

Mineral Resources of the Honeycomb Buttes Wilderness Study Area, Fremont and Sweetwater Counties, Wyoming



U.S. GEOLOGICAL SURVEY BULLETIN 1757-B



Chapter B

Mineral Resources of the Honeycomb Buttes Wilderness Study Area, Fremont and Sweetwater Counties, Wyoming

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U.S. GEOLOGICAL SURVEY BULLETIN 1757

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
SOUTHERN WYOMING

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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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 Honeycomb Buttes (WY-040-323) Wilderness Study Area, Fremont and Sweetwater Counties, Wyoming.

CONTENTS

Summary	1
Introduction	2
Investigations by the U.S. Bureau of Mines	3
Investigations by the U.S. Geological Survey	3
Appraisal of identified resources	6
Mining history	6
Commodities	6
Oil and gas	6
Uranium	6
Oil shale	7
Coal	7
Gold	7
Construction materials	8
Recommendations for further study	8
Assessment of potential for undiscovered resources	8
Geology	8
Geologic setting	8
Description of rock units	8
Geochemistry	11
Geophysics	12
Mineral and energy resource potential	12
Oil and gas	12
Uranium	15
Oil shale	16
Coal	16
Placer gold	17
Suggestions for future work	17
References cited	18
Appendix	21

PLATE

1. Mineral resource potential and geologic map of the Honeycomb Buttes Wilderness Study Area **(In pocket)**

FIGURES

1. Map showing mineral resource potential of the Honeycomb Buttes Wilderness Study Area 2
2. Index map showing location of the Honeycomb Buttes Wilderness Study Area 4
3. Map showing mining claims and oil and gas leases, Honeycomb Buttes Wilderness Study Area 5
4. Generalized geologic map of the southern end of the Wind River Range 9
5. Generalized gravity and structure map of the Honeycomb Buttes Wilderness Study Area 13

TABLES

1. Summary of areas of moderate mineral and energy resource potential **6**
2. Subsurface stratigraphy of the Honeycomb Buttes Wilderness Study Area **10**
3. Oil and gas wells in the vicinity of the Honeycomb Buttes Wilderness Study Area **14**

Mineral Resources of the Honeycomb Buttes Wilderness Study Area, Fremont and Sweetwater Counties, Wyoming

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SUMMARY

Field investigations to evaluate the mineral resource potential of the Honeycomb Buttes (WY-040-323) Wilderness Study Area (fig. 1) were conducted during the summer of 1984. Geologic mapping, geochemical sampling, geophysical surveys, stratigraphic and sedimentological studies, and surveys of prospects delineated areas of very low grade placer gold deposits in terrace gravels and low and moderate resource potential for additional similar undiscovered placer gold deposits, low and moderate resource potential for small uranium deposits, moderate resource potential for accumulation of oil and gas, and low resource potential for coal and oil shale (see resource classification system, Goudarzi, 1984, inside front cover of this report).

The Honeycomb Buttes Wilderness Study Area, 52 mi (miles) northeast of Rock Springs and 40 mi south of Lander, is reached by graded roads from State Highway 28, just south of historic South Pass (fig. 2). The wilderness study area comprises approximately 41,620 acres. Elevations range from a high of 8,431 ft (feet) at the summit of Continental Peak to a low of 6,980 ft on the southern margin of the wilderness study area. The wilderness study area lies mostly south of the Continental Divide and the Wind River Mountain Range, on the northern rim of the Great Divide Basin, and northeast of the Green River Basin (Love, 1961). The Continental Divide splits near Oregon Buttes and rejoins 89 mi to the south, forming a basin with interior drainage. Streams and springs are intermittent, flowing only during spring snowmelt and after summer rainstorms.

Rocks formed within the span of Tertiary time (see geologic time chart at end of report) are exposed in the Honeycomb Buttes Wilderness Study Area. These rock units are, in ascending order of age, the Cathedral Buttes Tongue of the Wasatch Formation and the Laney Member of the Green River Formation, both formed during the lower to middle portion of Eocene time, the Bridger Formation of Upper Eocene age, and the Arikaree Formation, formed during the lower portion of Miocene time.

The wilderness study area is underlain by up to 26,000 ft of nearly horizontal sedimentary rocks that may be as old as Cambrian at the base, and range in age up to Eocene just below the surface, but do not include rocks representative of all the geologic time periods between Cambrian and Eocene. These rocks presumably lie on crystalline basement rocks of late Archean age similar to those exposed in the Wind River Range to the north.

The northern margin of the study area is intersected by boundary faults of the Wind River Range, the Wind River thrust and the Continental fault, of Laramide and possibly younger age.

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 south of the Wind River thrust fault, and the overhang of the thrust itself may constitute a structural trap in the northern part of the wilderness study area. To date, no producing wells have been drilled in or near the wilderness study area, although some shows of oil and gas have been reported.

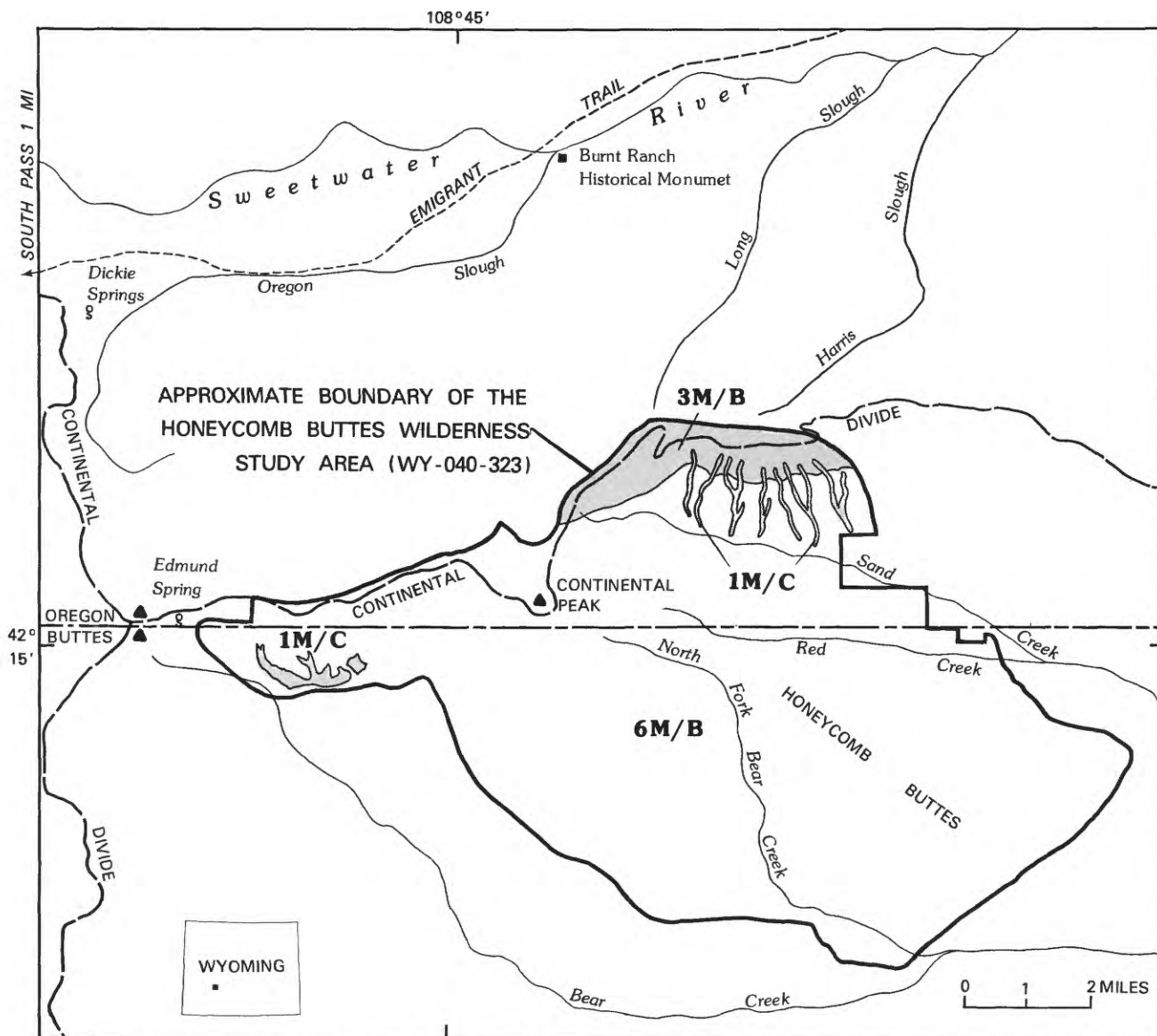


Figure 1 (above and facing page). Map showing mineral resource potential of the Honeycomb Buttes Wilderness Study Area.

A moderate mineral resource potential for placer gold exists in the westernmost and northeast parts of the wilderness study area. Several beds of boulder conglomerate within the Cathedral Bluffs Tongue were derived from the rocks of the Sweetwater gold-mining district. Consequently, small amounts of gold were incorporated into the conglomerate. Although of too low a grade to be considered as a possible gold resource themselves, the conglomerates in turn are a source for gold that has been reconcentrated locally by modern streams to form upgraded placer deposits. However, these modern stream gravels are quite limited in depth and extent.

