Mineral Resources of the Palisade Mesa and The Wall Wilderness Study Areas, Nye County, Nevada

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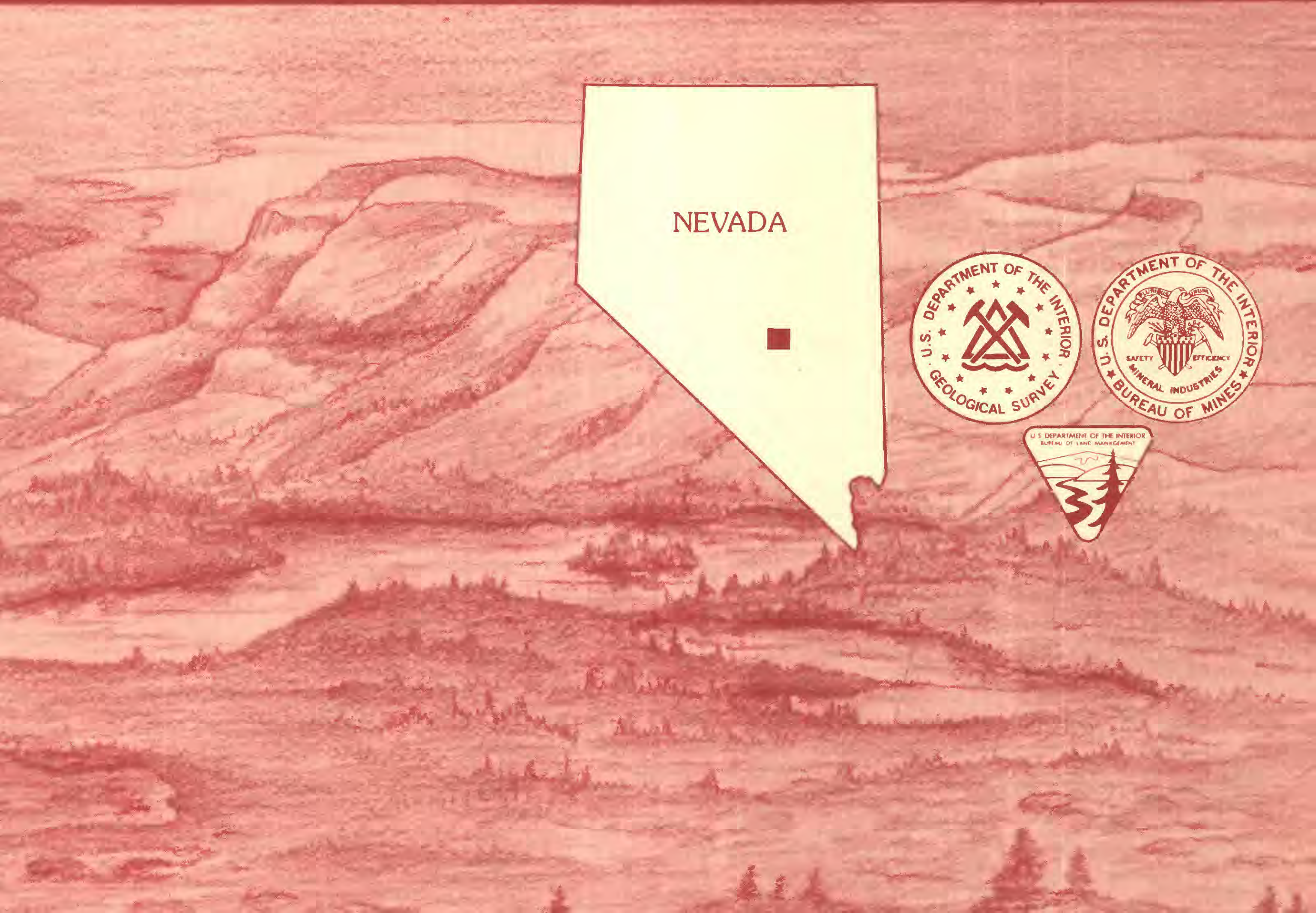

Chapter B

Mineral Resources of the Palisade Mesa and The Wall Wilderness Study Areas, Nye County, Nevada

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U.S. GEOLOGICAL SURVEY BULLETIN 1731–B

MINERAL RESOURCES OF WILDERNESS STUDY AREAS: CENTRAL 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 parts of the Palisade Mesa (NV-060-142/162) and The Wall (NV-060-163) Wilderness Study Areas, Nye County, Nevada.

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Mineral Resources of the Palisade Mesa and The Wall Wilderness Study Areas, Nye County, Nevada

By Michael F. Diggles, J. Thomas Nash, David A. Ponce, *and* Donald Plouff
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SUMMARY

Abstract

The parts of the Palisade Mesa (NV-060-142/162) and The Wall (NV-060-163) Wilderness Study Areas designated as suitable for mineral surveys are contiguous Bureau of Land Management Wilderness Study Areas in south-central Nevada. Although the wilderness study areas are larger, the U.S. Geological Survey and the U.S. Bureau of Mines were asked to study 66,110 and 30,320 acres, respectively. Throughout this report, "wilderness study area" and "study area" refer only to those acreages.

No mining activity has occurred within the wilderness study areas, or within 2 mi of their boundaries. There are no mining claims or identified metallic mineral resources present in the study areas. The areas around inferred caldera boundaries have low resource potential for gold, silver, copper, lead, and manganese.

Both the Palisade Mesa and The Wall Wilderness Study Areas have low resource potential for petroleum and natural gas. An area near the northeast part of The Wall Wilderness Study Area has low resource potential for geothermal resources. In this report, any reference to the Palisade Mesa and The Wall Wilderness Study Areas refers only to those parts of the wilderness study areas designated by the U.S. Bureau of Land Management as suitable for mineral surveys.

Character and Setting

The Palisade Mesa and The Wall Wilderness Study Areas are contiguous areas in south-central Nevada, about 65 mi northeast of Tonopah and about 15 mi east of Warm Springs (fig. 1). The part of the Palisade Mesa Wilderness Study Area designated suitable for mineral surveys covers about 66,110 acres and the part of The Wall Wilderness Study Area designated suitable for mineral surveys covers about 30,320 acres.

