

# Mineral Resources of the Weepah Spring Wilderness Study Area, Lincoln and Nye Counties, Nevada



U.S. GEOLOGICAL SURVEY BULLETIN 1728-E



## DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

### Definitions of Mineral Resource Potential

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

**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

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

Chapter E

# Mineral Resources of the Weepah Spring Wilderness Study Area, Lincoln and Nye Counties, Nevada

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U.S. GEOLOGICAL SURVEY BULLETIN 1728

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—  
EAST-CENTRAL NEVADA AND PART OF ADJACENT BEAVER AND  
IRON COUNTIES, UTAH

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 Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys 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 a part of the Weepah Spring (NV-040-246) Wilderness Study Area, Lincoln and Nye Counties, Nevada.

### RESOURCE / RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES		UNDISCOVERED RESOURCES		
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	Speculative
			(or)		
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.

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# Mineral Resources of the Weepah Spring Wilderness Study Area, Lincoln and Nye Counties, Nevada

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## SUMMARY

The USGS (U.S. Geological Survey) and the USBM (U.S. Bureau of Mines) studied the mineral resource potential of 50,499 acres of the 61,137-acre Weepah Spring Wilderness Study Area (NV-040-246), Lincoln and Nye Counties, Nev., at the request of the BLM (U.S. Bureau of Land Management). In this report, the area studied is referred to as the "wilderness study area" or the "study area." Field studies of the area were conducted during summer 1984 by USBM geologists and during spring 1984 and fall 1985 by USGS geologists, geochemists, and geophysicists. The FNB claims in the northeastern part of the study area have identified resources of 3,300 tons of material grading 2.13 ounces silver per ton. The mineral resource potential for metals in the study area is high in the northwestern part, where undiscovered deposits of disseminated gold and associated mercury may exist; moderate in two small areas in the eastern and southern parts, where epithermal vein deposits of gold, silver, copper, lead, and zinc may exist; and low for all metals in most of the study area (fig. 1). The resource potential for oil and gas, coal, uranium, and geothermal energy is low. The mineral resource potential for commodities with industrial applications is moderate in those parts of the study area underlain by surficial deposits and carbonate rock.

The Weepah Spring Wilderness Study Area is about 115 mi (miles) north of Las Vegas, Caliente, Nev., about 40 mi southeast of the area (fig. 2), is the nearest large town. The southeastern part of the area is accessible from Nevada State Route 38; the rest of the study area is accessible from graded unpaved roads that lead northward or westward from Route 38. The Seaman Range, which contains the study area in its northern, rugged part, is an arcuate, 30-mi-long by 7-mi-wide fault-block range that rises gently from Coal Valley on the west and steeply from White River Valley on the east.

Elevations in the study area range between 4,700 and 8,589 ft (feet).

The Seaman Range is underlain by carbonate sedimentary rocks of Silurian through Mississippian age and by Tertiary volcanic rocks (see geologic time chart at end of report). The former occur throughout the northeastern part of the study area and the latter throughout the southwestern part. Surficial deposits are extensive in the southern part. Volcanic and sedimentary strata are locally offset along high-angle faults that are abundant in the area.

There are no mining districts nor any record of production from mineral deposits in the study area. The FNB claims in the northeastern part of the area (fig. 2) include a 30-ft-deep shaft and a 146-ft-long adit from which a small amount of rock was mined. In the southern part of the area iron-oxide-coated fractures along a normal fault in silicified ash-flow tuff were prospected. A relatively large tract along the east edge of the study area (fig. 2), which comprises the Louie and Leone claims (Great Basin Geology-Energy-Minerals Joint Venture, 1983), has also been prospected. The Lucky Strike (1-9) prospect (Garside, 1973) in the northwestern part of the area (not shown on fig. 2) includes iron-oxide-stained, silicified breccia that is radioactive; the uranium content of this material is low and does not indicate a uranium resource. The Red Head claims are in the northwestern part of the study area; a small quantity of mercury was mined from pits and trenches in the claims. There has been extensive prospecting by several mining companies since the late 1960's for low-grade, disseminated gold along the northwestern boundary of the study area.

The mineral resource potential for all metals in most of the Weepah Spring Wilderness Study Area is low. However, the mineral resource potential for low-grade disseminated gold deposits and associated mercury in the northwestern part of the study area is high. (In this report, the term "deposit," unmodified, does not

