Mineral Resources of the Oregon Buttes Wilderness Study Area, Sweetwater County, Wyoming

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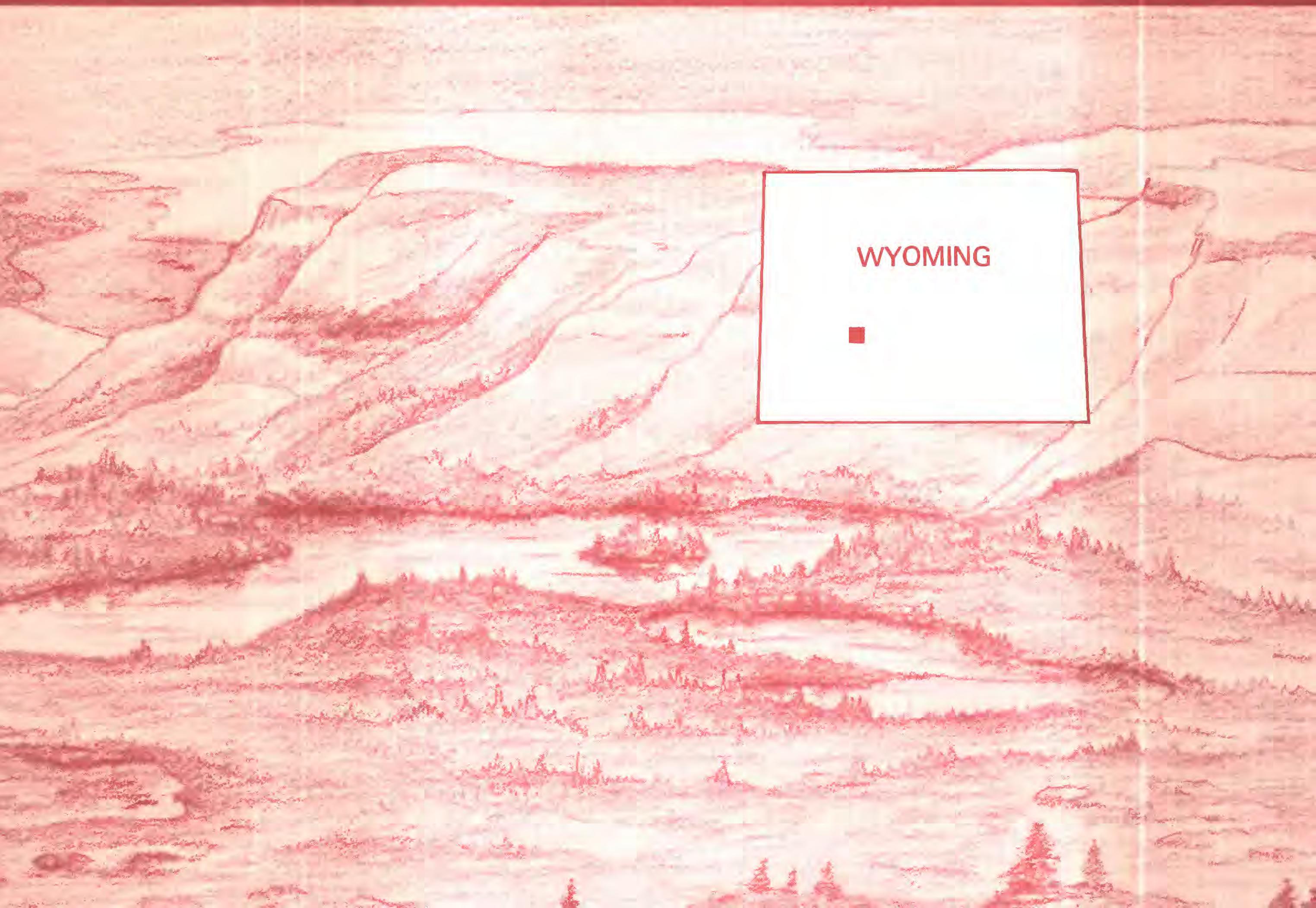

Chapter J

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U.S. GEOLOGICAL SURVEY BULLETIN 1757

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—SOUTHERN WYOMING

DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., 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 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 the Oregon Buttes (WY–040–324) Wilderness Study Area, Sweetwater County, Wyoming.

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Mineral Resources of the Oregon Buttes Wilderness Study Area, Sweetwater County, Wyoming

By Anthony B. Gibbons, Harlan N. Barton, *and* Dolores M. Kulik
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ABSTRACT

The Oregon Buttes Wilderness Study Area (WY–040–324) includes about 5,700 acres and is about 40 miles south of Lander, Wyo. The wilderness study area has minor occurrences of placer gold and possible deeply buried coal and a moderate resource potential for oil and gas. Energy resource potential is low for coal, oil shale, geothermal energy, and uranium. There is a low mineral resource potential for placer gold and all other metals, including uranium.

SUMMARY

Character and Setting

The Oregon Buttes Wilderness Study Area, 52 mi (miles) northeast of Rock Springs and 40 mi south of Lander, Wyo., is reached by graded roads from Wyoming State Highway 28 at South Pass (fig. 1) and comprises approximately 5,700 acres. In this report, the Oregon Buttes Wilderness Study Area will commonly be referred to as "the wilderness study area" or simply as "the study area."

Elevations range from 8,612 ft (feet) at the highest point of the Oregon Buttes (fig. 2) to 7,314 ft at the southeast corner of the study area. The wilderness study area lies on the Continental Divide south of the Wind River Range. The climate is dry, and streams are intermittent, flowing only during spring snowmelt and after summer rainstorms.

Tertiary-age sedimentary rocks (see geologic time chart in Appendix) are exposed in the Oregon Buttes Wilderness Study Area. The rock units are, from oldest to youngest, the Cathedral Bluffs Tongue of the Wasatch Formation (lower and middle Eocene), the Laney Member of the Green River Formation (middle Eocene), the Bridger Formation (middle Eocene), and the Arikaree Formation (lower Miocene).

The wilderness study area is underlain by as much as 26,000 ft of sedimentary rocks ranging in age from Eocene near the surface to perhaps as old as Cambrian at the base (table 1). These rocks are probably underlain by crystalline basement rocks of Precambrian age like those exposed in the Wind River Range to the northeast.

No faults or folds are present in the wilderness study area. However, the northern boundary of the study area lies near the boundary faults of the Wind River Range, being about 2 mi south of the Wind River thrust fault of Laramide age and about 3 mi south of the Continental fault of Tertiary and possibly Laramide age.

Identified Resources

The study area has no identified resources. Drill hole data indicate that coal of unknown quality and quantity is present beneath the wilderness study area, but it occurs at depths of 2,500 ft or more, making development unlikely.

Mineral Resource Potential

Investigations indicate a moderate resource potential for oil and gas because many reservoir and source rocks with known histories of production underlie the study area. Stratigraphic traps may exist in the subsurface of the study

