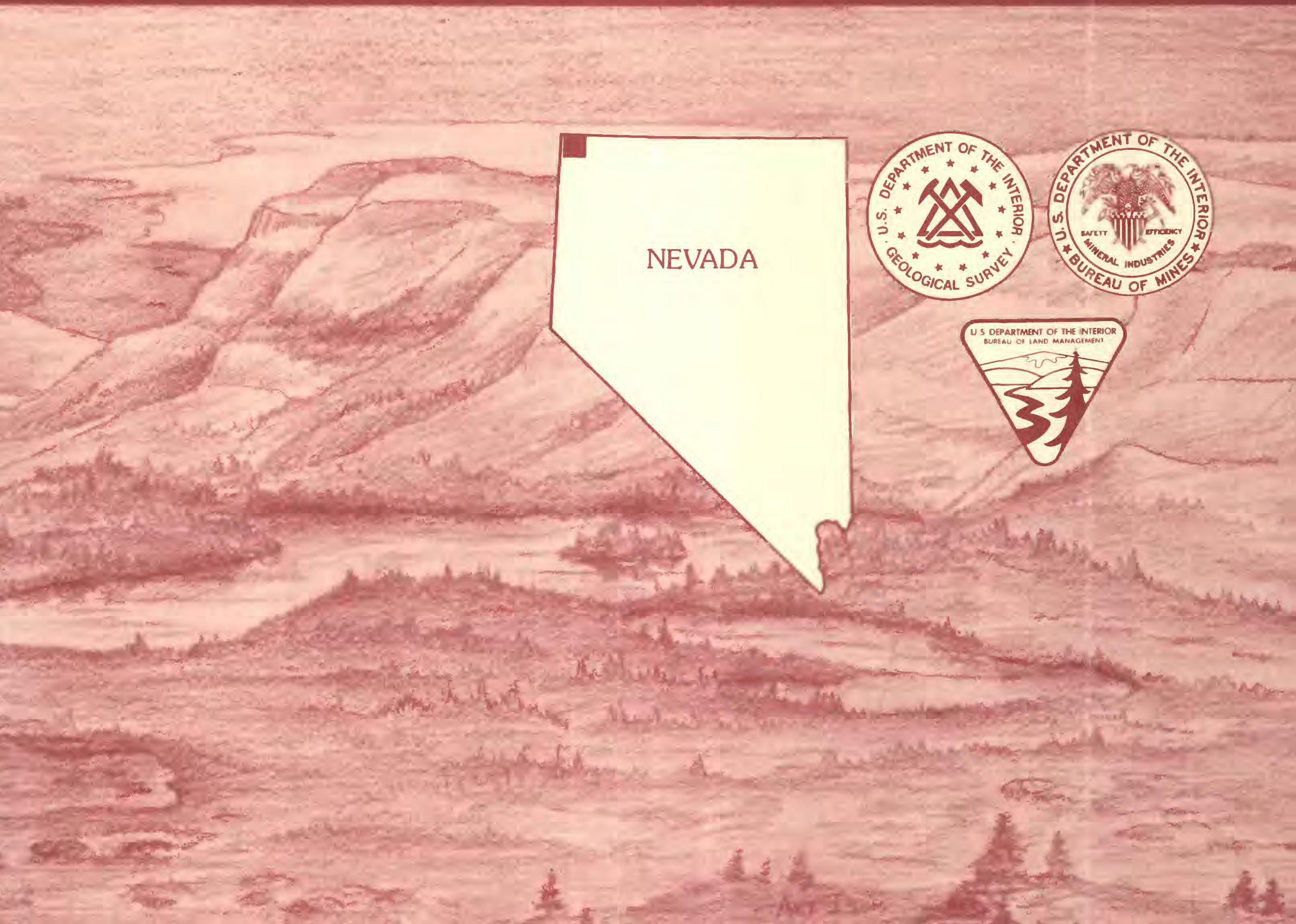
Mineral Resources of the Little High Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada

U.S. GEOLOGICAL SURVEY BULLETIN 1707–C



Chapter C

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MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
NORTHWESTERN NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

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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 the U.S. Bureau of Mines to conduct mineral surveys of 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 Little High Rock Canyon Wilderness Study Area (CA-020-913/NV-020-008), Humboldt and Washoe Counties, Nevada.

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MINERAL RESOURCES OF WILDERNESS STUDY AREAS: NORTHWESTERN NEVADA

Mineral Resources of the Little High Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada

By William J. Keith, Robert L. Turner, *and* Donald Plouff
U.S. Geological Survey

Thomas J. Peters
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SUMMARY

Abstract

At the request of the U.S. Bureau of Land Management, 17,320 acres of the Little High Rock Canyon Wilderness Study Area (CA-020-913/NV-020-008) were studied. In this report, the area studied is referred to as "the wilderness study area," or simply "the study area." The study area is in the west-central Calico Mountains in Humboldt and Washoe counties, Nevada. Geological, geochemical, geophysical, and mineral surveys were conducted by the U.S. Geological Survey and the U.S. Bureau of Mines in 1985 to assess the mineral resources (known) and mineral resource potential (undiscovered) of the study area. No resources were identified in the study area, but the results of these surveys indicate three areas with moderate resource potential for gold and silver in epithermal deposits in the northwestern, central, and southern parts of the area. Elsewhere within the study area, the potential for these resources is low. Two small areas in the southeastern part of the study area have low potential for uranium resources; one small area has low potential for pozzolan resources, and one area has low potential for perlite resources. Potential for geothermal resources is low in the entire study area.

Character and Setting

The study area is in the west-central Calico Mountains, about 45 mi southeast of Vya, Nev. (fig. 1). The topography is typical of deeply dissected plateaus. Relief in the area is moderate; elevations range from 5,000 ft at the east end of Little High Rock Canyon to 6,474 ft 0.25 mi north of McConnel Canyon (fig. 2). The study area is underlain by a sequence of lava flows and pyroclastic deposits that overlie and interfinger with lake and stream sediments; all are of Miocene age (see appendixes for geologic time chart). These volcanic and sedimentary rocks are faulted and locally altered.