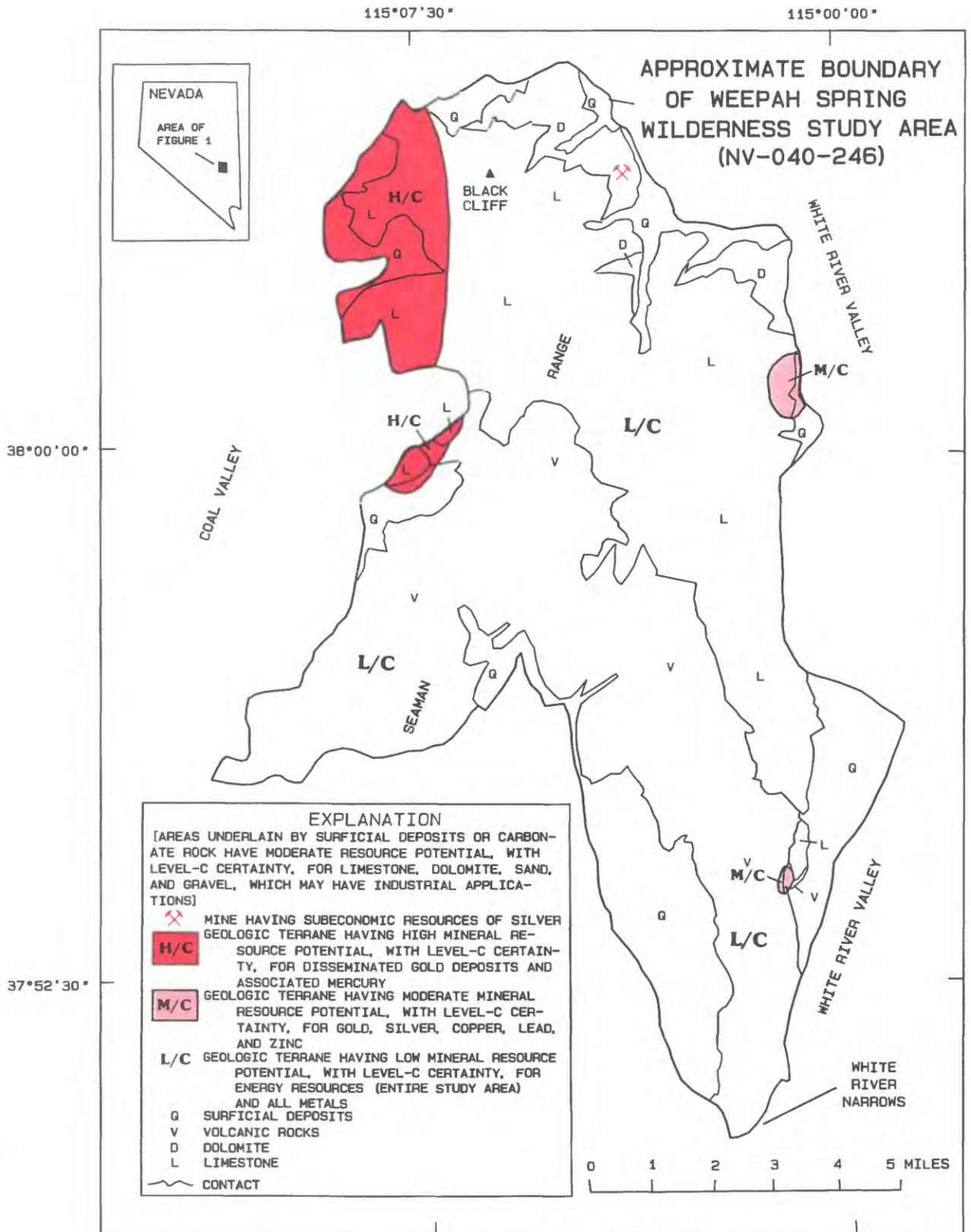
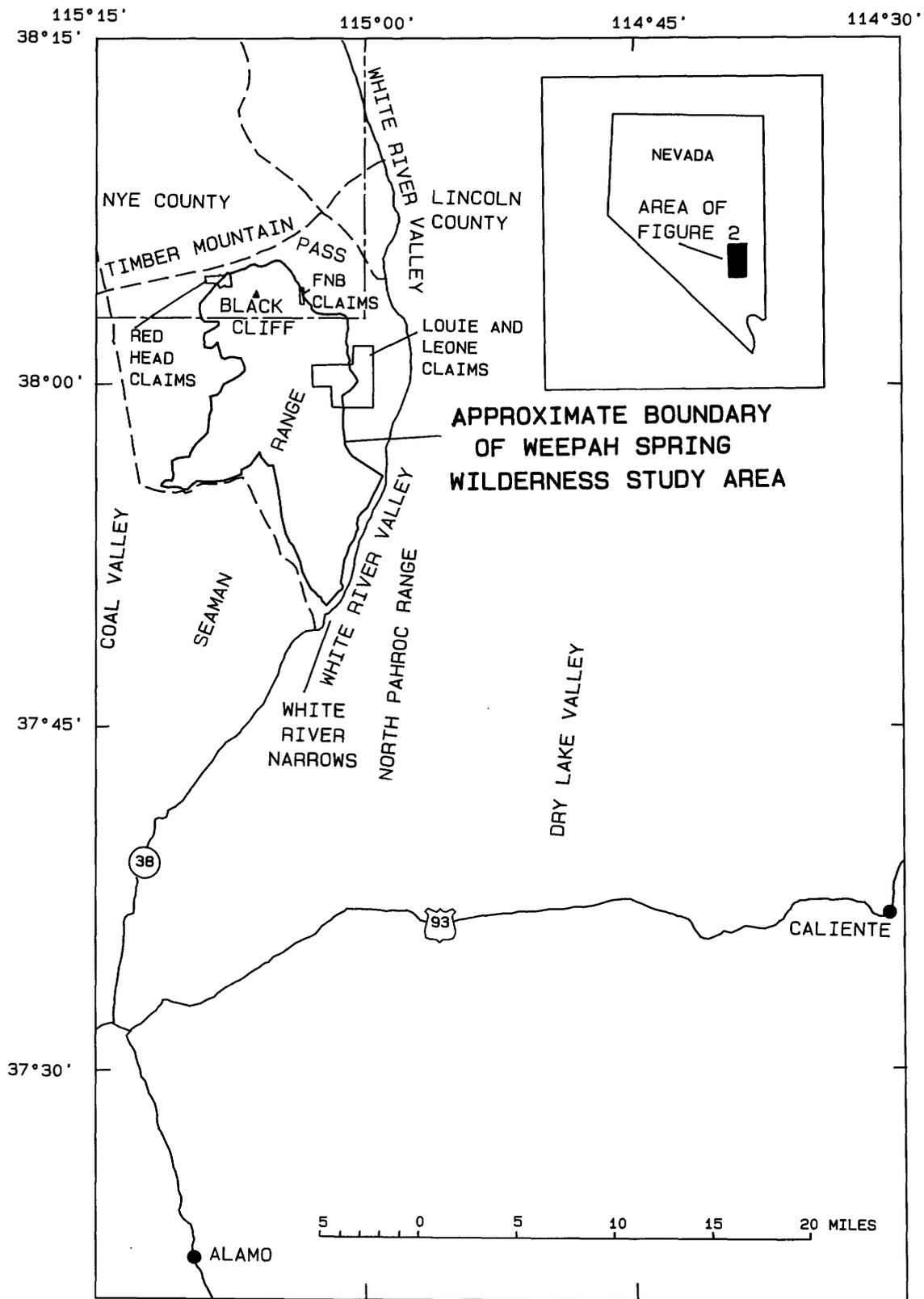