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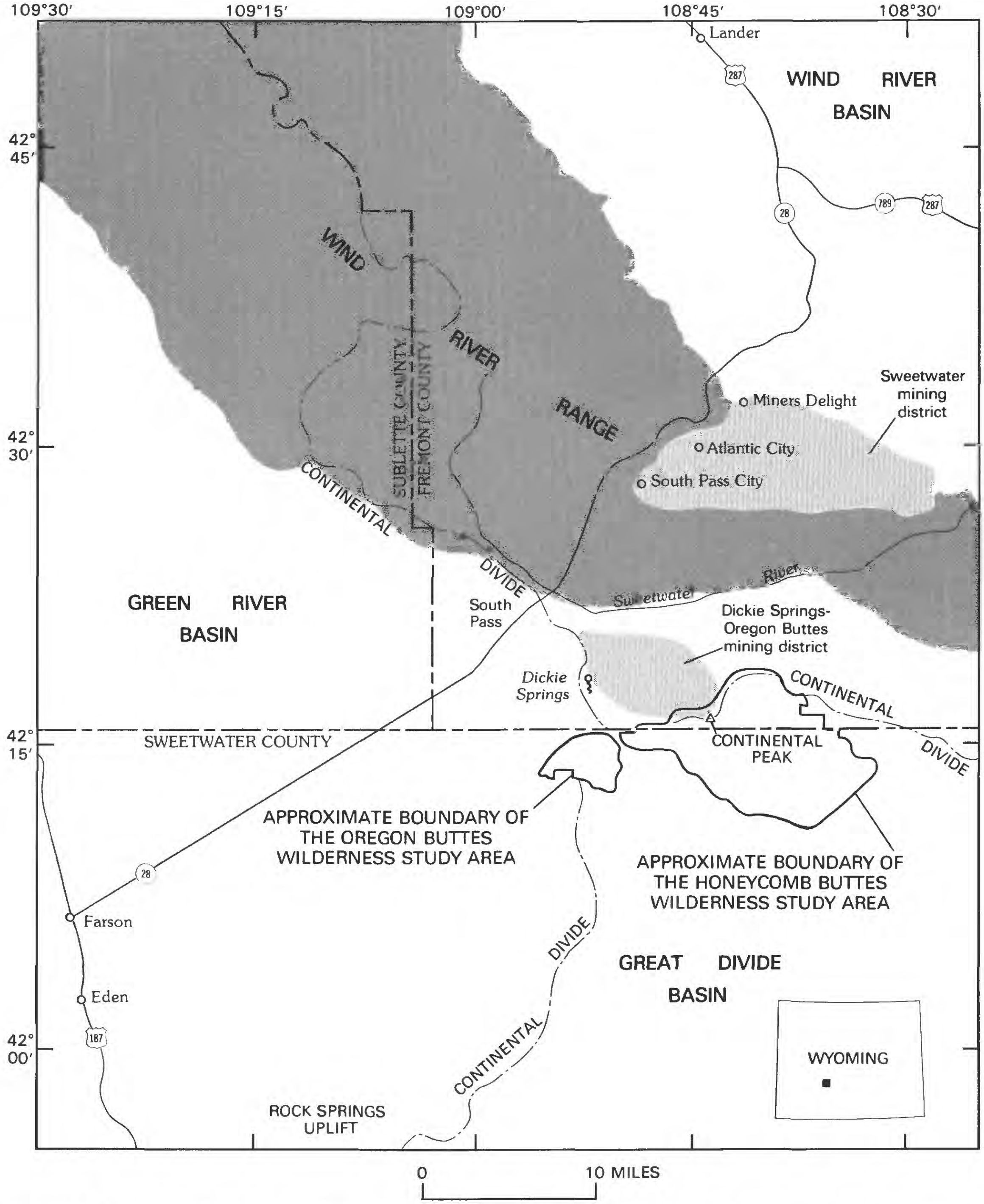


Figure 1. Location of the Oregon Buttes Wilderness Study Area. Modified from Patterson and others (1987).

area, but none of the dozen or more test wells drilled in the immediate vicinity have been productive.

Coal is likely to exist in the subsurface of the study area, but only two coal beds are indicated above a depth of 6,000 ft, the maximum depth at which a coal bed could constitute a resource. In view of the poor attributes of these coal beds, the energy resource potential for coal is low.

Several types of uranium deposits occur in the region 20–50 mi east of the study area in rocks similar in age and composition to those found in the study area. However, there are no indications in the study area that any such deposits might be present. The resource potential for uranium is low.

Two possible oil-shale-bearing units occur in the Green River Formation within the study area. However, oil shale that

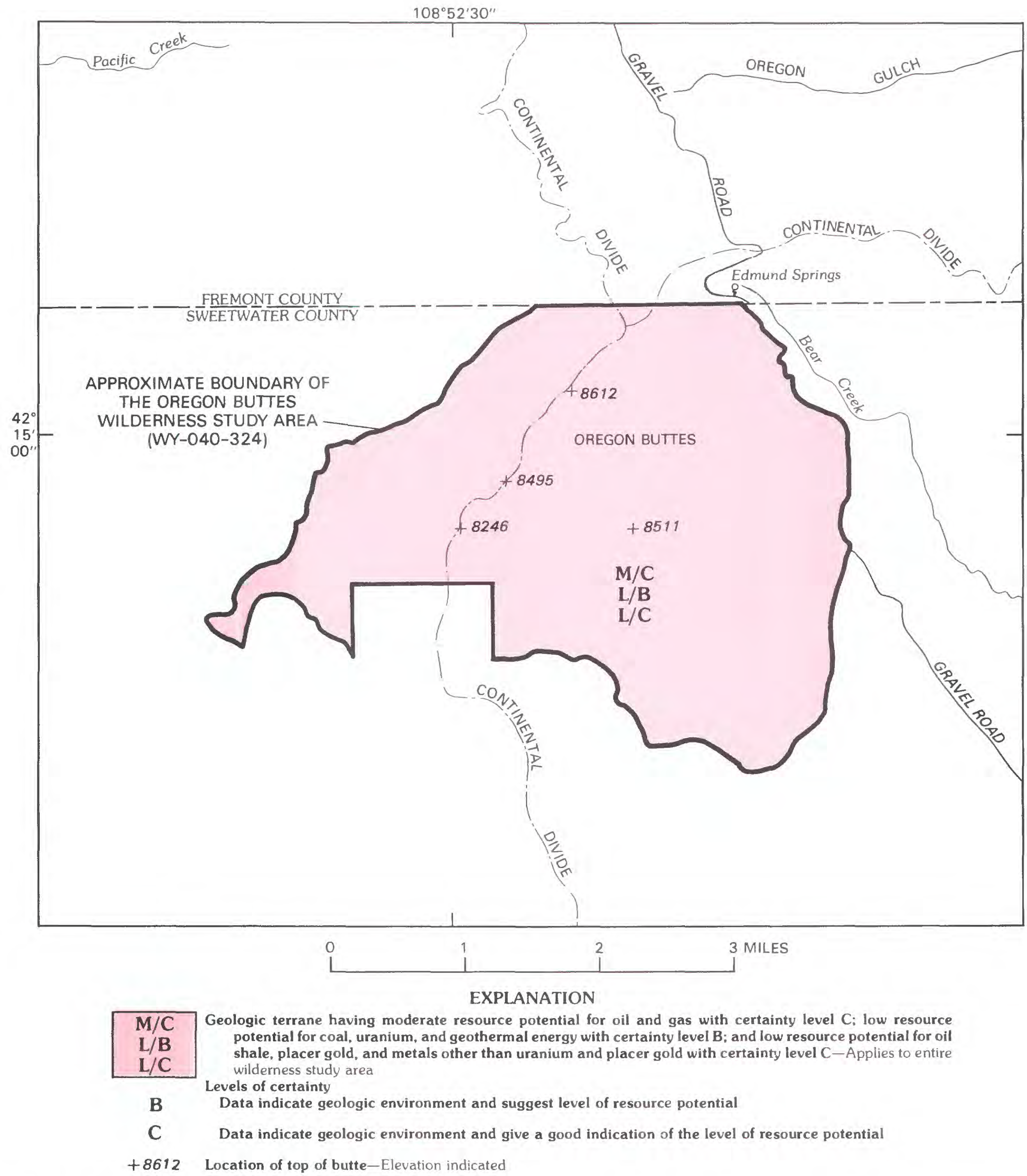


Figure 2. Mineral resource potential of the Oregon Buttes Wilderness Study Area, Sweetwater County, Wyoming.

was tested at two sites 10 mi east of the study area yielded values far below commercial grade. Because of the low grade, the scarcity of oil shale beds, and the distance from known areas of oil shale production, the potential for oil shale in the wilderness study area is rated as low.

The study area is without hot springs, and no other evidence of geothermal activity is present. The resource potential for geothermal energy is therefore low.

