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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHEAST QUARTER OF THE FIREHOLE BASIN 15-MINUTE QUADRANGLE, SWEETWATER COUNTY, WYOMING

[Report includes 9 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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This report has not been edited
for conformity with U.S. Geological
Survey editorial standards or
stratigraphic nomenclature.

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the northeast quarter of the Firehole Basin 15-minute quadrangle, Sweetwater County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-17104. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through May, 1978, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

In this report, the term "quadrangle" refers only to the northeast quarter of the Firehole Basin 15-minute quadrangle which is located in southwestern Sweetwater County, approximately 7 miles (11 km) southwest of the city of Rock Springs and 6 miles (10 km) southeast of the town of Green River, Wyoming. The area is unpopulated.

Accessibility

Wyoming Highway 373, a paved medium-duty road, crosses the quadrangle from north to south, connecting Interstate Highway 80 west of Rock Springs with the Wyoming-Utah border (Wyoming State Highway Commission, 1978). An improved light-duty road follows Little Bitter Creek along the eastern edge of the quadrangle, connecting Rock Springs with the South Baxter Basin gas field. The remainder of the quadrangle is served by several unimproved dirt roads and trails. Interstate Highway 80 lies approximately 3 miles (5 km) north of the quadrangle boundary.

The main east-west line of the Union Pacific Railroad passes approximately 3 miles (5 km) north of the quadrangle. This line provides railway service across southern Wyoming, connecting Ogden, Utah to the west with Omaha, Nebraska to the east.

Physiography

The northeast quarter of the Firehole Basin 15-minute quadrangle lies on the southwestern edge of the Rock Springs uplift. The landscape in the eastern half of the quadrangle is characterized by a relatively flat valley which changes abruptly to rugged badland topography, mountains and canyons on the west. Altitudes in the quadrangle range from 7,644 feet (2,330 m) on Wilkins Peak in the northwestern corner of the quadrangle to approximately 6,200 feet (1,890 m) in Little Firehole Canyon on the southwestern edge of the quadrangle. Flattop Mountain rises approximately 800 feet (244 m) above the valley of Middle Firehole Canyon.

Slippery Jim Canyon, Middle Firehole Canyon, and Little Firehole Canyon drain the western half of the quadrangle into the Flaming Gorge Reservoir on the Green River west of the quadrangle boundary. Little Bitter Creek drains the eastern half of the quadrangle. It flows north into Bitter Creek, a tributary of the Green River, north of the quadrangle boundary. All of the streams on the quadrangle are intermittent and flow mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of southwestern Wyoming is semiarid and is characterized by low precipitation, rapid evaporation, and large daily temperature changes. Summers are usually dry and mild, and winters are cold. The annual precipitation averages 9 inches (23 cm), with approximately two thirds falling during the spring and early summer months.

The average annual temperature is 42°F (6°C). The temperature during January averages 18°F (-8°C), with temperatures ranging from 8°F (-13°C) to 28°F (-2°C). During July temperatures range from 54°F (12°C) to 84°F (29°C), with an average of 69°F (21°C) (U.S. Bureau of Land Management, 1978, and Wyoming Natural Resources Board, 1966).

Winds are usually from the west-southwest and southwest with an average velocity of 11 miles per hour (18 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the area include sagebrush, saltbush, greasewood, rabbitbrush, mountain mahogany, juniper, serviceberry and grasses (U.S. Bureau of Land Management, 1978).