Figure 1. Map showing mineral resource potential and generalized geology of the Weepah Spring Wilderness Study Area, Nevada.



**Figure 2.** Index map showing the location of the Weepah Spring Wilderness Study Area, southern Nevada. Dashed lines are unpaved roads. Alternating long and short dashed line is county boundary.

carry a connotation of economic value.) The geologic environment there is comparable to that characteristic of the low-grade, disseminated gold deposits elsewhere in Nevada (Tooker, 1985). In addition, the geochemistry of rock in this area suggests that the processes responsible for the genesis of low-grade, disseminated gold deposits have been active. Two small areas in the eastern and southern parts of the study area have moderate mineral resource potential for gold, silver, copper, lead, and zinc in epithermal, fault-controlled veins.

Energy sources, including oil and gas, coal, and uranium, and geothermal-energy resources are unknown in the area, and the geologic environment is not favorable for their formation and accumulation. Their resource potential is therefore low.

The mineral resource potential for commodities with industrial applications, including nonmetallic minerals, sand and gravel, and carbonate rock, is moderate. Sand and gravel is present in abundance in alluvial fan deposits that form an apron around the Seaman Range. Limestone and dolomite form a major part of the Seaman Range.

## INTRODUCTION

The study area is located about 115 mi north of Las Vegas and 40 mi northwest of Caliente (fig. 2). The east side of the area is accessible from Nevada State Route 38; graded unpaved roads that lead northward or westward from Route 38 provide access to the rest of the study area. Travel in the study area is via a few rough jeep roads and on foot. The Seaman Range, which contains the study area in its northern, rugged part, is an arcuate, 30-mi-long by 7-mi-wide fault-block range that rises gently from Coal Valley on the west and steeply from White River Valley on the east. These playas, like others of the Basin and Range physiographic province, are covered by sage and other desert shrubs. The range itself is sparsely forested with pinyon pine and juniper trees. Elevations in the area range from about 4,700 ft in the valley bottoms to 8,589 ft at Black Cliff, the highpoint of the Seaman Range.

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the product of several separate studies by the USBM and the USGS. Identified resources are classified according to the system of the USBM and USGS (1980), which is shown on page IV of this report. Mineral resource potential is the likelihood of occurrence of undiscovered concentrations of metals and nonmetals, of unappraised industrial rocks and minerals, and of undiscovered energy sources (coal, oil, gas, oil shale, and geothermal sources). It is classified according to the system of Goudarzi (1984), which is shown on the inside front cover of this report.

## Investigations by the U.S. Bureau of Mines

USBM geologists made a literature search in which mining, mineral lease, and mining claim information were compiled. Files at the BLM State Office in Reno, Nev., were reviewed for patented and unpatented mining claim locations, and oil and gas and geothermal energy leases and lease applications. Lessees, mine owners, and persons having knowledge of mineral occurrences and mining activities in and near the study area were contacted. Field work by USBM personnel entailed examination of prospects and mines in and near the wilderness study area. Accessible mine workings were mapped, and mineralized areas and mine dumps were mapped and sampled. Detailed descriptions of analytic procedures and analytical results are presented by Gese and Harris (1985) and complete analytical results are available for public inspection at the Bureau of Mines, Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver, CO 80225.

## Investigations by the U.S. Geological Survey

Existing 1:250,000-scale geologic maps of Lincoln (Tschanz and Pampeyan, 1970; Ekren and others, 1977) and Nye (Kleinhampl and Ziony, 1985) Counties were examined and a photogeologic study of the area was made prior to field work by USGS personnel. Geologic mapping techniques appropriate to preparation of a 1:50,000-scale geologic map (pl. 1A) were used. Outcrops were examined for signs of mineralized rock. Samples of all rock units were collected for petrographic studies. Heavy-mineral concentrates were prepared from stream-sediment samples collected in drainages near the boundaries of the wilderness study area. Samples of mineralized or altered rock were collected for chemical analysis.

An aeromagnetic survey of the wilderness study area and vicinity was flown in January 1985, using a fixed-wing aircraft equipped with a cesium magnetometer. The aircraft maintained a nominal ground clearance of 1,000 ft; flight traverses were oriented east-west and spaced 0.5 mi apart. After correction for diurnal effects and tie-line discrepancies, the International Geomagnetic Reference Field was removed and the residual data were contoured. The resulting aeromagnetic map (pl. 1B) shows total-intensity contours at intervals of 20 nT (nanoteslas).