Identified Resources

No prospects or mineralized areas with identified resources were found within the study area. Small pozzolan (additive to aid in underwater hardening of cement), perlite (light-weight aggregate used in the plaster industry), and uranium occurrences are present, but are distant from transportation centers or anticipated markets.

Mineral Resource Potential

Three parts of the study area have moderate resource potential for gold and silver in epithermal deposits of hot-spring origin, and three small areas have low potential for pozzolan, perlite, or uranium resources. The rest of the study area has low resource potential for gold and silver in epithermal deposits and geothermal energy.

The three areas that have moderate resource potential for gold and silver of hot-spring origin (fig. 2) contain anomalous concentrations of arsenic, antimony, bismuth, cadmium, mercury, tellurium, and

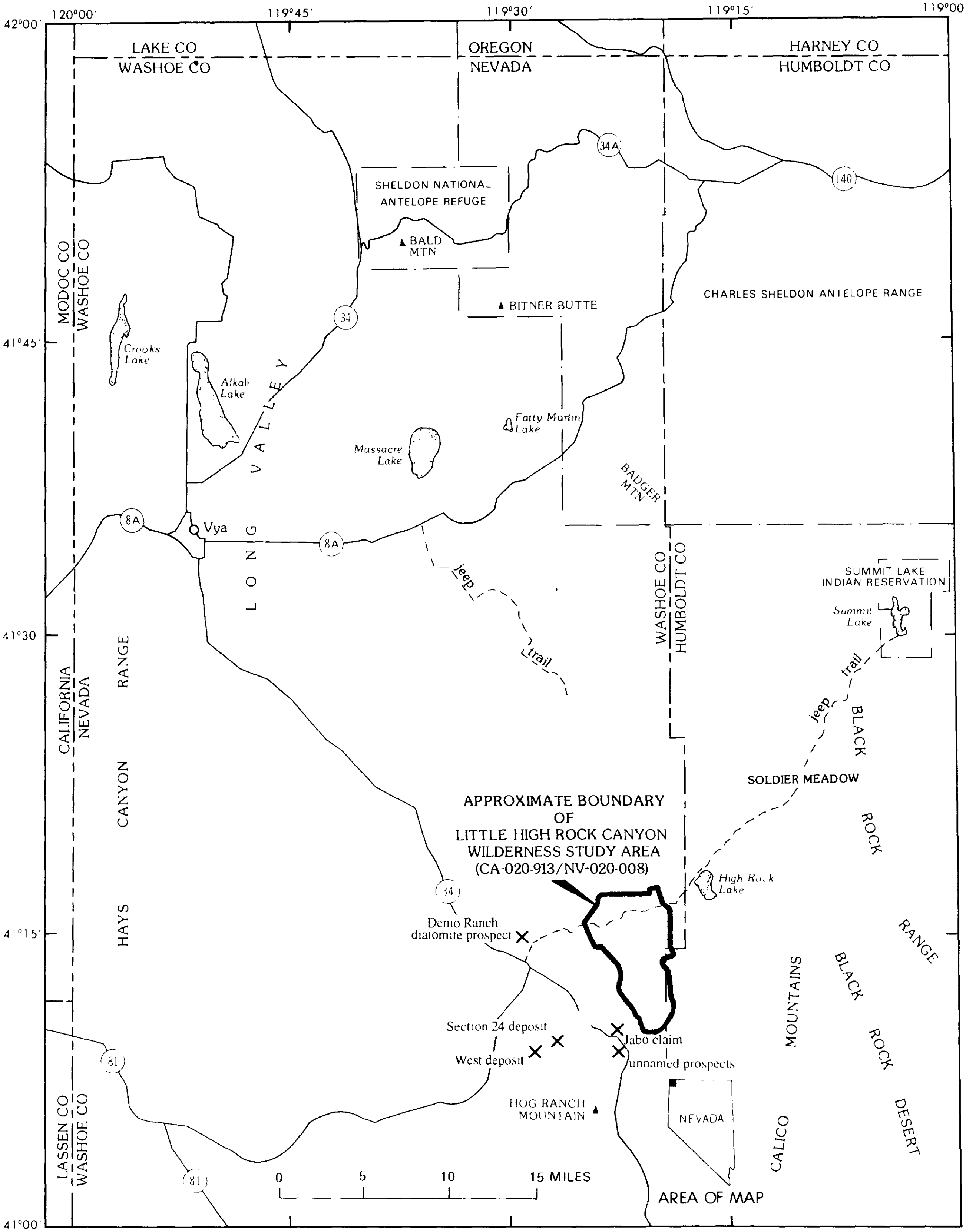

Figure 1. Index map showing the location of the Little High Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada.

silver (U.S. Geological Survey, unpub. data, 1986). This, combined with the occurrence of permissive rock types, faults to act as fluid conduits, and the presence of a similar deposit within 5 mi of the study area (Section 24 and West prospects, fig. 1) indicate moderate potential for gold and silver in epithermal hot-spring type deposits, similar to the Round Mountain deposit in Nye County, Nev., 250 mi southeast of the study area. The deposit would probably be similar in size or smaller than the Section 24 and West prospects (known hereafter as the Hog Ranch deposit). The rest of the study area has low potential for these same commodities in epithermal deposits. Although the rest of the study area does not have the anomalous concentrations of indicator elements, it has numerous occurrences of arsenic-bearing opal that also suggest the possible presence of hot-spring type gold/silver deposits.

The study area has relatively high heat flow and nearby low-temperature hot-springs (Soldier Meadow, fig. 1). This suggests a low potential for low-temperature (less than 90 ^{O}C) geothermal energy resources.

Small occurrences of pozzolan-bearing sediments, perlite, and uranium are present in the southeastern part of the study area. The resource potential for these commodities is low due to poor quality and small aerial extent.

INTRODUCTION

This mineral survey was requested by the U.S. Bureau of Land Management (BLM) and is a joint 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 were provided by Beikman and others, (1983). The U.S. Bureau of Mines (USBM) 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 (USGS) 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 appendix for the definition of levels of mineral resource potential, certainty of assessment, and classification of identified resources.