Land Status

The northeast quarter of the Firehole Basin 15-minute quadrangle lies in the southwestern part of the Rock Springs Known Recoverable Coal Resource Area (KRCRA). Approximately two thirds of the quadrangle's total area lies within the KRCRA boundary with the Federal government owning the coal rights for approximately 65 percent of this area. One active coal lease is present within the KRCRA boundary, as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Schultz described the geology and coal resources of the southern part of the Rock Springs coal field that includes the quadrangle in 1910. Hale (1950), Douglass and Blazzard (1961), Smith (1961), Burger (1965) and Gosar and Hopkins (1969) discussed the stratigraphy and depositional environment of Upper Cretaceous formations in the Rock Springs area. Roehler described the Late Cretaceous-Tertiary unconformity (1961) and Early Tertiary depositional environments (1965), and Bradley (1964) and Culbertson (1965) described Tertiary strata in the Rock Springs uplift area. Roehler and others described the geology and coal resources of the Rock Springs coal field in 1977. Roehler prepared a geologic map of the Rock Springs uplift in 1977 and correlated coal beds in several formations in the Rock Springs area in 1978. Culbertson (no date) provided semi-detailed coal outcrop maps and measured sections of parts of the Firehole Basin 15-minute quadrangle. Unpublished data from Rocky Mountain Energy Company (RMEC) also provided coal thickness information for this quadrangle.

Stratigraphy

The formations cropping out in the northeast quarter of the Firehole Basin 15-minute quadrangle range in age from Late Cretaceous to Oligocene. All the formations in this quadrangle, except the Ericson Sandstone and the Bishop Conglomerate, are thought to contain coal.

The Mesaverde Group of Late Cretaceous age is subdivided into four formations which are, in ascending order, the Blair, Rock Springs, Ericson Sandstone, and Almond Formations, of which only the upper three formations crop out in this quadrangle.

The upper part of the Rock Springs Formation crops out in the extreme northeast corner of the quadrangle (Culbertson, no date, and Roehler, 1977). The formation consists of carbonaceous shale, sandstone, siltstone and thin coal (Roehler, 1978).

The Ericson Sandstone, unconformably overlying the Rock Springs Formation, crops out in the northeastern corner of the quadrangle, generally in the area east of Little Bitter Creek (Culbertson, no date, and Roehler, 1977). The Ericson Sandstone is approximately 600 feet (183 m) thick where measured in sec. 16, T. 17 N., R. 105 W. (Roehler, 1978). It consists of upper and lower units of light-gray, cross-bedded, fine- to coarse-grained sandstone separated by a section of rusty-weathering shale approximately 80 feet (24 m) thick, carbonaceous shale, siltstone, and thin sandstone called the Rusty Zone (Smith, 1961, and Roehler, 1978).

The Ericson Sandstone is, in some places, conformably overlain by a deeply eroded section of the Almond Formation. The Almond Formation crops out just west of Little Bitter Creek in secs. 21, 28, and 33, T. 17 N., R. 105 W. (Culbertson, no date), but is missing due to erosion in other parts of the quadrangle. It is 120 feet (37 m) thick where measured in sec. 21, T. 17 N., R. 105 W. (Roehler, 1978), and consists of carbonaceous shale, shale, and thin sandstone and coal. The formation appears to thicken to the southeast (Roehler, 1977).

The Fort Union Formation of Paleocene age unconformably overlies either the Almond Formation or the Ericson Sandstone. The formation generally trends north-south, cropping out in the eastern half of the quadrangle (Roehler, 1977). It consists of approximately 600 to 900 feet (183 to 274 m) of light-gray shale, sandy shale and siltstone, thick beds of gray-white to white coarse-grained sandstone (some cross-bedded), gray to brown carbonaceous shale, and coal beds (Roehler, 1961).

The main body of the Wasatch Formation of Eocene age conformably overlies the Fort Union Formation and crops out over the central part of the quadrangle (Roehler, 1977). It is approximately 1,200 feet (366 m) thick and consists of a sequence of red sandstones and thin interbedded red shales, known as the Fire Hole Sandstone facies, overlain by a red-bed fluviatile unit that lacks the thick sandstones of the underlying Fire Hole Sandstone facies (Roehler, 1965). A few coal beds in the upper part of the main body are usually present (Culbertson, 1965).