Gravity data for the wilderness study area were obtained from files of the Defense Mapping Agency (available through the National Geophysical and Solar-Terrestrial Data Center, Boulder, CO 80303) and from about 40 additional gravity stations established for the present study. Observed gravity data were reduced by standard procedures (see, for example, Cordell and others,

1982) and terrain corrections were applied out to a radius of 100 mi.

Aerial gamma-ray spectroscopy is a radiometric technique that provides an estimate of the near-surface (0–20 in. depth) concentrations of uranium, thorium, and potassium, and is used in exploration for uranium deposits. Individual measurements made in typical aerial surveys reflect the concentrations of these elements in an area of about 0.02 sq mi. Aeroradiometric data for the wilderness study area were obtained from traverses flown between 1975 and 1983 by contractors working for the U.S. Department of Energy as part of the National Uranium Resource Evaluation program, and were extracted from a 1:1,000,000-scale map of Nevada (Duval, 1983). The traverses are along east-west lines spaced 3 mi apart and have a nominal ground clearance of 400 ft.

The assessment of the mineral resource potential of the Weepah Spring Wilderness Study Area is based on data from the aforementioned studies and from many other sources. Among these other sources are the study of geology and mineral deposits of Lincoln (Tschanz and Pampeyan, 1970) and Nye (Kleinhampl and Ziony, 1985) Counties, Nev.; a reconnaissance study of mineral resources (Great Basin Geology-Energy-Minerals Joint Venture, 1983); geophysical studies of the Caliente sheet (Healey and others, 1981; Snyder, 1983); geochemical studies by the USBM (Gese and Harris, 1985) and the USGS (Day and others, 1986); a study of geology (du Bray and others, 1987); an evaluation of oil and gas potential (Sandberg, 1983); an interpretation of aeromagnetic and gravity data (H. R. Blank, this report); and an interpretation of radiometric data (J. S. Duval, USGS, written commun., 1985).

*Acknowledgments.*— We thank Bill Robinson in the Ely office of the BLM and Glen and Le Moine Davis, owners of the Red Head claims.

## APPRAISAL OF IDENTIFIED RESOURCES

**By Diann D. Gese and Albert D. Harris**  
**U.S. Bureau of Mines**

A small quantity of ore was mined from the FNB claims in the northeastern part of the Weepah Spring Wilderness Study Area, and a minor amount of mercury ore was mined from the Red Head claims in the northwestern part. A large area along the east boundary of the area, including the Louie and Leone claims, and a small area in the southern part have been prospected. Gold exploration programs have been conducted recently in the northwestern part and adjacent areas.

The FNB claims are 2.3 mi east of Black Cliff, just inside the northeastern border of the wilderness study area (fig. 2). Workings on the five inactive claims consist

of a 30-ft-deep shaft and a 146-ft-long adit. Both workings explored veins as much as 3.5 ft wide composed of brecciated jasperoid, limonite, hematite, copper carbonates, specular hematite, pyrite, and calcite in a silicified dolomite country rock. All 18 samples collected at the FNB claims contained silver; values ranged from 0.01 troy oz per ton to 10.9 troy oz per ton. Seven of the 18 samples contained from a trace to 0.094 troy oz gold per ton (Gese and Harris, 1985).

An adit on the FNB claims has an inferred sub-economic resource (see diagram p. IV) of 3,300 short tons with an average grade of 2.13 troy oz silver per ton (Gese and Harris, 1985). The small tonnage and low grade of the resource make it unlikely that the deposit would be developed at the 1984 silver price of \$8.25 per oz (U.S. Bureau of Mines, 1985, p. 141).

Mercury was detected in most samples collected from the western part of the study area by the USBM; however, the highest concentrations and the only known production were from the Red Head claims, held by the Davis family since 1939 (Great Basin Geology-Energy-Minerals Joint Venture, 1983). The Red Head block of 20 lode mining claims (about 1.5 mi northwest of Black Cliff, fig. 2) is partly inside the northwesternmost part of the wilderness study area. Hematite, limonite, goethite, cinnabar, realgar, orpiment, and calcite occur as coatings and veinlets in the fractured and brecciated Paleozoic limestone and shale. Cinnabar was the primary mercury ore mineral.

All samples taken on the Red Head claims contain mercury; mercury values range from 0.03 ppm (parts per million) to 119 ppm and average 7.4 ppm (Gese and Harris, 1985, table 2). Existing surface data are insufficient to allow a determination of whether the Red Head claims have an identified mercury resource.

The Lucky Strike (1–9) uranium prospect has been reported (King and Olsen, 1956; Garside 1973, p. 71) on the northwestern flank of the Seaman Range (several miles southwest of Black Cliff); an exact location for the prospect was not given. Eleven holes totaling 647 ft were drilled for the U.S. Atomic Energy Commission; select samples contain 0.016 to 0.055 percent  $U_3O_8$  (uranium oxide) (King and Olsen, 1956). Neither uranium nor thorium minerals were identified in the drill core samples; radioactivity was reportedly associated with iron-stained, silicified breccia (King and Olsen, 1956; Garside, 1973). USBM geologists were unable to relocate the occurrence because of poor prospect location information. A uranium resource is not known to exist in the wilderness study area.

Large quantities of carbonate rock and sand and gravel, which have potential industrial applications, occur in the wilderness study area. Most of the carbonate rock is suitable for use as road metal, and some beds of limestone may be sufficiently pure to be considered for general chemical usage. Sand and gravel, which can be used as

road metal, fill, or aggregate in concrete, occurs along the flanks and in drainages of the Seaman Range. However, all of these commodities have low unit value (dollars per ton) and require local markets to be economically viable. Demand for these resources from the wilderness study area is unlikely.

## ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

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### Geology

The study area is located within the Seaman Range, a 30-mi-long by 7-mi-wide range underlain by Paleozoic sedimentary rocks and Tertiary volcanic rocks. Carbonate rocks are exposed mostly in the northeastern part of the study area, whereas volcanic rocks crop out mainly in the southwestern part. The thick section of sedimentary rocks includes the Silurian Laketown Dolomite, Lower Devonian Sevy Dolomite, Middle Devonian Simonson Dolomite, Upper and Middle Devonian Guilmette Formation, Upper Devonian West Range Limestone, Lower Mississippian Joana Limestone, and Mississippian Chainman Shale.

Fifteen separate Tertiary volcanic rock types were mapped in the study area. Of these, nine are part of the areally extensive southwestern Utah-southern Nevada mid-Tertiary ignimbrite sequence that has been studied by many geologists, including Cook (1965), Williams (1967), Ekren and others (1977), and Best and Grant (in press). These intermediate to silicic ash-flow sheets are areally and volumetrically extensive and can be distinguished from one another. Several volcanic units, including two petrographically distinct types of basalt and a flow-banded dacite that forms a discrete flow-dome complex, have limited areal distributions within the area. The northernmost part of a small volcanic center of intermediate composition crops out in the southwest lobe of the study area. Individually mapped components of this center include a hypabyssal (shallow) core unit, a series of outflow ash-flow tuff and lava, and minor lahar (bouldery mudflow) outflow sheets.

Quaternary surficial deposits form an apron around the carbonate and volcanic rocks that form the core of the range. Thick alluvial fan deposits encircle the range. Alluvium is locally present in active stream channels. Colluvium is locally abundant and may represent abandoned terrace deposits.

The Seaman Range is a north-trending fault-block range typical of others in the Basin and Range physio-

graphic province. Numerous high-angle normal faults (probably related to extensional tectonism in the Basin and Range province) that cut the rocks in the study area cause local offsets within the layered rocks. Both the carbonate rocks and the volcanic rocks generally strike northwest and dip southwest. Local fluctuation of bedding-plane attitudes depicts minor folding in the carbonate rocks. Geologic and topographic relations suggest that there was considerable relief on the Tertiary surface immediately prior to the onset of Tertiary volcanism in this region.

### Geochemistry

A reconnaissance geochemical study of the Weepah Spring Wilderness Study Area was conducted in the spring of 1984. Sample media used in the geochemical study were the nonmagnetic fraction of heavy-mineral concentrates prepared from stream-sediment samples, and mineralized or altered rocks; sample sites are shown in Day and others (1986). Seventy-eight heavy-mineral concentrates were prepared and 18 rock samples were collected. Stream-sediment sample sites were along the mountain range front, high enough in the mountains to preclude sample dilution by valley fill, which may represent material from previous erosional cycles and may not necessarily be representative of the drainage basin sampled. The drainage basins that were sampled range in areal extent from approximately 0.5 to several square miles. In the larger basins, tributaries to main streams were sampled in order to limit the area of basin being sampled to about 1 sq mi.

Stream-sediment samples were collected from the active alluvium in stream channels. Each sample was composited from several localities in an area within 30 ft of the sample site. Samples were sieved through a 10-mesh (2 mm) screen to remove coarse material. The less-than-10-mesh fraction was panned using standard gold-panning techniques until most of the quartz, feldspar, organic material, and clay-size material had been removed.

After air drying, bromoform was used to remove the remaining low-density minerals from the heavy-mineral concentrates. The heavy-mineral concentrates were then separated into three fractions using an electromagnet. The most magnetic fraction, primarily magnetite, was not analyzed. The second fraction, largely ferromagnesian silicates and other iron-titanium oxides, was archived for later analysis as necessary. The least magnetic fraction, which includes the nonmagnetic ore minerals, zircon, sphene, and other accessory minerals, was split. One split was handground for spectrographic analysis; the other split was archived for mineralogical analysis. The abundances of 31 elements were determined using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). Details of analytical methods, de-

tection limits, and anomaly thresholds are discussed by Day and others (1986). Anomalous elemental abundances are defined as those that are unusually large relative to (1) the abundances observed in the remainder of the samples collected in the study area and (2) the regional geochemistry. Rock samples were crushed, pulverized to less than 0.006 in. (0.15 mm) using a grinder with ceramic plates, and analyzed for 31 elements by the emission spectrographic method and for arsenic, bismuth, antimony, and zinc using a modified analytical technique developed by Viets (1978).

Of the 78 stream-sediment samples that were collected and analyzed, only 15 had anomalous elemental abundances (Day and others, 1986). Anomalous barium abundances were found in 12 samples from the northwestern and southern parts of the wilderness study area; they correlate with areas of known mineralized rock. In the northwestern part of the area these anomalies are spatially associated with carbonate rock that has been altered to jasperoid. Anomalies located in two other parts of the study area are associated with either (1) weakly mineralized rock within the Louie and Leone claims or (2) weakly mineralized silicified ash-flow tuff from the prospect located about 0.5 mi northeast of White Blotch Spring. Samples from three other sites have anomalous abundances of other elements. One of these samples is spatially associated with mineralized rock in the FNB claims and is anomalous in silver and lead. Another is associated with mineralized rock within the Louie and Leone claims and is anomalous in zinc. The last sample is anomalous in lanthanum and molybdenum and is associated with Tertiary volcanic rocks, located about 2 mi northwest of White Blotch Spring, that are otherwise non-anomalous.