A moderate mineral resource potential for uranium was recognized in the same conglomerates that contain

the gold values. Not all indications are favorable, but a low-level geochemical anomaly suggests uranium minerals may be present.

INTRODUCTION

The Honeycomb Buttes Wilderness Study Area (WY-040-323) is in Fremont and Sweetwater Counties, southwest-central Wyoming, approximately 40 mi south of Lander and 30 mi northeast of Farson. State Highway 28, an all-weather road, is west of the wilderness study area. Access to the wilderness study area is by graded gravel roads, negotiable by passenger cars in good wea-

EXPLANATION

M/C

Geologic terrane having moderate resource potential (commodity 1, certainty level C)

M/B

Geologic terrane having moderate resource potential (commodity 3, certainty level B)

M/B

Geologic terrane having moderate resource potential (commodity 6, certainty level B)—Applies to subsurface of entire area

Geologic terrane having low resource potential (commodity 3, certainty level B, subsurface of entire area); (commodity 4, certainty level C, subsurface of entire area); (commodity 2, certainty level C, outcrops of Cathedral Bluffs tongue adjacent to fault; see plate 1); (commodity 5, certainty level D, outcrop of Laney Member of Green River Formation; see plate 1)

Commodities

1. Placer gold of Quaternary age
2. Placer gold of Tertiary age
3. Uranium
4. Coal
5. Oil shale
6. Oil and gas

Levels of resource potential

- High mineral potential
- Medium mineral potential
- Low mineral potential

Levels of certainty

- A Available information not adequate
- B Available information suggests level of resource
- C Available information gives good indication of level of mineral resource potential
- D Available information clearly defines level of mineral resource potential

ther, and nonmaintained roads requiring four-wheel-drive vehicles in all seasons. The wilderness study area consists of 41,620 acres and ranges in elevation from 6,980 ft at the south boundary to 8,431 ft at the summit of Continental Peak in the northern part of the area. The wilderness study area is on the northern rim of, and almost entirely within, the Great Divide Basin, an unusual area of interior drainage encircled by the Continental Divide, which splits at Oregon Buttes, outlines the basin, and rejoins itself 89 mi to the south (fig. 2). Intermittent streams south of the divide flow into the Great Divide Basin and disappear through evaporation or infiltration. The area

north of the divide is drained by small unnamed intermittent tributaries of various creeks.

The climate of the wilderness study area is semiarid cold desert. Average annual precipitation is 10 in., more than half of it snow. Average daytime temperatures in July are 60–65 °F and 5–10 °F in January. Wind speeds average 15 mph, with gusts as high as 82 mph (Dutcher, 1983).

Southeast of prominent Continental Peak, flat-topped benches or mesas cap a spectacular badlands topography eroded into the soft, varicolored red and gray-green shales of the Cathedral Bluffs Tongue of the Wasatch Formation. This region is known as the Honeycombs due to extensive caves and sinkholes caused by piping, an hydraulic phenomenon common in unconsolidated clay-rich rocks (Parker and Jenne, 1967).

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the product of separate studies by the U.S. Bureau of Mines (USBM) and the U.S. Geological Survey (USGS). Identified resources are classified according to the system of the U.S. Bureau of Mines and the U.S. Geological Survey (1980) which is shown on p. 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

A detailed search was made for pertinent literature on mining in the region of the study area. Unpatented mining-claim records and oil and gas leases on file with the U.S. Bureau of Land Management in Cheyenne, Wyo., were examined and are shown on figure 3.

Two USBM geologists, D. C. Scott and Maynard Dunn, spent a total of 22 field days investigating the identified mineral resources of the study area. Seventeen gravel and eight rock-chip samples were taken (Scott, 1985). Sixteen of the 25 samples were fire assayed to determine gold content of gravel beds in the study area. Fourteen of the 25 samples were assayed for uranium content by the fluorimetric method. Twenty of the 25 samples were analyzed by semiquantitative optical emission methods for 40 elements. Analyses were performed by the USBM, Reno Research Center, Reno, Nev.

Investigations by the U.S. Geological Survey

Field work was done during the summer of 1984 by USGS personnel C. G. Patterson, D. M. Kulik, J. S. Loen, and M. E. Koesterer. USBM and USGS person-

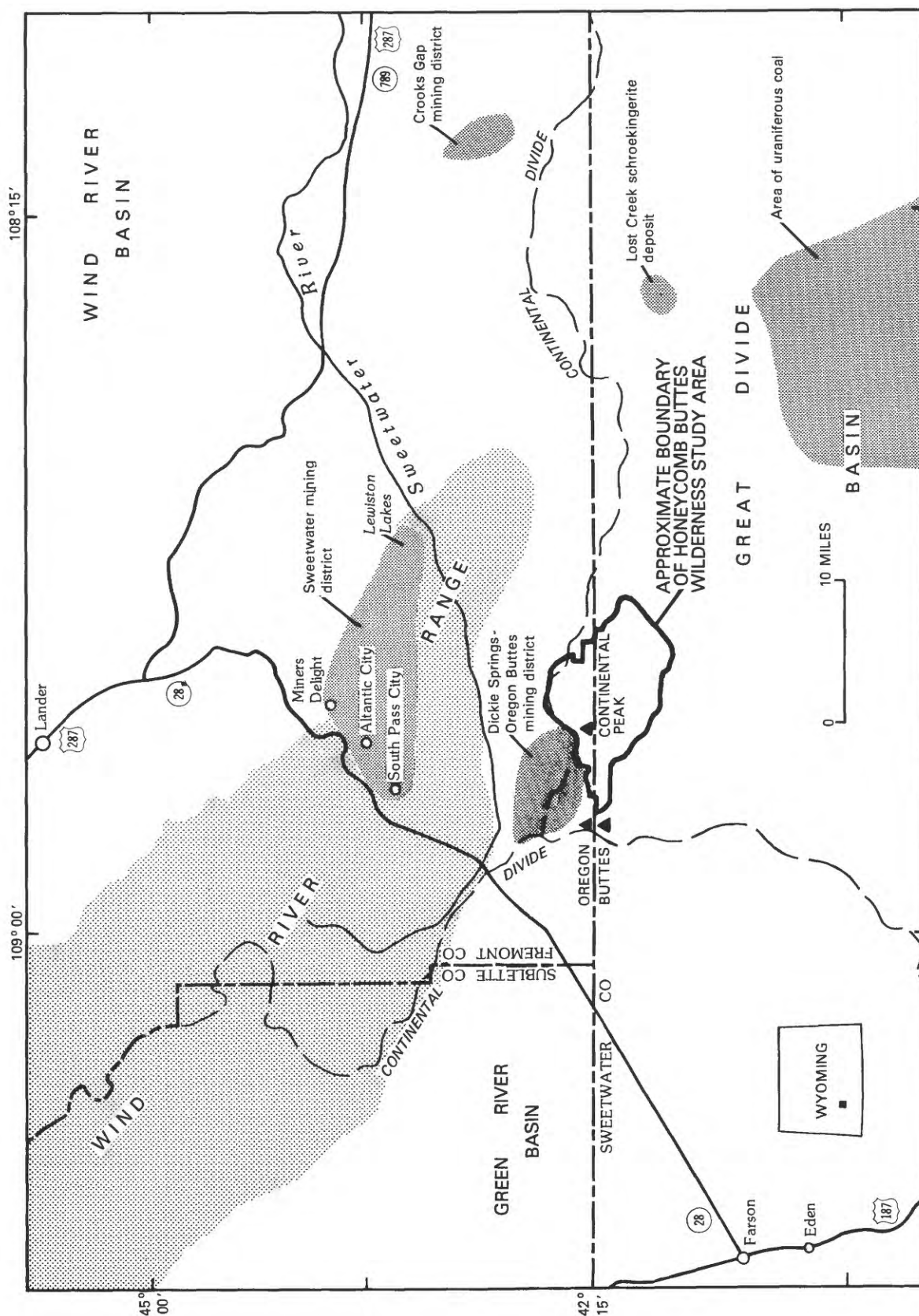


Figure 2. Index map showing location of the Honeycomb Buttes Wilderness Study Area.

