Mineral Resources of the Owens Peak and Little Lake Canyon Wilderness Study Areas, Inyo and Kern Counties, California

U.S. GEOLOGICAL SURVEY BULLETIN 1708-B

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By MICHAEL F. DIGGLES, ROBERT E. TUCKER,
and ANDREW GRISCOM
U.S. Geological Survey

J. DOUGLAS CAUSEY and RICHARD S. GAPS
U.S. Bureau of Mines

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Area

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Owens Peak (CDCA-158) and Little Lake Canyon (CDCA-157) Wilderness Study Areas, California Desert Conservation Area, Inyo and Kern Counties, California.

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By Michael F. Diggles, Robert E. Tucker, *and* Andrew Griscom
U.S. Geological Survey

J. Douglas Causey *and* Richard S. Gaps
U.S. Bureau of Mines

SUMMARY

Abstract

The Owens Peak (CDCA-158) and Little Lake Canyon (CDCA-157) Wilderness Study Areas are located in the southern Sierra Nevada 15 mi northwest of Ridgecrest. They include 26,112 and 30,542 acres, respectively. Field work was carried out in 1982 in order to assess the mineral resource potential of the areas as of March 1985. Metasedimentary rocks near the contact with the Sierra Nevada batholith or associated dikes host gold deposits at the Magnolia mine. Tungsten occurs in skarn deposits and quartz veins. The skarn bodies are small and many do not contain tungsten. The geology suggests that more tungsten-bearing skarn deposits may be discovered in the Owens Peak study area.

Seven localities have mineral resource potential, five in the Owens Peak study area and two in the Little Lake Canyon study area.

The Indian Wells Canyon area, where the largest metamorphic roof pendant was mapped during this study has the highest mineral resource potential for gold and tungsten. Rock samples from mineralized areas in the canyon, including mines and prospects, and stream sediments had anomalously high geochemical values for gold and tungsten. The Magnolia mine, which is presently active, has in excess of 1.2 million tons of gold-bearing rock averaging 0.02 oz/ton gold. The area around the Blue Max prospect and the Magnolia mine has moderate mineral resource potential for gold and tungsten; to the northwest there is a low mineral resource potential for the same commodities. Calculations indicate an estimated 20,000 tons of 0.1-percent tungsten trioxide (WO_3)-bearing rock is present at the Midnite Glow prospect at the base of Ninemile Canyon. Five workings at and near this prospect and geochemically anomalous samples from the base of Ninemile Canyon on the northern boundary of the Owens Peak study area indicate moderate mineral resource potential for tungsten. Although there are no known mineral deposits in Noname Canyon, some stream-sediment samples yielded slightly anomalous levels of tungsten, lead, and copper. The zone has been assigned low mineral resource potential for tungsten, lead, and copper. Near the head of Sand Canyon is a small metamorphic roof pendant that contains mineralized calcareous rock that has low mineral resource potential for tungsten.

The middle of Little Lake Canyon study area contains a zone of potentially mineralized rocks in which small pods of calcareous metamorphic rocks are exposed on the ridge south of Little Lake Canyon. This area has low mineral resource potential for tungsten. Geochemical evidence indicates that the mineral deposit at the Midnite Glow prospect extends into the southern part of the Little Lake Canyon study area. There is a low mineral resource potential for tungsten north of this prospect.

Character and Setting

The Owens Peak and Little Lake Canyon Wilderness Study Areas are located on the east slope of the southern Sierra Nevada north of Walker Pass (fig. 1). The Owens Peak study area contains 26,112 acres and the Little Lake Canyon study area contains 30,542 acres. Although snow is common in winter, especially above 5,000 ft, it would probably not affect mining. Local roads sometimes become impassable due to extensive erosion during flash floods.

Most of the area is underlain by intrusive rocks of the Sierra Nevada batholith; however, a pendant that consists of metasedimentary rocks including schist, phyllite, gneiss, minor lenses of quartzite and marble, and metamorphosed igneous rocks that are dominantly diorite gneiss with minor metamorphosed basalt trends southeast of Owens Peak for approximately 9 mi. Other small pendants crop out between Owens Peak and Noname Canyon to the north.

Identified Resources

In 1983, the U.S. Bureau of Mines examined and sampled 10 mineralized areas in order to appraise the identified mineral resources of the Owens Peak and Little Lake Canyon Wilderness Study Areas. Two mines, one of which has identified resource, and six prospects are located in the Owens Peak Wilderness Study Area. One prospect with identified resources is located outside but near the Owens Peak Wilderness Study Area. A rock pit was located in the Little Lake Canyon study area.

The Magnolia mine (fig. 2, No. 10) produced about 215 tons of gold ore before 1939, and a combined total of 97 tons of tungsten ore in 1951 and 1956. At least 64 tons of tungsten ore was mined from the Blue Max claims (fig. 2, No. 9) and about 83 tons from the Buckhorn mine (fig. 2, No. 8). A small amount of "ferro-alloy" material was reportedly mined during World War II from gabbro at an unknown site in the mouth of Noname Canyon. A pegmatite dike in Ninemile Canyon produced fifty tons of feldspar in 1930. About 100 tons of granite extracted from a quarry near the east edge of Little Lake Canyon (fig. 2, No. 1) study area was probably used in building the Los Angeles Aqueduct.

The Magnolia mine contains subeconomic gold resources that may be as much as 1.2 million tons averaging 0.02 oz/ton gold with by-product silver. Although scheelite occurrences at the Magnolia mine, the Blue Max prospect, and the Buckhorn mine were examined, no tungsten resources were identified. The Midnite Glow prospect (fig. 2, No. 2) in Ninemile Canyon, however, contains an estimated 20,000 tons of subeconomic resources averaging 0.10 percent WO_3. The ore is in a vein which trends north-northwest but could not be traced into the study area. Scheelite occurs on-strike to the south in the Owens Peak study area. A tungsten anomaly exists in Deadfoot Canyon to the north in Little Lake Canyon study area. Assays from the Ninemile Canyon feldspar mine (fig. 2, No. 3) indicate abundant ferric oxide, which disqualifies the feldspar for use in ceramics or glass. An embayment of the range front south of the mouth of Little Lake Canyon encloses a rock pit (fig. 2, No. 1). No sand and gravel or energy resources were identified in the Owens Peak or Little Lake Canyon study areas.

Mineral Resource Potential of the Owens Peak Wilderness Study Area

The area with the highest mineral resource potential occurs south of Indian Wells Canyon where a metamorphic roof pendant runs along the ridge. Rock samples collected from mines, prospects, and mineralized outcrops, and stream sediment have anomalously high gold and tungsten values. Samples from the Blue Max prospect contained from 0.05 to 1.45 percent WO_3. The Magnolia mine, in a pilot plant experiment, currently produces gold from lenses of quartz-rich rock in the roof pendant; tungsten has been produced there in the past (table 1). The area surrounding these properties has moderate mineral resource potential for gold and tungsten. To the north in and near the contact zone between the roof pendant and the granite of Owens Peak is an area having low mineral resource potential for gold and tungsten.

Five scheelite-bearing workings, including four at the Midnite Glow prospect, are located near the mouth of Ninemile Canyon on the northern boundary of the Owens Peak Wilderness Study Area. Geochemical data from samples collected at these prospects substantiate the presence of mineralized rock although no production has been reported. Samples from the workings have 0.1 percent WO_3. This area has a moderate mineral resource potential for tungsten.

Some samples collected around Noname Canyon have slightly anomalous levels of tungsten, lead, and copper. There are no known mineral deposits there, but small xenoliths of metasedimentary rocks in the upper parts of the canyon have low mineral resource potential for tungsten, lead, and zinc.

