Mineral Resources of the Sacatar Meadows Wilderness Study Area, Tulare and Inyo Counties, California

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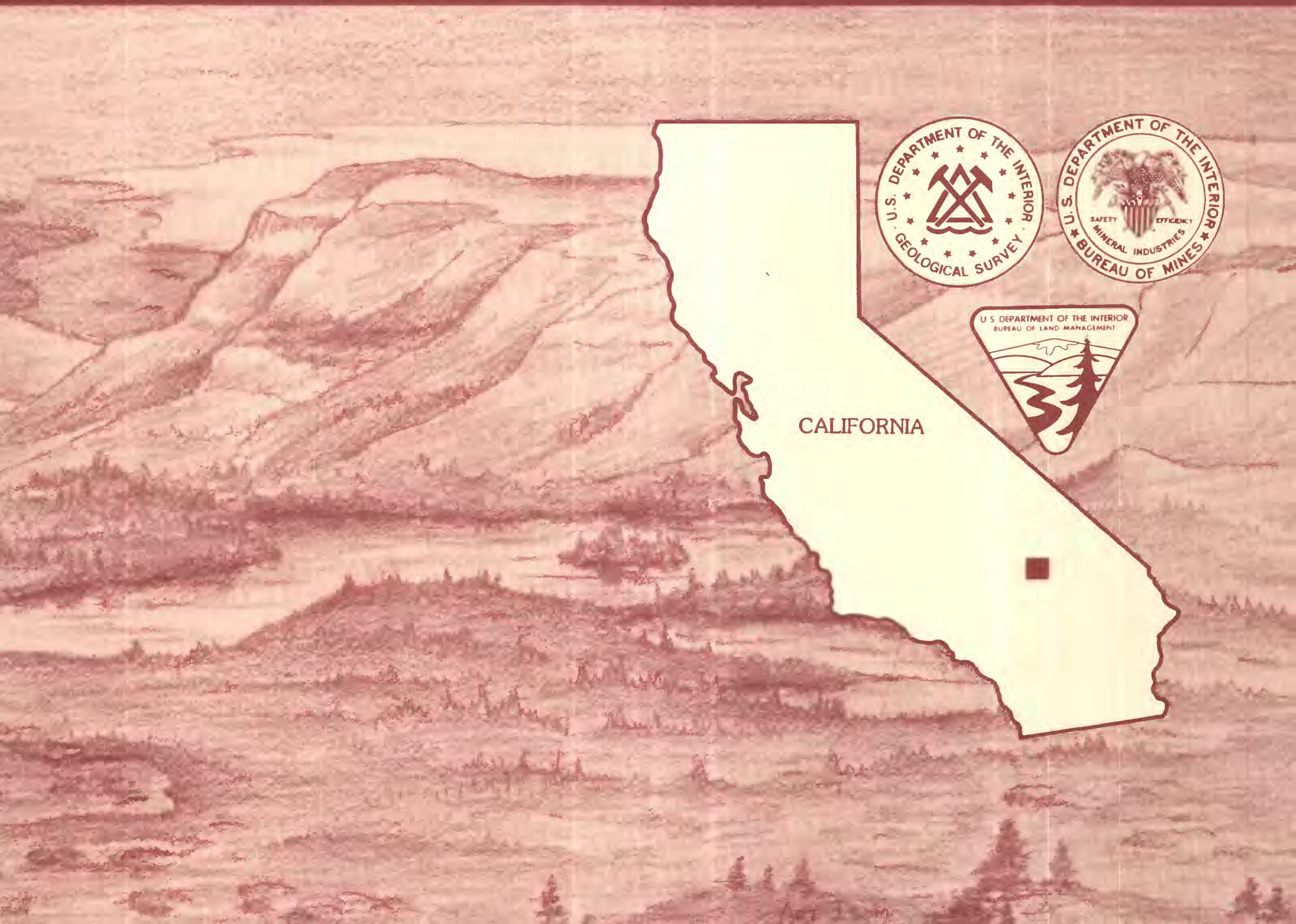

Chapter D

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MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
SOUTH-CENTRAL CALIFORNIA

DEPARTMENT OF THE INTERIOR
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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 part of the Sacatar Meadows (CA-010-027) Wilderness Study Area, Tulare and Inyo Counties, California.

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SOUTH-CENTRAL CALIFORNIA

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By Michael F. Diggles, James G. Frisken, *and* Andrew Griscom
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SUMMARY

Abstract

At the request of the U.S. Bureau of Land Management, approximately 11,447 acres of the Sacatar Meadows Wilderness Study Area (CA-010-027) were evaluated for mineral resources (known) and mineral resource potential (undiscovered). In this report, the area studied is referred to as the "wilderness study area" or simply "the study area"; any reference to the Sacatar Meadows Wilderness Study Area refers only to that part of the wilderness study area for which a mineral survey was requested by the U.S. Bureau of Land Management. Field work was conducted in 1984 through 1987 to assess the mineral resources (known) and resource potential (undiscovered) of the area. No mineral resources were identified.

There are five areas of low mineral resource potential in and near the Sacatar Meadows Wilderness Study Area. The ridge northwest of Big Pine Meadow, outside the study area, has low mineral resource potential for tungsten and molybdenum possibly in skarn. The hillside southeast of Scodie Meadow has low mineral resource potential for tungsten and molybdenum possibly in skarn. The valley east of Long Canyon, the small drainage northeast of Sacatar Meadow, and the area southeast of Big Pine Meadow have low mineral resource potential for tungsten possibly in skarn within granitoid rocks. The area has no geothermal energy, energy mineral, or oil and gas resource potential.

Character and Setting

The Sacatar Meadows Wilderness Study Area is approximately 11,447 acres in size and is 5 mi southwest of Coso Junction, Calif. (fig. 1). The terrane is generally steep and rugged, with elevations ranging from about 6,200 ft at Chimney Meadow to about 8,800 ft at unnamed points along the crest of the Sierra Nevada in the northern part of the study area. Access into the study area is by private roads from the Ninemile Canyon Road (County Road J41) off U.S. Highway 395.

Most of the area is underlain by plutonic rocks of the Sierra Nevada batholith. The oldest rocks in the area are Jurassic or older (see appendix for Geologic Time Chart) metamorphosed sedimentary rocks composed of quartz-mica schist and quartzite. These are intruded by the oldest intrusive rocks in the study area, which are Triassic and (or) Jurassic gabbros and diorites. A younger set of more mafic granitic rocks of Jurassic age that are granodioritic to tonalitic in composition dominate the study area. The youngest rocks in the study area are leucocratic, nonfoliated Cretaceous granites, alaskites, aplites, and pegmatites.

Identified Mineral Resources

There are no identified mineral resources in the Sacatar Meadows Wilderness Study Area. In 1984, U.S. Bureau of Mines personnel conducted a mineral appraisal of the study area. During this study, no mines or prospects were found and no mining claims or leases were current in or near the study area.