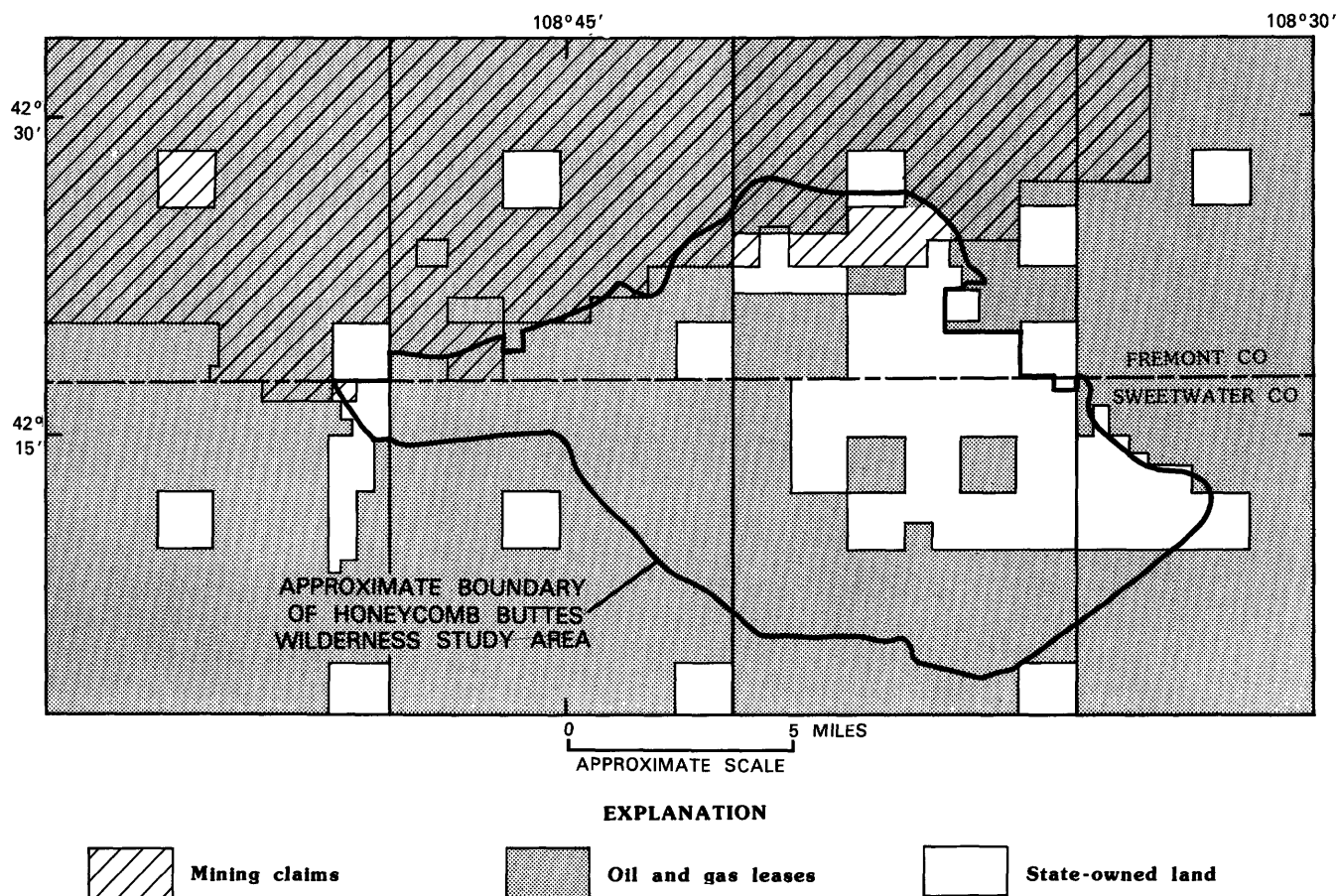


Figure 3. Map showing mining claims and oil and gas leases, Honeycomb Buttes Wilderness Study Area.

nel cooperatively studied the placer gold deposits of Sand Creek, which had been discovered during earlier phases of the USGS investigation.

Investigation was focused on the resources likely to be present: principally oil and gas or coal in the subsurface; coal, uranium, and (or) placer gold deposits in the Cathedral Bluffs Tongue of the Wasatch Formation; oil shale in the Laney Member of the Green River Formation; and various construction materials such as clay, sand, and gravel (table 1).

The field work consisted of geologic mapping, stratigraphic and sedimentologic analysis, rock and stream-sediment sampling, scintillometer surveys, and a gravity survey. Stratigraphic and sedimentologic studies included measurement of nine sections and mapping and study of ancient stream channels within the Cathedral Bluffs Tongue.

Approximately 20 pounds of sample was taken at each site, from pits and cross-channel trenches dug to a depth of 18 in. 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, after examination for

visible gold, were collected for later analysis of mineral content. The mineralogy of the nonmagnetic, heavy-mineral fractions of panned concentrates was studied to assist in provenance 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). Office studies included analysis of well-log data to assess the favorability of subsurface rocks for oil and gas, coal, and uranium.

Acknowledgments.—Acknowledgments and thanks go to Anne Aldrich of the Rock Springs district office of the Bureau of Land Management for information and access to aerial photographs. Geologists of the USGS who gave valuable advice and help with all aspects of the project include P. K. Theobald, E. A. Merewether, J. D. Love, J. C. Antweiler, R. B. Tripp, and M. E. MacLachlan. Professor Ron Frost and graduate students from the University of Wyoming conducted field trips to the crystalline rocks of the Wind River Range and provided data on structural and sedimentary geology. Geologists of Freeport Minerals, Inc., led field trips in the Sweetwater mining district. Robbie Gries, consulting geologist, provided well-log data and discussed aspects of regional structure.

Table 1. Summary of areas of moderate mineral and energy resource potential, Honeycomb Buttes Wilderness Study Area

Commodity	Area (mi ²) of moderate resource potential	Deposit type
Oil and gas--	65	Structural and stratigraphic traps.
Placer gold--	1.5	Quaternary placer.
Uranium-----	2	Tabular sandstone.

APPRAISAL OF IDENTIFIED RESOURCES

By D. C. Scott
U.S. Bureau of Mines

Mining History

The Dickie Springs-Oregon Gulch mining district includes the northwestern part of the wilderness study area (fig. 2). The district developed when placer gold deposits were discovered near Dickie Springs in 1863. Gold concentrations in the deposits average about 0.01054 oz per yd³ (cubic yard) of gravel (\$3.16 per yd³ at \$300 per oz) (Hausel, 1980, p. 16-18). Total production, although unknown, was probably minor.

The southern part of the Sweetwater mining district includes the southeastern part of the Wind River Range and is within 5 mi of the northern boundary of the wilderness study area (fig. 2). Gold in the district was discovered along the Sweetwater River in 1842, but it was not until 1867 that the gold was traced to quartz veins in a northeast-trending metagabbro body about 10 mi north to northwest of the study area. Gold production records are either ambiguous or in most cases nonexistent, but Hausel (1980, p. 6) reported an estimate of production at about 310,000 oz through 1926. Geologic formations in the Sweetwater district consist of igneous and metamorphic rocks that do not crop out in the study area.

Commodities

Subeconomic deposits of placer gold occur in terrace gravels in the extreme north-central part of the study area. Anomalous radioactive readings were found in sandstone near Continental Peak. Oil and gas are not known in the area but may exist in stratigraphic traps beneath the Wind River thrust fault. Low-grade oil shale and thin beds of coal are present at depth.

Oil and Gas

The study area is in the Southwestern Wyoming Basins province, a major oil- and gas-producing region of Wyoming. Oil and gas are produced from both structural and stratigraphic traps in this part of Wyoming. Cretaceous and Tertiary sandstones contain the major producing reservoirs (Spencer and Powers, 1983, p. 5). Most of the study area is presently under pre-Federal Land Policy Management Act (FLPMA) oil and gas lease (fig. 3).

In recent years oil companies have drilled through Precambrian rocks in the overthrust belt near the study area to test younger sedimentary rocks that lie concealed and virtually unexplored beneath the Precambrian rocks. Four holes have been drilled through Precambrian rocks into the younger sedimentary rocks near the study area. In 1973, Husky Oil Co. drilled a 12,944-ft hole in sec. 2, T. 29 N., R. 106 W.; there were no oil or gas shows reported from this hole. In 1970, Mountain Fuel Supply Inc. drilled the #1 Dickie Springs well (sec. 24, T. 24 N., R. 101 W.) and penetrated formations to a depth of 10,940 ft. Three drill-stem tests were run and recovered only minor amounts of mud before the well was abandoned. American Quasar Petroleum Co. subsequently drilled the #1 Skinner Federal well (sec. 32, T. 28 N., R. 101 W.), 5 mi northwest of the #1 Dickie Springs well, to a depth of 15,040 ft. Seven drill-stem tests were run across a thrust fault. Five tests were misruns; however, one test recovered 1,146 ft of mud, and one test gauged a maximum of 29,400 ft³ gas per day and recovered 2,458 ft³ of gas and very slightly oil-cut mud. No attempts were made to complete the well before abandonment. In 1976-77, West Coast Oil Inc. drilled the 9,700-ft #1 Skinner Federal test well 2 mi south of the American Quasar well (sec. 9, T. 27 W., R. 101 W.) (Gries, 1981, p. 12).

Uranium

Uranium was reported to occur in coal beds in the Wasatch Formation in the Red Desert area more than 10 mi southwest of the study area (Wilson, 1955, p. 186), but the uranium-bearing coal beds are not known to occur in the study area.