The region in which the wilderness study areas are located is in the Basin and Range physiographic province, which is characterized by subparallel north-trending mountain ranges separated by broad alluviated valleys. The study areas are in the southern part of the Pancake Range, and are bounded on the east by Railroad Valley and on the west by Hot Creek Valley. Elevations above sea level range from approximately 5,200 to 7,500 ft. A 7-mi-long series of northeast-trending dissected mesas named The Wall (fig. 1) forms the northwestern border of The Wall Wilderness Study Area. Lunar Crater (fig. 1), a National Natural Landmark in the northeast Palisade Mesa Wilderness Study Area, is an inactive volcanic crater.

Rainfall in the region is sparse and streams flow intermittently. Lunar Lake (fig. 1), north of The Wall Wilderness Study Area, is a playa, a shallow dry-lake basin, that is dry for most of the year.

Dirt roads provide access to the wilderness study areas from U.S. Highway 6, Nevada State Highway 375, and the Nyala Road (fig. 1). A dirt road from Highway 6 extends south to Lunar Crater and continues southward to Buttes Well, forming the boundary between the two wilderness study areas.

Identified Mineral Resources

No mineralized areas were identified and no evidence of past mining activity or prospecting was found in or within 2 mi of the Palisade Mesa and The Wall Wilderness Study Areas during field reconnaissance in 1984. There has been no recent prospecting in either wilderness study area. (The mine

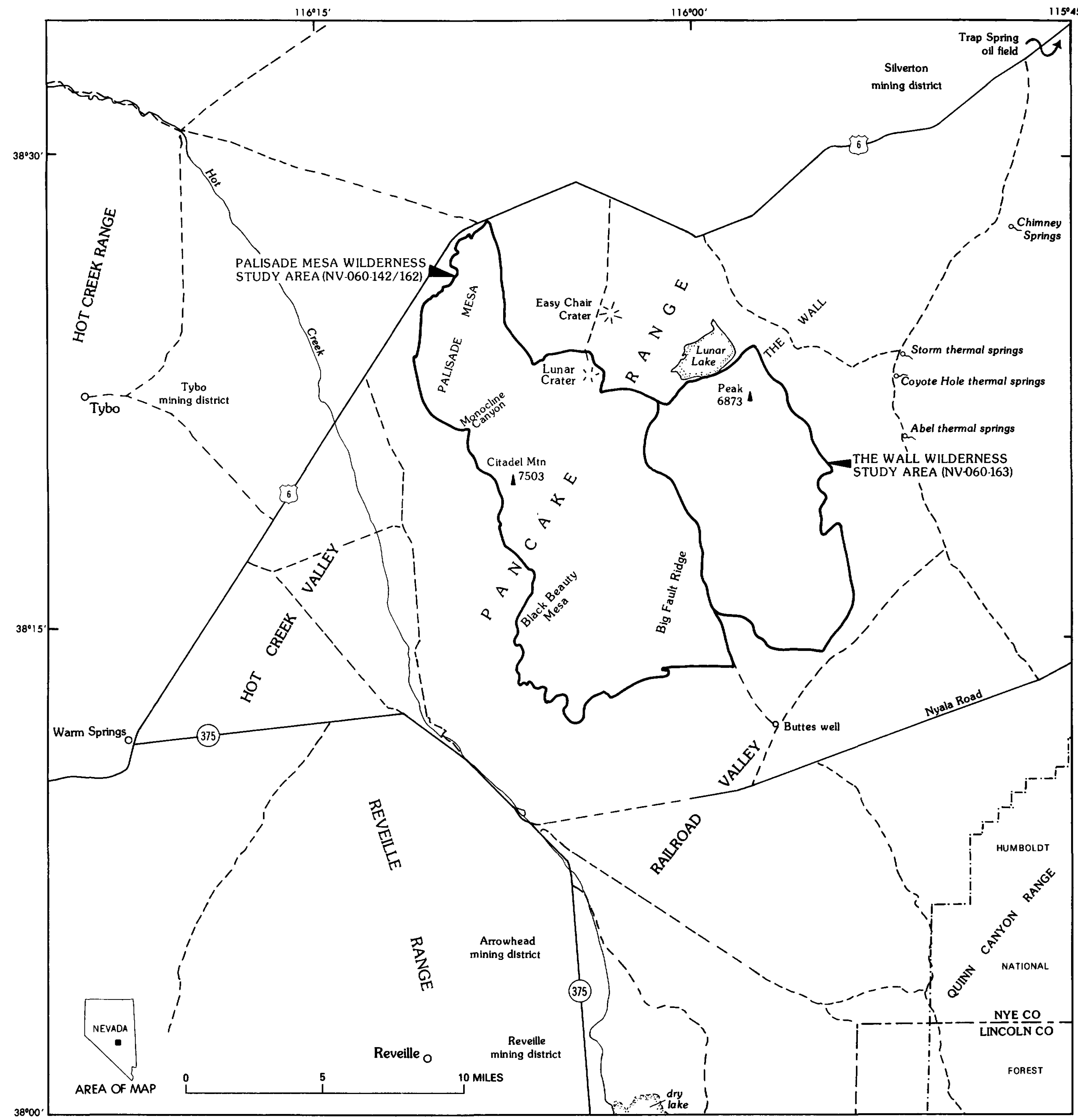

Figure 1. Index map showing location of Palisade Mesa (NV-060-142/162) and The Wall (NV-060-163) Wilderness Study Areas, Nye County, Nevada.

and spring symbol shown on the 1:62,500-scale Lunar Crater topographic map inside the northeastern Palisade Mesa Wilderness Study Area boundary is a hand-dug water well, not a mine). Rock, sand, and gravel are present in the wilderness study areas, but development of these materials is unlikely because similar materials of equal or better quality are abundant closer to existing markets.

