DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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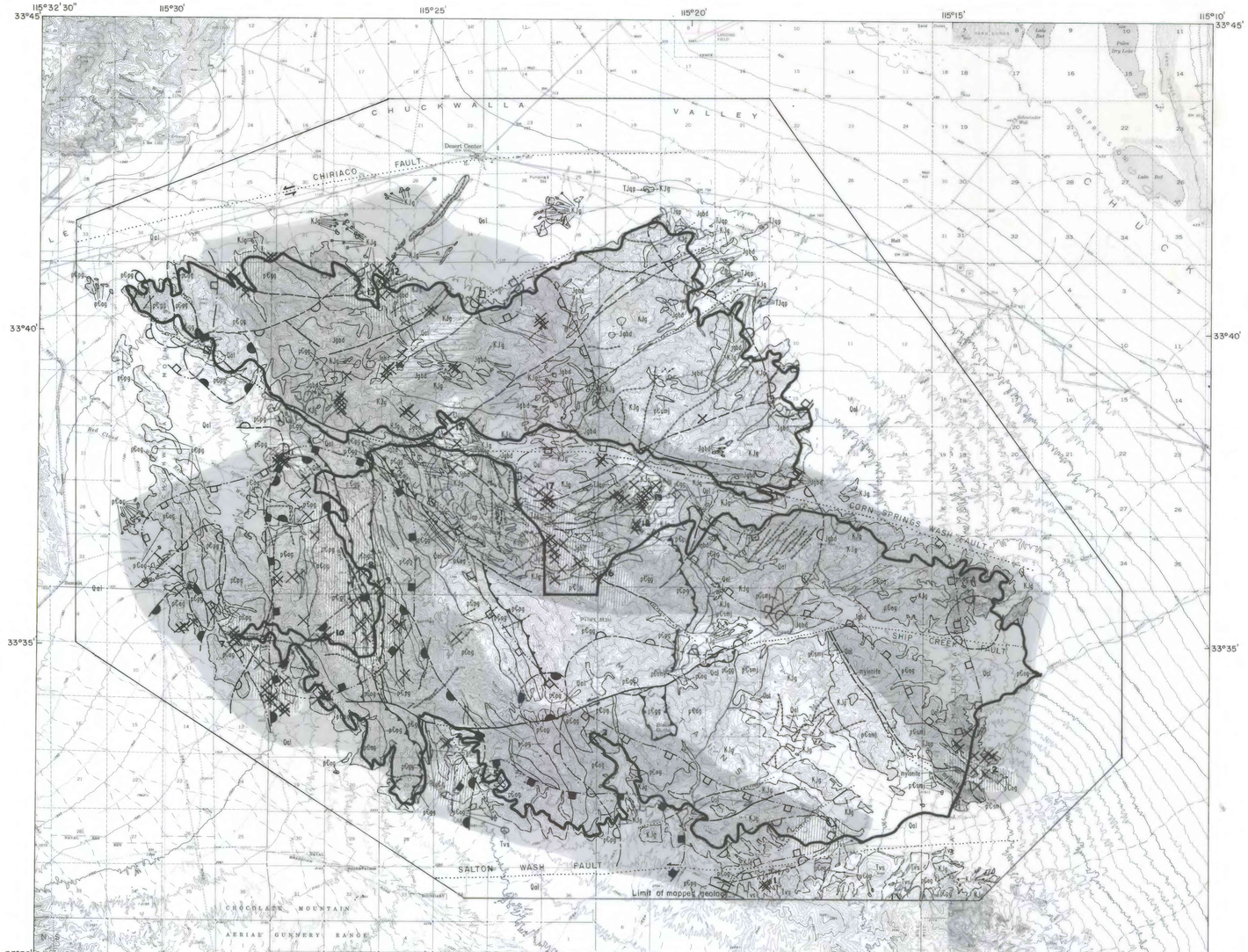
GEOLOGICAL SURVEY
AND THE
BUREAU OF MINES
FOR THE
U.S. BUREAU OF LAND MANAGEMENT

OPEN—FILE REPORT 84-674




Base from U.S. Geological Survey
Shoshone Well, 1950; Chuckwalla Spring, 1953;
Frink, 1956; Chuckwalla Mtn., Hayfield, Iris Pass, 1963

APPROXIMATE MEAN DECLINATION, 1984

SCALE 1:62500

CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped by R. E. Powell 1973-1980, 1983-1984

