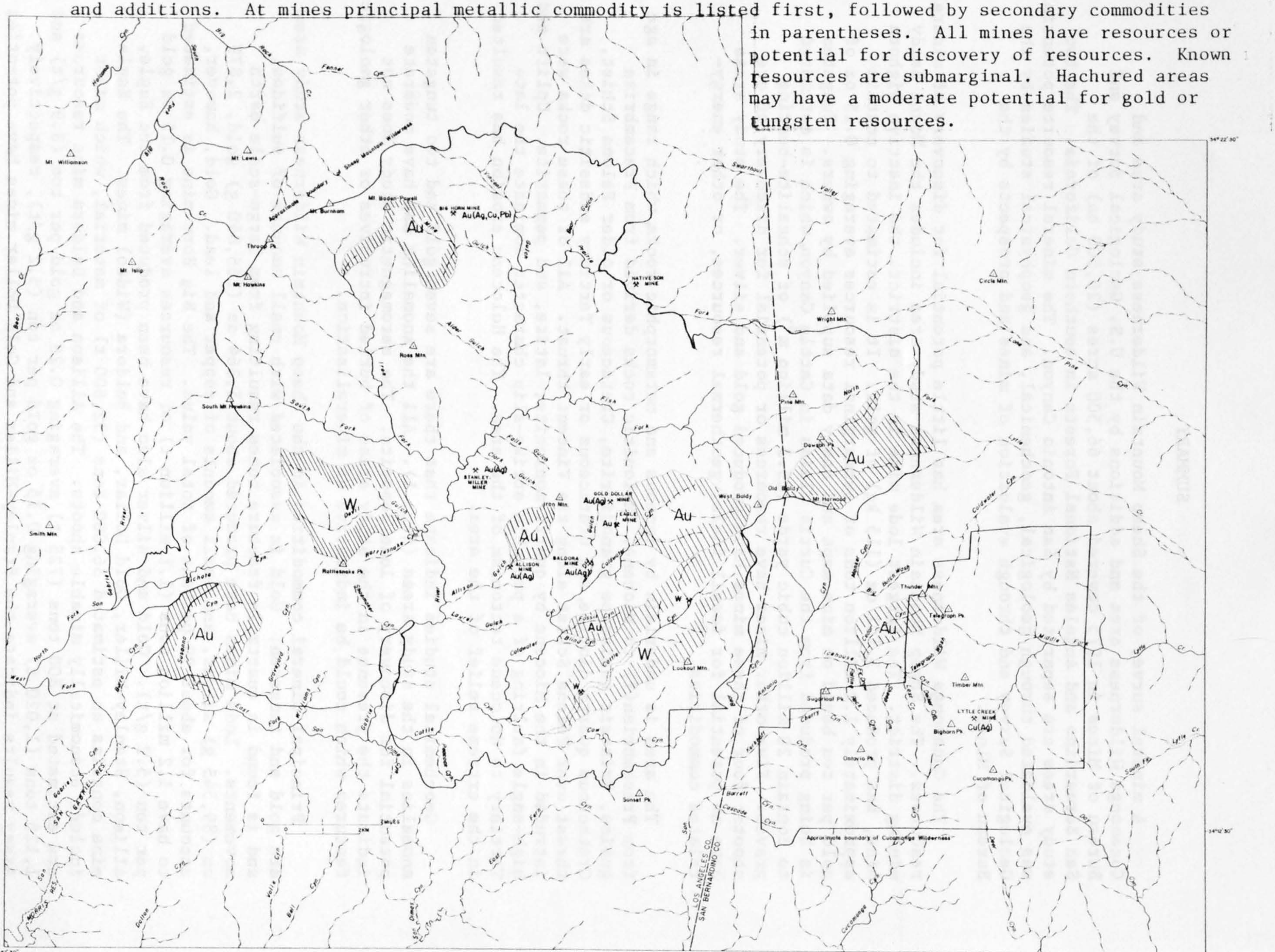
The Cucamonga Wilderness area has little potential for discovery of mineral resources. The Sheep Mountain Wilderness study area includes the Mount Baldy mining district. The largest lode mine in the district, the inactive Bighorn mine, has produced 3,701 oz (115 kg) of gold. It is estimated to contain approximately 1.2 million tons of submarginal resources averaging 0.15 oz of gold per ton based on mine maps and assay data supplied by owners. Tungsten is being produced from the Curtis claims in Cattle Canyon, which is estimated to contain 20 million cubic yards (15.3 million m^3) of scheelite-bearing gravel. Five other mines have resources or potential for discovery of ore shoots; four of these mines have produced gold and silver. The study areas have no potential for fossil fuels, geothermal resources, or other energy-related commodities.

The area is underlain by igneous and metamorphic rocks, which range in age from Precambrian(?) to Miocene. Mylonitic rocks derived from Precambrian gneiss, Triassic gneissose granodiorite, Cretaceous or older Pelona Schist, Cretaceous quartz diorite, and Cretaceous or early Tertiary andesitic dikes are thrust over Pelona Schist along the Vincent thrust. All of these rocks were intruded in the Miocene by quartz monzonite, latite, and pegmatite. Uplift and high-angle faulting of a probable strike-slip character dominate the late Tertiary to Holocene tectonism of the area. The Holocene erosion has resulted in the extreme relief of the area.

Geochemical studies indicate that there are seven gold and two tungsten anomalies in the study areas (fig. 1). All the anomalies may have moderate potential for discovery of lode deposits. The aeromagnetic study does not indicate the presence in the study areas of buried intrusives or other geologic features which could be indicative of mineralization.

Principal mineral commodities in the Sheep Mountain Wilderness study area are gold and tungsten. Gold is associated with small amounts of sulfides, and is found in quartz in fracture zones resulting from large-scale earth movements. Lode mines have produced about 5,364 oz (166,840 g) gold, 2,879 oz (89,545 g) silver, and small amounts of copper and lead. Gold, however, accounts for about 99 percent of total value. The Big Horn mine is estimated to have 1.2 million tons (1.1 million t) of resources averaging 0.15 oz gold per ton (5.2 g/t). Gold and silver also have been produced from the Eagle, Allison, Stanley-Miller, Gold Dollar, and Baldora (Widco) mines. The Eagle mine contains an estimated 36,000 tons (32,600 t) of material, which might include economically minable shoots. The Allison and Baldora mine resources are estimated at 800 tons (725 t) averaging 0.26 oz gold per ton (8.9 g/t) and 1,125 tons (1,020 t) averaging 0.15 oz gold per ton (5.2 g/t), respectively. Assay results indicate the Stanley-Miller and Gold Dollar mines have potential for discovery of mineral resources.

Figure 1.--Mineral-resource potential of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions. At mines principal metallic commodity is listed first, followed by secondary commodities in parentheses. All mines have resources or potential for discovery of resources. Known resources are submarginal. Hachured areas may have a moderate potential for gold or tungsten resources.



Scheelite occurrences in Cattle Canyon are abundant through a 2-sq-mile (5.2-km^2) area. The scheelite occurs in fractures in gneissic country rock underlain and intruded by quartz diorite. Production has exceeded 2,500 lb (1,134 kg) of scheelite concentrate averaging 38.29 percent tungsten trioxide (WO_3). Cattle Canyon contains an estimated 20 million cubic yards (15.3 million m^3) of gravel. Approximately 10 percent is minus one-fourth inch (0.6 cm) and averages 0.15 lb tungsten trioxide per cubic yard (85 g/m^3). Overall estimated minimum grade of the placer is 0.015 lb per cubic yard (8.5 g/m^3) valued at \$0.06 per cubic yard (0.08/m^3).

Placers were mined in the late 1800's and early 1900's. Such deposits in the Sheep Mountain Wilderness study area probably yielded more gold than the 89 oz (2,768 g) recorded by the Bureau of Mines. The richest deposits were apparently along the East Fork San Gabriel River from San Gabriel reservoir to below Heaton Flat, which is outside the study area. Gold has been produced near the Cucamonga Wilderness from remnants of ancient channel deposits in Lytle Creek, San Antonio Canyon, and Baldy Notch, but none has come from the study area.

Small production came from a copper deposit at Lytle Creek mine in the Cucamonga Wilderness, and from small lead, zinc, silver, graphite, tungsten, and gemstone deposits just outside the study area. An estimated 130 tons (118 t) containing significant copper-silver values remain at Lytle Creek mine.

Of the study areas, approximately 45 percent of Sheep Mountain and 22 percent of Cucamonga were included in lands withdrawn from mineral entry, by act of Congress, in 1928. Thirty-two percent of Sheep Mountain and 25 percent of the Cucamonga are subject to use restrictions during periods of high fire danger. Fire restrictions, lands withdrawn from mineral entry, exceedingly rugged topography, and complex geology are factors which contributed to the decline of mining in the area.

Scheelite occurrences in Cattle Canyon are abundant through a 2-sq-mile (5.2-km²) area. The scheelite occurs in fractures in gneissic country rock, porphyry, and intruded by quartz diorite. Production has exceeded 2,500 lb (1,134 kg) of scheelite concentrate averaging 38.28 percent tungsten trioxide (WO_3). Cattle Canyon contains an estimated 20 million cubic yards (15.3 million m³) of gravel. Approximately 10 percent is minus one-fourth inch (0.6 cm) and averages 0.15 lb tungsten trioxide per cubic yard (89 g/m³). Overall estimated minimum grade of the placer is 0.015 lb per cubic yard (8.9 g/m³) valued at $0.06 per cubic yard (0.08/m³).

Placers were mined in the late 1800's and early 1900's. Such deposits in the Sheep Mountain Wilderness study area probably yielded more gold than the 88 oz (2,755 g) recorded by the Bureau of Mines. The richest deposits were apparently along the East Fork San Gabriel River from San Gabriel Reservoir to below Heaton Flat, which is outside the study area. Gold has been produced near the Cucamonga Wilderness from remnants of ancient channel deposits in Lytle Creek, San Antonio Canyon, and Kelly Notch, but none has come from the study area.

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Of the study areas, approximately 45 percent of Sheep Mountain and 22 percent of Cucamonga were unpatented lands withdrawn from mineral entry, by act of Congress, in 1928. Thirty-two percent of Sheep Mountain and 73 percent of the Cucamonga are subject to the restrictions during periods of high fire danger. Fire restrictions, lands withdrawn from mineral entry, exceedingly rugged topography, and complex geology are factors which contributed to the decline of mining in the areas.

Chapter A

Geology of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions, Los Angeles and San Bernardino Counties, California

by

James G. Evans

U.S. Geological Survey

INTRODUCTION

The Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions cover 55,000 acres (22,275 ha) and 11,500 acres (4,700 ha), respectively, of the eastern San Gabriel Mountains, southern California (fig. 2). The Sheep Mountain Wilderness study area is in Los Angeles and San Bernardino Counties 27 miles (43 km) northeast of Los Angeles Civic Center. The Cucamonga Wilderness area and additions are in San Bernardino County 1-2 miles (1.6-3.2 km) east of the Sheep Mountain Wilderness study area.

Drainage from the two study areas is to the south of the San Gabriel Mountains. The range divide, trending generally northwest, forms part of the north boundary of the Sheep Mountain Wilderness study area.

Recent uplift of the range, has resulted in deep canyons carved in the igneous and metamorphic rocks of the eastern San Gabriel Mountains. Relief in the Sheep Mountain Wilderness study area is 8,000 feet (2,440 m) from an elevation of 2,000 feet (610 m) in the East Fork to Mount Baldy summit at 10,000 feet (3,050 m). In the Cucamonga Wilderness the relief is 4,000 feet (1,220 m) from an elevation of 4,800 feet (1,465 m) along the west and south borders of the wilderness to 8,800 feet (2,680 m) at Cucamonga Peak. Many of the peaks and ridge tops are above 7,000 feet (2,140 m).

The climate of the eastern San Gabriel Mountains is semiarid to subalpine. Precipitation occurs chiefly in the winter months, usually as snow, on the high peaks and ridges. Large storms sometimes result in flooding, especially after severe fires in the mountains. During the summer months the study area is subject to thundershowers with attendant fire hazard and flash flooding occuring.

Most south-facing slopes are covered by thick, wiry, drought-resistant brush. On north-facing slopes and in the canyon bottoms oak, alder, cedar, and Big Cone Douglas fir are present. The ridges and peaks above 6,000 feet (1,830 m) have a pine forest except where the steep slopes and microclimate deter tree growth. From these heights spectacular vistas to the south and east of the San Bernardino and San Jacinto Mountains, the Los Angeles Basin, and Catalina Island are available when the haze and smog are absent or confined to low elevations. The equally spectacular vistas across the Mojave Desert, available from the northern peaks, have in recent years been nearly obliterated by the dust and smog. In addition to the mountain scenery, visitors to the wilderness may occasionally enjoy glimpses of deer, black bear, and Nelson Big Horn sheep, or fish for the trout that inhabit sections of the less frequented streams.

Several paved roads lead to, and border on, the Sheep Mountain Wilderness study area (fig. 1): the East Fork Road, Highway 39, the Angeles Crest Highway (route 2), which is part of the north boundary of the study area, and Glendora Ridge Road, which is part of the south boundary. The Blue Ridge Road (unpaved) provides access to many parts of the northern Sheep Mountain Wilderness study area. Foot trails extend across the area from several points along these roads. The San Antonio Canyon Road (paved) and a ski lift provide access via branching roads and trails to both the Sheep Mountain study area and the Cucamonga Wilderness and additions. The Middle Fork Road and Baldy Road, both unpaved roads, provide access to the Cucamonga Wilderness area.

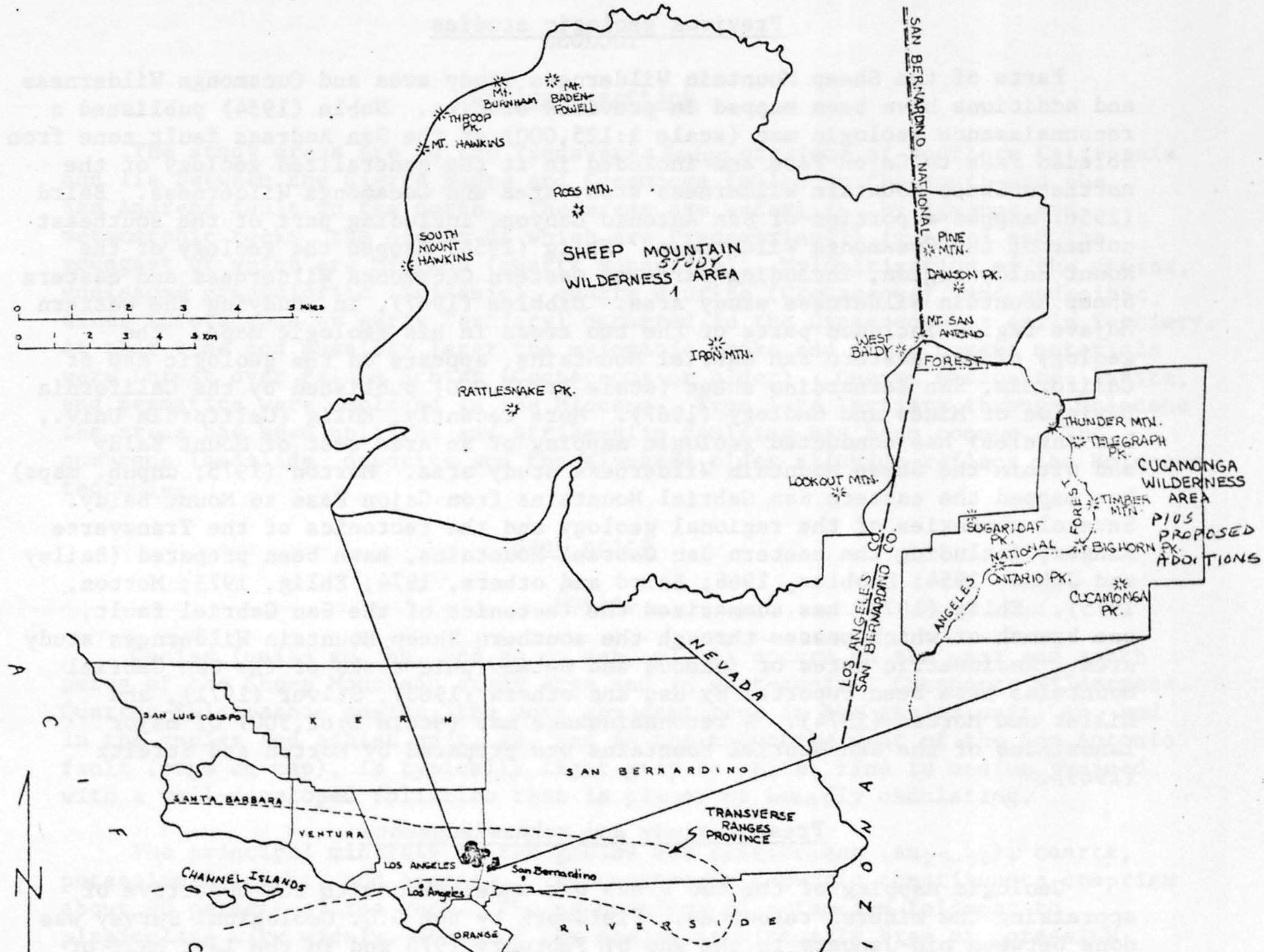

Figure 2.--Index map of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness area and additions.

The study area is covered by 7½-minute topographic maps at the scale of 1:24,000. The base for plate 1 consists of mosaicked parts of eight 7½-minute quadrangles (Glendora, Crystal Lake, Valyermo, Mescal Creek, Mount San Antonio, Mount Baldy, Telegraph Peak, and Cucamonga Peak) reduced to the scale of 1:48,000.

Previous geologic studies

Parts of the Sheep Mountain Wilderness study area and Cucamonga Wilderness and additions have been mapped in previous studies. Noble (1954) published a reconnaissance geologic map (scale 1:125,000) of the San Andreas fault zone from Soledad Pass to Cajon Pass and included in it the generalized geology of the northern Sheep Mountain Wilderness study area and Cucamonga Wilderness. Baird (1956) mapped a portion of San Antonio Canyon, including part of the southeast corner of the Cucamonga Wilderness. Ehlig (1958) mapped the geology of the Mount Baldy region, including parts of western Cucamonga Wilderness and eastern Sheep Mountain Wilderness study area. Dibblee (1967), in studying the western Mojave region included parts of the two areas in his geologic maps. The geology of the eastern San Gabriel Mountains appears on the geologic map of California, San Bernardino sheet (scale 1:125,000) published by the California Division of Mines and Geology (1967). More recently, Ehlig (California Univ., Los Angeles) has conducted geologic mapping of an area west of Mount Baldy and within the Sheep Mountain Wilderness study area. Morton (1975; unpub. maps) has mapped the eastern San Gabriel Mountains from Cajon Pass to Mount Baldy. Several summaries of the regional geology and the tectonics of the Transverse Ranges, including the eastern San Gabriel Mountains, have been prepared (Bailey and Johns, 1954; Dibblee, 1968; Baird and others, 1974; Ehlig, 1975; Morton, 1975). Ehlig (1973) has summarized the tectonics of the San Gabriel fault, one branch of which passes through the southern Sheep Mountain Wilderness study area. Radiometric dates of igneous and metamorphic rocks of the San Gabriel Mountains have been reported by Hsu and others (1963), Silver (1971), and Miller and Morton (1974). A reconnaissance map (scale 1:62,500) of major landslides of the San Gabriel Mountains was prepared by Morton and Streitz (1969).

Present study and acknowledgments

Geologic mapping of the two areas was undertaken with the objective of appraising the mineral resources. Fieldwork by the U.S. Geological Survey was done between mid-January to the end of February 1975 and in the last half of February 1976 by J. G. Evans, and between the last week in July and the first week of September 1975 by Evans assisted by John Olson. Foot traverses were made along most of the ridges, trails, and canyon bottoms. The geology was mapped at the scale of 1:24,000 and reduced to 1:48,000 for plate 1. Photogeologic interpretations were made by Evans before, during, and after field observations. These interpretations were generally inconclusive, as the crystalline rocks of the study area are covered by thick regolith and brush and do not weather to form geomorphic features which can be used to identify geologic units. Some of Ehlig's unpublished mapping and most of Morton's have been adopted for plate 1. Terminology for the cataclastic rocks is taken from Higgins (1971).

Thanks are due D. M. Morton (U.S. Geol. Survey), P. L. Ehlig (California Univ., Los Angeles), and A. K. Baird (Pomona College) for the informative discussions of the geology of the San Gabriel Mountains. The cooperation of members of the U.S. Forest Service, Mount Baldy district, is gratefully acknowledged.

GEOLOGY

Geologic setting

The study areas are in the Transverse Range province of southern California and lie between the Sierra Madre and Cucamonga faults on the south and the San Andreas fault on the north. The areas are underlain by igneous and metamorphic rocks, the oldest of which are Precambrian(?) (gneiss) and the youngest of which are Miocene (quartz monzonite). Mylonitization of the gneiss, gneissose granodiorite (Triassic), quartz diorite (Cretaceous), and andesitic dikes (Cretaceous or early Tertiary) occurred in the Cretaceous or early Tertiary. At that time and possibly later the mylonitic rocks and their parent materials were thrust over Pelona Schist (Cretaceous or older). Quartz monzonite, latite, and pegmatite were emplaced in the Miocene. From late Tertiary through Holocene the areas has been uplifted and strike-slip faulting has been common. The numerous landslide deposits and the elevated older alluvium reflect the Holocene tectonism.

Rock units

Gneiss

Gneiss (units gn, bg, and gs on map, pl. 1) occurs on the west and south parts of the Sheep Mountain study area and in west-central Cucamonga Wilderness. Quartzo-feldspathic gneiss, the most abundant rock in the gneiss unit, gn, and in the gneiss and schist unit, gs, and in the migmatite west of the San Antonio fault (migw on map), is typically light gray to white, fine to medium grained, with a well-developed foliation that is planar or broadly undulating.

The principal minerals of the gneiss are plagioclase (An_{25-50}), quartz, potassium feldspar, and biotite. The quartzo-feldspathic constituents comprise about 90 percent of the rock. The proportions of potassium feldspar to plagioclase vary widely. Some of the gneiss is virtually free of potassium feldspar or contains a few percent in thin veins which cut the foliation. In other gneiss, the potassium feldspar is much more abundant and the two feldspars occur in approximately equal amounts. Minor amounts of epidote, sphene, and garnet are also present.

Three kinds of biotite gneiss are present in the Sheep Mountain Wilderness study area. A fine-grained biotite gneiss occurs within the dominantly quartzo-feldspathic gneiss unit, gn, and comprises less than 10 percent of it. Biotite (15-40 percent), plagioclase, An_{25} (30-45 percent), and quartz (5-35 percent) are the major constituents. Locally, hornblende is abundant (60 percent max). Potassium feldspar, when it is present, is generally an accessory mineral along with magnetite, muscovite, pyrite, and sphene. In places the gneiss grades into schist. The foliation defined by the layering of the mafic minerals and the planar preferred orientation of the biotite of the biotite gneiss locally cuts across the foliation of the quartzo-feldspathic gneiss and suggests that the crosscutting bodies of biotite gneiss are metamorphosed dikes.

The gneiss and schist unit, gs, consists chiefly of quartzo-feldspathic gneiss, identical to the quartzo-feldspathic gneiss described above. The gneiss is interlayered with fine- to medium-grained biotite and hornblende schist zones 3-15 feet (1-4.6 m) thick, which comprise about one-third of the unit. The principal minerals of the schist are hornblende and biotite (45 percent), plagioclase, An_{45} (40 percent), and quartz (15 percent). Locally the schist grades into amphibolite. Potassium feldspar and muscovite are accessory minerals.

The fine- to medium-grained biotite gneiss unit, bg, in the northwest corner of the Sheep Mountain Wilderness study area has an irregular anastomosing foliation and numerous minor folds. Biotite (15-60 percent), plagioclase, An_{30} to An_{50} (15-40 percent), and quartz (35 percent max) are the principal minerals. Garnet (20 percent max), muscovite (15 percent max), and sillimanite (15 percent max) are locally important constituents. Potassium feldspar and pyrite are accessory minerals. The relationship between this biotite gneiss and the other gneiss units is not known, as the biotite gneiss is fault bounded.

Other minor lithologies occur in the gneiss in southern Sheep Mountain Wilderness study area. A zone 500 feet (153 m) thick of muscovite-quartzite with scattered porphyroblasts of garnet (2 cm max) is present in the canyon of the East Fork. Several boulders of dark-gray fine-grained marble occur in Suzanna and Williams Canyons, but no outcrops of the marble were found.

Secondary epidote, sericite, and clays are widespread in the gneiss as alteration products of the feldspars, chiefly the plagioclase. Biotite and hornblende have been altered to chlorite. Hematitic alteration of these mafic minerals and of pyrite is common. These secondary alterations of the gneiss are especially pronounced near the major Tertiary and Quaternary fault zones, such as the San Gabriel fault zone. Orange-brown siderite-quartz veins are abundant both parallel to the foliation of the gneiss and in fractured gneiss adjacent to faults. A few malachite veins less than 1 cm thick were found in the gneiss.

The presence of intermediate plagioclase in apparent equilibrium with epidote and the presence of hornblende and the presence of sillimanite indicate that the amphibolite grade of metamorphism was attained in the gneiss (Turner and Verhoogen, 1960, p. 544-553; Turner, 1967, p. 307-308).

The gneiss units are similar to the layered quartzo-feldspathic gneiss, amphibolite, quartzite, and rare calc-silicate beds in the western and central San Gabriel Mountains. Silver (1971) has investigated the U-Pb relations in zircons from these rocks west of the Sheep Mountain study area and believes that the rocks originated as early as 1750 to 1680 m.y. ago. Therefore, based on its gross similarity to the gneiss to the west of it, the gneiss of the Sheep Mountain Wilderness study area is assigned a Precambrian age in this report.

Pelona Schist

The Pelona Schist (ps on map), named by Hershey (1902) from its exposures in the Sierra Pelona, was mapped by Noble (1954a, b) in the northeast San Gabriel Mountains. The schist is exposed in the northeastern Sheep Mountain Wilderness study area and along the northern edge of the Cucamonga Wilderness.

The schist is typically fine-grained silvery-gray muscovite-chlorite schist. The proportions of the quartzo-feldspathic and the micaceous constituents vary widely: albite (30-75 percent), quartz (as much as 30 percent), muscovite (as much as 25 percent), and chlorite (as much as 10 percent). The albite occurs only as porphyroblasts, commonly black with graphite inclusions and generally 1 mm long. The muscovite-chlorite schist grades into quartzo-feldspathic schist and quartzite. The quartzo-feldspathic schist and the quartzite contain less than 15 percent muscovite and chlorite, are locally garnetiferous, and may contain potassium feldspar as an important primary constituent (25 percent max). In places the schist contains phyllite lenses up to 6 feet (2 m) long. Calcite, hematite, leucoxene, and pyrite are minor constituents.

Layers of fine- to medium-grained green chlorite and chlorite-actinolite schist, up to 200 feet (61 m) thick and several hundred feet (several hundred m) long occur in the muscovite-chlorite schist. The principal minerals in the green schist are albite (20-30 percent), chlorite (30 percent max), amphibole, principally actinolite (30-50 percent), and epidote (15 percent max). The albite and epidote form porphyroblasts up to 5 mm long, which are in a matrix of much finer grained chlorite, epidote, and actinolite. Augen composed of chlorite and actinolite grains are less common than the white albite and green epidote porphyroblasts. Allanite, blue-green hornblende, calcite, garnet, hematite, muscovite, potassium feldspar, pyrite, quartz, sphene, and tremolite are minor constituents.

Distinctive dark-gray to black, fine-grained quartzite layers up to 15 feet (4.6 m) thick occur within the green chlorite and chlorite-actinolite schist. The quartzite has few impurities (90 percent or more quartz) such as actinolite, albite, garnet, muscovite, and piedmontite. Locally, malachite, barite, soda amphibole, and psilomelane laminae are parallel to the foliation of the quartzite.

Calcareous quartzite layers 1-6 inches (2.5-15.2 cm) thick occur in the green chlorite and chlorite-actinolite schists. In addition to the major minerals, quartz and calcite, minor amounts of actinolite, chlorite, and stilpnomelane are present.

Rare coarse-grained, green actinolite and actinolite-talc schist lenses up to 6 feet (1.8 m) long and 6 inches (15.2 cm) wide occur in north-central Sheep Mountain study area. Grains of actinolite are up to 2 inches (5 cm) long.

Boulders and pebbles of layered pink and white piedmontite and piedmontite-alurgite quartzite occur in the alluvium of the upper East Fork and the Prairie Fork, Sheep Mountain Wilderness study area. Although these unusual rocks probably occur in the Pelona Schist in the northern Sheep Mountain study area, no outcrops of these quartzites were observed.