Anomalous high radioactivity occurs in conglomeratic sandstone within the Cathedral Bluffs Tongue of the Wasatch Formation approximately 10 mi northwest of the northwest study-area boundary (Wilson, 1955, p. 187). Because the Cathedral Bluffs Tongue is also present in most of the study area, a gamma-ray spectrometer was used to detect radioactivity. The highest spectrometer readings in the study area, 300 cps (counts per second) above a background of 30 (total radiometric count) (pl. 1, samples 23-25), were from a mottled sandstone exposed on the north side of Continental Peak. No uranium minerals were observed in the sandstone, and the source of radioactivity was not identified.

Fourteen of the 25 samples taken in the study area and analyzed for uranium contained from 0.82 to 72.0 ppm uranium (pl. 1, samples 1, 2, 12, 15–25, Scott, 1985). Although uranium may be present within the Wasatch Formation, it would require extensive exploration to determine extent and depth of any mineralization.

Oil Shale

More than 20 mi southwest of the study area, in the Green River Basin, high-grade oil shale (25–35 gal/t or gallons oil per ton rock, which is considered to have commercial value (Schramm, 1975, p. 967)) has been reported from the Wilkins Peak and Laney Members of the Green River Formation (Zeller and Stephens, 1969, p. 38). Low-grade oil shale occurs in the Laney Member of the Green River Formation in the study area. Zeller and Stephens (1969) reported that one 3-ft-long surface sample of marlstone from the Laney Member in the study area (sec. 9, T. 26 N., R. 99 W.) was estimated to contain 2.5 gal/t. About 1 mi east of that sample site, a core hole drilled by the USGS in sec. 10, T. 26 N., R. 99 W. shows that the marlstone contains from 0 to 7.4 gal/t over a stratigraphic interval of about 138 ft. Oil content of the lower 35 ft of the marlstone averaged about 3 gal/t (Zeller and Stephens, 1969, p. 38). Bulk sampling of the oil shale would have to be done to determine further the quality and quantity of the oil shale at depth in the area. Although the Laney Member is present in the study area, the low grade of the oil shale (2.5–3 gal/t) and the limited extent of the member in the study area would indicate little or no likelihood of development in contrast to the higher grade occurrences elsewhere.

Coal

Drilling shows that most of the study area south of the Wind River thrust fault is underlain by a coal-bearing sequence within the Fort Union Formation of Paleocene age that has an aggregate thickness of as much as 100 ft of coal. This coal sequence is buried beneath 2,300–5,000 ft of younger rocks.

Zeller and Stephens (1969) reported that the number of coal beds and the total thickness of coal decreases from south to north of the area. One oil well drilled 6 mi southwest of the area penetrated nine coal beds with an aggregate thickness of 100 ft, while only seven thin streaks of coal were penetrated at a depth of 2,500 ft in a well 1 mi north of the area. Extrapolating these data suggest that an aggregate thickness of 5–50 ft of coal could exist at depths greater than 2,500 ft in the study area. They further reported that the coal cuttings and cores from the northernmost well have an average value of 12,000 Btu (British thermal units) on an as-received basis.

Gold

Unpatented placer gold claims cover much of the Dickie Springs–Oregon Gulch mining district within and outside the northwest boundary of the wilderness study area (fig. 3). Placer gold occurs in the Dickie Springs boulder-conglomerate lobe of the Wasatch Formation, which is not exposed in the study area but could be present below the Laney Member of the Green River Formation.

To determine if gold might be present in gravels of exposed formations within the study area, 16 gravel samples, consisting of $\frac{1}{2}$ ft³ each, were taken, panned down to heavy-mineral concentrates, and fire assayed for gold and silver. Visible gold was present in six of the panned-concentrate samples; silver was not detected in any of the samples.

Samples 1, 2, 12–16, taken from formations in the study area, contained no gold; however, in the extreme north-central part of the study area, terrace gravels capping the Cathedral Bluffs Tongue of the Wasatch Formation contain minor amounts of placer gold (pl. 1, samples 3–11) (Scott, 1985). The terrace gravels are from 1 to 30 ft thick. Three terraces in a stair-step sequence are recognized in the study area. These gravels are probably remnants of alluvial fans developed as a result of uplifting along the Continental fault.

Gold values of the gravel range from \$0.05 to \$0.26 per yd³. In all the gold value determinations, a price of \$300 per oz was used (Scott, 1985). Samples 3–9 from the upper of three terraces represent a nearly continuous vertical section of the terrace. The highest gold value (sample 6), \$0.26 per yd³, was from a sample just above a contact between the terrace gravel and a clay unit. This location suggests that the base of the gravel may contain slightly enriched concentrations of gold. Based on surface measurements of approximately 1,500 ft in length, 1,000 ft in width, and 10 ft in thickness, 500,000 yd³ of gravel are present in the upper terrace.

Two samples (pl. 1, samples 10–11) were taken from the middle terrace, and both yielded \$0.05 per yd³ (Scott, 1985). Based on surface projections 1,500 ft in length, 1,000 ft in width, and 10 ft in thickness, 500,000 yd³ of gravel are present in the middle terrace.

Based on surface projections, 1 million yd³ of additional gravel, similar to the gravel in the upper and middle terraces, may exist in the lower terrace. The lower terrace was covered by slope wash and not sampled.

Bulk sampling would be required to appraise the quantity of gold in the terraces. Because there is no surface water in the area, some type of dry-wash method would be necessary to recover the gold. An estimate of 10–15 percent lower recovery would be expected by this method as opposed to wet washing methods (Wells, 1973, p. 83). The cost of recovering the gold by a dry-wash method would require a minimum of \$2.00 per yd³ (Joe

Wojcik, geologic consultant, Denver, Colo., oral commun., 1985). The likelihood of development of the Honeycomb Buttes gold is low because such a low grade will give a low return on investment. The highest gold value in the gravel is \$0.26 per yd³, so that even with a 100 percent gold recovery a tenfold price increase would be needed before considering development of higher grade parts of these deposits. Unless further work locates zones with higher gold values, the placer gold deposits of the study area are considered subeconomic.

Construction Materials

Poorly sorted sand and clay are abundant in the wilderness study area. The deposits of gravel are generally too decomposed to be usable. Other deposits can be found in similar abundance and quality closer to potential centers of use. No usable dimension stone was found in the wilderness study area.

Recommendations for Further Study

The placer-gold occurrences in the north part of the study area should be examined in detail. Bulk sampling the three terraces and sampling successive horizons down to and including the clay horizon is needed to delineate and quantify the gold distribution. A detailed study of the lithology of rocks in the gravel units could aid in determining the origin of the gold and therefore determine where the most significant concentrations within the terrace gravels might occur.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

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Geology

Geologic Setting

Useful summaries of local and regional geologic history have been published by Nace (1939), Bradley (1964), Zeller and Stephens (1969), Love (1970), Sullivan (1980), and Steidtmann and Middleton (1986).

Geologic events leading to the formation of rocks exposed in the Honeycomb Buttes Wilderness Study Area began during the Laramide orogeny, which began in latest Cretaceous time and lasted through the early part of the Tertiary Period. The Laramide was a time of general up-

lift, faulting, and volcanism in the western part of North America. In Wyoming, most major mountain ranges and basins were formed during this time. Uplift, faulting, and volcanism were renewed later in the Tertiary, after a long period of quiescence and erosion.

During Early Eocene time, the Wasatch Formation and its Cathedral Bluffs Tongue were deposited as alluvial fans by streams eroding the granitic and metamorphic crystalline rocks of the Wind River Range as it rose along the Wind River and Continental fault systems. Movement along the Wind River thrust fault was almost 70,000 ft horizontally and 40,000 ft vertically (Berg, 1983; Smithson and others, 1978). The Continental fault moved after the Wind River thrust and was of lesser magnitude (Steidtmann and others, 1983) (fig. 5). Influxes of volcanic ash from the Absaroka volcanic field to the north contributed to these sediments, and after deposition were altered to clay. The various members of the Green River Formation, including the Laney, were being deposited simultaneously with the Wasatch and Cathedral Buttes in a widespread shallow playa lake known as Lake Goshiute.

The Bridger Formation was deposited in streams, lakes, and swamps in the Middle Eocene. It also received abundant volcanic ash from the north.

Extensive erosion during Oligocene time removed much of the sedimentary rock cover north of the Continental fault, exposing Archean rocks at the surface. Renewed uplift during the Miocene, concurrent with volcanism to the north and east, caused deposition of the Arikaree Formation on the exposed Archean rocks north of the Continental fault and on Bridger Formation south of the fault.

Rocks in the subsurface of the Green River and Great Divide Basins consist of nearly 26,000 ft of flat-lying to gently dipping sediments of Cambrian to Eocene age which, based on seismic evidence (Gries, 1981), overlie crystalline basement rocks of presumably Archean age. The subsurface stratigraphy of the area is summarized in table 2.

Description of Rock Units

Early to Middle Eocene Cathedral Bluffs Tongue of the Wasatch Formation (unit Twc).—This unit consists of variegated reddish and grayish-green mudstones interbedded with 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 Buttes is as much as 220 ft thick, although the base is not exposed in the study area. The Cathedral Bluffs weathers and erodes to form colorful badlands.