Near the head of Sand Canyon a small metamorphic roof pendant contains mineralized calcareous rock. Gold, silver, and tungsten were not detected in samples collected at a prospect in the pendant, but tungsten was detected in stream sediment there. The geologic setting is conducive to the formation of skarn deposits, but the geochemical data do not indicate extensive mineralized rock. The area has a low mineral resource potential for tungsten.

Mineral Resource Potential of the Little Lake Canyon Wilderness Study Area

The Midnite Glow prospect is located along a northwest trending vein of tungsten-bearing rock just south of the Little Lake Canyon study area. Geochemical data from Deadfoot Canyon yielded anomalous values of tungsten (R.E. Tucker and M.F. Diggles, unpub. data, 1984). Although the mineral-bearing structure at the prospect was not traced into the Little Lake Canyon study area, these data suggest tungsten minerals may be present there on strike with the vein. The projection of the vein has a low mineral resource potential for tungsten.

Heavy-mineral concentrates from the lower part of Little Lake Canyon showed slightly anomalous levels of tungsten below small skarn exposures on the ridge to the south. The skarns have low mineral resource potential for tungsten.

No known energy mineral deposits exist in the study areas. Although the northeastern part of the Little Lake Canyon study area is adjacent to the Coso Known Geothermal Resource Area (KGRA), its geology differs significantly and does not suggest any potential for geothermal energy.

INTRODUCTION

Location and Physiography

The Owens Peak (CDCA-158) and Little Lake Canyon (CDCA-157) Wilderness Study Areas are located on the east slope of the southern Sierra Nevada north of Walker Pass (see fig. 1) The Owens Peak study area contains 26,112 acres and Little Lake Canyon study area contains 30,542 acres. Road access to the area is by State Highway 178 from the south,

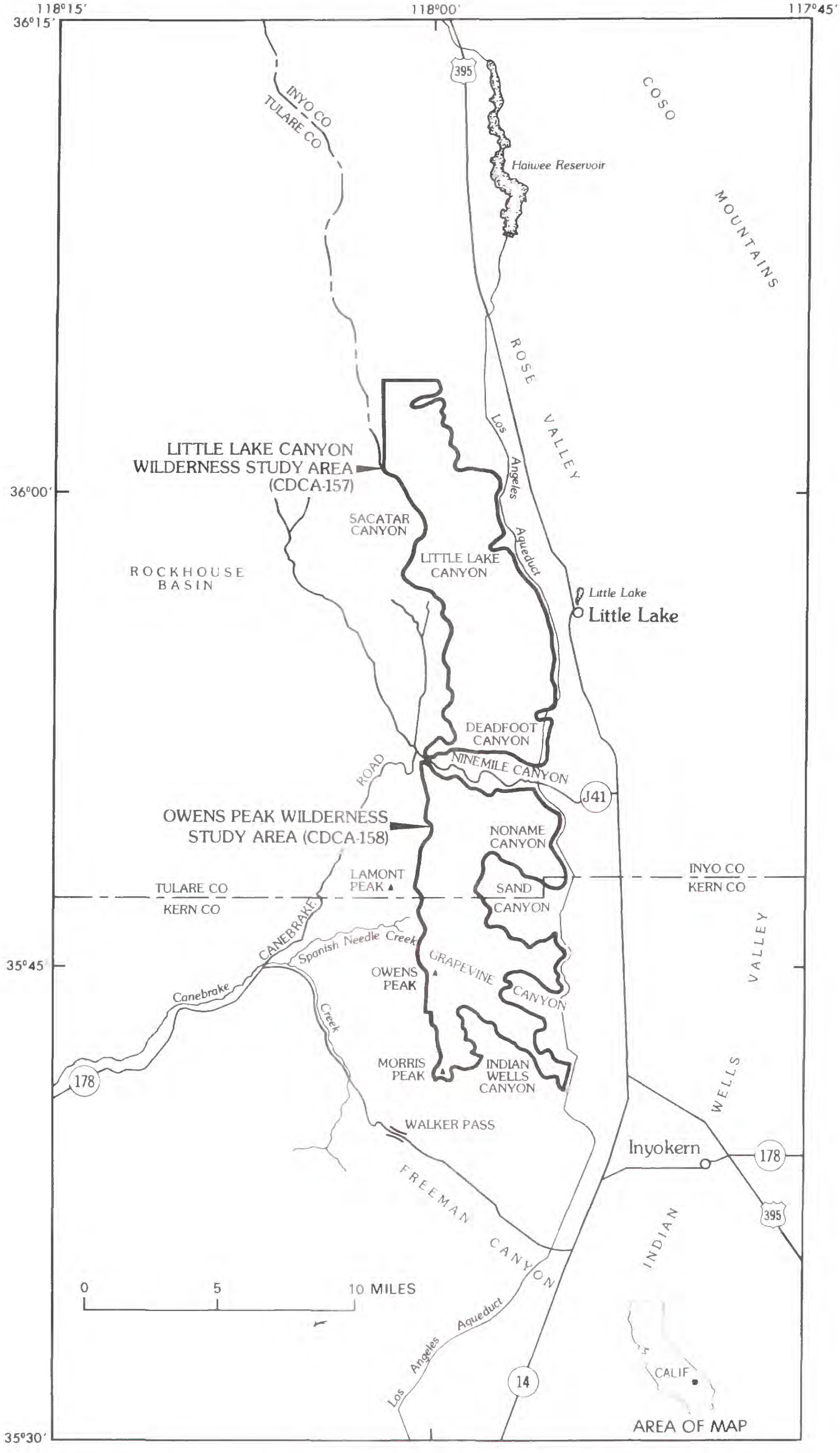

Figure 1. Index map showing location of the Owens Peak and Little Lake Canyon Wilderness Study Areas, Inyo and Kern Counties, California