Area Description

At the request of the U.S. Bureau of Land Management, 17,320 acres of the Little High Rock Canyon Wilderness Study Area (CA-020-913/NV-020-008) were studied. In this report, the area studied is referred to as "the wilderness study area," or simply "the study area." The study area is located in western Humboldt and eastern Washoe Counties, Nev. (fig. 1), and consists of sparsely vegetated, plateau-type terrane. It is in the west-central part of the Calico Mountains and the south, east, and west margins are accessible by gravel roads. With the exception of two short jeep roads, the interior is accessible only by helicopter, horseback, or on foot. Elevations range from 5,000 ft at the east end of Little High Rock Canyon to 6,474 ft 0.25 mile north of McConnel Canyon (fig. 2).

Previous and Present Investigations

A geologic map of the study area, prepared by the U.S. Geological Survey in 1986 (fig. 2), provides a base for the interpretation of geochemical, geophysical, and mining claim data. The reports and maps by Bonham (1969), Willden (1964), and Greene (1984) also provided geologic data for this report.

Geochemical data were obtained from a geochemical-geostatistical study done for the U.S. Bureau of Land Management by Barringer Resources, Inc. (1982), and from analyses of stream sediment and rock samples collected by the U.S. Geological Survey (unpub data, 1986).

Earlier geophysical studies, which consisted of a regional gamma-ray survey (Geodata International, Inc., 1978) and an aeromagnetic survey (U.S. Geological Survey, 1972), were supplemented in 1984 and 1985 with a gravity survey by the U.S. Geological Survey.

The U.S. Bureau of Mines studied the known prospects, claims, and mineralized areas within and adjacent to the study area as a means of predicting the tonnage and grade of resources that might be present in the study area (Peters and others, 1987). Available information on the geology and mineral resources of the Little High Rock Canyon Wilderness Study Area, including BLM and Washoe County mining records, and the USBM MILS (Mineral Industry Location System) files, was reviewed prior to field work. Field examinations included mapping and sampling of prospects and mineralized areas. A total of 269 samples, including 117 rock, 106 soil, and 46 placer samples, were taken in or adjacent to the study area. Detailed analytical procedures and sample results are given in Peters and others (1987). Additional information is available from the U.S. Bureau of Mines, Western Field Operations Center, E. 360 Third avenue, Spokane, WA 99202.

Acknowledgments

The U.S. Geological Survey and the U.S. Bureau of Mines received assistance from the following: Joseph McFarland and Richard Wessman, U.S. Bureau of Land Management geologists, provided information and logistical support; Ralph Barnard and Siegfried Holso of Ferret Exploration, Paul Glavinovich and Carl Herring of Noranda Exploration, and Fred Saunders and Jeffrey Wilson of Tenneco Minerals provided permission to examine their company's gold deposits as

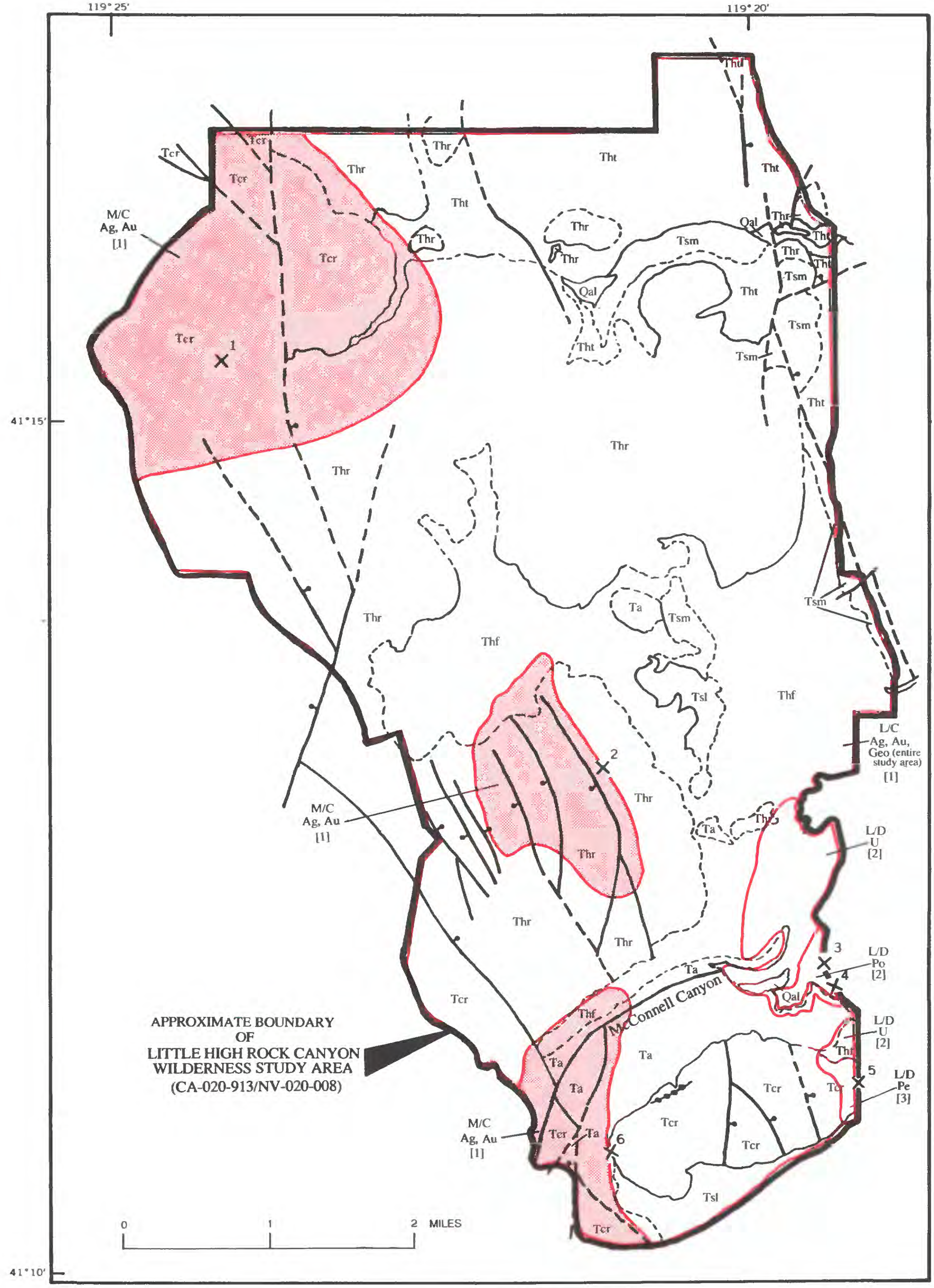

Figure 2. Mineral resource potential and generalized geology of the Little Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada.