Black, fine- to medium-grained hornblende schist and black- and white-banded amphibolite occur on Blue Ridge. The plagioclase is oligoclase, and some of the rock contains abundant garnet.

Coarse-grained, nodular white quartz and quartz-siderite veins up to 1 foot (0.3 m) thick and several feet (several meters) long are parallel to the schistosity of the schist. The grains of quartz and siderite are up to 2 inches (5 cm) long. The veins are most common in the schist along the upper East Fork and Prairie Fork.

The mineral assemblage albite-quartz-muscovite-chlorite, characteristic of most of the Pelona Schist, indicates that the bulk of the schist was metamorphosed in the greenschist facies (Turner and Verhoogen, 1960, p. 533-541; Turner, 1967, p. 268-270). In some schist blue-green hornblende occurs with albite and epidote, an assemblage indicative of transition to the amphibolite facies (Turner and Verhoogen, 1960, p. 533, p. 539-541; Turner, 1967, p. 303-307). The mineral assemblage hornblende-oligoclase-garnet of the amphibolite on Blue Ridge is characteristic of the amphibolite facies (Turner and Verhoogen, 1960, p. 544-553; Turner, 1967, p. 307-308). The Pelona Schist, then, varies in metamorphic grade from greenschist to amphibolite facies. However, a clear gradation from low to high metamorphic grade was not found in the study area, probably because the isograds in the schist have been faulted in the Tertiary and Quaternary.

The ages of the metamorphism of the Pelona Schist and of the sedimentary and volcanic sequence that the schist represents are not clearly known. The Pelona Schist has been generally assigned a Precambrian age (Hersey, 1925, p. 273; Hulin, 1925, p. 29-30; Simpson, 1934, p. 380-381; Clements, 1937, p. 231; Miller, 1946, p. 468; Wallace, 1949, p. 787; Dibblee, 1967, p. 9). Ehlig (1958, p. 33-40; 1968) proposed that the metamorphism of the Pelona Schist is Cretaceous and that the deposition of the protolith of the schist may have been Mesozoic. He reported (Ehlig, 1975, p. 183) a radiometric date for the Pelona Schist of 52 m.y. (K/Ar and Rb/Sr). However, this date may reflect the age of postmetamorphic cooling of the schist. The Pelona Schist in the Cucamonga Wilderness is intruded by quartz monzonite dated at 14.2 to 14.6 m.y. (Miller and Morton, 1974, K/Ar method) or Miocene. Consequently, the Pelona Schist is pre-Miocene and probably pre-Tertiary but could be as young as Cretaceous. In this report the Pelona Schist is considered to be Cretaceous or older.

Gneissose granodiorite

Dikes of gneissose granodiorite (gg on map) with distinctive large augen of pink potassium feldspar and black hornblende intrude both the gneiss and schist unit, gs, of western Sheep Mountain Wilderness study area and the gneiss, gn, of eastern Sheep Mountain Wilderness study area. The granodiorite is like the Mount Lowe Granodiorite of Miller (1934, p. 42-43). In the western Sheep Mountain Wilderness study area the dikes of gneissose granodiorite are up to 6 feet (1.8 m) thick and cut the foliation of the gneiss and schist (gs). In the southeastern part of the study area, the dikes are thicker. The largest one, shown on the geologic map (pl. 1), is at least 3,200 feet (976 m) thick. Parts of the gneiss host resemble the gneissose granodiorite and suggest hybridism of the two rock types.

The gneissose granodiorite consists principally of plagioclase, An_{40} (50 percent), quartz (20 percent), potassium feldspar (15 percent), and hornblende (10 percent). Almost all of the potassium feldspar of the rock occurs as subhedral to anhedral porphyroblasts up to 3 cm long. Where the potassium feldspar porphyroblasts are uncommon or absent, the bulk composition of rock is dioritic. The black augen are of two kinds: euhedral and subhedral porphyroblasts of hornblende up to 1 cm long; and black aggregates as large as the porphyroblasts of hornblende grains 1-3 mm long. Biotite, epidote, garnet, hematite, and magnetite are also present.

The main body of gneissose granodiorite to which this unit is correlated is the Mount Lowe Granodiorite, west of the Sheep Mountain study area (Miller, 1934, p. 43). Mount Lowe Granodiorite was dated at 220±10 m.y. (Silver, 1971, U-Pb method) or Triassic. This age designation is accepted here for the gneissose granodiorite of the Sheep Mountain Wilderness study area.

Migmatite

Two migmatite units are recognized in the eastern San Gabriel Mountains: migmatite west of the San Antonio fault in the Sheep Mountain Wilderness study area (migw on map) and migmatite east of the San Antonio fault in the Cucamonga Wilderness (mige on map).

The migmatite west of the San Antonio fault occurs within and south of the San Gabriel fault zone, Sheep Mountain Wilderness study area. The unit is largely gneiss, identical to the Precambrian gneiss described above. The gneiss is intruded by numerous dikes of quartz diorite, quartz monzonite, pegmatite, latite, hornblende porphyry, and andesite, all of which are described below. In parts of the migmatite, quartz diorite, quartz monzonite, and pegmatite are more abundant than the gneiss and the interconnected dikes enclose angular blocks of the gneiss. The latite, hornblende porphyry, and andesite are less abundant in the migmatite than are the other intrusive rocks. These less abundant dikes are up to 50 feet (16.4 m) thick in the migmatite. A few of them can be traced for distances of 1 mile (1.6 km). The age of the gneiss fraction of migmatite, like the gneiss to the north and west, is probably Precambrian. The igneous fraction of the migmatite is Cretaceous to Miocene in age.

The migmatite east of the San Antonio Canyon fault (mige) consists largely of metasedimentary rocks, named the San Antonio Canyon Metasediments by Ehlig (1958). The migmatite comprises most of the southern half of the Cucamonga Wilderness. The metasedimentary rock of the migmatite consists of dolomite and calcite marble, argillite, carbonaceous and pyritiferous metasiltstone, graphite schist, quartzite, biotite gneiss, and layered calc-silicate rocks with laminations of garnet, pyroxene, and calcic plagioclase. Layers of uniform lithology up to 200 feet (61 m) thick can be traced for several hundred feet (a few hundred meters). In many places the layering is contorted and intensively faulted. Calcic plagioclase, An_{50-65} (some of which is in equilibrium with epidote), pyroxene, hornblende, and sillimanite indicate at least amphibolite facies metamorphism for the metasedimentary rocks (Turner and Verhoogen, 1960, p. 544-552; Turner, 1967, p. 307-308). These metamorphic rocks are intruded by numerous dikes of quartz diorite and quartz monzonite, both of which are described below and, locally, by closely spaced potassium feldspar veins.

The metasediments generally resemble the Placerita Formation described by Miller (1934) and by Oakeshott (1937; 1958, p. 50-52) from the San Fernando quadrangle, 30 miles (48 km) west of the Cucamonga Wilderness. Graphite schist, an unusual lithology, occurs both in the migmatite and in the Placerita Formation. The limestone, both in the Placerita Formation and in the metasedimentary rocks, has been tentatively correlated on a lithological basis with late Paleozoic limestone in the San Bernardino Mountains (Woodford, 1960,

p. 403-404; Miller, 1946, p. 468; Baird, 1956; Ehlig, 1958; Oakeshott, 1958, p. 52; Stewart and Poole, 1975). A Precambrian age for these rocks has not been ruled out. In this report the metasedimentary rocks are considered to be Paleozoic or older. The igneous rocks in the migmatite are Cretaceous (quartz diorite) and Miocene (quartz monzonite).

Quartz diorite

Plutonic rock, chiefly quartz diorite but grading into granodiorite and diorite, intrudes the gneiss and migmatite in the study area. The quartz diorite is fine- to medium-grained, hypautomorphic granular, weakly gneissose to massive, and in places cataclastic. The foliation is defined by alinement of mafic minerals in millimeter-thick laminae and is locally warped around quartzo-feldspathic augen or porphyroblasts. The principal minerals are plagioclase, An_{40-50} (35-60 percent), quartz (10-30 percent), hornblende (30 percent max), and biotite (30 percent max). Potassium feldspar, generally a minor constituent (5 percent max), is important in some rocks. It usually occupies thin veins, occurs along grain boundaries, and replaces plagioclase. Magnetite, pyrite, sphene, and zircon are accessory minerals. The quartz diorite is more fractured and more intensely altered near large faults and near pegmatite dikes where the plagioclase is saussuritized, sericitized, and argillically altered and where mafic minerals are altered to chlorite and hematite. Orange-brown siderite-quartz veins are common in fractured quartz diorite.

The quartz diorite engulfed gneiss, amphibolite, coarse-grained hornblendite, and biotite-rich granodiorite. Xenoliths of these materials in quartz diorite and granodiorite are especially common in the quartz diorite block in the San Gabriel fault zone and in the vicinity of Allison Gulch. Most of the xenoliths are a few inches or feet (several centimeters or a few meters) long, occur in clusters, and are commonly arranged in such a way as to define the foliation in the rock. In places this foliation is contorted. The largest xenoliths are up to 1,000 feet (305 m) long and 500 feet (153 m) wide.

Quartz diorite from Ontario Peak area, Cucamonga Wilderness, was dated at between 80 and 115 m.y. (Hsu and others, 1963, p. 510, K/Ar and Rb/Sr methods) or Cretaceous. A similar age of 122 m.y. was obtained for the nearly identical quartz diorite of Mount Wilson 12 miles (19.3 km) west of the Sheep Mountain study area (Larsen and others, 1958, p. 48; Pbα method). Therefore, the quartz diorite in the study area is assigned a Cretaceous age.

Cretaceous or Tertiary dikes

Three kinds of gray andesitic dikes cut the gneiss and quartz diorite and comprise less than 10 percent of the migmatite west of the San Antonio fault (migw): dark dikes ranging in composition from andesite to latite; gray andesite dikes with conspicuous black hornblende phenocrysts; dark-gray andesite dikes with conspicuous white plagioclase phenocrysts. All of these dikes contain little or no quartz and between 15 and 40 percent mafic minerals, chiefly hornblende, but also pyroxene and biotite. Some of the dikes are hundreds of feet (hundreds of meters) long and can be located on aerial photographs as prominent lineaments.

The fine- to medium-grained andesite dikes are steeply dipping and up to 25 feet (7.6 m) thick. Some of the dikes are porphyritic with plagioclase phenocrysts, up to 6 mm long, comprising as much as 25 percent of the rock. The plagioclase, of intermediate composition, is commonly lath-shaped and poikilitic with inclusions of chlorite, magnetite, and quartz. Potassium feldspar (25 percent max) occurs principally in the groundmass. Hornblende, the principal mafic mineral, occurs with biotite. Together they comprise 15-40 percent of the rock. Leucoxene is a minor constituent. The plagioclase is saussuritized, the mafic minerals are much altered to chlorite and hematite, and quartz occupies veins and vugs.

The gray hornblende porphyry, with conspicuous abundant black acicular phenocrysts of hornblende up to 5 mm long, occurs in dikes up to 50 feet (15.3 m) thick. The groundmass consists of partly saussuritized plagioclase (60 percent max) in lath-shaped and equant subhedral grains less than 1 mm long, and hornblende usually much chloritized. Potassium feldspar and magnetite are minor constituents. In a few samples the potassium feldspar is abundant in the groundmass (30 percent max). Most of these dikes are andesite, although a few are latite. The andesitic hornblende porphyry is indistinguishable in the field from the gray latite with hornblende phenocrysts.

Dark-gray andesite dikes with 20-25 percent conspicuous white plagioclase phenocrysts 5-20 mm long are up to 20 feet (6.1 m) wide. These euhedral poikilitic phenocrysts are both lath-shaped and equant and exhibit polysynthetic twinning and normal compositional zoning. The groundmass consists largely of plagioclase (60 percent max) less than one-half mm across, and the mafic minerals (20 percent max), hornblende, pyroxene, and biotite. Calcite (veins), magnetite, potassium feldspar, and pyrite are present in minor amounts. An unusual sample, with its mafic minerals completely replaced by hematite, contained 30 percent potassium feldspar. Dark-gray andesite in the Cucamonga Wilderness contains green aggregates of epidote up to 3 mm across. Argillic alteration and sericitization of plagioclase and chloritization of the mafic minerals are common.

The relative ages of these three kinds of dikes is only partly known. Hornblende porphyry was observed intruding fine-grained andesite porphyry and, therefore, the hornblende porphyry must be the younger rock of the two. The three kinds of dikes are common in the Cretaceous quartz diorite and in the gneiss but do not occur in the mylonite or in the Pelona Schist. Some andesitic dikes cut the Miocene granodiorite. Consequently, some of the dikes may be Cretaceous and may have predated the mylonitization of their host rocks, but some are post-Miocene. In this report the dikes are considered to be Cretaceous and Tertiary.

Mylonitic rocks

Mylonite and mylonite gneiss (my and mg units on map) occur in the San Gabriel fault zone, above the Vincent thrust, along the San Antonio fault and in central-north and northwest Cucamonga Wilderness. Most of the mylonite occurs in a zone 200 to 2,000 feet (61-610 m) thick above the Vincent thrust. The mylonite unit includes protomylonite, mylonite, ultramylonite, and blastomylonite but is mostly mylonite. Characteristically the mylonite is fine grained to aphanitic, gray, green, violet, and white. The laminae are broadly undulating and anastomosing, with some laminae cutting across others at small angles. White porphyroclasts of plagioclase and potassium feldspar, usually less than 3 mm long, are abundant. The plagioclase is chiefly of intermediate composition (An_{20-35}). Dark porphyroclasts of epidote and hornblende, partly altered to biotite, epidote, and chlorite, are less common. Porphyroblasts of epidote and biotite are present in most mylonite. The fine-grained matrix of the mylonite is largely quartz and feldspar. White mica, epidote, chlorite, and biotite are also present in the matrix and are abundant in some of the mylonite. Potassium feldspar veins, pyrite (2 percent max), and saussuritization and sericitization of the calcic plagioclase are nearly ubiquitous in the mylonite.

Phacoids of relatively unmylonitized gneiss, quartz diorite, and possibly also of Pelona Schist occur in the mylonite above the Vincent thrust. Most of the phacoids are no more than 10 feet (3.2 m) long. The textural gradations of the gneiss and quartz diorite to the mylonite in addition to the unmylonitized fragments of these rocks in the mylonite indicate that the mylonite was derived from gneiss and quartz diorite. The derivation of mylonite from the Pelona Schist, too, is suggested by the schistose appearance of some mylonite and the presence of phacoids in the mylonite of medium- to coarse-grained muscovite schists resembling, but much coarser grained than, ordinary Pelona Schist.

The mylonite on Timber Mountain, Cucamonga Wilderness contains lenses as much as 20 feet (6.5 m) thick of medium-grained white marble, which suggest that this mylonite was derived from the metasedimentary rocks of the migmatite (mige).

The mylonite above the Vincent thrust, because it was derived in part from quartz diorite, must be of Cretaceous age or younger. The mylonite is intruded by Miocene quartz monzonite and so must be pre-Miocene. Ehlig (written commun., 1975) has obtained a K/Ar date of 52.7 m.y. for the mylonite near the Narrows in the East Fork Canyon. The significance of this date is not clear. It could be a cooling age, reflecting unloading, as could the similar age he reported for the Pelona Schist. In this report all the mylonite is assigned to the Cretaceous or early Tertiary.

Mylonite gneiss at least 1,000 feet (305 m) thick occurs between the mylonite above the Vincent thrust and below the gneiss in western Sheep Mountain Wilderness study area and in northwest Cucamonga Wilderness. Other mylonite gneiss is present in the San Gabriel and San Antonio fault zones.

The mylonite gneiss exhibits cataclastic textures reminiscent of the mylonite described above. Fragmented, rotated, augen-shaped to angular white porphyroclasts of feldspar (4 cm long max), mostly plagioclase, are the most conspicuous characteristics of the mylonite gneiss. The foliation is defined by the alinements of the porphyroclasts and by the laminar concentrations of micaceous minerals (biotite, chlorite, muscovite-sericite).

The principal minerals are plagioclase (An_{20-40}) (30-60 percent), quartz (20-40 percent) and the mafic minerals, hornblende (35 percent max), biotite (25 percent max), and chlorite (25 percent max). Potassium feldspar is an important constituent in some of the rock and comprises the largest porphyroclasts. Epidote (20 percent max) occurs as porphyroblasts and as an alteration product of plagioclase. Hematite, leucoxene, magnetite, and pyrite are accessory minerals.

Textural gradations from the gneiss to the mylonite gneiss near the Vincent thrust occur across a zone no more than 10 feet (3.2 m) wide and suggest that the parent material of the mylonite gneiss was the gneiss. The relatively high mafic mineral content (38 percent min) of the mylonite gneiss further suggests that the parent material was biotite-rich gneiss. The large porphyroclasts of potassium feldspar are probably from gneissose granodiorite that intruded the gneiss. The mylonite gneiss near the Vincent thrust is a thick lense between the mylonite and the gneiss and grades into mylonite over a zone from 0 to 15 feet (0 to 4.6 m) wide. The structural position of the mylonite gneiss and its transitional character between the gneiss and the mylonite suggest that the mylonite gneiss developed at the same time as the mylonite. In this report all the mylonite gneiss is considered to have formed in the Cretaceous or early Tertiary contemporaneously with the mylonite.

Quartz monzonite, latite, and pegmatite

Three kinds of white to creamy-white dikes, all of quartz monzonitic composition intrude the igneous and metamorphic rocks described above: equigranular and porphyritic quartz monzonite, aphanitic, and porphyritic latite, and pegmatite. The quartz monzonite and the latite occur in both wilderness areas. The pegmatite occurs only in the southern Sheep Mountain study area.

Quartz monzonite dikes in the study area range from less than 1 foot (0.3 m) to 2,000 feet (610 m) thick. The largest ones shown on the geologic map (pl. 1) are in western Sheep Mountain Wilderness study area and in northern Cucamonga Wilderness. Dikes up to 50 feet (15.3 m) thick are common throughout the two areas. The quartz monzonite, and the porphyritic varieties with up to 50 percent phenocrysts, consist largely of plagioclase, An_{15} to An_{30} (30-45 percent), potassium feldspar (20-35 percent), and quartz (15-35 percent). Biotite (15 percent max), partly intergrown with muscovite, is the principal mafic mineral. Hornblende is present in some quartz monzonite along with biotite. Apatite, epidote, garnet, leucoxene, magnetite, pyrite, and zircon are accessory minerals.

Most of the quartz monzonite is massive. Some of it, however, exhibits a weak foliation defined by the alinement of biotite. The foliation is parallel to the dike walls or at a small angle to them. These internal structural differences between quartz monzonite dikes could mean that two episodes of quartz monzonite intrusion occurred, the first episode followed by a minor deformation resulting in alinement of the biotite. Such a hypothesis is difficult to substantiate with the evidence at hand, and, for this report, no such distinction between quartz monzonite dikes has been made.

Latite dikes up to 200 feet (61 m) thick are abundant and grade into quartz monzonite porphyry. The creamy-white latite is aphanitic to porphyritic with up to 40 percent euhedral phenocrysts, up to one-half cm long, of plagioclase (oligoclase), quartz, and biotite. The very fine grained groundmass, with grains a few tenths of a millimeter long, consists of plagioclase, potassium feldspar, quartz, and biotite. Nearly all of the potassium feldspar of the rock is in the groundmass. Intense saussuritization of plagioclase and chloritization of biotite are common. Compositions of these dikes are mostly latite, but vary probably due to alteration. Some light-colored dikes, identical to the latite, have no potassium feldspar and appear to have been silicified.

Pegmatite dikes up to 50 feet (15.3 m) thick are common in the gneiss, quartz diorite, and quartz monzonite. The pegmatite contains conspicuously large pink subhedral grains of potassium feldspar (orthoclase, microcline) up to 10 cm across. Some of these grains are perthitic. The quartz and plagioclase (albite-oligoclase) tend to be finer grained than the potassium feldspar, but are also up to several centimeters across. Biotite, chlorite, epidote, garnet, and muscovite are minor constituents. The dikes are commonly symmetrically zoned parallel to the dike walls. The outer layers may contain a large amount of biotite, concentrated in laminae parallel to the dike wall. Toward the center of the dikes are alternating zones, up to 1 foot (0.3 m) thick, of coarse potassium feldspar-rich and finer plagioclase-rich pegmatite and millimeter-thick zones of tiny red garnets. Pegmatite veins and dikes in the quartz monzonite are not zoned and, in places, grade texturally into the quartz monzonite host. The compositional similarity of the pegmatite to its quartz monzonite host and the textural gradations from pegmatite to ordinary quartz monzonite indicate that the pegmatite is a late-stage differentiate of the quartz monzonite.

The quartz monzonite and latite intrude gneiss, metasedimentary rocks, quartz diorite, mylonitic rocks, and Pelona Schist. The pegmatite intrudes the gneiss, quartz diorite, and quartz monzonite and occurs only in southern Sheep Mountain Wilderness. The significance of this difference in distribution between the pegmatite and the quartz monzonite and latite is not clear. In general the occurrence of these three kinds of dikes decreases northeastward in the Sheep Mountain Wilderness study area. Therefore, one possible conclusion is that the center of intrusion of these dikes is in the south part of the wilderness. The pegmatite dikes may be more abundant near the center of intrusion and may not occur in the Pelona Schist and mylonitic rocks at least at the present eorsion level.

Near the dikes the host rocks have been altered. Some of the gneiss and quartz diorite near the dikes is more resistant to weathering than the same kind of rock away from the dikes. Host rocks are also intensely fractured near some of the dikes. Some of this fracturing could be due to postemplacement faulting parallel to the dike wall. Biotite and stilpnomelane are relatively abundant in the schist for several feet (a few meters) in the vicinity of some of the dikes. The largest metamorphic aureole in the schist is in the northern Cucamonga Wilderness where the quartz monzonite pluton intrudes the schist, and biotite is abundant in the schist for about 2,000 feet (655 m) from the intrusive contact.

Hsu and others (1963) dated quartz monzonite from the Telegraph Peak area, Cucamonga Wilderness, at 12-29 m.y. (K/Ar, 17±5, 26±3; also by Rb/Sr, 25±15, 19±15). Miller and Morton (1974) dated granitic rocks (belonging to the quartz monzonite unit) intruding the Pelona Schist in northern Cucamonga Wilderness at 14.2 to 14.6 m.y. (K/Ar) and similar rocks from Telegraph Peak at 18.8 m.y. (K/Ar). These ages are Miocene. The quartz monzonite, latite, and pegmatite of the study area are assigned Miocene ages in this report.

Breccia of the Punchbowl fault zone

The Punchbowl fault zone, 200-4,000 feet (61-1,220 m) wide, contains faults breccia and blocks of several kinds of rock: gneiss, Pelona Schist, quartz diorite, green mylonitic rocks like the ones above the Vincent thrust, red arkose and red arkosic boulder conglomerate. The sedimentary rock is probably derived from the upper Miocene Punchbowl Formation. The redbeds from the Punchbowl Formation are conspicuous at Vincent Gap and occur in the Punchbowl fault zone with diminishing frequency eastward towards Cabin Flat. Mylonitic rocks are abundant in the fault zone from Cabin Flat eastward for about 1 mile (1.6 km). Gneiss predominates elsewhere in the fault zone.

The breccia is post-Upper Miocene in age, as it includes the Upper Miocene Punchbowl Formation. The Punchbowl fault zone was active probably in Late Pliocene or Pleistocene time (Dibblee, 1968, p. 264) and possibly into Holocene (Noble, 1954a). Therefore, the breccia in the fault zone may be as old as Late Pliocene and as young as Holocene.

Surficial deposits

Surficial deposits of Holocene age in the study areas include landslide deposits (Qls on map), older alluvium (Qol on map), and alluvium (Qal on map). The largest ones, from 0.25 to 0.5 mi^2 (0.6 to 1.3 km^2), occur on the flanks of the highest peaks and on steep slopes especially those underlain by Pelona Schist. Angular fragments in the unsorted deposits vary widely from sand and pebbles to boulders 50 feet (15.3 m) across. The surfaces of the deposits are usually of unstable debris. Many of the landslide deposits are covered with thick brush and trees, which have partly stabilized the surface material. Minor scarps and closed depressions are common near the headwall. The basal contacts of the deposits with bedrock are usually irregular. Where the glide surface of the landslide cuts through bedrock, as at the base of the Airplane Flat Slide, East Fork Canyon, the base of the deposit resembles a fault zone.

One small deposit of older alluvium occurs in the Sheep Mountain Wilderness study area on a low ridge between Cow Canyon and Cattle Canyon. The deposit is bedded sand and gravel and contains rounded cobbles of gneiss up to 6 inches (15.2 cm) across. The deposit is 460 feet (140 m) above the alluvium in Cow Canyon and 320 feet (90 m) above the alluvium in Cattle Canyon. Uplift of the older alluvium occurred probably in the Pleistocene or Holocene.

The deeply incised canyons contain alluvium consisting of cobble and boulder gravels with clasts of crystalline rock up to 15 feet (4.6 m) across. These deposits may be more than 100 feet (30.5 m) thick in some of the wide canyons, such as Cattle Canyon and East Fork Canyon. The alluvium is commonly very coarse in the uppermost parts of the deposit, as much of the finer fractions of the bed load (sand, silt, clay) have been transported downstream or washed into the spaces between the larger clasts. Active stream channel gravels are up to 12 feet (3.6 m) below the general surface of the alluvium in the canyons, and are commonly cemented with caliche. In places, older caliche cemented alluvium is 20 feet (6.1 m) thick. Minor stream terrace deposits were included in the alluvium unit. The nearly flat-lying terrace deposits, generally less than 10 feet (3 m) thick, consist of sand, silt, and clays, and lie above the alluvium.

Structure

The oldest structures in the study area are the foliations in the gneissic rocks, in the metasedimentary rocks of the migmatite east of the San Antonio fault, and in the Pelona Schist. The foliation of the Precambrian gneiss units is older than the foliation in the Triassic gneissose granodiorite, as the dikes of gneissose granodiorite cut the foliation of the gneiss. However, both rocks may have been subjected to deformation in the Triassic or later. The foliations of the metasedimentary rocks and of the Pelona Schist tend to be parallel to their gross compositional layering. However, the internal structure of these two rock units is complex, and quite likely the general parallelism between the foliations and the compositional layering has resulted from a transposition of the original bedding. The relative ages of the foliations in the Precambrian gneiss, in the Paleozoic or older metasedimentary rocks, and in the Cretaceous or older Pelona Schist are not clearly known. The Cretaceous or early Tertiary mylonitic rocks above the Vincent thrust have well-developed foliations that clearly postdate the structures of the gneiss and Pelona Schist, from which they were derived and that are probably also younger than the metasedimentary rocks.

The foliations in the metamorphic rocks are directions of relative weakness along which later dikes have been intruded. Many of the large Cretaceous quartz diorite dikes are in part subparallel to the foliations of the gneiss and of the metasedimentary rocks of the migmatite (mige) (see cross secs. AA", C-C', D-D"). Miocene quartz monzonite and latite sills also intrude the metamorphic rocks, but are less common than dikes. Only a few pegmatite sills were observed.

Material from gneissic rocks, gneissose granodiorite, quartz diorite, and Pelona Schist was mylonitized in a zone 200-2,000 feet (61-610 m) thick during the Cretaceous or early Tertiary. The mylonite zone, cut by Tertiary faults, extends across the Sheep Mountain Wilderness study area from Mount Baden-Powell on the northwest to Mount Baldy on the east and is present in northern Cucamonga Wilderness (fig. 3). Probably contemporaneously with the mylonitization, a zone of mylonite gneiss up to 1,000 feet (305 m) thick was developed between the mylonite zone and unsheared gneiss. The main belt of mylonite gneiss occurs in western Sheep Mountain Wilderness study area and northern Cucamonga Wilderness. The base of the mylonite zone is called the Vincent thrust and marks a sharp break between the Pelona Schist (lower plate) and the mylonite (upper plate). In some places the thrust itself is a zone of silvery gray-green chlorite and chlorite-talc phyllonite from 0 to 5 feet (0. to 1.5 m) thick. As shown in cross section C-C' much of the Sheep Mountain study area, as far south as the San Gabriel fault zone, is underlain by the Vincent thrust. In fact, small unmapped mylonite blocks in the San Gabriel fault zone in Graveyard Canyon may be uplifted mylonite from the upper plate of the Vincent thrust.

Mylonitized Miocene quartz monzonite dikes occur along the Middle Fork of Lytle Creek. The episode of mylonitization represented by these dikes is probably related to late Tertiary faulting in the range.

