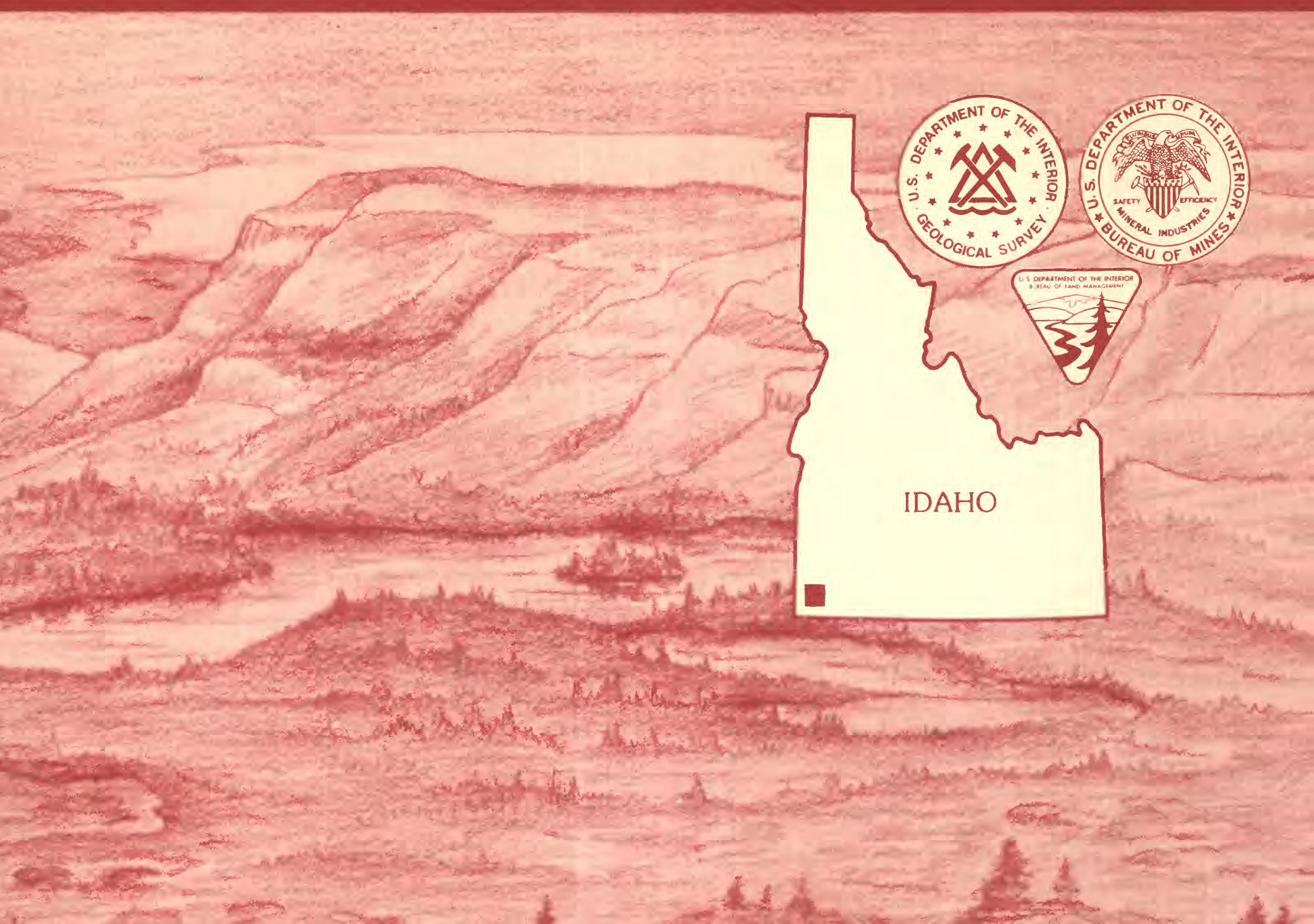
Mineral Resources of the Little Owyhee River Wilderness Study Area, Owyhee County, Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 1719–C



Chapter C

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MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
OWYHEE RIVER REGION, IDAHO AND NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study 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 of certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Little Owyhee River Wilderness Study Area (ID-016-48C), Owyhee County, Idaho.