EXPLANATION

Area with low mineral and geothermal resource potential

Area with moderate mineral resource potential

See appendixes for definition of levels of mineral resource potential and certainty of assessment

Commodities

Ag	Silver
Au	Gold
Geo	Geothermal
Pe	Perlite
Po	Pozzolan
U	Uranium

[ ] Types of deposits or occurrences

1	Epithermal hot-spring low-grade bulk-mineable
2	Tuffaceous sediments
3	Basal vitrophere

Correlation of Map Units

Qal } Holocene } QUATERNARY

Thr, Tht, Thf, Tsm, Tcr, Tsl, Ta } Miocene } TERTIARY

Geologic map units

Qal	Alluvium (Holocene)
	High Rock Sequence of Bonham (1969) (Miocene)
Thr	Rhyolite of Little High Rock Canyon
Tht	Tuff of Little High Rock Canyon
Thf	Fluviolacustrine sediments--Locally includes air-fall tuffs
Tsm	Soldier Meadow Tuff (Miocene)
Tcr	Cañon Rhyolite of Merriam (1910) (Miocene)
Tsl	Summit Lake Tuff (Miocene)
Ta	Andesite lava flows (Miocene)--Rocks equivalent to the Steens Basalt

Contact--Dashed where approximately located

Fault--Dashed where approximately located. Bar and ball on downthrown side

2 Prospect or mineralized area--See table 1 for description

Fissure

Figure 2. Continued.

well as technical advice on disseminated gold deposits; Robert Swinney of Lassenite Industries provided information on natural pozzolan; James Canwell of the U.S. Bureau of Mines assisted in the laboratory work.

APPRAISAL OF IDENTIFIED RESOURCES

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

Mining and Exploration History

No mineral production has taken place within the study area. The only historical mineral production near the study area is from the Leadville district (Bonham, 1969, p. 67-69), which lies 6 mi south of the study area. The Leadville mine produced over 1.3 million troy ounces (oz) silver and 4.9 million pounds (lb) lead from 1910 through 1927.

The Denio Ranch diatomite prospect is west of the study area (fig. 1). Several perlite claims were located in 1951 within and contiguous to the southeast corner of the study area (fig. 2, No. 5). Work began in September 1954 on the Big Doubt group (fig. 2, No. 3), which also straddles the study area boundary. An additional area of uranium prospect pits lies southwest of the study area along both sides of route 34 (fig. 1, unnamed) and was noted by Garside (1973, p. 98, locality No. 7).

Two active claim blocks cover disseminated epithermal gold prospects west of the study area and are being explored by mining companies. The Jabo claim block (fig. 1), owned by Tenneco Minerals, is adjacent to the study area. Directly west of the Jabo group is the Hog Ranch deposit, originally a uranium prospect, which is owned by Ferret Exploration. The Hog Ranch group includes the Section 24 and West prospects (fig. 1). Ferret Exploration is initially developing the Section 24 deposit and plans to begin processing ore in 1987.

There are no active or patented mining claims within the study area.

Mines, Prospects, Claims, and Mineralized areas

There are no mines in the study area, but, three mineralized areas have been identified (fig. 2, Nos. 1, 2, and 6). These include the west end of Little High Rock Canyon, the central part of the study area, and an area near the southwest corner. Three prospects for disseminated epithermal gold near the study area (fig. 1, Jabo, West, and Section 24 prospects) are being explored and are similar to the mineralized areas within the study area. In addition, uranium, pozzolan-bearing tuffaceous sediment, and perlite are also present in the study area (fig. 2, Nos. 3-5). A summary of available data from each occurrence within the study area is given in table 1.

Prospects for Epithermal Gold and Silver

The Section 24 prospect, West prospect, Jabo prospect (fig. 1), and Jabo extension (fig 2, No. 6) occur along a northeast-trending lineament and although the geology is different at each locality, they share some common features.

The Section 24 prospect is exposed in two trenches. Mineralization occurred near the base of a kaolinized and silicified tuffaceous sediment bed and in an underlying silicified rhyolite flow (north trench), and near the top of a tuffaceous bed and in an overlying silicified rhyolite flow (south trench). The northeast-trending lineament is represented by a fault that bisects the deposit between the trenches.

The West prospect is not yet as well understood. Characteristics include white silicified outcrops and anomalous concentrations of the pathfinder elements arsenic, antimony, and mercury in rock and soil.

The Jabo prospect (fig. 1) contains siliceous sinter, deposited within and over rhyolite flows and tuffaceous sediments. It is intruded by a diapiric breccia that contains clasts of sinter, rhyolite, and andesite. Both the sinter and the diapiric breccia are gold bearing (Fred Saunders, Tenneco Minerals, oral commun., 1985). Anomalous pathfinder elements in rock and soil include arsenic, antimony, and mercury.

At the Jabo extension area (fig. 2 and table 1, No. 6), silicification appears to follow a northeast-trending volcanic vent. Arsenic anomalies are found in rock and soil samples, but antimony and mercury anomalies are absent (Peters and others, 1987). A vertical volcanic fissure is as much as 40 ft wide and strikes N. 57° E. (fig. 2). It is filled with flow-banded, vesicular, partially devitrified and argillized obsidian, which contains cobble- and boulder-size rhyolite clasts.

In summary, these four sites, although geologically varied, define a northeast-trending lineament and show similar alteration. The complete alteration sequence, not all elements of which are present at each prospect, includes a silicified core area, an increase in argillization peripherally, and concentration of arsenic. Siegfried Holso (Ferret Exploration, oral commun., 1985) also noted an outer zone of opalization peripheral to argillization at the Section 24 and West prospects.

