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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE THAYER JUNCTION 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.

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Thayer Junction 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 Published and unpublished public information available through May, 1978, was used as the data base for this study.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

The Thayer Junction quadrangle is located in central Sweetwater County, Wyoming, approximately 12 miles (19 km) northeast of the city of Rock Springs and 5 miles (8 km) west of the town of Point of Rocks, Wyoming. Salt Wells and Thayer Junction are former loading stations on the Union Pacific Railroad. The quadrangle is unpopulated.

Accessibility

Interstate Highway 80 follows the Bitter Creek valley southwesterly through the central part of the quadrangle. Wyoming Highway 371, a paved medium-duty road connecting Interstate Highway 80 with the town of South Superior north of the quadrangle boundary, follows Horsethief Canyon north through the central part of the quadrangle (Wyoming State Highway Commission, 1978). The route of the old Overland Trail also crosses the quadrangle through the Bitter Creek valley. Numerous unimproved dirt roads and trails provide access through the remainder of the quadrangle.

The main east-west line of the Union Pacific railroad crosses the central part of the quadrangle through Bitter Creek valley. This line provides railway service across southern Wyoming connecting Ogden, Utah, to the west with Omaha, Nebraska, to the east.

Physiography

The Thayer Junction quadrangle is located in the north-central part of the Rock Springs uplift and on the northeastern edge of the Baxter Basin (Roehler, 1977). The landscape within the quadrangle is characterized by a rugged terrain of buttes, steep escarpments, canyons and ravines. One small area in the southwestern corner of the quadrangle, a part of the North Baxter Basin, is relatively flat-lying. Altitudes in the quadrangle range from approximately 6,340 feet (1,932 m) on Bitter Creek along the southwestern edge of the quadrangle to approximately 7,460 feet (2,274 m) at the crest of an escarpment along the northeastern edge of the quadrangle.

Bitter Creek, a tributary of the Green River to the west of the quadrangle, flows southwesterly across the central part of the quadrangle. Salt Wells Creek and Black Butte Creek, both tributaries of Bitter Creek, flow northwesterly through the southern part of the quadrangle. Horsethief Canyon, also a tributary of Bitter Creek, flows southerly through the north-central part of the quadrangle draining the northern two thirds of the quadrangle.

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 typically ranging from 8°F (-13°C) to 28°F (-2°C). During July temperatures typically range from

54°F (12°C) to 84°F (29°C), with an average of 69°F (21°C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west-southwest and southwest with an average annual 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, rabbitbrush, greasewood, mountain mahogany, juniper and grasses (U.S. Bureau of Land Management, 1978).

Land Status

The Thayer Junction quadrangle lies in the north-central part of the Rock Springs Known Recoverable Coal Resource Area (KRCRA). The northeastern part of the quadrangle, approximately 25 percent of the quadrangle's total area, lies within the KRCRA boundary. The Federal government owns the coal rights for less than half of this area as shown on plate 2. No outstanding Federal coal leases, prospecting permits, or licenses occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Schultz described the geology and coal resources of the northern part of the Rock Springs coal field in 1909 and the geology and structure of the Baxter Basin and surrounding area in 1920. Dobbin (1944) mapped the geology and coal resources of the adjacent Superior coal field. Hale described the stratigraphy and depositional history of the formations cropping out on the flanks of the Rock Springs uplift in 1950 and 1955. Weimer (1960), Smith (1961), Burger (1965), and Keith (1965) described the stratigraphy and discussed the depositional environment of Upper Cretaceous formations in the Rock Springs area. The depositional history of the Upper Cretaceous formations exposed on the flanks of the Rock Springs uplift was also described by Weimer (1961) and Douglass and Blazzard (1961). 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 and adjacent areas (1977) and correlated coal beds in the Rock Springs Formation on the east flank of the uplift (1978). Madden mapped the adjacent Point of Rocks quadrangle in 1977. Unpublished data from Rocky Mountain Energy Company (RMEC) provided coal thickness information.

Stratigraphy

The formations cropping out in the Thayer Junction quadrangle are Late Cretaceous in age and trend roughly northwest-southeast across the quadrangle (Roehler and others, 1977). The Rock Springs Formation is the only important coal-bearing unit in the quadrangle.

The Baxter Shale of Late Cretaceous age crops out in the southwestern corner of the quadrangle (Roehler, 1977) where it ranges in thickness from approximately 3,350 to 3,600 feet (1,021 to 1,097 m) (Hale, 1950). This formation consists of soft dark-gray, gypsiferous, slightly sandy shale and thin-bedded ripple-marked sandstone containing concretions of impure limestone. The Baxter Shale is generally divided into upper and lower shale units by a prominent middle sandy member. The marine Baxter Shale forms the floor of Baxter Basin and is non-coal-bearing (Hale, 1950 and 1955; Smith, 1961).