Placer gold is present in very low concentrations in the Arikaree Formation, which forms the cap rock of the Oregon

Table 1. Subsurface stratigraphy of the Oregon Buttes Wilderness Study Area

[Modified from Patterson and others, 1987. Thicknesses are approximate, estimated from well logs and from Love, 1970]

Age	Formation	Thickness (feet)
Tertiary	Tipton Shale Member of the Green River Formation	240
	Wasatch Formation (main body)	3,400
	Fort Union Formation	6,000
Cretaceous	Lance Formation	Included with Fort Union.
	Lewis Shale	1,900
	Mesaverde Group including Almond Formation, Ericson Sandstone, Rock Springs Formation, Blair Formation.	4,000
	Baxter Shale	2,000
	Frontier Formation	2,300
	Mowry Shale	450
	Thermopolis Shale	200
	Cloverly Formation	400
Jurassic	Morrison Formation	Included with Cloverly.
	Sundance Formation	250
	Gypsum Spring Formation	150
Jurassic(?) and Triassic(?).	Nugget Sandstone	525
Triassic	Chugwater Group including Popo Agie Formation, Crow Mountain Sandstone, Alcova Limestone, Red Peak Formation.	1,300
	Dinwoody Formation	100
Permian	Phosphoria Formation	325
Pennsylvanian	Tensleep Formation and Amsden Formation	700
Mississippian	Madison Limestone	500
Devonian	Darby Formation	20
Ordovician	Bighorn Dolomite	50
Cambrian	Undifferentiated, but probably includes Gallatin Formation, Gros Ventre Formation, Flathead Formation.	1,000
Precambrian	Basement complex composed of diverse crystalline rocks	Unknown.

Buttes, and in conglomeratic lobes in the Cathedral Bluffs Tongue of the Wasatch Formation along the south side of the Continental fault. The significant placers of the vicinity are in younger deposits derived from the conglomerate lobes in the Cathedral Bluffs Tongue. Gold was found in stream gravels on the east side of Bear Creek less than 1 mi east of the study area. Geochemical studies, however, provided no evidence of effective reconcentration of gold within the study area. The mineral resource potential for placer gold is rated as low.

Metals other than uranium and placer gold have not been found in the study area, and geochemical sampling did not discover any metallic anomalies. Accordingly, the mineral resource potential for metals other than uranium and placer gold is low.

INTRODUCTION

The Oregon Buttes Wilderness Study Area is in Sweetwater County, approximately 40 mi south of Lander in southwest-central Wyoming. Wyoming State Highway 28 passes north of the wilderness study area. Ten miles of graded gravel road connects the wilderness study area with the pavement of Highway 28; nonmaintained roads requiring four-wheel-drive vehicles in all seasons form the south, north, and west boundaries of the study area. The wilderness study area comprises about 5,700 acres and ranges in elevation from 7,314 ft at the southeast corner to 8,612 ft on the tallest of the Oregon Buttes. The study area straddles the Continental Divide and includes the point where the divide splits into two branches which continue to the south and southeast respectively, enclosing between them the Great Divide Basin, a region of interior drainage. This basin receives the drainage from the southeast part of the wilderness study area, whereas the western part of the study area drains to the Green River, in the Pacific drainage basin, and the extreme northeast part of the study area drains to the Sweetwater River, in the Atlantic drainage basin. The drainage network of the study area consists of small, unnamed, intermittent tributaries of various creeks.

The climate of the wilderness study area is semiarid cold desert. Average annual precipitation is 10 inches, more than half of it as snow. Mean maximum and minimum daily temperatures, respectively, are 80 and 45 °F for July and 25 and 0 °F for January. Vegetation consists exclusively of shrubs, forbs, and grasses over most of the study area, but the upper parts of the Oregon Buttes support stands of limber pine.

In 1984, acting at the request of the U.S. Bureau of Land Management (BLM), the U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) investigated the mineral resources of the Honeycomb Buttes Wilderness Study Area, which adjoins the Oregon Buttes Wilderness Study Area on the east (fig. 1). Their investigation reviewed and summarized available minerals information, appraised mineral resources and assessed the potential for undiscovered mineral resources. Results were reported by Patterson and others (1987) and by Scott (1985). The present investigation builds on the previous studies and extends them westward to include the Oregon Buttes Wilderness Study Area (fig. 1).

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the result of separate studies by the USBM and the USGS. Identified resources, studied by the USBM, are classified according to the system of the U.S. Bureau of Mines and the U.S. Geological Survey (1980), which is shown in the Appendix. Mineral resource potential, studied by the USGS, is the likelihood of occurrence of undiscovered concentrations of metals and nonmetals, of unappraised industrial rocks and minerals, and of undiscovered energy resources (coal, oil, gas, oil shale, and geothermal sources). It is classified according to the system of Goudarzi (1984), which is also shown in the Appendix.

Investigations by the U.S. Bureau of Mines

Bureau of Mines personnel reviewed literature concerning mining and geology of the region. In addition, BLM records were reviewed for mining claim information and oil and gas leases, which are shown on figure 3.

Two Bureau of Mines geologists spent 5 days during the spring of 1988 conducting a field examination in and within 1 mi of the study area. Nine samples were taken at two localities during the field investigation. The samples were analyzed by neutron activation for 34 elements, including gold, by Bondar-Clegg Company, Lakewood, Colo.

Investigations by the U.S. Geological Survey

Field investigations were carried out during the summer of 1988 by A.B. Gibbons, H.N. Barton, and D.M. Kulik. These investigations focused on oil, gas, and coal in the subsurface; uranium and (or) placer gold deposits in the Cathedral Bluffs Tongue of the Wasatch Formation and in the Arikaree Formation; possible oil shale in the Laney Member of the Green River Formation; and various construction materials such as clay, sand, and gravel.

Field work for the present study consisted of a geological reconnaissance and of rock and stream-sediment sampling. Office studies included analysis of well-log data to assess the favorability of subsurface rocks for oil and gas, coal, and uranium.

Acknowledgments.—We are grateful to Max Evans of U.S. Energy Corporation in Riverton, Wyo., for providing the Bureau of Mines with information on recent interest in gold mining near the wilderness study area.

APPRAISAL OF IDENTIFIED RESOURCES

By Michael E. Lane U.S. Bureau of Mines

Mining History

No prospects were found during the field investigation, and no mining claims are in the wilderness study area. One block of claims is adjacent to the northern boundary and another block is about 1 mi northeast. Recent interest in placer gold has focused on sites several miles north and northeast of the study area.