Mineral Resource Potential

The Palisade Mesa and The Wall Wilderness Study Areas have low mineral resource potential for gold, silver, copper, lead, and manganese. These base and precious metals are not common in rhyolite ash-flow sheets anywhere. Where alteration or mineralization is associated with caldera collapse, it is a product of hydrothermal systems that post-date caldera collapse (McKee, 1979). Eruption of Tertiary (about 2 to 6 million years before present) and Quaternary (about 0 to 2.2 million years before present) basalts and cinders in the study areas occurred during a post-caldera igneous event, but it is unlikely that mineralizing hydrothermal systems would be associated with basaltic volcanism. There is no evidence to indicate that alteration or mineralization of older collapse structures in the study areas has taken place, although the geologic environment is permissive for such mineralization. Two caldera-collapse structures are inferred to exist near the wilderness study areas, the Lunar Lake and the Pancake Range/Williams Ridge-Hot Creek Valley caldera boundaries. Hence, these localities are assigned a low resource potential for gold, sliver, copper, lead, and manganese.

Because of the proximity of geothermal resources east of The Wall Wilderness Study Area in Railroad Valley (fig. 2), geothermal resources may also be present beneath the wilderness study areas, although no evidence of their existence has been discovered. The area near the eastern edge of the Pancake Range on the northeast side of The Wall Wilderness Study Area has low resource potential for geothermal resources.

As of December, 1984, 5,500 acres in the Palisade Mesa Wilderness Study Area and 8,000 acres in The Wall Wilderness Study Area are under lease for oil and gas exploration. A dry borehole 9 mi northeast of The Wall Wilderness Study Area represents the only known exploration for hydrocarbons near the wilderness study areas. However, because possible source rocks may be of favorable maturity and because of their proximity to existing oil fields, both wilderness study areas have low resource potential for petroleum and natural gas.

Industrial grade rock, sand, and gravel are present in the wilderness study areas, although their development is unlikely because of remoteness from markets.

INTRODUCTION

Location and Physiography

The contiguous Palisade Mesa and The Wall Wilderness Study Areas are located in south-central Nevada, about 65 mi northeast of Tonopah and about 15 mi east of Warm Springs (fig. 1). The parts of the Palisade Mesa Wilderness Study Area studied covers about 66,110 acres and the part of The Wall Wilderness Study Area studied covers about 30,320 acres. Unimproved roads that lead from U.S. Highway 6, Nevada State Highway 375, and the Nyala Road provide access to the study areas. An unimproved road that extends south from Highway 6 to Lunar Crater continues south to Buttes Well, forming the boundary between the two wilderness study areas.

The wilderness study areas are located in the Basin and Range physiographic province, which is characterized by north-trending subparallel mountain ranges separated by broad alluviated valleys. The study areas are in the southern part of the Pancake Range and are bounded on the east by Railroad Valley and on the west by Hot Creek Valley. Elevations range from about 5,200 ft in Railroad Valley to 7,503 ft at Citadel Mountain near the western boundary of the Palisade Mesa Wilderness Study Area; the latter is named for a large mesa at its northern end. The Wall Wilderness Study Area derives its name from, and is bounded in part by, a prominent 20-mi-long northeast-trending series of mesas ranging in elevation from 6,450 to 6,750 ft.

Lunar Crater (figs. 1 and 2), a low, inactive volcanic crater inside the northeast boundary of the Palisade Mesa Wilderness Study Area, is designated as a National Natural Landmark. Lunar Lake (figs. 1 and 2) is a shallow dry-lake basin, or playa, located along the northwest boundary of The Wall Wilderness Study Area.

The climate in the region is semiarid to arid, rainfall averaging about 7 in./year (Scott, 1969); streams flow intermittently.

Sources of Data

Studies of the general geology of the region include those by Kleinhampl and Ziony (1967 and 1985), Scott and Trask (1971), Bergman (1982), Turrin and Dohrenwend (1984), and Turrin and others (1985). Geologic maps that cover the wilderness study areas include those by Ekren and others (1973) and Snyder and others (1972). Studies by Kral (1951) and Kleinhampl and Ziony (1984) provide mineral resource data.

A literature search was conducted by the authors for additional geologic and mining information pertinent to the wilderness study areas. National Uranium Resource Evaluation (NURE) reports, published by the U.S. Department of Energy (Geodata International, 1979), were studied in order to locate uranium occurrences and radiometric anomalies. Nye County records in Tonopah, Nevada, and records on file with the U.S. Bureau of Land Management in Reno, Nevada, were examined to determine the location of mining claims. In addition, U.S. Bureau of Land Management records were examined for geothermal, petroleum, and natural gas leases.

In 1984, the U.S. Geological Survey collected samples of rocks, stream sediment, and nonmagnetic heavy-mineral concentrates from 106 sites within the two wilderness study areas. The U.S. Bureau of Mines took 57 additional rock samples. Chemical analyses of the minus-sixty-mesh and the panned-concentrate fractions of stream sediment were used to help identify areas with mineral resource potential.

Acknowledgments

Frank J. Kleinhampl provided geological advice during field work.
Appointments of field assistants were based on recommendations by the National Association of Geology Teachers. Students employed through the program were Diane E. Clemens, Richard Graff, and Elizabeth Rochette. Others who provided assistance in the field are James A. Saunders, Robert J. Fairfield, Jr., Victoria E. Langenheim, and Robert E. Tucker. U.S. Bureau of Mines field work was carried out with the assistance of John T. Neubert and Robert A. Welsh.

APPRAISAL OF IDENTIFIED RESOURCES

By Richard F. Kness, U.S. Bureau of Mines

Mining and Mineral Exploration History

No mining has occurred in, or within 2 mi of either wilderness study area, but antimony, copper, gold, lead, silver, and zinc have been mined or prospected about 15 mi to the north.

Mines, Prospects, and Mineral Occurrences

No mining claims are located in the wilderness study areas. The nearest mining claims are 2.5 mi southwest of the Palisade Mesa Wilderness Study Area and 2.5 mi northeast of The Wall Wilderness Study Area. The Arrowhead, Reveille, Silverton, and Tybo mining districts (fig. 1) are located 10 to 15 mi from the wilderness study areas and contain the only known mineral deposits in the region (Schilling, 1976). Mining began in 1865 when gold and silver were discovered near Tybo. In 1867, silver and lead were discovered near the site of Reveille. Mineralization in the Arrowhead district was discovered in 1919. Information on history and production in these nearby mining districts was reported by Kral (1951) and Kleinhampl and Ziony (1984).