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Mineral Resources of the Little Owyhee River Wilderness Study Area, Owyhee County, Idaho

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SUMMARY

Abstract

The Little Owyhee River Wilderness Study Area (ID-016-48C) encompasses 8,460 acres in the extreme southwest corner of Idaho along the canyon of the Little Owyhee River. Throughout this report, "wilderness study area" and "study area" refer to the 8,460 acres on which mineral surveys were completed. Fieldwork for this report was carried out between 1983 and 1985. No mines, prospects, or mining claims were located inside the study area, and no mineral resources were identified. The wilderness study area has a low mineral resource potential for silver, gold, and mercury. There is also a low mineral resource potential for the nonmetallic commodities diatomite and zeolites.

Character and Setting

The Little Owyhee River Wildernesss Study Area is located 8 mi northeast of the southwest corner of Idaho (fig. 1). The terrain consists of a flat to gently rolling plateau deeply incised by the spectacular canyon cut by the Little Owyhee River to depths of 800 ft. The surface of the plateau is defined by the thin flows of the Banbury Basalt of late Miocene age. Beneath surficial flows, additional basalt flows are interbedded with lacustrine sediments. The Banbury Basalt and lacustrine sediments overlie the Swisher Mountain Tuff, a rhyolitic ash-flow tuff of middle Miocene age. The Swisher Mountain Tuff is the oldest unit exposed in the study area. (See Ekren and others, 1981, 1984.)

Identified Resources

No known mines, prospects, or mining claims are located within the study area, but parts of the study area are included in petroleum and natural gas leases or lease applications. There are no identified mineral or energy resources within the study area.

Mineral Resource Potential

The Little Owyhee River Wilderness Study Area does not lie within any established mining district.

The northeastern part of the wilderness study area has low mineral resource potential for both epithermal silver-gold and epithermal mercury deposits. This is indicated by weak geochemical anomalies in rock samples from within the study area and the presence of small areas of altered rock and additional geochemical anomalies immediately outside the study area.

Some geochemical evidence of the presence of tin was gathered to the west of the study area, although the geologic environment is not favorable for a tin resource in that area. However, no geochemical evidence of tin was found within the study area and the wilderness study area is considered to have no mineral resource potential for tin.

The mineral resource potential for the nonmetallic commodities diatomite and zeolites is also considered low in the wilderness study area. Evidence of the occurrence of these minerals exists 1-1.5 mi outside the study area in sedimentary rocks, but little evidence of their existence within the study area was found.

INTRODUCTION

Area Description

The Little Owyhee River Wilderness Study Area (ID-016-48C) consists of 8,460 acres recommended suitable for wilderness consideration out of 24,677 acres originally considered. The study area is located 8 mi northeast of the southwestern corner of Idaho