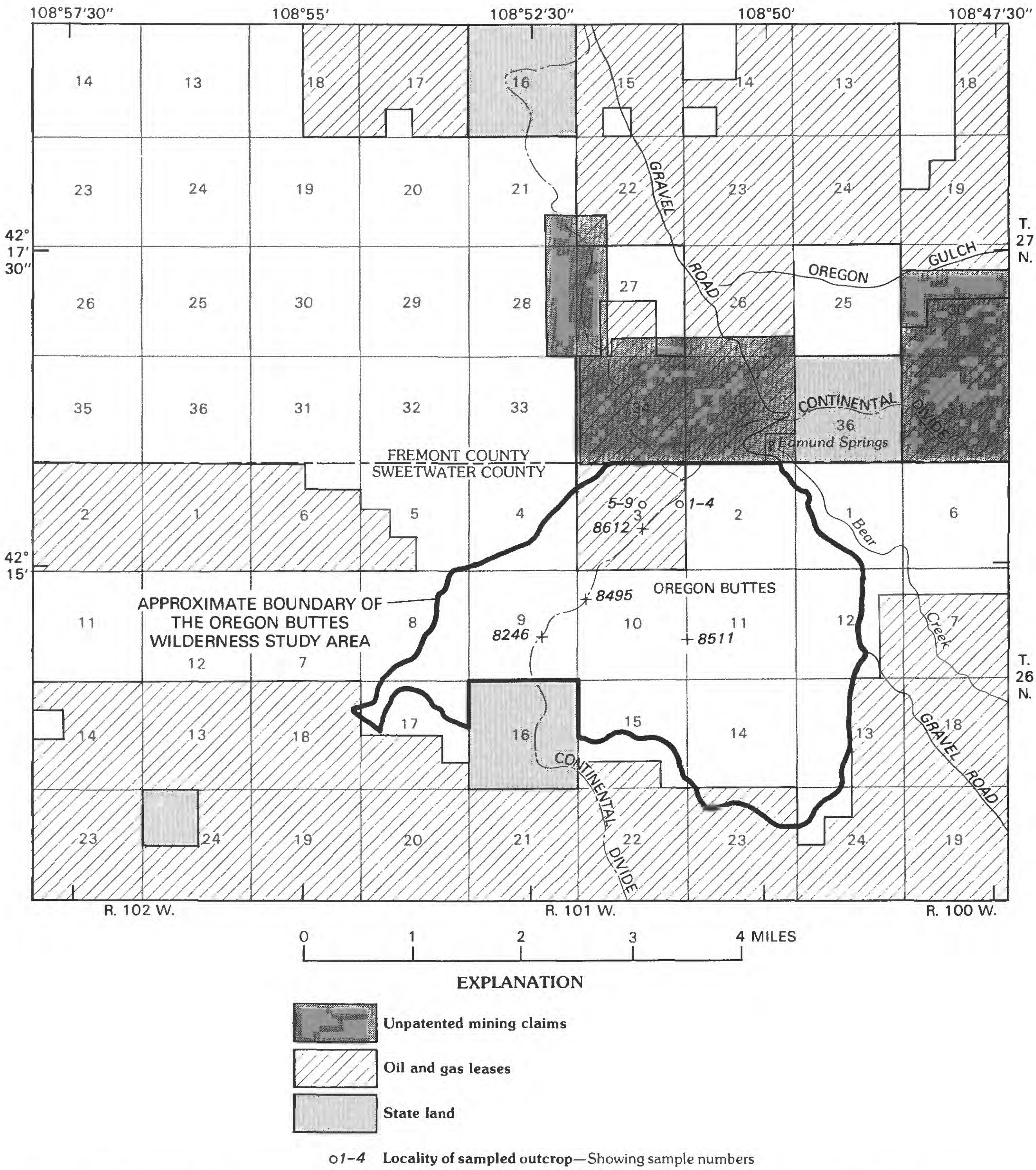


Figure 3. Mining claims, oil and gas leases, and sample localities in the Oregon Buttes Wilderness Study Area.

Old placer workings exist about 3.5 mi north of the study area at Dickie Springs, along the Oregon Trail, where gold was discovered in 1863 (Hausel, 1980). In addition, significant gold concentrations occur in gravels and boulder conglomerates of the Wasatch Formation and in recent alluvium deposited north of the Continental fault (Love and others, 1978). Zeller and Stephens (1969) state that the immediate source of gold in the placers could be the conglomerate of the Arikaree Formation north of the Continental fault. Gold-bearing

Table 2. Oil and gas wells in the vicinity of the Oregon Buttes Wilderness Study Area

Number (pl. 1)	Well name	Operator	Location	Depth (feet)	Unit	Results and date
1.	#1 Govt. McClintock--	British American Oil Co. -------	Sec. 30, T. 27 N., R. 100 W.	11,012	Lewis-------	Dry hole, Jan. 1960.
2.	#1 Dickie Springs------	Mountain Fuels, Inc.------------	Sec. 24, T. 27 N., R. 101 W.	12,282	Mesaverde	Dry hole, Oct. 1970.
3.	Sands of Time----------	Moncrief Oil --------------------	Sec. 16, T. 26 N., R. 100 W.	11,778	Ericson ----	Dry hole, May 1980.
4.	#1 Govt. Oregon Trail	Sinclair Oil Co. ------------------	Sec. 24, T. 27 N., R. 101 W.	1,857	Wasatch(?)	No data.
5.	#1 Skinner Federal----	West Coast Oil Co. -------------	Sec. 9, T. 27 N., R. 101 W.	9,700	Unknown--	Dry hole, 1977.
6.	Belfer 1 Govt.----------	Pan American Petroleum Corp.	Sec. 3, T. 25 N., R. 102 W.	5,220	Mesaverde	Dry hole.
7.	Musketeer Unit #1 ----	Davis Oil Co.--------------------	Sec. 8, T. 26 N., R. 101 W.	19,569	Unknown--	No data.
8.	#1 South Pass----------	Amoco Production Co.---------	Sec. 17, T. 27 N., R. 100 W.	22,690	Morrison --	Dry hole, Fall 1983.

veins mined about 20 mi northeast in the Atlantic City area (fig. 1) have been considered as a possible lode source of the placer gold. However, geochemical and trace-element studies of the placer gold indicate that much of it may have originated from hydrothermal veins other than those at Atlantic City (Love and others, 1978).

Mineral Resources

Nine samples were collected from outcrops of the Arikaree Formation in the wilderness study area to determine whether the conglomerate of Arikaree contains gold, as suggested by Zeller and Stephens (1969). Samples 1–4 make up a continuous sample of the basal conglomerate unit of the Arikaree Formation on the south side of butte 8,612 (pl. 1). Samples 5–9 are a continuous sample of the conglomerate unit on the north side of the butte. The conglomerate, approximately 50 ft thick at these localities, is poorly sorted and unconsolidated and contains fragments up to cobble size. Samples 1–3 contain minor gold: 11, 6, and 8 parts per billion, respectively. These analyses convert to 0.00032, 0.00018, and 0.00023 troy ounces per short ton, respectively. Gold content in other samples is below the detection limit of 5 parts per billion. These concentrations are too low to be considered a gold resource. All samples contain less than 5 parts per million silver. No other element concentration was considered anomalous. (See Lane, 1989.)

The few sand and gravel deposits in the wilderness study area are too small to be considered economic.

Energy Resources

Spencer (1983) assigned the study area a high potential for the occurrence of oil and gas. Oil and gas leases cover a small part of the study area (fig. 3). British American Oil Company drilled a dry 11,012-ft-deep hole about 2 mi northeast of the study area (drill hole 1, pl. 1; table 2). No uranium or geothermal occurrences were found in the wilderness study area. A coal-bearing sequence in the Fort Union Formation (Paleocene) that is approximately 1,200 ft thick and contains as much as 100 ft of coal underlies the study area (Zeller and Stephens, 1969, p. 32). The coal occurs at a depth of 2,500 ft or more, making development unlikely. Zeller and Stephens (1969) reported low-grade oil shale in the Laney Member of the Green River Formation near the study area; however, no oil shale was found during this investigation.

Conclusions

No mineral resources were identified in the Oregon Buttes Wilderness Study Area. Three of the nine samples taken in the study area show very low concentrations of gold. Oil and gas leases cover a small part of the study area, which was assigned a high potential for hydrocarbon accumulation by Spencer (1983), but no oil or gas has been discovered in or near the study area. No geothermal resources or uranium resources are known to exist in the study area. Coal-bearing rocks could exist at depths of 2,500 ft or more, but such deeply buried coal is not likely to developed.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Anthony B. Gibbons, Harlan N. Barton, and Dolores M. Kulik
U.S. Geological Survey

Geology

The stratigraphy and chronology of Zeller and Stephens (1969), supplemented by Love and others (1978) and Patterson and others (1987), are generally followed in presenting the geologic background of the wilderness study area. Other useful accounts of local and regional geology are by Nace (1939), Bradley (1964), Love (1970), Sullivan (1980), and Steidtman and Middleton (1986).

Geologic Setting

The Oregon Buttes Wilderness Study Area is within the border zone of the greater Green River Basin, the girdle of structural lowlands around the Rock Springs uplift. In the study area, fully 26,000 feet of sedimentary strata overlie the crystalline basement (table 1), even though granitic basement rocks are now exposed only a few miles to the north along the flanks of the Wind River Range (pl. 1). The Wind River Range and the Green River Basin both formed during the Laramide orogeny at the close of Cretaceous time, when overthrusting along the Wind River thrust fault brought the granitic rocks upward and southwestward, overriding the sedimentary strata. The thrust, with estimated lateral displacement of 70,000 ft and vertical displacement of 40,000 ft (Berg, 1983, Smithson and others, 1978), permanently changed local patterns of sedimentation. Lateral change in the Paleozoic and Mesozoic formations that pre-date the thrust is regional in scale. In the Tertiary sedimentary rocks that form the surface of the study area and extend nearly 10,000 ft into the subsurface (table 1) lateral change is basinal in scale and generally reflects the presence of a thrust-created upland to the north.

