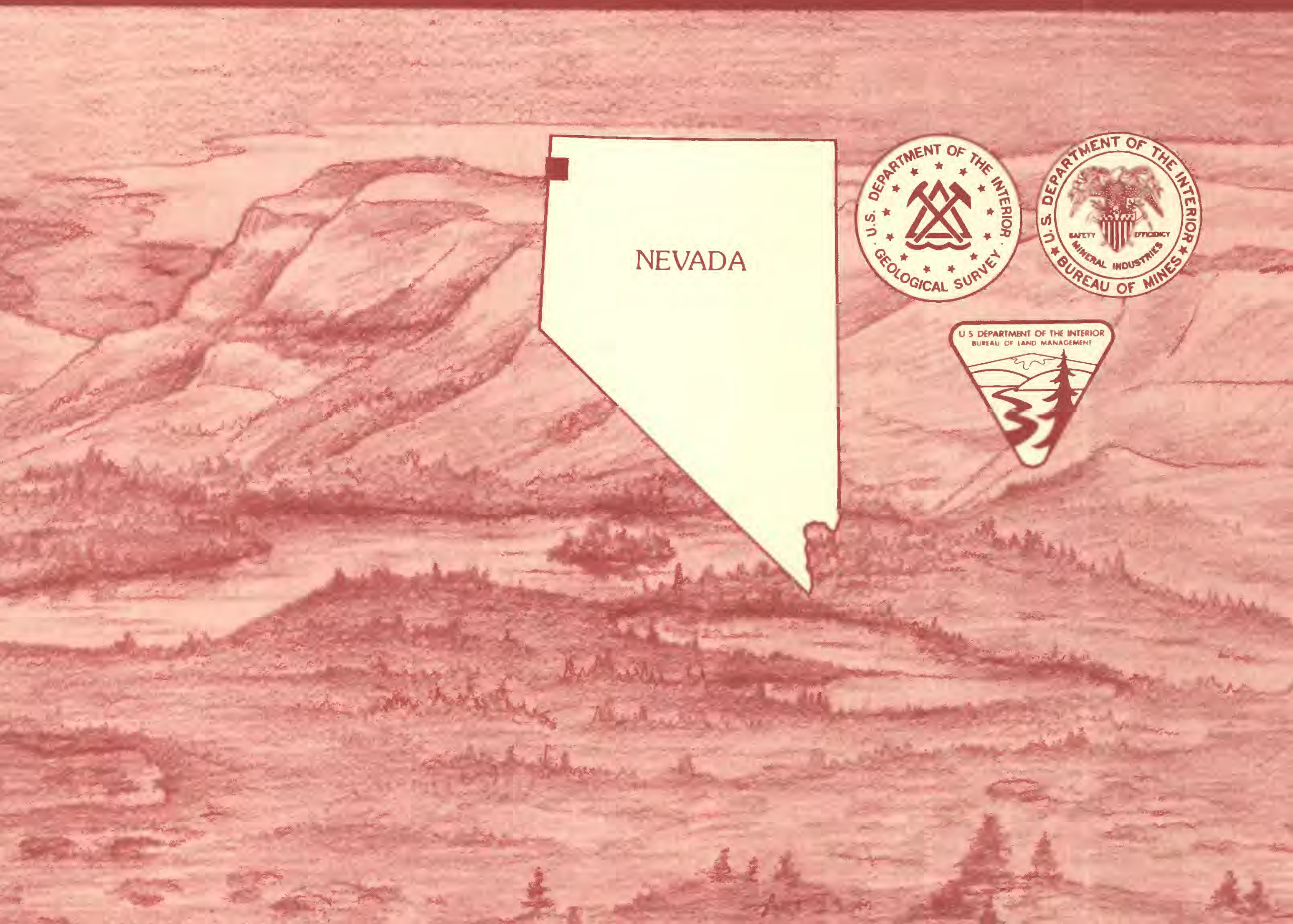
Mineral Resources of the Dry Valley Rim Wilderness Study Area, Washoe County, Nevada, and Lassen County, California

U.S. GEOLOGICAL SURVEY BULLETIN 1706–D



Chapter D

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U.S. GEOLOGICAL SURVEY BULLETIN 1706

MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
NORTHEASTERN CALIFORNIA AND PART OF ADJACENT WASHOE COUNTY, NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Area

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of part of the Dry Valley Rim (CA-020-615) Wilderness Study Area, Washoe County, Nevada, and Lassen County, California.

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Mineral Resources of the Dry Valley Rim Wilderness Study Area, Washoe County, Nevada, and Lassen County, California

By Michael F. Diggles, James G. Frisken, *and* Donald Plouff
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SUMMARY

Abstract

At the request of the U.S. Bureau of Land Management, approximately 54,480 acres of the Dry Valley Rim Wilderness Study Area (CA-020-615) were evaluated for mineral resources (known) and mineral resource potential (undiscovered). In this report, the area studied is referred to as the "wilderness study area" or simply "the study area;" any reference to the Dry Valley Rim Wilderness Study Area refers only to that part of the wilderness study area for which a mineral survey was requested by the U.S. Bureau of Land Management.

The study area is underlain by horizontal to gently dipping middle Miocene volcanic rocks including andesite, lava and lahar deposits, basalt lava, and minor rhyolite ash-flow tuff. These strata form a gently west-dipping homocline bounded on the east by a north-trending normal fault located along Dry Valley Rim. The Red Rock Canyon and Willow Springs areas contain an estimated 85 million tons of inferred subeconomic zeolite resources. These two areas have moderate mineral resource potential for zeolites. The zeolites occur as amygdule fillings in basaltic lava. Mining of zeolites in basalts is highly unlikely due to their low grade and difficulties and costs of extracting zeolites from basalts. A small area along the southeast margin of the study area has low mineral resource potential for perlite. All three areas that have resource potential are located in and around prospects along the east boundary of the study area. The wilderness study area has no resource potential for geothermal energy or oil and gas.

Character and Setting

The Dry Valley Rim Wilderness Study Area is located in Washoe County, northwestern Nevada, and Lassen County, northeastern California (fig. 1). The area encompasses 54,480 acres managed by the U.S. Bureau of Land Management and is located about 40 mi east of Susanville. Access to the study area is provided by several dirt roads that join boundary roads. Elevations range from 3,800 to 6,200 ft; most relief occurs along Dry Valley Rim. The rim is 1,500 ft higher in elevation than the Smoke Creek Desert to the east. Areas west of the rim form gentle slopes and rolling hills. Steep rim rock walls and talus-covered canyons are common in the eastern part of the area, while most of the study area is gradually sloping, covered only by sparse sagebrush and native grasses.

Identified Resources

No metallic resources are identified. The Red Rock and Willow Springs areas contain 85 million tons of altered basalt containing amygdules that host an inferred subeconomic resource of zeolites. This basalt, more than 50 percent of which consists of amygdules filled with chabazite (a zeolite mineral), constitutes an identified subeconomic zeolite resource.

The Broken Shovel claims, located along the southeast boundary of the study area, contain a 100,000-ton occurrence of perlite. While usable for lightweight aggregate, the deposit is too small for economic production. However, if considered for perlite production with other nearby deposits, this occurrence could become a subeconomic resource.