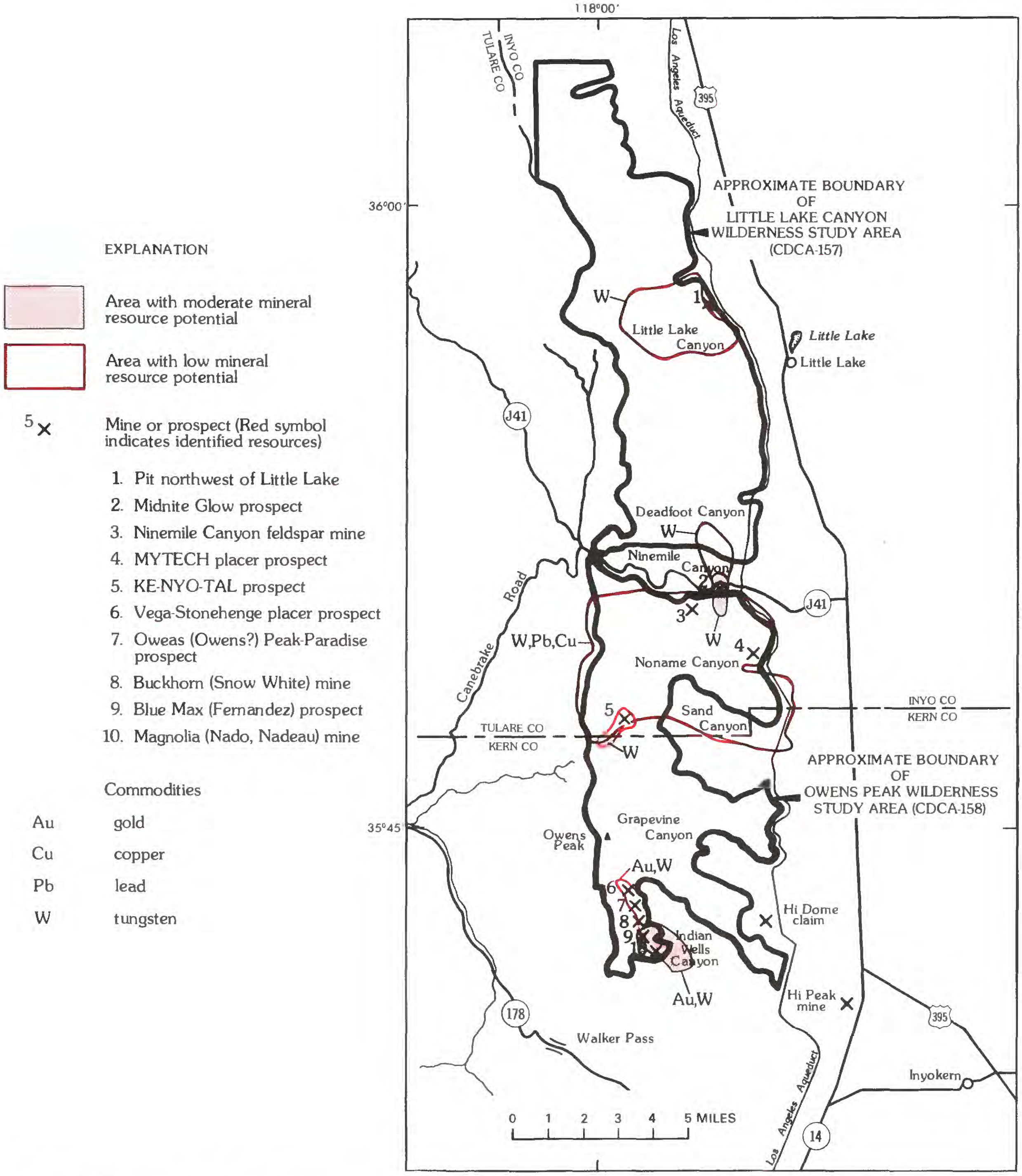

Figure 2. Map showing areas of mineral resource potential in the Owens Peak and Little Lake Canyon Wilderness Study Areas, Inyo and Kern Counties, California

county road J41 from the north, State Highway 14 and U.S. Highway 395 from the east, and spurs off of the Canebrake road from the west. Local roads sometimes become impassable due to extensive erosion during flash floods. Although snow is common in winter, especially above 5,000 ft, it would probably not affect mining. The terrane is steep and rugged in most places with elevations ranging from about 3,300 ft along the aqueduct to the east to 8,453 ft at the summit of Owens Peak in the west. The vegetation includes sagebrush, Joshua tree, creosote bush, desert holly, cactus, and mountain mahogany in the desert lowlands. Vegetation of the Yellow Pine belt (Transition Zone) (Storer and Usinger, 1963) in the higher country consists of piñon, juniper, incense cedar, black oak, and ceanothus. There is Jeffrey pine and rarely sugar pine, on the north side of Owens and Sawtooth Peaks. The foothills are in the Upper Sonoran Zone and have digger pine, live oak, ceanothus, manzanita, and chinquapin.

Procedures and Sources of Data

In the spring and summer of 1982, the U.S. Geological Survey did reconnaissance geologic mapping and stream-sediment sampling of the Owens Peak and Little Lake Canyon Wilderness Study Areas. More detailed geologic mapping was done where needed to extend beyond or to correct published work (Diggles unpub. data, 1984). The general geology of the area west of the Sierra Nevada crest was described by Miller (1931, 1946) and Miller and Webb (1940). The geology of the Haiwee Reservoir quadrangle was detailed by Stinson (1977). The geology of the young volcanic rocks in the Coso region is contained in Duffield and Bacon (1981) and Rinehart and Smith (1982), and its geothermal resources were covered by Higgins (1981). There are several references on the structural geology of the range front and the valley to the east including those by Pakiser and others (1964), Von Huene (1960), and U.S. Geological Survey (1982a, b). Studies of nearby areas are also available. The geology of the Owens Peak (CA-010-026) Wilderness Study Area directly west of the Owens Peak (CDCA-158) Wilderness Study Area was described in conjunction with the mineral resource study of that area (M.F. Diggles and D.E. Clemens, unpub. data, 1984). The geology of the Domeland Wilderness, 20 mi west of the study areas, was mapped by Bergquist and Nitkiewicz (1982) and its mineral resource potential was described by Bergquist (1983). The mineral resource potential of the Rockhouse Basin Wilderness Study Area, 15 mi west of the study areas, was described by Taylor and others (1984) and summarized by Taylor (1984).

The U.S. Bureau of Mines gathered information about current and past mining activities in and near the study areas and did a field study between March and July 1983. Data were taken from U.S. Bureau of Land Management mining claim recordation indices, and land status and use records, the U.S. Bureau of Mines Mineral Industry Location System, and county claim records. They attempted to contact all claim owners to obtain permission to examine their claims.

A search was made for all mines, prospects, mineralized zones, and claims. Mapping and sampling were done where warranted. A total of 188 rock and 18 alluvial samples were taken and assayed for gold and silver using a combined fire assay-ICP (Inductively Coupled Plasma) method, for tungsten by both colorimetric and x-ray fluorescence methods, and molybdenum and tellurium by atomic-absorption spectroscopy.

The 18 alluvial samples collected from stream channels near mineral properties and concentrated in the field were examined by microscope, ultraviolet lamp, and magnetic separator for gold, scheelite, ilmenite, garnet, zircon, and magnetite. All samples were analysed by semiquantitative spectroscopy for 40 elements (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Sb, Sc, Si, Sn, Sr, Ta, Te, Ti, V, Y, Zn, and Zr). Complete results of the U.S. Bureau of Mines' work on these study areas is included in Causey and Gaps (1985).

The present work by the U.S. Geological Survey and the U.S. Bureau of Mines is reported upon jointly according to guidelines provided by Goudarzi (1984).

Acknowledgements

The U.S. Geological Survey and the U.S. Bureau of Mines greatly appreciate the cooperation of property owners and officials of the U.S. Bureau of Land Management's California Desert Conservation Area Office. Ralph and Paul Siebert furnished copies of consultant reports; Dr. Carl Austin shared his knowledge of the area and its mining history. Mark Lawrence and Margaret Phillips of the U.S. Bureau of Land Management Ridgecrest Area Office gave support and use of Bureau of Land Management facilities and radio equipment. Nancy Parduhn, David Dellinger, Jamie Conrad, Diane Clemens, J. Mitch Linne, Terry Close, Terry Neumann, and Edward McHugh helped to complete the field work.

APPRAISAL OF IDENTIFIED RESOURCES

By J. Douglas Causey and Richard S. Gaps, U.S. Bureau of Mines

Mining and Mineral Exploration History

The Indian Wells Canyon district is the only mining district in either of the study areas. Troxel and Morton (1962) report that gold was discovered in Indian Wells Canyon (pl. 1) prior to 1880. The Magnolia (Nado, Nadeau) claims (pl. 1, No. 10) were located in the NW 1/4, section 2, T. 26 S., R. 37 E., by E.F. Morris in 1911. In 1943, the property was leased by William Siebert (U.S. Bureau of Mines, unpub. data, 1943) who subsequently purchased the property. It is currently owned by his sons Ralph and Paul Siebert. N.F. Stevens (unpub. data, 1936) stated that at least 64.8 tons of ore averaging 1.04 oz/ton gold was processed using an arrastra (a primitive grinding mill). U.S. Bureau of Mines records show shipments of 43 and 28 tons of ore in 1937 and 1938, respectively, with total recovery of 47 oz gold and 22 oz silver.