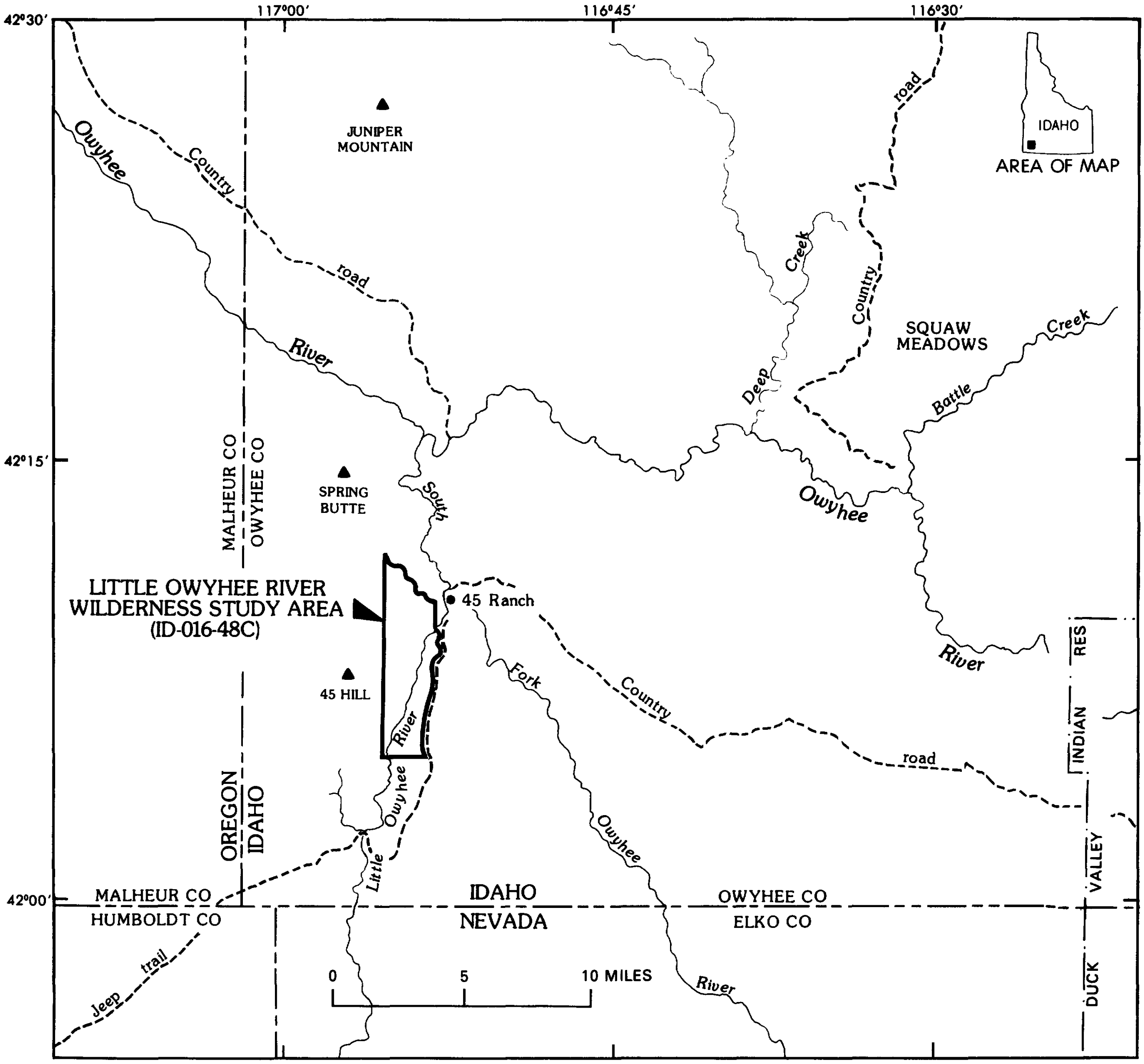

Figure 1. Index map showing location of the Little Owyhee River Wilderness Study Area, Owyhee County, Idaho.

(fig. 1) and includes a part of the Owyhee Plateau, a flat to gently rolling plateau with an average elevation of about 5,200 ft within the study area . The Owyhee Plateau is deeply incised by the spectacular and precipitous canyons of the various branches of the Owyhee River system. The part of the plateau included in this wilderness study area surrounds the canyon cut by the Little Owyhee River, immediately upstream of that river's junction with the South Fork of the Owyhee River. Within the wilderness study area, the canyon of the Little Owyhee River reaches depths of 800 ft below the surrounding countryside. The climate is arid to semiarid, with an average of less than ten inches of precipitation a year. The vegetation is sparse, consisting of sagebrush, various range grasses, and the odd juniper tree.

Access to the study area is by approximately 41 mi of graded dirt and gravel roads that lead west from Idaho State Highway 51 through the Duck Valley Indian Reservation to the 45 Ranch (fig. 1). From the ranch, the study area can be reached by the dirt road that bounds the area on the east.

Previous and Present Investigations

Geologic mapping and studies by Ekren and others (1981, 1984) provided the basis for the mapping for this study. Additional information on the general regional geology is contained in Walker and Repenning (1966), Kittleman and others (1967), Hope and Coats (1976), and Bonnichsen and Breckenridge (1982). Previous reconnaissance studies of the geology and the energy and mineral resources of wilderness study areas in the region were carried out by Mathews and Blackburn (1983a, b). The uranium resource potential for the region was evaluated as part of the National Uranium Resource Evaluation (NURE) program (Berry and others, 1982; Geodata, 1980).

The U.S. Geological Survey carried out field investigations in the study area during the summers of 1984 and 1985. The work included field checking of existing geologic maps, new mapping where necessary, and geochemical sampling. Rock samples were collected from areas of observed alteration and from each lithologic unit in order to obtain information about trace-element signatures associated with potentially mineralized areas and to provide trace-element background data.