Montmorillonitic clays are present in alluvial sediment in the Capricorn claims adjacent to the study area. Alluvial sediments contain more than 30 percent (volume) clays. The material is not usable as pozzolan and was not tested for other uses such as absorbency, oil clarification, or insecticide carrier.

Mineral Resource Potential

Amygdule-rich basalt that crops out in the Red Rock Canyon and Willow Springs areas has moderate resource potential for zeolites. Zeolite (chabazite) is present within middle Miocene basalt as amygdule-fill material (see appendix for geologic time chart). The areas of alteration that contain the zeolites are proximal to a north-trending fault that probably controlled the movements of alteration fluids. In both areas, zeolite-filled amygdules form more than 50 percent of the rock. The zeolite occurrence at Red Rock Canyon is the larger of the two; it contains about two to three times the volume present in the Willow Springs area. The quality of the zeolites around Red Rock Canyon and west of Willow Springs may be adequate for use as an absorbent in animal husbandry. These two areas have moderate mineral resource potential for zeolites.

The area of silicic volcanic rocks around the Broken Shovel claims has low resource potential for perlite. The perlite is hosted in displaced blocks of what possibly originated as a rhyolite flow-dome complex.

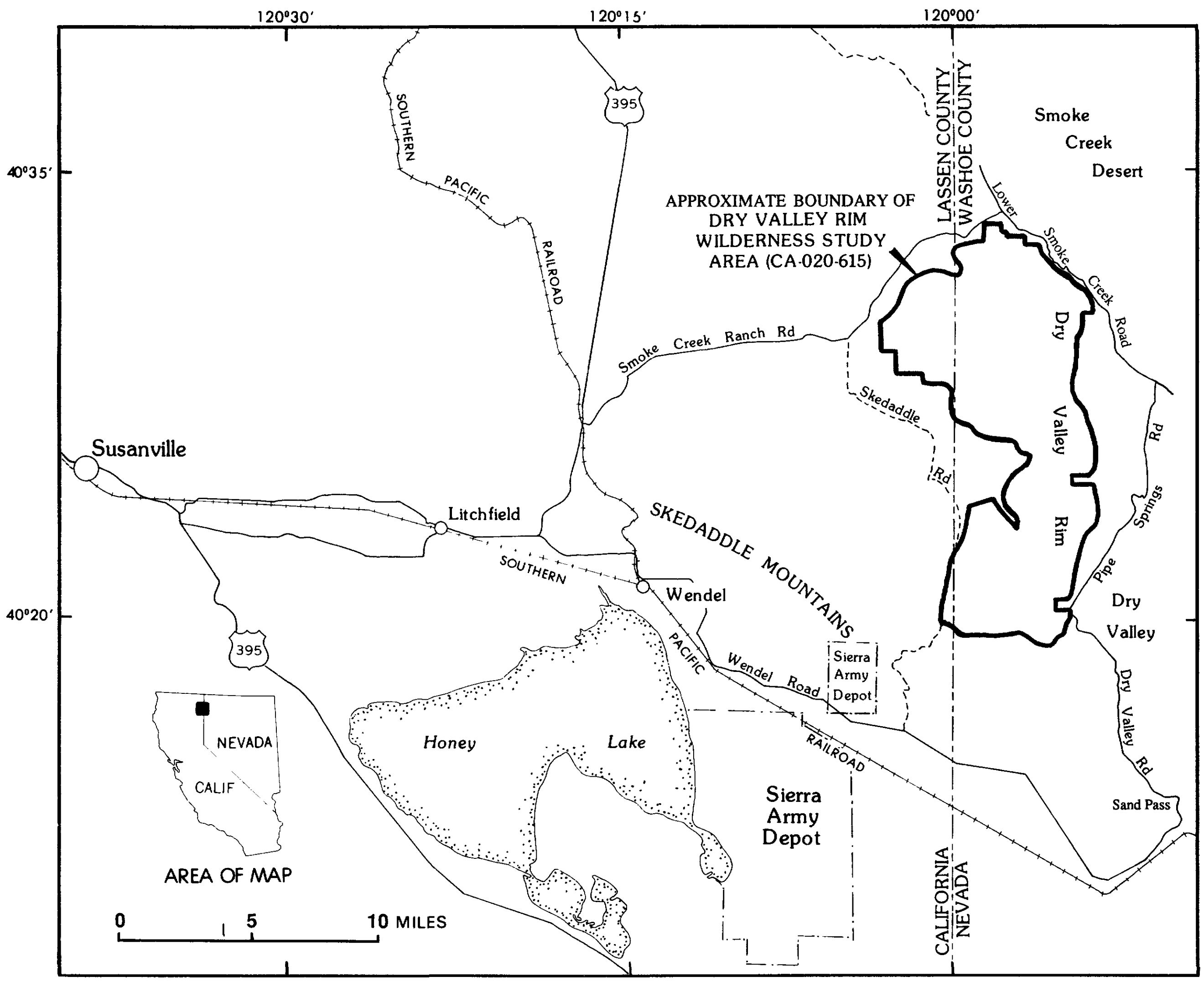

Figure 1. Index map showing location of the Dry Valley Rim Wilderness Study Area, Washoe County, Nevada, and Lassen County, California.

Montmorillonitic clay is present in alluvial sediment east of Red Rock Canyon at the Capricorn claims area east of the study area. Here the clays are mixed with silt-sized particles in the alluvium. This material is not suitable as a pozzolan but may qualify as fuller's earth, which is used as absorbents and for bleaching oils. The clay occurrence does not extend into the study area; therefore, there is no mineral resource potential for clay in the Dry Valley Rim Wilderness Study Area.

The wilderness study area has no resource potential for geothermal energy (Higgins, 1981) or oil and gas.

INTRODUCTION

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

Location and Physiography

The Dry Valley Rim Wilderness Study Area is located in the eastern part of the Modoc Plateau in Lassen County, northeastern California, and Washoe County, northwestern Nevada (fig. 1). The area encompasses 54,480 acres of public land administered by the U.S. Bureau of Land Management and located about 40 mi east of Susanville. The study area is bounded on the east by the lower Smoke Creek Ranch Road, the Dry Valley Road, and the Pipe Springs Road. The north boundary is located 1-2 mi southeast of Smoke Creek Ranch Road; the south boundary is a jeep trail located 5-6 mi north of the Wendel Road; and the west boundary is the Skedaddle Road. Access to the study area is provided by several dirt roads and jeep trails that join the boundary roads. Elevations range from 3,800 to 6,200 ft. Most of the study area is gently sloping and sparsely covered with sage and grasses. Steep rim rock walls and talus-covered canyons are common in the eastern one-third of the area along Dry Valley Rim.

Previous Studies

The geology of the study area has been previously mapped in reconnaissance at 1:250,000 scale. Bonham (1969) describes the Nevada side of the study area and Lydon and others (1960) give the geology of the California side. Diggles and others (1988a) mapped the geology at 1:48,000 scale, Munts and Peters discussed the mineral resources, and Diggles and others (1988b) described the mineral resource potential of the Skedaddle Mountain Wilderness Study Area to the west of this study area. Adrian and others (1987) presented geochemical data for both study areas. Aeromagnetic data are published for this area (U.S. Geological Survey, 1972) and radiometric data are given by Geodata International, Inc. (1978), and Western Geophysical Company of America (1981). In addition to those collected for this study, gravity data are given by Snyder and others (1982).