The San Gabriel and Punchbowl fault zones, both considered to be splays of the San Andreas fault system cut the northern and southern extremities of the Sheep Mountain Wilderness study area. The San Gabriel fault bifurcates in the western San Gabriel Mountains. The northern branch extends into the Sheep Mountain Wilderness study area where the fault zone is 1,200-8,000 feet (367-2,440 m) wide and is truncated by the San Antonio fault. The steep faults along Icehouse Canyon (fig. 4), which join the steep faults along the Middle Fork of Lytle Creek, may be extensions of the north branch of the San Gabriel

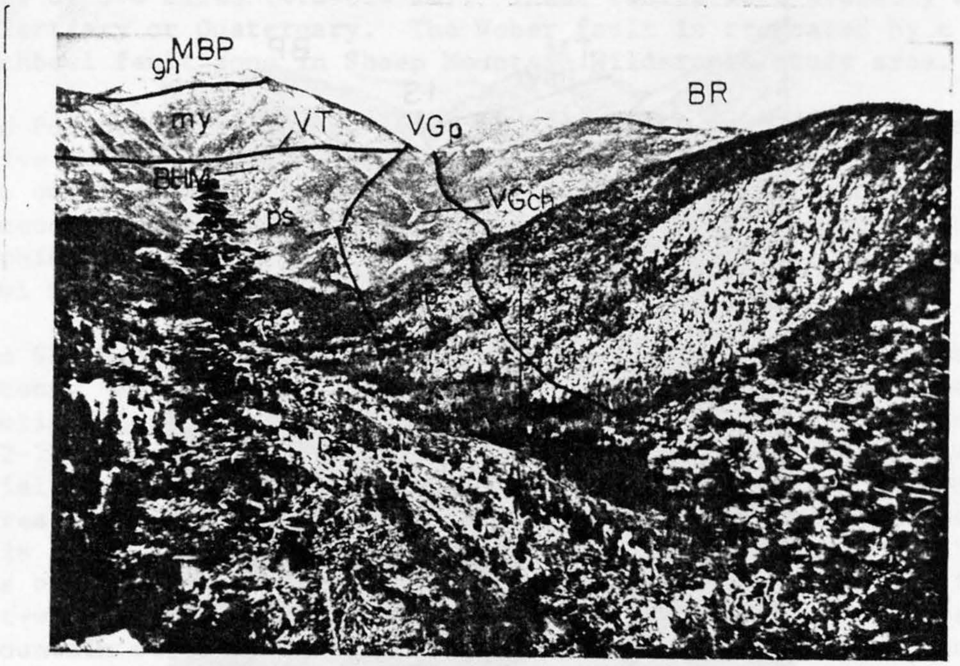

Figure 3.--View northwest along Punchbowl fault zone, northern Sheep Mountain study area. MBP, Mount Baden-Powell. VGp, Vincent Gap. BR, Blue Ridge. VGch, Vincent Gulch. PF, Prairie Fork. BHM, Big Horn mine. gn, gneiss. my, mylonite. ps, Pelona Schist. VT, Vincent thrust. pb, breccia in Punchbowl fault zone.

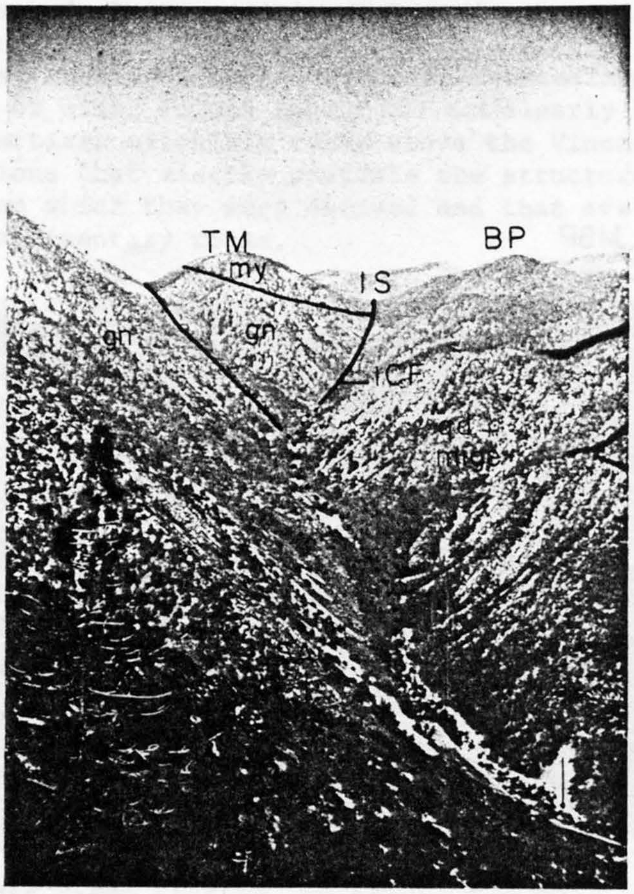

Figure 4.--View east along Icehouse Canyon into Cucamonga Wilderness. IS, Icehouse Saddle. BP, Bighorn Peak. TM, Timber Mountain. SAC, San Antonio Canyon. ICF, Icehouse Canyon fault. gn, gneiss. my, mylonite, qd, quartz diorite. mige, migmatite east of San Antonio fault.

fault east of the San Antonio fault (Dibblee, 1968, p. 266). Activity on the San Gabriel fault may have begun in late Oligocene or early Miocene (Crowell, 1954, p. 52). The fault was intermittently active in late Miocene-mid-Pleistocene (Eaton, 1939, p. 522; Crowell, 1950, p. 1644) and may have moved in the upper Pliocene and Quaternary (Oakeshott, 1958, p. 92) A right-lateral slip of 15-25 miles (24-40 km) is proposed for the San Gabriel fault in the northwestern San Gabriel Mountains (Crowell, 1952, p. 2034) and of 13 miles (21 km) in the central San Gabriel Mountains (Ehlig, 1966).

The San Antonio and Weber faults offset segments of the San Gabriel fault. The left-lateral separations of the Vincent thrust and associated mylonites along these two steep faults suggest a large left-lateral component of slip on the order of 3-4 miles (4.8-6.4 km). These faults were probably active in latest Tertiary or Quaternary. The Weber fault is truncated by a splay of the Punchbowl fault zone in Sheep Mountain Wilderness study area.

The Punchbowl fault zone (fig. 1), 200-4,000 feet (61-1,000 m) wide, was active in late Pliocene or Pleistocene (Dibblee, 1968, p. 264). In the Valyermo quadrangle Noble (1954b) mapped strands of the Punchbowl fault cutting Pleistocene and Holocene alluvium. However, no well-developed scarps or other topographic features associated with active faulting have been found along the Punchbowl fault (Morton, 1975, p. 175).

The San Gabriel Mountains have been a positive topographic area since the Miocene. Rugged mountains on the present site of the San Gabriel Mountains shed debris recognized in the Miocene conglomerate of the San Jose and Puente Hills, 2-20 miles (3.2-32 km) south of the present front of the eastern San Gabriel Mountains (Woodford and others, 1946). Holocene tectonism in the study area is primarily expressed by uplift of the crystalline rocks. The uplift is shown by the extreme relief within the study areas and by the deposits of fluvial gravels, which are now more than 300 feet (91.6 m) above the east-west segment of the East Fork of the San Gabriel River, south of the Sheep Mountain study area. The eastern San Gabriel Mountains, including the study area, lie on the south flank of the uplift recently discovered in the western Mojave Desert (Castle and others, 1976).

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Chapter B

Aeromagnetic studies of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions, Los Angeles and San Bernardino Counties, California

by

Leroy Pankratz

U.S. Geological Survey

An aeromagnetic survey of the Sheep Mountain Wilderness study area and Cucamonga Wilderness and vicinity was flown in 1975 along north-south flight lines spaced approximately 1.61 km apart at a barometric elevation of 2.9 km above sea level. The area of the survey was between lat 34°10' N. and 34°24.5' N. and long. 117°30' W. and 117°49' W. From the observed total magnetic field, a regional trend of 5.62 gammas/km north and 2.33 gammas/km east was removed using IGRF updated to July 1975. The resulting residual anomalies have been computer-contoured at an interval of 10 gammas at scale 1:62,500. A datum base of 50,437 gammas at the lower left corner was subtracted resulting in the negative values.

The residual magnetic map figure extends several kilometers beyond the boundaries of the two areas, except for the extreme western tip of the Sheep Mountain Wilderness study area. Subsequent to the aeromagnetic flight the boundaries of the Sheep Mountain Wilderness study area were modified. A lack of aeromagnetic data is evident on the western tip of this area. However, the earlier flight data by Hanna and others (1972) indicate a continuing inert trend in this small area.

An earlier aeromagnetic survey of the area (Hanna and others, 1972) detected two major positive magnetic anomalies in the region: a major northwest-trending high over the San Andreas fault directly north of the Sheep Mountain Wilderness study area, and a second major high near the southeast corner of the Cucamonga Wilderness. Both anomalies are somewhat better defined in this newer survey because of closer spacing of flight lines. The northern anomaly has a generally similar configuration on both maps, but the southeastern anomaly was originally contoured as being more equidimensional and of lower amplitude than shown on the new map.

Magnetic lineaments generally trend northwest along the San Andreas fault and the associated Punchbowl fault several kilometers to the south. The juncture of the Punchbowl fault and the San Antonio fault outlines a triangular feature of broad lows extending off the map to the west and southwest. Both the elevation and magnetization of the rocks are lower in this area. The San Antonio fault seems to cut off the high occurring southeast of Cucamonga Peak.

Intrusive rocks of the southeast part of the area, chiefly quartz diorites and monzonites, are moderately magnetic. Local magnetic benches are caused by the magnetic effects of Cucamonga and Ontario Peaks, but the main magnetic high over the intrusives occurs well south of the topographic crest. If these dioritic and monzonitic rocks cause the main Cucamonga high, they must be substantially more magnetic beneath the south slopes of these mountains than elsewhere on the map. It is possible that gabbroic or more mafic rocks occur at shallow depth beneath the surficial quartz diorite to cause the large 400-gamma high. Moreover, the Cucamonga high is quite elongate suggesting that the quartz diorite rocks whose southern extent coincides with the south slope of the high and whose northern extent coincides with the table on the north side might cause the anomaly. It seems likely that the quartz diorite rocks in the Cucamonga Peak area are much less magnetic than those to the south. Geologic cross sections which extend into the northern part of the anomaly (see pl. 1) and slightly to the west of the anomaly (Hsu, 1955) indicate the northerly dip of the fault planes and that the southernmost diorite may be structurally distinct from the other rocks of this area.

Additional surface rocks south to the Cucamonga fault zone include granodiorite, mylonite, and Precambrian igneous and metamorphic rocks (Rogers, 1967). Figure 5 is a representation of a model of this structure. The model seems to fit the observed data well except for the north side, which requires some further adjustment.

Within the Sheep Mountain Wilderness study area, mainly underlain by weakly magnetic Pelona Schist and mylonitic rocks, there are four magnetic anomalies of which three are of inconsequential magnitude. The fourth high occurs on the east-central edge of this area labeled H-523. This high most certainly correlates in part with the complex of quartz diorite and gneissic rocks while the magnetic gradient extending to the west is caused by the contrast in magnetization of these rocks as compared with the weakly magnetic Pelona Schist.

The magnetic anomalies of these two areas are adequately explained through modeling as a result of the exposed rocks extending to several kilometers depth. Consequently the aeromagnetic data does not support further mineral resource investigation.

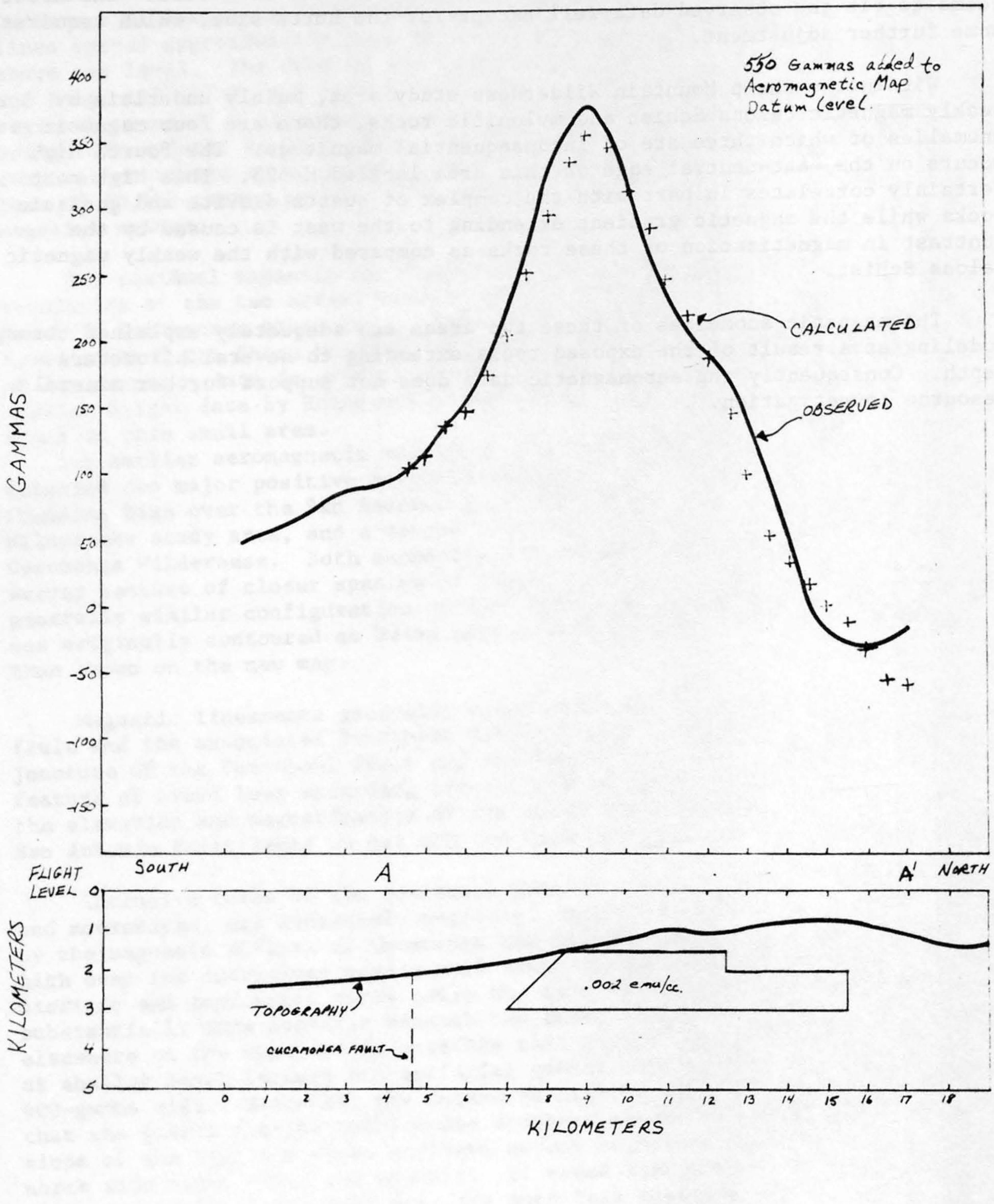

Figure 5.--Cucamonga magnetic profile A-A'. Profile south of A is inferred from south corners of map and Hanna and others (1972).

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Chapter C

A geological and geochemical evaluation of the mineral resources of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions, Los Angeles and San Bernardino Counties, California

by

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INTRODUCTION

The mineral resource potentials of the Sheep Mountain Wilderness study area and the Cucamonga Wilderness and additions were evaluated by examination of the rocks, investigations of geological features that control the occurrence of metals, and by geochemical sampling. Rocks and stream sediment in the study area were sampled during the geological field studies described in Chapter A. Rock samples included fresh and unaltered rocks, altered rocks, veins, and fault breccia. Outcrops were inspected for sulfide minerals (pyrite, chalcopyrite, and galena), malachite, and iron stains. Samples of fine stream sediment included, where possible, a significant amount of clay and silt in the 1-2 lb (0.5-1 kg) sample. Rock fragments in gravel bars were examined and fragments showing staining, alteration, or veining were sampled. Pan concentrate samples, taken at selected localities throughout the study area, were made from 5-10 lb (2.5-5 kg) samples of selected fine to coarse sand and gravel, taken from gravel bars where possible. Large pebbles and cobbles were removed after washing the fine material from them into the pan. During this study 297 samples were collected for chemical analysis (locations on pl. 2). Of these, eight are stream pebbles, 163 are stream sediments (135 fine stream sediments, 28 pan concentrates), and 126 are outcrop samples.

Rock and stream-sediment data are stored on magnetic tape and are available through the U.S. Department of Agriculture, National Technical Information Service (McDanal and others, 1977).

Fine stream-sediment samples were taken from the mouths of most of the tributaries to the main streams (East Fork, Iron Fork, Prairie Fork, Vincent Gulch, Cattle Canyon, Coldwater Canyon, Cow Canyon) in the Sheep Mountain Wilderness study area. The main canyons have a large bedload, the channels are very broad (greater than 20 feet (6.6 m)), and in many places the fine sediment fraction has been washed between the large boulders. The large canyons themselves were not sampled because it was believed that the large bedload would mask anomalous concentrations of elements and minerals entering the main canyons. Many tributaries of the Fish Fork were not sampled because of the numerous cliffs and waterfalls in the middle and upper parts of the canyon. Tributaries of the major streams in the easternmost San Gabriel Mountains were sampled (San Antonio Canyon, Cucamonga Canyon, Deer Canyon, Day Canyon, and the three forks of Lytle Creek). Upper Cucamonga Canyon was not sampled in detail because of its inaccessibility.

All fine stream-sediment, pan concentrate, and rock samples were sent to the U.S. Geological Survey laboratory in Denver for spectrographic analyses for 30 elements by H. G. Neuman, M. J. Malcolm, and N. M. Conklin; and by atomic absorption methods for gold by Jim Crock, A. Haubert, P. Guest, and L. Lee. The rock and fine stream-sediment samples were analyzed by mercury detector by J. D. Hoffman; and by wet oxidation and atomic absorption by J. Thomas and J. Gardner. Sixty samples (16 rock and 44 fine stream-sediment samples) were tested for lithium using atomic absorption by Lee, Huffman, L. Leo, and Guest. Twenty-three selected samples were analyzed for uranium and thorium by neutron activation by H. T. Millard, R. J. Knight, A. J. Bartel, J. P. Hemming, R. J. White, R. J. Vinnola, and E. Brandt. Heavy minerals were separated from pan concentrates using bromoform and were identified. The pan concentrates were analyzed by spectrographic and atomic absorption methods.

All gold, tungsten, silver, arsenic, and zinc values were plotted without additional analysis, as few samples contained detectable quantities of these metals. Samples containing barium, copper, lead, and mercury are more numerous, and these analytical results were treated by standard statistical methods for determination of background and threshold levels (Lepeltier, 1969). The sample data were evaluated by comparing the analytical results of the elements in each sample with geometric mean values (background) of the elements in all samples of the same rock type. The values that were sufficiently high were classified as anomalous (greater than or equal to the threshold value). Determination of an anomalous value is dependent on rock type, type of sample, and the analytical results. In this study the analytical differences between rocks of the major rock types (gneiss, quartz diorite, Pelona Schist and the mylonitic rocks) are small. Consequently, the background and threshold levels of many of the elements in these rocks, including barium, copper, lead, and mercury, do not differ appreciably, and the minor variation in analytical values from one rock type to another can be ignored.

EVALUATION OF GEOCHEMICAL DATA

Gold

Gold has been the main target of prospecting and mining activity in the Sheep Mountain Wilderness study area. Most of the gold production in the area was from placer mining along the East Fork of San Gabriel Canyon (see Chap. D). No gold mining occurs in the area today, but many visitors to the area pan for gold. Presumably, much of the gold recovered from the placer deposits in the East Fork was derived from gold veins in schist and mylonite.

Almost one-third of the samples contain detectable amounts of gold (lower limit of detection 0.05 ppm). Because ordinary crustal abundance of gold is estimated to be 0.003-0.004 ppm (Jones, 1968, p. 3; Lee and Yao, 1970, p. 782), any gold detectable in rock and fine stream-sediment samples is anomalous. The locations of the gold-bearing samples and their analyses are plotted in figure 7. The gold values and the lithologies of the rocks containing gold are summarized in table 1.

Gold concentrations in the rock samples, even in the most altered rock and vein material, are generally low, and the locations of these samples are widely scattered. Nearly all the gold concentrations $\geq$1 ppm in rock are at gold mines. Although most of the mines in the area are in mylonite and Pelona Schist, only five of the rock samples with gold are from these two rock types. Gold in detectable amounts occurs in samples of altered rock and quartz veins from the vicinity of the Allison (0.36 ppm), Baldora (0.13 ppm max), Big Horn (21.3 ppm max), Eagle (3.23 ppm), and Native Son mines (3.03 ppm max). Approximately one-third of the rock samples containing gold are from veins and dikes in gneiss, diorite, and migmatite above the Vincent thrust mylonite zone. Analyses of samples of breccia in the Punchbowl fault zone at the Native Son mine indicate a gold potential for part of the Punchbowl fault zone outside the Sheep Mountain study area. Gold in low concentrations ($\geq$0.23 ppm max) was found in rock samples along part of the San Gabriel fault zone.

Gold is present in low concentrations in about 7 percent of the fine stream-sediment samples. In part of the Mine Gulch and Vincent Gulch areas,

Figure 7.

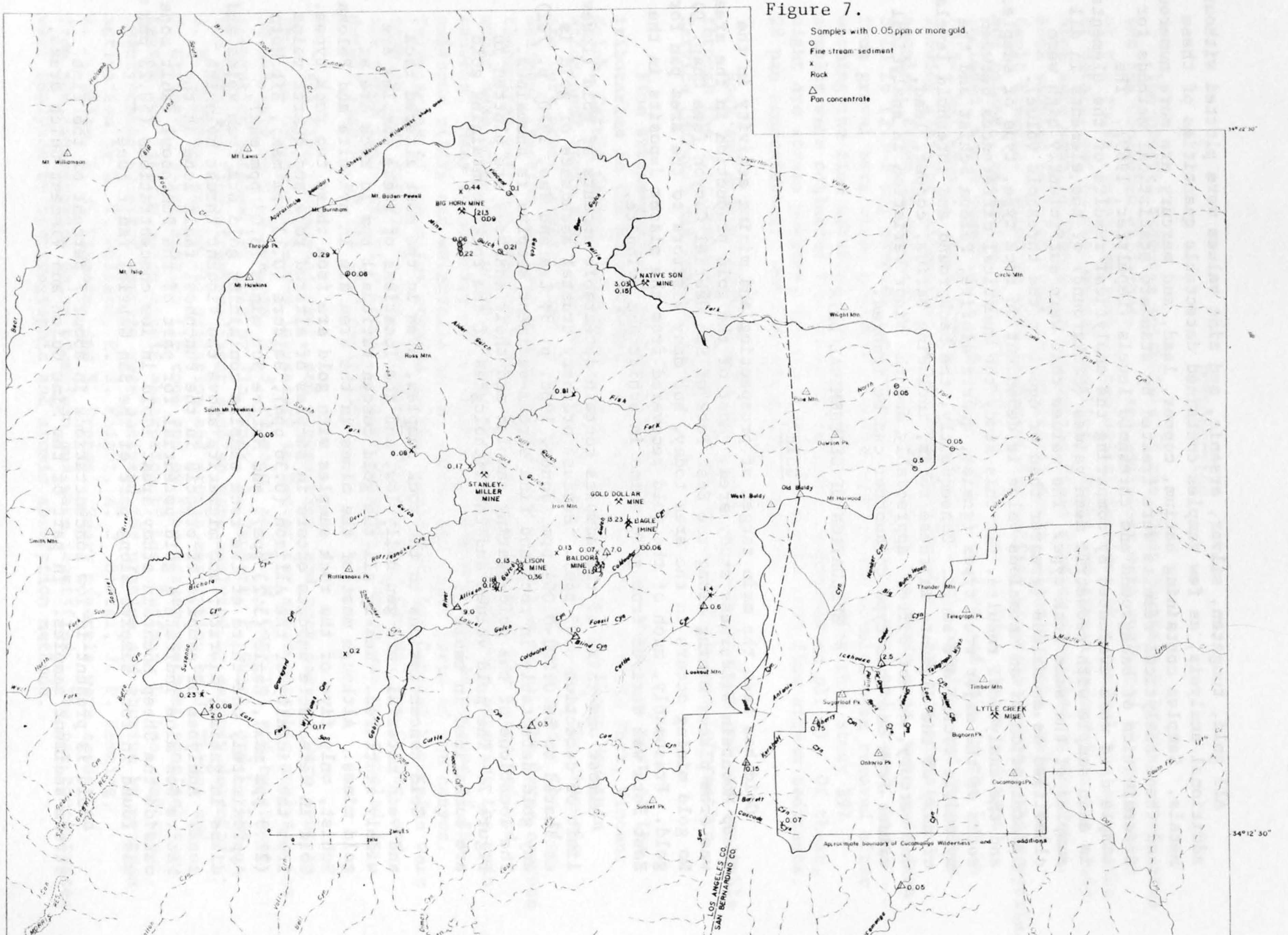
Samples with 0.05 ppm or more gold
Fine stream sediment
Rock
Pan concentrate
BIG HORN MINE
NATIVE SON MINE
STANLEY-MILLER MINE
GOLD DOLLAR MINE
EAGLE MINE
BALDORA MINE
LYTLE CREEK MINE
Mt. Williamson
Mt. Lewis
Mt. Baden-Powell
Mt. Burnham
Throop Pk.
Mt. Islip
Mt. Hawkins
South Mt. Hawkins
Ross Mtn
Iron Mtn
Rattlesnake Pk.
Smith Mtn.
Pine Mtn.
Dawson Pk.
Wright Mtn
Circle Mtn
Old Baldy
West Baldy
Mt Harwood
Thunder Mtn
Telegraph Pk.
Timber Mtn
Lookout Mtn.
Sugarloaf Pk.
Ontario Pk.
Bighorn Pk.
Cucamonga Pk.
Sunset Pk.
LOS ANGELES CO.
SAN BERNARDINO CO.
Approximate boundary of Cucamonga Wilderness and additions
34°22'30"
34°12'30"
117°32'30"

Table 1.--*Summary of gold analyses and lithologies of rocks with gold*

Sample type	No. samples with >0.05 ppm Au	Maximum value Au in ppm	Value of Au in rock sample in ppm
Fine stream sediment	10	0.5	
Pan concentrate	10	9.0	
Rock	23	21.3	
Breccia	3	---	0.05 .08 .15
Quartz-siderite vein	3	---	.08 .17 .23
Muscovite-chlorite schist with hematitic alteration	2	---	.17 .29
Quartzite (Pelona Schist) with hematitic veins	1	---	.81
Mylonite with hematitic alteration	2	---	.13 .36
Malachite vein	1	---	1.4
Quartz vein	7	---	.13 .18 .2 3.23 .13 .07 3.03
Pegmatite dike	1	---	.07
Fractured latite with hematite veins	3	---	21.3 .09 .44

gold in the fine stream sediment may be mainly derived from mining in the Big Horn mine area. However, the main branch of Mine Gulch and one of its tributaries contain gold and have not been contaminated by mined debris. These drainages, plus an adjoining tributary of Iron Fork, comprise one gold target. The source of the gold may be an extension of the mineralized zone along the Vincent thrust south and west of the Big Horn mine. At Allison Gulch, gold in the fine stream sediment occurs above the Allison mine and indicates gold-bearing veins in the mylonite. Gold is present in fine stream sediment in the headwaters of Coldwater Canyon and in three streams on the east side of Dawson Peak. No mining is known from these drainages. In upper Coldwater Canyon, the most likely host for gold is the breccia zone along the Weber fault. At Dawson Peak the gold is in Pelona Schist. The fine stream-sediment sample with the highest gold concentration, 0.5 ppm, is from one of the streams draining the east side of Dawson Peak.

Detectable quantities of gold were found in 32 percent of the pan concentrates. No gold was visible under microscopic examination of the pan concentrates. Pan concentrate samples seem to be more sensitive indicators of gold in the eastern San Gabriel Mountains than are fine stream-sediment samples. However, the time consumed in obtaining numerous pan concentrate samples is great. In addition, gold concentrations which are so small as to be detectable only in pan concentrate samples may be of the order of crustal abundance. In this study the occurrence of $\geq$1 ppm gold in pan concentrates from basins with no mines is considered high enough to indicate possibly anomalous amounts of gold upstream from the sample site. The relatively high values of gold in pan concentrates from Dry Gulch (7 ppm) and Allison Gulch (9 ppm) are probably due to the mining upstream. Gold $\geq$1 ppm also occurs in pan concentrates from canyons in which no mining is known: Susanna Canyon (2 ppm), Fossil Canyon (1 ppm), and Cedar Canyon (2.5 ppm). These drainages are designated as gold targets. A small part of the Susanna Canyon target and two-thirds of the Cedar Canyon target are outside the study area boundaries. The gold in the pan concentrate from Susanna Canyon may be from gold-bearing veins in fractured rock of the San Gabriel fault zone.