Middle Eocene Laney Member of the Green River Formation (unit Tgl).—The unit is approximately 200 ft thick in the study area and consists of brownish-weathering dark-gray paper shale and some thin to medium beds

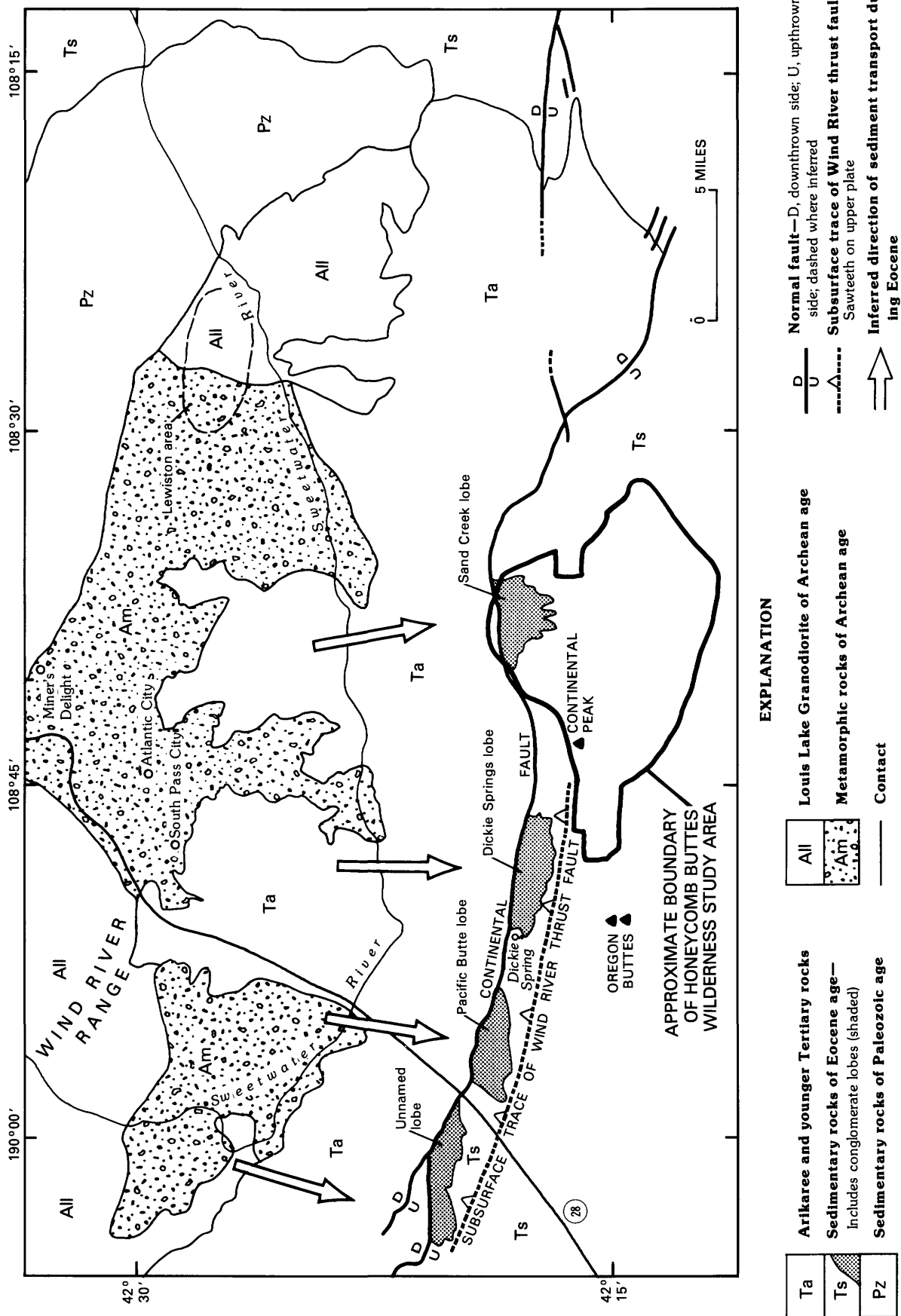


Figure 4. Generalized geologic map of the southern end of the Wind River Range.

Table 2. Subsurface stratigraphy of the Honeycomb Buttes Wilderness Study Area

[Thickesses are approximate, estimated from well logs and from Love, 1970. N/A, not available]

Formation	Thickness (ft)
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, Erikson 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 Springs Formation-----	150
Nugget Sandstone-----	525
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
Archean	
Basement complex composed of diverse crystalline rocks-----	N/A

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 unit.

Middle Eocene Bridger Formation (unit Tb).—The Bridger consists of drab gray-brown to grayish-orange mudstone, siltstone, sandstone, and marlstone. The Bridger coarsens upward and contains abundant silicified algal beds, fossil wood, and some vertebrate remains. Thick beds of tuffaceous sandstone form a cliff band near the summit of Continental Peak and have been mapped as the Continental Peak Formation by Nace (1939), Denson and Pipiringos (1974), but not by Love (1985), and were not differentiated in this report.

Lower Miocene Arikaree Formation (unit Ta).—The Arikaree may be as much as 750 ft thick on Oregon Buttes, as much as 400 ft thick north of the Continental fault, but only 20 ft of it remain as caprock on the summit of Continental Peak. There it consists of loosely cemented clasts as much as 30 in. across of dark metamorphic rock and smaller quartz and epidote fragments in a whitish, sandy, tuffaceous matrix. North of the fault the Arikaree is a medium- to coarse-grained sandstone, calcareous, and fairly well consolidated.

Quaternary alluvium of Pleistocene(?) and Holocene age (unit Qa).—Stream deposits of poorly sorted silt, sand, and gravel up to 5 ft thick found capping low terraces in the western part of the study area, which may in part be of Pleistocene(?) age, and thin (½-3 ft thick), poorly sorted deposits of clay, silt, sand, and gravel along modern stream courses, which was not shown on plate 1 except where gold-bearing.

Quaternary eolian deposits of Pleistocene(?) and Holocene age (unit Qes).—Sparsely vegetated low dunes and sand sheets in the southern part of the study area that generally are only a few feet thick.

Geochemistry

The stream-sediment-sampling scheme was designed with the assistance of P. K. Theobald (USGS) to determine the presence of low-grade gold placers in the Cathedral Bluffs Tongue and also to identify placers of Quaternary age reworked from the Cathedral Bluffs placers. Initial sample locations were chosen on second-order drainages at a density of one sample per square mile. A second phase of sampling was initiated to investigate and further characterize those areas that had shows of placer gold.

Sixty-eight panned concentrates of modern stream sediments and eight from channels of Eocene age within the Cathedral Bluffs Tongue were taken from within the Honeycomb Buttes Wilderness Study Area. These sediments were derived mainly from the Cathedral Bluffs Tongue, due to the greater outcrop area and higher percentage of heavy minerals in that unit than in the Laney,

Bridger, or Arikaree. Source areas for the Cathedral Bluffs Tongue are northwest, north, and northeast of the wilderness study area and include the Sweetwater gold mining district. Gold was seen in 10 samples, whose locations are shown on plate 1.

Sample preparation consisted of removal of the magnetic and light-mineral fractions of the sediment. Ten milligrams of the nonmagnetic, heavy-mineral fraction were analyzed for 31 elements by an optical-emission spectrographic method (Grimes and Marranzino, 1968). The analyses were performed by M. S. Erickson (USGS).

The visible gold and the heavy-mineral concentrate they were in were analyzed by the USGS. The aggregate weight of all flakes was approximately 0.1 g (gram). Analysis of the flakes of gold was performed by E. L. Mosier using inductively coupled plasma atomic emission spectroscopy (ICP) (Taggart and others, 1981). The fineness of the gold (874) and the trace-element composition were not inconsistent with values of gold from the Sweetwater district (J. C. Antweiler, written commun., 1985). Fire-assay analysis of the heavy-mineral concentrates that contained the gold flakes were conducted by S. A. Wilson, but no values were found.

Minimum, mean, standard deviation, and extreme values were tabulated from the geochemical data for each element. An anomalous concentration of an element was defined as the mean value plus twice the standard deviation. A high value was defined as any value higher than one standard deviation above the mean value for a particular element.

Barium (Ba) was present in large amounts in most samples. Thirty-eight samples showed more than 10,000 ppm (parts per million) barium. It is likely that Ba is present as barite in the Wasatch and Bridger Formations as a cementing agent, based on the occurrence in equivalents of these units, the Eocene Wind River and Wagon Bed Formations, which contain 0.1 and 0.2 percent Ba by weight, respectively (Love, 1970). The original barium source is likely to be barium-rich volcanic ash contained in all these formations. Rocks of granitic composition and their volcanic equivalents are enriched in barium compared to other rock types (Rankama and Sahama, 1950; Brobst, 1973). Barium leached from ash would quickly react with sulfate to form insoluble barite as a cement between grains. Examination of the final split of panned concentrates showed the typical irregular shards of barite cement. X-ray analysis of several of these fragments confirmed that they were barite. No barite was seen in hand specimens of rocks, and barite is not considered as a resource.