Acknowledgments

The authors thank Harry Banfield and Robert Swinney of Lassenite Industries for sharing information on pozzolan occurrences in the area. We greatly appreciate help from L.L. Teeter of the U.S. Bureau of Land Management's Susanville office for logistic and helicopter support. D.A. Dellinger, L.D. Batatian, and John Mariano, U.S. Geological Survey, M.S. Miller, U.S. Bureau of Mines, and R.P. Maddox, Helo-Wood Co., helped to complete the field work.

APPRAISAL OF IDENTIFIED RESOURCES

By J. Mitchell Linne
U.S. Bureau of Mines

U.S. Bureau of Mines personnel examined library materials and production records for information on mines, claims, and prospects. Ground and aerial field studies evaluated the known mines, prospects, and mineralized zones in or near the study area. Field work was conducted during May and June 1985. Seven alluvial (placer) and 52 rock samples were collected and analyzed at the Western Field Operations Center in Spokane, Wash. Rock samples of perlite, zeolitic basalt, and alluvial sediment were analyzed by various methods for specific end uses. All rock samples were checked for radioactivity and fluorescence, and 27 were assayed for gold and silver by fire assay or by a combined fire assay-atomic absorption method. Several samples from each locality were analyzed for 40 elements by semiquantitative emission spectrography. Perlite samples were checked under a petrographic microscope to determine index of refraction, perlitic texture, and

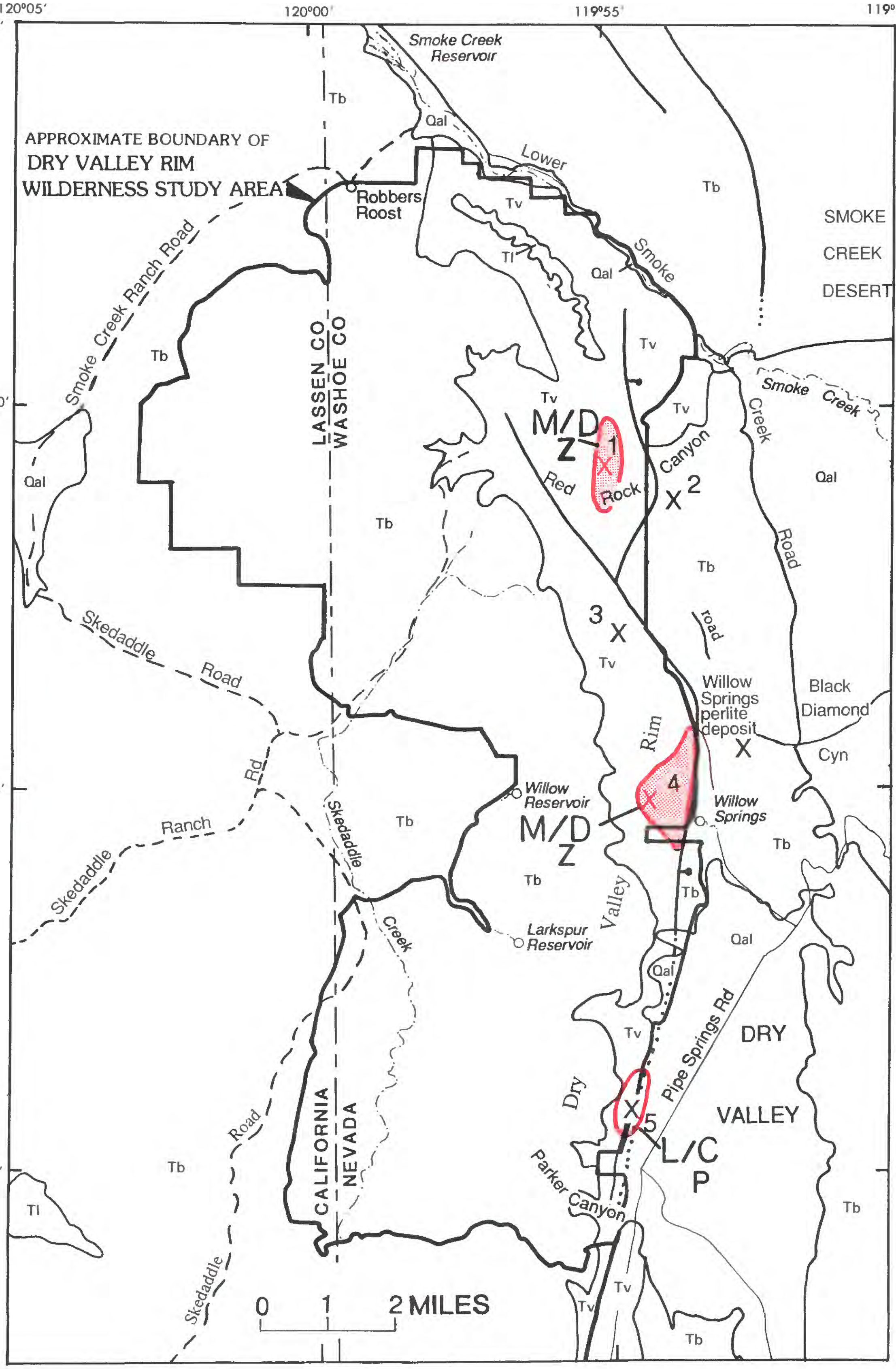

Figure 2. Generalized geology and areas of mineral resources and resource potential in the Dry Valley Rim Wilderness Study Area, Washoe County, Nevada, and Lassen County, California.

EXPLANATION

Area with moderate mineral resource potential

Area with low mineral resource potential

See appendix for definition of levels of mineral resource potential (M,L) and certainty of assessment (C,D)

Commodities

Z Zeolites
P Perlite

X Prospect—Red symbol indicates identified resources

1 Red Rock zeolite
2 Capricorn claims
3 Rocky Springs zeolite
4 Willow Springs zeolite
5 Broken Shovel claims

Correlation of map units

Qal — QUATERNARY

Unconformity

Tb
Tv — TERTIARY
Tl

Geologic map units

Qal Alluvium (Quaternary)—Unconsolidated silt, sand, and gravel deposited by fluvial processes; also includes colluvial, aeolian, lacustrine, and landslide deposits

Tb Basalt (Tertiary)—Olivine basalt flows consisting of fine-grained to aphanitic or glassy rocks with phenocrysts of olivine (less than 1 mm), often altered to iddingsite or with iddingsite rims

Tv Volcanic rocks (Tertiary)—Volcanic rocks consisting of intercalated basalt, andesite, rhyolite ash-flow tuff, and lahar deposits. Basalt is locally zeolitic and rhyolite is locally perlitic

Tl Lahar deposits (Tertiary)—Volcanic debris flow and breccia. Occurs as thick sequences of flows in northern part of study area, elsewhere as lobate flows filling channels and as crusts on sides of channels. Contain poorly sorted, angular to sub-rounded clasts of basaltic, andesitic, and (or) dacitic material, in a clast-supported matrix of fine lithic fragments and ash

Contact

Fault—Dotted where concealed; bar and ball on downthrown side

Figure 2. Continued.

percent glass. A representative sample was sent to the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, for expansion testing. Samples of altered zeolitic basalt were analyzed for quantity and type of zeolites and cation exchange capacity. Samples of alluvial sediment were screened for pozzolan suitability by using whole rock analysis. Two samples were sent to the U.S. Army Corps of Engineers' Waterways Experiment Station, Vicksburg, Miss., for determination of the pozzolan activity index. Complete analytical methods and assay results were presented by Linne (1987) and are available at Western Field Operations Center, U.S. Bureau of Mines, E. 360 3rd Avenue, Spokane WA 99202.