Mineral Resource Potential

Within and near the study area, five areas have low mineral resource potential (fig. 2) on the basis of analytical

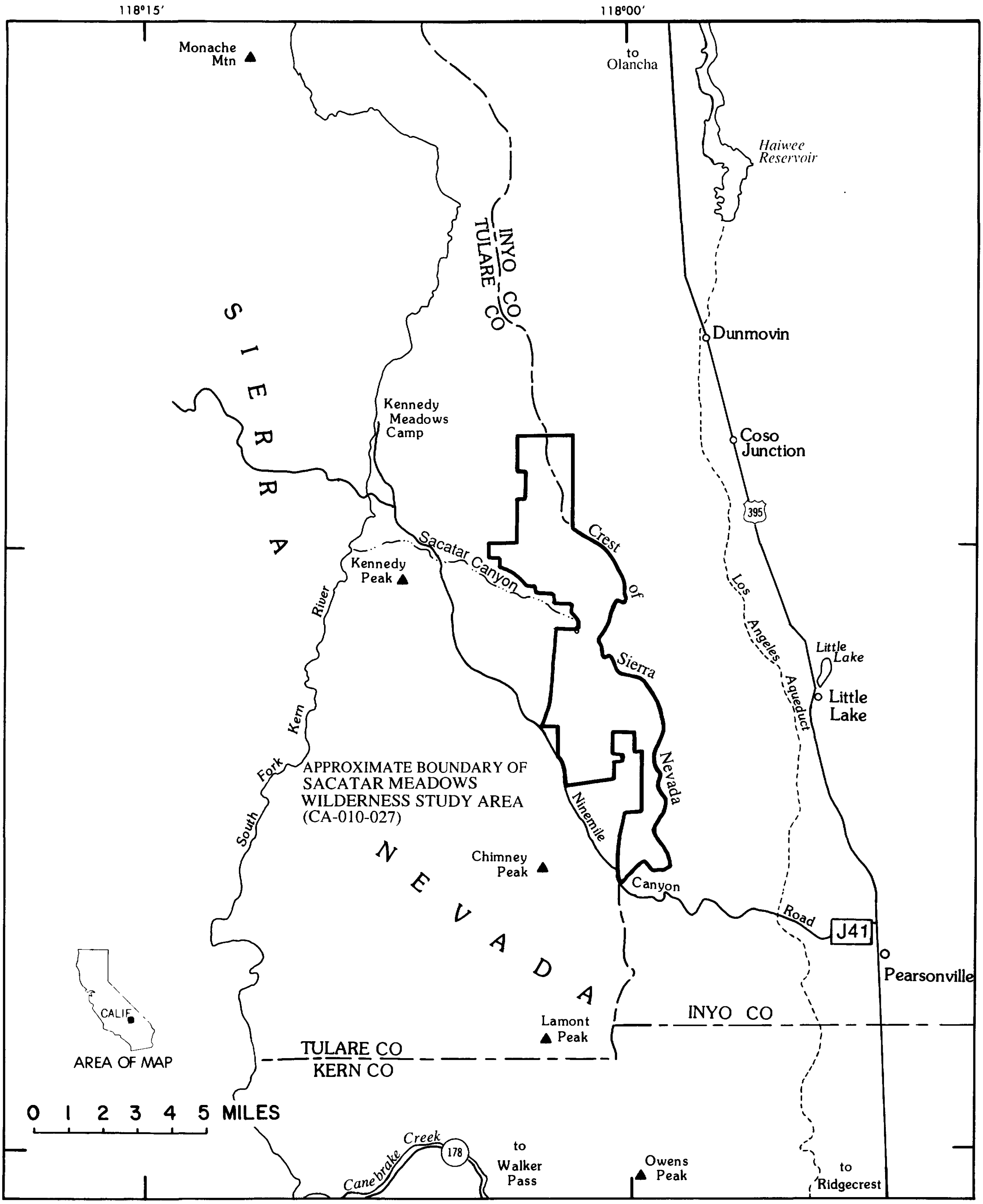


Figure 1. Index map showing location of the Sacatar Meadows Wilderness Study Area, Tulare and Inyo Counties, California.

results of geochemical sample collection; all five areas may be related to unmapped small pods of skarn. The five areas, the host rock, and associated commodity of each are as follows: (1) ridge northwest of Big Pine Meadow, outside the study area; metasedimentary rocks of the Kernville Series; tungsten and molybdenum, (2) hillside southeast of Scodie Meadow and nearby Deadfoot Canyon; granodiorite and quartz diorite; tungsten and molybdenum, (3) valley east of Long Canyon; quartz diorite; tungsten, (4) small drainage northeast of Sacatar Meadow; quartz diorite; tungsten, (5) area southeast of Big Pine Meadow; quartz diorite; tungsten.

The wilderness study area has no geothermal energy, energy mineral, or oil and gas resource potential.

INTRODUCTION

This mineral survey was requested by the U.S. Bureau of Land Management and is the result of a cooperative effort by the U.S. Geological Survey and the U.S. Bureau of Mines. An introduction to the wilderness review process, mineral survey methods, and agency responsibilities was provided by Beikman and others (1983). The U.S. Bureau of Mines evaluates identified resources at individual mines and known mineralized areas by collecting data on current and past mining activities and through field examination of mines, prospects, claims, and mineralized areas. Identified resources are classified according to the system described by U.S. Bureau of Mines and U.S. Geological Survey (1980). Studies by the U.S. Geological Survey are designed to provide a reasonable scientific basis for assessing the potential for undiscovered mineral resources by determining geologic units and structures, possible environments of mineral deposition, presence of geochemical and geophysical anomalies, and applicable ore-deposit models. Mineral assessment methodology and terminology as they apply to these surveys were discussed by Goudarzi (1984). See the appendixes for the definition of levels of mineral resource potential, certainty of assessment, and classification of identified resources.

Location and Physiography

The Sacatar Meadows Wilderness Study Area (CA-010-027) comprises 11,447 acres in the Sierra Nevada physiographic province. It is situated mostly in the southeast corner of Tulare County, about 5 mi southwest of Coso Junction. The east boundary generally follows the Tulare-Inyo County line along the crest of the Sierra Nevada. Elevations in the study area range from about 6,200 ft at Chimney Meadow to about 8,800 ft along the crest of the Sierra Nevada in the northern part of the study area.

Climate in the southern Sierra Nevada is classified as highland type, where precipitation averages 20 to 40 in. per year on the western slope and 12 to 20 in. per year on the eastern slope and supports vegetation of the Sonoran and Transition Zones (Storer and Usinger, 1963). Higher ground has the greatest precipitation and is covered by vegetation of the Transition Zone, principally Jeffrey pine, incense cedar, black oak, ceanothus, and, on the west side of Long Canyon, on the north side of Lamont Peak, rare sugar pine. The middle elevations are in the Upper Sonoran Zone and support pinon and digger pine, live oak, ceanothus, manzanita, and chinquapin. On the dryer lower slopes, the vegetation is typically lower Sonoran sagebrush and mountain mahogany.

Procedures

The U.S. Geological Survey conducted detailed field investigations of the Sacatar Meadows Wilderness Study Area in the spring and summer of 1985 with follow-up work in the summers of 1986 and 1987. This work included geologic mapping at a scale of 1:24,000, field checks of existing geologic maps, geochemical sampling, and the examination of outcrops for the tungsten-bearing mineral scheelite using ultraviolet lamps. Adrian and others (1987) presented the data from the U.S. Geological Survey stream-sediment sample-collection program for this study. The U.S. Bureau of Mines examined the Sacatar Meadows Wilderness Study Area in October 1984 for this study. During this survey, areas likely to contain mineralized rock were examined, sampled where warranted, and routinely checked for radioactivity with a scintillometer. Office studies, completed prior to the field study, included a review of literature and U.S. Bureau of Land Management mining claim records. One placer and four rock samples were collected from the study area during the U.S. Bureau of Mines' field studies. The rock samples were analyzed by fire-assay/inductively coupled-plasma (ICP) for gold and silver and analyzed spectrographically for 40 elements including antimony, barium, cadmium, cobalt, chromium, copper, gold, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, platinum, silver, tin, titanium, vanadium, and zinc. The placer sample was chemically analyzed for uranium and analyzed by a radiometric method for thorium.

Previous Studies

Kuizon (1985) presented the results of a mineral resource appraisal. Aeromagnetic data were collected for the U.S. Geological Survey in 1981 (U.S. Geological Survey, 1982). Smith (1964) and Matthews and Burnett (1966) compiled the regional geology of the Bakersfield and Fresno 1° by 2° sheets, respectively. The general geology of the area west of the Sierra Nevada crest was described by Miller (1931, 1946) and Miller and Webb (1940). A detailed geologic map of the Owens Peak (CDCA-158) and Little Lake Canyon Wilderness Study Areas, east of this study area, was made by Diggles and others (1987) and the mineral resources, geochemistry, and mineral resource potential of those areas were described

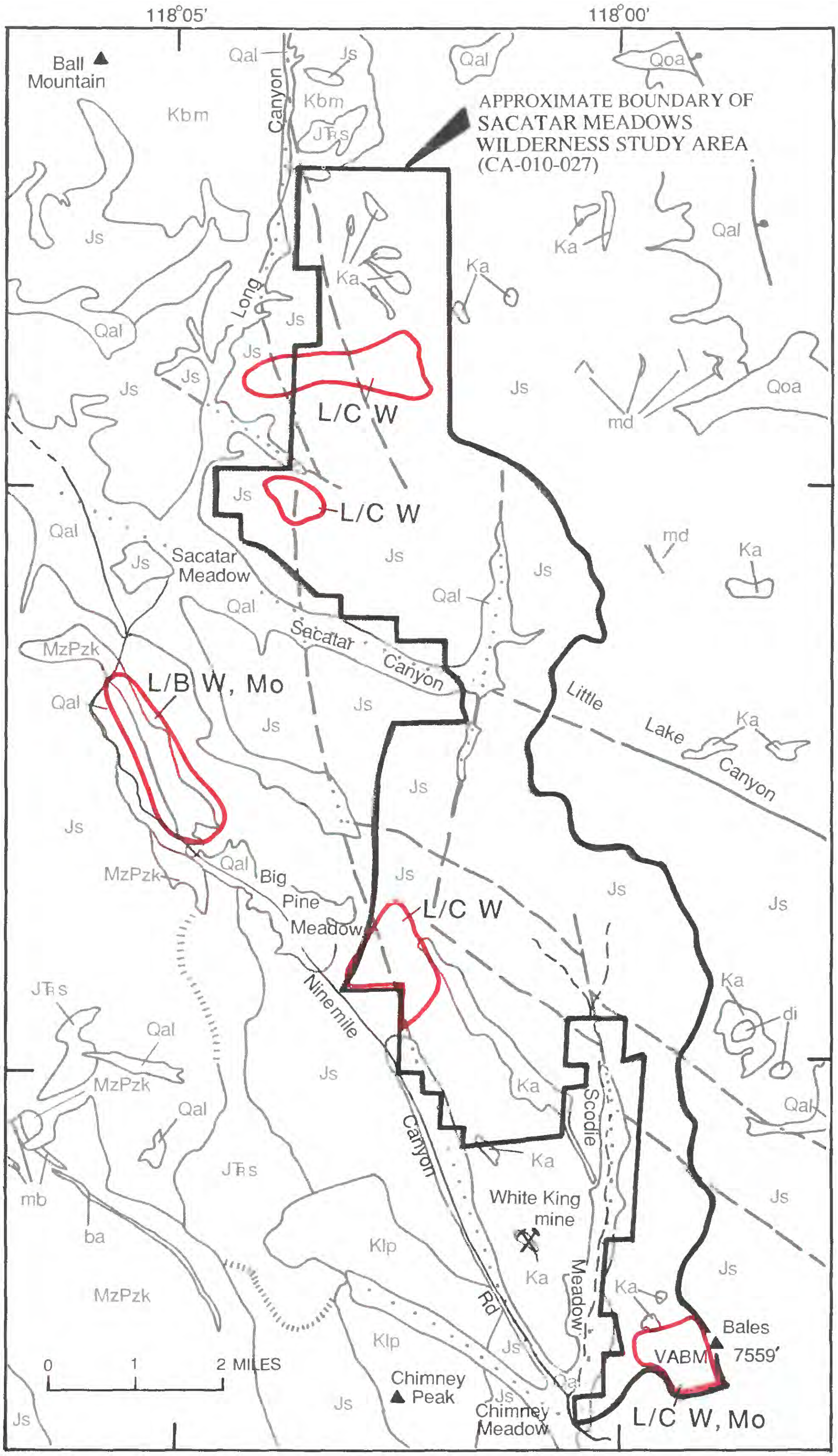


Figure 2. Mineral resource potential and generalized geology of the Sacatar Meadows Wilderness Study Area, Tulare and Inyo Counties, California. Geology from Diggles and others (1987).

by Diggles and others (1985). The geology of the Owens Peak Wilderness Study Area (CA-010-026), south of this study area, was mapped by Diggles and Clemens (1986) and the mineral resources, geochemistry, and mineral resource potential of that area were described by Diggles and others (1986). Causey and Gaps (1985) conducted a mineral resource appraisal of the Owens Peak (CDCA-158), Owens Peak (CA-010-026), and Little Lake Canyon Wilderness Study Areas. The geochemistry and mineral resource potential of the South Sierra Wilderness and the South Sierra Roadless Area was described by Diggles (1987). The geochemistry and mineral resource potential of the Rockhouse Basin Wilderness Study Area, 5 mi west of the study area, was described by Taylor and others (1984) and summarized by Taylor (1984).

Other resource-related studies of the area include a discussion of mines and prospects of Tulare County by Goodwin (1958). High Life Helicopters, Inc./QEB, Inc. (1980a, b), conducted an airborne gamma-ray and magnetometer survey of the region under contract to the U.S. Department of Interior. Hydrogeochemical and stream-sediment surveys were compiled for the Bakersfield and Fresno quadrangles by the Oak Ridge Gaseous Diffusion Plant (1981a, b). In 1983, the study area was studied as part of the U.S. Bureau of Land Management Geology, Energy, and Minerals (G.E.M.) inventory program (Great Basin GEM Joint Venture, 1983). Other mineral resources appraisal studies in the region include the Domeland Additions and Woodpecker Roadless Areas (Spear and McCulloch, 1981) and Domeland Wilderness (Leszcykowski and others, 1982) to the west, and the Golden Trout Wilderness (Zilka, 1982) to the north.

EXPLANATION

☐	Area with low mineral resource potential—See appendix for definition of mineral resource potential (L) and certainty (B,C)
	Commodities
Mo	Molybdenum
W	Tungsten
	Description of Map Units
Qal	Alluvium (Quaternary)
Qoa	Older alluvium (Quaternary)
Kbm	Granite of Ball Mountain (Cretaceous)
Ka	Alaskite, aplite, and pegmatite (Cretaceous)
Klp	Granite of Lamont Peak (Cretaceous)
Js	Sacatar Quartz Diorite of Miller and Webb (1940) (Jurassic)—Locally includes diorite (di)
J₹s	Summit Gabbro of Miller and Webb (1940) (Jurassic and (or) Triassic)
MzPzk	Kernville Series of Webb (1931) (Jurassic or older)—Locally includes marble (mb) and barite (ba)
md	Mafic dikes
	Contact—Hachured where gradational
	Fault—Dashed where inferred; dotted where concealed; bar and ball on downthrown side
⚒	Mine
----	Dirt road

Figure 2. Continued.

Acknowledgments

The authors greatly appreciate the cooperation of the local property owners and of Gary Walker and Robert Waiwood of the U.S. Bureau of Land Management's Bakersfield office. Logistical support was provided by Claire and John McDowell. D.A. Dellinger, L.D. Batatian, E.C. Roscoe, S.E. Jensen, Jr., J.D. Landells, Jackson Ruby, and Wiley Cranney assisted with the geologic mapping. M.C. Horn assisted the U.S. Bureau of Mines author with field examination.

APPRAISAL OF IDENTIFIED RESOURCES

By Lucia Kuizon
U.S. Bureau of Mines

Mining and Mineral Exploration History

There were no mining claims or mineral leases located within the Sacatar Meadows Wilderness Study Area in 1984. No workings, such as prospect pits or trenches, were found within the study area.

Sand and gravel were mined in 1981 from a pit 0.5 mi north of the study area in Long Canyon (Silva and others, 1983). Stream terrace deposits there are suitable for portland cement concrete aggregate; they do not extend into the study area in quantities sufficient to constitute a resource.

The White King mine, 1 mi west of the study area (fig. 2), is on a patented feldspar mining claim. Trenches at the mine expose pegmatite dikes of feldspar and quartz. Tucker and Sampson (1938) reported that several carloads of feldspar were shipped to Los Angeles in 1933. Current owners use the material for construction purposes on their ranch. The study area lies along the trend of the dikes, but no similar feldspar deposits were found within its boundaries.

Barite and tungsten occurrences were prospected 5 to 8 mi west of the study area in shear zones and skarn along the contact between plutonic rocks and metasedimentary carbonate rocks of the Kernville Series (Tucker and Sampson, 1938; Miller and Webb, 1940; Goodwin, 1958; Taylor and others, 1984). No carbonate rocks were found within the study area.

Identified Resources

No mineral resources were identified within the Sacatar Meadows Wilderness Study Area.

During a stream-sediment survey for the U.S. Department of Energy, 12 samples were collected near the study area (Oak Ridge Gaseous Diffusion Plant, 1981a, b). Reconnaissance by U.S. Bureau of Mines personnel using a hand-held scintillometer revealed one sample-collection site southeast of Big Pine Meadow within the study area having almost three times the background radioactivity. A placer sample collected there contains 7.8 parts per million (ppm) uranium and 30 ppm thorium (Kuizon, 1985, fig. 2, No. 5). Above-average values for uranium and thorium in the area can be interpreted to indicate radioactive minerals commonly associated with pegmatite dikes and disseminated in the quartz diorite (Troxel, 1957). Granitic rocks of the Sierra Nevada batholith may also contain average to above average values of thorium (Olson and Overstreet, 1964).

Samples of a quartz vein in the granodiorite phase of the Sacatar Quartz Diorite, an aplite dike in schlieric quartz diorite, and quartzite from the Kernville Series were collected because they were suspected to be mineralized. They contain no anomalous mineral concentrations (Kuizon, 1985, fig 2, Nos. 2, 4, and 1, respectively). Two faults noted by Diggles and others (1987) in Sacatar Canyon were examined, but showed no evidence of mineral concentrations.

Sand and gravel in sufficient quantities to be classified as resources were not found in the study area. Rock types found in the study area could meet local demand for dimension stone, road metal, riprap, crushed stone, and rubble stone for landscaping. However, similar material of equal or better quality is abundant closer to local markets.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Michael F. Diggles, James G. Frisken, and Andrew Griscom
U.S. Geological Survey

Geology

The Sacatar Meadows Wilderness Study Area consists dominantly of granitic rocks of the Sierra Nevada batholith that represent at least three major periods of intrusive activity (Evernden and Kistler, 1970). The granitic rocks intrude Jurassic or older quartz-biotite-muscovite schist and quartzite. The oldest intrusive rocks in the area are Triassic and (or) Jurassic in age, rich in mafic minerals, dioritic to gabbroic in composition, and schistose to gneissic in structure. Most of the study area is underlain by a younger suite of granitic rocks of Jurassic age that is commonly more mafic in composition and more foliated in texture than the Cretaceous rocks. The youngest rocks in the study area are leucocratic, nonfoliated Cretaceous rocks of granite composition.

Collectively, mineral survey reports on the six nearby study areas (listed in Previous Studies section, above) describe several types of mineral deposits that could be present in the Sacatar Meadows Wilderness Study Area. Mineral occurrences near the study area, many with small-scale production, are virtually all associated with late-stage pegmatites or with contact zones between granitic rocks and intruded metamorphic rocks of the Kernville Series, which are now preserved mainly as roof pendants and xenoliths. These host rocks, though not dominant in aerial extent, are present in all six study areas. The associated mineral-deposit types consist of: (1) bedded barite lenses in the Kernville Series and possibly remobilized barite in veins, (2) lead, copper, zinc, and local gold and silver disseminated sulfide deposits in the Kernville Series and in dike rocks, (3) tungsten-molybdenum (scheelite) skarn deposits where plutonic rocks are in contact with older calcareous sedimentary rocks, or less commonly, scheelite in quartz veins, (4) uranium-thorium occurrences in disseminated uranium- and (or) thorium-bearing zircon, thorite, and allanite and also possibly monazite, uraninite, and secondary uranium minerals in quartz diorite and in shear zones in the intrusive rocks, and (5) feldspar and quartz from large pegmatite dikes.

Jurassic or Older Metamorphic Rocks

Metamorphic rocks in the area consist chiefly of quartz-mica schist with lesser abundance of phyllite and quartzite. Skarn was mapped where plutonic rocks intruded calcareous metasedimentary rocks outside the study area, but geologic mapping does not indicate that such rocks or contact zones are present within the study area. Phyllite and quartzite, however, were observed in outcrop as pods too small to map at 1:24,000 scale and as float within the study area (M.F. Diggles and E.C. Roscoe, unpub. data, 1987). Calcareous metasedimentary rocks are common in outcrops of phyllite and quartzite outside the study area. Geochemical evidence suggests that small pods of skarn may be present locally within the study area. The metamorphic rocks define a roof pendant, mapped as part of the Jurassic or older Kernville Series of Miller (1931), that crops out in the area of Big Pine Meadow (fig. 2). The metamorphic rocks in the region of the study area may be at the older end of the age range (Diggles and others, 1985) while those west of the region of the study area are at the young end of this age range or younger (Saleeby and Busby-Spera, 1986).

Granitic Rocks

The oldest of three suites of plutonic rocks in the study area consists of two rock units of Triassic and (or) Jurassic age that commonly are schistose to gneissic. The Summit Gabbro of Miller and Webb (1940) is dark gray to black, coarse grained, and characterized by euhedral phenocrysts of hornblende; exposures rarely exceed 0.7 mi^2 in area. The Sacatar Quartz Diorite of Miller and Webb (1940) is a medium-dark-gray, medium-grained, foliated rock exposed over most of the study area. Its composition is granodioritic, particularly east of the Sierra Nevada crest near the base of the range front; elsewhere it is quartz dioritic. Locally, the Sacatar Quartz Diorite is porphyritic. In places it is rich in mafic inclusions in varying degrees of assimilation possibly formed by mingling of small amounts of high-alumina basalt magma with quartz diorite magma early in its crystallization (Frost and Mahood, 1987).

The younger of the three suites of plutonic rocks consists of Cretaceous granite, alaskite, aplite, and pegmatite. In general, these rocks are more leucocratic than the older ones and are nonfoliated. Numerous small pods of medium- to coarse-grained alaskite and associated alkali-feldspar granite, aplite, and pegmatite bodies crop out along the crest of the Sierra Nevada in and near the study area and extend east into the adjacent Little Lake Canyon Wilderness Study Area.

Quaternary Surficial Deposits

Quaternary surficial deposits include Holocene poorly sorted gravel, sand, and silt in stream-channel and flood-plain deposits. Older Quaternary stream-channel deposits form terraces that are dissected by streams.

Structure

The metamorphic rocks in and near Big Pine Meadow have a strong foliation that trends generally northwest. These rocks underwent at least two periods of uplift associated with major intrusive events (Nokleberg and Kistler, 1980).

En echelon faults trend west-northwest across the range and control the formation of the major canyons east of the study area. These faults are best exposed as shear zones in Sacatar and Little Lake Canyons. They are cut at the eastern margin of the range by faults along the Sierra Nevada range frontal fault zone along which the range was uplifted. A fault trending north-south through Scodie Meadow is probably part of the range-front fault system.

Geochemistry

Methods

In the spring of 1985, the U.S. Geological Survey collected three samples of rock (two of which are stream cobbles), 21 samples of minus-80-mesh stream sediment, and 20 samples of heavy-mineral concentrate from 22 sites in the Sacatar Meadows Wilderness Study Area. With the exception of one rock sample collected from outcrop, these samples represent eroded bedrock material from drainage basins that collectively constitute most of the surface of the study area. The minus-80-mesh stream-sediment reflects bedrock geochemistry and usually indicates the presence of mineralized areas in the drainage basin. The nonmagnetic fraction of panned concentrates is used because this medium concentrates many minerals associated with mineralized and altered rocks. Only samples of rocks thought to be mineralized or altered were collected for analysis from this study area.

In reconnaissance geochemical resource assessment programs, the semiquantitative spectrographic method is used for the initial studies. This method allows for both the rapid and economical analysis of large numbers of samples, but with many commodity elements detected at only fairly high lower limits of determination. To overcome the effects of this limitation, other elements associated with mineral occurrences, pathfinders, are studied. When anomalous concentrations of pathfinder elements are determined, selected samples are resubmitted for analysis by more sensitive techniques.

All samples were analysed for 31 elements, including antimony, barium, cadmium, cobalt, chromium, copper, gold, iron, lead, magnesium, manganese, molybdenum, nickel, silver, thorium, tin, titanium, tungsten, vanadium, and zinc, using a six-step semiquantitative emission spectrographic method described by Grimes and Marranzino (1968). In addition, the nonmagnetic panned concentrates were analyzed for tungsten by spectrophotometry (Welsch, 1983); the minus-80-mesh stream sediments and the three rock samples were analyzed for uranium and thorium by a neutron-activation method described by Millard and Keaten (1981). The rocks were analysed by ICP spectroscopy for five elements with limits of determinations as follows: arsenic, 5 ppm; antimony, 2 ppm; zinc, 2 ppm; bismuth, 2 ppm, and cadmium, 0.1 ppm. Methods used were those described by Crock and others (1983) and a modification of those described by O'Leary and Viets (1986). Two of the rock samples were analyzed by atomic absorption for gold at a determination limit of 0.1 ppm and mercury at a determination limit of 0.02 ppm by a modification of the methods described by Thompson and others (1968) and by methods described by Koirtyohann and Khalil (1976) respectively. Adrian and others (1987) presented tables of analytical data, descriptions of sample-collection, preparation, and analytical methods, and a map showing locations of sample-collection sites.

Results and Interpretations

Because of the small data set and the nonlognormal distribution of some of the data, the geochemical threshold values for rocks and minus-80-mesh stream sediments were calculated at two to three times the average concentrations for

Sierra Nevada plutonic rocks (Dodge, 1972) or for granodiorites worldwide (Levinson, 1980; Rose and others, 1979). Threshold values (in parentheses) for the nonmagnetic concentrates are based on numerous studies of concentrates. For nonmagnetic panned concentrates, nine samples contained anomalous concentrations of tungsten (10 ppm or greater), six contained anomalous concentrations of molybdenum (detected at slightly below the determination limit of 10 ppm), and six contained anomalous concentrations of thorium (500 ppm). For rocks and minus-80-mesh stream sediment, one sample contained an anomalous concentration of molybdenum (detected at slightly below the determination limit of 10 ppm), seven contained anomalous concentrations of thorium (30 ppm), 11 contained anomalous concentrations of uranium (8 ppm), one contained an anomalous concentration of barium (2,000 ppm), and three contained anomalous concentrations of copper (70 ppm).

Geochemical interpretations presented in this paper are based in part on the above anomalous-threshold values and on geochemical data from the Little Lake Canyon Wilderness Study Area (Detra and others, 1985). Anomalous concentrations of indicator elements in samples from the Sacatar Meadows Wilderness Study Area are generally low in contrast to nearby study areas. Anomalies are also isolated rather than found in clusters or being widespread throughout the study area.

Most if not all of the mineral-deposit types (listed in Geology section, above) may be locally present in the Sacatar Meadows Wilderness Study Area. Under current market conditions, it is unlikely that deposits, if they exist in the study area, would be economic due to their likely small size. Pegmatites cannot be detected geochemically, but a few pieces of coarse-grained potassium feldspar, probably derived from pegmatites, were seen in a few of the drainages along Long Canyon and at a site west of Bales vertical-angle bench mark (VABM) (fig. 2), in the southeast corner of the study area. Although no marble or calcsilicate rocks were observed at the sample-collection sites, tungsten values in concentrates ranging from 5 to 650 ppm were obtained from 10 of the 20 samples. These anomalies are probably due to the presence of small, unmapped skarn occurrences upstream from the sample-collection sites. Silicic metasedimentary rocks, like those known to be associated with skarn outside the study area were observed in drainages above two of the sample-collection sites. Except for a few molybdenum values of 10 ppm or slightly less, these are single-element anomalies. The skarn mineral occurrences in the nearby Owens Peak Wilderness Study Areas contain anomalous concentrations of tungsten, molybdenum, bismuth, copper, and lead.

The strongest evidence of mineralization in the study area comes from three panned-concentrate samples that have high tungsten concentrations and contain a few scheelite grains (found under shortwave ultraviolet radiation) and limonite pseudomorphs after pyrite. These sample-collection sites are located in: (1) a small drainage that flows into Long Canyon, (2) a very small drainage flowing south to Sacatar Canyon, and (3) a small south-flowing drainage located 0.5 mi southeast of Big Pine Meadow. These sites have tungsten values of 650, 45, and 250 ppm, respectively. These concentrations cannot be used alone to evaluate the importance of the individual sites because several variables can have an effect on the number of scheelite grains in the analyzed fraction. These variables consist of: (1) the choice of sample-collection site within the drainage basin, (2) the efficiency of the panning and sample preparation procedures, (3) the proximity of skarn outcrops, (4) the aerial extent of the exposed skarn, (5) the amount of scheelite present in the skarn, and (6) the homogeneity of the samples when split for analysis. Eight additional samples contain 5 to 15 ppm tungsten. Two are associated with detectable molybdenum (10 ppm) and one with limonite pseudomorphs after pyrite. The latter three samples are from: (1) a small drainage sampled from Scodie Meadow, (2) a very small drainage northwest of Big Pine Meadow, and (3) the small drainage west of Bales VABM. The latter site has 15 ppm tungsten and 10 ppm molybdenum as well as epidote and chlorite grains in the concentrate and 3,000 ppm barium and 70 ppm copper in a granitoid cobble. About 3 mi east of this site, samples collected from upper Deadfoot and upper Fivemile Canyons in the Little Lake Canyon Wilderness Study Area contain moderately anomalous concentrations of tungsten, molybdenum, lead, and copper, probably due to skarn mineralization, which may extend into the Sacatar Meadows Wilderness Study Area. Several of the stream sediments and nonmagnetic concentrates collected along the east side of the divide separating the two study areas contain higher concentrations of copper (100 ppm in sediments) and molybdenum (100 ppm in concentrates) than samples collected along the west side of the divide (this study area), in which two contained 70 ppm copper and and two contained 10 ppm molybdenum.

All of the above described tungsten-molybdenum anomalies could be accounted for if scattered small pods of mineralized skarn containing minerals of the scheelite-powellite series were present in the study area. No such pods were observed, but their existence is indicated by observations of silicic metasedimentary rocks in the study area similar to those seen in outcrop with skarn outside the study area, and by the geochemical results.

During a stream-sediment survey conducted by the U.S. Department of Energy (Oak Ridge Gaseous Diffusion Plant, 1981a, b), 12 samples were collected near the study area. Nine of those samples contain 1.76 to 5.88 ppm uranium, which falls within two standard deviations of the mean of 3.46 ppm for the Bakersfield quadrangle (Oak Ridge Gaseous Diffusion Plant, 1981a). One sample containing 10.59 ppm uranium was collected about 2 mi west of the study area and about 1 mi northeast of Chimney Peak. Thorium values for the 12 samples range from 10 to 42 ppm; seven are above the average value of 10 ppm for intermediate igneous rocks (Oak Ridge Gaseous Diffusion Plant, 1981a; Levinson, 1980). During the U.S. Geological Survey study, 21 stream-sediment and three rock samples were analyzed for uranium and thorium, and scintillometer readings were taken at ground level in the stream channels at most of the sample-collection sites. Thorium concentrations in samples collected from 20 stream-sediment sample-collection sites, including a granite stream cobble collected southwest the Bales VABM site, ranged from 14.6 to 80.9 ppm. At 15 of the 21 sites, uranium concentrations ranged from 6.29 to 15.8 ppm. These uranium and thorium concentrations are higher than those reported by the Department of Energy (Oakridge Gaseous Diffusion Plant, 1981a) and U.S. Bureau of Mines (Kuizon, 1985), perhaps due to selection of sample-collection sites since the sites for this study were selected where heavy minerals were naturally concentrated. All of the samples were collected from areas of granitic rock, have above-average thorium concentrations (most have above-average uranium concentrations for intermediate granitic rocks), and contain euhedral crystals of metamict zircon and thorite in the heavy-mineral concentrates, These facts suggest that the radioactive minerals are probably derived from widespread disseminations in the plutonic rocks. If this is the case, the uranium-thorium minerals will not be present in large amounts unless concentrated in placers. Five nonmagnetic concentrate samples have thorium concentrations of 500 to 700 ppm and one has a value of 1,500 ppm. These values are not unusually high for concentrates from felsic intrusive rocks, on the basis of comparison with values found in samples from several other study areas in similar geologic settings, and do not suggest concentrations sufficient to constitute placer deposits. Olson and Overstreet (1964) concluded that the granitic rocks of the Sierra Nevada batholith may contain above-average concentrations of thorium; Troxel (1957) discussed the disseminated uranium-thorium minerals in pegmatite dikes and in quartz diorite.

The scintillometer, set at its lowest range setting, produced readings ranging from two to 23 counts per second. The variation could be due to varying potassium content of the sediment and nearby bedrock, topographic variations, or variation in the degree of natural concentration of heavy minerals at the sites. The highest uranium and thorium concentrations from samples as well as the highest scintillometer readings were obtained in the central two thirds of the study area. Outcrops within a 2-mi radius of a point 2 mi south of the head of Sacatar Canyon appear to have contributed the highest concentrations of radioactive minerals. Three rock samples collected outside the 2-mi radius ranged from 0.43 ppm uranium in quartz veins to 2.95 ppm in granite.

In this study, low-detection-level gold analyses were not run on the concentrates; however, neither megascopic nor microscopic gold was observed. The three rocks that were analyzed contain no detected gold or mercury.

Geophysics

Aeromagnetic Data

An aeromagnetic survey of the Sacatar Meadows South Wilderness Study Area was flown in 1981 by a private contractor (U.S. Geological Survey, 1982). The aeromagnetic data were collected along parallel east-west flightlines 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 650 ft 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 is 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 Summit Gabbro, whereas the other plutonic rocks and the older metamorphic rocks tend to be weakly magnetic or nonmagnetic. One area of Sacatar Quartz Diorite within the study area is an exception and appears to be only weakly magnetic because here the local hills do not produce magnetic highs in the manner of the more typical Sacatar Quartz Diorite elsewhere. This uniquely nonmagnetic area is located in the westernmost part of the study area north of Big Pine Meadow and west of the fault striking N. 5° W. along the east side of the Big Pine Meadow. Perhaps some weak alteration has partly destroyed the magnetite within this nonmagnetic area. The faults in the study area tend to be associated with magnetic lows in those places where magnetic rocks are juxtaposed, but this association is most probably an effect of the low topographic expression of the faults.

In general, the aeromagnetic data do not appear to provide any evidence for mineral resource potential in this area.

Gamma-ray Survey

Airborne gamma-ray spectrometer surveys were flown within this study area (High Life Helicopters, Inc., and Geodata International, Inc., 1979; High Life Helicopters, Inc./QEB, Inc., 1980a and 1980b). These helicopter surveys were flown on east-west flightlines spaced 3.1 mi apart at an altitude of 400 ft above the ground. These data measure the effective uranium, thorium, and potassium content of the uppermost inch or so of soil or rock at the surface. Within the study area no uranium anomalies were observed.

Remote Sensing

Hydrothermal alteration is often accompanied by the formation of the minerals pyrite and (or) hematite, which, along with other iron-rich minerals, are oxidized during weathering in the near-surface environment to produce ferric oxide (hematite), hydrated ferric oxide (goethite, lepidocrocite), ferric sulfate (jarosite), or ferric carbonate (siderite) minerals (Blanchard, 1968). These secondary iron-bearing minerals, along with amorphous or poorly crystalline ferric oxide material like ferrihydrite, are collectively referred to as the limonite minerals and are recognized in the field by their red, yellow, or brown colors.

The limonite mineral group has unique spectral reflectance characteristics that can be detected on Landsat multispectral scanner (MSS) images using a color-ratio compositing technique described by Rowan and others (1974). This compositing was used to look for areas of limonite in the study area (D.H. Knepper, Jr., and F.A. Kruse, written commun., 1986). Areas of hydrothermal alteration lacking the limonite minerals cannot be found using this technique, and areas of limonite not related to hydrothermal alteration cannot be distinguished from those that are. The presence of limonite minerals cannot be reliably mapped in areas with approximately 50 percent or greater vegetation density and in areas of deep to moderate shadows.

The spectral response of Landsat MSS data of the study area is dominated by vegetation. Consequently, the presence of anomalous concentrations of limonite possibly associated with hydrothermal alteration could not be evaluated (D.H. Knepper, Jr., and F.A. Kruse, written commun., 1986).

Mineral Resource Potential

In and near the Sacatar Meadows Wilderness Study Area, five areas that have mineral resource potential were delineated. The study area is situated in the Sierra Nevada physiographic province, which contains the largest concentration of tungsten deposits in the United States (Newberry, 1982). The mineral-deposit model that is most appropriate to apply in this study area is the tungsten-skarn felsic-plutonic-rock model (Einaudi and others, 1981; Cox, 1983; Cox and Singer, 1986). Tungsten skarn deposits form along contacts and in roof pendants of batholiths and in thermal aureoles of apical zones of stocks that intrude carbonate rocks. Of 28 tungsten-skarn deposits, Cox (1986) notes a mean of 1.2 million tons with a one-standard-deviation range of from 0.06 to 24 million tons. He notes a mean grade of 0.67 percent tungsten trioxide with a one-standard-deviation range of from 0.34 to 1.4 percent tungsten trioxide.

The ridge northwest of Big Pine Meadow, located outside and adjacent to the study area to the east, has low mineral resource potential for tungsten and molybdenum with a certainty level of B. Geochemical analyses suggest that tungsten, molybdenum, uranium, and thorium are present in low-level concentrations on the ridge in areas underlain by metasedimentary rocks of the Kernville Series. Although geologic mapping does not indicate large bodies of calc-silicate hornfels along this ridge, skarn is present elsewhere in the Kernville Series and probably is present as small pods along the ridge.

The area from the valley to the ridge crest southeast of Scodie Meadow has low mineral resource potential for tungsten and molybdenum with a certainty level of C. This hillside is underlain by granodiorite and quartz diorite of the Sacatar Quartz Diorite. Silicic metasedimentary rocks were observed as small pods in outcrop in this drainage. Geochemical analyses indicate that tungsten, molybdenum, barium, and minor amounts of copper are present in low-level concentrations in the numerous small xenoliths of calcareous metasedimentary rock mapped in this unit (Diggles and others, 1986). Secondary alteration and skarn minerals are present in samples from the area. There is an area of low mineral resource potential for tungsten in Deadfoot Canyon, in the adjacent Little Lake Canyon Wilderness Study Area east of this hillside (Diggles and others, 1985).

The valley east of Long Canyon and the small drainage northeast of Sacatar Meadow both have low mineral resource potential for tungsten with a certainty of C. Float of silicic metasedimentary rock was observed in the former valley. Geochemical analyses indicate that tungsten, thorium, and uranium are present in low-level concentrations in both of these areas, which are underlain by the Sacatar Quartz Diorite. One of the samples from each of these areas contains visible pyrite.