High zirconium values in most samples indicate the presence of resistant crystals of zircon derived both from the volcanic-ash component of the sediment and from erosion of crystalline rocks in the source area during Wasatch, Bridger, and Arikaree time. Zircons were also seen in panned concentrates.

Samples from the streams draining the conglomerates of the Sand Creek lobe of the Cathedral Bluffs Tongue on the north side of the Sand Creek drainage were high in nickel, cobalt, chromium, lead, and vanadium. Although these sample values more likely indicate the mafic rocks and iron-formation of their Eocene source area in the Archean rocks north of the wilderness study area, they also may indicate the presence of uranium within the sandstone and conglomerate of the Cathedral Bluffs Tongue. As is discussed in the section of this report regarding assessment of resource potential, the conditions necessary for formation of a uranium deposit are not fully met in the wilderness study area, but the high concentrations of the previously mentioned elements are considered sufficiently suggestive to warrant further study.

Some pan-concentrate samples from the west side of the wilderness study area have a high to anomalous content of lanthanum and niobium. The abundant pegmatites in their granitic source area could account for this (Rankama and Sahama, 1950). A small lead anomaly was found in the westernmost samples and may be genetically related to the recently discovered sulfide minerals in cores and cuttings from the Amoco South Pass unit #1 well to the north of the wilderness study area (J. C. Antweiler, oral commun., 1985).

Anomalous concentrations of other elements were not found, and no systematic correlation of any element or elements with gold was observed.

Geophysics

Gravity studies were undertaken as part of the mineral resource evaluation of the Honeycomb Buttes Wilderness Study Area and provide information on the subsurface distribution of rock masses and the structural framework.

The gravity data were obtained in and adjacent to the study area in 1984, and were supplemented by data maintained in the files of the Defense Mapping Agency of the Department of Defense. Stations measured by the author were established using Worden gravimeter W-177.¹ The data were tied to the International Gravity Standardization Net 1971 (U.S. Defense Mapping Agency Aerospace center, 1974) at base station ACIC 0632-2 at Lander, Wyo. and ACIG 0322-1 at Sweetwater Station, Wyo. 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 anomaly is less than 1.5 mGal (milligals) for errors in elevation control. Bouguer anomaly values were computed using the 1967 gravity formula (Internation-

Association of Geodesy, 1967) and a reduction density of 2.67 g/cm³. Mathematical formulas are given in Cordell and others (1982). Terrain corrections were made by computer for a distance of 167 km from the station using the method of Plouff (1977). The data are shown in figure 5 as a complete Bouguer anomaly map with a contour interval of 5 mGal.

A relatively high plateau in the Bouguer gravity values occurs southwest of the study area and defines a north-northwest-trending structural high that is probably cored by basement rocks and separates the Green River and Great Divide Basins (fig. 5).

A gravity gradient is associated with the Continental fault where it is mapped in and adjacent to the study area. Between sec. 18, T. 27 N., R. 99 W. and sec. 1, T. 27 N., R. 102 W., the gradient associated with the fault broadens, and relatively high gravity values extend southwest of the Continental fault (A, fig. 5). These high values suggest that the Wind River fault diverges from the Continental fault here and carries a wedge of Precambrian crystalline rocks south of the Continental fault.

Local areas of high gravity values in N $\frac{1}{2}$ sec. 24, T. 27 N., R. 101 W., SW $\frac{1}{4}$ sec. 15, SE $\frac{1}{4}$ sec. 16, T. 27 N., R. 101 W. (H1, fig. 5) and secs. 16, 17, 18, and 20, T. 27 N., R. 99 W. (H2, fig. 5) are associated with surface expressions of conglomerate derived from Archean rocks. Another gravity high in secs. 19 and 30, T. 27 N., R. 99 W., and secs. 24 and 25, T. 27 N., R. 100 W. (H3, fig. 5) suggests that a similar body of conglomerate occurs at shallow depth, although no outcrops were mapped at this location (fig. 5).

Mineral and Energy Resource Potential

Oil and Gas

The potential for oil and gas resources in the Honeycomb 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 indicated by the presence of the four favorable factors necessary for hydrocarbon accumulation. These are source rocks, reservoir rocks, trapping mechanisms, and appropriate thermal history. Oil and gas have been produced from many of these units (table 3) in the general region of the wilderness study area. Trapping mechanisms include a structural trap beneath the overhang of the Wind River thrust fault, if in fact the fault extends into the wilderness study area, and stratigraphic traps south of the Continental fault, where sandstone bodies may pinch out within impermeable shales (Gries, 1981; Stillwell, 1981; Zeller and Stephens, 1969).

Studies are in progress by E. A. Merewether and others of the USGS to determine the thermal maturity of

¹Use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

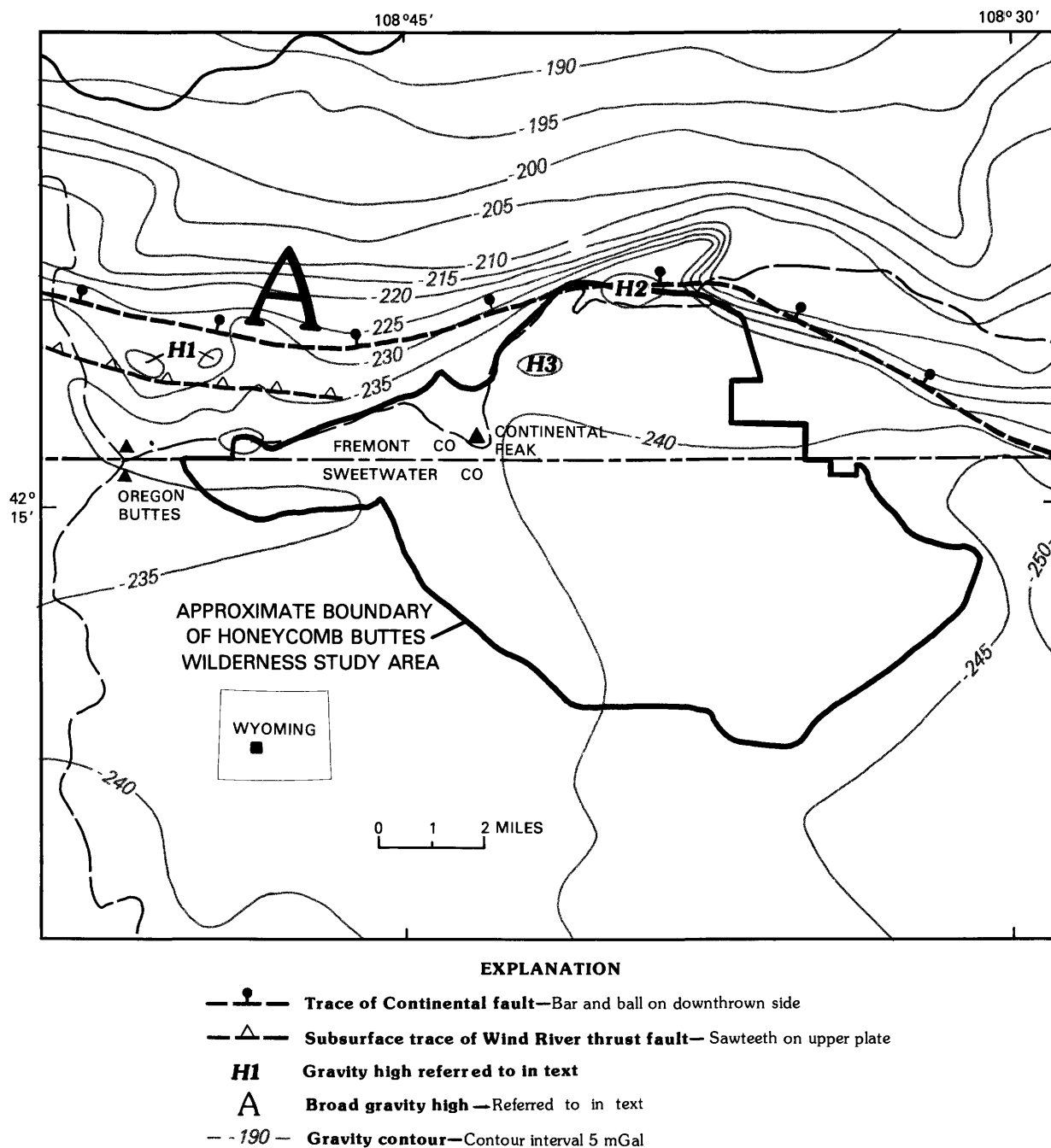


Figure 5. Generalized gravity and structure map of the Honeycomb Buttes Wilderness Study Area.

the subsurface rocks in Wyoming. Extrapolation from adjacent areas 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. These depths correspond roughly to the depth of the Cretaceous formations, which contain known favorable source and reservoir rocks in the Green River and Great Divide Basins. Rocks below that depth include the Phosphoria Formation (Permian) and the Madison Limestone (Mississippian), known source rocks for oil in other areas. The

deepest rocks may be thermally overmature for oil at this time but may have generated oil in the past which has since migrated upward to suitable reservoir rocks.