Mining claims and mineralized sites are shown on fig. 2. Summary descriptions of these areas are presented in table 1. Detailed descriptions of deposits and economic analysis are given in Linne (1987).

Mining History

No mining activity has been recorded within the study area. The earliest recorded mining activity near the study area was extraction of salt from brines at Buffalo Springs in the Smoke Creek Desert before 1885 (Russell, 1885) to 1907 (Lincoln, 1923). Buffalo Springs is approximately 20 mi northeast of the study area.

The Sand Pass mining district, located 22 mi north of Sand Pass (6 mi east of the southeastern corner of the study area) is approximately adjacent to the study area on the northeast corner and may include the area of the Capricorn claims (fig. 2 and table 1, No. 2). The Sand Pass bentonite property described by Rollin and others (1971) may be identical to the Capricorn claims property. This area was originally claimed in 1935 as the Whitetail group and in 1969 as association placer claims Capricorn 11-13. The claims are currently being prospected by Starr Hill and Richard Bailey. Standard Oil Company prospected fuller's earth within the Sand Pass mining district, probably during the early 1920's (Lincoln, 1923). Fuller's earth is a term for a variety of mineral materials, chiefly montmorillonite and palygorskite clays, used for bleaching oils and as absorbents.

The Sheepshead gold-mining district, in which the Washoe Lassen Mining Company reported work in 1907 (Yale, 1907), apparently lies adjacent to the southeast end of the study area (Hill, 1912). No workings from this district were seen in the study area. The Art Wilson Company clay mine is situated approximately 10 mi southeast of the study area (Schilling and Hall, 1981). The Willow Springs perlite deposit (Bonham, 1969), located about 1 mi east of the study area boundary in Black Diamond Canyon, was also known as the Silver Gray claims.

Identified Resources

No metallic resources were identified within the study area. The Red Rock Canyon and Willow Springs areas are underlain by 85 million tons of altered basalt that contain inferred resources of zeolites in amygdules. This material, averaging more than 50 percent chabazite, constitutes a subeconomic zeolite resource. This zeolite-bearing material is relatively low in grade and would require beneficiation to upgrade it for high-value uses such as catalysts and molecular sieves. Natural zeolites have a small market in the United States; that market is presently met by other higher grade deposits. Detailed analyses of the zeolite-bearing material are given by Linne (1987).

Perlite is present at the Broken Shovel claims, located along the southeast boundary of the study area. The claims encompass a 100,000-ton occurrence of the material. While usable for lightweight aggregate, the deposit is too small for economic production. However, if considered for perlite production with other nearby deposits in the Skedaddle Mountains (estimated 184,000 tons within 15 mi) (Diggles and others, 1988b) and at Black Diamond Canyon (estimated 1 million tons within 3 mi), this occurrence could become a resource.

Montmorillonitic clays are present at the Capricorn claims, adjacent to the study area. The claims are located on alluvial sediment that contains more than 30 percent montmorillonitic clays. The montmorillonitic material is of poor quality and is not suitable as pozzolan, a cement additive. It was not tested for other uses such as an absorbent in oil clarification or as an insecticide carrier.

Of the seven placer samples, only one panned-concentrate sample from Skedaddle Creek near the California-Nevada State line near Skedaddle Ranch Road contained gold (0.8×10^{-7} troy oz in a 1.75-lb pan-concentrate sample, 3.1 parts per billion). Therefore, placer gold resources are not indicated.

Sand and gravel resources are not present in the study area. Rocks in the study area could be used for road metal, riprap, and other stone resources, but similar material of equal or better quality is abundant closer to local markets.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

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

The U.S. Geological Survey conducted field investigations of the Dry Valley Rim Wilderness Study Area in 1985. This work included geologic mapping (Diggles and others, 1986), field checking of existing maps, geochemical sampling, gravity surveys, and inspecting outcrops for mineralization.

Geology

The Dry Valley Rim Wilderness Study Area is underlain by a 17-mi-long, north-trending fault block that strikes north to N. 10° E. and dips slightly (5°) to the west. The rim is 1,500 ft higher in elevation than the Smoke Creek Desert to the east. Rocks in the study area are mostly middle Miocene andesite, andesitic lahar deposits and basalt and include minor amounts of rhyolitic ash-flow tuff. These rocks are middle Miocene in age on the basis of potassium-argon age determinations made on correlative rocks 6 mi to the west (Diggles and others, 1988a).

The oldest rocks in the study area are andesite flows and lahar deposits, commonly intercalated with olivine basalt. These rocks underlie the northeastern part of the study area in continuous sections at least 800-1,000 ft thick. They are exposed to the south along the fault scarp at the base of Dry Valley Rim for most of its length. The andesite contains phenocrysts of calcic plagioclase, clinopyroxene (augite), and minor orthopyroxene (hypersthene) in fine-grained to aphanitic plagioclase-rich matrix. The silica (SiO_2) content of these rocks ranges from 53 to 62 weight percent. Dacite that crops out in the Skedaddle Mountains to the west (Diggles and others, 1988a) is not present in this study area except as clasts in lahar deposits. A potassium-argon age of 12.8±0.2 Ma (million years) was determined for andesite flows in the Skedaddle Mountains (Diggles and others, 1988a). Flows that are petrographically similar and stratigraphically equivalent to these extend eastward into the Dry Valley Rim study area.

Rhyolite ash-flow tuff and lithic tuff are exposed in the fault scarp of the central part of Dry Valley Rim stratigraphically above the andesite. The ash-flow tuff forms beds 20-50 ft thick and consists of pinkish-white ashy matrix with nonwelded pumice fragments 0.04 to 0.4 in. long. Lithic rhyolite tuff is matrix-supported and includes angular to sub-rounded clasts that are mostly rhyolite ash flow and include subordinate clasts of aphyric basalt and porphyritic andesite. The rhyolite tuff is locally zeolitic. Zeolites probably formed during and after burial by sediments or by reaction of pore waters with aluminosilicate minerals (Hay, 1978). No rhyolite domes were seen, but perlite is present in discontinuous blocks of altered rhyolitic material that may have been derived from domes east of Dry Valley Rim in the area now faulted down and buried by alluvium.

Thick lahar deposits are exposed stratigraphically above the andesite in the northern part of the study area and crop out locally above rhyolite ash-flow and lithic tuff in the central part of Dry Valley Rim. Lahar deposits are volcanic debris flows containing at least 80 weight percent solids (Fisher and Schmincke, 1984). These lahar deposits have a composite thickness of as much as 400 ft and are the dominant rock type in the mountains south of Smoke Creek as well as in the upper levels of the northern part of Dry Valley Rim. They consist of volcanic mud flow breccia mapped as lobate flows filling channels and as crusts on sides of channels. The flows contain poorly sorted, angular to sub-rounded clasts averaging about 4 in. in diameter of basaltic, andesitic, and (or) dacitic material within a lithic and ashy matrix. These lahar deposits are commonly interstratified with fluvial sedimentary rocks and andesite flows. They typically crop out as resistant ridges.