U.S. Bureau of Mines records also show that 97 tons tungsten ore was processed in 1951 and 1956.

The Indian Wells Canyon mining district encompasses properties 6 through 10 (pl. 1; fig. 2) and others located to the southeast. Early miners processed ore using an arrastra. Tungsten was produced in the Indian Wells district near the end of World War II and between 1951 and 1956 when the U.S. General Services Administration was purchasing tungsten concentrates for $63 per short ton unit of concentrated WO_3. About 400 tons of scheelite-bearing skarn was mined from the Buckhorn (Sierra tungsten) (pl. 1, No. 8) and Magnolia mines.

Since World War II, mining activity has been limited to exploration and small-scale mining, mainly for gold at the Magnolia mine and tungsten in scheelite-bearing skarn deposits nearby. There were no producing mines adjacent to the study areas in 1983, but several claimants were evaluating their holdings in Indian Wells Canyon, both in and adjacent to the Owens Peak study area.

The Giraud mine, reportedly located in sec. 35, T. 24 S., R. 37 E. was searched for but not found. A U.S. Bureau of Mines War Minerals Memorandum (unpub. data, 1943) states that this property is underlain by a 1- to 2-ft-thick low-grade copper-stained crust overlying a granitic plateau.

Two tungsten properties not examined, but located near the Owens Peak study area are the Hi Dome (formerly Greyhill and Blue Rock) claim and Hi Peak (formerly Tungsten Peak) mine (pl. 1; fig. 1). The U.S. Geological Survey and the U.S. Bureau of Mines examined the Hi Dome property in 1955 for a Defense Minerals Exploration Administration application. They concluded that the deposit was too small and too low grade to support further exploration efforts and expenditures. The Hi Peak mine produced tungsten in 1942, 1943, 1949, and 1953-1956. The ore grade reportedly ranged from 0.5 to 2.0 percent WO_3 (Troxel and Morton, 1962).

Iron-rich gabbroic rocks generated interest during World War II. F.A. vonKesselhut promoted a metal commercially known as "waltamonite". It was to be produced by reduction of gabbro in either open-hearth or direct-arc electric smelting furnaces to produce a high grade "ferro-alloy". During World War II the Owens Peak Mining Company mined an area at the mouth of Noname Canyon for gabbro. The U.S. Bureau of Mines sampled the mill concentrates and gabbro in 1943, when the mine and mill were operating, but found no tungsten or chromium, which were commodities of interest for the war effort.

The Coso mining district, about 6 mi north and northeast of the town of Little Lake, produced 231 flasks of mercury between 1931 and 1940 (Ross and Yates, 1943). The district also contains minor sulfur, perlite, pumice, volcanic cinders, gold, silver, iron, tungsten, uranium, and copper (Chesterman, 1956; Rockwell International, 1980; Ross and Yates, 1943; Tucker and Sampson, 1938). The Coso KGRA encompasses much of the Coso mining district (Higgins, 1981). In 1983, the U.S. Navy was exploring for geothermal resources on the China Lake Naval Weapons Center within the Coso mining district.

Mines, Prospects, and Mineral Occurrences

Ten mines and prospects, eight of which are in the Owens Peak study area were examined during this study (pl. 1; fig. 2; table 1). One property is a crushed-stone quarry on the east boundary of the Little Lake Canyon study area; another is between the two study areas in Ninemile Canyon. There are no known mineral occurrences in the Little Lake Canyon study area.

The Magnolia mine (pl. 1, No. 10) described in the gold section and the Midnite Glow prospect (pl. 1, No. 2) described in the tungsten section below contain identified resources.

Gold

Gold was found at the Magnolia mine and the adjoining Blue Max prospect. The Magnolia mine contains the highest assays (table 1). A roof pendant of schist and gneiss is the host rock for gold on both these properties, but the mineralized part of the pendant terminates at the Blue Max prospect.

No concentrations of lode gold were found elsewhere in the study areas and no placer gold was reported in any of the alluvial samples.

The Magnolia mine is located on the southwest side of Indian Wells Canyon, between 4,900 and 6,000 ft elevation. Access is by dirt road, approximately 6.5 mi west of State Highway 14 at Homestead, California. The mine is in a roof pendant within the Sierra Nevada batholith. The metamorphic rocks of the roof pendant include schist, gneiss, phyllite, quartzite, marble, and metabasalt. Granite dikes intruding the metamorphic rocks approximately parallel the foliation. Batholithic rocks range from granite to diorite.

Schist, gneiss, and iron-sulfide-bearing quartz lenses contain gold. Chip samples taken from metamorphic rocks and granite dikes at the Magnolia mine yielded as much as 0.58 oz/ton gold. Silver was insignificant, the highest value being 0.3 oz/ton. Most of the high gold values were derived from samples collected near the top of Magnolia Hill from metamorphic rock outcrops and workings. In most places within the study area, granite dikes, gabbro, and diorite are barren of precious metals. At the top of Magnolia Hill where the ten samples with the highest gold values were collected, however, these rock types are estimated to comprise only about 10 percent of the rock volume. Granite dikes there may have been the source of mineralizing fluids. Detectable gold was found in only a few of the samples taken below the level of the Franklin tunnel, about 350 ft below the top of Magnolia Hill. At least some of the gold is free milling.

The U.S. Bureau of Mines identified very fine-grained, disseminated galena, sphalerite, chalcopyrite, and stibnite in schist as well as pyrrhotite and pyrite in a sample from a tunnel in the Magnolia mine (J.J. Sjoberg, written commun., 1983). N.F. Stevens (unpub. data, 1936) reported the presence of tellurides at the

Magnolia mine; however, assays, semiquantitative spectrographic analyses, and petrographic studies did not detect any tellurium or telluride-bearing minerals.

An estimated 1.2 million tons of identified subeconomic gold resources averaging 0.02 oz/ton gold are located at the Magnolia mine. These calculations were made using the method of polygons (Parks, 1957). Each working was treated as a point and all chip samples from a working were averaged to yield a gold value. Topographically, this deposit closely approximates a pyramid which is about 1,500 ft long by 300 ft wide by 100 ft deep. Therefore, we estimate a volume of about 15 million ft^3, or weight of about 1.2 million tons based on 2.6 specific gravity of the schist. One hundred percent recovery would yield about 24,000 oz gold, and silver might be recovered as a by-product. Rocks with low gold grades may be minable at the Magnolia mine if the gold is free milling and a large-scale inexpensive recovery process is used. The host metamorphic rocks are friable where exposed and may not require much, if any, secondary crushing.

A drilling program and metallurgical studies are recommended to determine the extent of the mineralized area, and whether economic recovery is possible.

Tungsten

U.S. Bureau of Mines records list 376.8 tons of tungsten ore produced, probably from skarn bodies, at the Buckhorn mine, Blue Max prospect, and Magnolia mine (pl 1, Nos. 8, 9 and 10). Extensive areas containing scheelite are not exposed on most of these claims; small isolated skarn bodies, no more than 25 ft in diameter, occur in the metamorphic rocks and along contacts with granite.

At two prospects scheelite is associated with quartz veins. A scheelite-bearing quartz vein at the Blue Max prospect is 2 to 5 ft thick and at least 25 ft long. A 0.8- to 3-ft-thick scheelite-bearing quartz vein at the Midnite Glow prospect strikes north-northwest toward the Little Lake Canyon study area and south-southeast toward the Owens Peak study area.