The U.S. Bureau of Mines conducted a library search for information on mines and prospects within the study area. These data were supplemented by information from Owyhee County, U.S. Bureau of Land Management, and U.S. Bureau of Mines records. Field studies by U.S. Bureau of Mines personnel were carried out in 1984 (Buehler and Capstick, 1985). One hundred thirty-nine rock samples and 20 stream-sediment samples were collected from areas of possible mineralization within and immediately outside the study area. Samples were analyzed by fire-assay, atomic-absorption, and inductively coupled argon-plasma spectrophotometric methods. Selected rock samples of lacustrine and tuffaceous sediments were analyzed by X-ray diffraction for zeolites or examined microscopically and ignition-tested for diatomite. Complete analytical data are on file at the U.S. Bureau of Mines, Western Field Operations Center, Spokane, Washington 99202.

Acknowledgments

The staff of the Boise District Office of the U.S. Bureau of Land Management provided logistical support, information, and the use of the fine U.S. Bureau of Land Management camp at Mud Flat. Ben Glanville, owner of the 45 Ranch, and Sonny and Judy Smith, caretakers of the 45 Ranch, graciously provided information, access, and many courtesies.

APPRAISAL OF IDENTIFIED RESOURCES

By Alan R. Buehler and Donald O. Capstick, U.S. Bureau of Mines

History and Production

The Little Owyhee River Wilderness Study Area is not within a mining district and there are no mines or prospects within or near the area. Minor, unrecorded production of jasper, chalcedony, and common opal suitable for lapidary purposes or as specimens has occurred. The only known production near the wilderness study area is of several hundred pounds of this material produced from the Lu Lew prospect (P.M. Gabby, unpub. data), a rock collectors' locality located approximately 0.4 mi west of the 45 Ranch (fig. 2)(see table 1).

Mineral Deposits

No diatomite or zeolites were found in the wilderness study area. However, nearby areas show evidence of zeolitic alteration or diatomite deposition. These occur within the lacustrine sediments beneath and interbedded with the Banbury Basalt flows and the tuffaceous horizons lying beneath the flows. At one location 1 3/4 mi south-southwest of the southwest corner of the study area (locality A, fig. 2), a 100-ft-thick section of zeolitic ash beds averaged 42 percent clinoptilolite (a zeolite mineral) (Table 1). Development of the zeolite minerals here would be nearly impossible because of the 200-300 ft of sediment and basalt overburden at this locality. At another location 1.3 mi west of the northern end of the study area (locality B, fig. 2), an exposure of lacustrine sediments contains diatomite, although much of it is of unsuitable quality (Table 1).

Stream-sediment samples from the Little Owyhee River show only minor, very fine placer gold, typical of the Owyhee River region (highest value $\$0.03/yd^3$, average value $\$0.016/yd^3$; calculated with gold at $400.00/oz).

Sand and gravel deposits suitable for construction use occur in the wilderness study area, but larger, more accessible deposits are widely available outside the study area.