The Mesaverde Group of Late Cretaceous age conformably overlies and laterally intertongues with the Baxter Shale. The Mesaverde Group is subdivided into four formations which are, in ascending order, the Blair Formation, the Rock Springs Formation, the Ericson Sandstone, and the Almond Formation.

The Blair Formation crops out in the southwestern quarter of the quadrangle (Roehler, 1977) and is approximately 1,350 feet (411 m) thick where measured in several oil and gas wells drilled in the quadrangle. The lower section of the formation is composed of a thick series of light-brown, thin-bedded, fine- to medium-grained sandstones. This is overlain by light-brownish-gray arenaceous siltstone, and brownish-gray silty to sandy shale. The upper section of the formation consists of light-brown sandy shale, occasional thin coal beds and thin brown sand stone which grades upward into the sandstones of the Rock Springs Formation (Hale, 1950 and 1955; Smith, 1961; Keith, 1965).

The Rock Springs Formation, conformably overlying the Blair Formation is approximately 1,750 feet (533 m) thick where measured by Roehler (1978) in the quadrangle. Cropping out across the northern and eastern part of the quadrangle (Roehler, 1977), the Rock Springs Formation consists of a sequence of interbedded coal, carbonaceous shale, siltstone, claystone, and sandstone (some cross-bedded), and coal (Hale, 1950; Keith, 1965; Roehler, 1978).

The Ericson Sandstone unconformably overlies the Rock Springs Formation (Roehler and others, 1977) and crops out in the northeastern corner of the quadrangle (Roehler, 1977). The formation consists of light-gray to white, massive cross-bedded sandstone (Hale, 1950 and 1955; Smith, 1961).

Part of the Almond Formation, which conformably overlies the Ericson Sandstone, crops out in the northern part of sec. 36, T. 21 N., R. 102 W. (Roehler, 1977). The lower section of the formation consists of carbonaceous shale, siltstone, mudstone and sandstone alternating with coal beds of variable thickness and quality (Hale, 1950 and 1955). The Almond Formation has been faulted into this area and is not shown in the composite stratigraphic section shown on plate 3.

Holocene deposits of alluvium cover the stream valleys of Bitter Creek, Black Butte Creek and Salt Wells Creek.

The Cretaceous formations in the Thayer Junction quadrangle indicate the transgressions and regressions of a broad, shallow, north-south-trending seaway that extended across central North America. They accumulated near the western edge of the Cretaceous sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

Deposition of the Baxter Shale marked a westward or landward movement of the sea with shale, sandstone, and limestone deposited in an offshore marine environment (Hale, 1950; Douglas and Blazzard, 1961).

The Blair Formation, composed of intertonguing nearshore sandstones and offshore marine shales, was deposited in a shallow-water marine sequence as the Cretaceous sea regressed eastward (Douglass and Blazzard, 1961; Gosar and Hopkins, 1969).

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 Rock Springs Formation consists of sediments deposited in swamp, deltaic and fluvial environments. Southeast of the strand line the Rock Springs Formation consists mainly of shallow-water marine deposits (Douglass and Blazzard, 1961; Burger, 1965; Gosar and Hopkins, 1969).

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

The Almond Formation reflects deposition in fresh-water coastal swamps, brackish-water lagoons and shallow-water marine environments (Hale, 1950).

Structure

The Thayer Junction quadrangle lies on the northern end of the Rock Springs uplift which separates the Great Divide and Green River structural basins. The axial trace of the Rock Springs uplift, a doubly plunging asymmetric anticline, crosses the western edge of the quadrangle. Beds on the west side of axial trace strike northeasterly and dip 4° to 35° to the northwest. On the east side of the axial trace, the beds strike northwesterly and dip 5° to 8° to the northeast (Roehler and others, 1977). Dips in the quadrangle range from 3° to 6° to the northeast.

Several faults are present in the Thayer Junction quadrangle as shown on plate 1. The strike of the faults is nearly perpendicular to the strike of the beds (Schultz, 1909).

COAL GEOLOGY

For the most part, this quadrangle contains only the thin coal beds of the Rock Springs Formation. A single coal bed of the Almond Formation has been mapped near the northern boundary of the quadrangle (Schultz, 1909), but no information is available regarding its thickness.

Chemical analyses of coal.--Analyses of representative samples of Rock Springs Formation coal from the Rock Springs and southeast quarter of the Boars Tusk 15-minute quadrangles are shown in table 1. An analysis of Almond Formation coal from the Point of Rocks quadrangle is also listed in the table.