The Midnite Glow prospect, between 3,700 and 4,100 ft elevation and situated between the two study areas on the north side of Ninemile Canyon, is located south of county road J41 about 1 mile west of the Los Angeles Aqueduct siphon. Scheelite is associated with a quartz vein and fault gouge between the brecciated vein and foliated granite. The vein strikes N. 25^{o} W. and dips about 65^{o} NE. It ranges from 10 in. to 3 ft thick where exposed, and recent mapping demonstrates that it has a possible strike length of more than 900 ft. Its thickness averages 1.5 ft. Samples of outcrops and workings have an average grade of 0.10 percent WO_3. Assuming the vein and gouge zone extend at least 220 ft downdip, and assuming a total strike length of 900 ft, the identified resource is about 20,000 tons averaging 0.10 percent WO_3. Although this vein was not traced into either study area, geochemical data (R.E. Tucker and M.F. Diggles, unpub. data, 1984) suggest tungsten minerals may be found in the Little Lake Canyon study area on strike with this structure. In addition, a small prospect pit in the Owens Peak study area about 1,700 ft south of this property contains scheelite in a quartz vein.

Feldspar

Simple pegmatites occur throughout the Sierra Nevada batholith. Within an area about 400 ft long and 150 ft wide are three pegmatite exposures in Ninemile Canyon which are part of the Ninemile Canyon feldspar mine (pl. 1, No. 3). Two have been mined for feldspar producing 50 tons in 1930 (Sampson and Tucker, 1931). Potash feldspar from Ninemile Canyon contained from 0.26 to 0.38 percent ferric oxide, which makes it unsuitable for glass- or pottery-grade (maximum of 0.1 percent ferric oxide for glass- or pottery-grade allowed). An analysis of feldspar from the Ninemile Canyon deposit reported in Tucker and Sampson (1938) contained 0.11 percent ferric oxide.

Conclusions

The Magnolia mine has an estimated 1.2 million tons of identified subeconomic gold resources with an average grade of 0.02 oz/ton gold and, possibly, by-product silver. This tonnage and grade are not adequate for mine development but warrant further exploration since the grade approaches that of producing mines (for example Zortman-Landusky mine, Montana, 0.03 oz/ton gold (Russell Dugdale, oral commun., 1984); Round Mountain, Nevada, 0.04 oz/ton gold (Nielsen, 1984)).

At least 375 tons of scheelite ore has been produced from mines within the Owens Peak study area. The Midnite Glow prospect, located between the two study areas, has an estimated 20,000 tons of identified scheelite ore.

Feldspar is present at the Ninemile Canyon feldspar mine, but because the pegmatite exposures in the study area are small and impure, selective mining and (or) milling techniques would be necessary to produce a high grade feldspar concentrate.

The crushed-stone quarry in Little Lake Canyon was used in the past and could be utilized in the future if there was local demand for the material. There is a possibility that stone in the study areas could meet local demand for riprap and other stone products.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Michael F. Diggles, Robert E. Tucker, and Andrew Griscom, U.S. Geological Survey

Geology

The Owens Peak and Little Lake Canyon Wilderness Study Areas are underlain mostly by granitic rocks of the Sierra Nevada batholith, that were emplaced during at least three major periods of intrusive activity (Evernden and Kistler, 1970). These include Cretaceous leucocratic, nonfoliated rocks of granitic to granodioritic composition and an older set of slightly more mafic granodioritic to tonolitic rocks of Jurassic and (or) Cretaceous age that often have foliated to schlieric textures. The oldest intrusive rocks of the batholith in the area are probably of Triassic and (or) Jurassic age. They are gabbroic to dioritic rocks with foliated to gneissic textures. The granitic rocks intruded and metamorphosed Paleozoic to Mesozoic sedimentary and volcanic rocks to quartz-mica schist, quartzite, marble, and minor greenschist. Zones of garnet-epidote-wollastonite calc-silicate hornfels developed near contacts with granitic rocks. The geology was mapped in detail in conjunction with this study (M.F. Diggles, unpub. data, 1984).

Metamorphic Rocks

Metamorphic rocks that occur in roof pendants mainly along the south side of Indian Wells Canyon extend as far west as Canebrake Creek (fig. 1). They include quartz-biotite schist, phyllite, quartzite, marble, calc-silicate hornfels, and meta-dacite. Skarns formed where carbonate rocks were intruded by plutonic rocks. These consist of garnet, epidote, and wollastonite, with scheelite present at some locations.

Triassic and (or) Jurassic Plutonic Rocks

The Triassic and (or) Jurassic plutons usually have foliated to gneissic textures. In general, these older rocks are mesocratic while the Cretaceous rocks are leucocratic. We include three units within the Triassic and (or) Jurassic rocks. The diorite of Indian Wells Canyon is a dark-colored medium-grained, inequigranular, foliated to gneissic rock exposed along the contacts of metamorphic rocks from Owens Peak southeast into Indian Wells Canyon. Dibblee (1954) divided this unit into diorite and gneiss subunits, but there is a continuous gradation between the two rock types rather than a sharp contact. The Summit Gabbro of Miller and Webb (1940) is a dark-colored, coarse-grained, rock characterized by euhedral phenocrysts of hornblende. It is exposed as small bodies almost never exceeding 0.7 mi^2 in area, but occurs in localities throughout both study areas. The Sacatar Quartz Diorite of Miller and Webb (1940) is a medium-dark-colored, medium-grained, foliated to schlieric rock exposed over small parts of the northern part of the Owens Peak study area and most of the Little Lake Canyon study area. Its composition is granodioritic in places, particularly east of the Sierra Nevada crest near the base of the range front. Locally, the Sacatar Quartz Diorite is porphyritic. In places it is rich in mafic inclusions that have been assimilated to varying degrees.

Cretaceous Granites and Granodiorites

Cretaceous rocks are leucocratic, medium- to coarse-grained, and seriate to porphyritic. They are exposed over much of the central and northern parts of the Owens Peak study area and they consist of six defined units. The granodiorite of Lamont Peak (M.F. Diggles, unpub. data, 1984) exposed along the western boundary of the study area, is a medium-grained, porphyritic rock containing conspicuous megacrysts of potassium feldspar and generally composed of quartz, potassium feldspar, oligoclase, biotite, and hornblende. The granite of Owens Peak (M.F. Diggles, unpub. data, 1984) is a leucocratic, coarse-grained, equigranular rock exposed in and north of Indian Wells Canyon from the Sierran crest to the bajada along the eastern edge of the study area. The outcrops are rounded; weathering forms coarse grus. The granite of Sand Canyon (M.F. Diggles, unpub. data, 1984) is leucocratic, fine- to medium-grained, equigranular and locally is slightly porphyritic. The outcrops are blocky to massive and locally contain mafic inclusions. The alaskite of Noname Canyon (Diggles, 1984) is a very leucocratic, medium-grained, hypidiomorphic-granular rock composed of quartz, potassium feldspar, albite, and muscovite with minor amounts of garnet and magnetite. It is exposed in canyon bottoms near the range front over about 4.5 mi^2 as small pods connected by nearly horizontal dikes. This pluton is atypical of Sierran granites because it is high in silica, aluminum, and alkalis, and low in iron and magnesium (Diggles, 1984), which is a type usually derived from a sedimentary source (Chappell and White, 1974; Clark, 1981a, b). The alaskite of Freeman Canyon (M.F. Diggles, unpub. data, 1984) is a salmon- to pink-colored, medium- to coarse-grained, potassium feldspar-porphyritic, garnet-bearing, alkali-feldspar granite containing areas of pegmatite that consist almost entirely of microcline. It is exposed over a small area below the ridge crest on the north side of Freeman Canyon. The granodiorite of Morris Peak (M.F. Diggles, unpub. data, 1984) is a leucocratic to mesocratic, medium-grained, biotite-porphyritic rock composed of quartz, potassium feldspar, andesine, abundant biotite, and minor hornblende, with minor amounts of magnetite. The biotite phenocrysts occur in books up to 0.4 in. in diameter. This granodiorite is exposed over much of the southern part of the study area and as far south as State Highway 178. Outcrops are generally massive and foliated to schlieric near contacts with diorite near Owens Peak. The crest of the Sierra Nevada in and around the study areas contains small but numerous pods of medium- to coarse-grained leucocratic granite, alkali feldspar granite and associated aplite and pegmatite bodies. These alaskite pods are perhaps late-stage crystallization products of nearby intrusive bodies of more mafic composition.