Approximately 15 feet (4.6 m) of low-grade oil shale and lignite, forming the Luman Tongue of the Green River Formation of Eocene age, conformably overlie the main body of the Wasatch Formation (Culbertson, 1965). It crops out in a narrow north-south trending band through the west-central part of the quadrangle (Roehler, 1977). The Luman Tongue undergoes a facies change to the south, where it is characterized by shales and siltstones (Roehler, 1965).

The Niland Tongue of the Wasatch Formation crops out in the west-central part of the quadrangle (Roehler, 1977), where it conformably overlies the Luman Tongue of the Green River Formation. It consists of approximately 455 feet (139 m) of red-bed fluvial claystone, siltstone, mudstone and sandstone (Culbertson, 1965).

The Tipton Tongue (Tipton Shale Member) of the Green River Formation conformably overlies the Niland Tongue of the Wasatch Formation and crops out in a narrow north-south trending band through the west-central part of the quadrangle (Roehler, 1977). It consists of approximately 150 feet (46 m) of buff-colored papery low-grade oil shale, marlstone, and sandstone (Bradley, 1964).

The Wilkins Peak Member of the Green River Formation conformably overlies the Tipton Tongue and is approximately 1,000 feet (305 m) thick (Bradley, 1964), cropping out along the western edge of the quadrangle (Roehler, 1977). This member is composed of gray to green mudstone, and abundant thin beds of gray dolomitic siltstone, marlstone, dolomite and limestone, and buff-colored calcareous sandstone.

The Bishop Conglomerate unconformably overlies the main body of the Wasatch Formation in the southeastern corner of the quadrangle. The conglomerate is believed to be Oligocene in age and consists of cobbles and pebbles of quartz, hornblende gneiss, granite, and chert (Bradley, 1964 and Roehler, 1973, 1977).

Recent deposits of alluvium cover Slippery Jim, Middle Firehole, and Little Firehole Canyons, as well as the stream valley of Little Bitter Creek.

Both marine and continental deposits are contained in the Rock Springs Formation. Northwest of a strand line extending from approximately the southeastern corner of T. 16 N., R. 106 W., northeastward through T. 22 N., R. 100 W., the formation consists of sediments deposited in swamp, deltaic and fluvial environments. Southeast of the strand line the formation consists mainly of shallow-water marine deposits (Burger, 1965, Douglass and Blazzard, 1961, and Gosar and Hopkins, 1969).

The Ericson Sandstone was deposited in stream and floodplain environments with a source area to the northwest (Douglass and Blazzard, 1961, and Gosar and Hopkins, 1969).

The Almond Formation reflects deposition in fresh-water coastal swamps (Hale, 1950, and Roehler, 1978).

The rocks of the Fort Union Formation are characteristic of sediments deposited in intermontane paludal environments (Roehler, 1978).

The coarse clastic nature of the main body of the Wasatch Formation suggests a local sediment source and deposition in a well-drained oxidizing environment (Roehler, 1965).

Swampy and fluvial conditions alternately prevailed between episodes of fresh-water lake formation, giving rise to the Luman, Niland, Topton, and Wilkens Peak Members (Culbertson, 1965, and Roehler, 1965).

The cobbles and pebbles of the Bishop Conglomerate were derived from the ancestral Uinta Mountains to the south of this area (Bradley, 1964).

Structure

The northeast quarter of the Firehole Basin 15-minute quadrangle is located along the western flank of the Rock Springs uplift. Throughout most of the quadrangle, the formations generally strike northeast, north, or northwest and dip 4° to 15° to the southwest-northwest. Dips become progressively steeper in the Fort Union Formation as it is traced northward to the northern boundary of the quadrangle. Several faults have been mapped in the northeastern part of the quadrangle (Culbertson, no date).

COAL GEOLOGY

Outcrops of coal beds within the Rock Springs, Almond, and Green River (Luman Tongue) Formations in this quadrangle have not been reported by previous workers. It is believed that coal beds which may exist are probably less than Reserve Base thickness (5.0 feet or 1.5 meters).