In general, Rock Springs Formation coals are high-volatile C bituminous in rank and the Almond Formation coals rank as subbituminous B on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Coal Beds of the Rock Springs Formation

The thicker coal beds of the Rock Springs Formation are restricted to areas of coastal swamp deposition in the northwestern part of the Rock Springs uplift (Roehler and others, 1977). A number system adopted by the Union Pacific Railroad is most commonly used (Schultz, 1909) to name coal beds in the Rock Springs Formation. The coal beds mined in the Rock Springs coal field are, in ascending order, the Nos. 19, 17, 15, 13, 11, 10, 9, 8, 7, 7 1/2, 1, 3, and 5. The same nomenclature is used across the field, although recent stratigraphic investiations suggest that the coal beds were commonly miscorrelated (Roehler and others, 1977).

Madden (1977) and Roehler (1978) have applied Dobbin's (1944) local name (Superior) to some of the coal beds in the area.

The coal beds of the Rock Springs Formation crop out in the northern and eastern parts of the quadrangle, as shown on plate 1. The outcrop traces are after Schultz (1909) and in many cases do not agree with more recent drill-hole data obtained from RMEC. The derivative maps show projected outcrop traces using this more recent data.

Rock Springs (Superior) No. 15 Coal Bed

The No. 15 coal bed, isopached on plate 4, occurs approximately 350 feet (107 m) above the base of the formation (Roehler, 1978). The coal bed thickens to 6 feet (1.8 m) in the northwestern corner of the quadrangle. This coal bed thickens to the northwest and thins to the southeast, as do the other Rock Springs Formation coal beds, and, in the southeast quarter of the Boars Tusk 15-minute quadrangle, the No. 15 coal bed attains a thickness of 13.3 feet (4.1 m) in a single bed. Further to the west in the southwest quarter of the Boars Tusk 15-minute quadrangle, the No. 15 coal bed contains considerable amounts of rock partings and has been mapped as a zone.

Rock Springs (Superior) No. 3 Coal Bed

The No. 3 coal bed occurs approximately 800 feet (244 m) stratigraphically above the No. 15 (Roehler, 1978) coal bed. This coal bed has been isopached in secs. 34 and 35, T. 21 N., R. 102 W., where it is inferred to attain a thickness of 7 feet (2.1 m). Two faults in the area limit the areal extent of the coal bed.

In general, the No. 3 coal bed is not one of the thicker Rock Springs Formation coal beds and rarely exceeds Reserve Base thickness (5 feet or 1.5 meters). A maximum thickness of approximately 6 feet (1.8 m) was recorded for this bed in the southeast and southwest quarters of the Boars Tusk 15-minute quadrangles.

COAL RESOURCES

Information from coal test holes drilled by RMEC and surface mapping by Schultz (1909) were used to construct isopach and structure contour maps of the coal beds in the Thayer Junction quadrangle. At the request of RMEC, coal-rock data for some of their drill holes have not been shown on plate 1. 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 maps (plates 4 and 6). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed, and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous 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 those used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bituminous coal.

Reserve Base and Reserve tonnages for the isopached coal beds are shown on plate 8, 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 1.27 million short tons (1.15 million metric tons) for the entire quadrangle. Reserve Base tonnages in the development potential category for surface mining methods are shown in table 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 those areas where no coal beds 5 feet (1.5 m) or more thick are known, but may occur.

Areas classified as having coal development potential for surface mining methods are shown on plate 9. Of those Federal land areas within the KRCRA boundary having a known develoment potential, 81 percent are rated high and 19 percent are rated moderate. The remaining Federal lands within the KRCRA boundary are classified as having 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 include 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 a development potential for in-situ mining methods.

In the Thayer Junction quadrangle, Federal land areas within the KRCRA boundary have been rated as having an unknown development potential for conventional subsurface mining methods since no known coal beds meet the above criteria.

Because the coal beds in this quadrangle have dips of less than 15°, all Federal land areas within the KRCRA boundary have been rated as having an unknown development potential for in-situ mining methods.

Table 1.--Chemical analyses of coals in the Thayer Junction quadrangle, Sweetwater County, Wyoming.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
SW¼, sec. 26, T. 20 N., R. 101 W., Point of Rocks Mine (Dobbin, 1944)	Almond Formation, undifferentiated	A	16.6	30.2	44.0	9.2	0.7	-	-	-	-	-	9,410
		C	0.0	36.3	52.7	11.0	0.8	-	-	-	-	-	11,290
NW¼, NW¼, sec. 2, T. 18 N., R. 105 W., Blairtown Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 3	A	11.5	36.8	50.1	1.6	0.8	-	-	-	-	-	12,220
		C	0.0	41.6	55.6	1.8	0.9	-	-	-	-	-	13,810
Sec. 35, T. 19 N., R. 105 W., Union Pacific No. 1 Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 1	A	8.5	35.6	50.4	5.5	0.8	-	-	-	-	-	11,830
		C	0.0	38.9	55.1	6.0	0.9	-	-	-	-	-	12,940
Sec. 26, T. 19 N., R. 105 W., Sweetwater No. 2 Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 7	A	9.8	32.6	48.6	9.0	0.9	-	-	-	-	-	11,300
		C	0.0	36.2	53.8	10.0	1.0	-	-	-	-	-	12,530
Sec. 3, T. 21 N., R. 103 W., Prospect Pits (U.S. Bureau of Mines, 1931)	Rock Springs, undifferentiated	A	13.8	31.7	49.5	5.0	0.9	-	-	-	-	-	10,790
		C	0.0	36.8	57.4	5.8	1.0	-	-	-	-	-	12,520