As the fine stream-sediment samples are more representative of the average rock composition of the drainage basins than are the pan concentrates, the gold targets based on detectable amounts of gold in fine stream sediment are considered to be the most important ones. These gold anomalies do not appear to be strong but may reasonably be expected to contain as much as, but probably no more than, the amount of gold that has already been found and inferred to exist at the lode mines in the area. Therefore, there may be a moderate potential for gold, chiefly in the Sheep Mountain Wilderness study area.

Tungsten

Scheelite has been mined from veins in quartz diorite and from the alluvium in upper Cattle Canyon, Sheep Mountain Wilderness study area. The 17 samples containing detectable amounts of tungsten (lower limit of detection by spectrographic methods is 50 ppm) are from the Sheep Mountain study area. The locations of the tungsten-bearing samples and the analytical data are plotted in figure 8. The analyses and lithologies of the rock samples with tungsten are summarized in table 2.

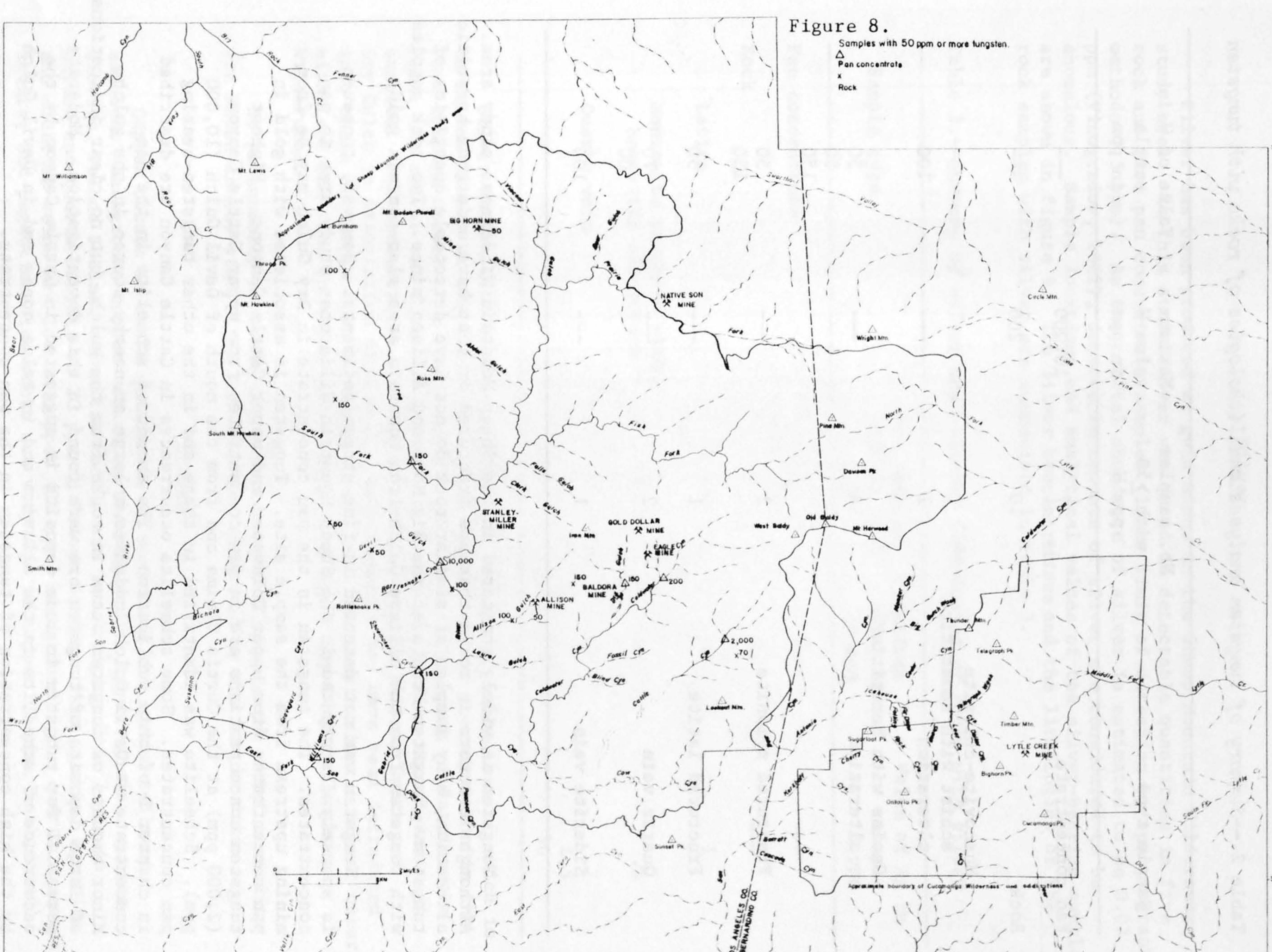
Samples with 50 ppm or more tungsten.
Pan concentrate
Rock
BIG HORN MINE
NATIVE SON MINE
STANLEY-MILLER MINE
GOLD DOLLAR MINE
EAGLE MINE
BALDORA MINE
ALLISON MINE
LYTLE CREEK MINE
Mt Williamson
Mt Lewis
Mt Burnham
Mt Baden-Powell
Throop Pk
Mt Islip
Mt Hawkins
South Mt Hawkins
Ross Mtn
Iron Mtn
Rattlesnake Pk
Smith Mtn
Circle Mtn
Wright Mtn
Pine Mtn
Dawson Pk
West Baldy
Old Baldy
Mt Harwood
Thunder Mtn
Telegraph Pk
Timber Mtn
Bighorn Pk
Sugarloaf Pk
Ontario Pk
Cucamonga Pk
Lookout Mtn
Sunset Pk
LOS ANGELES CO.
SAN BERNARDINO CO.
Approximate boundary of Cucamonga Wilderness and additions
Approximate boundary of Sheep Mountain Wilderness study area
34°22'30"
34°12'30"
117°52'30"
117°32'30"

Figure 8.

Table 2.--*Summary of tungsten analyses and lithologies of rocks with tungsten*

Sample type	No. samples with >50 ppm W	Maximum value W in ppm	Value of W in sample in ppm
Pan concentrate	7	10,000	---
Rock	10	200	---
Muscovite-chlorite schist with hematitic alteration	1	---	100
Gneiss with hematitic alteration	3	---	50 50 150
Fractured mylonite	2	---	50 150
Fractured latite	1	---	50
Quartz vein	2	---	70 100
Siderite vein	1	---	100

Tungsten is widely scattered in the Sheep Mountain Wilderness study area. Although it occurs in rocks that are fractured or that have undergone hematitic alteration, many samples of similar rock do not have detectable quantities of tungsten. Tungsten occurs at the Big Horn and Allison mines. Two rock samples with tungsten from the Allison Gulch-Iron Mountain area also contain gold.

Tungsten was not detected in fine stream sediments. However, tungsten is sparsely distributed in the Sheep Mountain Wilderness study area in pan concentrates. The tungsten in the pan concentrate in Dry Gulch may be from mining upstream from the sample site. Tungsten is associated with gold in pan concentrates from upper Coldwater and upper Cattle Canyons. Highest tungsten concentrations are in pan concentrates from upper Cattle Canyon (2,000 ppm) at the Curtis Claims and from the mouth of Devil Gulch (10,000 ppm). Scheelite was identified in these and in the other tungsten-bearing pan concentrates. Some scheelite occurrences in Cattle Canyon are described in chapter D of this publication. The amount of scheelite in the pan concentrate at Devil Gulch indicates a large or nearby source in the gulch. Minor amounts of tungsten occur in rocks from the gulch, but no clear indications of large deposits of tungsten ore were found in this investigation. Moderate potential for tungsten in lode deposits is suggested in Cattle Canyon by the occurrence of scheelite in the alluvium and in talus cones and in Devil Gulch by the high concentration of tungsten in the pan concentrate.

Silver

Silver has been produced at gold mines in the Sheep Mountain Wilderness study area. In this study silver was found in detectable quantities in five rock and five pan concentrate samples (lower limit of detection by spectrographic methods 0.5 ppm). As the crustal abundance of silver is estimated to be 0.07 ppm (Vinogradov, 1962), detectable amounts of silver are considered to be anomalous. Sample locations and analytical values of the silver-bearing samples are shown in figure 9. The silver concentrations and the lithologies of the rock samples with silver are summarized in table 3.

Table 3.--*Summary of silver analyses and lithologies of rocks with silver*

Sample type	No. samples with Ag ≥0.5 ppm	Maximum value Ag in ppm	Value of Ag in sample in ppm
Pan concentrate	5	30	---
Rock	5	30	---
Latite	1	--	1
Monzonite porphyry with hematitic alteration	1	--	.5
Quartz vein	3	--	.7 1.5 30

Silver occurs with arsenic and lead in two quartz veins, one of which is in Pelona Schist at the Eagle mine. The highest silver concentration in the rock samples occurs in a single quartz vein on a ridge south of Rattlesnake Peak. No silver was found in detectable quantities in fine stream-sediment samples. Pan concentrates containing silver occur in Allison Gulch and Dry Gulch in association with gold. Both elements may have been introduced into these drainages from mining upstream from the sample sites. Silver occurs with lead and zinc in a pan concentrate from upper Day Canyon, Cucamonga Wilderness.

No potentially economic deposits in which silver is the chief commodity are known in the study area and none are indicated by the sample data.

Copper

Copper occurs in small quantities in most rock and stream-sediment samples. Background copper values in the major rock types (gneiss, quartz diorite, Pelona Schist, mylonitic rocks) are low, ranging from 7 ppm in gneiss and quartz diorite to 20 ppm in Pelona Schist. Most quartz, hematite and siderite veins are low in copper (15 ppm, background), the quartz monzonite, latite, and pegmatite dike rocks are very low in copper (2 ppm, background)

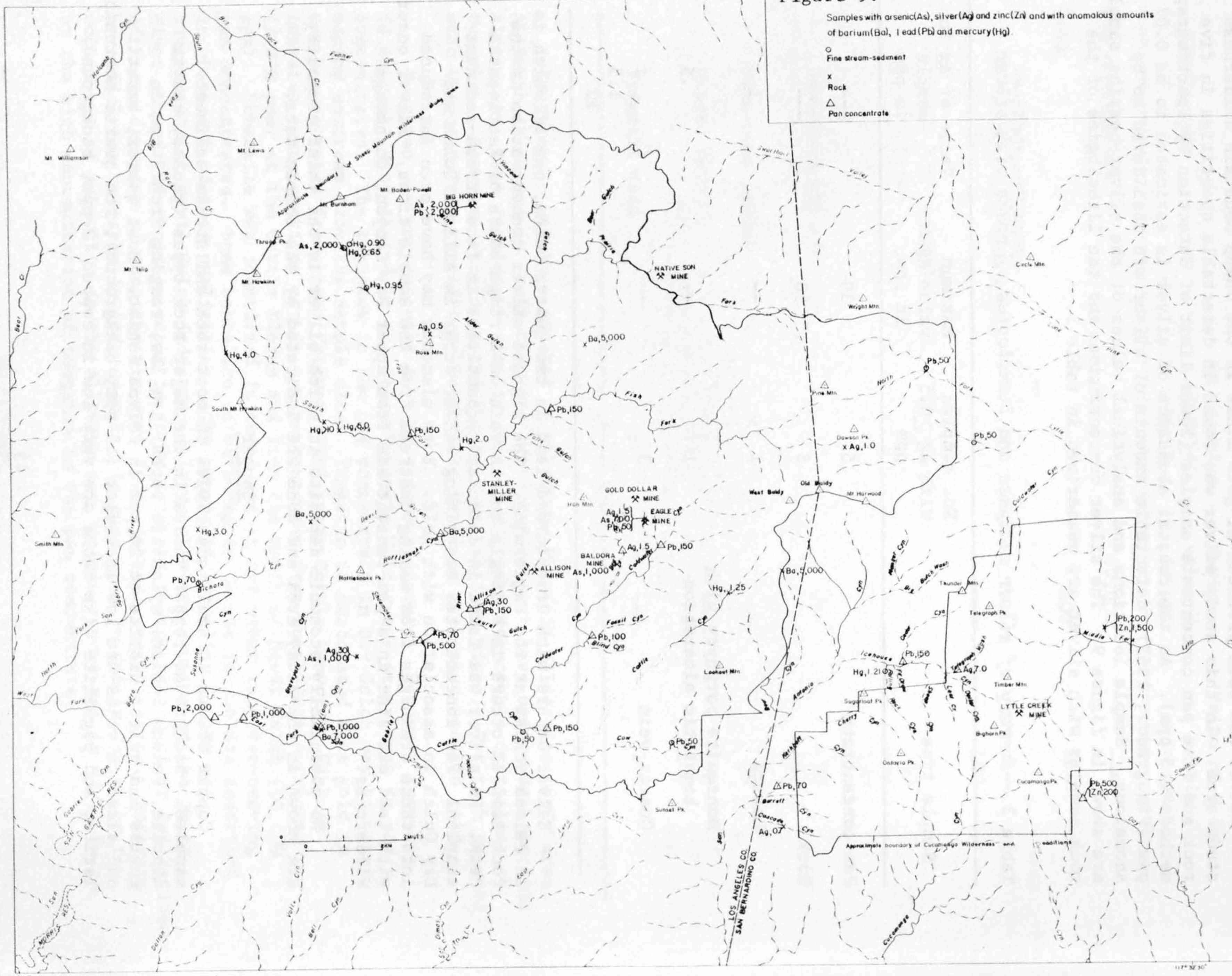

Figure 9.

Samples with arsenic(As), silver(Ag) and zinc(Zn) and with anomalous amounts of barium(Ba), lead(Pb) and mercury(Hg).

and the metasedimentary rocks in the migmatite of southern Cucamonga Wildernes are relatively high in copper (most samples $\geq$50 ppm) as compared to the other rocks. As the background level for copper in all rock samples is low and does not range widely, the samples were grouped together in order to determine a threshold level of anomalous copper concentrations. Similarly, the fine stream-sediment samples were not subdivided into groups defined by the rock types underlying the drainages that were sampled, because the range in background values among the major rock types is small and the copper concentrations are low. The background level of copper for rock samples (10 ppm) is a little less than the background level for fine stream-sediment samples (20 ppm). Threshold levels of anomalous copper concentrations are the same (70 ppm) for both types of samples. Pan concentrates are somewhat enriched in copper (background, 50 ppm; threshold, 100 ppm). The locations of all samples with anomalous copper concentrations are shown in figure 10 with the analytical data. A summary of the anomalous copper concentrations and the lithologies of the rock samples with $\geq$70 ppm copper is shown in table 4.

Anomalous copper concentrations are widely distributed in and near the two areas. Rock samples from the Allison and Dry Gulch areas suggest that copper occurs in the proximity of gold deposits. Two veins of quartz (1,000 ppm Cu) and quartz-malachite (2,000 ppm Cu) are high in copper and also contain gold but are not close to mines. Some rock samples containing silver and tungsten also contain $\geq$70 ppm copper. Three samples of metasedimentary rock in southwest Cucamonga Wilderness range from 70 to 200 ppm copper. These samples may not be anomalous in copper, as most of this kind of rock has copper concentrations $\geq$50 ppm, and the distribution of copper in them is not clearly known. The quartz and quartz-malachite veins with $\geq$1,000 ppm are scattered, isolated, discontinuous zones less than 3 feet (1 m) thick.

The fine stream sediments with $\geq$70 ppm copper are sparsely scattered in the Sheep Mountain Wilderness study area and do not outline areas which appear to be especially rich in copper (100 ppm max). Anomalous quantities of copper were not detected in stream-sediment samples from the area of the Lytle Creek copper mine, Cucamonga Wilderness.

The pan concentrates, although richer in copper than other sample types, do not contain noteworthy amounts of copper (200 ppm max). The distribution of the pan concentrates with 100 ppm copper reinforces the association of copper and gold, as four of the pan concentrates with anomalous amounts of copper also contain gold. In the Allison and Dry Gulch areas the copper may have been introduced during mining.

The sample data show generally weakly anomalous copper concentrations scattered broadly across the study area. The few veins relatively rich in copper do not appear to be indicative of large copper deposits in the area. Conceivably, minor amounts of copper could be recovered from gold mining as has been done in the past. However, there does not appear to be a potential in the study areas for deposits in which copper is the chief target.

Barium

A few anomalous concentrations of barium are scattered in the Sheep Mountain study area. All samples contained barium (lower limit of detection by spectrographic methods 20 ppm). The background level of barium for each of the major rock types (gneiss, quartz diorite, Pelona Schist, mylonitic

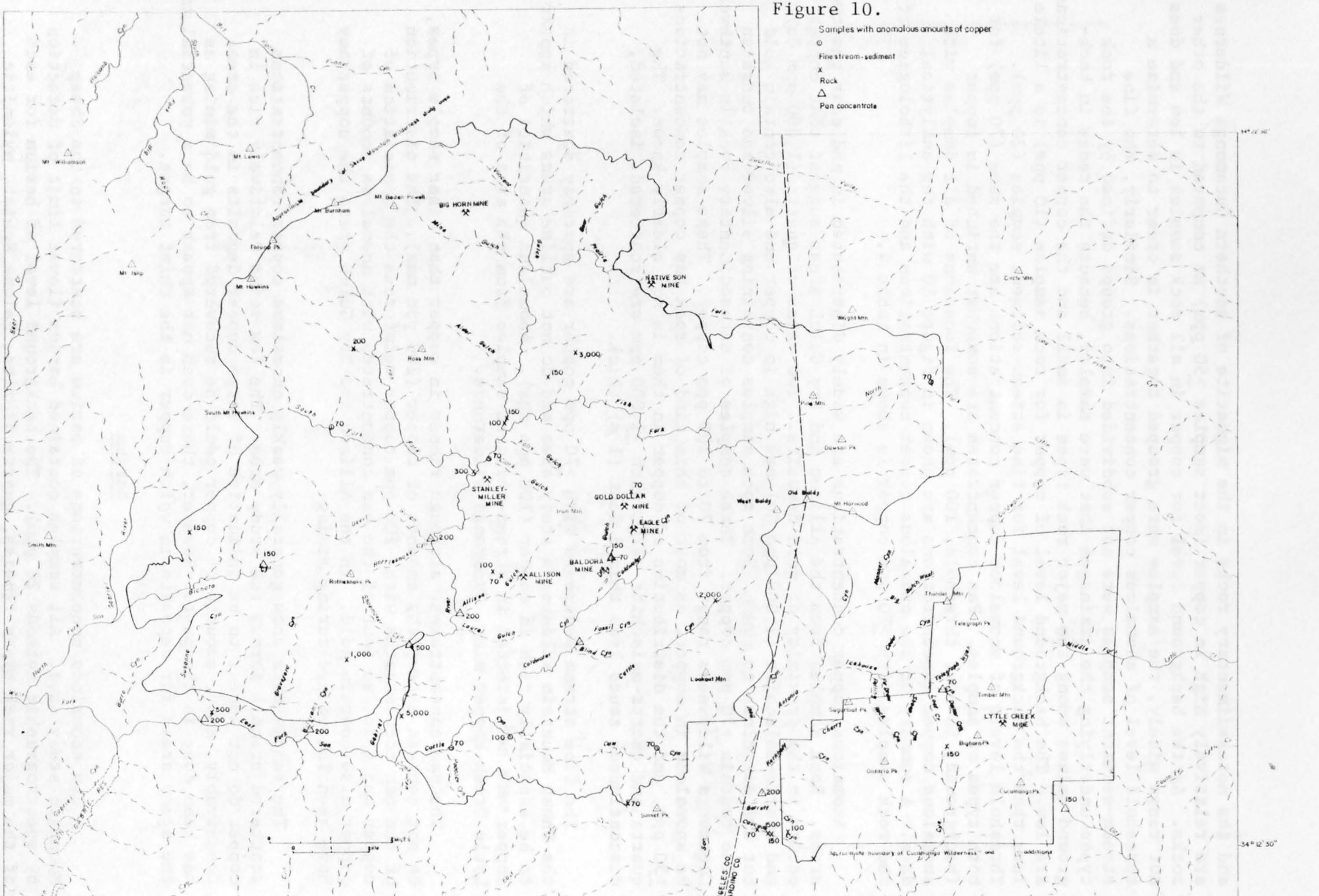
Samples with anomalous amounts of copper
Fine stream-sediment
Rock
Pan concentrate
Approximate boundary of Sheep Mountain Wilderness study area
Approximate boundary of Cucamonga Wilderness and additions
BIG HORN MINE
NATIVE SON MINE
STANLEY-MILLER MINE
GOLD DOLLAR MINE
EAGLE MINE
BALDORA MINE
ALLISON MINE
LYTLE CREEK MINE
Mt Baden Powell
Mt Burnham
Mt Lewis
Mt Williamson
Mt Islip
Mt Hawkins
South Mt Hawkins
Throop Pk
Ross Mtn
Iron Mtn
Old Baldy
West Baldy
Mt Harwood
Pine Mtn
Dawson Pk
Wright Mtn
Circle Mtn
Rattlesnake Pk
Lookout Mtn
Sugarloaf Pk
Ontario Pk
Bighorn Pk
Cucamonga Pk
Telegraph Pk
Thunder Mtn
Timber Mtn
Sunset Pk
Smith Mtn
LOS ANGELES CO
SAN BERNARDINO CO
3,000
2,000
5,000
1,000
500
200
150
100
70
300
34°22'30"
34°12'30"
117°32'30"

Figure 10.

Table 4.--*Summary of samples with anomalous amounts of copper including lithologies of the rock samples anomalously rich in copper*

Sample type	No. samples with ≥70 ppm	Maximum value Cu in ppm	Value of Cu in sample in ppm
Fine stream sediment	7	100	---
Pan concentrate	11	200	---
Rock	22	5,000	---
Quartz-malachite or quartz vein	6	---	70 1,000 1,500 2,000 3,000 5,000
Breccia	2		150 500
Siderite vein	1		100
Chlorite schist	2		70 150
Pelona Schist with hematitic alteration	1		300
Gneiss with hematitic alteration	3		70 150 200
Metasedimentary rock	3		70 150 200
Hematite vein	2	---	150 200
Pegmatite	1		100

rocks, and the granitoid rocks) is 1,000 ppm. The background level for quartz, hematite, and siderite veins is less (300 ppm), although the highest barium concentration encountered (7,000 ppm) occurs in a quartz-siderite vein. The threshold level of anomalous concentrations of barium in rocks is 5,000 ppm. Stream-sediment samples generally contained amounts equal to or less than the rock background (fine stream sediment, 700 ppm, background; pan concentrate, 300 ppm, background). Barite was identified in some of the pan concentrates and is the most likely source of the barium. One pan concentrate has a barium concentration of 5,000 ppm, which is probably anomalous. The five samples with anomalous barium concentrations are plotted in figure 9.

Barium $\geq$5,000 ppm is associated with gold in a quartz-siderite vein in Williams Canyon, with anomalous amounts of copper in quartzite of the Pelona Schist, and with tungsten in the pan concentrate from Devil Gulch. No large barium anomaly is indicated by the sample data.

Lead

Lead-bearing minerals occur at the Big Horn mine (galena) and at the Blew Jordam prospect southeast of the Cucamonga Wilderness. Lead occurs in detectable quantities in nearly all the stream-sediment samples and in 101 of the rock samples (lower limit of detection by spectrographic methods 5 ppm). The background levels for the major rock types are similar (gneiss, quartz diorite, and Pelona Schist, 15 ppm; mylonitic rocks, 10 ppm). Veins have lower (7 ppm) and granitoid rocks have higher (20 ppm) background levels. In all rock types the range of lead concentrations is small. Grouped together, the rocks have a background level of 15 ppm and a threshold level of 50 ppm. Fine stream sediments have identical background and threshold concentrations. Pan concentrates are somewhat richer in lead (background, 50 ppm; threshold, 70 ppm). The locations of samples with anomalous lead concentrations and the analytical data are shown in figure 8.

Lead in anomalous quantities is not common in rock samples from the study area. Lead $\geq$50 ppm is associated with arsenic and silver in a quartz vein at the Eagle mine, with arsenic and tungsten in a latite dike at the Big Horn mine, and with zinc in oxidized metasedimentary rock in the Middle Fork of Lytle Creek. The highest concentration of lead in rock (2,000 ppm) is in a latite dike at the Big Horn mine.

Lead $\geq$50 ppm in fine stream-sediment samples and lead $\geq$70 ppm in pan concentrate samples is variously associated with copper, gold, silver, and zinc. Four pan concentrates contained lead in quantities $\geq$500 ppm: Shoemaker Canyon, 500 ppm, Susanna Canyon, 2,000 ppm, Graveyard Canyon, 1,000 ppm, and Williams Canyon, 1,000 ppm. Slivers of lead probably from bullets were identified in the sample from Susanna Canyon. All these canyons are, or have been, readily accessible from the main paved road along the East Fork and were much frequented by shooters. It seems likely that the high lead concentrations in these pan concentrate samples are due to human activity and do not result from naturally occurring lead-bearing minerals in the area. Lead in the fine stream-sediment sample from a tributary of Bichota Canyon may also be due to lead from bullets, as the Bichota Canyon road is a much used shooting range. The broad, weak lead anomaly outlined by stream sediment in southeast Sheep Mountain Wilderness study area, may also be a result of human activity, as that part of the study area is one of the most accessible for visitors to the mountains.

Arsenic

Four rock samples in the Sheep Mountain Wilderness study area contained detectable amounts of arsenic (lower limit of detection by spectrographic methods 200 ppm). Three of the samples, two quartz veins and a latite dike rock, are from the Big Horn, Baldora, and Eagle mines and have arsenic concentrations ranging from 700 to 2,000 ppm (fig. 9). Two of these samples also contain anomalous amounts of lead. The arsenic-bearing quartz vein south of Rattlesnake Mountain also contains gold, silver, and anomalous quantities of copper. Arsenic, then, is a minor element associated with mineralization in the study area, and does not by itself form significant deposits. However, its presence in gold ore may increase the cost of gold extraction.

Lithium

The 60 selected samples analyzed for lithium contained concentrations, which were less than or equal to normal crustal abundance (20 ppm for the upper crust, Heier and Billings, 1969). The greatest concentration of lithium was 63 ppm in a quartz vein. No lithium potential in the study area was suggested by the sample data.

Mercury

Mercury was detected in anomalous amounts (0.6 ppm in fine stream sediment; 1 ppm in rock) in a few widely scattered samples, most of which are in the Sheep Mountain Wilderness study area (fig. 9). Most of the rocks anomalous in mercury are hematitically altered. One sample contained malachite. Some fine stream-sediment samples anomalous in mercury also contain anomalous amounts of copper. In general, however, the broad mercury anomaly outlined in the Iron and South Forks is spatially unrelated to anomalous concentrations of other elements in the area. No indication of a potential mercury deposit was inferred from the geochemical data.

Zinc

Two samples with detectable zinc (lower limit of detection by spectrographic methods 200 ppm) are from the Cucamonga Wilderness: oxidized quartzite, 1,500 ppm, Middle Fork Lytle Creek; pan concentrate, 200 ppm, upper Day Canyon (fig. 9). Each of the samples contained 200 ppm lead. The pan concentrate also contained a small amount of silver. Zinc is a minor element in the study area of no economic importance.

Uranium and thorium

Thirteen rock and 10 fine stream-sediment samples were analyzed for uranium and thorium by neutron activation analyses. The samples were selected after detecting lanthanum, niobium, scandium, and yttrium in the spectrographic analyses. These elements are associated with uranium and thorium in heavy minerals from igneous and metamorphic terrains, and samples exceptionally rich in these elements were submitted for the uranium and thorium analyses. Of the rock samples, three are from pegmatite dikes, three are mylonite, four are metasedimentary rock in southern Cucamonga Wilderness area, two are gneiss, and one is Pelona Schist.

Uranium content of the rock samples varies from 0.78 to 22.73 (pegmatite) ppm. Eleven samples contain less than 4 ppm, which is equivalent to crustal abundance (2-4 ppm, Finch and others, 1973, p. 465). The uranium content of the fine stream-sediment samples varies from 0.83 to 5.35 ppm. Seven of these samples contained less than 3 ppm uranium and apparently reflect the uranium content of the rock. The highest uranium analysis obtained is still less than the average uranium content of the Chattanooga shale in eastern Tennessee (35 ppm), a large but submarginal uranium resource. Therefore, based on the sample data, no potential for a uranium deposit is indicated in either of the areas.

Thorium content of the rock samples ranges from 4.31 to 30.29 ppm (quartzite from metasedimentary rock). Eleven samples contain less than 20 ppm thorium and are equivalent to crustal abundance (6-13 ppm, Staatz and Olson, 1973, p. 471). The fine stream-sediment samples range in thorium from 7.81 to 18.76 ppm and seem to reflect the concentration of thorium in the rock. These amounts of thorium are small in comparison with the average grade of 56 ppm of the Conway Granite, New Hampshire (Adams and others, 1962, p. 1902), a submarginal thorium resource. No potential for a thorium deposit in either of the areas is indicated by these sample data.