Rock samples with anomalous elemental abundances also are associated with areas of known mineralized rock. Eleven samples of altered and mineralized jasperoid from the northwestern part of the study area contain anomalous concentrations of arsenic, antimony, cadmium, zinc, and silver. A sample from the FNB claims contains anomalous abundances of arsenic, antimony, cadmium, and zinc. A sample of iron-oxide-coated fractures in silicified ash-flow tuff from the prospect located 0.5 mi northeast of White Blotch Spring contains anomalous abundances of arsenic, antimony, cadmium, and zinc. Three samples from the eastern part of the area, in the Louie and Leone claims, contain anomalous abundances of arsenic, antimony, cadmium, zinc, and silver.

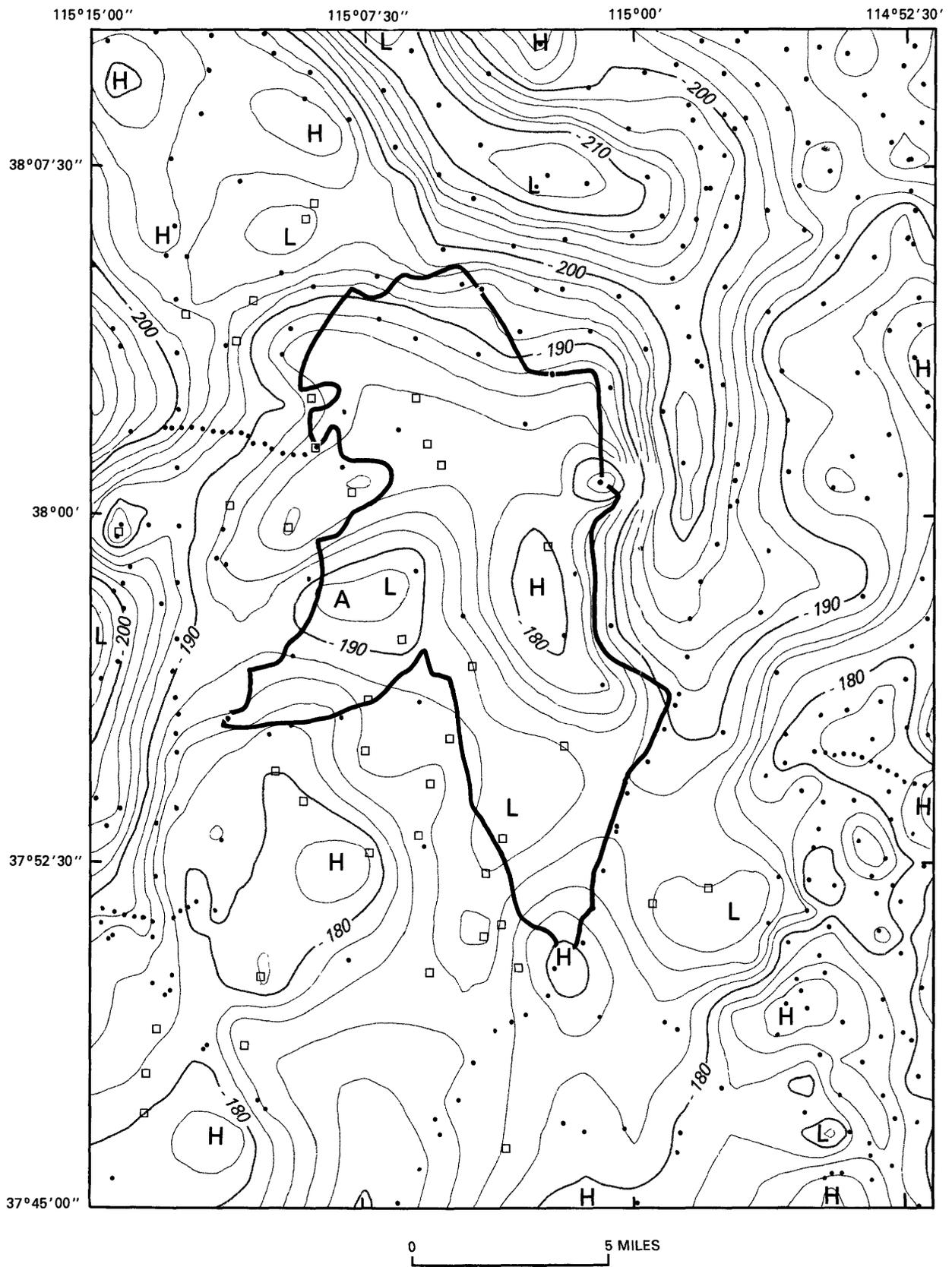
## Geophysics

Reconnaissance aeromagnetic, gravity, and aeroradiometric surveys of the Weepah Spring Wilderness Study Area do not reflect structural or lithologic features

that might identify terranes favorable for mineral resources.