The newly developed Wind River upland may already have been an influence when the continental clastic deposits of the Fort Union Formation (Paleocene) were laid down. In the Fort Union, the number of coal beds and the total thickness of coal decrease northward across the study area, perhaps reflecting steeper stream gradients and a more abundant supply of inorganic clastic fill closer to the eroding upland.

The influence of the Wind River Range is more definite in the mostly fluviatile Wasatch Formation and the contemporaneous but dominantly lacustrine Green River Formation (lower and middle Eocene). The thick lacustrine deposits that characterize both the Tipton Shale Member and the Wilkins Peak Member of the Green River Formation in areas to the south wedge out within or just south of the wilderness study area. Moreover, the partial lateral equivalent of the Wilkins Peak, the Cathedral Bluffs Tongue of the Wasatch Formation, contains beds of granitic conglomerate, which thicken and coarsen northward from the study area toward their source in the Wind River Range.

Quiet subsidence along the south front of the Wind River Range during the later part of middle Eocene time is recorded by the lacustrine Laney Member of the Green River Formation and the conformably overlying lacustrine and fluviatile Bridger Formation. However, a conspicuous volcanogenic element is first evident in the Bridger and marks succeeding Tertiary formations. Erosion along the base of the Wind River Range during the Oligocene was followed by renewed uplift of the range in the early Miocene. These events are recorded by a strong unconformity at the top of the Bridger Formation and a conglomerate bed overlying the unconformity, at the base of the partly volcanogenic Arikaree Formation (Miocene). Still later uplift, beginning near the close of the Miocene and continuing into the Pliocene, resulted in deposition of the coarse, tuffaceous South Pass Formation along the south margin of the Wind River Range.

Some time after the mid-Pliocene, the Wind River Range subsided, relative to the basin area to the south, along the Continental fault (pl. 1). Downward movement of the north block of the fault, estimated at about 1,400 ft (Zeller and Stephens, 1969; Love and others, 1978), offset Tertiary units as young as the South Pass Formation. Since the fault movement ended, erosion has continued and surficial deposits of regionally familiar types have formed during the Quaternary.

Description of Rock Units

The descriptions in this section are modified from Zeller and Stephens (1969), except where noted.

Precambrian granitic and metamorphic rocks (unit p€gm*).*—The unit consists of pinkish-gray coarse-grained to pegmatitic granite and the dark-gray, slabby metagraywacke that the granite intrudes. It is considered to be of older Precambrian (Archean) age (Love and Christiansen, 1985).

Tipton Shale Member of the Green River Formation (unit Tgt*).*—This member is of early Eocene age. Where exposed in the southern part of the area of plate 1, it includes a lower unit about 60 ft thick consisting of fossiliferous limestone, fissile shale, and gray-green to blue-green mudstone and an upper unit about 240 ft thick consisting mostly of coarse, brown, arkosic sandstone that is capped by 5–10 ft of ledge-forming algal limestone. The northward extent of the Tipton in the subsurface is not known exactly, but the member is not considered to extend north of T. 26 N.

Cathedral Bluffs Tongue of the Wasatch Formation (unit Twc*).*—The Cathedral Bluffs is of early and middle Eocene age and consists predominantly of mudstones that are grayish green in the study area but elsewhere may be variegated in red and light yellowish gray. Interbedded with the mudstones are thin calcareous sandstones and conglomerates. Layers or lenses of uncemented boulder conglomerate are found near the Continental fault and bear small amounts of detrital gold. The Cathedral Bluffs is as much as 220 ft thick, although the base is not exposed in the study area. The unit weathers and erodes to form badlands.

Wilkins Peak Member of the Green River Formation (unit Tgw*).*—This member is of middle Eocene age and consists of greenish brown and grayish green claystone, oil shale, and marlstone. It is about 20 ft thick in outcrop in the southwest part of the area of plate 1 and forms a conspicuous white-weathering band. The Wilkins Peak pinches out to the south of the wilderness study area.

Laney Member of the Green River Formation (unit Tgl*).*—The member is of middle Eocene age and consists of brownish-weathering dark-gray paper shale and some thin to medium beds of siltstone, sandstone, limestone, and partly to fully silicified algal layers. Prominent benches are formed by a persistent limestone layer near the top of the member. The Laney is approximately 150 ft thick in the study area.

Bridger Formation (unit Tb*).*—The Bridger, of middle Eocene age consists of drab gray-brown to grayish-orange mudstone, siltstone, sandstone, and marlstone. The formation coarsens upward and contains abundant silicified algal beds, fossil wood, and some vertebrate remains. It is as much as 800 ft thick in the wilderness study area.

Arikaree Formation (unit Ta*).*—The Arikaree, of early Miocene age, is as much as 750 ft thick on Oregon Buttes and as much as 400 ft thick north of the Continental fault. On Oregon Buttes, the Arikaree consists of light-gray, calcareous, very fine grained tuffaceous sandstone and siltstone overlying a basal conglomerate 20–50 ft thick that is composed of material derived from local Precambrian rocks. About 20 feet of this conglomerate remain as cap rock on the summit of Continental Peak (fig. 1). North of the Continental fault the Arikaree is a medium- to coarse-grained calcareous sandstone that is fairly well consolidated (Patterson and others, 1987) and contains some conglomerate (Zeller and Stephens, 1969).

South Pass Formation (unit Tsp*).*—The formation, of late Miocene to middle Pliocene age, is a conglomeratic sequence of sandstone, limestone, and volcanic ash. Its maximum thickness is about 350 ft (Denson and others, 1965). The formation consists predominantly of pinkish-gray pebble to cobble conglomerate in a matrix of fine-grained tuffaceous sandstone. In the area of plate 1, it rests unconformably on Precambrian rocks and on the Arikaree Formation.

Pediment deposits (unit Qp*).*—Unit consists of gravel, sand, and silt of Pleistocene(?) age preserved along minor divides.

Alluvium (unit Qal*).*—Unit consists of (1) stream deposits of poorly sorted silt, sand, and gravel up to 5 ft thick, which cap low terraces in the western part of the study area, and may in part be of Pleistocene age, and (2) thin (½- to 3-ft-thick), poorly sorted deposits of clay, silt, sand, and gravel along modern stream courses.

Colluvium (unit Qc*).*—Unit consists of unstratified slope wash and talus of Holocene and perhaps Pleistocene age that are localized along the north side of the Continental fault.

Geochemistry

A reconnaissance geochemical survey was conducted in Oregon Buttes Wilderness Study Area during July 1988.

Sample Media and Collection

Minus-80-mesh stream sediments, heavy-mineral panned concentrates derived from stream sediments, and rocks were selected as sample media.

Stream-sediment samples represent a composite of the types of rock and soil exposed in the drainage basin upstream. Their analysis provides information that helps identify basins containing unusually high concentrations of elements that may be related to mineral occurrences.

Chemical analysis of heavy minerals concentrated from stream sediments provides information about the chemistry of certain high-density, resistant minerals eroded from the drainage basin upstream. The removal of most of the rock-forming silicates, clays, and organic material by panning permits the determination of some elements in the concentrate that are commonly not detectable in bulk stream sediments by the analytical methods available. Some of these elements can be constituents of minerals related to ore-forming processes.

Rock samples were collected to provide information on background metal concentrations in unaltered bedrock. No visibly altered and mineralized rock samples were found.

Bulk stream-sediment and heavy-mineral-concentrate samples were collected from active alluvium in 15 first- or second-order ephemeral streams, which have drainage basins ranging from 0.1 to 1.0 square miles. The drainage of the study area is radial, with streams originating at the Oregon Buttes. These streams were sampled upstream from their intersections with the jeep trails and improved roads that encircle the Oregon Buttes and generally form the study area boundary. Nonmagnetic heavy-mineral-concentrate samples of sufficient size for analysis (5 milligrams) were recovered from all 15 sites.