Other commodities

Monazite

Monazite, a possible source of thorium and the rare earths, cerium, lanthanum, and yttrium, is present in all pan concentrates. All but one of the samples have 35 percent or less (by volume) monazite, which could have been derived from the low concentrations of monazite ordinarily disseminated in the igneous and metamorphic rock. The high concentration of monazite (70 percent) in the pan concentrate from Dry Gulch may be a result of mining upstream from the sample site and the monazite could be related to mineralization in that area. The bedrock source of the monazite has not been identified. The latite dikes, certain quartz veins, the mylonite, or the Pelona Schist could be the monazite host. However, the monazite is likely to occur in small deposits if it is associated with scattered dikes and quartz veins, or may well be disseminated in low concentrations if it is associated with the mylonite and Pelona Schist. It is unlikely that small or low-grade deposits of monazite, as are inferred for the Dry Gulch area, would be economically competitive with the larger and richer monazite sources outside the study areas (Staatz and Olson, 1973).

Graphite

Small bodies of graphite schist occur in the migmatite near the southwest corner of the Cucamonga Wilderness. Although locally the graphite comprises as much as 35 percent of the schist, the graphite schist comprises less than 1 percent of the metasedimentary rock unit. Much larger deposits occur in the migmatite immediately west of the wilderness boundary and in the Placerita Formation in the San Fernando quadrangle, 30 miles (48 km) west of the Cucamonga Wilderness, where the graphite has been mined (Oakeshott, 1958, p. 112). There appears to be no potential for graphite in the study area.

Stone

Deposits of high quality ornamental stone were not found in the study area. Most of the rocks are thoroughly fractured and faulted and, thus, unsuitable for building stone. Parts of the Pelona Schist could be used for flagstone, but flagstone can be obtained from the schist outside the wilderness areas. Vein quartz for possible use as a source of silica or for decorative rock, occurs in small scattered veins of no economic importance. Lenses of fractured, highly impure calcite and dolomitic marble occur in the migmatite of southern Cucamonga Wilderness. The small quantity of the marble, its fractured and impure character, and its location in extremely rugged terrain eliminate the marble from consideration for use in construction or industry.

Sand and gravel

Deposits of sand and gravel occur in all the major canyons (in the study areas). However, much larger and more accessible deposits occur farther down the San Gabriel River and outside both of the areas.

Fossil fuels

No fossil fuels were found in either of the areas. Ordinarily, fossil fuels do not occur in crystalline terrain such as that which comprises the two areas. However, a small amount of oil was produced from fractured crystalline rocks in and near the San Gabriel fault zone in the Placerita oil field, San Fernando quadrangle (Oakeshott, 1958, p. 121). The oil probably migrated into the crystalline rock from nearby Tertiary strata. Petroliferous Tertiary strata do not occur near the study area; and the Tertiary and Quaternary faults, including the San Gabriel fault in southern Sheep Mountain Wilderness study area, do not have oil seeps. Therefore, there appears to be no oil or other fossil fuel potential in the study area.

Geothermal resources

No hot springs, geysers, or other indications of a concentration of geothermal energy beneath either of the areas were found. Most geothermal areas in the world are associated with Holocene or Pleistocene volcanism, commonly rhyolitic in composition. However, in the areas the youngest rocks are Miocene quartz monzonite. The geology of the area, therefore, also suggests no potential for geothermal resources.

CONCLUSIONS

General

The Sheep Mountain Wilderness study area and the Cucamonga Wilderness area and additions may have a moderate potential for the discovery of lode gold and lode tungsten (scheelite) deposits. Silver, copper, and lead may be produced with gold, but, by themselves do not appear to form significant deposits. Barium and mercury are nearly ubiquitous in small quantities, but no indications of large deposits of these two elements were found. Arsenic and zinc are minor elements in the area. No potential was found for graphite, monazite, and marble. Sand and gravel and flagstone are available in more accessible deposits outside the study area. No ornamental or building stone occurs in the study area. No ornamental or building stone occurs in the study area. No potential for fossil or nuclear fuels, or geothermal resources were indicated.

Gold

Seven lode gold targets occur in the study areas: southwest Mine Gulch area, upper Allison Gulch, upper Coldwater Canyon, eastern Dawson Peak area, Susanna Canyon, Fossil Canyon, Cedar Canyon. The first four are based on the occurrence of detectable gold in fine stream sediment. The last three are based on the occurrence of 1 ppm gold in pan concentrates. All targets may have moderate potential for the discovery of new deposits.

Tungsten

Two tungsten (scheelite) targets occur in the Sheep Mountain Wilderness study area: Upper Cattle Canyon and Devil Gulch. Both targets may have moderate potential for lode deposits.

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Chapter D

Economic appraisal of the Sheep Mountain Wilderness study area, Los Angeles and San Bernardino Counties, California

by

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U.S. Bureau of Mines

ECONOMIC APPRAISAL

Tungsten and gold resources occur in the Sheep Mountain Wilderness study area. These commodities are in fault and shear zones and in placer deposits derived from these zones. The Big Horn mine contains an estimated 1.2 million tons (1.1 million t) of gold-, silver-, copper-, and lead-bearing quartz, and is the only one systematically sampled by owners. The mineralized zone is in the Vincent thrust and is the largest lode in the study area. The Stanley-Miller, Baldora (Widco), Gold Dollar, Allison, and Eagle mines have resources or potential for discovery of resources. These occurrences are associated with intense shearing and, generally, with porphyritic granodiorite intrusives. The gold occurs in pockets or shoots in quartz-cemented and quartz-filled shear zones. Systematic exploration and development have not been conducted on these properties, apparently because of random distribution of the ore shoots in these bodies. It appears that high-grade pockets were mined out following initial discovery, and the mines were essentially abandoned.

Placer gold deposits are too small and too low grade to be minable at current prices. Gold has been found in both recent and older alluvium; the older alluvium, remnants of ancestral streams, contained the metal in relative abundance. Some gold may remain in a few deposits, but the higher grade ones have probably been mined out.

Tungsten-bearing rock is being recovered in Cattle Canyon by handpicking high-grade pieces from talus cones and alluvium. Four scheelite-bearing fracture zones observed near the head of the canyon, and scheelite in talus cones apparently derived from similar occurrences, indicate a potential for discovery of tungsten lode deposits. Approximately 20 million cubic yards (15.3 million m^3) of submarginal placer gravel is in the canyon. It has not been tested at depth.

SETTING

The Sheep Mountain Wilderness study area includes most of the East Fork San Gabriel River and small portions of North Fork Lytle Creek and North Fork San Gabriel River drainages in Los Angeles and San Bernardino Counties (fig.11). Mines, prospects, and mineralized areas within the boundary constitute the Mount Baldy mining district.

Mining activity began in the 1840's (Clark, 1970) and has continued intermittently. By 1874, more than $2 million in gold had been produced from placer deposits along the San Gabriel River (Clark, 1970) and its tributaries. The most productive deposits on East Fork San Gabriel River were along the east-west reach of the river from San Gabriel reservoir to below Heaton Flat. Gold was found in recent stream beds and in remnants of perched ancient channels.

The search for sources of the placer gold, in the late 1800's, led to discovery of the Big Horn mine (A. P. Rogers, unpub. report on the Big Horn mine). This mine was worked principally during the early 1900's. Other mine discoveries followed, notably Allison, Gold Dollar, Baldora (Widco), and the Stanley-Miller. Historic value of ore from these mines totals nearly $150,000 in gold (table 5). By the early 1900's, two placer claims, 15 lode claims,

1. Big Horn mine
2. Jumbo-channel placers
3. Native Son mine
4. Blue Jay No. 1 and 2
5. Next Best placer
6. Stanley-Miller mine
7. Prospect
8. Chicken Finlay placer
9. Horse Shoe Consolidated placer
10. San Gabriel Mining Co.
11. Reconnaissance placer sample
12. Reconnaissance placer sample
13. Allison mine
14. Baldora (Widco) mine
15. Gold Dollar mine
16. Eagle mine
17. Curtis claims
18. Curtis claims
19. Coldwater Canyon prospect
20. Holly (Dot) placer
21. Reconnaissance placer sample
22. Reconnaissance placer sample
23. Queenie
24. Dime Canyon prospect (placer)
25. Glen-Marie placer

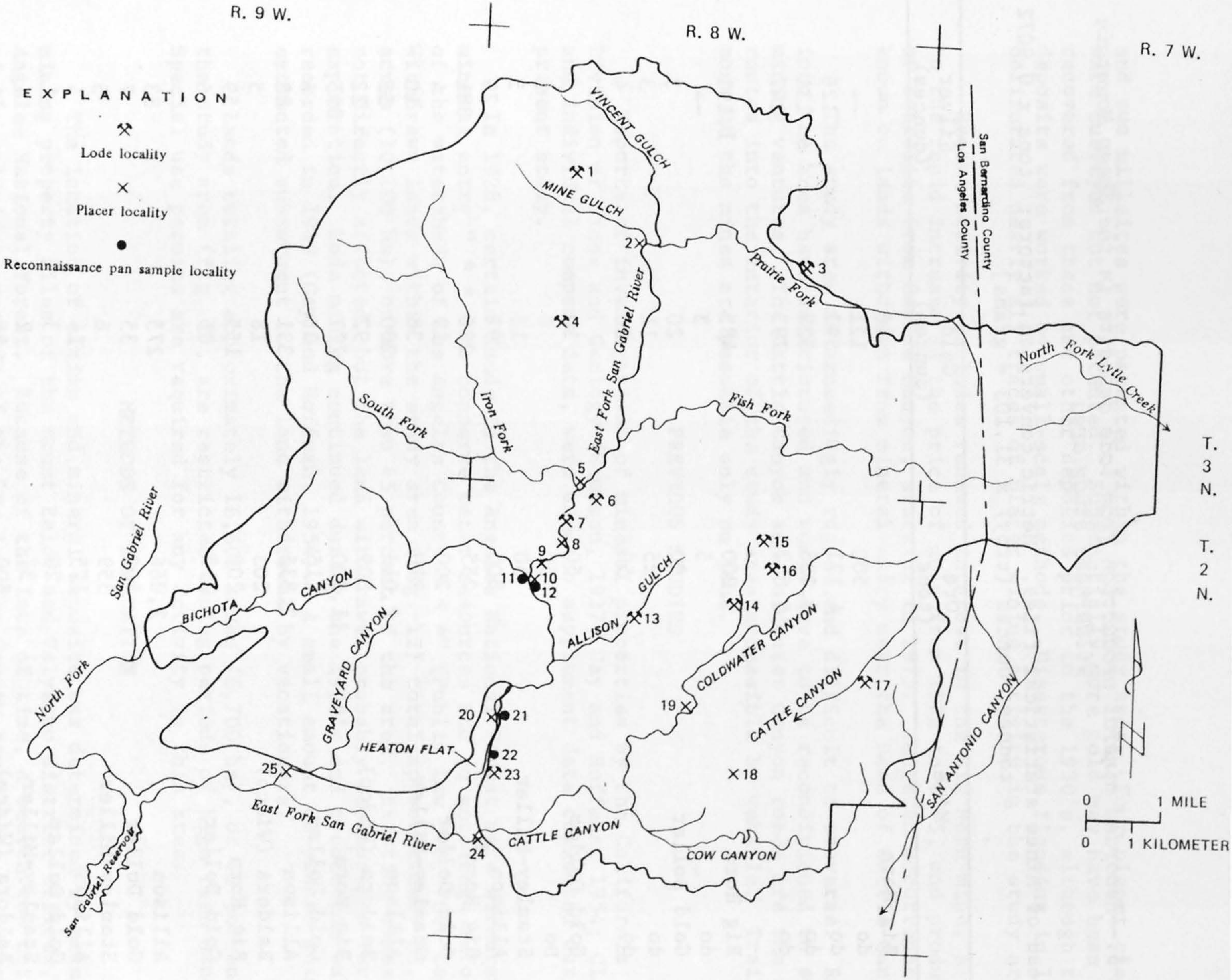

Figure 11.--Mines and prospects in the Sheep Mountain Wilderness study area.

Table 5.--*Recorded mineral production from lode deposits in the Sheep Mountain Wilderness study area*

[Bureau of Mines statistical files. Metric conversion factors: tons x 0.9072 = tonnes; ounces (troy) x 31.103 = grams]

Year	Mine	Ore (tons)	Gold (ounces)	Silver (ounces)
1896	Big Horn	?	16	--
1903	do	500	121	--
1904	do	4,171	597	126
1905	do	5,028	528	131
1906	do	6,692	793	147
1907	Big Horn	3,000	485	1,191
1908	do	5	3	--
1921	Gold Dollar	90	20	3
1923	do	25	11	3
1924	do	50	26	4
1928	Gold Dollar	50	10	2
1933	Do	50	6	1
	Stanley-Miller	50	13	5
1934	Allison	800	97	29
	Big Horn[1]	255	226	381
	Gold Dollar	200	19	4
	Stanley-Miller	210	38	10
1935	Allison	2,013	200	55
	Baldora (Widco)	509	92	22
	Big Horn[1]	11,200	777	395
	Gold Dollar	215	36	6
1936	Allison	2,835	331	88
	Baldora (Widco)	203	18	5
	Big Horn	200	155	59
	Gold Dollar	215	36	6
1937	Allison	2,066	275	83
	Gold Dollar	300	35	7
	Stanley-Miller	359	6	5
1938	Allison	175	14	4
	Gold Dollar	20	3	1
	Stanley-Miller	37	2	1
1939	Baldora (Widco)	500	55	14
1940	Allison	1,480	171	44
	Baldora (Widco)	110	17	5
1941	Allison	684	56	17
1942	do	317	20	7
1943	do	120	2	3
	Totals	44,734	5,310	2,864

[1]Copper production was 707 lb (321 kg) in 1934 and 650 lb (295 kg) in 1935; lead production was 1,296 lb (588 kg) in 1934.

and two millsites were patented within the study area. Four placer claims were surveyed but not patented. Substantially more gold may have been recovered from these and other deposits prior to the 1930's, although the deposits were worked by small-scale methods. Disasterous flooding in 1938 obliterated nearly all traces of placer mining activity in the study area.

Recent activity includes renewed interest in the Big Horn mine, a response to the rapid increase in the price of gold from 1972 to 1975, and production of scheelite from Cattle Canyon, starting in 1975. Tungsten occurrences are known on lands withdrawn from mineral entry near the head of Cattle Canyon.

The study area is exceedingly rugged and difficult to traverse. Roads into the area have deteriorated and would have to be reconditioned to support mining ventures. The Cattle Canyon and Coldwater Canyon roads are the only routes into the interior of the study area accessible by vehicle. Trails to most of the mines are passable only on foot.

PREVIOUS STUDIES

Reports of investigations of mineral properties by the California Division of Mines and Geology (Sampson, 1937; Gay and Hoffman, 1954; Clark, 1970) and individual company data, were used to supplement data collected during the present study.

In 1928, certain lands in the Angeles National Forest were withdrawn from mineral entry " * * * to conserve water resources and to encourage reforestation of the watersheds of Los Angeles County * * *" (Public Law 578, 70th Congress). Withdrawn lands within the study area (fig. 12) total approximately 25,000 acres (10,100 ha), or more than 45 percent of the area. Existing mines were not directly affected, but the land withdrawal probably discouraged further exploration. Lode mining continued during the 1930's and production was last recorded in 1949 (Gay and Hoffman, 1954). A small amount of placer gold was extracted subsequent to the land withdrawal by vacationers.

Lands totaling approximately 16,600 acres (6,700 ha), or 32 percent of the study area (fig. 2), are restricted during periods of high fire danger. Special use permits are required for any activity in this area.

METHODS OF EVALUATION

The location of claims and mineral deposits was determined by examining mining property files of the Mount Baldy and Valyermo district offices, Angeles National Forest. Because of the lack of time, a search was not made of the voluminous records of the Los Angeles County courthouse to determine the location of all claims located within the study area. Owners of mineral properties were contacted and data concerning the history of their property, production records, and unpublished reports were obtained when available.

Attempts were made to find all known mines, prospects, and claims in the field. Lode properties were examined and mapped, and samples were taken from all workings whether mineralized material was apparent or not. Most placer claims were examined by sampling near-surface gravel. Channel samples were taken of some gravel deposits.

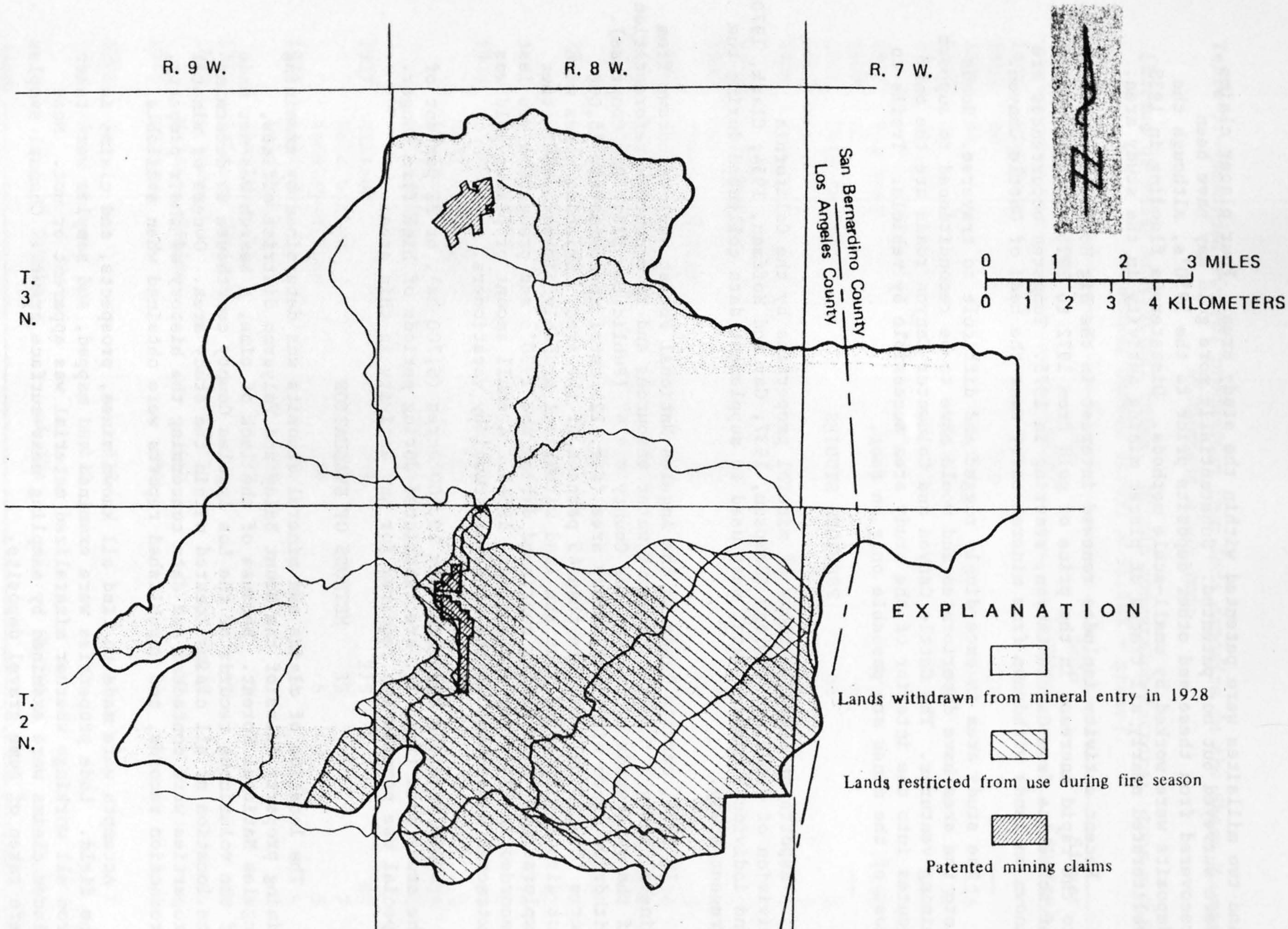

Figure 12.--Restricted lands in the Sheep Mountain Wilderness study area.

A total of 175 lode and 57 placer samples were analyzed. Most lode samples ranged from 5 to 10 lb (2.3 to 4.5 kg) and were taken by chipping across veins, mineralized zones, and altered zones. Selected material was taken from stockpiles or dumps of caved workings when no structure was visible. It is assumed that stockpiled material is the richest available at these sites, and that a prospect may have little potential for development if stockpile assay values are low. All samples were checked for the presence of radioactive and fluorescent minerals, and most were fire assayed to determine gold and silver content. Metallic values of visible minerals were determined by atomic absorption, colorimetric, or X-ray fluorescent methods. At least one sample from each type of mineralized structure or zone at a property was analyzed by semiquantitative spectrographic methods. If anomalous amounts of elements with economic significance were indicated, it was further analyzed by more accurate methods. A selected number of specimens were examined petrographically.

Samples of gravel assumed to contain gold were collected and partially processed in a 14-inch (36 cm) gold pan. Pan concentrates were further processed on a laboratory-sized Wilfley table. Table concentrates were treated with acid and base washes and amalgamated to determine recoverable gold. The residual material was fire assayed for gold content.

Gravel sampled for scheelite content was screened on site to minus one-fourth inch (0.6 cm). The bulk samples constituted one-half cubic foot (0.01 m^3). In the laboratory, these were sieved through Tyler screens ranging in size from minus 12 mesh to plus 200 mesh. Table concentrates from selected fractions were then analyzed for tungsten trioxide (WO_3).

ECONOMIC CONSIDERATIONS

The following are generalizations, intended to familiarize the reader with some of the factors relative to mining. Production costs have a wide range, and may differ by twofold or threefold for different deposits of the same commodity. Relative mining costs are usually highest when the deposit is at great depth and in unstable ground. Where large, thick ore bodies are encountered near the surface, unit mining costs are lowest. The location of the deposit has a significant effect on such costs as access, transportation to market, environmental considerations, and development requirements. For example, transportation charges from a mine to a distant mill or smelter can reduce even a relatively high-grade deposit to an uneconomical status. Metallurgy of the deposit is also a significant factor. The presence of more than one commodity can make the difference between a subeconomic and an economic deposit. The commodities can, in combination (for example, silver with gold; copper and lead with gold, and so forth), increase the total value of a deposit. However, certain elements, such as arsenic and pyrite containing gold, can raise the costs of extractive metallurgy.

The most significant factors affecting the economics of placer mining are size of the deposit (at a given grade) and water requirements. The source, amount, and delivered cost of water will often determine the type of equipment or mining method used. The range of water requirements is large; rockers require only 4-5 gallons per minute (15-19 liters per minute) and bucket-line dredges can require a fresh input of more than 2,000 g.p.m. (7,570 liters per minute) (Wells, 1969).

Mineral commodities

The principal mineral commodities in the Sheep Mountain study area are gold and tungsten. Silver, lead, and copper have been produced as byproducts of gold mining. Data for the following section are from Bureau of Mines Commodity Data Summaries, January 1975, and Engineering and Mining Journal, January 1976.

Gold

The United States produced an estimated 1.03 million troy oz (32 million g) of gold in 1975 while consuming an estimated 4 million troy oz (124.4 million g). Most imports came from Canada and Switzerland. Major uses are for jewelry and arts and in dental work. Gold price averaged $139.50 per oz ($4.49/g) during December 1975. The unrefined metal used in jewelry and as specimens is usually sold for much higher prices. Commercial demand declined in 1975 but is expected to increase at 3.4 percent annually through 1980.

Bureau of Mines research continues on gold extractive technology. Research results suggest that ores containing as little as 0.05 oz per ton (1.71 g/t) can be treated by heap leaching, providing a minimum amount of cyanicides (soluble sulfides, sulfates, and arsenates) are present. Gold production was nearly 99 percent of the total value of all minerals produced from within the study area.

Tungsten

The United States produced an estimated 3,500 tons (3.175 t) of tungsten, approximately 48 percent of the 1975 domestic consumption. The major foreign supplier was Canada. Principal uses of tungsten are in metal working and construction machinery, transportation, and lighting and electrical equipment. The demand is projected to increase 7 percent annually through 1980. The average price per short ton unit (20 lb (9.1 kg)) of contained tungsten trioxide (WO_3) was $77.96 in December 1975.

Silver

Approximately one-fifth of an estimated 156 million oz (4.8 billion g) of silver consumed domestically was produced in the United States in 1975. Major foreign sources are Canada, Mexico, and Peru. Primary uses are silverware, photographic materials, and electrical equipment. The average silver price during December 1975 was $4.08 per oz ($0.13/g). Demand is expected to increase at an annual rate of 2-3 percent through 1980.

Silver has been produced as a byproduct from lode gold mines within the study area. Total production in ounces is more than 50 percent of the gold produced, but accounts for only about 1 percent of the total value.

Copper and lead

Domestic consumption of refined copper was estimated at 1.5 million tons (1.4 million t) in 1975. U.S. mine production was 1.4 million tons (1.3 million t). Imports were mainly from Canada, Peru, and Chile. Major uses include electrical, construction, and industrial machinery. Average price per pound during December 1975 was 64 cents ($1.41/kg), down from a high of 85 cents ($1.87/kg) in 1974. Demand is expected to increase at an annual rate of 3.5 percent through 1980.

An estimated 1.2 million tons (1.1 million t) of lead was consumed by the United States in 1975, compared with domestic mine production of about 625,000 tons (567,000 t). The main consuming industries are transportation, electrical, construction, paints, and ammunition. Canada, Peru, and Australia accounted for most of the imports. Domestic demand for lead is expected to increase through 1980 at an annual rate of 1.7 percent. Average price per pound in December 1975 was 19 cents (42 cents/kg).

Approximately 1,350 lb (612 kg) of copper and 1,300 lb (590 kg) of lead have been produced as byproducts from the Big Horn mine. The presence of copper and lead is not expected to significantly affect the economics of gold mining.

Definitions of reserves and resources

Categories of resources used for this study follow those agreed to by the Bureau of Mines and the U.S. Geological Survey (U.S. Bur. Mines and U.S. Geol. Survey, 1976). Resources are concentrations of naturally occurring materials from which commodities may be extracted, either currently or in the future. Reserves are part of the total resources and refer to mineralized material (ore) which can be mined and marketed under prevailing economic conditions. Measured resources are those computed from sample analyses and measurements from closely spaced sample sites. Indicated resources are computed partly from sample analyses and measurements, and partly from reasonable projections. Inferred resources are estimates based on relatively few sample sites and measurements, and on geologic evidence and projection. Paramarginal resources (a) border on being economic grade, or (b) are not exploitable because of legal or political circumstances. Submarginal resources require more than 1.5 times the current price or a major cost-reducing advance in mining and extractive technology. Undiscovered resources include hypothetical resources in known mining districts, and speculative resources in undiscovered districts.

MINES, PROSPECTS, AND MINERALIZED AREAS

Gold deposits in the area are mainly confined to quartz-filled fractures, faults, and shears, and in placers derived from them. Shear zones at various mines appear to be related to recognizable regional faults such as the Weber fault and the Vincent thrust. Gold appears to be in shoots or pockets rather than being distributed evenly throughout any given zone, and is commonly associated with pyrite and arsenopyrite which rarely exceeds 2 or 3 percent of the mineralized rock.

Tungsten-bearing deposits also occur in shear zones and in placers. In shear zones, scheelite, quartz, and calcite cement the brecciated zones. Scheelite is reported to occur from near Mount Baldy notch, east of the study area, to the East Fork San Gabriel River (R. Curtis, oral commun.), but the Cattle Canyon area contains the mineral in relative abundance. Observed occurrences indicate exploration targets are most favorable near biotite gneiss-quartz diorite contacts, toward the head of the canyon, and in the gravel deposits derived from these rocks.

The following mines, prospects, and mineralized areas are important because of past production and (or) potential for discovery of resources.

Curtis claims

Scheelite (calcium tungstate) was discovered in Cattle Canyon in the 1950's, and the Curtis group of lode and placer claims (fig. 11, nos. 17 and 18) were located. The property has been worked intermittently since its discovery. Small amounts of ore are produced by handpicking high-grade pieces of rock from the canyon floor and from talus cones along the canyon walls. To date, the property has produced more than 2,500 lb (1,134 kg) of scheelite concentrate averaging 38.29 percent tungsten trioxide (WO_3). At the time of our investigation, the Curtis Mining Co. was examining scheelite-bearing fracture zones and conducting mill tests to establish recovery rates.