Geologic conditions are appropriate for the generation and accumulation of hydrocarbons in the wilderness study area, and fifteen wells have been drilled (1 in and 14 near the study area) to test structural and stratigraphic traps (pl. 1). Four had shows of gas or oil but were capped due to lack of volume of flow. A major subthrust test was completed by Amoco Production Co. north of

Table 3. Oil and gas wells in the vicinity of the Honeycomb Buttes Wilderness Study Area

[p/a, plugged and abandoned; ND, no data]

Name and operator	Location	Depth (ft) and formation	Results and date
#1 Govt. McClintock British American Oil Co.	Sec. 30, T. 27 N., R. 100 W.	11,012; Lewis	Dry hole. Jan. 1960
#1 Dickie Springs Mountain Fuels, Inc.	Sec. 24, T. 27 N., R. 101 W.	12,282; Mesa Verde	Dry hole. Oct. 1970
#1 Circle Bar Chorney Oil Co.	Sec. 30, T. 27 N., R. 98 W.	10,970; Mesa Verde	Show oil, gas; p/a ¹ . Sept. 1971
#1 Columbus Federal Davis Oil Co.	Sec. 25, T. 26 N., R. 100 W.	11,564; Erikson	Show oil, gas; p/a. April 1977
#1 Scotty Lake Davis Oil Co.	Sec. 9, T. 26 N., R. 98 W.	13,150; Tensleep	Show gas; p/a. Aug. 1979
#1 Honeycomb Buttes Davis Oil Co.	Sec. 25, T. 27 N., R. 99 W.	11,500; Erikson	Dry hole. Oct. 1979
#1 Hourglass Woods Petroleum Corp.	Sec. 10, T. 26 N., R. 100 W.	15,304; Erikson	Show gas; p/a. Oct. 1980
#1-A Harris Slough Energetics, Inc.	Sec. 26, T. 27 N., R. 99 W.	13,620; Mesa Verde	Dry hole. April 1981
#1 Harris Slough Energetics, Inc.	Sec. 34, T. 27 N., R. 99 W.	13,620; Mesa Verde	Dry hole. May 1981
Sands of Time Moncrief Oil	Sec. 16, T. 26 N., R. 100 W.	11,778; Erikson	Dry hole. May 1980
#1 Lost Valley Anadarko Production Co.	Sec. 30, T. 26 N., R. 98 W.	11,290; Lewis	Show gas; p/a. Aug. 1981
#1 South Pass Amoco Production Co.	Sec. 17, T. 27 N., R. 100 W.	22,690; Morrison	Dry hole. Fall 1983
#1 Govt. Oregon Trail Sinclair Oil Col	Sec. 24, T. 27 N., R. 101 W.	1,857; Wasatch(?)	ND
Husky Oil Co. ¹	Sec. 2, T. 29 N., R. 106 W.	12,944; ND	Dry hole; p/a. 1973
#1 Skinner Federal American Quasar Petroleum Co. ¹	Sec. 32, T. 28 N., R. 101 W.	15,040; ND	Show gas; p/a. 1971
#1 Skinner Federal West Coast Oil Co. ¹	Sec. 9, T. 27 N., R. 101 W.	9,700; ND	Dry hole. 1977

¹Not shown on plate 1.

the wilderness study area in sec. 17, T. 27 N., R. 100 W. This well bottomed in the Dakota Formation at 22,690 ft after penetrating several thousand feet of crystalline rock in the thrust plate, and it was plugged and abandoned with no shows of oil or gas (Robbie Gries, oral commun., 1985). The lack of success of the large number of wells in the area does not support a rating of high potential. Accordingly, the resource potential for oil and gas is judged as moderate for areas beneath the overhang of the Wind River thrust and moderate for areas south of the fault zone in stratigraphic traps. The certainty level of this assessment is rated as C.

Uranium

Four types of uranium deposits occur near the wilderness study area in rocks similar to those found in the wilderness study area. These are the roll-front-type deposits of Crooks Gap, the tabular deposits of the Sweetwater district, the schroekingerite deposits of Lost Creek, and the uraniferous coals of the Great Divide Basin (fig. 2).

The largest of these deposits are the roll-front-type deposits of Crooks Gap, Lost Soldier Creek, and Picket Lake (Bailey, 1972; Love, 1970). These occur in the Paleocene and Eocene Battle Spring Formation, which is the equivalent of parts of the Wasatch and Green River Formations but is generally coarser grained, due to its proximity to source areas. 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). It is arkosic, coarse grained, and permeable, and contains much carbonaceous material that may have acted as the reductant for the precipitation of uranium minerals (Rackley, 1972).

Possible sources for the uranium include the granitic rocks of the Granite Mountains (Stuckless and Nkomo, 1978), either in solutions derived from weathered granite or as leachate from granitic fragments after deposition in the arkose. Another model proposes that uranium-rich tuffaceous strata once covered the area and provided uranium-rich ground water. These may have been lacustrine rocks of Pliocene age (Love, 1970) or tuffaceous rocks of Oligocene or Miocene age (Harshman, 1972). In either case, factors considered critical for the formation of a deposit are uranium-rich water migrating through gently tilted permeable rocks, a reductant to precipitate the uranium minerals, and sufficient quantity of solution and host rock to produce a deposit. The deposits may be tabular masses of uranium ore within a sandstone bed

or may take the form of a roll front (or roll), a curvilinear zone of rich ore that may extend laterally several hundred yards to several miles, such as at Crooks Gap. These roll fronts are thought to represent an interface zone between two solutions: a migrating, oxidizing solution, which carries the dissolved uranium; and the reducing solution that occupies pore spaces in the host rock. The oxidizing solutions alter the sediments as they migrate through them, bleaching the gray to gray-green reduced rocks to white and rusty colors. At the interface, where oxidizing solutions meet reducing solutions, a series of geochemical reactions occur, resulting in the deposition of uranium oxides. Deposits are characterized by sharp ore contacts. Successive episodes of precipitation may be necessary to create an ore-grade deposit. The major deposits of the region all still lie below the ground water table (Bailey, 1972; Harshman, 1972; Rackley, 1972).

The tabular deposits of the Sweetwater district (Wayland and Sayala, 1983) resemble roll-type deposits except that the ore is lower grade and more disseminated in sandstone. Generally the sandstone is encased in impermeable reducing rock, such as carbonaceous mudstone.

Deposits of this type have been mined by in-situ techniques in Bison Basin, 20 mi east of the study area, by the Ogle-Western Corp. The producing zone was apparently the intertonguing contact of the Laney Member and the Battle Spring Formation (Ray Harris, Wyoming Geological Survey, oral commun., 1986).

The schroekingerite deposits of Lost Creek, used as a model here, just east of the wilderness study area, apparently form by the evaporation at the surface of uranium-bearing ground water (Sheridan and others, 1962). The mineralized rock appears as crusts or caliche deposits at or near the surface. Schroekingerite is a vivid yellow, hydrated fluo-carbonate-sulfate of calcium, sodium, and uranium (Bailey, 1972; Elevatorski, 1976).

Some coal beds in the Great Divide Basin have been found to contain more than 0.003 percent uranium (Pipiringos, 1961; Masursky, 1962). Although generally of low grade, the beds may be quite extensive in some parts of the basin. Deposits of this type are discussed in the section on "Coal" in this report.

Rocks favorable for a roll-front-type uranium deposit are scarce within the wilderness study area. Investigations of sandstone bodies within the Cathedral Bluffs Tongue of the Wasatch Formation showed a lack of carbonaceous material, some low detectable radioactivity, but no visible uranium minerals. The sandstone bodies represent paleostream channels within the Cathedral Bluffs Tongue and make up only 5 to 15 percent of each stratigraphic section measured. The sandstones were mainly re-

duced facies, indicating no passage of oxidizing fluids. The exception was a major paleodrainage within the Cathedral Bluffs Tongue in the southern part of the wilderness study area that had been fully oxidized as indicated by rock colors, but the solution interface, wherever it had existed, was eroded away.

The main body of the Wasatch in the subsurface is difficult to evaluate directly. Examination of well logs from the vicinity showed no unusually radioactive zones or extensive sandy zones characteristic of the Battle Spring Formation, the common host rock for roll-type deposits. Mineral resource potential for uranium in roll-type deposits in the study area was judged as low, with a certainty level of B.