The Arrowhead and Reveille mining districts (9 and 12 mi south of the wilderness study areas, respectively) are geologically similar. In the Arrowhead district, silver was mined from argentite- and pyrargyrite-bearing veins within fault zones that crosscut Tertiary volcanic rocks. Recorded production from both districts between 1920 and 1939 was 225 tons valued at $4,755 (Kral, 1951). Mineral occurrences are in veins along faults and in replacement bodies near the contacts between Paleozoic sedimentary rocks and Tertiary volcanic rocks. Ore minerals within the Reveille district are argentiferous galena (PbS), cerargyrite (AgCl), cerussite ($PbCO_3$), and stibnite (Sb_2S_3). Production records for the Reveille district are incomplete, but from 1866 to 1946 recorded production (Au, Ag, Cu, Pb, Sb, and Zn) was 8,261 tons of ore valued at approximately $613,000 (Kral, 1951).

In the Silverton district, about 12 mi northeast of the wilderness study areas, silver occurs in replacement bodies in Paleozoic limestones near the contact with Tertiary rhyolitic dikes and sills. Small shipments of ore assayed at 10 to 30 oz of silver per ton were made during the 1930's (Kral, 1951).

In the Tybo district, about 12 mi west of the wilderness study areas, mineralized veins have replaced Tertiary quartz-latite-porphyry dikes that occurred within faults in Paleozoic sedimentary rocks. Veins contain calcite, chalcopyrite, pyrite, quartz, sphalerite, and argentiferous galena. From 1874 to 1944, total recorded production was about 600,000 tons valued at about $9,800,000 (Kral, 195).

Although several borrow pits are located in alluvium and basalt cinders that are present along U.S. Highway 6 and Nevada State Highway 375, no such workings were found within the wilderness study areas.

Appraisal of Identified Resources

No mineralized areas were identified and no evidence of past mining activity or prospecting is evident in or within 2 mi of the Palisade Mesa and The Wall Wilderness Study Areas. The mine and spring symbol shown on the 1:62,500 scale Lunar Crater topographic quadrangle (U.S. Geological Survey, 1967), at the northeastern edge of the Palisade Mesa Wilderness Study Area, is a hand-dug water well, not a mine.

Petroleum and natural gas exploration is not known to have occurred in either wilderness study area; however, a borehole drilled to a depth of 1,711 ft about 9 mi northeast of The Wall Wilderness Study Area boundary in Railroad Valley came up dry. As of December, 1984, 5,500 acres in the Palisade Mesa Wilderness Study Area and 8,000 acres in The Wall Wilderness Study Area are under lease for oil and gas exploration (Kness, 1985).

Energy Resources

Sandberg (1983) evaluated the petroleum and natural gas resources of wilderness lands in Nevada using the presence of source and reservoir rocks, the maturation history, and the presence of structural and stratigraphic traps as the major parameters governing the accumulation of petroleum and natural gas. Although this report initially rated the wilderness study areas as having no potentialfor petroleum and natural gas, C.A. Sandberg (oral commun., 1986) subsequently revised the rating to that of low potential.

Railroad Valley, to the east of The Wall Wilderness Study Area, is the major oil producing area in Nevada. The Trap Spring field is the nearest oil field, about 22 mi northeast of the wilderness study area. Production occurs in a structural and stratigraphic trap in ash-flow tuff reservoir rock consisting of the Tertiary Pritchards Station

Formation (Duey, 1979). Structure is controlled by the down-thrown side of the fault that bounds Railroad Valley (Duey, 1979). Other fields in Railroad Valley consist of the Current, Eagle Springs, and the recently discovered Grant Canyon field.

The Railroad Valley geothermal area is 0.25 mi outside the eastern boundary of The Wall Wilderness Study Area; however, no geothermal leases or lease applications are located within either wilderness study area. Thermal springs and wells in Railroad Valley occur mainly along the margins of the valley, either coincident with, or basinward from Basin and Range faults. Abel, Chimney Springs, Coyote Hole, and Storm Springs are thermal springs that occur along the trend of a northeast-striking fault outside The Wall Wilderness Study Area. The temperatures of the thermal springs range from 84° to 160° F. (Garside and Schilling, 1979). No thermal springs, travertine, or similar deposits were observed during the field study in the wilderness study areas.

Results of Field Investigation

U.S. Bureau of Mines field studies included ground reconnaissance and a helicopter overflight of the wilderness study areas. A total of 57 rock samples were collected. Twenty-six chip and grab samples, 6 panned-concentrate samples, and 13 stream-sediment samples were collected in and near the Palisade Mesa Wilderness Study Area; 4 panned-concentrate and 8 stream-sediment samples were collected in and near The Wall Wilderness Study Area. Chip samples were collected across suspected mineralized structures. Panned-concentrate samples of black sands were collected in stream beds. Stream-sediment samples collected from larger drainages were assessed for tin or mineralized rock related to mapped faults. Sampling sites and analytical data are shown by Kness (1985).

Analyses for gold, silver, and tin were done by fire assay and atomic-absorption methods. Semiquantitative spectrographic analyses for 40 elements including antimony, barium, cadmium, cobalt, chromium, copper, gold, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, platinum, silver, tin, titanium, vanadium, and zinc were performed on all samples. Results of the U.S. Bureau of Mines' analyses are available for public inspection at the Bureau of Mines, Intermountain Field Operations Center, Denver, Colo.

A reconnaissance study of Tertiary volcanic centers in Nevada (Albers and Kleinhampl, 1970) suggests that the two calderas in the area, the Pancake Range/Williams Ridge-Hot Creek Valley caldera and the Lunar Lake caldera, contain no significant mineral deposit; our field investigation confirms this.