Aeromagnetic data can be used to provide information about the subsurface, in particular to determine whether hypabyssal (shallow) intrusive rock is concealed beneath the Paleozoic carbonate rocks. There are no substantial aeromagnetic features in the northeastern part of the map area (pl. 1B), where exposures consist entirely of Paleozoic carbonate rocks. In contrast, there is a complex pattern of anomalies in the southwestern part of the study area, where volcanic rocks predominate. The sharp, very intense anomaly approximately in the center of the map area (anomaly A, pl. 1B) is produced by a normally polarized dacite plug; the topographic expression of the plug is mimicked by the shape of the aeromagnetic anomaly but its source seems to project to the east of the dacite exposures, beneath exposures of Mississippian Joana Limestone. A circular low (anomaly B, pl. 1B) 2 mi southwest of the dacite anomaly is associated with mapped Shingle Pass Tuff and is due either to a shallow plug or to a thick vitrophyre within the tuff; in either case, the source has no particular topographic expression, and seems to be reversely polarized. Weaker highs (anomalies C, D, and E, pl. 1B) south and west of the circular negative anomaly are associated with topographic promontories of the outflow tuff from the Seaman volcanic center. Finally, the complex of anomalies (anomaly F, pl. 1B) in the southeastern corner of the map area is the signature of basaltic lava, in part concealed beneath alluvial fan deposits.

A complete Bouguer gravity anomaly map (fig. 3) indicates that the study area is situated on a flattish, regional gravity high of moderate (10–15 mgal (milligals)) anomaly relief upon which anomaly levels are generally above –190 mgal. The high occupies most of the area shown on figure 3 and extends north-northwest of the study area as an anomaly ridge with levels between –190 and –200 mgal. In broad outline, the high reflects the distribution of Paleozoic carbonate rocks at the surface or in the shallow subsurface of the region. Steep gradients to the west and to the east-northeast of the study area lead to lows associated with surficial deposits in Coal Valley and the White River Valley, respectively; the White River Valley deposits produce an embayment in the regional high that ends at White River Narrows. A weak, trough-like low on the southwest margin of the study area corresponds to the magnetically active zone of volcanic rocks described above and is due to the average low density of the volcanic rocks, relative to the carbonate rocks. The axis of this low delineates a structural axis which is probably the locus of thickest accumulation of volcanic deposits from the Seaman volcanic center. The anomaly minimum (anomaly A, fig. 3) coincides with the dacite complex associated with the negative aeromagnetic anomaly.



**Figure 3.** Complete Bouguer gravity anomaly map of the Weepah Spring Wilderness Study Area and vicinity. Heavy line, approximate boundary of study area; contour interval, 2 milligals; reduction density, 2.67 grams per cubic centimeter; H, anomaly high; L, anomaly low; A, anomaly discussed in text; •, Defense Mapping Agency gravity station; □, gravity station, this study.

The Weepah Spring Wilderness Study Area has low radioactivity. Anomalous concentrations of the radioactive elements (uranium, thorium, and potassium) require that an element's concentration be high relative to threshold values established for the area studied. The aerial radiometric survey indicated values of 0–2.5 ppm uranium, 0–10 ppm thorium, and 0–2.0 percent potassium (J. S. Duval, written commun., 1985). None of these values exceeds the background levels established for this region.

## Characteristics of Ore Deposit Models

Several ore deposit models whose characteristics resemble those of the deposits in the wilderness study area have been identified.

A model for sediment-hosted, disseminated gold deposits has evolved from recent syntheses of information on these deposits. The disseminated gold deposits of Nevada, where the majority of known deposits of this type occur, were used to define the characteristics of the model (Tooker, 1985). The dominant host lithologies for these deposits are thin-bedded Paleozoic carbonaceous limestone, calcareous siltstone, and chert. Fine-grained ore occurs in banded coatings and fillings in fractures and open vugs, where it forms stratabound disseminations in permeable or chemically reactive beds that contain micro-faults, breccia, minor folds, shears, crossfaults, and breccia pipes. Indirect evidence indicates that an igneous heat source is involved in most cases; ore formation occurs at between 200 and 250 °C. Hydrothermal silicification, argillization (alteration of feldspars to clay minerals), brecciation, and jasperoid formation precede ore deposition. Deposits may range in size from a few to tens of square miles and may include older mines. Ore grades range from 0.1 to 0.25 troy oz gold per ton (3.4–8.6 grams gold per ton); deposits have produced between 0.5 and 3 million troy oz of gold. Ore minerals include native gold (generally not visible), native silver, cinnabar, stibnite, realgar, orpiment, and locally, base-metal (copper, lead, and zinc) sulfides; gangue minerals include barite, carbon, quartz, pyrite, fluorite, calcite, and hematite. Associated geochemical anomalies include gold, silver, mercury, arsenic, and antimony, and locally thallium, fluorine, and tungsten. Mercury deposits are associated with some disseminated gold deposits.

Epithermal (low-temperature) gold-silver base-metal (copper, lead, and zinc) vein deposits form in near-surface environments at low to moderate temperatures in the upper parts of geothermal systems (Berger, 1982). The deposits occur in all rock types, but the most important deposits are replacement and vein deposits in sedimentary sequences and vein, stockwork, and replacement deposits in volcanic rocks. Ore minerals include native gold and silver or gold-silver alloy (electrum); telluride minerals;

and sulfide minerals of arsenic, antimony, mercury, and base metals (copper, lead, and zinc). The abundances of copper, lead, zinc, arsenic, antimony, cadmium, silver, and gold can be anomalous in terranes containing epithermal deposits. Alteration and alteration zonation are the keys to understanding epithermal deposits. The degree of host-rock alteration and metal concentrations are strongly zoned both laterally and vertically along veins. Structures such as faults and folds can localize ore deposition.