Alluvium

Alluvial deposits are found in canyon bottoms and compose the large fans in Rose and Indian Wells Valleys. This includes Holocene stream-channel deposits consisting of poorly sorted gravel, sand, and silt in channels and flood plains. It contains minor colluvium and older alluvium consisting of dissected Quaternary stream-channel deposits on terraces.

Structure

The metamorphic rocks in and near Indian Wells Canyon have a strong foliation that trends generally northwest-southeast. These rocks underwent at least two periods of uplift following major intrusive events (Nokleberg and Kistler, 1980). The dominant geomorphic features in the study area are a series of en echelon faults that run west-northwest across the range and which controlled the formation of the major canyons in the area. This fault series is best exposed in Ninemile Canyon where evidence of shearing and juxtapositioning as well as potassic alteration along high-porosity shear zones can be seen in road cuts along the Ninemile Canyon road. This canyon also provides an unusually low pass over the crest, probably due to erosion of fault-weakened rocks. Subordinate to this fault system is the Sierra Nevada front fault zone along which the range was uplifted. Parts of the front-faults can be seen in saddles from the base of the range to the crest.

Geochemistry

Methods

In the spring and summer of 1982, the U.S. Geological Survey collected samples of rock, stream sediment, and nonmagnetic heavy-mineral concentrates from 62 sites within the Owens Peak Wilderness Study Area and 33 sites within the Little Lake Canyon Wilderness Study Area. The sampling procedures were similar to those employed by Tucker and others (1981, 1982).

Stream-sediment samples represent eroded material from within drainage basins. Chemical analyses of the minus-80-mesh and the panned-concentrate fractions of such stream sediment can be used to identify areas of mineral potential (Theobald and Thompson, 1959; Miller and others, 1980; Tucker and others, 1981, 1982; Diggles, 1983). The panned-concentrate fraction selectively concentrates many minerals related to metallization processes.

Samples were analyzed for 31 elements (Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, Mo, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Th, Ti, V, W, Y, Zn, and Zr) using a six-step semiquantitative emission spectrographic method (Grimes and Marranzino, 1968). The data are included in Detra and others (1985). The geochemical interpretation is based on data from the heavy-mineral concentrate samples. Seventeen of the 31 elements for which the samples were analysed are most useful as possibly being related to hydrothermal alteration and (or) mineralization. For the sediment and concentrate samples, the anomalously high concentrations for each selected element were assigned to concentration-range categories in order to better identify weakly, moderately, or strongly anomalous samples. In general, the more anomalous the results from a sampling site, the more significant is that site (or drainage basin) in terms of mineral potential.

Results and Interpretation

The data in Detra and others (1985) were interpreted in detail for this study (R.E. Tucker and M.F. Diggles, unpub. data, 1984). The elements most useful in this study are bismuth, tungsten, tin, barium, lead, copper, beryllium, thorium, yttrium, niobium, lanthanum, cobalt, boron, vanadium, nonmagnetic iron, strontium, and molybdenum because these elements are commonly associated with mineralized areas and altered zones in this part of the Sierra Nevada. Many drainage basins in the Owens Peak study area contain one or more anomalous concentrations of tungsten (100 parts per million (ppm)) bismuth (500 ppm), or tin (150 ppm). Only five drainage basins in the Little Lake study area have anomalous concentrations of these three elements. Anomalous concentrations of barium (2,000 ppm), lead (70 ppm), and copper (20 ppm) are found predominately in basins draining the Owens Peak study area. Anomalous concentrations of thorium (500 ppm), niobium (200 ppm), and yttrium (2,000 ppm) occur throughout both study areas. Only 14 samples contained beryllium concentrations above the detection limit of 2 ppm.

Fifteen basins in three groups showed clustered anomalies. Areas of highest mineral resource potential are those that contain adjacent basins with clusters of anomalous metal concentrations. Single isolated anomalies deserve note but not great emphasis. Areas where previously undetected tungsten skarn-type mineralization has occurred should contain anomalous concentrations of tungsten, bismuth, lead, tin, and copper.

Evaluation of the geochemical characteristics of rocks collected from sites near known mineralized areas can be used to help determine the mineral resource potential of the study area. The best geochemical indicators for the skarn-type mineralization within the study area are tungsten, bismuth, tin, barium, lead, and copper. Four samples collected near the Hi Peak mine (fig. 1; pl. 1) contain elevated values of bismuth (500 ppm), one of which also has elevated values of tungsten (100 ppm), lead (70 ppm), and copper (20 ppm). Several other samples from the mine have high values of tin, tungsten, and lead.

Our geochemical interpretations suggest there are two zones of mineralization in these study areas. One zone extends from State Highway 178 at the southern end of the Owens Peak study area to Grapevine Canyon. The other zone extends from Sand Canyon on the south to slightly north of Ninemile Canyon.

Geophysics

An aeromagnetic survey of the Owens Peak and Little Lake Canyon Wilderness Study Areas was flown in 1981 by a private contractor (U.S. Geological Survey, 1982b). The aeromagnetic data were collected along parallel east-west flight lines spaced 0.5 mi apart and at an elevation of 9,000 ft. The contractor then gridded the data set using a grid spacing of 200 m and machine-contoured the gridded data at a scale of 1:62,500.

Variations in the earth's magnetic field are generally caused by variations in the amounts of magnetic minerals in different rock units, magnetite being the common magnetic mineral in this area. Magnetic minerals, where locally concentrated or absent, may cause a high or low magnetic anomaly that can be a guide to mineral occurrences or deposits. Boundaries between magnetic and relatively less magnetic rock units are located approximately at the steepest gradient on the flanks of the magnetic anomaly because at these magnetic latitudes the inclination of the Earth's magnetic field is relatively steep (61° below the horizontal).

Comparison of the contoured aeromagnetic map with the geologic and topographic maps indicates that most of the magnetic anomalies are caused by topographic relief in magnetic terrane composed of Mesozoic plutonic rocks, in particular the mesocratic to melanocratic ones. Relatively magnetic intrusive rocks include the Sacatar Quartz Diorite and the diorite of Indian Wells Canyon of Triassic (or) Jurassic age. Local more mafic masses of diorite and gabbro within these two rock units are not appreciably more magnetic and do not have significant local magnetic expression on the aeromagnetic map. Of the Cretaceous plutonic rocks only the relatively mafic granodiorite of Morris Peak appears to cause magnetic anomalies associated with topography; the other plutons do not contain sufficient amounts of magnetite. The older Paleozoic(?) metamorphic rocks also do not cause any evident magnetic anomalies. The only major magnetic feature that is clearly caused by a contact between two differing rock units is a northwest-trending magnetic gradient along the southwest side of Indian Wells Canyon. This gradient slopes down from the magnetic granodiorite of Morris Peak and diorite of Indian Wells Canyon southwest of the canyon to the relatively nonmagnetic metamorphic rocks and granite of Owens Peak that form the floor of the canyon. Along this contact and magnetic gradient between the two plutons occur, perhaps fortuitously, the elongate roof pendant of Indian Wells Canyon and the row of gold or tungsten mines and prospects associated with the Magnolia mine. Like the roof pendant, this magnetic gradient extends on strike to the northwest a distance of about 3 mi beyond Owens Peak to the headwaters of Spanish Needle Creek at an elevation of about 4,800 ft. No other significant correlation is apparent between the aeromagnetic map and the other known mineral occurrences or geochemical anomalies.