Granite throughout the world contains an average concentration of 3 parts per million (ppm) tin, and values of 20 ppm may indicate tin-mineralized granites (Levinson, 1980). Ash-flow tuff exposed in the wilderness study areas is rhyolitic to quartz-latitic (the fine-grained equivalent of granite) in composition. Eighteen rock samples contained between 5 and 14 ppm tin. Tin concentrations were not detected in the other rock samples. The highest concentration is 36 ppm tin. The sample with greater than 20 ppm tin is not significant because it is a single-point anomaly.

Epithermal gold-silver veins in faults related to calderas and tin-bearing rhyolites are the deposit types that occasionally form in geologic environments similar to those of the wilderness study areas. Surface indicators of epithermal mineralization may include silicified fault zones, stockwork quartz veins, silicified and pyritized vent breccia, and propylitic alteration (chlorite, calcite, and pyrite). None of these indicators were observed along the fault traces in Monocline Canyon in the Palisade Mesa Wilderness Study Area. The N. 50° E.-striking Monocline Canyon fault and a N. 10° E.-striking fault can be traced on the surface for approximately 1.25 and 0.75 mi, respectively. Except for small patches of silica crust just outside the Palisade Mesa Wilderness Study Area (Kness, 1985), no surface indicators of epithermal mineralization were noted in either wilderness study area.

Pathfinder (mobile) elements may be closely associated with, and may assist in finding, mineral occurrences or deposits. Analytical data (Kness, 1985) show no anomalous concentrations of pathfinder or precious metals in the areas studied. Pathfinder elements for epithermal gold-silver veins are antimony, arsenic, bismuth, and silver (Rose and others, 1979; Levinson, 1980). Other elements associated with epithermal gold-silver veins, but not observed in this study, are copper, gold, lead, mercury, tellurium, thallium, uranium, and zinc (Berger, 1982).

Ten panned-concentrate samples of stream gravels and 21 stream-sediment samples were collected from drainages in and near the wilderness study areas to determine if pathfinder elements are related to possibly mineralized faults. Analytical data (Kness, 1985) did not indicate the presence of any of these elements in the areas studied.

Antimony, bismuth, copper, gold, lead, and silver were not detected. Although arsenic, tellurium, and zinc are present, the concentration and distribution of these elements is not indicative of the presence of near-surface mineral deposits.

Basalt and cinders in the Lunar Crater volcanic field are sources of aggregate and crushed stone. Construction materials have a high bulk-to-value ratio that restricts the use or market area. Transportation costs generally limit use of such deposits to under 30 mi.

Rock, sand, and gravel are present in the wilderness study areas, but development of these materials is unlikely because similar materials of equal or better quality are abundant closer to existing markets.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By M.F. Diggles, J. Thomas Nash, David A. Ponce, and Donald Plouff, U.S. Geological Survey

Geology

Silicic volcanic rocks of Tertiary age, basaltic

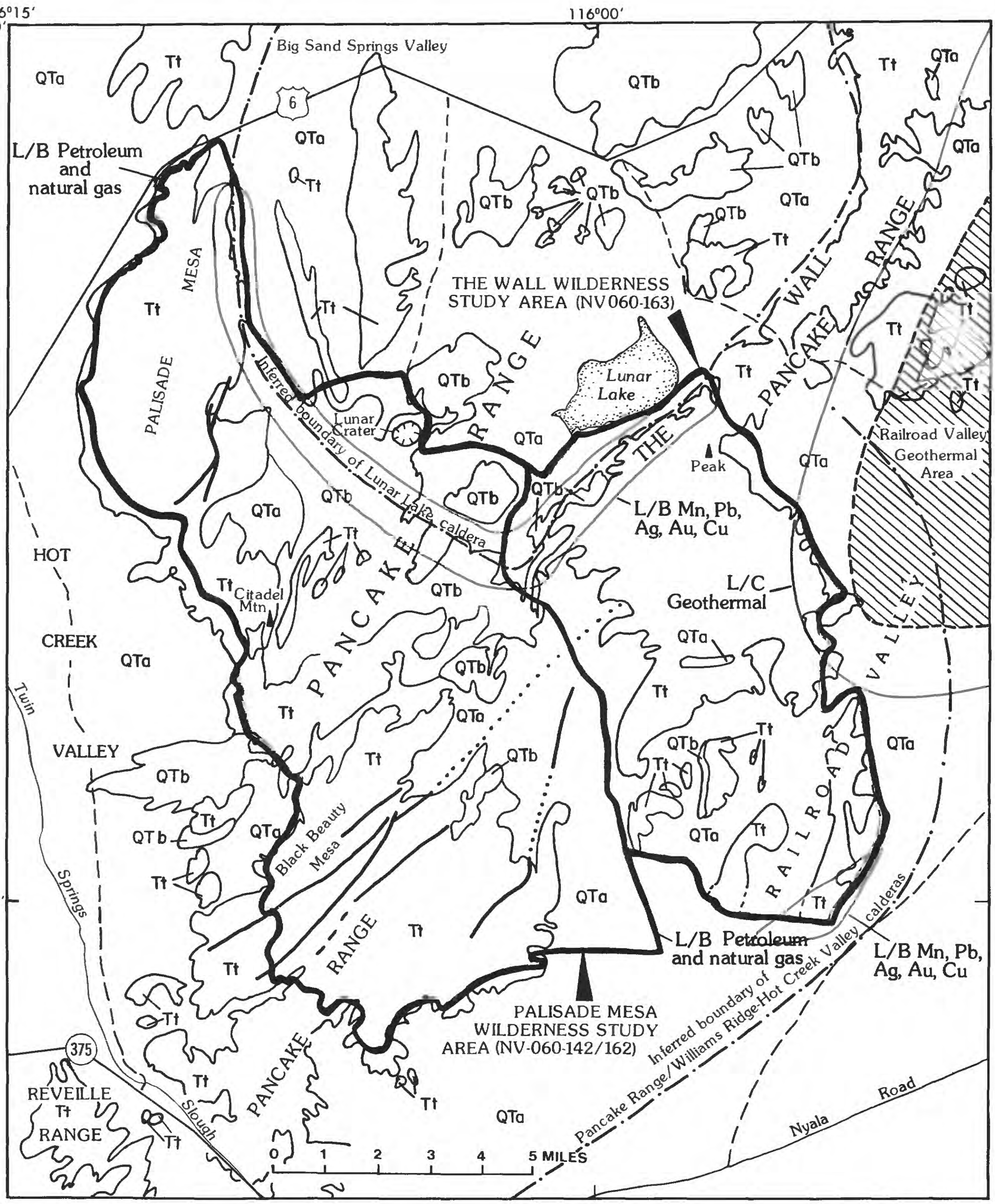

Figure 2. Map showing genralized geology and mineral resource potential of the Palisade Mesa and The Wall Wilderness Study Areas. Nevada.