Massive gneiss with augen horizons, and interfingering schist are the predominant rock types in the area. A quartz diorite mass underlies and has intruded the gneiss near the head of the canyon. Quartz monzonite and andesite dikes, ranging from a few inches (cm) to more than 6 feet (1.8 m) thick, crosscut all rock types. Porphyry dikes and sills, and hornblendite lenses in gneiss are also present.

General strike of the gneiss and schist is N. 36° to 40° W. with a 41° to 43° SW. dip. Several stages of faulting are indicated by slickensides and by displacements of dikes exposed in the canyon walls. Scheelite was deposited in fracture zones, probably as a result of the intrusion of the quartz diorite mass. The fracture zones strike from N. 70° E. to due east, and dip steeply to the north. Average width is usually less than 2 feet (0.6 m), and observed zones were not traceable for more than 39 feet (12 m). Scheelite occurs as veinlets, pods, and fine disseminations in and along fracture planes. Veinlets as much as 1 inch (2.5 cm) thick are common. Locally the scheelite is associated with quartz, calcite, and limonite.

Eleven separate fracture zones were sampled; eight of them were near the headwaters of Cattle Canyon (fig. 13). At one locality, a mineralized fracture zone 39 feet (12 m) in length was observed. Four samples (R-104, R-127, R-128, and R-130, fig. 13) across the zone averaged 0.66 percent tungsten trioxide (WO_3). At least 127 tons (115 t) of mineralized rock is estimated to be present. This zone and others observed are not uniformly mineralized, but high-grade scheelite can be obtained by hand cobbing.

High-grade tungsten-bearing rock fragments were observed in alluvium on the canyon floor and in talus cones. At one locality (below sample R-104, fig. 13), about 800 lb (360 kg) of minus one-fourth inch (0.6 cm) material from a talus cone averaged about 3 percent WO_3 before milling and 6 to 6½ percent after concentrating (R. Curtis, oral commun.). A separate talus locality was observed from which scheelite-bearing rock could be handpicked to yield a grade higher than 30 percent tungsten trioxide. The talus cones are usually no more than 150 to 200 feet (46 to 61 m) from apex to toe.

The tungsten placer deposits consisting of scheelite-bearing alluvium extend about 3 miles (4.8 km) through an elevation change of more than 2,600 feet (790 m) (fig. 13). The upper 5,000 feet (1,500 m) averages about 275 feet (84 m) in width and may be as shallow as 46 feet (14 m). The lower 10,000

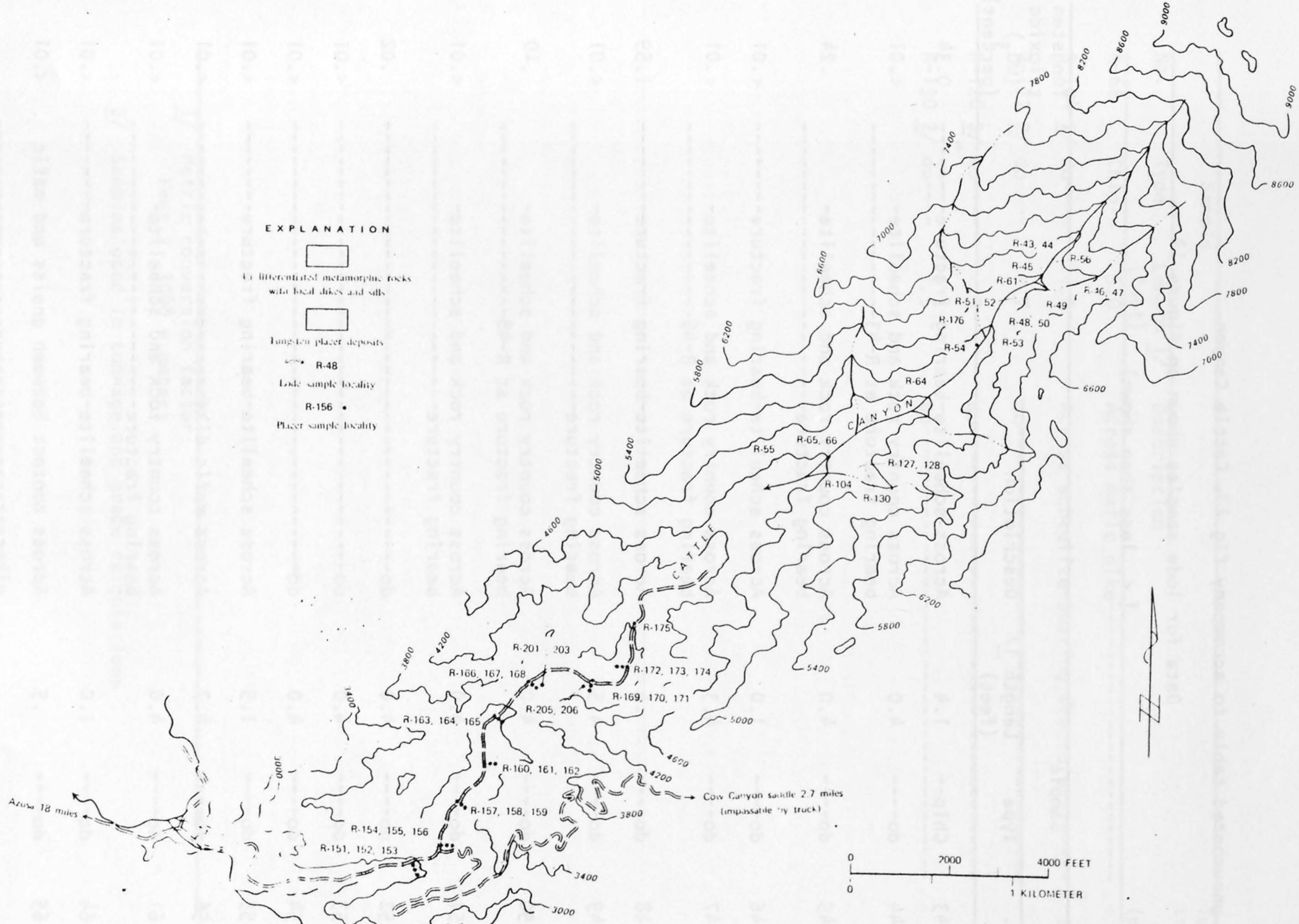

Figure 13.--Sample localities in Cattle Canyon.

An unnumbered table to accompany fig. 13, Cattle Canyon

Data for lode samples shown on figure 13

[<, less than shown]

Sample No.	Type	Length 1/ (feet)	Description	Tungsten trioxide (WO_3) (percent)
R-43	Chip--	1.4	Across scheelite-bearing fracture-------	0.34
R-44	do----	4.0	Across country rock and scheelite-bearing fracture at R-43----------------	<.01
R-45	do----	4.0	Across country rock and scheelite-bearing fracture-----------------------	.24
R-46	do----	1.0	Across scheelite-bearing fracture--------	<.01
R-47	do----	4.3	Across country rock and scheelite-bearing fracture at R-46----------------	<.01
R-48	do----	.6	Across scheelite-bearing fracture-------	1.59
R-49	do----	4.5	Across country rock and scheelite-bearing fracture-----------------------	<.01
R-50	do----	4.0	Across country rock and scheelite-bearing fracture at R-48----------------	.10
R-51	do----	4.0	Across country rock and scheelite-bearing fracture-----------------------	<.01
R-52	do----	4.0	do---------------------------------------	.02
R-53	do----	4.0	do---------------------------------------	<.01
R-54	do----	4.0	do---------------------------------------	<.01
R-55	do----	1.5	Across scheelite-bearing fracture-------	<.01
R-56	do----	4.7	Across mafic dike------------------------	<.01
R-61	do----	4.0	Across country rock and scheelite-bearing fracture-----------------------	<.01
R-64	do----	1.0	Across scheelite-bearing fracture--------	<.01
R-65	do----	.5	Across contact between gneiss and mafic dike---------------------------------------	<.01

Sample No.	Type	Length 1/ (feet)	Description	Tungsten trioxide (WO_3) (percent)
R-66	Chip--	5.0	Across mafic dike------------------------	< .01
R-104 2/	do----	4.0	Across scheelite-bearing fracture--------	1.28
R-127 2/	do----	1.7	do---------------------------------------	.10
R-128 2/	do----	.9	do---------------------------------------	.05
R-130 2/	do----	1.5	do---------------------------------------	< .01

1/ Metric conversion factor:
Feet x .3048 = meters

2/ Samples used in tonnage and grade calculations

An unnumbered table to accompany fig.13, sample localities in Cattle Canyon

Data for placer samples shown on figure 13

ANALYSES BY SIZE FRACTIONS

No.	Samples Volume (ft^3) 1/	+12 mesh 2/ WO_3 (percent)	+12 mesh 2/ Percent of sample (wt.)	-12 to +40 mesh WO_3 (percent)	-12 to +40 mesh Percent of sample (wt.)	-40 to +100 mesh WO_3 (percent)	-40 to +100 mesh Percent of sample (wt.)	-100 to +200 mesh WO_3 (percent)	-100 to +200 mesh Percent of sample (wt.)	- 200 mesh WO_3 (percent)	- 200 mesh Percent of sample (wt.)
Surface alluvium											
R-151	0.5	<0.01	46.8	<0.01	22.5	<0.01	23.9	0.01	4.1	0.03	2.7
R-152	.5	< .01	50.8	< .01	24.7	< .01	20.0	.03	2.6	.04	1.9
R-153	.5	< .01	35.5	< .01	30.0	< .01	29.3	.03	4.2	.04	1.0
R-154	.5	< .01	56.6	< .01	26.2	< .01	15.3	.02	1.2	.03	.7
R-155	.5	< .01	27.7	< .01	38.9	< .01	28.6	.02	2.9	.06	1.9
R-156	.5	< .01	45.3	< .01	37.5	< .01	15.9	.07	.8	.03	.5
R-157	.5	< .01	58.6	< .01	28.8	< .01	10.9	.04	1.0	.01	.7
R-158	.5	< .01	45.9	< .01	29.7	< .01	18.7	.02	3.8	.03	1.9
R-159	.5	< .01	40.5	< .01	38.9	< .01	17.4	.04	1.8	.03	1.4
R-160	.5	< .01	45.5	< .01	34.4	< .01	15.2	.01	3.0	.01	1.9
R-161	.5	< .01	44.3	< .01	39.2	< .01	12.3	.02	3.5	.02	.7
R-162	.5	< .01	45.3	< .01	36.3	< .01	13.1	.01	2.6	.03	2.7
R-163	.5	< .01	53.5	< .01	33.0	< .01	10.6	.04	1.9	.03	1.0
R-164	.5	< .01	41.1	< .01	41.6	< .01	13.0	.01	2.8	.02	1.5
R-165	.5	< .01	33.3	< .01	37.9	< .01	22.9	.02	2.5	.02	3.4
R-166	.5	< .01	32.2	< .01	40.6	< .01	21.6	.04	2.1	.04	3.5
R-167	.5	< .01	44.0	< .01	38.6	< .01	14.5	.02	2.0	.05	.9
R-168	.5	< .01	42.4	< .01	41.5	< .01	12.6	.04	2.0	.03	1.5
R-169	.5	< .01	24.0	< .01	39.0	< .01	28.1	.03	5.8	.18	3.1
R-170	.5	< .01	44.8	< .01	35.2	< .01	14.1	.05	4.2	.05	1.7
R-171	.5	< .01	29.3	< .01	35.7	< .01	25.7	.02	5.9	.06	3.4
R-172	.5	< .01	27.1	< .01	43.7	< .01	20.7	.02	5.6	.09	2.9
R-173	.5	< .01	30.6	< .01	33.8	< .01	26.7	.06	6.4	.10	2.5
R-174	.5	< .01	33.6	< .01	47.8	< .01	12.8	.05	3.5	.08	2.3
R-175	.5	< .01	47.2	< .01	37.0	< .01	12.5	.06	2.0	.10	1.3
		-1/4 inch 1/									
Subsurface alluvium											
R-176	.5	.07									
R-201	1.5	results missing									
R-202	1.8	.05									
R-203	2.0	.04									
R-205	1.5	.04									
R-206	2.0	.06									

1/ Metric conversion factors:
$ft^3 \times 0.0283 = m^3$
inches x 2.54 = cm
pounds x 0.4536 = kg

2/ Mesh sizes:
12 mesh = 0.0661 inch = 1.68 mm
40 mesh = 0.0165 inch = 0.420 mm
100 mesh = 0.0059 inch = 0.149 mm
200 mesh = 0.0029 inch = 0.074 mm

feet (3,050 m) averages more than 500 feet (150 m) in width and may be at least 100 feet (30 m) deep. The average stream gradient is 1,200 feet per mile (227 m/km). Average thickness was estimated by constructing cross sections of the canyon at four locations and projecting the canyon slopes to a point below the surface.

The alluvium consists of subrounded boulders, cobbles, and sand, and is proportionately representative of the rock types found in the canyon area. Six-foot (1.8-m) diameter boulders are common in the upper part of the deposit, and in places comprise up to 50 percent of the volume. The lower part contains as much as 15 percent boulders. The minus 6-inch (15-cm) fraction ranges from 40 to 60 percent by volume. The minus 1 inch (2.5 cm) fraction is variable, ranging from 25 to 50 percent, but is noticeably less where the canyon narrows. The minus one-fourth inch (0.6 cm) is estimated to comprise from 10 to 15 percent of the deposit. The gravel is loosely compacted and has little or no clay.

The gravel was deposited in roughly stratified sheets or layers by spring runoff and freshets. Lack of continual reworking of alluvium by the stream flow has resulted in less chemical-mechanical disintegration of scheelite particles than if subjected to continual reworking.

Twenty-five surface samples and six vertical channel samples (subsurface) were collected from the alluvium in Cattle Canyon. At most samples sites, a 1½ cubic foot (0.03 m^3) loose volume yielded one-half cubic foot (0.01 m^3) of minus one-fourth inch (0.6 cm) material. The surface samples were screened into five fractions and weighed. The rough concentrates were further processed in a lab and assayed for tungsten trioxide (WO_3) (fig. 13). Each was assayed for tungsten to determine concentration by particle size. The minus 100-plus 200 and minus 200 mesh sands contained the highest concentrates. Most of the other fractions contained traces of scheelite, but assays were not sensitive enough to determine precise WO_3 values (fig. 13).

Sample radioactivity was not above anticipated levels typical of alluvium. Two surface samples contained traces of free gold. Heavy detrital black sands, mostly magnetite and ilmenite, average 21.6 lb per cubic yard (12.8 kg/m^3).

The deposit is estimated to contain 20 million cubic yards (15.3 million m^3) of alluvium. Only the minus one-fourth inch (0.6 cm) fraction, comprising an estimated 10 percent volume of the alluvium, has been sampled. Average grade for this size is 69 grams scheelite per cubic yard (85 g/m^3). Scheelite particles ranging in size from about one-fourth inch (0.6 cm) diameter to vein masses over 3 inches (8 cm) in diameter were observed in the plus one-fourth inch (0.6 cm) material. An estimated grade for the entire deposit is 6.9 grams per cubic yard (8.5 g/m^3), based on the minus one-fourth inch (0.6 cm) fraction. The figure is conservative because it excludes undetermined values present in the remaining 90 percent, by volume, of the placer.

A mining operation would process scheelite-bearing talus cones in conjunction with the alluvium. In addition, a mining operation could easily separate and stockpile black sands during recovery of scheelite.

The deposit, as tested, is a submarginal resource. Statistically valid sampling of the plus one-fourth inch (0.6 cm) fraction would require bulk sampling beyond the scope of this study. Scheelite was observed in relative abundance in lode occurrences and in gravel on the canyon floor, indicating a possible higher grade of tungsten trioxide at depth in the placers.

Big Horn mine

The Big Horn mine (fig. 1, no. 1) has been the major mineral producer in the study area. Bureau of Mines production records indicate approximately 31,000 tons (28,123 t) of ore were extracted from it which contained 3,701 oz (115,112 g) of gold, 2,430 oz (75,580 g) of silver, 1,357 lb (616 kg) copper, and 1,296 lb (588 kg) lead (see table 1).

The workings were inaccessible at the time of this investigation. The following descriptions and resource estimates are based on previous examination reports furnished by Siskon Corporation. The Big Horn vein was discovered in 1891, and underground exploration initiated in 1893. The property was idle during the late 1890's, but exploration was renewed in 1901, when the property was purchased by the Lowell and California Mining Co. Encouraged by early exploration results, the company located additional claims. The claim group consists of 15 patented lodes and two patented millsites. Development work continued between 1914 and 1917, and ore was probably stockpiled and treated during a brief period in the 1930's. The property was acquired by principals of Siskon Corporation, Reno, Nev., in 1939; it has been idle since 1936. Siskon Corporation has applied to the U.S. Forest Service for a permit to upgrade the access road, the purpose of which is to transport equipment to the mine in order to reevaluate its worth.

Country rocks are a gray, medium-textured, muscovite schist containing layers of chlorite schist and carbonaceous schist, overlain by mylonite. A feldspar porphyry sill intrudes the schist below the Vincent thrust. The foliation strikes approximately N. 60° E. and dips between 20° and 40° NW. The deposit occurs mainly on the footwall of the mineralized zone in the soft carbonaceous schist, which is fractured over a thickness ranging from 20 to 60 feet (6.1 to 18.3 m), and cemented with a mixture of country rock fragments, quartz, and calcite. The mineralized zone is well marked on both walls by 2-6 inches (5.1-15.2 cm) of gouge, and generally dips from 17° to 20° northwesterly, but steepens to 30° near the head of Mine Gulch.

Gold occurs in two shoots along the hanging wall and footwall of the zone, but the middle part of the zone is more or less barren. Metallurgical tests indicate about 65 percent of the gold is in a free state and the remaining 35 percent is associated with pyrite and arsenopyrite. Total sulfide mineral content of the zone is about 2 percent. Copper, lead, and silver-bearing minerals are present. The higher grade shoot, along the hanging wall of the zone, averages 30 feet (9 m) thick, but is variable in thickness and tenor. The average grade of ore ranges from 0.12 to 0.20 oz per ton (4.1 to 6.9 g/t).

A total exceeding 6,100 feet (1,860 m) of crosscuts, drifts, raises, and stopes have been excavated in ten adits (fig. 14). Several small cuts and additional short adits are on the property. Milling equipment consisted of a 50-ton (45-t) ore bin, jaw crusher, rod mill, classifier, flotation cells, and a Wilfrey table. Most of the equipment has been removed or destroyed.

Ore was produced mainly from the No. 6 adit, adjacent to the millsite, and from stopes in the No. 9 adit. The developed ore is mostly in the oxidized zone. Primary sulfides were encountered at the face of the Fenner adit (6600 level) indicating the probable zone of secondary enrichment is downdip of the 6900 level where the major stoping was accomplished. At least 400,000 tons (360,000 t) of indicated resources is estimated from company data, compiled in 1918, above the 6900 level in the Nos. 6 and 9 adits. These resources are based on a strike length of 270 feet (82 m), a dip length of 600 feet (183 m), and a thickness of 30 feet (9 m). An additional 340,000 tons (308,000 t) of resources are inferred between the Nos. 4 and 5 adits, based on a strike length of 630 feet (192 m), a dip length of 215 feet (66 m), and a thickness of 30 feet (9 m). These resources are in the oxidized zone, above the zone of secondary enrichment, and do not include near-surface material. Below the 6900 level between the Fenner adit and adit No. 6 are an additional 460,000 tons (417,000 t) of inferred resources based on a length of 770 feet (235 m), a depth of 240 feet (73 m), and a thickness of 30 feet (9 m). All calculations were made using a tonnage factor of 12 cubic feet per ton (0.37 m^3/t).

Based on data from the owners, total resources are estimated at 1.2 million tons (1.1 million t) containing a weighted average of 0.15 oz gold per ton (5.2 g/t). The Big Horn mine gold resources are considered submarginal (requiring more than 1.5 times a price of $139.50 per oz).

Allison mine

The Allison mine (fig. 11, no. 13) accounted for 22 percent of total gold production reported from the study area. The Bureau of Mines statistical files indicate 1.166 oz (36,266 g) of gold and 330 oz (10,264 g) of silver were extracted from 10,489 tons (9.516 t) of mineralized rock.

The property is developed by several levels with numerous stopes and interconnecting raises (fig. 15). Over 1,100 feet (335 m) of workings are accessible. Crushed ore was stored in a bin located near the main workings and transported by pipe a short distance downslope to a mill. The millsite contains remnants of a ball mill, rake classifier, and a shaking table.

The country rock is a thinly laminated mylonite that strikes N. 65°-77° W. and dips 20°-28° NE. Porphyritic granodiorite are also present in the vicinity of the workings.

The gold-bearing zones consist of intensely sheared schist. The shear zones are discontinuous and range from 0.7 to 3.0 feet (0.2 to 0.9 m) in thickness. Some shear boundaries are not well defined and are composed of crumbly limonite-stained mylonite. Other shears are well defined and contain green, siliceous mylonite, often accompanied by quartz veins containing as much as 2 percent disseminated pyrite.

The shear zone in the stope level has an indicated resource of 800 tons (725 t) averaging 0.26 oz gold per ton (8.9 g/t) through a 3.0-foot (1.0-m) average width, a length of 80 feet (24 m), and a depth of 40 feet (12 m). Two samples of other structures contained significant gold-silver values, indicating a potential for undiscovered resources.

Stanley-Miller mine

The Stanley-Miller mine (fig. 11, no. 6) produced 59 oz (1,835 g) gold and 21 oz (653 g) silver between 1933 and 1938. The surface plant consisted of

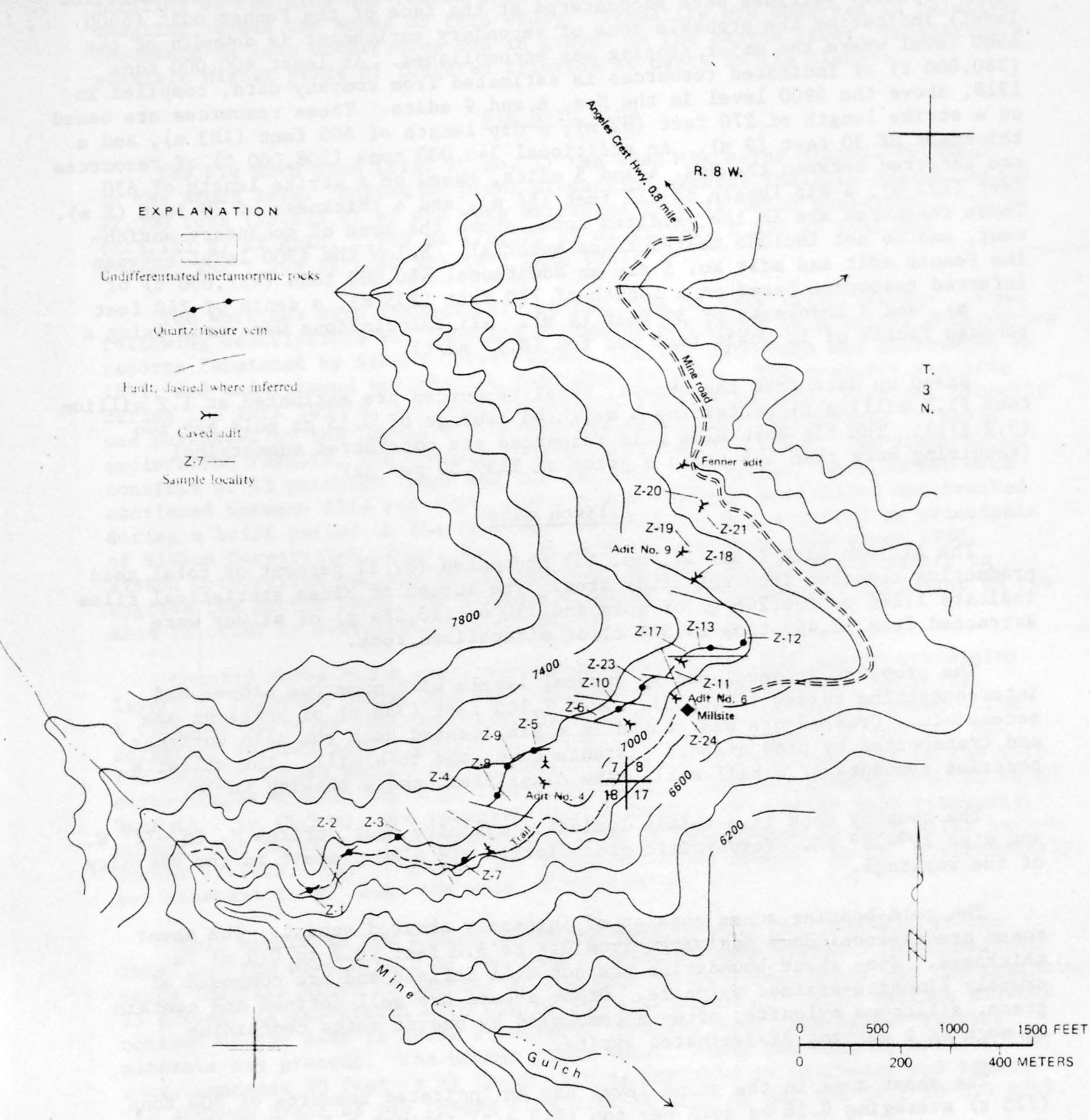

Figure 14.--Big Horn patented claim group (surface workings).

An unnumbered table to accompany fig. 14, Big Horn mine

Data for samples shown on figure 14.

[Tr, trace; N, none detected]

Sample				Gold (ounce 1/ per ton)	Silver (ounce 1/ per ton)
No.	Type	Length 1/ (feet)	Description		
Z-1	Chip--	11.0	Across quartz fissure vein------------	N	N
Z-2	do----	20.0	do------------------------------------	N	N
Z-3	do----	12.0	do------------------------------------	N	N
Z-4	do----	8.0	Across quartz fissure vein and altered rock------------------------------------	N	N
Z-5	do----	15.0	Across quartz fissure vein------------	N	N
Z-6	do----	22.0	do------------------------------------	N	Tr
Z-7	do----	12.0	do------------------------------------	N	N
Z-8	do----	16.0	do------------------------------------	N	N
Z-9	do----	12.0	do------------------------------------	N	N
Z-10	do----	10.0	do------------------------------------	N	N
Z-11	do----	14.0	do------------------------------------	N	0.1
Z-12	Grab--	--	Quartz float--------------------------	0.14	.1
Z-13	Chip--	8.0	Across quartz fissure vein------------	N	.1
Z-17	Grab--	--	Altered rock near dike----------------	.03	N
Z-18	do----	--	Quartz on dump------------------------	.09	.1
Z-19	Chip--	3.0	Across altered augen schist-----------	Tr	N
Z-20	do----	2.8	Across siliceous dike-----------------	Tr	.1
Z-21	do----	4.0	do------------------------------------	.1	.1
Z-23	do----	10.0	Across quartz fissure vein------------	Tr	N
Z-24	Grab--	--	Quartz from ore bin at stamp mill-----	.01	N

1/ Metric conversion factors:
Feet x 0.3048 = meters
Ounces (troy) per ton x 34.285 = grams per tonne

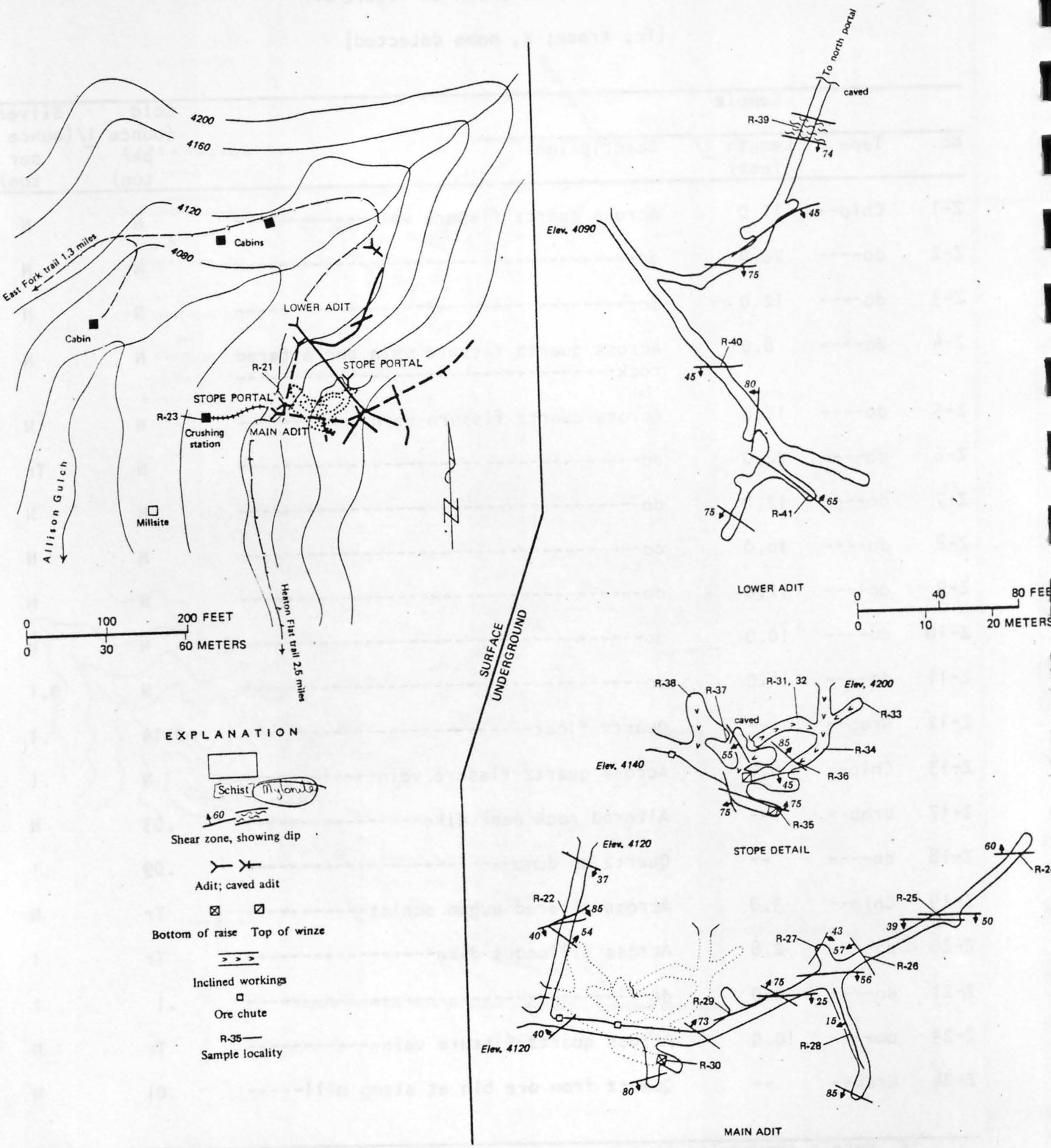

Figure 15.-- Allison mine (surface and underground workings).