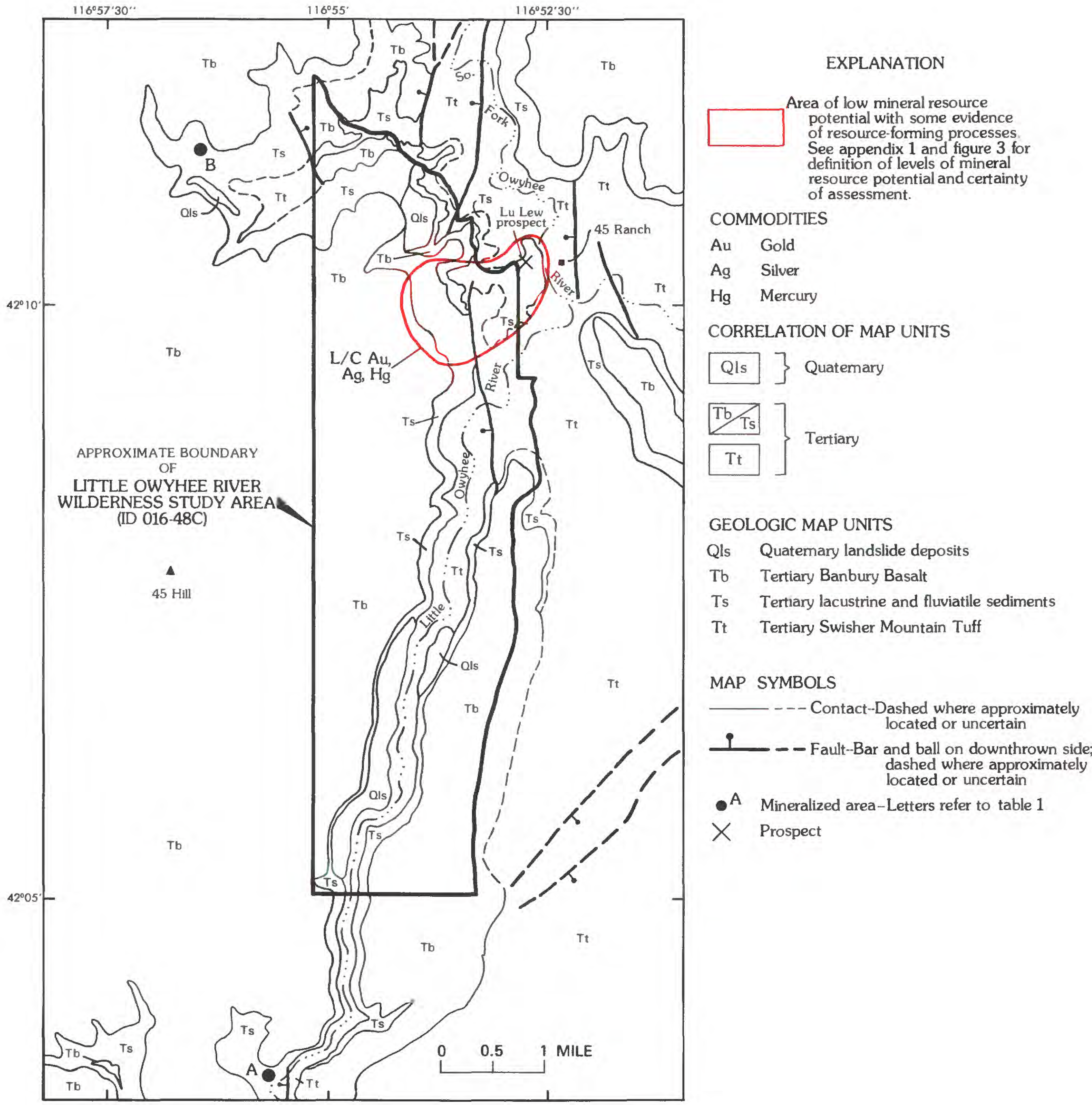

Figure 2. Map showing mineral resource potential and geology of the Little Owyhee River Wilderness Study Area, Owyhee County, Idaho.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Jay A. Ach and Harley D. King, U.S. Geological Survey

Geology

Pre-Miocene basement rocks are not exposed within or near the Little Owyhee River Wilderness Study Area, but may consist of Cretaceous granites overlain by mixed volcanic rocks of Eocene and Oligocene age. The oldest unit exposed in the study area is the middle Miocene Swisher Mountain Tuff. It is overlain by the late Miocene Banbury Basalt and associated interbedded sediments.

Cretaceous granitic plutons of the Idaho Batholith, which intrude metasedimentary rocks of pre-Cretaceous age, crop out on South Mountain and in the Owyhee Mountains, 35 mi north and 45 mi north-northeast, respectively, of the study area. These outcrops of basement rocks are the closest to the study area; however, similar basement rocks may extend beneath the area (Ekren and others, 1984). In the Owyhee Mountains, locally preserved Eocene intermediate lavas and quartz latite tuffs, and Oligocene olivine basalt and andesite of restricted extent overlie the Cretaceous granites. The regional extent of all of these lavas is conjectural, and they may or may not overlie basement rocks within the study area.

The oldest unit exposed in the wilderness study area is the middle Miocene Swisher Mountain Tuff (fig. 2), with reported potassium-argon ages of 14.2 ± 0.4 m.y. (Armstrong and others, 1980), and 13.1 ± 0.2 m.y. and 13.8 ± 0.4 m.y. (Neill, 1975). Ekren and others (1984) assumed an age of 13.85 m.y. The tuff is a flow-foliated compound cooling unit of rhyolitic ash-flow tuff of calc-alkalic (Ekren and others, 1984) or possibly peralkaline (J.J. Rytuba, oral comm., 1985) chemistry. The unit ranges in color from light grey to light purple- or pink-grey. Phenocrysts total approximately 15 percent and include plagioclase (62 percent of total), alkali feldspar (15 percent), pigeonite (20 percent), and opaque oxides (3 percent) (Ekren and others, 1984). An upper vitrophyre is well developed in the study area; additional vitrophyres within the unit are found at other locales. The maximum exposed thickness of the Swisher Mountain Tuff in the study area is about 650 ft, but the base is not exposed. Ekren and others (1984) consider Juniper Mountain, 12 mi to the north of the study area (fig. 1), to be the eruptive center for the Swisher Mountain Tuff, the second oldest of five tuffs erupted from this center over a time span of at least two million years. These eruptions did not produce a caldera or other eruption-related subsidence features.