EXPLANATION

AREA WITH LOW RESOURCE POTENTIAL–Commodities as shown. See appendix 1 and figure 3 for definition of levels of mineral resource potential

COMMODITIES

	Petroleum and natural gas
	Geothermal
Ag	Silver
Au	Gold
Cu	Copper
Mn	Manganese
Pb	Lead

CORRELATION OF MAP UNITS

QTa	QTb	Holocene; Pleistocene and Pliocene	QUATERNARY AND TERTIARY
Unconformity			
Tt		Miocene and Oligocene	TERTIARY

DESCRIPTION OF MAP UNITS

QTa	Alluvium (Holocene, Pleistocene, and Pliocene)
QTb	Basalt (Pleistocene and Pliocene)
Tt	Tuff (Oligocene and Miocene)

MAP SYMBOLS

- Contact--Dashed where approximately located
- Fault–Dashed where approximately located; dotted where concealed
- Boundary of Railroad Valley geothermal area
- Inferred caldera boundary
- Dirt road

Geology from Ekren and others (1972) and Ekren and others (1973).

Figure 2. Continued.

flows of Tertiary and Quaternary age, and sediments of Tertiary and Quaternary age are the dominant stratigraphic units of the Palisade Mesa and The Wall Wilderness Study Areas (fig. 2). The oldest rocks in the study areas are 27 to 7 Ma (Ekren and others, 1971) and comprise thick sequences of felsic ash-flow tuffs. These are overlain by basaltic flows of the Lunar Crater volcanic field that range in age from 3.8 to 0.13 Ma (Turrin and others, 1985). About one third of both study areas are covered with alluvium and colluvium deposited on pediment surfaces and valley-fill, lake, and landslide deposits.

Nine ash-flow tuff units in the Pancake Range were mapped by Ekren and others (1972; 1973) and Snyder and others (1972). The oldest is the tuff of Halligan Mesa, a massive, light-gray rhyolitic welded tuff that weathers pale buff. The tuff of Palisade Mesa is a medium-gray rhyolitic welded tuff that weathers reddish-gray to brown and has prominent vertical columnar jointing. The Monotony Tuff (Ekren and others, 1971) is a medium-purplish-gray devitrified rhyodacitic to quartz-latitic welded tuff that weathers brown to rust brown. It contains abundant plagioclase, quartz, and biotite phenocrysts. The tuff of Shingle Pass consists of a reddish-gray devitrified rhyolitic welded tuff that weathers red and contains fewer phenocrysts than other tuffs in the area. The tuff of Lunar Cuesta is a bluish-gray vitric to mostly devitrified quartz-latitic welded tuff that weathers light brown to buff. The tuff of Buckskin Point is a gray dacitic to quartz-latitic welded tuff that weathers brownish gray. The tuff of Buckskin Rim consists of partially to densely welded light-gray to brown rhyolitic to quartz latitic ash-flow tuff and vitric nonwelded tuff that weather brown to buff. The tuff of Black Beauty Mesa is a densely welded quartz-latitic to rhyodacitic tuff that is black where vitrophyric, and red-brown where devitrified. It forms cliffs with steps of tuffaceous sandstone. The youngest tuff unit in the area is reddish gray granite-weathering tuff that is partly to densely welded devitrified rhyolitic tuff that weathers dark brown to reddish brown. All the tuff units are exposed in fault blocks tilted generally eastward; their cumulative thickness in the wilderness study areas is about 8,000 ft (Scott and Trask, 1971).

The ash-flow tuffs, dated at 5.8 to 0.13 Ma, are overlain by basaltic flows of the Lunar Crater volcanic field (Turrin and Dohrenwend, 1984), which show a regular and continuous compositional evolution (Turrin and others, 1985). Little or no tilting or uplift occurred in the Pancake Range during Quaternary time (Turrin and Dohrenwend, 1984). Structures in the area consist of mild folds, generally eastward-trending pre-Quaternary tilted layers of Tertiary rocks, some northeast-trending faults, and inferred caldera structures.

There are two inferred caldera boundaries within and near the wilderness study areas: the Pancake Range/Williams Ridge-Hot Creek Valley caldera boundary (Ekren and others, 1976), which lies outside of and encircles the wilderness study areas; and the more striking structure known as The Wall, which Scott (1969) mapped as the edge of the Lunar Lake caldera. This geologic environment is permissive for epithermal gold-sliver-copper-lead-manganese mineralization similar to that occasionally associated with caldera fracture systems elsewhere in Nevada. However, McKee (1979) points out that such mineralization is usually the result of later hydrothermal-fluid circulation taking place along the pre-existing structure.

Geochemistry

Methods

Rock, stream-sediment, and nonmagnetic heavy-mineral samples were collected at 106 sites in the conterminous Palisade Mesa and the Wall Wilderness Study Areas in 1984 by U.S. Geological Survey personnel. The sampling and analytical procedures are described and the analytical data are listed in Siems and others (1986b).

Geochemical analyses of stream-sediment samples reflect the mineral content of rocks underlying the drainage basin upstream from the sample site. Two media were analyzed for each sample collected from recently active stream sediment: the minus-sixty-mesh (less than 0.25 mm) fraction and the unsieved nonmagnetic heavy-mineral fraction. The heavy-mineral fraction is used because it concentrates minerals that are associated with alteration and mineralization processes. Results of these analyses are used to identify areas with unusual geochemistry, an important step in identifying areas with mineral resource potential.