Culbertson (no date) mapped four laterally continuous Fort Union Formation coal beds in the eastern half of the quadrangle and Roehler (1977) indicates two Wasatch Formation (main body) coal beds on his map of the Rock Springs uplift where indicated on plate 1.

Chemical analyses of coal.--Roehler and others (1977) state that coal in the main body of the Wasatch Formation is ranked from subbituminous A to lignite and consistently has 4 to 9 percent sulfur. Data on coal quality for the Fort Union, Almond and Rock Springs Formation coal beds in this quadrangle are not available.

Coal Beds of the Fort Union Formation

Four Fort Union Formation coal beds in two distinct zones have been mapped by Culbertson (no date) in this quadrangle. The upper zone consists of two coal beds separated by approximately 30 feet (9 m) of rock. Rocky Mountain Energy Company (RMEC) has named the upper coal bed G and the lower one F. Neither of these coal beds exceeds Reserve Base thickness (5 feet or 1.5 meters) in this quadrangle or where they can be traced to the south in the adjacent southeast quarter of the Firehole 15-minute quadrangle.

The lower coal zone is located approximately 350 feet (107 m) below the upper coal zone and consists of two coal beds, the E and D, separated by 3 to 43 feet (0.9 to 13.1 m) of rock. The E coal bed is stratigraphically higher. The D coal bed ranges from 4.0 to 7.2 feet (1.2 to 2.2 m) in thickness where measured in the quadrangle and commonly contains 0.5 feet (0.2 m) of rock partings. The E coal bed does not exceed Reserve Base thickness in this quadrangle or in the adjacent quadrangle to the south. The D coal bed thickens locally to 8.5 feet (2.6 m), excluding 0.7 feet (0.2 m) of partings, in the quadrangle to the south. To the north, in the Kanda quadrangle, the D coal bed thickens locally to 11 feet (3.4 m), but is usually less than Reserve Base thickness.

Coal Beds of the Wasatch Formation

The Big Firehole and Middle Firehole coal beds, located in the upper part of the main body of the Wasatch Formation, are shown on plate 1. Although information pertaining to the thickness of these coal beds is not available, the coal beds can be traced south (beyond the quadrangle boundary) for several miles (Roehler, 1977).

Isolated Data Points

In instances where isolated measurements of coal beds thicker than 5 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known beds. For this reason, isolated data points are included on a separate sheet (in U.S. Geological Survey files) for non-isopached coal beds. The isolated data point used in this quadrangle is located in sec. 7, T. 16 N., R. 105 W., where a Fort Union Formation coal bed 6 feet (1.8 m) thick was encountered 53 feet (16.2 m) below the D coal bed.

COAL RESOURCES

Coal test holes drilled by RMEC, as well as surface mapping by Schultz (1910) and Culbertson (no date), were used to construct outcrop, isopach, and structure contour maps of the D coal bed in this quadrangle. At the request of RMEC, coal-rock data for some of their drill holes are not shown on plate 1 or on the derivative maps. However, data from these holes have been used to construct the derivative maps. These data may be obtained by contacting RMEC. The source of each indexed data point shown on plate 1 is listed in table 3.

Coal resources were calculated using data obtained from the coal isopach map (plate 4). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed, and by a conversion factor of 1,770 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, yields the coal resources in short tons for each isopached coal bed. Coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from that used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a maximum depth of 1,000 feet (305 m) for subbituminous coal.

Reserve Base tonnages have been calculated for all areas where the D coal bed is of Reserve Base thickness or greater. However, Reserves have been calculated for only that part of the Reserve Base considered to be suitable for conventional subsurface mining. An arbitrary dip limit of 15° is assumed to be the maximum dip suitable for conventional subsurface mining methods, and Reserves have not been calculated for those areas where the dip of the D coal bed exceeds 15°.