Industrial Minerals and Energy-related Occurrences

Pozzolan is a siliceous volcanic ash, or artificial substance resembling the ash, used to produce hydraulic cement. Tuffaceous sediments with pozzolanic qualities (U.S. Bureau of Mines, 1969, p.1) are present in many parts of the study area. A 130-acre area southeast of McConnell Canyon (fig. 2. and table 1, No. 4) includes approximately 28 million tons of montmorillonitic tuffaceous fluviolacustrine sediments. Chemically, silica and alumina and iron oxide exceed 70 percent and magnesium oxide was less than 5 percent in all samples. Loss on ignition is less than 10 percent for most samples (table 1, No. 4), indicating the sediments are within the range of natural pozzolans. The alkali-metal oxides (potassium oxide and sodium oxide) exceed the 1.5 percent maximum in all samples (American Society for Testing and materials, 1985); however, the alkalies are not available to the pozzolan reaction because they occur mainly as relatively inert feldspar minerals and would not affect pozzolan suitability.

Three representative samples were subjected to a 28-day Pozzolan Activity Index with Portland Cement test (No. 4, table 1) One sample exceeded the required compressive strength of 75 percent of the 4,870 psi (pounds per square inch) control cube strength. None of the samples were within the maximum allowable water requirement of 115 percent of the control cube requirement (T.S. Poole, Cement and Pozzolan Unit, Army Corps of Engineers, written commun., 1985) High water requirements of the samples are probably caused by the montmorillonite clay content (R.R. Swinney, Lassenite Industries, oral commun. 1986).

Perlite is commonly found at the base of rhyolite flows, especially where flows have been extruded over wet sediments, but most deposits large enough to be commercial formed over rhyolite domes (Kadey, 1983, p. 987) The largest perlite occurrence (fig. 2 and table 1, No. 5) is south of the pozzolan occurrence. Four samples from the perlite prospect had refractive indices of 1.496 (± 0.004), similar to commercial perlite (Kadey, 1963, p. 334). Approximately 2 million tons of perlite is present at this locality; it is in a north- to northwest-trending, 2,600-ft-long by 200- to 400-ft-wide belt along the northeast-facing slope of a rhyolite mesa. The perlite is capped by rhyolite to the southwest and removed by erosion to the northeast. The perlite has a high expanded density, making it unsuitable to "lighter weight" uses such as filter aid or cryogenics. However, high compaction resistance (table 1, No. 5) would make the product excellent for building and construction product end uses such as lightweight aggregate in plaster or concrete (J.M. Baker and J.S. Hingtgen, New Mexico Bureau of Mines and Mineral Resources, written commun., 1985).

Uranium is present at the Big Doubt prospect (fig. 2 and table 1, No. 3) in scattered petrified tree parts in the upper part of the pozzolanic deposits. Uranium concentrations are low; all samples contained less than 0.2 lb per ton. Uranium is also present in petrified wood (Garside, 1973, p. 98) southwest of the study area (fig. 1, unnamed prospect).

Mineral Economics

There are no prospects or mineralized areas with identified resources (U.S. Bureau of Mines and U.S. Geological Survey, 1980) within the study area.

Three occurrences in the study area are of interest (fig. 2, Nos. 1, 2, and 6) because the rhyolite has been epithermally altered, mainly by silicification and the introduction of arsenic, a pathfinder element that commonly indicates disseminated gold in the vicinity. The USBM did not find significant gold at prospects in the study area, even within a favorable fissure structure at the Jabo extension (fig. 2 and table 1, Nos. 1, 2, and 6). Disseminated gold may be present at depth, but a low-grade disseminated deposit that is not at, or near, the surface cannot be economically mined. Pathfinder element concentrations do not indicate the presence of an economic gold deposit at the prospects, but the possibility of such an occurrence cannot be ruled out.

The pozzolan-bearing sediment occurrence (fig. 2 and table 1, No. 4) contains 28 million tons of pozzolanic material. Most pozzolan used in the United States is fly ash, a byproduct of coal-fired furnaces. The only known producing domestic natural pozzolan deposit, Lassenite Industries mine at Doyle, Calif., is located at a railhead. The Lassenite product is calcined (roasted) to ensure a low-water requirement, but calcining alone would probably not produce a suitable product from pozzolanic material in the study area; montmorillonite clay would also need to be removed. Remoteness and expensive processing make exploitation of the deposit unlikely.

The perlite occurrence (fig. 2 and table 1, No. 5) contains approximately 2 million tons of material, which is considerably less than typical economic deposits, which generally exceed 10 million tons. More importantly, however, the occurrence is 45 mi from the nearest railhead at Gerlach, Nev. In addition, the perlite is only suitable for aggregate, a high bulk-low value end use. Alternate materials can be substituted for all uses of perlite, if necessary (U.S. Bureau of Mines, 1986, p. 115).

Mining of perlitic and pozzolanic materials from the study area could be feasible if a major local construction project were required by a government agency such as the U.S. Bureau of Reclamation, Department of Defense, or Department of Energy. Product quality and remoteness, however, preclude the usefulness of these materials to the general economy for the foreseeable future.

Uranium occurrences at the Big Doubt prospect (fig. 2 and table 1, No. 3) are too low in grade and too scattered to be of economic interest. The best material found, 0.2 lb per ton uranium oxide is worth only $3.45 per ton at a price of $17.25 per lb (Engineering and Mining Journal, 1986, p. 9).

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By William J. Keith, Robert L. Turner, and Donald Plouff
U.S. Geological Survey

Geological Studies

The study area is in the west-central part of the Calico Mountains, a poorly defined group of mountains in the transition zone between the Basin and Range and the Columbia Plateau physiographic provinces. It consists of interfingering pyroclastic deposits, mafic and silicic lava flows, and fluviolacustrine sediments. All of these rocks are of Miocene age (5 to 24 million years before present, or Ma; see appendixes for geologic time chart).