All samples were analyzed for 31 elements, including antimony, barium, cadmium, cobalt, chromium, copper, gold, iron, lead, magnesium, manganese, molybdenum, nickel, silver, thorium, tin, titanium, tungsten, vanadium, and zinc, using a six-step semiquantitative emission-spectrographic method (Grimes and Marranzino, 1968). When using the spectrographic method, antimony, arsenic, bismuth, cadmium, and zinc have high lower limits of detection. Therefore, an atomic absorption analytical technique (modified from Viets, 1978) was used to search for these elements in rock and stream-sediment samples. The locations of sampling sites and the analytical data were presented by Siems and others (1986b).

The interpretation of the geochemical data from the wilderness study areas is done in a regional context by comparison with the geochemical signatures of known deposits and mining areas in the region in which similar geochemical techniques were used. The regional context for this interpretation is provided by U.S. Geological Survey geochemical studies in the Tonopah 1° by 2° quadrangle (Fairfield and others, 1985; Siems and others, 1986a) that include analysis of more than 1,200 samples of stream sediments, an equal number of heavy-mineral concentrates, and more than 2,000 samples of mineralized rocks from mines and prospects. Sites characterized by anomalous concentrations of one or more elements in both sample media are considered especially useful. Sites characterized by multiple-element associations that are consistent with geochemical theory or have been recognized in known ore deposits in the region are considered the most reliable indicators for mineral resource assessment.

Results and Interpretation

Geochemical data for the study areas, after making the above comparison, show no unusual concentrations of elements; they reveal no significant areas of alteration or mineralization. Although seven sites characterized by zinc concentrations greater than 200 ppm in the stream sediments were found, no unusual concentrations of other elements were found in either the stream-sediment or panned-concentrate samples. Such zinc concentrations are not unusual, however, and experience has shown that the anomalous values probably reflect silicate minerals derived from the volcanic rocks and are not indicative of the presence of mineralized rock.

Geophysics

Aerial Gamma-ray Data

The U.S. Department of Energy conducted a regional aerial gamma-ray spectrometric survey of the two wilderness study areas as part of the NURE program. Four flight lines, one running north-south and three east-west, spaced at 3-mi intervals and flown 400 ft above terrain, traversed the area (Geodata International, Inc., 1979). Evaluation of data acquired by the survey was made by J.S. Duval (written commun., 1985) utilizing techniques described by Duval (1983). Concentrations encountered in the wilderness study areas are 1.5 to 3.0 percent potassium, 2.4 to 3.3 ppm equivalent uranium, and 10 to 15 ppm equivalent thorium. A moderately strong potassium anomaly occurs in the eastern part of the wilderness study areas and a moderately strong thorium anomaly occurs north of the study areas, but there are no uranium anomalies in or near the two wilderness study areas.

Gravity Data

D.A. Ponce prepared a regional Bouguer gravity map of the wilderness study areas at a scale of 1:62,500 (D.A. Ponce, unpub. data, 1985) using existing data (Healey and others, 1981; Snyder and others, 1984) at a reduction density of 2.67 mg/m^3. Gravity data coverage is excellent throughout the study areas; measurements were spaced at intervals of about 1 mi or less along many of the traverses. A conspicuous feature on the map is an elongate, north-northeast-trending gravity low centered east of Lunar Crater. This low (amplitude about 6 mGal) is about 3 mi wide and 8 mi long. A Bouguer gravity-anomaly map prepared at a reduction density of 2.30 mg/m^3 (D.A. Ponce, unpub. data, 1985) indicates that this low has a roughly circular shape and is about 5 mi in diameter. The gravity low near Lunar Crater only overlies the southern part of the Lunar Lake caldera, suggesting that Tertiary volcanic rocks are thicker and the caldera deeper near its southern boundary. Other subcircular gravity lows near Lunar Crater probably reflect low-density volcanic rocks and sediments within the central Nevada caldera complex (Ekren and others, 1974). For example, a 4-mGal gravity low at Black Beauty Mesa may be part of a separate caldera.

A 5-mi-diameter gravity high is located near the southern tip of The Wall Wilderness Study Area. Although the amplitude of the closed contour of the gravity high is 5 mGal, it forms the northernmost nose of a north-trending high that is 10 to 15 mGal higher than the surrounding region. A steep gravity gradient that separates the gravity high from the Pancake Range in the wilderness study areas, indicates the existence of a steep contact between near-surface pre-Tertiary basement rocks beneath the thick Tertiary volcanic rocks of the caldera complex to the north.

Aeromagnetic Data

Aeromagnetic data include a survey flown at 500 ft above ground level over both wilderness study areas with east-trending flightlines spaced about 1 mi apart (U.S. Geological Survey, 1968) and a survey in the eastern part of the study areas flown at 1,000 ft above ground level with east-trending flightlines spaced at 0.5 mi intervals (U.S. Geological Survey, 1978). The aeromagnetic map of the study areas is generally complex, and anomalies are associated with variations in relatively magnetic Tertiary volcanic rocks. Anomalies are generally of low amplitude and correlate with mapped geologic units. The irregular pattern of the aeromagnetic map reflects topography and sharp changes of rock magnetization of moderately to intensely magnetized Tertiary volcanic rocks over short distances. The anomaly pattern is irregular because some of the volcanic rocks are reversely magnetized (Ekren and others, 1974), creating intense local lows that interrupt the combined positive effects of magnetic susceptibility and normal remnant magnetization in rocks of the surrounding volcanic terrane.

A prominent feature of the aeromagnetic map is a 4-mi-wide belt of elongate north-northeast-trending magnetic anomalies extending from Lunar Crater to the southwest edge of the Palisade Mesa Wilderness Study Area. This pattern correlates with a chain of cinder cones, vents, faults, and joints along fault zones (Scott and Trask, 1971; Ekren and others, 1974).

Another prominent feature of the aeromagnetic map is an anomaly that coincides with the arcuate trend of The Wall. This anomaly correlates with the eastern boundary of the inferred Lunar Lake caldera and thus delineates a major structural boundary. Farther east, a broad, featureless magnetic pattern coincides with the location of a 20-mGal gravity high and reflects the low magnetization of exposed Paleozoic rocks.