Olivine basalt flows cap the western dip slope of the study area. The basal flows in the basalt sequence are exposed at the top of the central and southern parts of Dry Valley Rim. The sequence comprises thin (10-30 ft) flows that have a composite thickness exceeding 800 ft. Flows are fine grained to aphanitic lava that commonly contains olivine phenocrysts (less than 0.04 in.) that are characteristically altered to iddingsite to various degrees. These rocks have silica contents of 50-53 weight percent. Diggles and others (1988a) determined a potassium-argon age of 12.3±0.4 Ma on basalt in the Skedaddle Mountains that is stratigraphically correlative with the flows in the study area.

Pleistocene Lake Lahontan, a large pluvial extension of Pyramid and Honey Lakes, occupied the Smoke Creek Desert and Dry Valley basins during glacial periods. The Dry Valley basin includes a small part of the eastern margin of the study area and is underlain in part by lake sediments deposited during the lacustrine inundation.

North of the study area boundary, a flat-lying basalt flow is present that may be as young as Pliocene. Quaternary surficial deposits are comprised of colluvium, alluvium, and talus, as well as aeolian, lacustrine, and fluvial deposits.

The major structure in the study area is the normal fault scarp that forms Dry Valley Rim. Faulting along the Dry Valley Rim began in the Miocene and continued through the Quaternary. The amount of displacement along this fault is at least 2,000 ft. North-trending normal faults such as this are characteristic of Basin and Range tectonics and commonly have vertical displacements on the order of several thousand feet. The study area lies along a major northwest-trending lineament called Walker Lane. Right-lateral shear along this feature is interpreted as having formed a regional stress pattern that controlled Basin and Range structures (Albers, 1967). Moody and Hill (1956) proposed that right-lateral shear systems along Walker Lane control the north-south orientation of many of the ranges in the western Basin and Range Province.

Geochemistry

Methods and Background

A reconnaissance geochemical study of the Dry Valley Rim Wilderness Study Area was undertaken in June 1985 by the U.S. Geological Survey. A sample-location map, tables of analytical data, and a description of sampling, preparation, and analytical methods are presented in Adrian and others (1987). Three sample media were selected on the basis of their ability to reveal anomalies where present in the volcanic terrane of northeast California. Forty-six stream-sediment samples and 45 nonmagnetic, heavy-mineral panned concentrates were prepared from stream-sediment material collected mostly from dry stream beds. The stream sediment reflects bedrock geochemistry and can indicate major areas of mineralization. The nonmagnetic fraction of panned concentrates contains minerals with high specific gravity that are associated with mineralization and alteration. Fifteen rock samples, thought possibly to be mineralized or altered, were collected as stream cobbles or from outcrops within the study area. Sixty nonmineralized rocks of basaltic to andesitic composition were collected during the geological mapping studies of this study area and the contiguous Skedaddle Mountain Wilderness Study Area (Diggles and others, 1988b). These were analyzed to provide background geochemical data for both study areas.

All of the samples were analyzed for 31 elements including antimony, barium, cadmium, cobalt, chromium, copper, gold, iron, lanthanum, lead, magnesium, manganese, molybdenum, nickel, silver, thorium, tin, titanium, tungsten, vanadium, yttrium, and zinc using a six-step semiquantitative emission spectrographic method routinely used by the U.S. Geological Survey (Grimes and Marranzino, 1968). In addition, the minus-80-mesh sediments were analyzed for uranium and thorium by the delayed neutron technique (Millard, 1976). The rocks were analyzed for uranium, thorium, arsenic, cadmium, bismuth, antimony, zinc, and mercury; five of these samples were analysed for gold. These additional analyses of rock samples were run by atomic-absorption methods described by Koirtyohann and Khalil (1976) and O'Leary and Viets (1986).

Nonmetallic commodities with recorded production in Washoe County and (or) eastern Lassen County include clays, diatomite, tufa, limestone, sodium chloride, borates, gypsum, perlite, silica, feldspar, lightweight aggregate, and sand and gravel (Bonham, 1969). With the possible exception of borate, these commodities would not be detected by our geochemical methods. Samples collected from an iron-stained, vesicular, volcanic outcrop cut by a small tributary on the north side of Red Rock Canyon contain over 50 percent chabazite. Similar zeolite-bearing cobbles were noted in the stream bed of Rocky Spring Canyon, about 2.5 mi to the south-southeast.

Dacitic to rhyolitic flows and domes as well as surface evidence of alteration and mineralization present in the Skedaddle Mountain Wilderness Study Area (Diggles and others, 1988a) were not found in the Dry Valley Rim Wilderness Study Area (Diggles and others, 1986). The data from rocks collected from silicic outcrops and altered areas were omitted in compiling background geochemical data for the Dry Valley Rim Wilderness Study Area.

In U.S. Geological Survey reconnaissance geochemical resource assessment studies, a semiquantitative spectrographic method (Grimes and Marranzino, 1968) is used for the initial studies. This method allows for both the rapid and economical analysis of large numbers of samples; a limitation is that some commodity elements will not be detected because this method is not sufficiently sensitive. The presence of such commodity elements may be inferred by analysis of other elements, pathfinders, that are characteristically associated with the commodity element of interest and easily detected by this method. When anomalous concentrations of such pathfinder elements are determined, selected samples are resubmitted for analysis by more sensitive techniques.

Results and Interpretation

The stream-sediment and panned-concentrate sample data were evaluated by comparing them to background concentrations. Background concentrations are considered to represent samples from an unmineralized provenance. The geochemical threshold values for rock and stream-sediment samples were calculated at three times the arithmetic means of element concentrations of local basalts and andesites. The threshold is the concentration of a given element above which a sample is considered anomalous in that element. For elements with extrapolated mean values below the lower level of determination, the lower level of determination is assigned as threshold value. The threshold values for the nonmagnetic concentrates are chosen on the basis of prior experience. Threshold values in parts per million (ppm) for elements present in anomalous concentrations in concentrate samples are: lead, 100; molybdenum, 10; copper, 100; barium, 5,000; manganese, 2,000; arsenic, 500; chromium, 300; vanadium, 500; lanthanum, 500; and yttrium, 500. For rock and minus-80-mesh sediments the thresholds are lead, 30; molybdenum, 5; copper, 100; barium, 3,000; manganese, 1,500; arsenic, 5; chromium, 200; vanadium, 500; lanthanum, 100; yttrium, 50; and uranium, 3.

Analyses of stream-sediment and panned-concentrate samples from the Dry Valley Rim Wilderness Study Area have concentrations that are at or near threshold values, do not occur in combinations indicative of metallic ore deposits, and are scattered throughout the study area. No gold, sulfides, or other ore-related minerals were noted during microscopic examination of the nonmagnetic and slightly magnetic concentrate fractions.