The oldest unit in the study area is a series of aphanitic andesite lava flows equivalent in age to the Steens Basalt (lavas of Steens age, Noble and others, 1973, p. 1396). Most flows do not contain visible phenocrysts but a few contain large (0.5 in) thin plagioclase phenocrysts, a distinctive feature of the Steens Basalt. The unit interfingers with the fluviolacustrine sediments of the High Rock sequence of Bonham (1969).

The Summit Lake Tuff (Noble and others, 1970), which overlies the andesite, is a brown to reddish-brown, generally quartz-poor, densely welded ash-flow tuff. The tuff typically displays fiamme and contains phenocrysts of anorthoclase and minor biotite, clinopyroxene, and amphibole. It has an approximate potassium-argon age of 15.5 Ma (Noble and others, 1970, p. D27).

The Cañon Rhyolite (Merriam, 1910) consists of a series of laminated rhyolite flows. The flow laminations usually appear as pink, red, or gray color bands separated by thin bands of quartz. Much of the unit is spherulitic, with spherulites as much as 5 cm in diameter (Bonham, 1969). Three potassium-argon ages are available for this unit: 13.7±1.4 Ma on glass, 16.3±1.3Ma on sanidine, and 22.3±1.8 Ma on alkali feldspar. The 22.3 Ma age is considered unreasonable in light of stratigraphic and structural relations and dates of other units (McKee and Marvin, 1974, p. 3).

The Soldier Meadow Tuff (Noble and others, 1970) overlies the Summit Lake Tuff in this area and is a bluish gray, partly to densely welded ash-flow sheet composed of many individual flows (Korringa, 1973, p. 3856). Phenocrysts consist largely of smokey quartz and sodic sanidine, minor arfvedsonite, and iron-rich clinopyroxene. The sanidine is locally chatoyant. The Soldier Meadow Tuff has an approximate potassium-argon age of 15 Ma (Noble and others, 1970, p. D29).

The High Rock sequence of Bonham (1969) consists of a sequence of ash-flow and air-fall tuffs, silicic lava flows, and tuffaceous fluviolacustrine deposits that both interfinger with and overlie the rock units described above.

The oldest unit in the High Rock sequence consists of white to buff to gray fluviolacustrine sediments that grade upward into air-fall tuffs and tuffaceous fluviolacustrine sediments. This unit interfingers with the andesite.

Overlying the fluviolacustrine sediments is the tuff of Little High Rock Canyon. This tuff is pink to bluish red and shows abundant fiamme near the base. Sparse sanidine crystals are the only phenocrysts.

The uppermost unit of the High Rock sequence, the rhyolite of Little High Rock Canyon, is a pink to buff to gray rhyolite lava flow petrographically similar to the Cañon Rhyolite. Phenocrysts consist of glassy feldspar, quartz (some of which are amethyst), and biotite. The unit has more vapor phase material and more phenocrysts than the Canon Rhyolite.

Geochemical Studies

Geochemical data were obtained from a regional geochemical reconnaissance study (Barringer, 1982) and rock and stream sediment samples collected by the U.S. Geological Survey in 1985 (unpub. data).

Three localities within the study area contain anomalous concentrations of several precious-metal indicator elements: the northwestern part, a small area in the center of the study area, and McConnel Canyon.

The northwestern part of the study area has anomalous concentrations of arsenic, antimony, and silver, which may indicate epithermal precious-metal mineralization. Anomalous concentrations of zinc, cadmium, and lead also are found in this area. The highest concentrations are found in the Cañon Rhyolite. Anomalous concentrations of arsenic, antimony, and zinc are found in and near Little High Rock Canyon in the High Rock sequence.

The small area in the center of the study area contains anomalous concentrations of arsenic, antimony, bismuth, cadmium, silver, tin, and zinc. Mineralization is probably controlled by north-trending fault systems.

Samples from the McConnel Canyon area contain anomalous concentrations of antimony, arsenic, bismuth, cadmium, chromium, mercury, nickel, tellurium, tin, and zinc. The nickel and chromium anomalies represent concentrations of the elements from the nearby mafic andesite. The tin is probably concentrated from the Cañon Rhyolite upstream; the other anomalous concentrations probably represent a hot-spring type deposit. This conclusion is also supported by the nearby occurrence of siliceous sinter.

Anomalous concentrations of tin and arsenic are present sporadically throughout the study area. Small areas (2 to 20 ft^2) of opal containing anomalous concentrations of arsenic are also found throughout the area. These opalized areas are present at various stratigraphic levels in the silicic rocks. The tin anomalies found in the heavy mineral concentrates are probably derived from the silicic rocks.

Geophysical Studies

Geophysical evaluation of the mineral resources of the study area was based on interpretations of three kinds of geophysical data: aerial gamma-ray, aeromagnetic, and gravity surveys.

Radiometric data were compiled by Geodata International, Inc. (1978), for the National Uranium Resource Evaluation (NURE) program of the Department of Energy. Two east-west flightlines totalling about 8 mi in length and separated by about 3 mi recorded gamma-ray flux from radioactive isotopes of uranium, thorium, and potassium. Flight altitudes varied from 300 to 700 ft above the ground. The northern flightline recorded no anomalies in the study area. The southern flightline, which nearly overlies McConnel spring, has conspicuously low radioactive levels for all three records of radioactive flux. The lows occur over a one-mile segment near the east edge of the study area. The values of the minima are approximately the same as the background level over sediments in other parts of the region. The location of the minima does not correlate with a flight-altitude high (topographic low) nor an area of marked surface rock alteration. Inasmuch as a layer with a thickness of 1 ft at the surface would be sufficient to mask the radioactivity of underlying rocks (Duval and others, 1971), only a small thickness of sediments or nonradioactive rocks could cause the observed low.