Conclusions for the Owens Peak Wilderness Study Area

The area with the highest mineral resource potential covers a metamorphic roof pendant that runs along the ridge to the south of Indian Wells Canyon. The area has a history of mining activity, and rock samples from mineralized areas, and stream sediments had anomalously high geochemical values for tungsten, bismuth, thorium, beryllium, niobium, and yttrium. Samples from the Blue Max prospect contained high levels of tungsten. The Magnolia mine, in a pilot plant experiment, currently produces gold from lenses of quartz-rich rock in the roof pendant; tungsten has been produced there in the past (table 1). The area in and around the Blue Max prospect and the Magnolia mine has moderate mineral resource potential for gold and tungsten with a certainty of D. The area near the contact between the roof pendent and the granite of Owens Peak has low mineral resource potential for gold and tungsten with a certainty of C. See Appendix 1 and figure 3 for definition of levels of mineral resource potential and certainty.

The Midnite Glow prospect is located at the mouth of Ninemile Canyon on the northern boundary of the Owens Peak study area. Bismuth and molybdenum, pathfinder elements for tungsten mineralization, are present in anomalous amounts in the stream sediments. Rock samples from the workings average 0.1 percent WO_3. Based on the known mineralization and the geochemical anomalies, this area is assigned a moderate mineral resource potential for tungsten with a certainty of D.

In the general vicinity of Noname Canyon several geochemical sampling sites showed slightly anomalous levels of tungsten, lead, and copper. These are in an area of granite and granodiorite that has many small mafic dikes and numerous small shear zones that contain potassically altered rock. These mafic dikes or zones of potassically altered rock may account for the anomalies, but undiscovered pods of mineralized rock may exist. There are no known mineral deposits in the area. Based on the geochemical evidence, the zone has a low mineral resource potential for tungsten, lead, and copper with a certainty of B.

Near the head of Sand Canyon there is a small roof pendant that contains mineralized calcareous rock. The KE-NYO-TAL prospect (pl. 1, No. 5) is located in this pendant, but no gold, silver, or tungsten were detected in rock samples collected there. Tungsten was detected in two stream-sediment samples in the area but other elements usually associated with skarn deposits are absent. The geology is favorable for a skarn deposit, but the geochemical results do not indicate a high degree of mineralization. The area has low mineral resource potential for tungsten with a certainty of C.

Conclusions for the Little Lake Canyon Wilderness Study Area

The Midnite Glow prospect is located along a vein of tungsten-bearing rock just south of the Little Lake Canyon study area. Two stream-sediment samples collected in Deadfoot Canyon, just north of the prospect, yielded greater than 70 ppm tungsten (R.E. Tucker and M.F. Diggles, unpub. data, 1984). Although the mineral-bearing structure at the prospect was not traced into the Little Lake Canyon study area, the data suggest tungsten minerals may be present there on strike with the vein. The projection of the vein has a low mineral resource potential for tungsten with a certainty of B.

In the lower half of Little Lake Canyon, there is a zone of potentially mineralized rocks in the Sacatar Quartz Diorite. Heavy-mineral concentrates from this area contain slightly anomalous levels of tungsten. These are accompanied by anomalous levels of cobalt in one sample; nonmagnetic iron, which is usually an indication of sulfide deposits, in four samples; strontium in one sample; and thorium, yttrium, and niobium in six samples. The association of these elements indicates that the anomaly is probably derived from mineralized rock. However, the levels are low, are not associated with any known mineral deposits, and are not in a host rock that is likely to contain ore deposits. Small pods of calcareous metamorphic rocks that are exposed on the ridge south of Little Lake Canyon (M.F. Diggles, unpub. data, 1984) may be the sole source of the anomalies. The pods are small, but their occurrence and the observed geochemical anomalies fit tungsten-skarn deposit models (Rose and others, 1979); the area has a low mineral resource potential for tungsten at a certainty level of B.

There are no known deposits of energy minerals in the study areas. The Little Lake Canyon study area is adjacent to the Coso KGRA. The areas surrounding KGRAs are considered lands valuable prospectively for geothermal resources. The geology along the edge of the Little Lake Canyon study area, however, changes from young volcanic rocks outside the area to Mesozoic plutonic rocks inside the area. These plutonic rocks were intruded during thermal events that are long since over. The area of geothermal resource potential is therefore limited to the region adjacent to the study area directly east of the study area boundary.

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APPENDIX 1. Definition of levels of mineral resource potential and certainty of assessment

Mineral resource potential is defined as the likelihood of the presence of the mineral resources in a defined area; it is not a measure of the amount of resources or their profitability.

Mineral resources are concentrations of naturally occurring solid, liquid, or gaseous materials in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Low mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment where the existence of resources is permissive. This level of potential embraces areas of dispersed mineralized rock as well as areas having few or no indications of mineralization. Assignment of low potential requires specific positive knowledge; it is not to be used as a catchall for areas where adequate data are lacking.

Moderate mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable chance for resource accumulation, and where an application of genetic and (or) occurrence models indicates favorable ground.

High mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resources, where interpretations of data indicate a high likelihood for resource accumulation, where data support occurrence and (or) genetic models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential requires positive knowledge that resource-forming processes have been active in at least part of the area; it does not require that occurrences or deposits be identified.

Unknown mineral resource potential is assigned to areas where the level of knowledge is so inadequate that classification of the area as high, moderate, or low would be misleading. The phrase "no mineral resource potential" applies only to a specific resource type in a well defined area. This phrase should not be used if there is the slightest possibility of resource occurrence; it is not appropriate as the summary rating for any area.

Expressions of the certainty of the mineral resource assessment incorporate a consideration of (1) the adequacy of the geologic, geochemical, geophysical, and resource data base available at the time of the assessment, (2) the adequacy of the occurrence or genetic model used as the basis for a specific evaluation, and (3) an evaluation of the likelihood that the expected mineral endowment of the area is, or could be, economically extractable.

Levels of certainty of assessments are denoted by letters, A-D (fig. 3).

A. The available data are not adequate to determine the level of mineral resource potential. Level A is used with an assignment of unknown mineral resource potential.

B. The available data are adequate to suggest the geologic environment and the level of mineral resource potential, but either evidence is insufficient to establish precisely the likelihood of resource occurrence, or occurrence and (or) genetic models are not known well enough for predictive resource assessment.

C. The available data give a good indication of the geologic environment and the level of mineral resource potential, but additional evidence is needed to establish precisely the likelihood of resource occurrence, the activity of resource-forming processes, or available occurrence and (or) genetic models are minimal for predictive applications.

D. The available data clearly define the geologic environment and the level of mineral resource potential, and indicate the activity of resource-forming processes. Key evidence to interpret the presence or absence of specified types of resources is available, and occurrence and (or) genetic models are adequate for predictive resource assessment.