No evidence of extensive alteration was noted in the field. Some low-level anomalies of yttrium, lanthanum, and arsenic in U.S. Geological Survey stream-sediment and panned concentrate samples, as well as gold in a U.S. Bureau of Mines placer sample, were detected. The five rock samples analysed by the U.S. Geological Survey contained no anomalies. The mineralized material may be derived from detrital sediment or lahar flows from the Skedaddle Mountains, a site underlain by an area of known gold mineralization (fig. 1). The anomalies would therefore not be related to mineralization within the Dry Valley Rim Wilderness Study Area.

Three concentrates with particularly high lead values (1,500, 5,000, and 7,000 ppm) all contain metallic lead, presumably from lead gunshot. Numerous shotgun shells were noted at these and other sites. Three other sites produced heavy-mineral concentrates with anomalous lead values ranging from 150 to 500 ppm, which may or may not be due to lead shot. The 500 ppm lead value is associated with 15 ppm molybdenum and is located at the mouth of Parker Canyon. No gold or silver was detected in samples collected from the study area.

A single small pebble of polycrystalline apatite collected from upper Skedaddle Creek at the 5,400 ft elevation contained 34 ppm uranium, 150 ppm lanthanum, 70 ppm yttrium, and 2,000 ppm manganese. Apatite commonly contains abundant lanthanum and other rare-earth elements, yttrium, and uranium (De Voto, 1978). The minus-80-mesh sediment collected at the same site is not anomalous in either uranium (1.9 ppm) or thorium (3.9 ppm). Two other rock samples, collected as clasts from lahar deposits southwest of Smoke Creek contained 3.8 and 5.2 ppm uranium. The latter sample also contained 7 ppm arsenic, 1,500 ppm manganese, and 3,000 ppm barium. The clasts in the lahar deposit probably originated from outside the study area. Two minus-80-mesh stream-sediment samples also have slightly anomalous uranium values of 3.3 ppm. They were collected from a stream bed in small tributaries of Skedaddle Creek. These scattered low-level uranium and thorium values do not suggest mineral resource potential.

Numerous small, rounded, light-colored pebbles of silicified rhyolite collected from a site west of Larkspur Reservoir contain lanthanum at a level greater than the 150 ppm threshold used to interpret anomalies in basalt and andesite. Lanthanum concentrations above 150 ppm in rhyolite, however, are not unusual and do not constitute an anomaly. The panned-concentrate sample collected at this site is not anomalous in lanthanum but contains 150 ppm lead and the stream-sediment sample contains 300 ppm chromium and 500 ppm vanadium. These slightly anomalous values of chromium are attributed to chromite, which is present as minute inclusions in the olivine phenocrysts in basalt. Vanadium anomalies are probably due to abundant magnetite in the stream sediment derived from the andesitic lavas and lahar deposits. No obvious area of alteration was seen upstream of this site and the data do not suggest mineral resource potential.

The geologic and geochemical data do not suggest that any areas are likely to contain mineral resources of rare earth or radioactive minerals. Seven nonmagnetic concentrates from scattered localities contained 500 ppm lanthanum and (or) 500 ppm yttrium. These values probably indicate the presence of rare earth accessory minerals such as allanite and do not suggest the presence of mineralized rocks. Thorium values in rocks and minus-80-mesh sediments are all less than 20 ppm; only six are above 10 ppm and the highest thorium values in concentrates is 200 ppm (three samples).

Geophysics

Geophysical evaluation of the mineral resource potential of the study area was based on interpretations of three kinds of geophysical surveys. These were aerial gamma-ray, gravity, and aeromagnetic surveys.

Aerial Gamma-ray Data

Radiometric data were compiled by Geodata International, Inc. (1978), in Nevada and by Western Geophysical Company of America (1981) in California for the National

Uranium Resource Evaluation (NURE) program of the Department of Energy. The coverage in Nevada consists of five east-west flightlines and one north-south flightline; the total length of the flightlines is about 35 mi. No flightlines crossed the part of the study area in California. Flight altitudes ranged from 300 to 500 ft above the ground with fluctuations in altitude ranging from 200 ft over hillcrests to 1100 ft over canyons. Recordings were made of gamma-ray flux from radioactive isotopes of uranium, thorium, and potassium. No anomalous count rates were recorded in the study area. Count rates greater than three standard deviations above mean background level were recorded for thorium along an east-west flightline in California that terminates at the Nevada border about 0.5 mi south of the south edge of Smoke Creek Reservoir (fig. 2). The closest flightline to that location in Nevada, located about 1 mi south, did not indicate an anomaly.

Gravity Data

In 1985, gravity was measured at 7 stations in the study area, 3 stations along the border, and 21 stations within 3 mi of the study area. Five stations were previously established within 3 mi of the study-area in California (Snyder and others, 1982) and ten stations in Nevada (A.H. Cogbill, written commun., 1985). A preliminary Bouguer gravity anomaly map (Donald Plouff, unpub. data, 1986) shows three anomalies in the study area. A narrow gravity low, about 2 mi in width and 3 milligals (mGal) in amplitude, extends southeastward from Robbers Roost at the north margin of the study area along a ridgecrest for about 4 mi into the study area. The gravity low interrupts a north-dipping sloping gradient in gravity values that decreases 16 mGal from Willow Reservoir near the center of the study area to the north edge of the study area. This gravity gradient continues north for about 8 mi northwest of the study area. A broad gravity high extends from Willow Reservoir to about 5 mi south of the study area. This gravity high, and the broad decline in gravity to the north may reflect a change in the relative proportions of Cenozoic volcanic rock cover and denser pre-Cenozoic basement rocks. The higher gravity values are attributed to relatively shallow depths to the basement rocks.

Aeromagnetic Data

A regional aeromagnetic survey was flown over the Nevada part of the study area (U.S. Geological Survey, 1972). The survey was flown at an approximately constant barometric elevation of 9,000 ft above sea level and a flightline spacing of about 2 mi. The magnetic intensity level is generally higher in the study area than in surrounding areas, reflecting the normal magnetization of most of the volcanic rocks at the surface in this upland area. Inasmuch as the flight level exceeds 3,000 ft above the ground for most of the study area and the flight spacing is rather wide, only a few broad magnetic anomalies are observed in the study area.

A decrease in magnetic intensity of 100-300 nanoteslas (nT) characterizes the zone along the east edge of the study area. This decrease reflects the higher magnetic susceptibility of the volcanic rocks that underlie most of the study area compared to the sedimentary rocks that underlie the area to the east. This decrease is probably also due, in part, to a 1,000-ft increase in the flight altitude over the valley to the east. A magnetic high covers the part of the study area south of Larkspur Reservoir and extends for about 6 mi to the south. If the magnetic high is not entirely a topographic effect of near-surface Cenozoic volcanic rocks but is partly an effect of the basement source of the gravity high, the pre-Cenozoic rocks concealed at shallow depth may be plutonic. The source of a small magnetic low, which nearly coincides with the gravity low in the northern 4 mi of the study area, is not known. The magnetic low is accentuated by a magnetic high of topographic origin, which covers the study area farther to the west.