An aeromagnetic survey (U.S. Geological Survey, 1985) was flown over the study area at an elevation of approximately 1,000 ft above the mean ground surface elevation. Flightlines were flown north-south at a line spacing of 0.5 mi. The most conspicuous feature of the aeromagnetic map is a north-trending elongate cluster of magnetic lows in an area of about 2.5 by 6 mi in the southern part of the area. Inverse correlation of magnetic anomalies with topography indicates that the source rocks for the magnetic lows are reversely magnetized and are near the ground surface. Steep magnetic gradients with magnetic intensities increasing outward, especially along the west edge of the cluster of anomalies, suggest that the source rocks are part of a larger underlying body. The reversely magnetized source rocks probably consist of rhyolite that caps the mesas, underlying rocks that are equivalent in age and composition to the Steens Basalt, and older flows. An aeromagnetic map of the region (U.S. Geological Survey, 1972) includes many magnetic lows over the Steens Basalt and its equivalent rocks. Sample measurements of reversed magnetization made over extensive areas of the Steens Basalt and equivalent basalt in Oregon, Nevada, and Idaho indicate that these rocks are both normally and reversely magnetized (E.A. Mankinen, written commun., 1986).

The only conspicuous anomaly on the preliminary Bouguer gravity anomaly map (Plouff, unpub. data) is shown by north-trending gravity contours along the east edge of the north half of the study area. The contours outline a 5-milligal (mGal) gravity high and a magnetic high centered about 0.5 to 1 mi east of the study area. Inasmuch as Cenozoic rocks of relatively low density crop out within the gravity high, the source of the anomaly must be a body of relatively dense rocks concealed at shallow depth. These rocks probably are basement rocks similar to pre-Cenozoic rocks (Stewart and Carlson, 1974) that crop out in the study area and reveal the source of a 10- by 25-mi, 40-mGal gravity high (Plouff, unpub. data) located 5 to 30 mi south-southwest of the study area.

Mineral and Energy Resources

Three parts of the study area have moderate potential for gold and silver in epithermal deposits. The rest of the area has low potential for gold and silver in epithermal deposits. In addition, the study area also has low potential for geothermal resources and small areas have low resource potential for pozzolan, perlite, or uranium.

Three parts of the study area (fig. 2) have moderate resource potential with a certainty level of C for gold and silver. These resources would probably be of a low-grade bulk-minable hot-spring type similar to the Round Mountain deposit in northern Nye county (Berger, 1986) and the Hog Ranch deposit (Harvey and others, 1986) 5 mi southwest of the study area. The size of these deposits would probably be similar to, or smaller than the Hog Ranch deposit. The geochemical anomalies, permissive rock types and ages, and faulting all support this classification.

Small (2 to 20 ft^2) outcrops of opalized rock scattered throughout the study area contain anomalous concentrations of arsenic, which is a precious-metal indicator. Outcrops of opal are described by Berger (1986) as one of the characteristics of hot-spring gold-silver deposits. Opalized outcrops are also found in and near the Hog Ranch deposit. This evidence would place the rest of the study area in a low resource potential for gold and silver category with a certainty level of C.

Although the study area contains no active hot-springs, the presence of a low temperature (less than 90 ^{o}C) system in nearby Soldier Meadow (Reed, 1983) and the relatively high heat flow (approximately 100 milliwatts/m^{2}) in the area (Muffler, 1979) suggests a geothermal resource classification of low with a C certainty level.

Deposits of pozzolanic tuffaceous sediments, perlite, and uranium are present in the southeastern part of the study area and have low resource potential, certainty level D. The quality of these commodities is low which limits their usefulness and the areal extent of their respective host areas is small.

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APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

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.

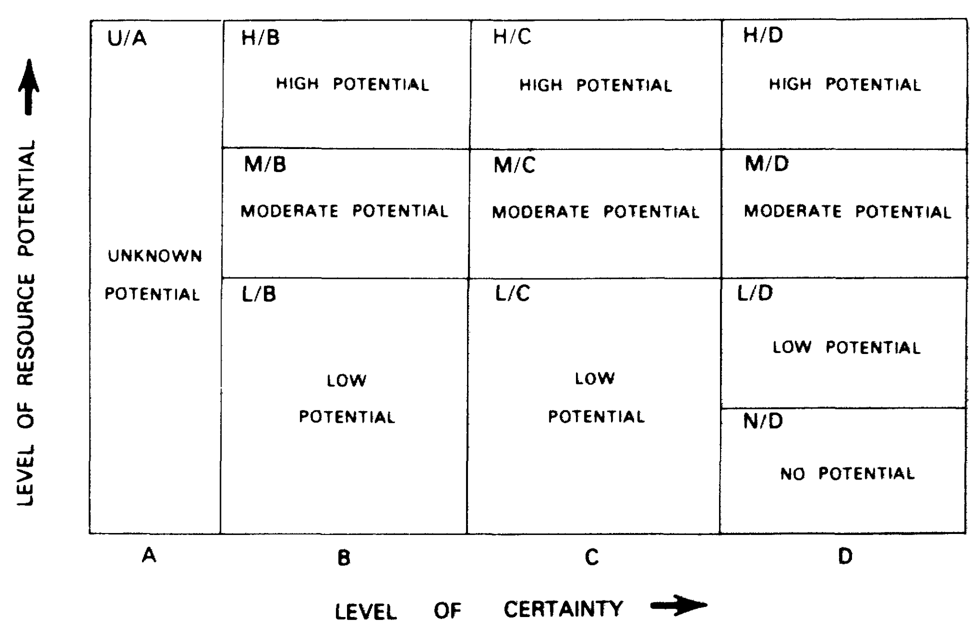
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application 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.

Abstracted with minor modifications from:

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.

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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 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.

TABLE 1. *Prospects, claims, and mineralized areas in and near the Little High Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada*

[*, prospect straddles study area boundary]