Approximately 20 pounds of sample was taken at each site, from pits and cross-channel trenches dug to a depth of 18 inches or to bedrock in locations favorable for the accumulation of heavy minerals. Samples were panned after collection, as no surface water was available at the sample sites. Panned concentrates were examined for visible gold and then saved for analysis of mineral content. The mineralogy of the nonmagnetic heavy-mineral fractions of panned concentrates was studied to assist in provenience determination, and the fractions were analyzed using the 31-element six-step direct-current-arc optical-emission semiquantitative spectrographic method of Grimes and Marranzino (1968).

Sample Analysis

All samples were analyzed using a semiquantitative emission spectrographic method for 37 elements. In addition, stream-sediment and rock samples were analyzed for arsenic, antimony, bismuth, cadmium, gold, uranium, thorium, and zinc by specific chemical and instrumental methods. Analytical data, sample sites, analysis method references, and a detailed description of the sampling and analytical techniques are given in Bullock and others (in press).

Results

Anomalous values, defined as being above the upper limit of normal background values, were determined for each commonly occurring element by inspection of the analytical data rather than by statistical techniques. However, because of the small number of samples (15 stream-sediment samples, 15 heavy-mineral concentrates, and 2 rock samples) collected, many elements had only a few measurable occurrences, and for some elements (Ag, As, Au, Bi, Cd, Mo, Sb, Sn, W, Th, U), any occurrence above the detection limit was considered anomalous. For these elements, anomalies were evaluated with reference to published crustal abundances of the elements (Rose and others, 1979).

Particular emphasis was placed on the analyses for gold and uranium because of minor known occurrences in the vicinity. Uranium has been mined from sandstones and conglomerates of the Wasatch Formation in the South Pass City area, approximately 20 mi to the north (fig. 1 and Shannon, 1979). Traces of placer gold have been reported in conglomerate of the lower part of the Arikaree Formation approximately 4 mi north at Dickie Springs (fig. 1 and Zeller and Stephens, 1969) and in the Cathedral Bluffs Tongue of the Wasatch Formation approximately 11 mi east-northeast of the study area (Patterson and others, 1987).

Two sample sites, both in the Cathedral Bluffs Tongue of the Wasatch Formation, had measurable uranium and thorium and thus were anomalous for these elements. Values obtained only slightly exceed published crustal abundances (Rose and others, 1979).

Site OB002 is in sec. 12, T. 26 N., R. 101 W. (See fig. 3.) The stream-sediment sample contained 44 parts per million (ppm) thorium and 4.67 ppm uranium. Associated slightly elevated values are 7 ppm As in the stream sediment and 1,500 ppm La, 70 ppm Pb, and 300 ppm Th in the heavy-mineral concentrate.

Site OB103 is in sec. 24, T. 26 N., R. 101 W. (See fig. 3.) The stream-sediment sample contained 116 ppm Th and 11 ppm U. Associated slightly elevated values in the stream sediment were 10 percent Fe, 1 percent Ti, 5,000 ppm Ba, 500 ppm Cr, 200 ppm La, 1,000 ppm Mn, 15 ppm Sc, 200 ppm V, 70 ppm Y, 1000 ppm Zr, and 0.9 ppm Cd. Associated slightly elevated values in the heavy-mineral concentrate were 200 ppm Sn and 7,000 ppm Sr.

These slightly anomalous values for the above two sites are not believed to be indicative of mineralization.

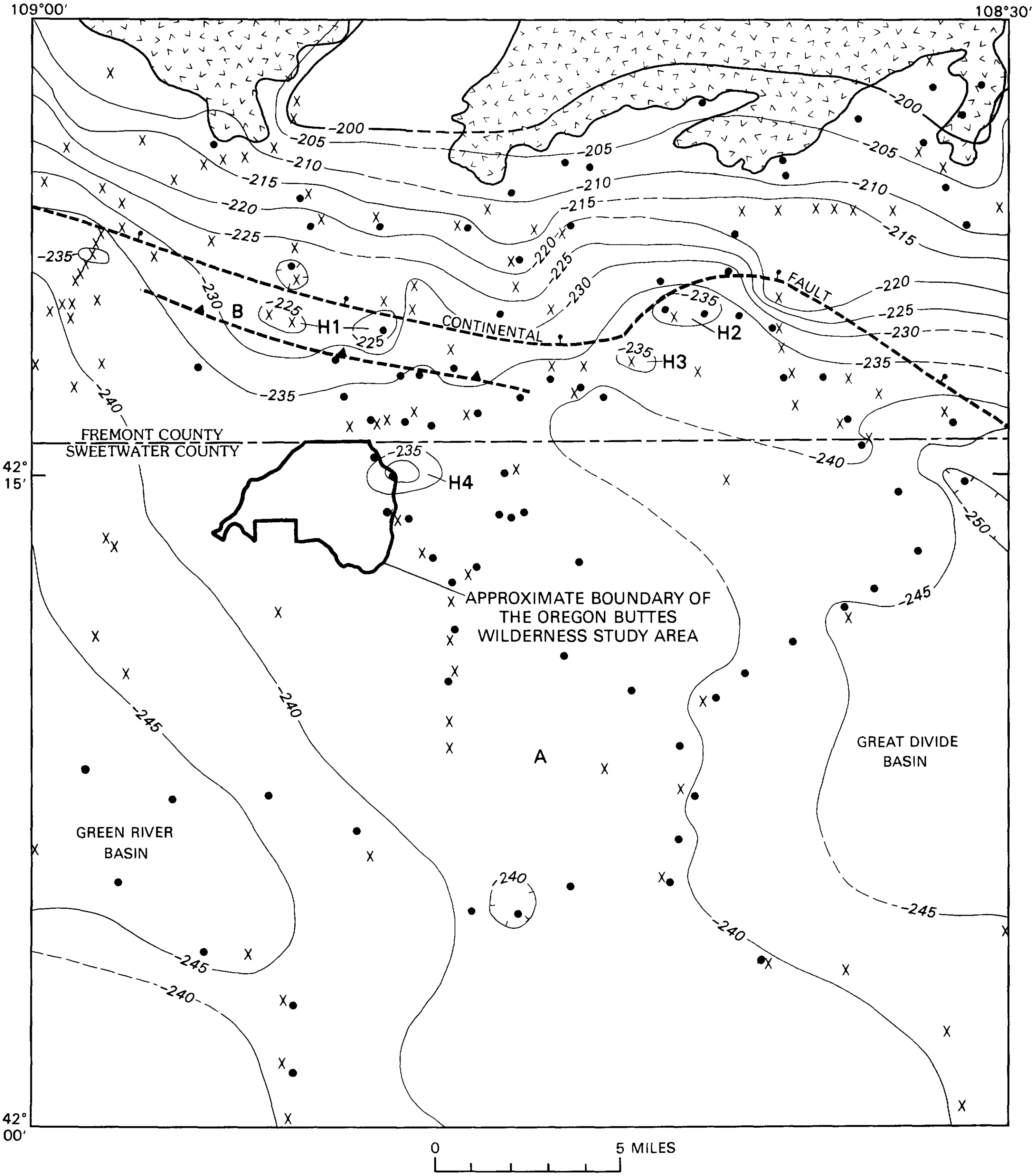
Gold was not detected in the analysis of any of the sample types, although the detection limit was 0.05 ppm.

Geophysics

Gravity studies were undertaken to provide information on the subsurface distribution of rock masses and the structural framework in and near the study area. The data are of a reconnaissance nature and are generally adequate only to define regional structural features.

The gravity data were obtained adjacent to the study area in 1984 and 1987 for evaluation of the Honeycomb Buttes (Patterson and others, 1987) and Sweetwater Canyon (Day and others, 1988) Wilderness Study Areas, and were supplemented by data maintained in the files of the Defense Mapping Agency of the Department of Defense. At stations established for this study, measurements were made using Worden gravimeter W-177. The data were tied to the International Gravity Standardization Net 1971 (U.S. Defense Mapping Agency Aerospace Center, 1974) at base station ACIC 0322–1 at Sweetwater Station, Wyo. (about 40 mi northeast of the study area). Station elevations were obtained from benchmarks, spot elevations, and estimates from topographic maps at 1:24,000 scale, and are accurate to ±20 ft. The error in the Bouguer (gravity) anomaly is less than 1.5 milligals for errors in elevation control. Bouguer anomaly values were computed using the 1967 gravity formula (International Association of Geodesy, 1967) and a reduction density of 2.67 grams per cubic centimeter. Mathematical formulas are given in Cordell and others (1982). Terrain corrections were made by computer for a distance of 104 mi from the station using the method of Plouff (1977). The data are shown in figure 4 as a complete Bouguer anomaly map with a contour interval of 5 milligals.