# MINERAL RESOURCE POTENTIAL MAP OF THE CHUCKWALLA MOUNTAINS WILDERNESS STUDY AREA (CDCA—348), RIVERSIDE COUNTY, CALIFORNIA

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1984

## EXPLANATION

AREAS WITH POTENTIAL FOR UNDISCOVERED MINERAL RESOURCES

GOLD AND SILVER RESOURCES--Probably occur in vein deposits

High potential--Delineated on basis of assay values or silver concentrations in nonmagnetic heavy-mineral fractions of stream-sediment samples

Moderate potential--Delineated on basis of assay values

Low to moderate potential--Delineated on basis of proximity to mafic dikes and a lack of geochemical evidence for moderate or high potential

TUNGSTEN RESOURCES--Delineated on basis of elemental concentrations in nonmagnetic heavy-mineral fractions of stream-sediment samples. Resources probably occur in vein deposits

High potential (concentration greater than 700 ppm)--Teeth on side of higher concentration

Moderate potential (concentration greater than 100 ppm)--Teeth on side of higher concentration

MOLYBDENUM RESOURCES--Delineated on basis of elemental concentrations in nonmagnetic heavy-mineral fractions of stream-sediment samples. Resources probably occur in vein deposits

High potential (concentration greater than 70 ppm)--Teeth on side of higher concentration

Moderate potential (concentration greater than 10 ppm)--Teeth on side of higher concentration

COPPER AND LEAD RESOURCES--Low potential in all areas that have moderate or high potential for gold, silver, tungsten, or molybdenum resources

TIN AND THORIUM RESOURCES--Low potential throughout the north part of the wilderness study area

MINE OR PROSPECT

1 Cap Hunter mine
2 Aztec mine
3 Seal mine
4 Mine with unknown name
5 Liberation(?) mine
6 Model mine
7 Echo Valley mine
8 Red Cloud mine
9 Great Western mine
10 Eureka mine
11 Lost Pony mine
12 Granite mine
13 Gold Crown (San Diego) mine
14 Gold King mine
15 Lucky strike mine
16 Triangle (Pilot) mine
17 C.O.D. mine
18 Bryan mine
19 Mine with unknown name

## CORRELATION OF MAP UNITS

| | | | |
|---|---|---|---|
| Qal | | QUATERNARY | CENOZOIC |
| Tvs | | TERTIARY | |
| | Tdgp | TERTIARY, CRETACEOUS, AND (OR) JURASSIC | CENOZOIC AND (OR) MESOZOIC |
| | Kdg | CRETACEOUS AND (OR) JURASSIC | MESOZOIC |
| | Jgbd | JURASSIC | |
| San Gabriel terrane | Joshua Tree terrane | | |
| | Pzqg | PALEOZOIC AND (OR) PRECAMBRIAN | |
| Pzpq, Pzqg | | PRECAMBRIAN | |
| Pzpq | | PRECAMBRIAN | |
| Pzpg | | PRECAMBRIAN | |
| Pzqg | | PRECAMBRIAN | |

Age relations unknown

## DESCRIPTION OF MAP UNITS

Qal ALLUVIUM (QUATERNARY)--Sand and gravel in active stream channels and in older, inclised deposits; locally, may include Pliocene alluvium

Tvs VOLCANIC AND SEDIMENTARY ROCKS (TERTIARY)--Volcanic rocks include basaltic and (or) andesitic flows and pyroclastic units; sedimentary rocks include terrestrial arkosic sandstone and conglomerate. The unit crops out in the southern Chuckwalla Mountains and is probably correlative with part of the Diligencia Formation of Crowell (1975)

Tdgp QUARTZ PORPHYRY DIKES (TERTIARY, CRETACEOUS, AND (OR) JURASSIC)--Quartz latite; light- to medium-gray on fresh surfaces; phenocrysts of quartz, alkali feldspar, plagioclase, and rare garnet in a siliceous aphanitic groundmass that constitutes 80 to 85 percent of the rock. Weathers separately only where wide enough to show on map, otherwise, included with the felsic dikes

Kdg FELSIC DIKES (TERTIARY, CRETACEOUS, AND (OR) JURASSIC)--Consist of: (1) aphanitic or fine-grained, light-gray or white dikes; (2) light- to medium-gray quartz porphyry (unit Tdgp; where outcrop width is too thin to distinguish on map); (3) gray, fine-grained latite and dacite with microphenocrysts of feldspar, biotite, and hornblende in varying proportions; rare quartz and garnet; (4) feldspar porphyry with cream-colored to pinkish-white alkali feldspar phenocrysts and smaller phenocrysts of hornblende, biotite, and rare quartz set in a dark-gray, aphanitic groundmass that makes up 75-80 percent of the rock