Reserve Base and Reserve tonnages for the D coal bed are shown on plate 7 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 13.89 million short tons (12.60 million metric tons) for the entire quadrangle, including tonnages from the isolated data point. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 1 and 2.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn so as to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is as follows:

$$MR = \frac{t_o \, (cf)}{t_c \, (rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining ratio values of 0 to 10, 10 to 15, and greater than 15.

These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potentials for surface mining methods. This applies to the areas where no known coal beds of 5 feet (1.5 m) or more thick occur and to the area influenced by the isolated data point. Limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coals in these areas prevents accurate evaluation of the development potential in the high, moderate, or low categories. The area influenced by the isolated data point in this quadrangle contains only approximately 50,000 short tons (45,000 metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 8. Of the Federal land areas having a known development potential for surface mining methods, 87 percent are rated high, 2 percent are rated moderate, and 11 percent are rated low. The remaining Federal lands within the KRCRA boundary are classified as having an unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods are those areas where the coal beds of Reserve Base thickness are between 200 and 3,000 feet (61 and 914 m) below the ground surface and have dips of 15° or less. Coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining are defined as areas underlain by coal beds of

Reserve Base thickness at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 feet to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), below the ground surface, respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to those areas where coal beds of Reserve Base thickness are not known to occur, and to those areas where coal beds of Reserve Base thickness lie at depths greater than 200 feet (61 m) and have dips exceeding 15°.

The coal development potential for conventional subsurface mining methods is shown on plate 9. All of the Federal land areas classified as having known development potential for conventional subsurface mining, 91 percent are rated high and 9 percent are rated moderate. The remaining Federal land is classified as having unknown development potential for conventional subsurface mining methods.

In some areas of the quadrangle, coal beds are present that dip in excess of 15°, but because of the low amount of tonnages available for in-situ mining and the presence of several faults, these areas have been rated as having an unknown development potential for in-situ mining methods.

Table 1. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the northeast quarter of the Firehole Basin quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
D	3,450,000	940,000	2,610,000	-0-	7,000,000
Isolated data points	-0-	-0-	-0-	50,000	50,000
Totals	3,450,000	940,000	2,610,000	50,000	7,050,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 2. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the northeast quarter of the Firehole Basin quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
D	5,250,000	1,380,000	-0-	210,000	6,840,000
Totals	5,250,000	1,380,000	-0-	210,000	6,840,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AD
2	↓	Drill hole No. 2AD
3	↓	Drill hole No. 3AD
4	↓	Drill hole No. 4AD
5	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 238	Measured Section
6	↓	Measured Section
7	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AD
8	↓	Drill hole No. 2AD
9	↓	Drill hole No. 3AD
10	↓	Drill hole No. 4AD
11	↓	Drill hole No. 1AS
12	Mountain Fuel Supply Co.	Oil/gas well No. 1 Unit-Firehole
13	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
14	Culbertson, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-470 B
15	↓	Measured Section No. C62-471
16	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
17	Culbertson, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-573
18	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3AS
19	Cities Service Oil Co.	Oil/gas well No. 1 Unit
20	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
21	Culbertson, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-461
22	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AD
23	↓	Drill hole No. 2AD
24		Drill hole No. 3AD
25		Drill hole No. 4AD
26		Drill hole No. 5AD
27		Drill hole No. 1AD
28		Drill hole No. 2AD
29		Drill hole No. 3AD
30		Drill hole No. 4AD
31		Drill hole No. 5AD
32		Drill hole No. 6AD
33		Drill hole No. 1AS

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
34	Culbertson, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-470 A
35	Davis Oil Co.	Oil/gas well No. 1 Little Miller Canyon
36	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
37	Culbertson, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-469
38	↓	Measured Section No. C62-468
39	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
40	↓	Drill hole No. 1AS
41	↓	Drill hole No. 2AS
42	Miami Oil Producers	Oil/gas well No.1 North Firehole
43	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
44	Culbertston, (no date), U.S. Geological Survey, unpublished data	Measured Section No. C62-479

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