Late Miocene basalt flows and interbedded sediments overlie the Swisher Mountain Tuff. The basalt was assigned to the Banbury Basalt by Ekren and others (1984), which gives potassium-argon ages of 8.0 to 10.5 m.y. (Armstrong and others, 1975). These numerous, thin flows (generally less than 50 ft thick) are olivine tholeiites (Ekren and others, 1984) and contain small quantities of small phenocrysts (less than 2 mm) of plagioclase and olivine in a very fine-grained matrix of intergranular to ophitic texture. Small vesicles, less than 4 mm in diameter, are common, some of which are partially filled with secondary silica or zeolites. At least some of these flows are of local derivation, and were erupted from 45 Hill and Spring Butte, inferred vents (figs. 1, 2).

The white-to-buff sediments beneath and interbedded with the basalt flows are of lacustrine and fluviatile origin. The part of the sediments beneath the basalts contains some beds of tuffaceous material. The sediments are generally composed of fairly well-bedded clay- to coarse sand-sized material, with lenses of gravel and rare cobbles occasionally found in the fluvial deposits. The combined thickness of the sediments and the Banbury Basalt varies from 300 to 600 ft within the study area.

Quaternary deposits consist of alluvium in the canyon bottoms, talus on canyon slopes, and fairly large landslide and slump deposits at some locations along the canyon sides.

Geochemical Studies

A reconnaissance geochemical study was made based on analysis and evaluation of stream sediments, the non-magnetic fraction of heavy-mineral concentrates from stream sediments, and rock samples. The stream-sediment and concentrate samples contain material derived from major rock units of the drainage basin. Sampled drainage basins range in area from less than one to several square miles.

All 39 stream-sediment samples, 24 heavy-mineral-concentrate samples, and 16 rock samples were analyzed for 31 elements by six-step semiquantitative emission-spectrographic methods (Myers and others, 1961; Grimes and Marranzino, 1968), with additional analyses by atomic-absorption spectroscopy and inductively coupled argon plasma-atomic emission spectroscopy (ICAP-AES). These analyses identify drainages with anomalously high concentrations of metallic and metal-related elements. Anomalous values were determined by inspection of histograms and noting enrichment relative to crustal abundances.

Stream-sediment samples and heavy-mineral-concentrate samples show no geochemical anomalies within the wilderness study area; however, heavy-mineral concentrates from some drainages of 45 Hill, 1.5 mi west of the wilderness study area, show anomalously high concentrations of tin (3 samples, 500 to 1,000 ppm). Microscopic examination of those concentrates revealed the presence of cassiterite, the primary tin ore. Tin mineralization is most commonly associated with granites, although epithermal vein deposits of cassiterite are mined from silicic volcanic rocks in Bolivia and Mexico. The veins there occur in rhyodacite-to-rhyolite stocks, plugs, and breccia pipes interpreted to represent volcanic vents (Hutchinson, 1983). There are no recorded instances of tin deposits associated with basalt, however, and the drainages near the wilderness study area that have anomalously high tin values are entirely underlain by basalt. The likelihood that these anomalies are related to a tin resource is therefore very remote.

Widely scattered tin anomalies in heavy-mineral concentrates are relatively common elsewhere in the Owyhee Plateau (H.D. King, unpub. data). Peralkaline rhyolites are commonly enriched in lithophile elements, including tin (MacDonald and Bailey, 1973). The Swisher Mountain Tuff and other peralkaline rhyolitic tuffs occurring in the region are probably the source of the tin detected regionally; however, the source of the tin detected in the 45 Hill drainages is unknown.