Jgbd MAFIC DIKES (TERTIARY, CRETACEOUS, AND (OR) JURASSIC)--Typically fine-grained, diorite commonly propylitically altered to a greenish-gray rock characterized by actinolite, chlorite, and epidote; nonresistant to erosion; 0.5 to 4 m thick; locally dikes are pervasively foliated parallel to their contacts

Jqmz GRANITIC ROCKS (CRETACEOUS AND (OR) JURASSIC)--Consists of subunits of (1) coarse-grained biotite monzogranite (youngest), typically containing 25 to 35 percent quartz; (2) fine-grained porphyritic biotite monzogranite with scattered small phenocrysts of alkali feldspar; (3) fine-grained equigranular monzogranite that grades into the fine-grained porphyritic biotite monzogranite subunit, and that contains local concentrations of dark bluish-gray, 2- to 5-cm spherical clots of biotite, quartz, and muscovite commonly surrounded by white zones from which all the mafic minerals have been leached; (4) coarse-grained porphyritic biotite monzogranite with phenocrysts of pink alkali feldspar; and (5) medium-grained sphene-biotite-hornblende granodiorite (oldest)

Jgbd GABBRO AND DIORITE (JURASSIC)--Biotite-hornblende gabbro and diorite, and subordinate hornblendite and biotite-hornblende monzodiorite; color index ranges from about 50 to 95+. Clinopyroxene and olivine locally are poikilitically enclosed within hornblende in the more mafic rocks; small amounts of alkali feldspar and quartz are almost always present; sphene and secondary epidote and chlorite are ubiquitous. As mapped, unit may contain pre-Jurassic mafic intrusive rocks

### San Gabriel terrane

Pzpq STONITE-MANGERITE-JOTUNITE (PRECAMBRIAN)--Medium-grained, rusty-brown-weathering syenite, monzodiorite, and diorite rocks characterized by mesopertite and mafic clots with relict corona-textures in which orthopyroxene(?) has been replaced by amphibole; typically contain less than 5 percent quartz

Pzpg ORTHOGNEISS (PRECAMBRIAN)--Consists of two subunits: (1) a heterogeneous mixture of tonalite to granite gneiss that locally displays relict mesopertite, antiperthite, and garnet and corona-textured replacement of pyroxene; (2) a granodiorite to monzogranite orthogneiss that is characterized by eye-shaped or tabular megacrysts of pink or white alkali feldspar oriented in a foliated dark-colored feldspar-quartz-biotite matrix; where undeformed, such as locally in the southern Chuckwalla Mountains, the unit has a porphyritic igneous texture with randomly oriented, equigranular-textured phenocrysts of alkali feldspar in a dark, medium-grained matrix of biotite, quartz, and feldspar

Pzpq PARAGNEISS (PRECAMBRIAN)--Biotite and pelitic metasedimentary gneiss characterized by mineral assemblages containing prograde biotite + quartz + plagioclase + alkali feldspar ± sillimanite ± garnet with retrograde muscovite and chlorite

### Joshua Tree terrane

Pz(pq) QUARTZITE (PALEOZOIC AND (OR) PRECAMBRIAN)--Consists of two lithologic subunits: (1) cross-bedded quartzite; coarse- to very coarse-grained, vitreous, mottled gray and bluish gray; medium-bedded to massive with low-angle sets of tangential planar cross-laminations; compositionally mature (95+ percent quartz) with abundant white sillimanite; (2) vitreous white to light-gray quartzite; very coarse-grained; massive with bedding obscure or obliterated; compositionally supermature, commonly with 98-99+ percent quartz

Pzqg GRANITIC GNEISS (PRECAMBRIAN)--Granitic to monzogranitic; augen and rod gneiss, with deformed megacrysts of alkali feldspar and spindle-shaped aggregates of feldspar and quartz; typically contains less than 10 percent biotite in recrystallized, lenticular aggregates. Where overlain by the quartzite unit, the granite gneiss is capped by an aluminous schist (sillimanite + muscovite + quartz) characterized by 2-5-mm augen of recrystallized-quartz aggregates; the schist is inferred to represent a metamorphosed paleosol. Near the schist layer, the granite gneiss is muscovitic

CONTACT--Dashed where approximately located

THRUST FAULT--Dashed where approximately located, dotted where covered; sawteeth on upper plate

HIGH-ANGLE FAULT OR FRACTURE--Dashed where approximately located, dotted where covered; arrows indicate relative movement

MYLONITE ZONE

APPROXIMATE BOUNDARY OF WILDERNESS STUDY AREA

## STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U. S. Geological Survey and the U. S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral values. 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 Chuckwalla Mountains Wilderness Study Area (CDCA-348), California Desert Conservation Area, Riverside County, California.