Form of Analysis: A, as received
B, air dried
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2.--Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Thayer Junction quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Rock Springs No. 3	220,000	90,000	60,000	-	370,000
Rock Springs No. 15	470,000	50,000	380,000	-	900,000
Totals	690,000	140,000	440,000	-	1,270,000

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. 1 line A
2	↓	Drill hole No. 2 line A
3	Continental Oil Co.	Oil/gas well No. 8-2 Black Butte Unit
4	Signal Exploration, Inc.	Oil/gas well No. 9-1 Black Butte Creek
5	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3 line A
6	Davis Oil Co. and Southland Royalty Co.	Oil/gas well No. 1 SE Snowshoe
7	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
8	↓	Drill hole No. 1AS
9	True Oil Co.	Oil/gas well No. 14-4 Lebsak-Federal
10	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
11	↓	Drill hole No. 1AS
12	↓	Drill hole No. 1AS
13	↓	Drill hole No. 2AS
14	↓	Drill hole No. 1AD
15	↓	Drill hole No. 1AS

Page 1 of 2

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
16	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
17	True Oil Co.	Oil/gas well No. 41-20 Lacoy-Federal
18	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
19	↓	Drill hole No. 2AS
20	↓	Drill hole No. 1AS
21	Union Pacific Railroad and Wolf Exploration Co.	Oil/gas well No. 32-23 U.P.R.R.
22	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
23	↓	Drill hole No. 1 line A
24	↓	Drill hole No. 3 line A
25	↓	Drill hole No. 1AS
26	Continental Oil Co.	Oil/gas well No. 1 Unit
27	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
28	↓	Drill hole No. 1AS
29	↓	Drill hole No. 1AS
30	↓	Drill hole No. 2AS

Page 2 of 2

REFERENCES

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, in Gaseous fuels; coal and coke; atmospheric analysis: ASTM Standard Specification D 388-77, pt. 26, p. 214-218.

Burger, J. A., 1965, Cyclic sedimentation in the Rock Springs Formation, Mesaverde Group, on the Rock Springs uplift, in Rock Springs uplift, Wyoming, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 55-63.

Dobbin, C. E., 1944, The Superior district of the Rock Springs coal field, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished report.

Douglass, W. B., Jr., and Blazzard, T. R., 1961, Facies relationships of the Blair, Rock Springs, and Ericson Formations of the Rock Springs uplift and Washakie Basin, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 81-86.

Gosar, A. J., and Hopkins, J. C., 1969, Structure and stratigraphy of the southwest portion of the Rock Springs uplift, Sweetwater County, Wyoming, in Geologic Guidebook of the Uinta Mountains, Intermountain Association of Geologists and Utah Geological Association Guidebook, 16th Annual Field Conference, September 4, 5, and 6, 1969: p. 87-90.

Hale, L. A., 1950, Stratigraphy of the Upper Cretaceous Montana group in the Rock Springs uplift, Sweetwater County, Wyoming, in Southwestern Wyoming, Wyoming Geological Association Guidebook, 5th Annual Field Conference, 1950: p. 49-58.

______ 1955, Stratigraphy and facies relationship of the Montanan group in south-central Wyoming, northeastern Utah and northwestern Colorado, in Green River Basin, Wyoming, Wyoming Geological Association Guidebook, 10th Annual Field Conference, 1955: p. 89-94.

Keith, R. E., 1965, Rock Springs and Blair Formations on and adjacent to the Rock Springs uplift, Sweetwater County, Wyoming, in Rock Springs uplift, Wyoming, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 42-53.

Madden, D. H., 1977, Preliminary geologic map of the Point of Rocks quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

References--Continued

Rocky Mountain Energy Co., (no date), Unpublished drill hole data from the Union Pacific coal inventory of 1969-1970.

Roehler, H. W., 1977, Geological map of the Rock Springs uplift and adjacent areas, Sweetwater County, Wyoming: U.S. Geological Survey Open-File Report 77-242, scale 1:250,000.

______ 1978, Correlations of coal beds in the Rock Springs Formation in measured sections on the east flank of the Rock Springs uplift, Sweetwater County, