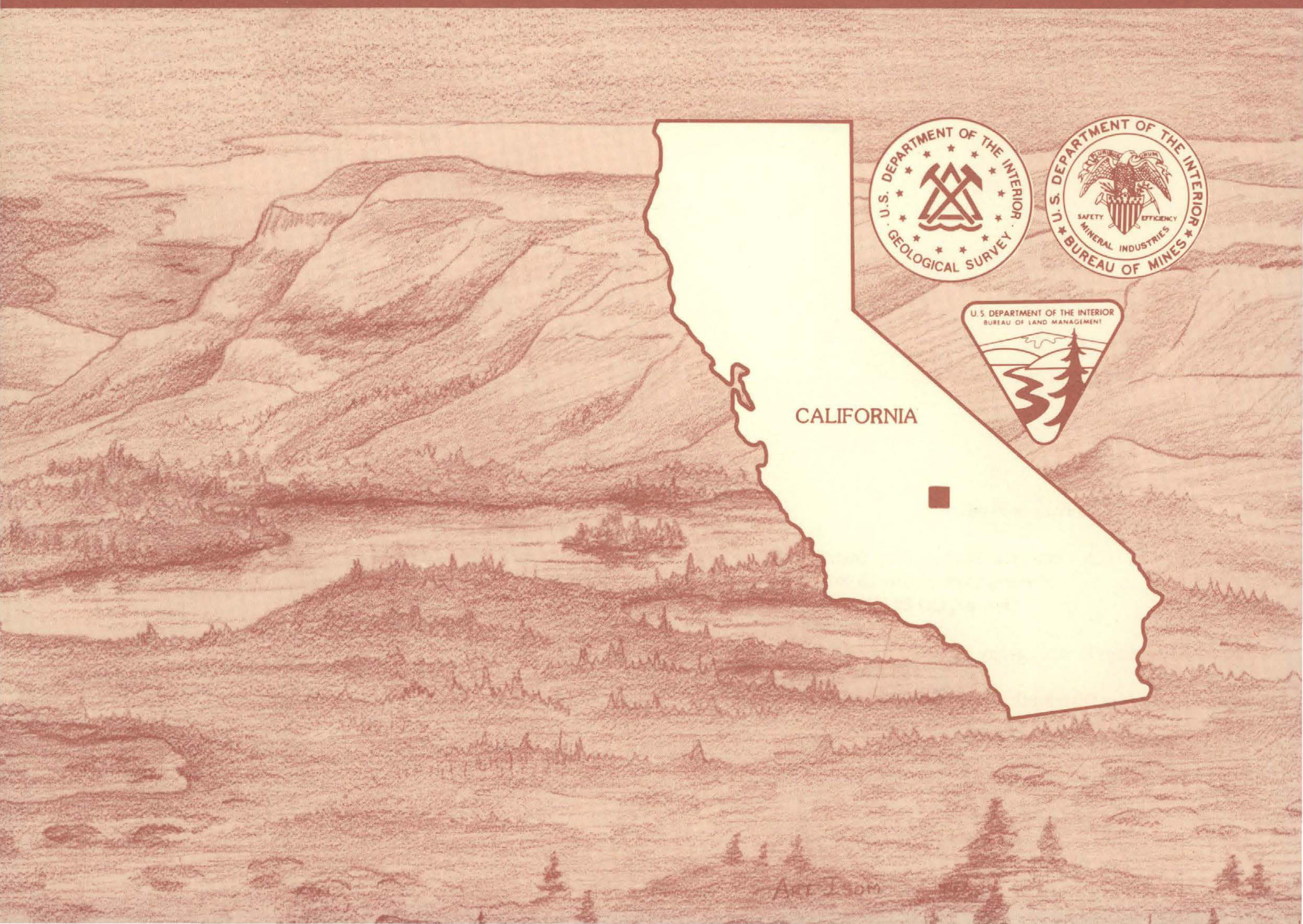
Mineral Resources of the Rockhouse Wilderness Study Area, Kern and Tulare Counties, California

U.S. GEOLOGICAL SURVEY BULLETIN 1705–E



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Chapter E

Mineral Resources of the Rockhouse Wilderness Study Area, Kern and Tulare Counties, California

By MICHAEL F. DIGGLES and ROBERT C. JACHENS
U.S. Geological Survey

THOMAS J. PETERS
U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1705

MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
SOUTH-CENTRAL CALIFORNIA

DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1989

For sale by the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

Library of Congress Cataloging-in-Publication Data

Diggles, M.F.
Mineral resources of the Rockhouse Wilderness Study Area, Kern and Tulare Counties, California.
(Mineral resources of wilderness study areas—south-central California ; ch. E)(U.S. Geological Survey bulletin ; 1705-E)
Bibliography: p.
Supt. of Docs. no. : I 19.3:1705-E
1. Mines and mineral resources—California—Rockhouse Wilderness. 2. Rockhouse Wilderness (Calif.) I. Jachens, Robert C. II. Peters, Thomas J., 1943- . III. Title. IV. Series. V. Series: U.S. Geological Survey bulletin ; 1705-E.
QE75.B9 no. 1705-E. 557.3 s 88-600445
[TN24.07] [553'.09794'88]

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 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 Rockhouse Wilderness Study Area (CA–010–029), Kern and Tulare Counties, California.

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Mineral Resources of the Rockhouse Wilderness Study Area, Kern and Tulare Counties, California

By Michael F. Diggles *and* Robert C. Jachens
U.S. Geological Survey

Thomas J. Peters
U.S. Bureau of Mines

SUMMARY

Abstract

At the request of the U.S. Bureau of Land Management, approximately 12,564 acres of the Rockhouse Wilderness Study Area (CA-010-029) were evaluated for identified mineral resources (known) and mineral resource potential (undiscovered). In this report, the area studied is referred to as the "wilderness study area" or "the study area." Field work was conducted in 1986 and 1987 to assess the mineral resources and resource potential of the area.

The study area contains identified inferred marginally economic resources of turquoise at the Blue Gem prospect. No gold, tungsten, feldspar, or rare-earth elements are present in economic concentrations at any of the properties examined.

Seven areas have potential for undiscovered mineral resources in the Rockhouse Wilderness Study Area. In the study area, the mineral resource potential for small deposits of turquoise is high in the immediate vicinity of the Blue Gem prospect, moderate near the Red Knob claims, and low in the surrounding area. There is moderate mineral resource potential for tungsten and associated molybdenum and low mineral resource potential for barite along the southwest edge of the study area. Three zones in the study area have low mineral resource potential for minor sulfide deposits: a large zone in the center of the study area (silver, arsenic, lead, and antimony), a zone along the ridge on the southeast boundary of the study area (silver, lead, antimony, and zinc), and a small zone near the south tip of the study area (lead, antimony, and zinc). The study area has no geothermal energy or oil and gas resource potential.

Character and Setting

The Rockhouse Wilderness Study Area is approximately 12,564 acres in size and is 20 mi northeast of the town of Lake Isabella, Calif. (fig. 1). The terrain is generally steep and rugged, with elevations ranging from about 3,200 to 7,025 ft. The vegetation includes sagebrush, piñon and digger pine, oak, and juniper. Access to the area is by California Highway 178 from the south. Most of the area is underlain by plutonic rocks of the Sierra Nevada batholith.

Manuscript approved for publication September 30, 1988.

Identified Mineral Resources

Turquoise at the Blue Gem prospect is the only resource that was identified in the study area. Gem quality indicates the resource is marginally economic if mined as a hobby. However, because of limited exposure and the irregular distribution of gemstones in the host rock, it is not possible to quantify the turquoise resources. Feldspar at the White Cross prospect, near the study area, may be suitable for many applications, but tonnage is too small to constitute a resource. No rare-earth elements or tungsten are present in economic concentrations at any of the properties examined. Analyses of samples from two gold prospects, one inside and one near the study area, do not indicate the presence of gold resources.

Mineral Resource Potential

In the northern part of the Rockhouse Wilderness Study Area, the mineral resource potential for small deposits of turquoise is high in the immediate vicinity of the Blue Gem prospect, moderate in the immediate vicinity of the Red Knob claims, and low in the surrounding area. Anomalous concentrations of tungsten, molybdenum, and barium are present in panned-concentrate samples collected from streams draining the zone underlain by metamorphosed sedimentary rocks along the southwest edge of the

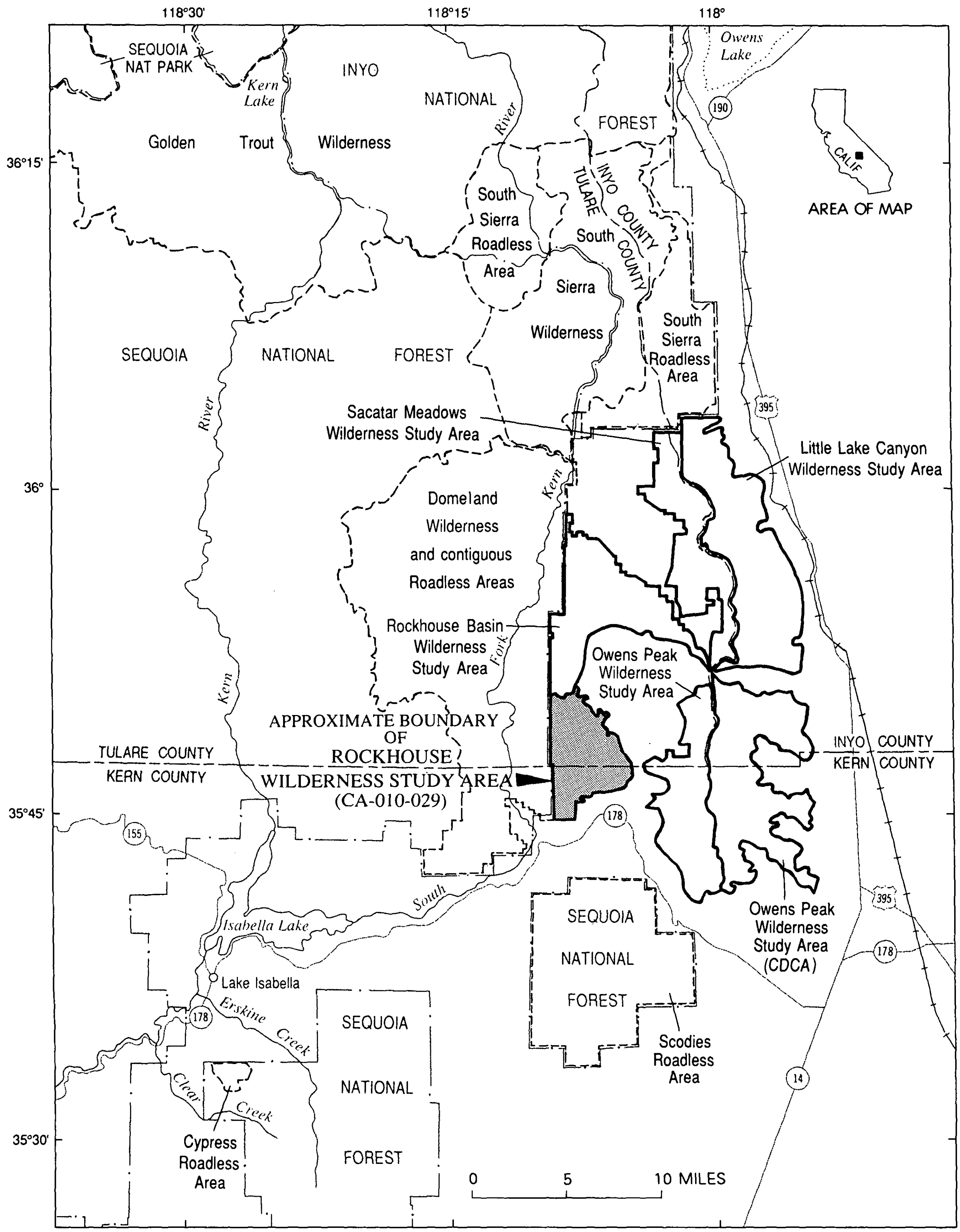

Figure 1. Index map showing location of Rockhouse Wilderness Study Area, Kern and Tulare Counties, and other wilderness study areas, wildernesses, and roadless areas on the Kern Plateau, California.

study area; this zone has moderate mineral resource potential for tungsten and associated molybdenum deposits and low mineral resource potential for barite.

Three zones underlain by granodiorite cut by pegmatite dikes contain geochemical anomalies of silver, arsenic, lead, antimony, and (or) zinc; the anomalies are assumed to be derived from minor sulfide deposits associated with the pegmatite dikes. One large zone in the center of the study area has low mineral resource potential for silver, arsenic, lead, and antimony. Another zone along the ridge on the southeast boundary of the study area has low mineral resource potential for silver, lead, antimony, and zinc. The third small zone near the south tip of the study area has low mineral resource potential for lead, antimony, and zinc.

Because the youngest thermal event near the study area took place nearly 3 million years ago, the study area has no geothermal energy resource potential. The study area is underlain by intrusive and metamorphic rocks that are not permissive for the formation or accumulation of hydrocarbons; hence the study area has no oil and gas 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 a system that is a modification of that described by McKelvey (1972) and U.S. Bureau of Mines and U.S. Geological Survey (1980). U.S. Geological Survey studies are designed to provide a 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. Goudarzi (1984) discussed mineral assessment methodology and terminology as they apply to these surveys. See appendixes for the definition of levels of mineral resource potential and certainty of assessment and for the resource/reserve classification.

Location and Physiography

The Rockhouse Wilderness Study Area is approximately 12,564 acres in size and is 20 mi northeast of the town of Lake Isabella and 50 mi south of Lone Pine, Calif. (fig. 1). The terrain is generally steep and rugged, with elevations ranging from about 7,025 ft at an unnamed point near the west boundary to about 3,200 ft in the lower Chimney Creek valley. Access to the area is by California Highway 178 from the south, Canebrake road from the east, and the Long Valley Loop road from the north (fig. 2). Vegetation at the higher elevations belongs primarily to the Sierran Montane Conifer Forest biotic community of the California Floristic Province, while that at the lower elevations belongs to the Great Basin Montane Scrubland biotic community of the Great Basin Floristic Province, which consists mostly of deciduous scrub, although evergreen elements are regularly present and may dominate locally (Brown, 1982). The higher country is covered by conifer forest (Transition Zone) (Storer and Usinger, 1963), which in the study area consists predominantly of piñon pine (*Pinus monophylla*) and includes oak (*Quercus* spp.), digger pine (*P. sabiniana*), and juniper (*Juniperus* spp.). The middle elevations are in the Upper Sonoran Zone, where some pine is replaced by oak—mainly Arizona white oak (*Q. arizonica*) with canyon live oak (*Q. chrysolepis*) and California black oak (*Q. kelloggii*) closer to drainages—, ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), and bush chinquapin (*Castanopsis sempervirens*). The vegetation found in the lower elevations of the study area consists of sagebrush (*Artemisia tridentata*) and mountain mahogany (*Cercocarpus* spp.). Black cottonwood (*Populus trichocarpa*) and California sycamore (*Platanus racemosa*) grow along the lower drainages.

Most of the area is underlain by plutonic rocks of the Sierra Nevada batholith. The oldest rocks in the area are Paleozoic and (or) Mesozoic (see appendixes for geologic time chart) metamorphosed sedimentary rocks composed of quartz-mica schist and quartzite. Nokleberg (1983) assigned these rocks to the Kings terrane. The metamorphosed sedimentary rocks were intruded by leucocratic, nonfoliated Cretaceous granite, alaskite, aplite, and pegmatite.

Procedures

The U.S. Geological Survey conducted detailed field investigations of the Rockhouse Wilderness Study Area in the summer of 1986, with follow-up work in the summer of 1987. This work included geologic mapping at a scale of 1:24,000, field checks of existing geologic maps, and the examination of outcrops for the tungsten-bearing mineral scheelite using ultraviolet lamps. Inspection of known mineralized zones was conducted in order to assess the potential for undiscovered extensions of known deposits. A discussion of the methods of geochemical sampling, analysis, and interpretation is included in the "Geochemistry" section.

Sources of data examined by the U.S. Bureau of Mines include geologic and mining literature, Bureau of Land Management, county, and U.S. Bureau of Mines mining claim data, property owners, and field studies. A search was conducted for mine and prospect workings and other indications of mineralization. Four prospects were examined: two in the Rockhouse Wilderness Study Area and two within approximately 1 mi of the study area (fig. 2); 49 samples (33 rock and 16 alluvial placer) were collected in the study area and vicinity. All samples were checked for radioactivity and scheelite fluorescence. Rock samples were prepared for analysis at the U.S. Bureau of Mines Western Field Operations Center (WFOC); 30 were analyzed for 34 elements by neutron activation analysis (NAA), 10 samples were analyzed for oxide concentrations of 13 elements, and 3 samples were examined for selected mineral identification by X-ray diffraction at contract laboratories. Panned alluvial samples were further concentrated on a laboratory-size Wilfley table at WFOC to extract free gold and other heavy minerals. Details of the analytical data are presented by Peters and Winters (1988).

Previous Studies

Smith (1964) compiled the regional geology of the Bakersfield 1° by 2° sheet. The general geology of this part of the Kern Plateau was described by Miller (1931, 1946), Webb (1936), and Miller and Webb (1940). Lawson (1906), Wahrhaftig (1965), and Bergquist and Diggles (1986b) discussed the geomorphology of the Kern Plateau. Other resource-related studies of the area include a discussion of mines and prospects of Tulare County by Goodwin (1958). Results of the study of the Rockhouse Basin Wilderness Study Area (fig. 1), of which the Rockhouse Wilderness Study Area is a part, were summarized by Taylor (1984); details were presented by Taylor and others (1986). The present mineral resource assessment is the last of a series of studies conducted on public lands on the Kern Plateau over the past several years (fig. 1, table 1).

Acknowledgments

The writers greatly appreciate the cooperation of Gary Walker, James Jennings, Maureen Horne, John and Clair McDowell, and James Boukidis of the U.S. Bureau of Land Management who gave support and use of their facilities. Fern Shepard of the Sacramento office of the U.S. Bureau of Land Management provided a data disk of geochemical data from previous studies. Gary C. Taylor of the California Division of Mines and Geology, Sacramento, Calif., provided logistical advice and technical information. Elsa C. Roscoe, Gerilyn S. Andrews, and Gifford Keith helped with the field work. Stephanie L. Jones provided physiographic information. The authors are grateful to Stephan R. Smith, owner of the Blue Gem turquoise prospect, and John W. Nicoll, owner of the White Cross prospect, for showing us their properties and providing much helpful information. Allen E. Lombardo, of the Lombardo Turquoise Company, Inc., Austin, Nev., and James E. Shigley, of the Gemological Institute of America, Santa Monica, Calif., provided expert advice on turquoise.

APPRAISAL OF IDENTIFIED RESOURCES

By Thomas J. Peters
U.S. Bureau of Mines

Mining and Mineral Exploration History

The Rockhouse Wilderness Study Area was probably prospected for gold during the late 1800's and early 1900's when placer gold was mined along the South Fork of the Kern River and its tributaries south and southwest of the area. Four prospects (fig. 2) and a millsite ruins are situated in the study area and vicinity. The mill was built by Chester D. Smith, Thurston Cooper, Richard B. Rogers, and Frank Tucker in 1954 in Long Valley, where water was available, to service the Rockhouse tungsten prospect about 2.5 mi north of the study area (Unknown Tungsten of Taylor and others, 1986). It was operational only for 18 months (S.R. Smith, oral commun., 1987).

In 1955 the Red Knob gold claims (fig. 2, table 2, No. 1) were located by Ralph G. Barnett, Richard B. Rogers, and Chester D. Smith. The Blue Gem turquoise prospect (fig. 2, table 2, No. 3) was discovered and located by Chester D. Smith about 1930, but old location papers found by Smith on the site dated back to 1914; his son, Stephen R. Smith has held the property since 1972. Stephen W. Smith, son of Stephen R., established the Little Steve gold prospect (fig. 2, table 2, No. 2) in 1975.

The White Cross feldspar prospect (fig. 2, table 2, No. 4) is easily identified by a 15-ft-high quartz spire. John W. Nicoll, owner, recalls seeing the spire from the southeast rim of Chimney Creek canyon whilst herding cattle as a boy about 1920. Messrs. Nicoll and Clyde L. Robinson located three claims that included the prospect in 1977.

Prospects

The Little Steve prospect, in the north end of the study area, (fig. 2, table 2, No. 2) is located at the contact between the granodiorite of Church Dome and the Sacatar Quartz Diorite of Miller and Webb (1940). A milky quartz vein is poorly exposed but appears to dip steeply. The only working is a 4-ft by 4-ft by 2-ft-deep pit. Two samples were collected; the highest gold concentration is 240 parts per billion (ppb), or 0.007 oz gold per ton (oz Au/ton). No production has been recorded.

The nearby Blue Gem turquoise prospect (fig. 2, table 2, No. 3) is underlain by iron-oxide-stained micaceous quartzite. Sky-blue and blue-green turquoise was observed

Table 1. Available reports of studies related to wilderness on the Kern Plateau, southern Sierra Nevada, California

[AB, abstract; B, USGS Bulletin; GQ; USGS Geologic Quadrangle Map; MF; USGS Miscellaneous Field Studies Map; MLA, USBM Open-File Report, Mineral Lands Assessment; OF, USGS Open-File Report; OP, outside publication; SR, California Division of Mines and Geology Special Report. See references cited for complete listing of each report; see figure 1 for location of each area]

Golden Trout Wilderness:	
Geology:	
du Bray and Dellinger (1981)	MF–1231–A
du Bray and Moore (1985)	MF–1734
Moore and Sisson (1985)	GQ–1584
Geochemical data:	
Leach and others (1981a, b, c, d, e, f)	OF 81–752–757
Geochemical interpretation:	
Goldfarb (1981)	Thesis
Leach and others (1983a, b)	MF–1231–B,C
Geophysical studies:	
Jachens and Elder (1983)	MF–1231–D
Known mineral deposits:	
Zilka (1982)	MLA 52–82
Mineral resources and resource potential:	
Dellinger and others (1983)	MF–1231–E
South Sierra Wilderness and South Sierra Roadless Area:	
Geology and mineral resource potential:	
Diggles (1987)	MF–1913–A
Geochemical data:	
Diggles and others (1986b)	OF 86–359
Domeland Wilderness and contiguous Roadless Areas:	
Geology:	
Bergquist and Nitkiewicz (1982)	MF–1395–A
Bergquist and Diggles (1986a)	AB
Bergquist and Diggles (1986b)	OP
Geochemical data:	
McHugh and others (1981)	OF 81–730
Motooka and others (1980)	OF 80–918
Geochemical interpretation:	
Miller and McHugh (1985)	MF–1395–E
Miller and others (1985a, b)	MF–1395–C,D
Geophysical studies:	
Jachens (1983)	MF–1395–B
Known mineral deposits:	
Leszcykowski and others (1982) (Domeland Wilderness)	MLA 36–82
Spear and McCulloch (1981) (Domeland Addition and Woodpecker Roadless Areas)	MLA 10–81
Mineral resources and resource potential:	
Bergquist and others (1983)	MF–1395–F
Scodies Roadless Area:	
Geochemical data:	
Sutley and others (1983a)	OF 83–645
Known mineral deposits:	
Capstick (1983b)	MLA 47–83
Mineral resources and resource potential:	
Harner and others (1983)	OF 83–510
Cypress Roadless Area:	
Geochemical data:	
Sutley and others (1983b)	OF 83–643
Geochemical interpretation:	
Chaffee and others (1986)	MF–1532–B
Known mineral deposits:	
Capstick (1983a)	MLA 64–83
Mineral resources and resource potential:	
Kennedy and others (1983)	MF–1532–A
Rockhouse Basin Wilderness Study Area:	
Geology, mineral resources, and resource potential:	
Taylor (1984)	OP
Taylor and others (1986)	SR 157
Rockhouse Wilderness Study Area:	
Known mineral deposits:	
Peters and Winters (1988)	MLA 24–88
Mineral resources and resource potential:	
This report	B 1705–E
Sacatar Meadows Wilderness Study Area:	
Geology:	
Diggles and Dellinger (1988)	AB
Geochemical data:	
Adrian and others (1987)	OF 87–172
Known mineral deposits:	
Kuizon (1985)	MLA 53–85
Mineral resources and resource potential:	
Diggles and others (1988)	B 1705–D
Owens Peak (CA–010–026) Wilderness Study Area:	
Geology:	
Diggles and Clemens (1986)	MF–1833
Geochemical data:	
Adrian and others (1986)	OF 86–282
Geophysical studies:	
Pierce and others (1987)	OF 87–134
Known mineral deposits:	
Causey and Gaps (1985)	MLA 2–85
Mineral resources and resource potential:	
Diggles and others (1986c)	B 1705–A
Owens Peak (CDCA–158) and Little Lake Canyon Wilderness Study Areas:	
Geology:	
Diggles (1984)	AB
Diggles and others (1987)	MF–1927–A
Geochemical data:	
Detra and others (1985)	OF 85–034
Diggles and others (1986a)	OF 86–594
Known mineral deposits:	
Causey and Gaps (1985)	MLA 2–85
Mineral resources and resource potential:	
Diggles and others (1985)	B 1708–B

Table 2. Claims and prospects in and near the Rockhouse Wilderness Study Area, Kern and Tulare Counties, California

[*, prospect outside study area]

Map No.	Name	Summary	Workings and production	Sample and resource data
*1	Red Knob claims	Iron-oxide-stained quartzite roof remnant prospected for gold in 1955. One 2-ft-wide granitic-pegmatite dike along east side of prospect area strikes N. 10° E., dips 90°.	One shallow, 90-ft-long bulldozer cut trends N. 35° E. No production recorded or indicated by workings.	Seven random chip samples of quartzite and one 2.2-ft-long chip sample across pegmatite dike were collected. Analyses range from less than 5 to 130 ppb gold.
2	Little Steve prospect	Vein of milky quartz containing minor sulfide minerals appears to be 4 ft wide and strike approximately north-south. Vein is at contact between granodiorite and quartz diorite.	One pit, 4 ft by 4 ft by 2 ft deep. No production.	Chip sample across the pit and select sample; have 5 to 10 percent sulfide minerals, mainly pyrite, and contain 210 and 240 ppb gold, respectively.
3	Blue Gem prospect	Gem-quality turquoise [$CuAl_6(PO_4)_4(OH)_8 \cdot 5H_2O$] occurs in 0.4-in.-thick quartz vein along contact between pegmatite dike trending N. 10° E. and iron-oxide-stained quartzite and within zone of argillic alteration along joint or fault planes.	Six small pits and trenches, in two clusters (three pits each) that are 500 ft apart along contact. Limited turquoise collecting by claimants, but no production.	Seven samples collected. three samples identified as turquoise by X-ray diffraction; four samples analyzed for gold and other metals but contain no significant concentrations. Turquoise ranges from sky blue ($3.75 per carat) to bluish green ($1.25 per carat). Mining would be labor-intensive, low-capital, part-time operation. The prospect contains marginally economic turquoise resource of undetermined quantity.
*4	White Cross prospect	White to pinkish granitic pegmatite with banded aplitic and milky-quartz zones, appears to strike northwest and dip 45° NE., crops out over more than 140 ft of strike length.	One northeast-facing, 20-ft-high cut extends 140 ft northwest across outcrop area. No production.	Nine chip and two grab samples collected and analyzed for gold, 9 rare-earth elements, and 24 other metals, including tungsten; no significant concentrations detected. Ten samples analyzed for major-element oxides. Pegmatite contains perthitic mixture of potassium and sodium feldspar minerals constituting about 75 percent of rock; suitable for many modern industrial applications. Feldspar occurrence estimated at 5,000 tons.

at one small trench within a thin (0.4-in.) quartz vein along the contact between a granitic pegmatite dike and metasedimentary rocks. The contact strikes N. 8° E. and dips 72° E. Bluish-green turquoise was observed on the dumps of five additional small pits and trenches; the workings are in two clusters about 500 ft apart (Peters and Winters, 1988). Seven samples (four chip and three grab) were collected. Turquoise was identified by X-ray diffraction from three samples; sample specimens were also evaluated by a gemologist and found to be of gem quality. Four samples of host rock were analyzed for gold and other metals, but they contained no significant metallic concentrations (table 2, No. 3). No production has been recorded.

The inactive Red Knob claims, 0.3 mi north of the study area (fig. 2, table 2, No. 1), are located within roof remnants of iron-oxide-stained micaceous quartzite similar to that at the Blue Gem prospect. Metamorphic foliation strikes north and dips steeply east. An iron-oxide-stained micaceous granitic pegmatite dike that strikes N. 10° E. and dips 90° cuts the quartzite and is exposed along the west face of a shallow bulldozer trench. Seven samples of quartzite and one of pegmatite were collected (table 2, No. 1). The highest gold concentration in the U.S. Bureau of Mines samples is 130 ppb (0.004 oz Au/ton). No production has been recorded, and no resources are identified at the Red Knob claims.

The White Cross feldspar prospect, 0.6 mi east of the study area (fig. 2, table 2, No. 4), is a granodioritic to granitic pegmatite dike that cuts through medium-grained granodiorite and has a quartz-pegmatite zone on the hanging-wall side. It was not possible to determine attitude directly from the dike, but flow banding indicates the pegmatite body strikes northwest and dips about 45° NE. Workings consist of one 140-ft-long, northwest-trending cut which exposes a 20-ft-high northeast-facing rock face. At least 5 of 11 samples of the pegmatite would qualify as "sodic feldspar" (more than 7 percent Na_2O). One of the pegmatite samples qualifies as "potassic feldspar" (more than 10 percent K_2O). Much of the pegmatite either contains perthitic or antiperthitic feldspar (table 2, No. 4).

Mineral Resources and Economics

Turquoise at the Blue Gem prospect (fig. 2, table 2, No. 3) is the only known mineral resource in the study area. Although exposures are too poor to estimate the quantity of turquoise present, enough material is present in outcrops and on dumps to indicate that a marginally economic resource is present. Both sky-blue and blue-green varieties are present; blue-green turquoise, although marginally economic alone, has value as a by-product. Turquoise from the deposit was examined at the Lombardo Turquoise Co., Inc., Austin, Nev. Blue turquoise was valued at $3.75 per carat and blue-green turquoise at $1.25 per carat (A.E. Lombardo, written commun., 1987). Although a large mining operation is not likely, profitable mining could be carried out as a low-capital part-time hobby-type operation. Most domestic gemstone is mined in this way (Pressler, 1985).

The Red Knob gold claims, just north of the Rockhouse Wilderness Study Area (fig. 2, table 2, No. 1), have no significant gold concentrations; the highest concentration was 130 ppb (less than 0.004 oz Au/ton), worth $1.80 per ton at $450 per oz gold.

Gold concentrations from the Little Steve prospect (fig. 2, table 2, No. 2) are 210 and 240 ppb, or approximately 0.007 oz Au/ton. The lode contains gold worth about $3.00 per ton in a setting that would probably require underground mining methods costing as much as $100 per ton.

The White Cross prospect, just east of the study area (fig. 2, table 2, No. 4), is located in pegmatite that contains about 75 percent feldspar, much of which is perthitic. Although formerly unacceptable, perthitic feldspar is now considered suitable for many industrial applications (Potter, 1985). However, the estimated 5,000 tons of feldspar is too small to be considered a resource. Even if a larger tonnage is present, which is unlikely, the remoteness of the property would make mining and transportation prohibitively expensive. In addition, iron in some samples exceeds 1 percent and could make the feldspar unusable. Analyses of samples did not reveal economic concentrations of rare-earth elements. All samples were analyzed for tungsten because of the presence of roof remnants within granitic intrusions, a common environment for tungsten occurrences. Most samples have concentrations at or near the detection limit of 2 parts per million (ppm) tungsten. No economic concentrations of tungsten were observed.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

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Geology

The Rockhouse Wilderness Study Area consists dominantly of granitic rocks of the Sierra Nevada batholith. Of the three major periods of intrusive activity (Evernden and Kistler, 1970) in the Kern Plateau region, only the younger two are represented within the study area. The granitic rocks intruded and metamorphosed Paleozoic and (or) Mesozoic sedimentary rocks that form small roof remnants of quartz-biotite-muscovite schist, phyllite, and quartzite. The oldest intrusive rocks in the region, situated north of the study area, are Triassic and (or) Jurassic in age, rich in mafic minerals, dioritic to gabbroic in composition, and schistose to gneissic in fabric. In the northern part of the study area, a younger Jurassic suite of granitic rocks crops out. The Jurassic rocks are commonly more mafic in composition and more foliated in texture than two younger Cretaceous rock units. Most of the study area is underlain by the youngest intrusive rocks in the region, which are leucocratic, nonfoliated Cretaceous granitic units. Tertiary basalt caps ridges north and west of the study area. Extensive Quaternary alluvium deposits occupy valleys and stream channels adjacent to the study area.

Paleozoic and (or) Mesozoic Metamorphic Rocks

Metamorphic rocks in the area consist of quartz-mica schist, small areas of phyllite and quartzite, and narrow areas of marble and barite. Skarn sometimes forms where plutonic rocks have intruded calcareous rocks, and one such area is present in the study area (Taylor and others, 1986). These contact-metamorphic zones are important for their mineral resource potential. Calcareous metasedimentary rocks are common in outcrops of phyllite and quartzite outside the study area. Geochemical evidence suggests that additional small unmapped pods of skarn may be present locally in discontinuous roof remnants (roof pendants) within the study area. The metamorphic rocks within the study area (fig. 2) are correlated with the Paleozoic and (or) Mesozoic Kernville Series of Miller (1931). These rocks in the region of the study area may be Paleozoic in age (Diggles and others, 1987), while those farther west 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 region 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 and are outside the study area. The Sacatar Quartz Diorite of Miller and Webb (1940) crops out in the northeastern part of the study area and consists of a complex of related plutons that are generally mesocratic, medium grained, equigranular to seriate, and foliated. The composition is highly varied (Diggles and Dellinger, 1988), ranging from quartz diorite through quartz monzodiorite, tonalite, and granodiorite to granite (nomenclature of Streckeisen, 1976). The unit locally contains abundant mafic inclusions in varied degrees of assimilation by the granitic host. The textures range from angular agmatitic to schlieric. Three potassium-argon determinations on hornblende give ages of 146.3±4.4 to 144.5±4.3 million years (Ma) (R.M. Tosdal, in Bergquist and Nitkiewicz, 1982), but these are considered minimum ages, as the hornblende may have been partly reset by later intrusions.

The youngest of the three suites of plutonic rocks in the region underlies most of the study area. This suite is represented within the study area by two Cretaceous granodiorite units and contains associated alaskite, aplite, and pegmatite. In general, these rocks are more leucocratic than rocks of the older suites and are nonfoliated. The two granodiorite units are the granodiorite of Church Dome (Diggles, 1987) and the granodiorite of Lamont Peak (Diggles and others, 1987). These two units form part of what was called the Isabella Granodiorite of Miller (1931). Current usage by most authors is to divide the Isabella rocks into informally designated, separate and (or) related plutons.

The granodiorite of Church Dome (Diggles, 1987) is a leucocratic, medium- to coarse-grained, seriate to porphyritic granite and granodiorite. It is characterized by large (greater than 1 in.) potassium-feldspar megacrysts. The unit, which is similar to the Cathedral Peak Granodiorite in Yosemite National Park (Bateman and Chappell, 1979), underlies most of the Domeland Wilderness (fig. 1) and is named for exposures of this granodiorite at Church Dome in that area (Bergquist and Nitkiewicz, 1982). This unit gives a potassium-argon age of 81.1±2.4 Ma (R.M. Tosdal in Bergquist and Nitkiewicz, 1982).

The granodiorite of Lamont Peak is a leucocratic, medium- to coarse-grained, equigranular to seriate rock. It is exposed over much of the eastern part of the study area as blocky to rounded, massive to jointed outcrops. The unit was informally named for exposures in the vicinity of Lamont Peak east of the study area (Diggles and others, 1987). It is generally composed of quartz, potassium feldspar, oligoclase, and varied amounts of biotite and hornblende. Sphene, apatite, zircon, and magnetite are present as accessory minerals. Along the southwest boundary of the study area, the contact between the two units follows the discontinuous metamorphic roof remnants. The tungsten-bearing mineral scheelite is sometimes formed in skarn along the contacts between metamorphic roof pendants and granitic intrusions (Cox, 1986).

Volcanic Rocks

North and west of the study area, volcanic rocks crop out on ridge tops. The volcanic rocks are erosional remnants of formerly extensive flows erupted onto a surface of relatively low relief. These remnants are now perched on the elevated, dissected Kern Plateau in an area of rugged relief (Bergquist and Diggles, 1986a). The volcanic rocks are mostly basalt flows that are dark gray to black, medium-gray weathering, massive to blocky, and locally banded vesicular to scoriaceous. The basalts locally contain quartz xenocrysts, as large as 1.5 in. in diameter, and xenoliths, both of which are derived from the underlying granitic rocks. The volcanic rocks are typically olivine-augite-plagioclase phyric basalts. They contain euhedral to subhedral microphenocrysts of magnesian olivine (some of which are fragmented), greenish, euhedral, zoned, titaniferous augite, and variously resorbed fragments of zoned plagioclase. The basalts were extruded during two time periods. The older basalts are west of the study area and range in age from 12.8±0.7 to 10.6±0.2 Ma; the youngest rocks range in age from 2.9±0.1 to 3.9±0.2 Ma and include the flows north of the study area (Bergquist and Diggles, 1986b).

Quaternary Alluvium

Alluvial deposits are found in canyon bottoms and compose the large fans in the South Fork Kern River valley south of the study area. These include modern stream-channel deposits consisting of poorly sorted gravel, sand, and silt in channels and flood plains, minor colluvium, and older alluvium consisting of dissected Quaternary stream-channel deposits on terraces.

Structure

Metamorphic rocks near the southwest boundary of the study area 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). The prebatholithic rocks are considered part of the accreted Kings terrane of Nokleberg (1983). This terrane is characterized by metamorphosed quartzite, arkose, limestone, marl, mudstone, and calcareous sandstone, as well as minor metamorphosed volcanic rocks. It extends north to the eastern parts of the Kings and Kaweah Rivers and was accreted during the Jurassic and Early Cretaceous Nevadan orogeny.

A dominant joint set that trends north-northeast and a subordinate joint set that trends west-northwest control the morphology of the eroded granitic domes in the Domeland Wilderness, just west of the study area. En echelon faults trend west-northwest across the eastern Kern Plateau, parallel to the subordinate joint set, and control the orientations of the major canyons east of the study area. These faults are best exposed as shear zones in saddles east of Lamont Meadow (4 mi east of the study area) and are cut at the east margin by the Sierra Nevada range-front fault zone along which the range was uplifted. A fault trending north-south through Lamont Meadow and just southwest of the study area may represent one strand of this range-front fault system.

Geochemistry

The geochemical data used in this mineral resource assessment are part of those gathered for the evaluation of the Rockhouse Basin Wilderness Study Area (Taylor and others, 1986).

Methods and Background

Taylor and others (1986) collected 294 samples, 47 of which were in or near the Rockhouse Wilderness Study Area. Stream-sediment samples were collected from all major streams and tributaries and represent eroded bedrock that underlies the drainage basin whence the sediment came. Panned concentrates of the sediment were prepared and analyzed separately. The panned-concentrate fraction may contain minerals related to metallization processes. The samples were analyzed for 30 elements by inductively coupled argon plasma emission spectrometry (ICP). The panned concentrates were also analyzed for gold by a combined fire-assay and atomic-absorption technique. The analyses were made by Acme Analytical Laboratories Ltd., Vancouver, British Colombia; the data were presented by Taylor and others (1986).

J.T. Alfors, R.C. Loyd, M.C. Stinson, and M.A. Silva (in Taylor and others, 1986) developed statistical data by using the SAS UNIVARIATE procedure (SAS Institute, Inc., 1982) and defined levels above which concentrations are considered anomalous for the Rockhouse Basin Wilderness Study Area. For the Rockhouse Wilderness Study Area, a disk containing the Taylor data was provided by the U.S. Bureau of Land Management and further processed. The file was transferred to Lotus 123 and compared with the data from other U.S. Geological Survey studies on the Kern Plateau. New geometric means and geometric deviations were determined for the 47 Rockhouse Wilderness Study Area samples by using the STATPAC statistical software for the IBM–PC (Grundy and Miesch, 1987). For gold, any concentration above the lower limit of determination is considered anomalous. For the other elements, the value two geometric deviations above the geometric mean is used as the anomalous threshold.

Results and Interpretation

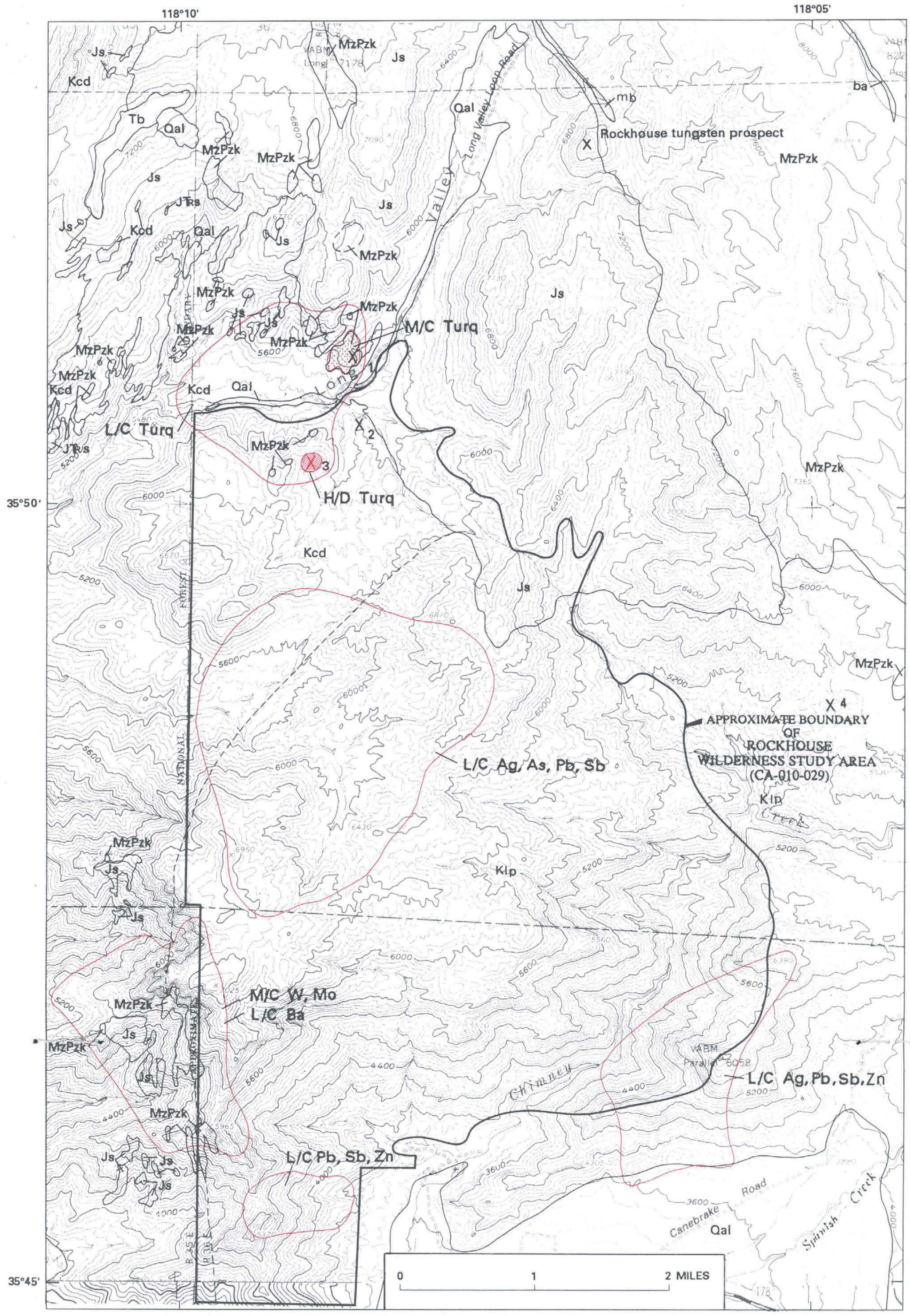
The geochemical data suggest four geochemical anomalies in the study area. Samples collected from streams draining the metamorphic roof remnants along the southwest edge of the study area contain anomalous concentrations of tungsten, molybdenum, and barium in panned concentrates. Two panned-concentrate samples collected from streams draining a large zone near the center of the study area contain slightly anomalous concentrations of silver, arsenic, lead, and antimony. Elevated levels of uranium and thorium in those two samples represent the normal high background for granitic rocks in the Sierra Nevada batholith. Several panned-concentrate samples collected from small drainages along the southeast edge of the study area contain anomalous concentrations of silver, lead, antimony, and zinc. Stream-sediment samples from those drainages also contain anomalous copper, lead, and zinc concentrations. Panned-concentrate samples collected from streams draining a small zone in the southern tip of the study area contain anomalous concentrations of lead, antimony, and zinc.

Geophysical Studies

Three types of regional geophysical data (magnetic, radiometric, and gravity) from south-central California cover the study area and were examined to aid in the assessment of the mineral resource potential. The substantial height of the magnetic survey above the ground surface and the sparsely distributed nature of the gravity and radiometric data sets make the geophysical data adequate for addressing the regional geophysical setting of the study area but do not permit detailed statements about mineral resource potential at the scale of the deposits.

Aeromagnetic Data

An aeromagnetic survey of the study area and vicinity was flown and compiled in 1981 by High Life–QEB, Inc., under contract to the U.S. Geological Survey. Total-field magnetic data were collected along east-west flightlines spaced approximately 0.5 mi apart at a constant altitude of 9,000 ft. Corrections were applied to the data to compensate for diurnal variations of the Earth's magnetic field, and the International Geomagnetic Reference Field (updated to the month that the data were collected) was subtracted to



EXPLANATION

- Area having high mineral resource potential (H)
- Area having moderate mineral resource potential (M)
- Area having low mineral resource potential (L)
- X Prospect having identified resources

Levels of certainty of assessment

- C Data give good indication of level of potential
- D Data clearly define level of potential

Commodities

Ag	Silver	Sb	Antimony
As	Arsenic	Turq	Turquoise
Ba	Barite	W	Tungsten
Mo	Molybdenum	Zn	Zinc
Pb	Lead		

Claims and prospects

1. Red Knob claims
2. Little Steve prospect
3. Blue Gem prospect
4. White Cross prospect

Correlation of map units

- Qal — QUATERNARY
- Unconformity
- Tb — TERTIARY
- Unconformity
- Klp, Kcd — CRETACEOUS
- Js — JURASSIC
- J̄Ts — JURASSIC AND (OR) TRIASSIC
- Unconformity
- MzPzk — MESOZOIC AND (OR) PALEOZOIC

Description of map units

Qal Alluvium (Quaternary)—Alluvial fan deposits and stream deposits of gravel, sand, and silt

Tb Basalt (Tertiary)—Dark-gray to black, medium-gray-weathering, massive to blocky, and locally banded vesicular to scoriaceous olivine basalt 2 mi west of Long Valley. K-Ar age of 2.9±0.1 to 3.9±0.2 Ma (Bergquist and Diggles, 1986b)

Klp Granodiorite of Lamont Peak (Cretaceous)—Leucocratic, medium- to coarse-grained, equigranular to seriate granite and granodiorite

Kcd Granodiorite of Church Dome (Cretaceous)—Leucocratic, medium- to coarse-grained, seriate to porphyritic granite and granodiorite. K-Ar age of 81.1±2.4 Ma (R.M. Tosdal in Bergquist and Nitkiewicz, 1982)

Js Sacatar Quartz Diorite of Miller and Webb (1940) (Jurassic)—Mesocratic, medium-grained, equigranular to seriate biotite-hornblende granodiorite having compositions that range from quartz diorite through quartz monzodiorite, tonalite, and granodiorite to granite. Contains inclusions of diorite. K-Ar ages of 146.3±4.4 to 144.5±4.3 Ma (R.M. Tosdal in Bergquist and Nitkiewicz, 1982)

J̄Ts Summit Gabbro of Miller and Webb (1940) (Jurassic and (or) Triassic)—Coarse-grained, seriate to porphyritic, mesocratic to melanocratic, poikilitic hornblende gabbro. Named for exposures along Sierra Nevada crest

MzPzk Kernville Series of Miller (1931) (Mesozoic and (or) Paleozoic)—Metamorphic rocks including quartz-biotite schist, phyllite, and quartzite. Locally also includes marble (mb) and bedded barite (ba)

——— Contact—Dashed where approximately located

X² Prospect or claims

Figure 2. Mineral resource potential and generalized geology of Rockhouse Wilderness Study Area, Kern and Tulare Counties, California. Geology modified from Bergquist and Nitkiewicz (1982). Base from U.S. Geological Survey 1:62,500 Lamont Peak and Onyx quadrangles, Calif. Contour intervals 100 and 80 feet.

yield a residual magnetic field. The data were compiled on an aeromagnetic map (U.S. Geological Survey, 1982) that primarily reflects the distribution of magnetization in the underlying rocks. Because the elevation of the ground surface in the study area ranges between about 4,000 ft and 7,000 ft above sea level, the magnetic data collected at 9,000 ft above sea level cannot resolve detailed variations in magnetization of the underlying rocks.

The residual magnetic map shows a broad 3-mi-wide elongate magnetic high that trends northeast-southwest across the center of the study area. This smooth anomaly, about 120 nanoteslas in amplitude, is typical of magnetic anomalies present over exposures of the granodiorite of Church Dome immediately west of the study area (Jachens, 1983) and probably reflects normal variations in the magnetite content of these granitic rocks. No other prominent magnetic anomalies are present on the residual magnetic map of the study area.

Radiometric Data

An aeroradioactivity survey of the Bakersfield 1° by 2° quadrangle, California, was flown and compiled by High Life–QEB, Inc., in 1980 under contract to the U.S. Department of Energy as part of the NURE program (U.S. Department of Energy, 1980). Recordings were made of gamma-ray flux indicative of radioactive isotopes of potassium, thorium, and uranium. These data were collected along east-west flightlines spaced about 3 mi apart and at a nominal height of 400 ft above the ground surface. Three flightlines (lat 35°46.3' N., 35°48.4' N., 35°51.0' N.) pass over or close to the study area. No anomalies indicative of unusual concentrations of any of the three elements were observed over the study area (U.S. Department of Energy, 1980). However, because gamma rays are strongly attenuated during passage through earth material, these data do not preclude significant concentrations of the elements between the 3-mi-spaced profiles or buried more than about 2 ft beneath the ground surface. M.M. Bushnell (in Taylor and others, 1986) delineated a radiometric anomaly in the northwest corner of the study area on the basis of the same NURE data. Re-examination for this study, however, led to the conclusion that the thorium reading that is slightly elevated compared to the immediately surrounding areas represents random background fluctuations. In addition, most of the anomaly is over alluvium outside of the study area and may not suggest a bedrock source.

Gravity Data

Gravity data for the study area and vicinity were obtained from Snyder and others (1982). The data are sparsely distributed; only one gravity station is within the study area, and data outside the area are scattered at 2- to 4-mi spacing. The data were reduced to complete Bouguer anomalies by using standard techniques (Telford and other, 1976) and further reduced to isostatic residual gravity according to the Airy-Heiskanen isostatic model (Jachens, 1983).

The study area lies within an east-west-trending gravity trough having typical isostatic residual gravity values of –15 to –20 milligals (mGal). The gravity high north of the study area probably is caused by the Sacatar Quartz Diorite, a granitic rock type that is an average of 0.2 gram per cubic centimeter more dense than the granodiorite of Lamont Peak that underlies most of the study area (Jachens, 1983). The source of the gravity high south of the study area has not been studied in detail but probably is mafic granitic rock. Gravity values near the study area are comparable to gravity values over the granodiorite of Church Dome in the Domeland Wilderness immediately west of the study area.

Mineral Resource Potential Assessment

There is high mineral resource potential, certainty D, for small deposits of turquoise in the immediate vicinity of the Blue Gem prospect and moderate mineral resource potential, certainty C, for similar turquoise deposits in the immediate vicinity of the Red Knob claims, both in the north end of the study area. There is low mineral resource potential, certainty C, for small, low-grade deposits of turquoise in the surrounding several hundred acres that are underlain by iron-stained roof remnants.

The Rockhouse Wilderness 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, 1986). The metamorphic roof remnants along the southwest edge of the study area are the source of geochemical anomalies of tungsten, molybdenum, and barium in panned concentrates and contain a mapped occurrence of a small body of skarn (Taylor and others, 1986). These remnants have moderate mineral resource potential, certainty C, for tungsten and associated molybdenum deposits in skarn.

Barite resources are identified in a large metamorphic roof pendant 4 mi north of the study area (G.C. Taylor and J.L. Burnett in Taylor and others, 1986). No barite was mapped in the roof remnants within the study area, but anomalous concentrations of barium are present in panned-concentrate samples collected from streams draining the zone underlain by those remnants. The area of metamorphic roof remnants along the southwest edge of the study area has low mineral resource potential, certainty C, for barite.

Three zones within the granodiorite of Lamont Peak contain pegmatite dikes that have anomalous concentrations of silver, arsenic, lead, antimony, and (or) zinc in panned-concentrate and (or) stream-sediment samples (J.T.

Alfors, R.C. Loyd, M.C. Stinson, and M.A. Silva in Taylor and others, 1986). (1) A large zone near the center of the study area has low mineral resource potential with a certainty of C for silver, arsenic, lead, and antimony as minor sulfide deposits in pegmatite dikes. (2) A zone along the ridge on the southeast boundary of the study area has low mineral resource potential with a certainty of C for silver, lead, antimony, and zinc as minor sulfide deposits in pegmatite dikes. (3) A small zone near the south tip of the study area has low mineral resource potential with a certainty of C for lead, antimony, and zinc as minor sulfide deposits in pegmatite dikes.

The study area has no geothermal energy resource potential, certainty level D. There are no volcanic rocks in the study area, and the youngest volcanic rocks near the study area were dated at 2.9 Ma (Bergquist and Diggles, 1986b). Blankenship and Bentall (1965) do not show any thermal springs, and Higgins (1981) does not show any geothermal resources in or near the study area.

The study area is considered to have no oil and gas resource potential (Scott, 1983; Charles Bishop in Taylor and others, 1986), certainty level D, inasmuch as it is underlain by Cretaceous and older intrusive and metamorphic rocks that are not permissive for the formation or accumulation of hydrocarbons.

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APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

LEVELS OF RESOURCE POTENTIAL

H **HIGH** 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 high degree of likelihood for resource accumulation, where data support 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.

M **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 for resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

L **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 little or no indication of having been mineralized.

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

U **UNKNOWN** mineral resource potential is assigned to areas where information is inadequate to assign a low, moderate, or high level of resource potential.

LEVELS OF CERTAINTY

A Available information is not adequate for determination of the level of mineral resource potential.
B Available information only 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.

LEVEL OF RESOURCE POTENTIAL →

A	B	C	D
U/A	H/B HIGH POTENTIAL	H/C HIGH POTENTIAL	H/D HIGH POTENTIAL
UNKNOWN POTENTIAL	M/B MODERATE POTENTIAL	M/C MODERATE POTENTIAL	M/D MODERATE POTENTIAL
	L/B LOW POTENTIAL	L/C LOW POTENTIAL	L/D LOW POTENTIAL
			N/D NO POTENTIAL

LEVEL OF CERTAINTY →

Abstracted with minor modifications from:

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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 McKelvey, V.E., 1972, Mineral resource estimates and public policy: American Scientist, v. 60, p. 32-40; and 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 MILLION YEARS (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	[1]~570
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

This volume was published as separate chapters A–E

U.S. GEOLOGICAL SURVEY BULLETIN 1705

DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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[Letters designate the separately published chapters]

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U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

Diggles and others—MINERAL RESOURCES, ROCKHOUSE WILDERNESS STUDY AREA, CALIFORNIA—U.S. Geological Survey Bulletin 1705-E