Mineral Resource Assessment

Two areas in the Dry Valley Rim Wilderness Study Area have moderate mineral resource potential for zeolites. This mineral forms amygdule fillings in basaltic lava. Eighty-five million tons of inferred subeconomic resources of basalt containing over 50 percent amygdules filled with chabazite (a zeolite consisting of $CaAl_2Si_4O_{12} \cdot 6H_2O$) are identified in Red Rock Canyon and west of Willow Springs. The quality of the zeolites around Red Rock Canyon and west of Willow Springs may be adequate for use as an absorbent in animal husbandry. The areas surrounding Red Rock Canyon and Willow Springs have moderate mineral resource potential for zeolites with a certainty of D. Mining of zeolites in basalts is highly unlikely due to their low grade and difficulties and costs of extracting zeolites from basalts.

An area north of Parker Canyon has low mineral resource potential for perlite. Perlite is hydrated rhyolitic volcanic glass characterized by numerous small, crudely spheroidal fractures and contains 2 to 5 percent water. After mining, heating will soften the glass while the water causes it to expand from 4 to 20 times its original volume with a corresponding drop in density to as low as 5.0 lb/ft^3 (8 percent that of water). Perlite has greater thermal and acoustic insulation properties than pumice, is more durable than plastics, does not moisten, and is fireproof (Kuzvart, 1984). It is used in lightweight aggregate, filters, potting soil, insulation, absorption material for oil-spill cleanup on ocean surfaces, and as filler for paints and plastics. A 100,000-ton occurrence of this mineral is present on the Broken Shovel claims; this perlite is of usable grade but is too small to be mined. The area of rhyolitic ash flows surrounding the Broken Shovel claims north of Parker Canyon has low resource potential for perlite with a certainty of C. If undiscovered resources are as small as the known occurrence in the study area, they would be too small to be mined. If, however, the known occurrence and (or) any undiscovered resources were considered with other nearby deposits in the Skedaddle Mountains (estimated 184,000 tons within 15 mi) (Diggles and others, 1988b) and at Black Diamond Canyon (estimated 1 million tons within 3 mi) (Linne, 1987), they could be mined economically.

Gold was observed in one placer sample collected by the U.S. Bureau of Mines and some low-level anomalies of yttrium, lanthanum, and arsenic were detected in the U.S. Geological Survey stream-sediment sample-collection program. The rock samples collected by the U.S. Geological Survey contained no anomalies. The mineralized material may be derived from detrital sediment or lahar flows from the Skedaddle Mountains, 6 mi west of the study area. The Skedaddle Mountains are underlain by an area that underwent hot-spring alteration and known gold mineralization (Diggles and others, 1988b). As no evidence of similar hot-springs or other extensive alteration was noted in the field, the anomalies are not interpreted to be related to mineralization within the Dry Valley Rim Wilderness Study Area.

There is an occurrence of alluvial sediment east of Red Rock Canyon at the Capricorn claims area outside of the study area. This alluvial sediment contains beds of montmorillonitic clay with silt impurities. It may qualify as fuller's earth, which is used as absorbents and for bleaching oils. The occurrence of this material does not extend into the study area; therefore, there is no mineral resource potential for clay in the Dry Valley Rim Wilderness Study Area.

Aeromagnetic data indicate that the wilderness study area may be underlain by plutonic rocks at shallow depth. These rocks, if they exist, are pre-Tertiary rocks and therefore cooled tens of millions of years ago. The study area therefore has no geothermal energy potential with a certainty of D. This assessment is also given by Higgins (1981). There is no oil or gas resource potential in the study area (Scott and Miller, 1982; Scott, 1983) with a certainty of D. This conclusion is made on the basis of a thin sedimentary section for sources and (or) reservoirs.

REFERENCES CITED

Adrian, B.M., Frisken, J.G., Malcolm, M.J., Bradley, L.A., and Briggs, Paul, 1987, Location of stream sediments (S), heavy-mineral concentrates (C), rocks (R), and water samples (W) from the Skedaddle (CA-020-612) and Dry Valley Rim (CA-020-615) Wilderness Study Areas, Lassen County, California and Washoe County, Nevada: U.S. Geological Survey Open-File Report 87-494, 44 p.

Albers, J.P., 1967, Belt of sigmoidal bending and right-lateral faulting in the western Great Basin: Geological Society of America Bulletin, v. 78, p. 143-156.

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

Bonham, H.F., 1969, Geology and mineral deposits of Washoe and Story Counties, Nevada: Nevada Bureau of Mines Bulletin 70, 140 p.

De Voto, R.H., 1978, Uranium geology and exploration-lecture notes and references: Colorado School of Mines, p. 54.

Diggles, M.F., Batatian, L.D., and Dellinger, D.A., 1986, Geologic map of the Dry Valley Rim Wilderness Study Area, Lassen County, California and Washoe County, Nevada: U.S. Geological Survey Open-File Report 86-83, scale, 1:48,000.

Diggles, M.F., Dellinger, D.A., and Batatian, L.D., 1988a, Geologic map of the Skedaddle Mountain Wilderness Study Area, Lassen County, California, and Washoe County, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-2006, scale 1:48,000 [in press].

Diggles, M.F., Frisken, J.G., Plouff, Donald, Munz, S.R., and Peters, T.J., 1988b, Mineral resources of the Skedaddle Mountain Wilderness Study Area, Lassen County, California, and Washoe County, Nevada: U.S. Geological Survey Bulletin 1706-C [in press].

Fisher, R.V., and Schmincke, H.-U. 1984, Pyroclastic rocks: Berlin, Springer-Verlag, 472 p.

Geodata International, Inc., 1978, Aerial radiometric and magnetic survey Lovelock national topographic map, Nevada: U.S. Department of Energy Grand Junction Office Open-File Report GJBX-125 (78), v. 2, 69 p.

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

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

Hay, 1978, Geologic occurrence of zeolites, *in*, Sand, L.B., and Mumpton, F.A., eds., Natural zeolites: New York, Pergamon.

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

Hill, J. M., 1912, The mining districts of the western United States: U.S. Geological Survey Bulletin 507, 309 p.

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

Kuzvart, Milos, 1984, Industrial minerals and rocks: Amsterdam, Elsevier, 454 p.

Lincoln, F.C., 1923, Mining districts and mineral resources of Nevada: Nevada Newsletter Publishing Company, 280 p.

Linne, J.M., 1987, Mineral resources of the Dry Valley Rim study area, Washoe County, Nevada and Lassen County, California: U.S. Bureau of Mines Open-File Report MLA 18-87, 18 p.

Lydon, P.A., Gay, T.E., Jr., and Jennings, C.W., 1960, Geologic map of California, Westwood (Susanville) sheet: California Division of Mines and Geology geologic map scale 1:250,000.

Millard, T.H., Jr., 1976, Determination of uranium and thorium in the U.S. Geological Survey standard rocks by the delayed neutron technique: U.S. Geological Survey Professional Paper 840, p. 61-65.

Moody, J.D., and Hill, M.J., 1956, Wrench-fault tectonics: Geological Society of America Bulletin, v. 67, p. 1207-1246.

Munts, S.R., and Peters, T.J., 1987, Mineral resources of the Skedaddle study area, Lassen County, California, and Washoe County, Nevada: U.S. Bureau of Mines Open-File Report MLA 22-87, 53 p.

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

Rollin, La Verne, Horton, R.C., and Schilling, J.H., 1971, Nevada's no. 1 basic industry: Reno, Nevada Bureau of Mines and Geology.