Rock samples within and immediately outside the wilderness study area just west of the 45 Ranch show weak-to-moderate geochemical anomalies for arsenic (As) (6 and 17 ppm), antimony (Sb) (12 and 17 ppm), molybdenum (Mo) (5, 7, and 15 ppm), and possibly mercury (Hg) (0.07 and 0.19 ppm) . These samples are all from the tuffaceous sediments overlying the Swisher Mountain Tuff. Two samples of sediments of the same unit from outside the study area (near the Lu Lew prospect and 0.2 mi south-southeast of the prospect area) are of locally brightly stained rock that has been very locally brecciated, silicified, and cut by thin goethite veins. These two samples produced the strongest geochemical anomalies, with one containing anomalous quantities of As, Sb, Mo, and Hg and the other containing anomalous As and Mo only. This rock occurs in only two small outcrops that seem to lie on the local north-northwest fault trend, suggesting that the alteration was fault-controlled. Such visibly altered rock is not found within the study area, although the three samples with slightly anomalously high values (Sb in one, Mo in another, and Hg in the third) indicate that some alteration or mineralization may have occurred. The locus of mineralization probably lies outside the wilderness study area in the visibly altered rocks to the east.

Anomalously high values for As, Sb, Mo, and Hg are often associated with epithermal mercury mineralization (Rytuba and Glanzman, 1979) or epithermal silver-gold mineralization of the low-sulfur type (Bonham, 1984; Bonham and Tingley, 1984), both of which occur within silicic volcanic or related host rocks. Important mineral deposits of these two different types are usually associated with the complex structures found in volcanic eruptive centers. These structures include strongly persistent fracture systems, especially caldera-related ring fractures and grabens, and volcanic domes and plugs in complexly faulted areas (Berger, 1982). Although minor faults of limited offset are present in the study area, such complex structures are absent, and the study area is several miles removed from Juniper Mountain, the postulated eruptive center for the Swisher Mountain Tuff. Even though the overall geologic environment of the study area is permissive for epithermal silver-gold and epithermal mercury deposits, it is not a highly favorable environment because of the study area's distance from the Juniper Mountain eruptive center and the corresponding absence of complex structures in the area.

Previous regional uranium surveys, which included aerial gamma-ray emission studies (Berry and others, 1982; Geodata, 1980), found no indications of uranium concentrations in the vicinity of the wilderness study area.

Conclusions

Geological and geochemical data indicate that the Little Owyhee River Wilderness Study Area has low resource potential for epithermal mercury deposits and epithermal silver-gold deposits with a C certainty level. The resource potential for zeolites and diatomite is also low with a C certainty level. The resource potential for petroleum and natural gas is unknown (certainty level A), but their occurrence within the study area is very unlikely. The resource potential for geothermal energy is low, with a C certainty level. See Appendix 1 and Figure 3 for definitions of levels of mineral resource potential and certainty.

The investigations by the U.S. Geological Survey and the U.S. Bureau of Mines indicate that there is low mineral resource potential for epithermal silver-gold and epithermal mercury in the area just west of the 45 Ranch (fig. 2). A certainty level of C is assigned because the area of strongest alteration, denoted by the strongest geochemical anomalies and most visibly altered outcrops, lies outside the study area. This alteration may be fault-controlled; if so, local fault trends indicate that the trend of the inferred fault and the alteration involved do not intersect the study area. Geologic mapping indicates that the tuffaceous lacustrine sediments, the host rock for the alteration, are very thin (0 to 100 ft) in the area around the visibly altered zone. Therefore, the alteration (and any associated mineralized zone) must necessarily be of very limited vertical extent, assuming the alteration is indeed confined to the sediments. The only possible indication of this type of mineralization within the study area is the presence of slightly anomalous geochemical values in rock samples collected from within the indicated area of low potential (fig. 2).

Although traces of zeolites and diatomite occur in the sediments associated with the Banbury Basalt in the wilderness study area, and somewhat higher-grade accumulations are found within two miles of the study area, the resource potential of these two minerals is probably poor. A low resource potential with a certainty level of C is assigned because no evidence of deposits of suitable purity was found within or near the study area. Additionally, the traces of these minerals observed within the study area do not seem to be of great thickness or large lateral extent. Development of any deposit of either of these minerals, if they existed, would be nearly impossible because of the 100 to 400 ft of basalt and sediment overburden that would need to be removed.

Sand and gravel deposits suitable for construction use occur in the wilderness study area. Because similar materials of equal or better quality are abundant closer to local markets, and the probable costs of mining exceed the present market value of these materials, their future development is highly unlikely.