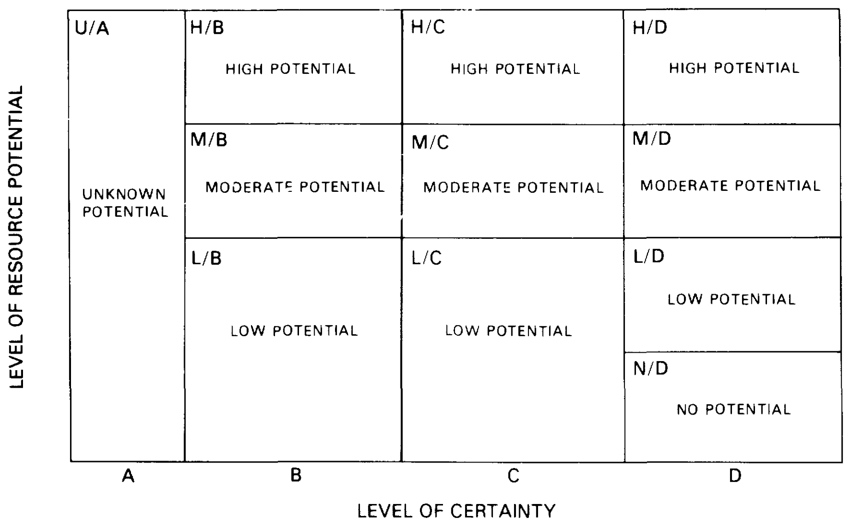

Figure 3. Major elements of mineral resource potential/certainty classification

Table 1.—Mines and prospects in and adjacent to the Owens Peak and Little Lake Canyon Wilderness Study Areas
[*, outside wilderness study area]

Map No.	Name	Summary	Workings and production	Sample and resource data
1	Stone pit	Massive granitic rock crops out in the pit.	Open cut.	No samples taken. Crushed rock possibly used for fill material in construction of the los Angeles Aqueduct
2*	Midnite Glow prospect	An 0.8-ft- to 3 thick quartz vein averaging 1.5 ft thick is at least 900 ft long and 400 ft deep in granitic host rock. The vein strikes N. 25° W., dips 65° NE, and contains scheelite.	Two adits (50 and 40 ft long), a caved adit, a 20-ft-long trench, and a mill foundation.	About 20,000 tons of subeconomic resources average 0.10 percent tungsten trioxide (WO_3). Fifteen samples were taken. Samples contained 0.04 percent to 0.76 percent WO_3, and 10 samples contained 0.010 to 0.036 oz/ton silver.
3	Ninemile Canyon feldspar mine	Three cylindrical simple pegmatite bodies, 100 ft, 30 ft, and 8 ft in diameter are in granitic country rock. Perthitic feldspar crystals are as long as 4 in. About 25 percent of pegmatite is quartz and less than 1 percent is biotite.	Three adits; a 65-ft-long adit stoped to the surface and 2 adits 45 and 10 ft long. Fifty tons of feldspar produced in 1930.	Six samples were taken. One contained 0.0014 oz/ton gold. Three samples that were further analyzed contained 10.3 to 14.2 percent potassium oxide, 0.67 to 0.71 percent calcium oxide, 2.1 to 2.9 percent sodium oxide, 66.2 to 71.9 percent silicon dioxide, and 0.26 to 0.38 percent ferric oxide.
4	MYTECH placer prospect	A valley about 50 ft wide containing gravel less than 10 ft deep drains granitic to dioritic rocks of the Sierra Nevada batholith.	No workings.	An alluvial sample taken from MYTECH claims contained no significant mineral values.
5	KE-NYO-TAL prospect	An epidote-quartz skarn outcrop, about 25 ft in diameter is in metamorphic rocks near contact with granitic rocks.	One 8-ft-long adit.	One sample was taken; it contained no significant mineral values.
6	Vega-Stonehenge placer prospect	Head of Indian Wells Canyon is underlain by granite, diorite, and gabbro of the Sierra Nevada batholith. Gravel less than 10 ft deep and 25 ft wide occurs in this narrow, steep valley in which the Vega and Stonehenge claims are located.	No workings.	One alluvial sample taken; it contained trace of scheelite.
7	Oweas (Owens?) Peak-Paradise prospect	A hornblende-gabbro intrusion, more than 100 ft wide in this area, contains less than 1 percent pyrite. Some weathered pyrite is rimmed by secondary copper minerals.	Two small pits.	One sample of hornblende gabbro was taken; it contained 9.6 percent iron, 0.018 percent copper, and 0.007 percent chromium.
8	Buckhorn (Snow White, Sierra tungsten) mine	Three skarn bodies, the largest of which is about 3 by 20 by 30 ft in size are surrounded by granite to granodiorite of the Sierra Nevada batholith.	Three adits (10, 20, and 60 ft long) and a 13-ft-deep shaft. U.S. Bureau of Mines records indicate more than 80 tons of ore mined on the Snow White claims.	Seven samples were taken; three contained 0.0014, 0.00073, and 0.00047 oz/ton gold. One sample contained 0.04 percent WO_3. The skarn bodies are too small and low grade to constitute a resource.
9	Blue Max (Fernandez) prospect	Both tungsten-bearing skarn and low-grade gold in metamorphic rocks occur on parts of the property. A skarn pod 45 by 15 by 25 ft deep enclosed by diorite is the main occurrence. Six smaller skarn bodies and a scheelite-bearing quartz vein 2 to 5 ft thick and more than 25 ft long also crop out.	Six adits (12, 15, 45, 63, 95, and 125 ft long), two caved adits, and nine small pits.	Thirty-two samples were taken; gold was detected in 12, but only two had more than 0.006 oz/ton; one had 0.0195 the other 0.0188 oz/ton. Of 11 samples containing tungsten, four had less than 0.05 percent WO_3, six contained between 0.15 percent and 0.44 percent WO_3, and one contained 1.45 percent WO_3. The pods are too small and low grade to be a resource.
10	Magnolia (Nado, Nadeau) mine	Deposit is in a roof pendant of mineralized metamorphic rocks within the Sierra Nevada batholith. Schists contain pyrite, pyrrhotite, and minor very fine-grained disseminated galena, chalcopyrite, sphalerite, and stibnite associated with gold. Quartz veins and granite dikes are spatially related to gold mineralization. Highest gold values are from samples of quartz veins, schist, and gneiss collected near and in workings on top of Magnolia Hill. A small amount of scheelite occurs in skarn formed at the contact between a marble unit and granitic rocks of the batholith. Metamorphosed igneous rocks do not contain gold.	Nine adits (8, 10, 20, 28, 45, 75, 90, 95, and 110 ft long), five caved adits, three partly caved shafts, and 11 small pits. A mill, house, and shop are on the property. U.S. Bureau of Mines records indicate that 47 oz gold and 22 oz silver were recovered between 1937 and 1938 and 92 tons of tungsten ore with an average of 2.2 percent WO_3 was mined in 1955. Recovery was 94 short ton units of WO_3.	Within the study area, there is an estimated 1.2 million tons of rock containing an average of 0.02 oz/ton gold and by-product silver. One hundred fourteen samples of metamorphic and igneous rock were taken. Seventy-nine samples had detectable gold values which were as high as 0.58 oz/ton. Fifty-five had detectable silver values, as high as 0.31 oz/ton. Twenty-one of these samples were from outside the study area and show that mineralized rock occurs there, but these were not used in the resource estimate. Only 12 samples contained tungsten. Ten samples of schist had from 0.0006 percent to 0.0036 percent tungsten and two skarn samples had 0.14 percent and 1.6 percent WO_3. The mine is currently operating a pilot mill on an experimental basis.

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