A relatively high plateau in the Bouguer gravity values (A, fig. 4) southeast of the study area defines a



EXPLANATION

Trace of continental fault—Bar and ball on downthrown side

Subsurface trace of Wind River thrust fault in Oregon Buttes area—Sawteeth on upper plate

Precambrian rock outcrop

● Gravity station location measured for wilderness study

X Gravity station measured by U.S. Defense Mapping Agency

A Gravity anomaly referred to in text

—-200— Gravity contour—Contour interval 5 milligals. Hachures show closed areas of low values

Figure 4. Complete Bouguer gravity and generalized structure of the Oregon Buttes Wilderness Study Area and vicinity.

north-northwest-trending structural high that may be cored by basement rocks; it connects the Rock Springs uplift and the Wind River Range, which lie south and north, respectively, of the area shown on figure 4, and separates the Green River and Great Divide Basins.

A gravity gradient is associated with the mapped Continental fault. Directly north of the study area, the area spanned by this gradient broadens so that relatively high gravity values extend southwestward beyond the Continental fault (B, fig. 4). These high values suggest that a wedge of Precambrian crystalline rocks in the upper plate of the Wind River thrust fault extends south of the Continental fault in this area.

The local gravity highs shown as H1 and H2 on figure 4 are associated with surface deposits of conglomerate derived from Precambrian rocks. The presence of gravity highs H3 and H4 (fig. 4) suggests that similar bodies of conglomerate may occur at shallow depth, although no outcrops were mapped at these locations. H4 occurs at the northeastern boundary of the wilderness study area.

Available magnetic data (Geodata International, 1980) were reviewed for this study. The study area lies entirely within a regional low anomaly whose source is in the basement. No flight lines cross the study area, and the data are insufficient to evaluate factors relating to its mineral resource potential.

Mineral and Energy Resource Potential

Oil and Gas

The potential for oil and gas resources in the Oregon Buttes Wilderness Study area has been rated as moderate to high by Spencer and Powers (1983) in their assessment of the wilderness study areas of Wyoming. This rating was based primarily on the presence of four factors required for hydrocarbon accumulation: source rocks, reservoir rocks, appropriate thermal history, and trapping mechanisms. The first three of these factors are indisputably present in the vicinity of the wilderness study area; the presence of the fourth is questionable.

Source rocks for oil and gas are common at depths below 6,500 ft in the Cretaceous and lower Tertiary formations of southwestern Wyoming (table 1); these include the Thermopolis and Mowry Shales below the Baxter Shale (Burtner and Warner, 1984) and interbedded coal sequences for gas in the uppermost Cretaceous and lower Tertiary section (Law, 1984). Moreover, the pre-Cretaceous section includes the Madison Limestone (Mississippian) and the Phosphoria Formation (Permian), both known source rocks in other areas.

Reservoir rocks occur in many of the subsurface units shown in table 1. In the general region of the study area, oil and (or) gas have been produced from the Nugget Sandstone, the Morrison and Cloverly Formations, the Thermopolis Shale, the Frontier Formation, and the Mesaverde Group (table 1).

A regional study by Merewether and others (1987) of the thermal maturity of the subsurface rocks indicates that rocks beneath the wilderness study area are capable of generating oil or gas between 6,000 ft and 16,000 ft, and gas only below that depth. The deepest rocks may be thermally overmature for oil at this time but may in the past have generated oil, which has since migrated upward.

The presence of effective traps in the vicinity of the study area is not established. Trapping mechanisms suggested include sandstone stratigraphic traps in front of and beneath the Wind River thrust fault (Spencer and Powers, 1983).

Because overall geologic conditions are appropriate for the generation and accumulation of hydrocarbons, numerous wells have been drilled near the wilderness study area to test structural and stratigraphic traps along the front of the Wind River Range. The eight wells in the area of plate 1 are plotted there, and data for them are presented in table 2. None were producers. A few nearby tests had shows of gas or oil but were capped due to insufficient volume of flow (Patterson and others, 1987). Although exploration to date has not been exhaustive in that it has largely neglected deeper targets in the Paleozoic and lower Mesozoic, the lack of success of the large number of wells in the area is not consistent with a rating of high potential. Accordingly, the resource potential for oil and gas is judged as moderate at a certainty level of C.

Coal

In discussing the presence of coal in a large report area encompassing the present Oregon Buttes Wilderness Study Area, Zeller and Stephens (1969, p. 32) state:

> * * * the part of the area south of the Wind River thrust fault is underlain by a coal-bearing sequence approximately 1,200 feet thick that has an aggregate thickness of as much as 100 feet of coal and contains several coal beds more than 15 feet thick. This coal sequence is buried beneath 2,300–5,000 feet of younger rocks.

In the same place, these authors also state and present evidence that within this coal sequence both the number of coal beds and the total thickness of coal decrease northward. As shown on their figure 9, the sequence decreases from full development in T. 25 N., south of the Oregon Buttes Wilderness Study Area, to a single coal bed or merely a few streaks of coal in T. 27 N., north of the study area.

Geophysical logs of Davis Oil Co. Musketeer Unit #1 (pl. 1, drill hole 7), in T. 26 N. near the west boundary of the wilderness study area, reflect the northward decrease in coal recognized by Zeller and Stephens (1969). Only two thin coals, one at 5,478–5,482 ft and the other at 5,536–5,539 ft, are indicated above a depth of 6,000 ft, the maximum depth at which a coal bed could constitute a resource (Wood and others, 1983). In view of the poor attributes of these coal beds and the uncertainty as to their extent within the wilderness study area, the energy resource potential for coal is rated as low with certainty level B.

Uranium

Several types of uranium deposits occur in the region 20 to 50 mi east of the wilderness study area in rocks similar in age to those found in the wilderness study area. As recognized by Patterson and others (1987), these include roll-type deposits in sandstone, tabular deposits in sandstone, evaporitic deposits of schroeckingerite, and uraniferous coals. Inasmuch as the study area is a well-drained upland lacking evaporation basins and underlain only by very deeply buried coal beds, neither schroeckingerite nor uraniferous coal is likely to be present.

The two types of sandstone uranium deposits, roll-front and tabular, that are found in areas to the east occur within and at the boundaries of coarse-grained, arkosic sandstones of the Battle Spring Formation, a time-equivalent of parts of the Green River and Wasatch Formations. The Battle Spring Formation was deposited as alluvial-fan material derived from the uplift of the Granite Mountains along the Emigrant Trail thrust fault (Love, 1970). Possible sources for the uranium in the Battle Spring include the granitic rocks of the Granite Mountains (Stuckless and Nkomo, 1978) or uranium-rich tuffaceous strata that once covered the area (Love, 1970; Harshman, 1972).

The conglomeratic facies of the Cathedral Bluffs Tongue of the Wasatch Formation localized along the Continental fault is in many respects an analogue of the Battle Spring Formation. As such, this facies could possibly host sandstone uranium deposits of either the roll-front type or the tabular type.

A roll-front uranium deposit characteristically consists of a curvilinear zone of rich ore in sandstone that may extend laterally several hundred yards to several miles. The roll front is thought to record an interface between two solutions: a migrating oxidizing solution, which carries the dissolved uranium, and a reducing solution that represents the original pore solution of the host rock. The oxidizing solutions alter the sediments as they migrate through them, bleaching the gray or gray-green reduced rocks to white and rusty colors. At the reduction interface, where oxidizing solutions meet reducing solutions, the uranium is chemically reduced and precipitated. Carbonaceous material is thought to play an important role as a reductant in the precipitation of uranium minerals (Rackley, 1972). The Battle Spring Formation is rich in such material.