An unnumbered table to accompany fig. 15, Allison mine

Data for samples shown on figure 15.

[Tr, trace; N, none detected]

Sample				Gold (ounce 1/ per ton)	Silver (ounce per ton)
No.	Type	Length 1/ (feet)	Description		
R-21	Chip--	11.0	Across limonite-stained breccia zone striking N. 65° E. and dipping 38° SE.	N	N
R-22	do----	1.7	Across limonite-stained shear zone------	Tr	N
R-23	Grab--	--	Crushed rock from ore bin---------------	Tr	0.3
R-24	Chip--	.7	Across gouge-filled shear zone----------	Tr	.2
R-25	do----	5.0	Across fractured, silicified, green mylonite bounded by 6-inch (15-cm)-thick shears------------------------------------	Tr	N
R-26	do----	3.0	Across green mylonite wallrock and small shear zone-----------------------------	Tr	.1
R-27	do----	3.0	do--------------------------------------	Tr	.2
R-28	do----	3.0	do--------------------------------------	Tr	N
R-29	do----	5.0	do--------------------------------------	Tr	.1
R-30 2/	do----	3.0	Across highly-fractured mylonite wallrock in raise----------------------------------	0.15	.4
R-31	do----	5.0	Across green mylonite wallrock with one-half inch (1 cm) thick gouge-filled shears	Tr	.1
R-32	do----	.9	Across green, highly-fractured micaceous mylonite --------------------------	N	N
R-33	do----	1.9	Across highly-fractured siliceous mylonite	.14	N
R-34	do----	3.1	Across quartz-cemented mylonite with about 1 percent medium- to fine-grained, disseminated pyrite-------------------	N	N
R-35 2/	do----	2.9	Across fractured, siliceous mylonite ---	Tr	.3
R-36	do----	3.0	Across prominent shear zone-----------	N	Tr
R-37 2/	do----	3.4	Across highly-fractured, siliceous mylonite	.18	N
R-38 2/	do----	3.0	do-------------------------------------	.69	N

Sample				Gold (ounce 1/ per ton)	Silver (ounce per ton)
No.	Type	Length 1/ (feet)	Description		
R-39	Chip--	12.0	Across limonite-stained zone of brecciated mylonite and gouge ------	N	N
R-40	do----	1.5	Across shear zone of brecciated mylonite	N	0.2
R-41	do----	1.7	do---------------------------------	0.07	N

1/ Metric conversion factors:
Feet x 0.3048 = meters
Ounces (troy) per ton x 34.285 = grams per tonne

2/ Samples used in resource calculations

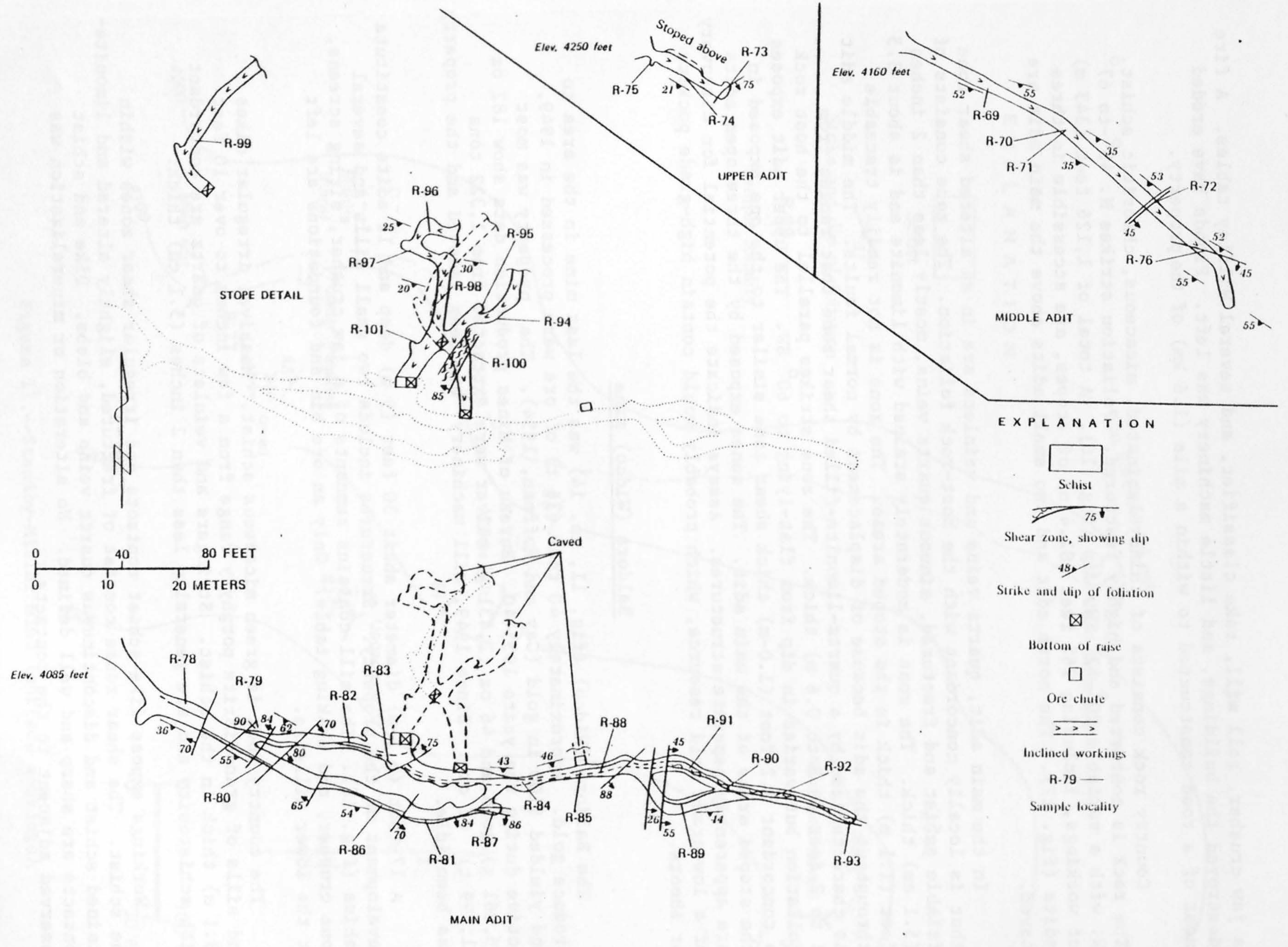

Figure 16.--Stanley-Miller mine (underground workings).

a jaw crusher, ball mill, rake classifier, and several Wilfley tables. A fire destroyed the buildings, and little machinery was left. Floods have eroded most of a road constructed to within a mile (1.6 km) of the property.

Country rock consists of thinly laminated, micaceous, chloritic schist. The rock is contorted and highly fractured. Foliation strikes N. 45°-to 67° W. with a variable 20°-62° SW. dip (fig. 16). A total of 1,126 feet (343 m) of workings, including 267 feet (81.4 m) of stopes, are accessible in three adits (fig. 17). The north adit and two small adits above the main adit are caved.

In the main adit, quartz veins and veinlets are in an altered shear zone that is locally concordant with the host-rock foliation. The zone consists of friable schist and fractured, sinuous quartz veins, mostly less than 2 inches (5.1 cm) thick. The zone is moderately stained with limonite and is about 3.5 feet (1.1 m) thick in the stoped areas. The zone is not readily traceable throughout the adit because of displacement by normal faults. The middle adit is characterized by a quartz-limonite-filled shear zone that ranges from 1 to 2 feet (0.3 to 0.6 m) thick. The zone strikes parallel to the host rock foliation but varies in dip from flat-lying to 60° SW. The upper adit exposes a concordant 3.2-foot (1.0-m) thick shear zone similar to the one exposed in the stoped areas of the main adit. The zones exposed by the three open adits are apparently separate structures. Assays indicate the potential for discovery of a low-grade gold resource, which probably would contain high-grade pockets or shoots.

Baldora (Widco) mine

The Baldora (Widco) (fig. 11, no. 14) was the last mine in the area to produce gold. Approximately 40 tons (36 t) of ore were processed in 1949, and yielded $100 in gold (Gay and Hoffman, 1954). The property was most active during the years 1935-40. Bureau of Mines production data show 182 oz (5,661 g) gold and 46 oz (1,431 g) silver were extracted from 1,322 tons (1,199 t) of ore. Since 1949, mill machinery has been removed and the property has been idle.

A 17-foot (5.2-m) diameter shaft 30 feet (9 m) deep and 11 adits constitute development of the property. Structures include two small mills and several cabins (fig. 18). The mill contains remnants of a jaw crusher, sizing screens, cone crusher, and shaking table. Only an ore bin and foundations are left at the lower millsite.

The country rock is green micaceous schist. Massive, irregular dikes and sills of granodiorite porphyry range from a few inches to over 10 feet (3.1 m) thick in the schist. Stringers and veinlets of quartz are concordant with schistosity and are generally less than 2 inches (5.1 cm) thick.

Workings expose dike-schist contacts and irregular shear zones within the schist. The shear zones consist of fractured, slightly altered and limonite-stained schist and discontinuous quartz veins and blebs. Dike and schist contacts are sharp and well defined. No alteration or mineralization was observed adjacent to the contacts.

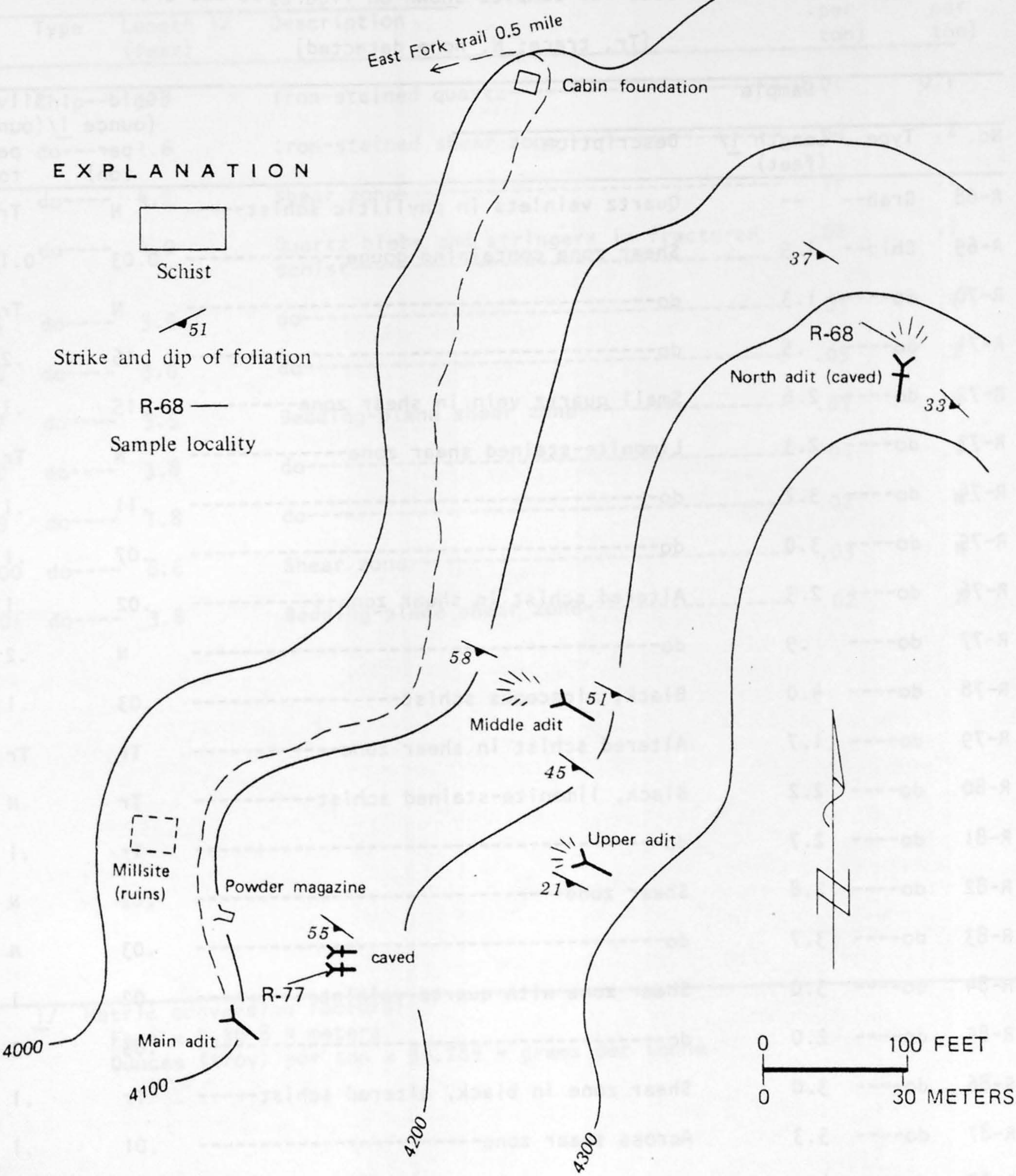

Figure 17.--Stanley-Miller mine (surface workings).

An unnumbered table to accompany figs. 16 and 17, Stanley-Miller mine

Data for samples shown on figures 16 and 17.

[Tr, trace; N, none detected]

Sample				Gold (ounce 1/ per ton)	Silver (ounce per ton)
No.	Type	Length 1/ (feet)	Description		
R-68	Grab--	--	Quartz veinlets in phyllitic schist-----	N	Tr
R-69	Chip--	1.5	Shear zone containing gouge-------------	0.03	0.1
R-70	do----	1.3	do--	N	Tr
R-71	do----	.5	do--	.16	.2
R-72	do----	2.6	Small quartz vein in shear zone---------	.15	.1
R-73	do----	2.3	Limonite-stained shear zone-------------	N	Tr
R-74	do----	3.2	do--	.11	.1
R-75	do----	3.0	do--	.07	.1
R-76	do----	2.3	Altered schist in shear zone------------	.02	.1
R-77	do----	.9	do--	N	.2
R-78	do----	4.0	Black, micaceous schist-----------------	.03	.1
R-79	do----	1.7	Altered schist in shear zone------------	Tr	Tr
R-80	do----	2.2	Black, limonite-stained schist----------	Tr	N
R-81	do----	2.7	do--	Tr	.1
R-82	do----	2.8	Shear zone------------------------------	.02	N
R-83	do----	3.7	do--	.03	N
R-84	do----	3.0	Shear zone with quartz veinlet----------	.02	.1
R-85	do----	2.0	do--	.05	.2
R-86	do----	3.0	Shear zone in black, altered schist-----	Tr	.1
R-87	do----	3.3	Across shear zone-----------------------	.01	.1
R-88	do----	4.0	do--	.01	.1
R-89	do----	1.5	Iron-stained altered schist-------------	.01	.1
R-90	do----	2.5	Altered schist in shear zone------------	.01	N

Sample No.	Type	Length 1/ (feet)	Description	Gold (ounce 1/ per ton)	Silver (ounce per ton)
R-91	Chip--	3.8	Iron-stained quartz----------------------	0.01	0.1
R-92	do----	1.6	Iron-stained shear zone----------------	.04	.2
R-93	do----	4.2	Shear zone------------------------------	Tr	.1
R-94	do----	4.0	Quartz blebs and stringers in fractured schist---------------------------------------	.02	.1
R-95	do----	3.5	do---------------------------------------	.03	.1
R-96	do----	3.0	do---------------------------------------	.03	.2
R-97	do----	3.5	Bedding-plane shear zone----------------	.03	N
R-98	do----	3.8	do---------------------------------------	.04	.1
R-99	do----	1.8	do---------------------------------------	.02	N
R-100	do----	8.6	Shear zone------------------------------	.03	N
R-101	do----	3.8	Bedding-plane shear zone----------------	.02	N

1/ Metric conversion factors:
Feet × 0.3048 = meters
Ounces (troy) per ton × 34.285 = grams per tonne

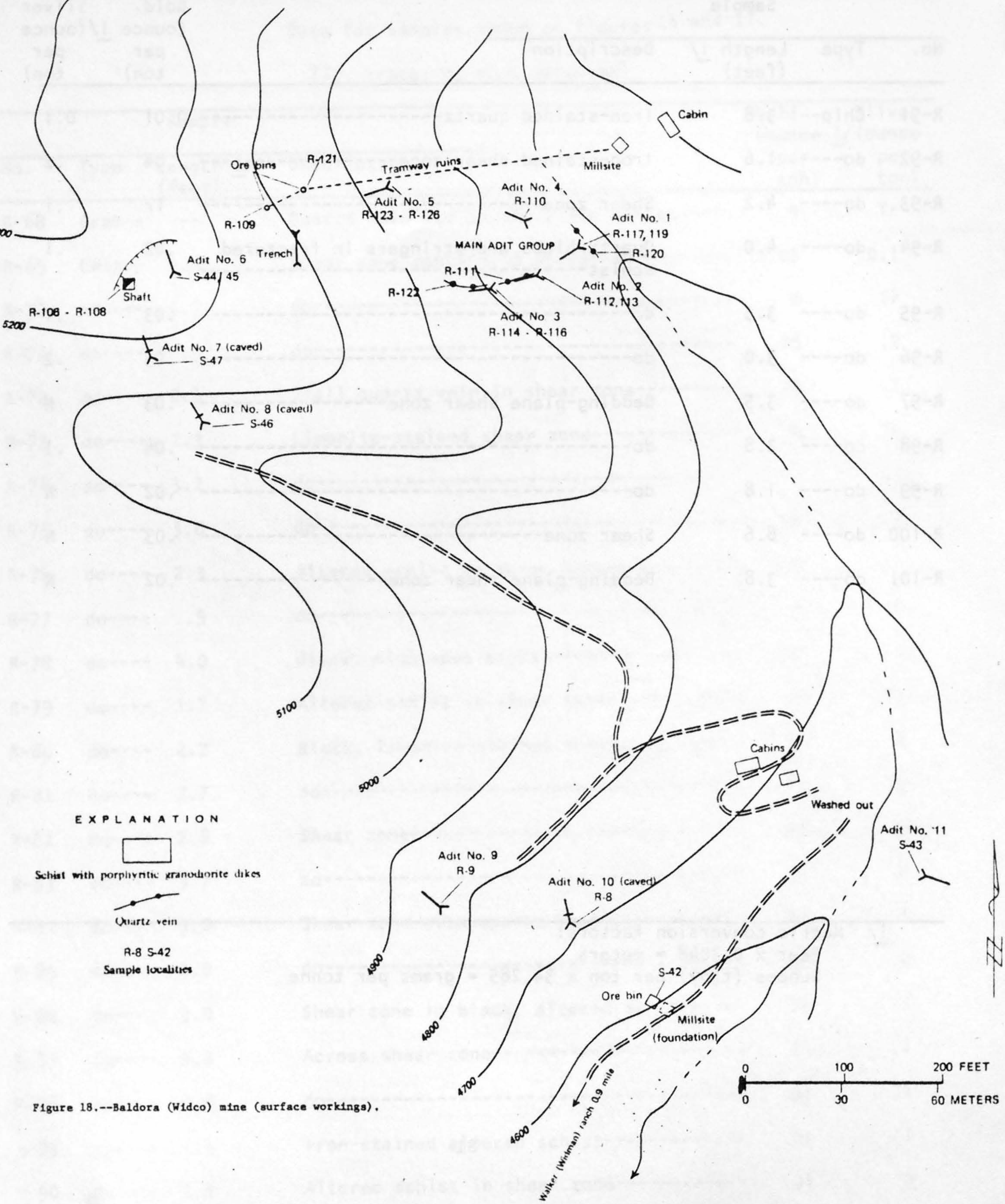

Figure 18.--Baldora (Widco) mine (surface workings).

An unnumbered table to accompany fig. 18, Baldora (Widco) mine

Data for samples shown on figure 18.

[Tr, trace; N, none detected]

Sample No.	Type	Length 1/ (feet)	Description	Gold (ounce per ton) 1/	Silver (ounce per ton)
R-8	Chip--	6.0	Across fracture zone, above caved portal, containing stringers of quartz	Tr	0.2
R-9	do----	4.0	Across schist containing quartz stringers, below contact with porphyritic granodiorite dike-------	N	.2
R-106	do----	9.5	Across quartz stringers striking N. 65° E., dipping 30° to 40° SE. in fractured schist------------------	0.29	Tr
R-107	do----	2.4	Across small quartz veins at collar of shaft on hanging wall above dike-	.10	Tr
R-108	do----	2.4	Kaolinized porphyritic granodiorite at bottom of shaft----------------	N	N
R-109	Grab--	--	Quartz vein material from ore bin---	.02	Tr
R-110	Chip--	2.3	Across small quartz vein in fractured schist, adit No. 4--------	.01	.2
R-111 2/	do----	3.3	Across quartz fissure-filling on surface------------------------------	N	.2
R-112 2/	do----	3.3	Across quartz and schist at face of adit No. 2------------------------	.05	.3
R-113 2/	do----	1.5	Across quartz fissure-filling 30 feet from portal in adit No. 2------	Tr	Tr
R-114	do----	1.0	Across shear zone near face in adit No. 3-----------------------------	Tr	Tr
R-115 2/	do----	2.7	Across quartz fissure-filling 15 feet from portal in adit No. 3------	N	N
R-116 2/	do----	1.9	Across quartz fissure-filling 30 feet from portal in adit No. 3-----------	.65	Tr
R-117	do----	1.0	Across quartz fissure-filling 30 feet from portal in adit No. 1------	Tr	N

Sample				Gold (ounce per ton) 1/	Silver (ounce per ton)
No.	Type	Length 1/ (feet)	Description		
R-119	Chip--	4.0	Across silicified schist (normal to foliation) containing stringers of quartz; near face of adit No. 1-----	Tr	N
R-120	do----	3.6	Across quartz fissure-filling-------	Tr	N
R-121	Grab--	--	Quartz vein material in schist from ore bin------------------------------	0.05	N
R-122 2/	Chip--	3.3	Across quartz fissure-filling-------	.29	N
R-123	do----	1.5	Across quartz fissure-filled shear zone in siliceous schist, 75 feet from portal in adit No. 5-----------	Tr	N
R-124	do----	1.0	Across quartz fissure-filled shear zone in siliceous schist, 105 feet from portal in adit No. 5-----------	Tr	N
R-125	do----	1.8	Across quartz fissure-filled shear zone in siliceous schist, at face of adit No. 5----------------------	Tr	N
R-126	do----	1.2	Across shear zone 160 feet from portal in adit No. 5----------------------	Tr	N
S-42	Grab--	--	Siliceous schist and quartz from ore bin-------------------------------	N	N
S-43	Chip--	1.5	Shear zone in porphyritic granodiorite in adit No. 11-------------------	N	N
S-44	do----	.6	Across quartz vein-----------------	N	N
S-45	do----	4.0	Across schist, normal to foliation, in adit----------------------------	N	N
S-46	Grab--	--	Quartz blebs in schist from dump of adit----------------------------------	N	N
S-47	do----	--	Across porphyritic dike of portal of adit----------------------------	N	N

1/ Metric conversion factors:
Feet x 0.3048 = meters
Ounces (troy) per ton x 34.285 = grams per tonne

2/ Samples used in resource calculation

Nine samples contained measurable gold, four of these from the quartz fissure-filling exposed in adits 2 and 3. This structure contains about 1,125 tons (1,020 t) of inferred resources averaging 0.15 oz gold per ton (5.2 g/t). Resource estimates are based on a strike length of 100 feet (30 m), a depth of 50 feet (15 m), and an average thickness of 2.7 feet (0.8 m). Although the quartz veins are narrow in places, systematic investigation may lead to the discovery of veins containing minable shoot, particularly in the vicinity of the north group of workings.

Eagle mine

More than 450 feet (137 m) of underground workings have been excavated at the Eagle mine (fig. 11, no. 16), which was served by a small mill. An aerial tramway was used to transport ore from the main adit (fig. 19) to the millsite. The miners stayed at a cabin at the foot of the trail in Coldwater Canyon. All structures are in a state of ruin. No production is listed from the property, but some ore was probably mined from a currently inaccessible level above the main adit and milled at the Gold Dollar mine to the west. The Eagle has apparently been idle for many years.

One of the upper adits, 10 feet (3.0 m) in length, was partly open but unsafe to enter. The main and lower adits are in fairly good condition, but the main adit is inaccessible beyond the raise.

Country rock is a chloritic schist, but outcrops are scarce, because a thin regolith mantles the bedrock. The foliation varies in strike from N. 45° W. to north-south, and in dip from 26° to 40° westward. A porphyritic granodiorite dike and sill have intruded the schist several hundred feet west of the upper workings, but were not observed near the main workings.

Gold occurs in a shear zone containing gouge, brecciated country rock, and quartz. The zone has been cemented with quartz and refractured. It strikes N. 30° to 60° E. and dips 80° NW. to vertical, and ranges from 2.1 to 3.5 feet (0.6 to 1.1 m) thick in the main adit, and 1.2 to 2.7 feet (0.4 to 0.8 m) thick in the lower adit. Quartz veins and quartz-filled shear zones contain as much as 0.16 oz gold per ton (5.5. g/t) and 5 percent limonite and hematite. No sulfides were observed, but gold may have been associated with pyrite.

Continuity of the zone between the lower and upper workings is questionable. It has been offset at least twice in the main adit, and appears to have been offset between the lower and main adits. However, about 18,000 tons (16,000 t) of indicated resources are estimated between the main and lower adits and an additional 18,000 tons (16,000 t) is inferred (one-half of the tonnage above and below the adits). These resources are based on a strike length of 500 feet (150 m), a depth of 180 feet (55 m), and a thickness of 2.4 feet (0.7 m), and an average grade of 0.04 oz per ton (1.4 g/t). Gold values are erratic in the zone; assay results, however, indicate a potential for the discovery of high-grade shoots.

Gold Dollar mine

Bureau of Mines statistical records list 1,235 tons (1,120 t) of ore produced at the Gold Dollar mine (fig. 11, no. 15), intermittently from 1921 through 1938. The yield was 202 oz (6,283 g) gold and 37 oz (1,151 g) silver.