Geologic conditions suitable for a tabular deposit may exist in the conglomeratic lenses of the Cathedral Bluffs Tongue in the drainage of Sand Creek adjacent to the Continental fault. These rocks are from a mainly nongranitic source area and are not visibly carbonaceous. The lenses are, however, encased in reduced gray-green mudstone and were overlain by tuffaceous beds of the Arikaree Formation, which may have contributed uranium to ground water percolating down or along the Continental fault. This situation could conceivably be favorable for development of small tabular uranium deposits. Water issuing from a spring at the base of the conglomerate body (NW¼ sec. 29 T. 27 N., R. 99 W.) (pl. 1) was sampled and analyzed as part of the National Uranium Resource Evaluation (NURE) Program and found to contain only 5 to 10 ppb (parts per billion) dissolved uranium, which is as much as 10 times less than water associated with an actual deposit but greater than the regional average of 3.5 ppb. Sediments at the spring were also low in uranium (2.1–3.0 ppm) (Shannon and Sandoval, 1979; Denson and others, 1956). Elevatorski (1976) reported a uranium occurrence in sec. 27, T. 27 N. R. 101 W., just outside the wilderness study area, but failed to specify the formation or mineral name, and we could not locate the site. Low geochemical anomalies for uranium were noted from USGS samples taken adjacent to the Continental fault. Possible explanations include leaching of uranium from overlying tuffaceous sandstones of the Arikaree Formation, percolation down the Continental fault, precipitation in the Cathedral Bluffs conglomerates, or simply the presence of some heavy detrital minerals from an unknown Archean source to the north. The latter explanation is considered the more likely due to lack of known effective precipitation mechanisms in the conglomerate. It is not, however, possible to rule out the possibility of a small, tabular uranium deposit adjacent to the Continental fault.

A moderate mineral resource potential for uranium in tabular deposits is designated for 2 mi² of conglomerate-rich ground adjacent to the Continental fault in the Sand Creek drainage. Certainty of the assessment is rated

as B, due to paucity of data. A small geochemical anomaly for uranium and a moderately favorable geologic environment also suggest a moderate resource potential for uranium.

Deposits of schroëckingerite were never observed at any locality where alkali crusts indicated a zone of evaporation of ground water at the surface.

Botanical indicators of uranium mineralization were noted only in places. Some areas underlain by the Laney Member of the Green River Formation had isolated prince's plume (*Stanleya* sp.), but no locoweed (*Astragalus* sp.) was seen. If selenium, which accompanies uranium minerals, is present at the surface, these plants will grow in some abundance (Cannon and Kleinhampl, 1956).

Scintillometer surveys of the area by the USGS and the USBM showed only one zone of anomalously high radioactivity. Joints in a tuffaceous sandstone within the Bridger Formation high on the north side of Continental Peak gave values somewhat greater than twice background level, indicating some reconcentration of radioactive materials by downward-percolating fluids, but no mineralized rock was observed.

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 200 ft thick and covering approximately 10,000 acres. The Tipton Shale Member underlies the wilderness study area but is nowhere exposed at the surface.

The richest deposits of oil shale in Wyoming are found 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 gal/ton (gallons of oil per ton of rock), in beds more than 30 ft thick, less than 1,500 ft below the surface (Culbertson, 1972).

The oil shales of the Laney have been tested by the USGS and USBM. Locations of drill holes are shown on plate 1. The average values of contained oil were 2.5 gal/ton. The highest value from one bed was 7.4 gal/ton (Zeller and Stephens, 1969). No additional oil shale sampling was done during this investigation. The previously established low grade, thinness of possible source beds, and distance from known areas of rich oil shale mandate a rating of low potential for oil shale, with certainty level of A.

Coal

No outcrops of coal were found within the wilderness study area. Evaluation of well logs from south and

west of the study area show thin, discontinuous coal beds between depths of 2,500 and 6,000 ft. These coals are considered to be in the Paleocene Fort Union Formation. The beds decrease in number and thickness northward. Only thin streaks of coal were noted in the main body of the Wasatch at shallower depths as determined from the same well-log data (Zeller and Stephens, 1969). The resource potential for coal is rated as low, as is the potential for uranium-rich coal, with a certainty level of B.

Placer Gold

During Eocene time, uplift of the north side of the Continental fault caused deposition of coarse boulder conglomerate in alluvial fans and sheets over the muddy flood plains of the Cathedral Bluffs Tongue of the Wasatch Formation. Today, these ancient alluvial fans stand as rounded hills above and to the south of the north-facing fault scarp produced by downward sag of the Wind River Range along the Continental fault in Pliocene time (fig. 4) (Love, 1970). Examples of these conglomerates adjacent to the wilderness study area include an unnamed lobe north of State Highway 28, Pacific Butte, and the butte above Dickie Springs. Another lobe within the wilderness study area north of Sand Creek was identified during the course of these investigations (fig. 5). Each has lithology characteristic of an identifiable source area in Archean rocks north of the fault.

The Dickie Springs lobe has received attention in the past due to its associated placer-gold deposits in T. 27 N., R. 100 W. and R. 101 W. at Dickie Springs and Oregon Gulch (fig. 2). The source of the gold has not been identified to date; trace-element signatures of gold from the Dickie Springs placers do not match those of the Sweetwater district (Love and others, 1978). Cuttings from the deep Amoco Production Co. subthrust well in sec. 17, T. 27 N., R. 100 W. (pl. 1) show sulfide-mineralized rock from the deeply buried thrust plate, which may represent the source of the gold in the placers near Dickie Springs (J. C. Antweiler, oral commun., 1985). Apparently fluvial reconcentration mechanisms were not sufficiently active in the alluvial fans to enrich gold much beyond bedrock values. The concentrating effect of modern stream erosion and deposition was, in some cases, sufficient to enrich the gold values in the Quaternary alluvium. Similar deposits have been described in the Iron Springs district of northern Colorado by Theobald (1970).

The Dickie Springs deposit serves as a model for the deposit of Sand Creek (herein called the Sand Creek lobe), which was shown to contain small amounts of detrital gold. The characteristic and unique lithologies of the Sweetwater mining district to the north (figs. 2, 4) (Bayley, 1973) dominate the clast composition of this lobe, and therefore that area is presumed to be the source.

The presence of gold was first established by stream-sediment sampling during a geochemical survey of the wilderness study area. Discoveries were made near Edmund Springs (pl. 1), the westernmost tip of the study area, and in the drainage of Sand Creek to the east. The western location has a limited conglomeratic source area remaining due to erosion and seems to have been a paleochannel or channels in the Cathedral Bluffs Tongue related to the Dickie Springs lobe. The Sand Creek discovery is in alluvium of Quaternary age derived from a large body of conglomerate in the upper Cathedral Bluffs. Additional sampling of Quaternary alluvium and of conglomerate of Tertiary age showed that 5 of 28 samples of alluvium contained one or more gold flakes, but none of the 7 samples of Tertiary conglomerate yielded any gold. A large volume (0.5 yd³) of the uppermost conglomerate was sampled and panned by D. C. Scott of the USBM, and a few flakes were recovered.

The measured aggregate thickness of the gold-bearing conglomerate layers within the mudstone is 49 ft. The exact grade is unknown, but it seems low. The Quaternary gravels that yielded most of the gold were uniformly less than 2 ft thick and of variable width. The highest gold values were found in the narrow upper parts of the tributaries of Sand Creek. Total volume of Tertiary conglomerate exposed at the surface is estimated at 2 million yd³, of the Quaternary alluvium, 65,000 yd³. The regional gravity survey (fig. 5) shows anomalies over the known conglomerate lobes. A gravity high with no associated topographic feature is just southeast of Continental Peak and perhaps represents a conglomerate lobe in the subsurface.

The mineral resource potential for deposits of placer gold within the Honeycomb Buttes Wilderness Study Area is rated as low for those of Tertiary age and moderate for those of Quaternary age. The certainty of this assessment is rated C. Two areas of moderate potential are designated: stream gravels north of Sand Creek and stream gravels south of Edmund Spring (pl. 1, fig. 1), which are derived from gold-bearing paleochannels of Eocene age within the Cathedral Bluffs Tongue.

Suggestions for Future Work

Drilling of areas adjacent to the Continental fault might delineate more areas of possible gold-bearing gravels in the Cathedral Bluffs Tongue and zones of uranium mineralization localized by the fault. Trenching and testing large volumes of Quaternary alluvium might reveal the presence of workable placer gold deposits on Sand Creek and other drainages.

Regional geologic studies and deep drilling would give a more detailed understanding of stratigraphic traps for oil and gas in the deeper subsurface.

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APPENDIX

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:

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RESOURCE / RESERVE CLASSIFICATION

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

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

GEOLOGIC TIME CHART
Terms and boundary ages used by the U. S. Geological Survey, 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
				Mesozoic	Cretaceous
	Early	96			
	Jurassic	Late	138		
		Middle			
	Triassic	Early	205		
		Paleozoic	Permian		Late
	Early				290
	Carboniferous Periods		Pennsylvanian	Late	290
			Mississippian	Middle	
			Early	~ 330	
			Devonian	Late	360
	Middle				
	Silurian		Early	410	
			Ordovician	Late	435
	Middle				
	Cambrian	Early	500		
		Proterozoic	Late Proterozoic		
	Middle Proterozoic			900	
	Early Proterozoic			1600	
Archean	Late Archean			2500	
	Middle Archean			3000	
	Early Archean			3400	
pre - Archean ²		3800?			
					4550

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

² Informal time term without specific rank.