Mineral Resource Potential

The geology, geochemistry, and geophysics of the Palisade Mesa and The Wall Wilderness Study Areas indicate a relatively simple and unaltered volcanic pile with no indications of exposed or buried mineral deposits. Concentrations of base (copper and lead) and precious (gold and silver) metals are uncommon in rhyolite ash-flow tuffs. Where ore deposits are associated with caldera collapse, they are usually a product of younger hydrothermal systems (McKee, 1979). Eruption of the Tertiary and Quaternary basalts in the two study areas represents a later thermal event, but no evidence exists that alteration along the older collapse structures occurred. In addition, basaltic magmas are unlikely sources of significant mineralizing hydrothermal systems. Metals known to occur in flows, tuff, breccias, and agglomerates include gold, silver, copper, lead, and manganese and are considered in a subaerial volcanogenic mineral deposit model developed by Cox (1983). Concentrations of these metals, however, tend to occur in rocks emplaced at greater depth where secondary alteration of existing collapse structures has taken place (McKee, 1979). Although the geologic environment in the two study areas is permissive for mineralization, evidence is insufficient to establish precisely the likelihood of resource occurrence. The areas along the inferred boundaries of the Lunar Lake and Pancake Range/Williams Ridge/Hot Creek Valley calderas are therefore assigned a low resource potential for gold, silver, copper, lead, and manganese with a certainty of B. See Appendix 1 and figure 3 for the definition of levels of mineral resource potential and certainty of assessment.

Geothermal resources exist outside The Wall Wilderness Study Area in Railroad Valley where thermal springs and wells are present along or basinward of major Basin and Range faults. Geothermal resources may occur at depth within the wilderness study areas. The area near the range front to the northeast of The Wall Wilderness Study Area has low resource potential for geothermal resources with a certainty of C.

The Palisade Mesa and The Wall Wilderness Study Areas have low potential for petroleum and natural gas resources. The two wilderness study areas are located in a "cold spot" (Sandberg and Gutschick, 1977), an area without excessive heating. Therefore, the source rocks are considered to be at optimum maturation for petroleum and natural gas generation (Sandberg, 1983). According to Picard (1960), the source beds in existing fields in Railroad Valley may consist of Paleozoic rocks and (or) Cretaceous or Paleogene lacustrine rocks. These rocks may also be present at depth in the wilderness study areas. The only known drilling for hydrocarbons in close proximity to either wilderness study area resulted in a dry hole 9 mi northeast of The Wall Wilderness Study Area. Because of the optimum maturity of source rocks and proximity to producing oil fields, the wilderness study areas have low resource potential with a certainty of B for petroleum and natural gas (C.A. Sandberg, oral commun., 1986).

Rock, sand, and gravel are present in the wilderness study areas but development of these materials is unlikely because similar materials of equal or better quality are abundant closer to existing markets.

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APPENDIX 1. Definition of levels of mineral resource potential and certainty of assessment.

Mineral resource potential is defined as the likelihood of the presence of mineral resources in a defined area; it is not a measure of the amount of resources or their profitability.

Mineral resources are concentrations of naturally occurring solid, liquid, or gaseous materials in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Low mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment where the existence of resources is unlikely. This level of potential embraces areas of dispersed mineralized rock as well as areas having few or no indications of mineralization. Assignment of low potential requires specific positive knowledge; it is not used as a catchall for areas where adequate data are lacking.

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 a reasonable chance for resource accumulation, and where an application of genetic and (or) occurrence models indicates favorable ground.

High mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resources, where interpretations of data indicate a high likelihood for resource accumulation, where data support occurrence and (or) genetic models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential requires positive knowledge that resource-forming processes have been active in at least part of the area; it does not require that occurrences or deposits be identified.

Unknown mineral resource potential is assigned to areas where the level of knowledge is so inadequate that classification of the area as high, moderate, or type in a well-defined area. This phrase is not used if there is the slightest possibility of resource occurrence; it is not appropriate as the summary rating for any area.

Expression of the certainty of the mineral resource assessment incorporates a consideration of (1) the adequacy of the geologic, geochemical, geophysical, and resource data base available at the time of the assessment, (2) the adequacy of the occurrence or the genetic model used as the basis for a specific evaluation, and (3) an evaluation of the likelihood that the expected mineral endowment of the area is, or could be, economically extractable.

Levels of certainty of assessment are denoted by letters, A-D (fig. 3).

A. The available data are not adequate to determine the level of mineral resource potential. Level A is used with an assignment of unknown mineral resource potential.

B. The available data are adequate to suggest the geologic environment and the level of mineral resource potential, but either evidence is insufficient to establish precisely the likelihood of resource occurrence, or occurrence and (or) genetic models are not known well enough for predictive resource assessment.

C. The available data give a good indication of the geologic environment and the level of mineral resource potential, but additional evidence is needed to establish precisely the likelihood of resource occurrence, the activity of resource-forming processes, or available occurrence and (or) genetic models are minimal for predictive applications.

D. The available data clearly define the geologic environment and the level of mineral resource potential, and indicate the activity of resource—forming processes. Key evidence to interpret the presence or absence of specified types of resources is available, and occurrence and (or) genetic models are adequate for predictive resource assessment.

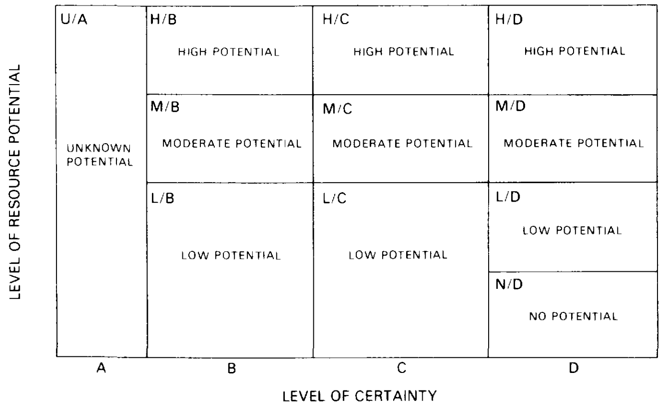

Figure 3. Major elements of mineral resource potential/certainty classification.

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