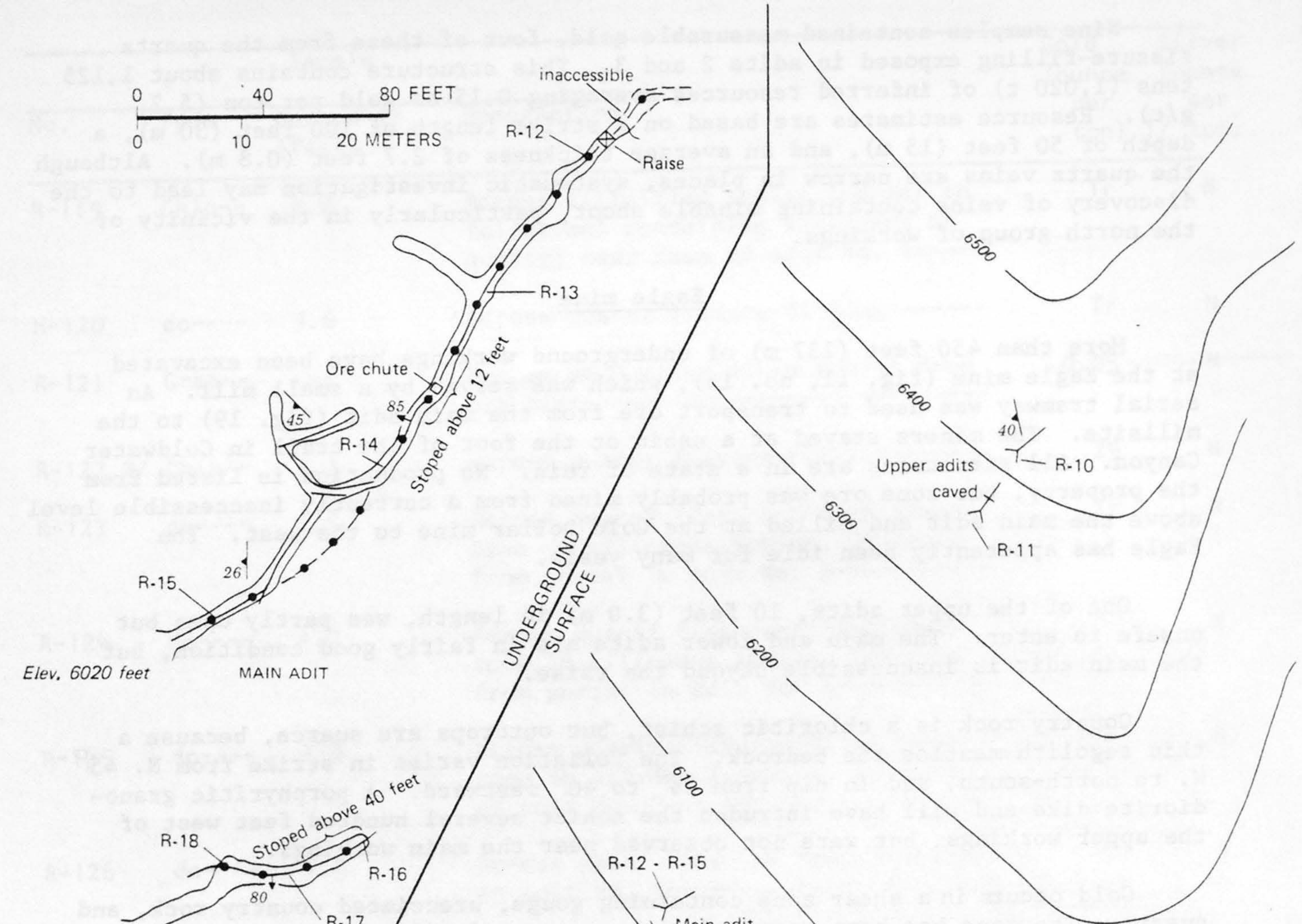

Figure 19.--Eagle mine (surface and underground workings).

An unnumbered table to accompany fig. 19, Eagle mine

Data for samples shown on figure 19.

[Tr, trace; N, none detected]

Sample				Gold (ounce per ton) 1/	Silver (ounce per ton)
No.	Type	Length 1/ (feet)	Description		
R-10	Grab--	--	Lightly limonite-stained quartz from dump---------------	0.01	N
R-11	Chip--	0.9	Across quartz-filled shear zone in a block of schist on adit dump--------	N	N
R-12	do----	2.5	Across quartz-filled shear zone-----	N	N
R-13	do----	3.5	do----------------------------------	Tr	Tr
R-14	do----	3.4	do----------------------------------	Tr	0.1
R-15	do----	1.4	do----------------------------------	.16	.4
R-16	do----	1.8	do----------------------------------	.12	.2
R-17	do----	2.7	do----------------------------------	N	N
R-18	do----	1.2	do----------------------------------	.09	.1

1/ Metric conversion factors:
Feet x 0.3048 = meters
Ounces (troy) per ton x 34.285 = grams per tonne

The ore was treated on site at a mill consisting of a jaw crusher, ball mill, rake classifier, and Wilfley tables. An aerial tramway brought ore 1,000 feet (35 m) from the main adit to the mill. The mill and bunkhouse are in ruins, and the main adit has been blasted shut at the portal. Two other sites of possible adits or surface cuts are badly sloughed. Total length of the workings is not known.

Chloritic schist country rock strikes roughly north-south and dips about 30^{o} or less in a westerly direction. The rock has been intruded by a porphyritic diorite which locally exhibits the characteristics of both a dike and sill. Near the hanging wall side of the intrusive mass are numerous quartz veins, which can be traced by flat and sparse outcrops for about 700 feet (213 m) uphill from the main adit. An outcrop near the adit consists of quartz veins, a maximum of 6 inches (15 cm) thick and bands of chloritic schist. The vein-bearing zone is approximately 10 feet (3.1 m) thick and is exposed for 30 feet (9.1 m) along a north-south strike. The quartz contains light to moderate limonite staining. No other exposures of this magnitude were observed, and it is assumed that ore was mined from this zone in the main adit.

Four samples of quartz contained as much as a trace gold and 0.4 oz silver per ton (13.7 g/t). The values in the vein which was mined were probably localized in pockets or shoots. Geologic conditions indicate a potential for discovery of resources along the schist-diorite contact.

Miscellaneous properties

Several prospects were examined that have little or no economic potential or are not sufficiently exposed to permit evaluation. Some of these prospects were located on placer deposits, but in a few cases, adits were also driven on shear zones in various host rock types. These properties are listed in table 6.

Table 6.--*Miscellaneous properties in the Sheep Mountain study area*

Map No. (fig. 1)	Prospect	Summary	Number and type of workings	Sample data	Remarks
3	Native Son mine 1/	Gold associated with pyrite in quartz stringers in mica schist and gneiss (Gay and Hoffman, 1954, p. 627; Sampson, 1937, p. 188).	Six caved adits ranging in length from 100 to 750 feet.	One grab sample; no gold and 0.2 ounce silver per ton.	Mine produced 54 ounces of gold and 15 ounces of silver from 105 tons of ore during 1905-1907 (BuMines statistical files).
23	Queenie	Shear zones striking N. 47° to 53° E. dipping 75° to 90° SE. near contact between mylonitic gneiss and granodiorite. A dacite porphyry dike was intruded between the granodiorite and the mylonitic gneiss.	Adit, 150 feet long.	Three samples; nil to 0.01 ounce gold and nil to 3.8 ounces silver per ton. Copper values range from 25 to 80 parts per million.	Prospect is in the San Gabriel fault zone.
4	Blue Jay No. 1 and 2	Quartz pods and narrow veins in schist and along contacts with felsite dikes and country rock. Locally-heavy limonite staining near dike-schist contacts. No visible sulfides.	Pit and a short adit, caved at the portal.	Three samples; nil to 0.02 ounce gold and nil to 0.2 ounce silver per ton.	Claims located in 1935.
9	Horse Shoe Consolidated placer	An adit, driven 240 feet through siliceous schist, penetrated older stream gravels covered by landslide deposits. At least 370 cubic yards of gravel was removed from the adit.	Adit.	One placer sample; no recoverable gold. Three hardrock samples; one sample contained 0.1 ounce silver per ton.	Patented placer claim. Current owner reports 2,000 ounces of gold were produced from drifts, now inaccessible. Deeded land totals 60 acres.
10	San Gabriel Mining Co.	Land claimed includes both recent placer and older stream deposits. Floods have obliterated all workings in stream bed gravels, but a few small pits were found in older stream gravels.	Several sloughed pits.	Four of six vertical channel samples contained gold. The highest value came from older gravel and is equivalent to 39 cents per cubic yard.	Patented placer claim. Deeded land totals 160 acres.
20	Holly 1/ (Dot) placer	Two drift mines and a pit explore older stream gravels exposed by an intermittent tributary. Gravel is moderately compacted and well-stratified.	Pit and two drift mines, totaling 125 feet in length.	Three placer samples; one sample contained (.31 mg gold per .5 cu ft) 7.5 cents per yard.	(Gay and Hoffman, 1954, p. 624).
2	Jumbo-Channel placers	Drift mine along bedrock-gravel contact. Pit exposes 8 feet of gravel.	Pit and drift mine, 110 feet long.	Five placer samples; two samples from the drift mine contained less than 0.01 mg gold.	Surveyed for patent in 1937 (MS 6211).
25	Glen-Marie placer	A small deposit of angular, coarse gravel and boulders moderately cemented with clay.	Sloughed pit?	One placer sample; no gold.	
19	Coldwater Canyon prospect (placer)	Moderately sorted, subrounded gravels occur as a stream bed remnant occupying a small pre-existing topographical low area.	Trench 1, 40 x 80 feet.	One placer sample; no gold.	Remnants of a screen and galvanized sluiceways. Small piles of boulders. Reported adit not found.
24	Dime Canyon prospect (placer)	Loosely-consolidated gravel and sand intermixed with Cattle Canyon alluvium.	None.	One placer sample; no gold, a trace of scheelite observed in panned concentrate.	
8	Chicken Finlay (placer)	The strike of country rock is parallel to the stream locally, and provides a natural sluiceway. Roughly-stratified flood deposits dissected by a tributary of the East Fork San Gabriel River.	None.	Two placer samples; one sample contained 0.01 mg of gold.	Forest Service campground.
5	Next Best placer	Pit exposes over 100 feet of a discordant, limonite-stained shear zone in schist. Small pockets of well-sorted sand occur behind large boulders near the confluence of Iron Fork and the East Fork San Gabriel River.	Pit.	One placer sample; no gold. One hardrock sample; no gold or silver detected.	Patented claim (MS 5409).
7	Prospect	Adit exposes small iron-stained quartz stringers. Schist country rock strikes N. 75° E., dips 47° SE.	Adit, 10 feet long.	One sample; no gold or silver detected.	
11, 12, 21, 22	Reconnaissance placer samples	Recent and older stream bed gravel deposits were sampled along East Fork San Gabriel River. The highest value was from a lower part of an older stream deposit.	None.	Five samples; three contained gold as much as 16 cents per cubic yard.	

Metric conversion factors:

Inches X 2.54 = centimeters
Feet X .3048 = meters
Acres X .4047 = hectares
Tons X .9072 = tonnes
Ounces (troy) X 31.103 = grams
Ounces (troy) per ton X 34.285 = grams per tonne

1/ Outside of study area boundary.

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Chapter E

Economic appraisal of the Cucamonga Wilderness and additions, San Bernardino County, California

by

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ECONOMIC APPRAISAL

Minor copper production came from the Lytle Creek mine inside the Cucamonga Wilderness. An estimated 130 tons (118 t) of mineralized rock containing copper-silver values remain. Small lead, zinc, silver, graphite, tungsten, and gemstone occurrences are at the boundary or just outside the study area.

SETTING

The Cucamonga Wilderness and its proposed additions (fig. 20) comprise approximately 13,000 acres (5,261 ha). It is located 8 miles (13 km) north of Upland, Calif., and is separated from the Sheep Mountain Wilderness study area by San Antonio Canyon.

Roads reach all sides of the wilderness areas. The rugged topography makes it difficult to traverse the area except by trail. The region's aridity and numerous fires have resulted in an impenetrable growth of brush and yucca on many slopes. Water occurs year-round in the lower valleys only.

Mining activity in the vicinity began in the 1840's and has continued intermittently to the present. Most activity has involved recovery of placer gold from both recent stream bed and older, perched stream channel deposits.

Lytle Creek, named for Andrew Lytle who settled in San Bernardino in 1851, was the site of several mining operations (Clark, 1970). Placer mining, which reached a peak in the 1890's, extended from near the mouth of the canyon to near its headwaters. Gold was found mainly in elevated high river terraces on lower Lytle Creek. Both hydraulic and hand methods were used. By the turn of the century, much of the gold had been removed, and water consumption by nearby agricultural developments hampered operations. Total production from the canyon is not recorded, but was estimated at over $80,000 (Cloudman, 1915).

An auriferous gravel deposit was discovered in 1882 in Mount Baldy Notch, now the site of a ski area, just northwest of the study area. The channel deposit was 200-250 feet (61-76 m) wide and trended northwest (Cloudman, 1915). The deposit was hydraulicked, and the gold recovered in a series of sluice boxes. Water came from reservoirs supplied by snow melt and Hocamac Spring. The Mount Baldy activity ceased near the turn of the century when the deposit was nearly mined out, and when muddy debris-filled water from the operation interfered with agricultural and power developments in lower San Antonio Canyon. Total production is unknown, but daily yield is stated to have had a value of $48 (Cloudman, 1915).

In 1889, a company constructed a dam, a tunnel, and a sequence of sluice boxes to work gold-bearing gravels in San Antonio Canyon (Cloudman, 1915). Details of the operation are unavailable, and 1938 floods obliterated the remnants of operations in most of the region's major canyons.

As placer production decreased, prospectors began to search for the source of the gold. Most were unsuccessful since it came from numerous, small, low-grade veins throughout the area, and not from a few large deposits.

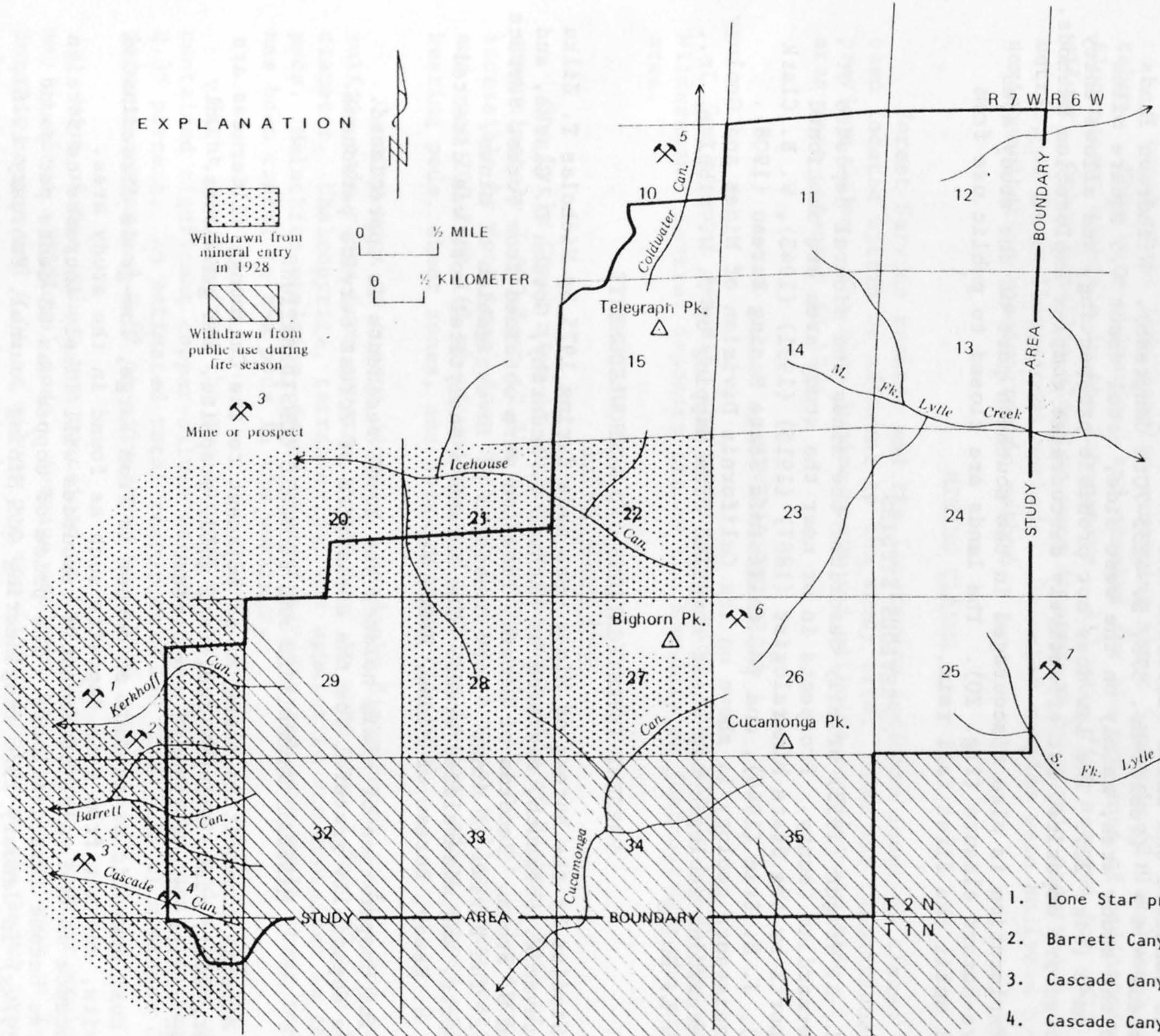

Figure 20.--Map of Cucamonga Wilderness and proposed additions, showing mines, prospects, and lands with restricted entry.

1. Lone Star prospect
2. Barrett Canyon graphite
3. Cascade Canyon corundum
4. Cascade Canyon lapis lazuli
5. Coldwater Canyon tungsten
6. Lytle Creek mine
7. Blew Jordam mine
8. California-Hercules mine

The Lytle Creek mine (fig. 20, no. 6) had been worked for copper since about 1888 (California State Mining Bur., 1908). In the mid-1900's, lead-zinc-silver deposits were mined at the Blew Jordam and California-Hercules properties, just outside the Cucamonga area. Production from them apparently was small.

Lands in Angeles National Forest were withdrawn from mineral entry in 1928 "to conserve the water resources and encourage reforestation of the watersheds * * * " (Public-No. 578, S. 4135-70th Congress). Withdrawn lands within the study area, mainly on the west side, total about 4.5 square miles (11.6 km^2) (fig. 20). The law does not prohibit prospecting, and allows entry to proven ore deposits, but effectively discourages complex exploration methods.

Exploration is also discouraged in the southern part of the study area by fire-hazard closure (fig. 20). The lands are closed to public use from July 1 until the first fall rain.

PREVIOUS STUDIES

L. A. Wright (1953) briefly described the mines and mineral deposits of San Bernardino County. Prospects in or near the study area are mentioned in reports by the State Mineralogist (1887) (1915) (1931) (1943), W. B. Clark (1970), J. H. Eric (1948), and the California State Mining Bureau (1908). Reconnaissance geology is shown on the California Division of Mines and Geology San Bernardino geologic map sheet compiled from mapping by T. W. Dibblee, Jr., and P. L. Ehlig.

PRESENT INVESTIGATIONS AND ACKNOWLEDGMENTS

Studies by the Bureau of Mines were made during 1975 by Nicholas T. Zilka and Steven W. Schmauch, assisted by Michael C. McCarthy, Gordon D. Clarke, and Steven D. Brown. Records of mineral location were obtained from Forest Service files. The Bureau of Mines' work consisted of investigation of mines, prospects, and mineralized areas. The Bureau's analytical work was directed by H. H. Heady, Bureau of Mines, Reno, Nev.

The cooperation of claim holders and local residents is appreciated. We are especially grateful for the assistance of Forest Service personnel.

MINERAL COMMODITIES AND ECONOMIC CONSIDERATIONS

Mineral commodities found in or adjacent to the Cucamonga Wilderness are copper, lead, zinc, silver, tungsten, gold, graphite, and gemstones. Only copper occurs in significant quantities.

Most domestic production of copper is from large, low-grade disseminated deposits, and not from vein deposits such as found in the study area. Dependence on and value of domestic resources will likely increase as foreign sources become less available. The price of copper was 63 cents per pound ($1.39/kg) in January 1976 (Engineering and Mining Journal, February 1976).

METHODS OF EVALUATION

Prospect locations were obtained from Forest Service records, various publications, and local residents. All prospects in and near the study area were mapped and sampled. Samples were also taken of mineralized material occurring outside claim boundaries.

A total of 54 lode samples averaging about 5 pounds (2.3 kg) each were taken. They were pulverized and checked for the presence of radioactive or fluorescent minerals in the laboratory. All were fire assayed for gold and silver. Other metallic elements were determined by atomic absorption, colorimetric, or X-ray fluorescent methods. Selected samples were analyzed by a semiquantitative spectrographic method.

MINING CLAIMS

Forest Service records and the literature indicate about 53 claims have been located within or adjacent to the study area. Some are relocations of previous claims. The Blew Jordam claim and millsite on the east side of the area were patented in 1944.

MINERALIZED AREAS

One mineral deposit, the Lytle Creek mine, lies within the Cucamonga Wilderness. Several deposits are on the boundary or just outside the study area.

Lytle Creek mine

The Lytle Creek mine is located on the east side of Bighorn Peak at approximately 7,600 feet (2,316 m) elevation (fig. 20, no. 6). The site is accessible by foot trail from Icehouse Canyon. A small hillside excavation and over 200 feet (61 m) of underground workings in four adits expose copper-bearing pods, shear zones, and joint systems (fig. 21).

Country rock is quartz diorite. Randomly distributed sulfide and quartz-sulfide pods range from several inches (cm) to more than 2 feet (0.6 m) in diameter. Chalcopyrite, tetrahedrite, and sphalerite are contained in the pods. Malachite staining, found along fractures and some small shear zones, has been traced to the pods in the workings.

Eight samples from the two largest pods, a shear zone, and a joint system contained signficant copper-silver values. Zinc values averaged less than 0.05 percent. An estimated total resources of 130 tons (118 t) averages 0.67 percent copper and 0.67 oz silver per ton (23.0 g/t).

Most of the values are contained in the sulfide pods. Further exploration may disclose additional pods. Average grade of the pods is as much as 2.18 percent copper and 4.06 oz silver per ton (139.2 g/t), but the known tonnage makes the occurrence submarginal.

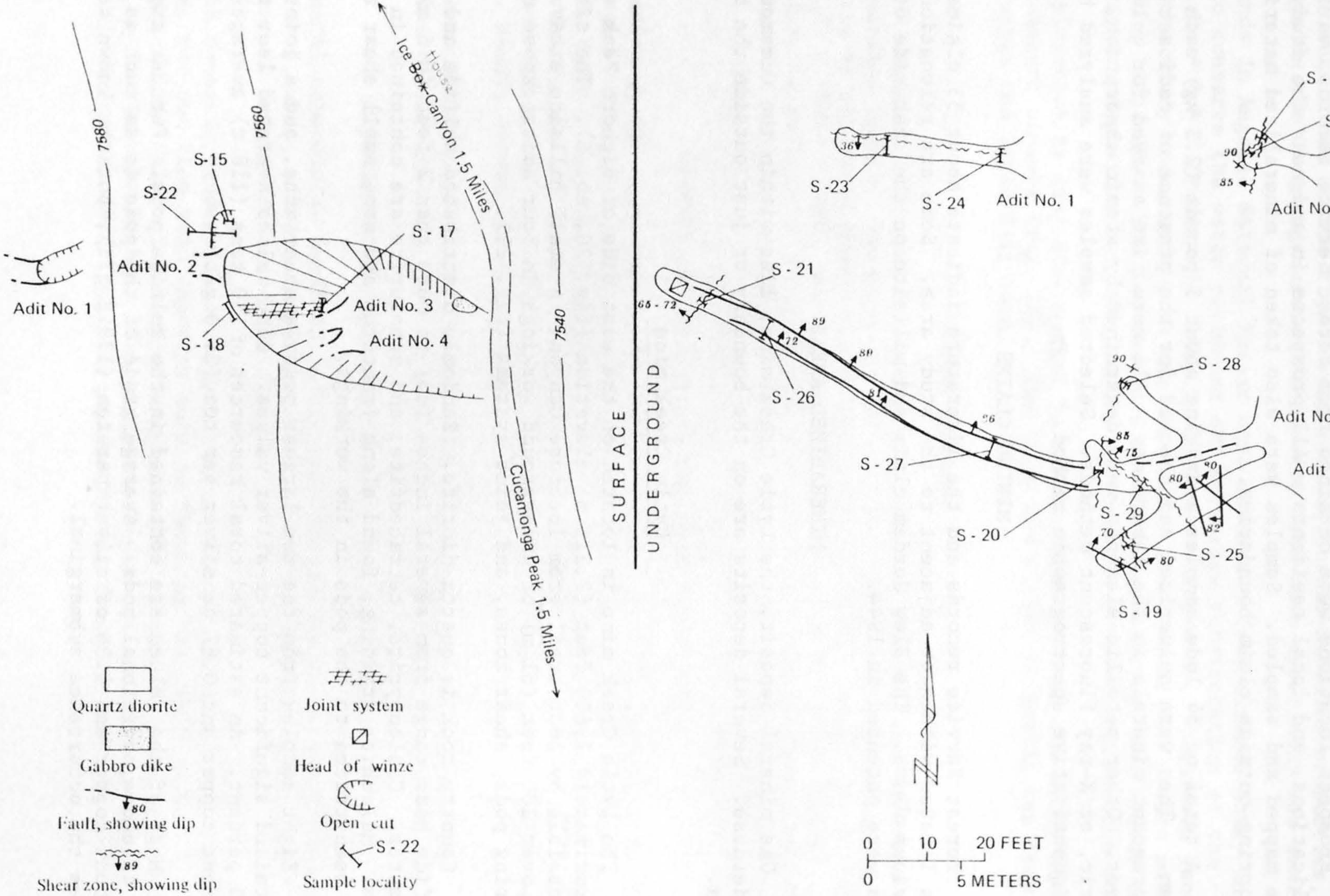

Figure 21.--Lytle Creek mine.

An unnumbered table to accompany fig. 21, Lytle Creek mine

Data for samples shown on figure 21.

[Tr, trace; N, none detected]

Sample				Gold (ounce per ton) 1/	Silver (ounce per ton)	Copper (percent)
No.	Type	Length (feet) 1/	Description			
S-14	Chip--	1.0	Across shear zone------------------	N	N	0.83
S-15	do----	2.5	Across sulfide pod-----------------	Tr	15.9	7.7
S-16	do----	1.0	Across shear zone------------------	Tr	1.4	.95
S-17	do----	3.0	do---------------------------------	N	.2	1.4
S-18	do----	2.4	do---------------------------------	N	.2	.90
S-19	do----	1.0	do---------------------------------	Tr	.3	Tr
S-20	do----	1.2	do---------------------------------	Tr	.1	Tr
S-21	do----	1.0	do---------------------------------	Tr	.1	Tr
S-22	do----	10.0	do---------------------------------	Tr	1.1	.80
S-23	do----	4.0	do---------------------------------	N	N	.09
S-24	do----	1.9	Across sulfide pod-----------------	Tr	3.9	1.4
S-25	do----	2.1	Across shear zone------------------	Tr	.2	Tr
S-26	do----	2.5	do---------------------------------	N	.2	Tr
S-27	do----	2.5	do---------------------------------	N	.1	Tr
S-28	do----	.8	do---------------------------------	Tr	.1	.03
S-29	do----	1.5	do---------------------------------	Tr	.1	Tr

1/ Metric conversions:
Feet x 0.3048 = meters
Ounces (troy) per ton x 34.285 = grams per tonne

Miscellaneous deposits

Thirteen trenches, seven pits, and a 13-foot (4-m deep shaft at the Blew Jordam intermittently expose a garnet-epidote tactite along a quartz diorite - limestone contact. Lead-zinc sulfides are found locally in the contact zone. Samples reportedly (Wright, 1953) contained as much as 13.1 percent zinc, 3.6 percent lead, and 6.65 oz silver per ton (228 g/t). The 20- to 30-foot (6.1- to 9.1-m) thick zone is traceable for over 1,000 feet (305 m) but does not appear to extend into the study area.

The California-Hercules mine (fig. 20, no. 8) is outside the study area on South Fork Lytle Creek. Lead-zinc sulfides occur locally along quartz diorite - limestone contacts. All workings are caved, and the mine road has been washed out.

Crystals of ruby corundum in migmatite occur just outside the study area (fig. 20, no. 3) and veinlets of lapis lazuli are on the boundary in Cascade Canyon (fig. 20, no. 4). A graphite occurrence exists on the boundary on North Fork Barrett Canyon (fig. 20, no. 2). The quality and size of these occurrences cause them to be economically valuable only as mineral specimens.

A 103-foot (31-m) long adit was driven in highly sheared migmatite outside the study area north of the mouth of Kerkhoff Canyon (fig. 20, no. 1). Samples contained no economic mineral values.

Several cuts in sec. 10, T. 2 N., R. 7 W., expose scheelite-bearing veinlets in mylonite gneiss (fig. 20, no. 5). Select samples taken across the four mineralized outcrops contained as much as 3.13 percent tungsten trioxide (WO_3). Foliation trends north-south but sampling and an ultraviolet lamp survey indicate the occurrence does not extend into the study area.

Reconnaissance pan samples from all stream beds indicate no placer potential for the study area.

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