Tabular uranium deposits (Wayland and Sayala, 1983) are oxidation-reduction phenomena similar to roll-type deposits except that the ore is lower grade and more disseminated in the host sandstone. Generally the sandstone is encased in impermeable reducing rock, commonly carbonaceous mudstone.

Investigations by Patterson and others (1987, p. 15–16) of sandstone bodies within the Cathedral Bluffs Tongue of the Wasatch Formation showed some low radioactivity but no visible uranium minerals and also showed a lack of carbonaceous material. The sandstone bodies represent paleostream channels within the Cathedral Bluffs Tongue and make up only 5 to 15 percent of each section measured. Sandstones were mainly reduced facies, indicating no passage of oxidizing fluids.

The main body of the Wasatch Formation in the subsurface (table 1) is indicated by geophysical logs of wells drilled in the vicinity to be unlike the coarse, uraniferous Battle Spring Formation. It is mostly fine grained and is lacking in unusually radioactive zones.

Patterson and others (1987, p. 16) judged that the resource potential for a uranium deposit was low in most of the Honeycomb Buttes Wilderness Study Area. They rated the potential for a uranium deposit, of the tabular type, as moderate rather than low only in a limited area adjacent to the Continental fault, where a spring produced water that was slightly anomalous in uranium.

As the distance between the Oregon Buttes Wilderness Study Area and the Continental fault is nowhere less than about 3 mi (pl. 1), no part of the study area is especially favored for uranium occurrences. Accordingly, its potential for uranium is low, with a certainty level of B.

Oil Shale

Two possible oil-shale-bearing units occur in the Green River Formation within the wilderness study area. Exposed at the surface is the Laney Member, averaging 150 ft thick. The Tipton Shale Member may underlie the wilderness study area, but is nowhere exposed at the surface. If it is present, the Tipton would be near the northern limit of its deposition, and would be expected to consist mostly of sandstone with very little oil shale or other lacustrine facies. (See Zeller and Stephens, 1969.)

The richest deposits of oil shale in Wyoming are in the Green River Formation in the southeast part of the Green River Basin (Culbertson and Pitman, 1973). West, north, and south of this part of the basin, the oil shale becomes lower grade and contains more coarse detritus.

Prior to 1980, beds considered of commercial grade yielded more than 30 gpt (gallons of oil per ton of rock), in beds more than 30 ft thick, less than 1,500 ft below the surface (Culbertson, 1972).

Oil shales in the Laney Member of the Green River Formation at two sites about 10 mi east of the study area were tested by the USGS and the USBM (Zeller and Stephens, 1969). The average value of contained oil was 2.5 gpt, and the highest value from one bed was 7.4 gpt. No additional oil shale sampling was done during this investigation. The previously established low grade, the scarcity of oil shale beds, and the distance from known areas of rich oil shale mandate a rating of low potential for oil shale, with a certainty level of C.

Geothermal Sources

The study area is without hot springs or other evidence of unusually high earth temperatures. The thermal gradients typical of the Green River and Great Divide Basins are only in the normal range at about 13 and 15 °F per thousand feet, respectively (Heasler and others, 1983). Geothermal energy would have to come from the deep subsurface, where high temperatures are usually present. Thermal water from the deep subsurface can constitute a resource where it can be tapped in quantity by an existing drill hole (Heasler and others, 1983). Aquifers capable of delivering significant quantities of low- to moderate-temperature thermal water (195 °F or less) could exist beneath the study area at depths no greater than those already attained by exploratory drilling. However, no such aquifer is known at present, and no indications of thermal waters at shallow depth have been observed. Therefore, the wilderness study area is assigned a low resource potential for geothermal energy with certainty level B, based on sparse information.

Placer Gold

Placer gold is present in conglomeratic lobes in the Cathedral Bluffs Tongue of the Wasatch Formation along the south side of the Continental fault. The conglomerate thickens and coarsens northward toward a source somewhere in the direction of the Wind River Range (Love and others, 1978). The total amount of gold contained in the conglomerate lobes is large: on the basis of data reported in Love and others (1978), calculations indicate about 28 million ounces for just the deposits east of Dickie Spring. The tenor is low, however—only about 0.00123 ounces per short ton on average, from the same data.

Owing to their low grade, the conglomerate lobes of the Cathedral Bluffs Tongue are important only as interim repositories of placer gold. The significant placers of the vicinity are in younger deposits derived from the conglomerate lobes. Apparently, fluvial concentration mechanisms were not sufficiently effective in the alluvial fans of the Cathedral Bluffs Tongue to enrich gold content much beyond bedrock values. However, the concentrating effect of modern stream erosion and deposition was in some cases sufficient to enrich the gold values in the Quaternary alluvium. Such secondary enrichment is responsible for the placer-gold deposits in T. 27 N., R. 100 and 101 W., at Dickie Springs and Oregon Gulch, about 2 mi northeast of the study area (fig. 1; pl. 1).

The presence of gold considerably nearer the Oregon Buttes Wilderness Study Area was established by stream-sediment sampling during a geochemical survey of the Honeycomb Buttes Wilderness Study Area (Patterson and others, 1987, p. 17, pl. 1). Gold was discovered in stream gravels on the east side of Bear Creek near Edmund Springs (pl. 1, fig. 2), less than a mile east of the Oregon Buttes Wilderness Study Area. The Edmund Springs placers have only a limited conglomeratic source area remaining, owing to erosion. The conglomerate was inferred to represent one or more paleochannels in the Cathedral Bluffs Tongue related to the Dickie Springs lobe (Patterson and others, 1987).

The regional gravity survey (fig. 4) shows anomalies over the known conglomerate lobes. A gravity high with no associated topographic feature (H4, fig. 4) overlaps the eastern border of the study area near Edmund Springs and perhaps represents a conglomerate lobe that is either unexposed or poorly exposed.

This inferred lobe and the basal conglomerate of the Arikaree Formation (see earlier section, "Appraisal of Identified Resources") both contain a supply of Tertiary placer gold available for reconcentration into ore-grade placers by modern streams. However, analyses of stream deposits reported above under "Geochemistry" provide no evidence of effective reconcentration within the Oregon Buttes Wilderness Study Area. Inasmuch as the reconcentration process is apparently essential for the development of a resource, the mineral resource potential for placer gold is rated as low at a certainty level of C.

Metals Other Than Uranium and Placer Gold

Metals other than uranium and placer gold are not represented by known deposits in the vicinity of the wilderness study area, and geochemical sampling carried out for the present study did not discover any metallic anomalies. Accordingly, the mineral resource potential for metals other than uranium and placer gold is low with certainty level C.

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APPENDIX

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

LEVELS OF RESOURCE POTENTIAL

H 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.

M MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood for resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

L LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is permissive. This broad category embraces areas with dispersed but insignificantly mineralized rock, as well as areas with little or no indication of having been mineralized.

N NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

U UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign a low, moderate, or high level of resource potential.

LEVELS OF CERTAINTY

A Available information is not adequate for determination of the level of mineral resource potential.
B Available information only 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.

LEVEL OF RESOURCE POTENTIAL ↑	A	B	C	D
	U/A UNKNOWN POTENTIAL	H/B HIGH POTENTIAL	H/C HIGH POTENTIAL	H/D HIGH 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

LEVEL OF CERTAINTY →

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.
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RESOURCE/RESERVE CLASSIFICATION

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

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from McKelvey, 1972, Mineral resource estimates and public policy: American Scientist, v.60, p.32-40, and U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, p.5.

GEOLOGIC TIME CHART

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

EON	ERA	PERIOD	EPOCH	AGE ESTIMATES OF BOUNDARIES (Ma[1])
Phanerozoic	Cenozoic	Quaternary	Holocene	0.010
			Pleistocene	1.7
		Tertiary: Neogene Subperiod	Pliocene	5
			Miocene	24
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	Middle Proterozoic			1600
	Early Proterozoic			2500
Archean	Late Archean			3000
	Middle Archean			3400
	Early Archean			3800?
pre-Archean[3]				4550

[1]Millions of years prior to A.D. 1950.

[2]Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

[3]Informal time term without specific rank.

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Dallas L. Peck, Director

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