The area southeast of Big Pine Meadow has low mineral resource potential for tungsten with a certainty of C. Geochemical analyses indicate that tungsten, thorium, uranium, and minor molybdenum are present in low-level concentrations in this area, which is underlain by the Sacatar Quartz Diorite and adjoins an area underlain by a belt of alaskite. There is visible pyrite in one of the samples. A U.S. Bureau of Mines scintillometer reading in this area was three times the background level. A placer sample collected here, however, contains only low-level concentrations of uranium and thorium.

The Sacatar Meadows Wilderness Study Area has no geothermal energy potential (Higgins, 1981) and the geology is not conducive to petroleum or natural gas resource potential (Scott and Miller, 1982; Scott, 1983). The radioactive minerals are probably derived from widespread disseminations in the plutonic rocks. In the absence of placers of these minerals, there are no concentrations of energy minerals and therefore no energy mineral resource potential in the study area.

REFERENCES CITED

Adrian, B.M., Frisken, J.G., Malcolm, J.M., Kelley, D.L., Vaughn, R.B., and Taylor, C.D., 1987, Analytical results and sample locality map of stream sediment, heavy-mineral concentrate and rock samples from the Sacatar Meadows Wilderness Study Area (CA-010-027), Tulare County, California: U.S. Geological Survey Open-File Report 87-172, 19 p.

Beikman, H.M., Hinkle, M.E., Frieders, Twila, Marcus, S.M., and Edward, J.R., 1983, Mineral surveys by the Geological-Survey and the Bureau of Mines of Bureau of Land Management Wilderness Study Areas: U.S. Geological Survey Circular 901, 28 p.

Blanchard, Roland, 1968, Interpretation of leached outcrops: Nevada Bureau of Mines Bulletin 66, 196 p.

Causey, J.D., and Gaps, R.S., 1985, Mineral resources of the Little Lake Canyon (BLM NO. CDCA-157), Owens Peak (BLM NO. CDCA-158), and Owens Peak (BLM NO. CA-010-026) Wilderness Study Areas, Inyo, Kern, and Tulare Counties, California: U.S. Bureau of Mines Mineral Land Assessment MLA 2-85, 39 p.

Cox, D.P., ed., 1983, U.S. Geological Survey-INGEOMINAS mineral resource assessment of Colombia: Ore deposit models: U.S. Geological Survey Open-File Report 83-423, 65 p.

Cox, D.P., 1986, Descriptive model of W skarn deposits, *in* Cox, D.P., and Singer, D.A., eds., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 55-57.

Cox, D.P., and Singer, D.A., eds., 1986, Mineral deposit models: U.S. Geological Survey Bulletin 1693, 379 p.

Crock, J.G., Lichte, F.E., and Briggs, P.H., 1983, Determination of elements in National Bureau of Standards geological reference materials SRM278 obsidian and SRM668 basalt by inductively coupled argon plasma-atomic emission spectrometry: Geostandards Newsletter, no. 7, p. 335-340.

Detra, D.E., Erickson, M.S., Tucker, R.E., Diggles, M.F., and Parduhn, N.L., 1985, Analytical results and sample locality map of stream-sediment and heavy-mineral-concentrate samples from the Little Lake Canyon (CDCA-157) and Owens Peak (CDCA-158) Wilderness Study Areas, Inyo and Kern Counties, California: U.S. Geological Survey Open-File Report 85-34, 21p.

Diggles, M.F., 1987, Mineral resource potential map of the South Sierra Wilderness and the South Sierra Roadless Area, Inyo and Tulare Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1913-A, scale 1:48,000.

Diggles, M.F., and Clemens, D.E., 1986, Geologic map of the Owens Peak Wilderness Study Area (CA-010-026), Tulare and Kern Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1833, scale 1:48,000.

Diggles, M.F., Dellinger, D.A., and Conrad, J.E., 1987, Geologic map of the Owens Peak and Little Lake Canyon Wilderness Study Areas, Inyo and Kern Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1927-A, scale 1:48,000.

Diggles, M.F., Frisken, J.G., Griscom, Andrew, Pierce H.A., and Causey, D.J., 1986, Mineral Resources of the Owens Peak Wilderness Study Area, Tulare and Kern Counties, California: U.S. Geological Survey Bulletin 1705-A, 13 p.

Diggles, M.F., Tucker, R.E., Griscom, Andrew, Causey, J.D., and Gaps, R.S., 1985, 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, 14 p.

Dodge, F.C.W., 1972, Trace-element contents of some plutonic rocks of the Sierra Nevada batholith: U.S. Geological Survey Bulletin 1314-F, 13 p.

Einaudi, M.T., Meinert, L.D., and Newberry, R.J., 1981, Skarn deposits, *in* Skinner, B.J., ed., Economic Geology, 75th Anniversary Volume: Lancaster, Penn., Lancaster Press, p. 317-391.

Evernden, J.F., and Kistler, R.W., 1970, Chronology of emplacement of Mesozoic batholithic complexes in California and western Nevada: U.S. Geological Survey Professional Paper 623, 42 p.

Frost, T.R., and Mahood, G.A., 1987, Field, chemical, and physical constraints on mafic-felsic magma interaction in the Lamarck Granodiorite, Sierra Nevada, California: Geological Society of America Bulletin, v. 99, p. 272-291.

Goodwin, J.G., 1958, Mines and mineral resources of Tulare County, California: California Journal of Mines and Geology, v. 54, no. 3, p. 317-492.

Goudarzi, G.H., 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84-787, 51 p.

Great Basin GEM Joint Venture, 1983, Sacatar Meadow G-E-M resources area (GRA No. CA-11) technical report (WSA CA 010-027): U.S. Bureau of Land Management Contract YA-553-RFP2-1054, 28 p.

Grimes, D.J., and Marranzino, A.P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Higgins, C.T., compiler, 1981, Geothermal resources of California: California Division of Mines and Geology, Geologic Data Map No. 4, scale 1:750,000.

High Life Helicopters, Inc., and Geodata International, Inc., 1979, Aerial radiometric and magnetic survey, Trona quadrangle, California [1° by 2° sheet; National Uranium Resource Evaluation program, GJBX-65(79)]: Grand Junction, Colo., U.S. Department of Energy, variously paged, scale 1:250,000.

High Life Helicopters, Inc./QEB, Inc., 1980a, Airborne gamma-ray spectrometer and magnetometer survey, Bakersfield quadrangle, California [1° by 2° sheet, National Uranium Resource Evaluation program, GJBX-231 (80)]: Grand Junction, Colo., U.S. Department of Energy, scale 1:500,000.

_____1980b, Airborne gamma-ray spectrometer and magnetometer survey, Fresno quadrangle, California [1° by 2° sheet; National Uranium Resource Evaluation program, GJBX-231 (80)]: Grand Junction, Colo., U.S. Department of Energy, scale 1:500,000.

Koirtyohann, S.R., and Khalil, Moheb, 1976, Variables in the determination of mercury by cold-vapor atomic absorption: Analytical Chemistry, 48, p. 136-139.

Kuizon, Lucia, 1985, Mineral resources of the Sacatar Meadow South Wilderness Study Area, Tulare and Inyo Counties, California: U.S. Bureau of Mines Mineral Land Assessment MLA 53-85, 10p.

Leszcykowski, A.M., Morlock, C.R., and Willett, S.L., 1982, Mineral resources of the Domeland Wilderness, Kern and Tulare counties, California: U.S. Bureau of Mines Mineral Land Assessment MLA 36-82, 5 p.

Levinson, A.A., 1980, Introduction to exploration geochemistry, (2nd ed.): Wilmette, Illinois, Applied Publishing Ltd., 924 p.

Matthews, R.A., and Burnett, J.L., 1966, Geologic map of California Fresno sheet: California Division of Mines and Geology, scale 1:250,000.

Millard, H.T., Jr., and Keaten, B.A., 1981, Precision of uranium and thorium determinations by delayed neutron counting: Journal of Radioanalytical Chemistry, v. 72, p. 489-500.

Miller, W.J., 1931, Geologic sections across the southern Sierra Nevada of California: University of California Publications, Bulletin of the Department of Geological Sciences, v. 20, p. 331-360.