Geologic data indicate a low probability for the occurrence of petroleum and natural gas in the Cenozoic rocks of the wilderness study area. Evidence for hydrocarbon potential is negligible; the volcanic rocks and lacustrine and fluviatile sedimentary strata immediately underlying the study area might include suitable reservoir rocks, but lack hydrocarbon source beds. The nature of the basement rocks is conjectural, however, and therefore the hydrocarbon resource potential is considered unknown, certainty level A.

Geothermal energy resource potential for the wilderness study area is low with a C certainty level. There is no evidence of geothermal activity in or near the study area. Previous regional geothermal surveys have not indicated any geothermal potential for the area (Muffler, 1979; Reed, 1983), but the absence of wells in the study area and surrounding region makes a survey of local groundwater temperatures impossible (see Bliss, 1983a, b, c). The existence of a geothermal resource is considered highly unlikely.

This assessment of mineral resource potential for the Little Owyhee River Wilderness Study Area was completed November, 1985.

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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 low would be misleading. The phrase "no mineral resource potential" applies only to a specific resource 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.

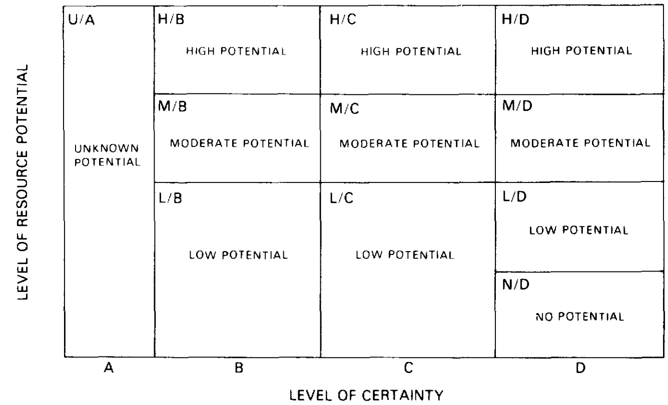

Figure 3. Major elements of mineral resource potential/certainty classification.

Table 1. Mines, prospects, and mineralized areas in and adjacent to the Little Owyhee River Wilderness Study Area

Map No. or name (fig. 2)	Location	Summary	Workings	Sample and resource data
Lu Lew prospect	SE1/4 sec. 26, T. 14 S., R. 5 W. and SW1/4 sec. 25, T. 14 S., R. 5 W.	Upper surface of Swisher Mountain Tuff, containing "thunder eggs" (fist-sized, spherical to oblong aggregations of chalcedony). Overlain by lacustrine sediments.	Several small, shallow pits and a 20-ft-long bulldozer scrape. Several hundred pounds of thunder eggs and jasper suitable for lapidary purposes or as specimens were probably produced over the past several years.	Thunder eggs occur on the uppermost surface of the Swisher Mountain Tuff, at the contact with overlying lacustrine sediments. Such thunder eggs occurrences are common throughout the study area and surrounding areas where the upper surface of the Swisher Mountain Tuff is exposed, indicating that the silicification involved was probably by meteoric rather than hydrothermal circulation. At the bulldozer scrape, however, small amounts of red-stained, altered rock is exposed. This rock contains anomalously high geochemical values for molybdenum (7 ppm) and arsenic (17 ppm). No gold, silver, or mercury was detected.
A	SE1/4 sec. 4, T. 16 S., R. 5 W.	One hundred ft of zeolitic ash beds and pebble conglomerate, overlain by 200-300 ft of lacustrine sediments and basalt.	None	Ten samples analyzed for zeolites gave an average of 42.2 percent clinoptilolite, with a range of 33 to 48 percent. All samples were analyzed for gold, silver, arsenic, antimony, and mercury; no anomalous amounts of these elements were found. Development of the zeolite would be nearly impossible due to the thick overburden.
B	SE1/4 sec. 20, T. 14 S., R. 5 W.	Lacustrine sediments containing diatomite and volcanic ash beds. Overlain by basalt.	None	Twenty-four chip samples representing 113.5 vertical ft of sediment from hand-dug trenches were collected. Twenty-three contained diatomite; of these, 20 were of unsuitable quality due to high non-diatom contamination, high crystal content, poor diatom structure,or dark color. One sample had desirable properties, and two others were slightly poorer. One sample was checked for zeolite content; none was detected.

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