## SUMMARY

Geologic and geochemical investigations and a survey of mines and prospects indicate that those parts of the Chuckwalla Mountains Wilderness Study Area (chiefly in the Red Cloud Canyon and Corn Springs Wash vicinities) that are intruded by propylitically altered mafic dikes with spatially associated quartz veins and shear zones have moderate or high potential for resources in vein deposits. High stream-sediment concentration of molybdenum strongly suggest that parts of those areas intruded by the dikes also contain molybdenum-bearing minerals and thus have moderate or high potential for the production of molybdenum resources. However, there has been no recorded production of molybdenum in the region and any resources that may be present in the study area are likely to be significant only if the mineralized quartz veins and shear zones are manifestations of an extensive subsurface quartz-vein stockwork system. All areas with moderate or high potential for gold, silver, tungsten, or molybdenum resources also have low potential for the presence of undiscovered copper and lead resources. Low potential for the presence of undiscovered tin and thorium resources exists in the north part of the wilderness study area. Sand, gravel, and stone suitable for construction materials are found in the study area, but similar or better quality materials are abundant and equally or more readily accessible outside the area. No new mineral occurrence was located during this study.

## INTRODUCTION

This map summarizes the results of geologic and geochemical surveys by the U.S. Geological Survey and an investigation of mines, prospects, and mineralized areas by the U.S. Bureau of Mines. Our objectives in this summary map are to appraise identified resources[1] in the study area and to assess the potential for undiscovered resources.

[1]Resource--a concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible (U.S. Bureau of Mines and U.S. Geological Survey, 1980). Defined in this broad fashion, a resource may include material (reserves) that can be developed profitably under current market conditions or it may contain only material (marginal reserves, subeconomic resources) that requires more favorable market conditions or more advanced technological capability to be developed profitably.

The Chuckwalla Mountains Wilderness Study Area consists of about 57,312 acres in the northern Chuckwalla Mountains, Riverside County, Calif., just south of Interstate 10 about 180 mi east-southeast of Los Angeles (index map). The wilderness study area is split in two by a corridor along Corn Springs Wash; embayments into each segment exclude areas with numerous mines and prospects and the roads leading to them. These roads provide ready access to the wilderness study area.

## GEOLOGY

Crystalline rocks of the Chuckwalla Mountains Wilderness Study Area constitute parts of a Mesozoic batholith and Precambrian and Precambrian and (or) Paleozoic country rock into which the batholith has intruded. In the Chuckwalla Mountains and several nearby mountain ranges, prebatholithic rocks comprise two lithologically distinct terranes: the Joshua Tree and San Gabriel terranes of Powell (1981, 1982). The two terranes are superposed along a prebatholithic low-angle fault system of regional extent, the Red Cloud thrust.

The structurally lower Joshua Tree terrane consists of Precambrian granite capped by a metamorphosed paleosol and overlain nonconformably by orthoquartzite that interfingers with pelitic and feldspathic granofels units. The rocks of the Joshua Tree terrane were metamorphosed under amphibolite-grade conditions and, near the Red Cloud thrust, were pervasively deformed to granite gneiss, lineated quartzite, and schist.

Precambrian units of the San Gabriel terrane comprise a three-part deep-crustal section. At the highest level, metasedimentary gneiss of upperout amphibolite-grade is intruded by granodioritic augen gneiss. Both of these units are intruded by retrograded granulite gneiss at an intermediate level, and the granulitic rocks are in turn intruded by syenite-mangerite-jotunite at the lowest level exposed.

Mesozoic plutonic rocks comprise two batholithic suites, both of which intrude the Joshua Tree and San Gabriel terranes and the Red Cloud thrust system. West-northwest-, north-northwest-, and northeast-trending swarms of felsic, intermediate, and mafic dikes crosscut plutons of both batholithic suites in the region. The orientations of the dikes are parallel to the orientations of fractures that crosscut batholithic and prebatholithic rocks throughout the Chuckwalla Mountains and nearby ranges. Gold, scheelite, molybdenite, fluorite, and copper minerals occur in quartz veins and bleached and limonite-stained altered rock associated spatially with propylitically altered mafic dikes in the Chuckwalla Mountains.