_____1946, Crystalline rocks of southern California: Geological Society of America Bulletin, v. 57, p. 457-542.

Miller, W.J., and Webb, R.W., 1940, Descriptive geology of the Kernville quadrangle, California: California Journal of Mines and Geology, v. 36, p. 343-368.

Newberry, R.T., 1982, Tungsten-bearing skarns of the Sierra Nevada. I. The Pine Creek mine: Economic Geology, v. 77, p. 823-844.

Nokleberg, W.J., and Kistler, R.W., 1980, Paleozoic and Mesozoic deformations in the central Sierra Nevada, California: U.S. Geological Survey Professional Paper 1145, 24 p.

Oak Ridge Gaseous Diffusion Plant, 1981a, Hydrogeochemical and stream sediment reconnaissance basic data for Bakersfield quadrangle, California: U.S. Department of Energy Report GJBX-419(81), 155 p.

_____1981b, Hydrogeochemical and stream sediment reconnaissance basic data for Fresno quadrangle, California: U.S. Department of Energy Report GJBX-24(82), 99 p.

O'Leary, R.M., and Viets, J.G., 1986, Determination of antimony, arsenic, bismuth, cadmium, copper, lead, molybdenum, silver, and zinc in geological materials by atomic absorption spectrometry using a hydrochloric acid-hydrogen peroxide digestion: Atomic Spectroscopy, v. 7, p. 4-8.

Olson, J.C., and Overstreet, W.C., 1964, Geologic distribution and resources of thorium: U.S. Geological Survey Bulletin 1204, 61 p.

Rose, A.W., Hawkes, H.E., and Webb, J.S., 1979, Geochemistry in mineral exploration: London, Academic Press, 657 p.

Rowan, L.C., Wetlaufer, P.H., Goetz, A.F.H., Billingsely, F.C., and Stewart, J.H., 1974, Discrimination of rock types and detection of hydrothermally altered areas in south-central Nevada by the use of computer-enhanced ERTS images: U.S. Geological Survey Professional Paper 883, 35 p.

Saleeby, J.B., and Busby-Spera, Catherine, 1986, Stratigraphy and structure of metamorphic framework rocks, Lake Isabella area, southern Sierra Nevada, California, field trip number 14, *in* Dunne, G.C., compiler, Mesozoic and Cenozoic structural evolution of selected areas, east-central California: Geological Society of America Annual Meeting, Cordilleran Section, 82d meeting, Los Angeles, Calif., p. 81-94.

Scott, E.W., 1983, Petroleum potential of wilderness lands in California: U.S. Geological Survey Circular 902-D, 12 p.

Scott, E.W., and Miller, B.M., 1982 , Petroleum potential of wilderness lands, California: U.S. Geological Survey Miscellaneous Investigations Map I-1538, scale 1:1,000,000, 1 sheet.

Silva, M.A., Burnett, J.L., Rapp, J.S., and Cole, Kenneth, 1983, Mines and mineral producers active in California, 1983: California Division of Mines Special Publication 67, 61 p.

Smith, A.R., compiler, 1964, Geologic map of California Bakersfield sheet: California Division of Mines and Geology, scale 1:250,000.

Spear, J.M., and McCulloch, R.B., 1981, Mineral resources of the Domeland Addition (5207) and Woodpecker (5206) RARE II areas, Tulare and Kern Counties, California: U.S. Bureau of Mines Mineral Land Assessment MLA 10-81, 11 p.

Storer, T.I., and Usinger, R.L., 1963, Sierra Nevada natural history: Berkeley, University of California Press, 374 p.

Taylor, G.C., 1984, Rockhouse Basin Wilderness Study Area, Kern and Tulare Counties: California Geology, v. 37, p. 263-272.

Taylor, G.C., Loyd, R.C., Alfors, J.T., Burnett, J.L., Stinson, M.C., Chapman, R.C., Silva, M.A., Bacon, C.F., and Anderson, T.P., 1984, Mineral resource potential of the Rockhouse Basin Wilderness Study Area, Kern and Tulare Counties, California: California Division of Mines and Geology Special Report 157, 31 p.

Thompson, C.E., Nakagawa, H.M., and Van Sickle, G.H., 1968, Rapid analysis for gold in geologic materials, in Geological Survey research 1968: U.S. Geological Survey Professional Paper 600-B, p. B130-B132.

Troxel, B.W., 1957, Thorium, *in* Wright, L.A., ed., Mineral commodities of California: California Division of Mines and Geology Bulletin 176, p. 635-640.

Tucker, W.B., and Sampson, R.J., 1938, Mineral resources of Inyo County: California Journal of Mines and Geology, v. 34, p. 368-500

U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, 5 p.

U.S. Geological Survey, 1982, Aeromagnetic map of the Sierra Owens area, California: Open-File Report 82-1083, scale 1:62,500.

Welsch, E.P., 1983, A rapid geochemical spectrophotometric determination of tungsten with dithiol: Talanta, v. 30, p. 876-878.

Zilka, N.T., 1982, Mineral resources of the Golden Trout Wilderness, Tulare and Inyo Counties, California: U.S. Bureau of Mines Mineral Land ASsessment MLA 52-82, 9 p.

APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is permissive. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

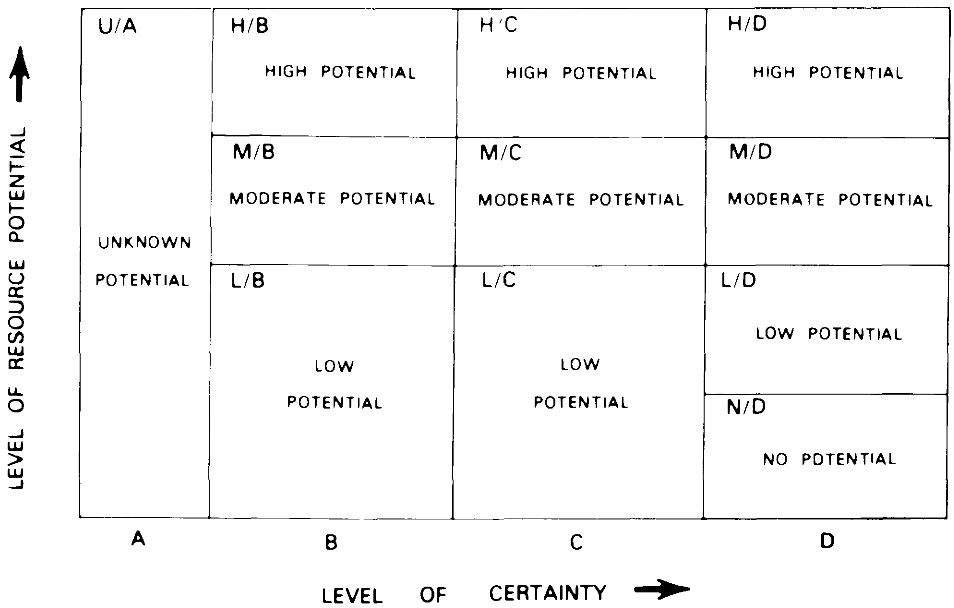
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data supports mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty



A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential
D. Available information clearly defines the level of mineral resource potential.

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Taylor, R B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

Taylor, R B., Stoneman, R. J., and Marsh, S P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40–42.

Goudarzi, G H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–0787, p. 7, 8.

RESOURCE/RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, p. 5.

GEOLOGIC TIME CHART

Terms and boundary ages used by the U.S. Geological Survey in this report

EON	ERA	PERIOD		EPOCH	AGE ESTIMATES OF BOUNDARIES (in Ma)
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late	96
				Early	138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				
		(3800?)			
pre-Archean[2]					4550

[1]Rocks older than 570 Ma also called Precambrian, a time term without specific rank.

[2]Informal time term without specific rank.

Mineral Resources of Wilderness Study Areas: South-Central California

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DONALD PAUL HODEL, Secretary

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