Map No.	Name	Summary	Workings and production	Sample and resource data
1	Unnamed mineralized area	A 5- to 30-ft-thick sill-like zone of limonite-colored and black chalcedony and opal extends for approximately 0.5 mi along north wall of Little High Rock Canyon. Similar irregular void fillings and veins, 0.5 to 2 ft thick, are fairly common in west and central parts of study area north of canyon.	None	Six chip samples from sill-like zone, two chip samples from dikes, and two grab samples taken. Gold not detected. Silver detected in two samples; 0.79 and 0.55 ppm. Antimony detected in seven samples; 3 to 5 ppm. Arsenic, detected in all samples, ranged from 4 to 170 ppm. No resources found, but pathfinder elements indicate epithermal mineralization.
2	Unnamed mineralized area	An approximately 60-acre area of intensely silicified and commonly brecciated gray rhyolite along a north-northwest-trending ridge. Chalcedony and opal locally common as small fracture and irregular void fillings.	None	Three chip, one grab, and two soil grab samples contained no detectable gold or silver. Antimony detected in one sample; 3 ppm. Arsenic, detected in all samples, ranged from 8 to 29.7 ppm. No free gold found in placer grab sample. No resources found, but pathfinder elements indicate epithermal mineralization.
3*	Big Doubt prospect	Scattered fossil tree parts, partially replaced with silica and near top of sequence of tuffaceous sediments, emitted as much as 250 cps (counts per second) gamma radiation (40-50 cps background). Coextensive with prospect No. 2.	One 10-ft-long adit and at least 12 small prospect pits, approximately 15 ft by 10 ft by 5 ft deep. No production recorded or indicated by excavations at site.	Ten rock samples from fossil tree parts contained 28 to 84 ppm uranium (0.07 to 0.2 lb/ton uranium oxide). Resources not indicated because material is of insufficient grade and tonnage. Petrified tree parts are potentially of value to recreational collectors.
4*	Pozzolanic sediment occurrence (unnamed)	A 100-ft-thick pile of poorly consolidated waterlain tuffaceous sediments with pozzolanic qualities occurs as partially dissected mesa over a 130-acre area east of mouth of McConnel Canyon. Deposit is readily accessible from an unimproved road along east side of prospect, and is not capped by overburden, except for a few local 10-ft-thick patches of unconsolidated perlite. Coextensive with prospect No. 1.	None	Ten chip samples from occurrence contained 59.1 to 71.0 percent silica, 12.9 percent to 20.3 percent alumina, 1.3 percent to 6.0 percent ferric oxide, 0.21 percent to 0.99 percent magnesium oxide, 1.9 percent to 7.2 percent potassium oxide, and 1.1 percent to 1.8 percent sodium oxide. Loss on Ignition ranged from 5.51 to 10.57 percent. No samples passed all chemical standards. Three samples passed all chemical standards. Three samples subjected to a 28-day Pozzolan Activity Index with Portland Cement had compressive strengths of 3950, 3250, and 3400 psi (pounds per square inch), water requirements of 127 percent, 124 percent and 122 percent were above American Society for Testing Materials maximums. Specific gravity was 2.54, 2.51, and 2.43, respectively. Pozzolan occurrence contains 28 million tons (at 12.8 ft^3/ton) of material[1], 14 million tons within, and 14 million tons contiguous to the study area.

TABLE 1. *Prospects, claims, and mineralized areas in and near the Little High Rock Canyon Wilderness Study Area, Humboldt and Washoe Counties, Nevada*—Continued

Map No.	Name	Summary	Workings and production	Sample and resource data
5*	Perlite claims (name unknown)	An approximately 2,600-ft-long by 200- to 400-ft-wide belt of dark-gray perlite trends north to northwest along northeast facing slope of a rhyolite mesa. Perlite, which apparently formed as a chill zone at base of rhyolite, is approximately 50 ft thick along southwest margin of belt where it extends under the rhyolite; it pinches out along northeast margin of belt because of erosion; average thickness is 25 ft.	Four trenches, 40 ft by 7 ft by 4 ft deep, 50 ft by 6 ft by 4 ft deep, 13 ft by 2 ft by 2 ft deep, and 40 ft by 12 ft by 6 ft deep, spread over approximately 700 ft from north to south along length of deposit. No production indicated by excavations at site.	Four perlite chip samples had refractive indices of 1.496 (±0.004). Dsta from one sample expanded in a vertical furnace includes: expanded density, 10.7 lb/ft^3; furnace yield, 97 percent; sinkers (unexpanded fraction, 11 percent; compacted density, 14 lb/ft^3; compaction resistance, 280 lb/in^2 (at 1 in.) and 410 lb/in^2 (at 2 in.). Tests indicated material is unsuitable for lightweight sggregate, but suitable for end use such as road material. Occurrence contains 2 million tons (at 12.6 ft^3/ton of material[1], 1 million tons within and 1 million tons contiguous to study area.
6	Jabo extension mineralized area	An area of altered rhyolite extends over more than 320 acres near northeast-trending structural lineament that extends into southern part of study area from west. In study area, lineament appears to have been the locus of an elongate rhyolitic vent, marked by vertical or highly contorted flow bands. A northeast-trending fissure, 40 ft wide and over 1,000 ft long, formed within vent. Subsequent epithermal mineralization was marked by silicification, local kaolinization, and the introduction of arsenic.	None. Southwest of study area along the same structural lineament, two disseminated gold prospects are being actively explored and a third is undergoing preproduction development.	A total of 102 soil grid, 35 rock, 2 soil grab, and 15 placer grab samples taken. Four north-south soil lines, 600 ft apart and approximately 6,000 ft long, were run across northeast lineation west of No. 6 (fig. 2) along study area boundary between unimproved road on south and McConnel Canyon on north; sample spacing was 300 ft. Gold was detected in 92 soil samples (0.017 to 0.287 ppm), silver in 21 (0.35 to 23.2 ppm), mercury in 11 (2 ppm), arsenic in 63 (3 to 15 ppm), and barium in all samples (430 to 1060 ppm); antimony was not detected (less than 2 ppm). Contours of arsenic and barium soil data (Peters and others, 1987, appendix I) show the northeast-trending lineament. A crosscutting north-south fault suggested by gold contours, and a N. 20° E. fault by mercury and silver contours. Thirty-five rock and 2 soil grab samples were taken in and near alteration area, including two samples from volcanic fissure (fig. 2). Gold, mercury, and antimony not detected, and silver (1.198 ppm) found in only one sample. Arsenic, however, detected in 22 samples (3 to 100 ppm). Barium, detected in all samples, had wide range of values (14 to 1900 ppm). Placer grab samples taken from stream beds; six of 15 samples contained free gold (0.003 to 0.038 mg (milligrams)). No resources were found, but pathfinder elements indicate epithermal mineralization.

[1]The "material" is not designated "resources" because factors such as product quality and distance to markets make mining unlikely.

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