Cenozoic east-west trending left-lateral strike-slip faults bound the northern Chuckwalla Mountains to the north and south and transect the range.

## GEOCHEMISTRY

Nonmagnetic heavy-mineral fractions of stream-sediment samples from the Chuckwalla Mountains contain anomalously high concentrations of tungsten, molybdenum, silver, lead, beryllium, and bismuth in a north-northeast trending zone along the southern flank of the northern part of the range, especially in and around Red Cloud Canyon. In a west-northwest trending zone that lies roughly parallel to and just south of Corn Springs Wash, tungsten and molybdenum are detected in lower concentrations than in the Red Cloud Canyon zone. The detectable metallic-element concentrations in these two zones are elevated relative to values expected from sediment derived from unmineralized rock, and linked with the identification of scheelite and fluorite in panned concentrates, indicate that these elements were mobilized and concentrated in a mineralizing system. Anomalously high concentrations of tin, niobium, and thorium along the north flank of the range are probably contained in minerals such as sphene, apatite, and zircon rather than in ore-minerals such as cassiterite (tin) or monazite (thorium).

## MINING DISTRICTS AND MINERALIZED AREAS

The Chuckwalla mining district contains occurrences of gold, silver, scheelite, molybdenite, galena, sphalerite, hematite, and limonite. Prospects and mines range in size from small pits to small well-developed mines. Mining claims in and near the study area filed with the U.S. Bureau of Land Management (1981 records) include 7 patented claims. Incomplete production records indicate that half a dozen mines immediately adjacent to the study area have produced a total of 1,829 oz of gold, 519 oz of silver, and 1,764 lb of lead since the late nineteenth century. During this investigation, the U.S. Bureau of Mines mapped and sampled all known mines, prospects, and mineralized areas that were accessible, inside and within about 1 mi of the study area. A total of 312 samples were collected in 18 separate mineralized areas and fire-assayed for gold and silver. About a quarter of these samples contained detectable gold (greater than 0.005 oz/ton) and a subordinate number contained detectable silver (greater than 0.2 oz/ton).

## ASSESSMENT OF MINERAL RESOURCE POTENTIAL

### Assessment criteria

Gold, silver, tungsten, molybdenum, bismuth, lead, and copper have been mobilized and concentrated throughout much of the Chuckwalla Mountains. Data gathered during this study permit neither specification of the processes or absolute timing of mineralization in the Chuckwalla Mountains, nor substantiation of the presence of undiscovered resources. However, from the geologic and geochemical surveys and the examination of mines and prospects we have established the following empirical criteria for assessing potential for the presence of undiscovered gold, silver, tungsten, and molybdenum resources in the region:

(1) the presence of quartz veins and zones of fracturing and faulting where accompanied by the presence of propylitically altered mafic dikes;

(2) elevated concentrations of tungsten, molybdenum, silver, gold, or bismuth in stream-sediment samples;

(3) the presence of mines and prospects and gold or silver detected in assays of samples of quartz veins and bleached or limonite-stained rocks; areas in which there is evidence for potential for gold, silver, tungsten, or molybdenum resources are usually indicated by more than one criterion. We judge all areas that contain mafic dikes to have potential for these resources. Although areas with potential generally are indicated by a combination of geological and geochemical criteria, our assignment of a specific level of low, moderate, or high potential for the presence of a particular metallic mineral resource is based on the strength of the geochemical evidence for that resource. Because areas in which mafic dikes are not exposed yield no geochemical or geologic evidence for mineralization, we have not assigned them a potential.

### Gold and silver

In areas where a third or more of assays on systematically collected vein samples show gold or where silver is detected in the nonmagnetic heavy-mineral fraction of stream-sediment samples, we assign a high potential for the presence of undiscovered gold resources in quartz veins or shear zones. In areas where less than a third of assays on vein samples show gold, we assign a moderate potential. In areas where gold is rare in assayed vein samples or where field observations did not indicate a need for assays, we assign a low to moderate potential.

Known vein gold deposits in the Chuckwalla Mountains are small in volume and typically of low to medium grade, although high-grade pockets have been found. Although any undiscovered gold deposits in the study area are likely to be similar in size and grade to those already known, the presence of much larger subsurface deposits of gold in veins or disseminated in country rock cannot be ruled out.

Potential for the presence of undiscovered silver resources in quartz-vein deposits parallels, and is incidental to, the potential for gold resources.

### Tungsten

We assign a high potential for the presence of undiscovered tungsten resources in vein deposits to areas that are characterized by high tungsten concentrations (greater than 700 parts per million (ppm)) in the nonmagnetic heavy-mineral fraction of stream-sediment samples. Where stream-sediment tungsten concentrations fall in the range from 100 ppm to 700 ppm, we assign a moderate potential. Areas where stream-sediment tungsten concentrations are 100 ppm or less are also characterized by the absence of mafic dikes, and thus are areas in which we have recognized no evidence of a potential.

A lack of significant tungsten production from the Chuckwalla Mountains, together with the relatively low tungsten concentrations detected in vein samples, are consistent with the presence of widespread small, low-grade vein deposits. However, by analogy with vein scheelite deposits elsewhere in the region, it is possible that larger and higher-grade subsurface deposits are present.

### Molybdenum

We assign a high potential for the presence of undiscovered molybdenum resources to areas that are characterized by high concentrations of molybdenum (greater than 70 ppm) in the nonmagnetic heavy-mineral fraction of stream-sediment samples. Where stream-sediment molybdenum concentrations are fall in the range from 10 ppm to 70 ppm, we assign a moderate potential. Areas where stream-sediment molybdenum concentrations are 10 ppm or less are also characterized by the absence of mafic dikes, and thus are areas in which we have recognized no evidence of a potential. If tungsten is inferred to be a pathfinder for subsurface molybdenum deposits, as it is in many of the world's large molybdenum deposits, then areas with high potential for the presence of tungsten resources may also be considered to have high potential for the presence of molybdenum resources.

There has been no molybdenum production from the Chuckwalla Mountains and little production from molybdenum deposits anywhere in southern California. Evidence for molybdenum mineralization in the study area occurs in and around the same vein and fracture system as evidence for tungsten, gold, and silver mineralization. However, more detailed mineralogical and geochemical studies are needed to evaluate the likely form and content of potential molybdenum resources in the Chuckwalla Mountains.

### Copper and lead

In and around the wilderness study area, evidence for copper and lead mineralization tends to be found in areas characterized by evidence for gold, silver, tungsten, and molybdenum mineralization. Consequently, we assign a low potential for the presence of undiscovered copper and lead resources in small vein deposits to all areas with potential for gold, silver, tungsten, or molybdenum resources.

### Tin and thorium

Although tin and thorium concentrations in some panned concentrates from stream-sediment samples in the Chuckwalla Mountains are anomalously high for the region, the principal ore minerals of tin and thorium--cassiterite and monazite, respectively--have not been observed microscopically in panned concentrates. Comparison of geochemical data for stream-sediment samples from the Chuckwalla Mountains with those for samples from the nearby Eagle Mountains (Powell and others, 1981)--where identical rocks are exposed--shows that elevated concentrations of tin are derived from areas underlain both by the Precambrian granite gneiss of the Joshua Tree terrane and Mesozoic granitic rocks. This observation is consistent with deposition of tin in a crosscutting mineralizing system. Therefore, we assign a low potential for the presence of undiscovered tin and thorium resources in small vein deposits to the north part of the wilderness study area; in the south part, we have found no evidence of a potential for tin or thorium resources.

### Oil and gas

The alluvial basin flanking the northern half of the study area is largely leased and under application for leases for oil and gas. Locally, these leases extend into the crystalline rocks that underlie the study area. We have found no evidence of a potential for oil or gas resources in or under the igneous and metamorphic rocks of the wilderness study area.

### Sand, gravel, and stone

Sand, gravel, and crystalline rocks suitable for construction purposes are abundant in the study area, but similar or better grade material is abundant and accessible in the region outside the study area.

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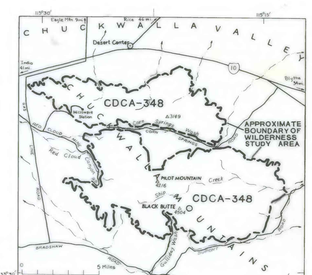


Index map showing location of the Chuckwalla Mountains Wilderness Study Area (CDCA-348), California Desert Conservation Area, Riverside County, Calif.

Explanatory pamphlet accompanies map