## Characteristics of Known Deposits and Occurrences

The geologic attributes of the northwestern part of the study area and of the area immediately to the west are similar to those characteristic of disseminated gold deposits. Silicified carbonate rock (jasperoid) crops out extensively immediately northwest of the study area and to a lesser extent in its northwestern part. Jasperoid occurs along many faults that cut the Devonian West Range and Mississippian Joana Limestones. Both of these formations are similar to those that host disseminated gold deposits elsewhere in Nevada. The abundance of ignimbrites throughout southern Nevada, and the presence of two nearby volcanic centers (units Td, Tsc, and Tso, pl. 1A), suggest that necessary heat sources probably existed in the study area region. Gangue minerals associated with jasperoid, including barite, quartz, pyrite, calcite, and hematite, are also associated with disseminated gold deposits.

The geochemical signature in the jasperoid-containing area is also similar to that in areas containing disseminated gold deposits. Soil samples collected in the northwestern part of the study area in 1979 by Bear Creek Mining Co. defined several gold, arsenic, mercury, and antimony anomalies. In 1981, Bear Creek Mining Co. drilled several holes to shallow depths and confirmed the presence of gold, especially near the barite-bearing jasperoids (R. E. Wilcox, Jr., former exploration manager, Bear Creek Mining Co., Spokane, Wash., written commun. to A. D. Harris, 1984). The average arsenic, antimony, and mercury contents of 50 samples of jasperoid collected in and near the study area by USBM personnel are 200, 21, and 2 ppm, respectively (Gese and Harris, 1985), and mercury was mined from small deposits within the Red Head claims. One jasperoid sample contained 0.05 ppm gold. Similarly, Devonian West Range Limestone from this area contains anomalous concentrations of these same three elements (Hg, As, Sb).

The characteristics of the two small areas located in the eastern and southern parts of the study area (fig. 1 and pl. 1A) are similar to those of epithermal deposits. Sedimentary and volcanic host rocks in these three areas are cut by high-angle faults that could have served as

conduits for mineralizing fluids. The gangue minerals in these areas include quartz, calcite, copper carbonates, pyrite, and hematite. Host-rock alteration, including weak silicification, argillization, and oxidation, is common to all three areas. Each of these three areas is characterized by anomalous abundances of zinc, cadmium, arsenic, antimony, copper, and silver.

## Mineral and Energy Resource Potential

Geologic evidence suggests that there is high mineral resource potential, with level-C certainty, for undiscovered deposits of disseminated gold and associated mercury in the northwestern part of the study area (pl. 1A). Many of the features characteristic of terranes that contain disseminated gold deposits are present in the northwestern part of the wilderness study area, but additional surface and subsurface sampling is necessary to more conclusively determine the resource potential of this area.

There is moderate mineral resource potential, with level-C certainty, for gold-silver base-metal (copper, lead, and zinc) epithermal vein systems in two small areas in the study area (pl. 1A). Several of the attributes of epithermal systems are present in these areas. The weak geochemical and alteration signatures associated with these three areas preclude the existence of a well-developed, near-surface zone of mineralized rock. The lack of detailed information regarding these occurrences precludes a comprehensive evaluation of their mineral resource potential.

The mineral resource potential for all metals in the rest of the wilderness study area is low (pl. 1A). The geologic environment is unfavorable for metalliferous deposits; mineralized rock was not identified at the surface during field work; there were no anomalous values in the geochemical data; and geophysical data do not reflect favorable geologic environments. These findings suggest that the near-surface mineral resource potential for all metals in the rest of the wilderness study area is low, with level-C certainty.

The mineral resource potential for commodities with industrial applications is moderate, with level-C certainty. The geologic environment of the area surrounding the Seaman Range is favorable for the occurrence of sand and gravel deposits. The sedimentary carbonate rocks are favorable for the occurrence of limestone or dolomite with industrial applications, as noted in the "Appraisal of Identified Resources" section.

Energy-mineral occurrences, including oil and gas, coal, and uranium, are unknown in this region. Available information indicates that the geologic environment in the wilderness study area is not favorable for the occurrence of these commodities or of geothermal-energy sources. Accordingly, potential for energy sources in the study area

is considered low, with level-C certainty. Most of Coal Valley and White River Valley, including about 1,300 acres in the study area, is leased for oil and gas (location of leases indicated by Gese and Harris, 1985). In 1979, American Quasar Petroleum Co. drilled the Adobe Federal 19-1 well to 7,706 ft, 5 mi west of the wilderness study area (Nevada Bureau of Mines and Geology, 1982), and oil and gas shows were encountered. Tertiary volcanic rocks and the Mississippian Joana Limestone, both potential oil- and gas-bearing horizons in the Basin and Range province, were intersected in the test well (Great Basin Geology-Energy-Minerals Joint Venture, 1983, p. 25). Because Tertiary volcanic rocks and Paleozoic sedimentary rocks, which may be thermally mature, occur in the adjacent valleys, and because possible oil- and gas-bearing strata have been eroded throughout much of the Seaman Range, the study area was rated by Sandberg (1983) as having a low potential for oil and gas resources. Tschanz and Pampeyan's (1970) report does not mention any coal in Lincoln County. The radiometric survey did not detect significant, near-surface uranium deposits in the area (J. S. Duval, written commun., 1985). The ages of igneous rocks in Lincoln County (Ekren and others, 1977) and the absence of geothermal phenomena in this region indicate that the energy resource potential for geothermal resources in the study area is low, with level-C certainty.

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**GEOLOGIC TIME CHART**  
 Terms and boundary ages used by the U. S. Geological Survey, 1986

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

<sup>1</sup> Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

<sup>2</sup> Informal time term without specific rank.