Russell, I.C., 1885, Geological history of Lake Lahontan: U.S. Geological Survey monograph 11, 288 p.

Schilling, John, and Hall, Joyce, 1981, The Nevada mineral industry, 1980: Nevada Bureau of Mines and Geology Special Publication MI-1980, 41 p.

Scott, E.W., 1983, Petroleum potential of wilderness lands in California, *in* Miller, B.M., ed., 1983, Petroleum potential or wilderness lands in the western United States: U.S. Geological Survey Circular 902-D, p D1-D12.

Scott, E.W., and Miller, B.M., 1982 (1984), Petroleum potential of wilderness lands, California: U.S. Geological Survey Miscellaneous Investigations Map I-1538, scale 1:1,000,000.

Snyder, D.B., Roberts, C.W., Saltus, R.W., and Sikora, R.F., 1982, Magnetic tape containing the principal facts of 64,026 gravity stations in the state of California: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, PB-82-168279, description, 30 p., PB-82-168287, magnetic tape.

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

U.S. Geological Survey, 1972, Aeromagnetic map of parts of the Lovelock, Reno, and Millet 1° x 2° quadrangles, Nevada: U.S. Geological Survey Open-File Report 72-386, 1 plate, scale 1:250,000.

Western Geophysical Company of America, 1981, National gamma-ray spectrometer and magnetometer survey, Susanville quadrangle, California - Final report: U.S. Department of Energy Grand Junction Office Open-File Report GJBX-410 (81), v. 2, 95 p.

Yale, C.G., 1908, Gold, silver, copper, lead, and zinc in the United States—Nevada, *in* U.S. Geological Survey, 1908, Mineral resources of the United States, part 1, metallic products: U.S. Geological Survey, p. 337-398.

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.

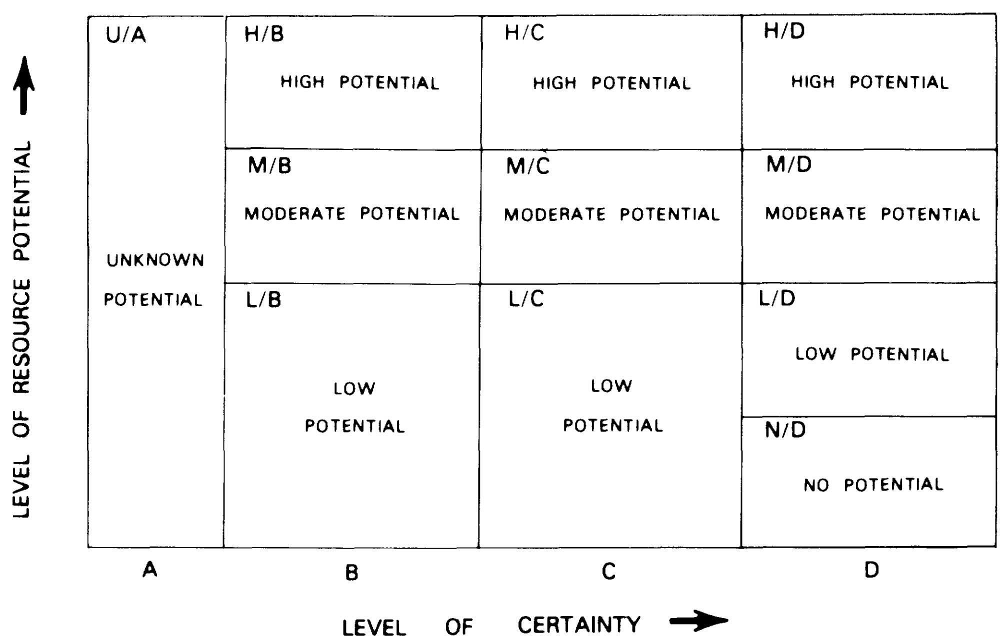
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application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

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

RESOURCE/RESERVE CLASSIFICATION

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

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

GEOLOGIC TIME CHART

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

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

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

[2]Informal time term without specific rank

Table 1. Mining claims and mineralized sites in and adjacent to the Dry Valley Rim Wilderness Study Area
[*, outside study area boundary]

Map No. (fig. 2)	Name	Summary	Workings and Production	Sample and resource data
1	Red Rock zeolite	Chabazite fills voids in altered basalt over an area of about 150 acres with estimated thickness of 200 ft. Deposit centers on basalt dike and may be related to a north-trending fault. Road access is within 3 mi. Not previously reported in literature.	None	Eleven samples were taken; samples contained between 36 percent and 70 percent chabazite with a sample weighted average of 53 percent. Ammonia cation exchange capacities for two samples were 1.5 (50 percent chabazite) and 1.84 (70 percent chabazite) milliequivilant/gm. Deposit contains an estimated 70 million tons of subeconomic zeolite-bearing resources.
2*	Capricorn claims (Sand Pass bentonite)	Remnant pediment or fan of pre-Lake Lahontan alluvial sediments over an area of about 300 acres with an estimated thickness of 50 ft. Material consists of more than 30 percent montmorillinitic clay, less than 30 percent feldspar, and less than 10 percent each calcite, gypsum, and diatoms.	Three trenches between 20 and 100 ft long and as much as 3 ft deep and one pit 2 ft deep and 5 ft in diameter. No production.	Twelve samples of alluvial sediment were taken; ten of these samples analyzed by X-ray diffraction contained over 30 percent montmorillinitic clay. All twelve samples were analyzed for oxide content by whole-rock inductively coupled-plazma (ICP) analysis and for loss-on-ignition (wet chemical) as a screen for pozzolan suitability. Only one sample passed all chemical standards. Other samples had excess moisture and loss on ignition. Two samples submitted for pozzolan activity index; both failed American Society for Testing Material standards. None had visible bentonitic character.
3	Rocky Springs zeolite	Chabazite fills voids in altered basalt over an area of about 20 acres with estimated thickness of 25 ft. Deposit may be related to a north-trending fault.	None	Four samples taken contained between 10 percent and 45 percent chabazite with a weighted average of 29 percent.
4	Willow Springs zeolite	Chabazite fills voids in altered basalt over an area of about 70 acres with estimated thickness of 100 ft. Deposit may be related to a north-trending fault.	None	Three samples taken contained from 35 percent to 65 percent chabazite with a weighted average of 52 percent. One sample had an ammonia cation exchange capacity of 1.46 milliequivilant/gm (63 percent chabazite). Deposit contains an estimated 15 million tons of subeconomic zeolite-bearing resources.
5	Broken Shovel claims	Perlite zone in a disrupted mass as much as 125 ft thick, 100 ft wide, and 700 ft long. Perlitic material is surrounded by basalt. Perlite crops out locally over a distance of 1.25 mi with a northerly trend along range front.	No apparent recent work. Claims were located in 1955.	Eleven samples of perlitic material were taken and checked optically. Eight had good perlitic texture and estimated glass content ranged from 50 percent to 95 percent. One sample tested for expansion had a furnace yield of 95.5 percent, a negligible sinker fraction, compacted density of 12 lb/ft^3 and high compaction resistance of 97 and 270 $lb/in.^2$ of 1 in. and 2 in. pressure, respectively. Largest exposed part of the deposit contains an estimated 100,000 tons of perlite that would be suitable for lightweight aggregate.

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March 3, 1849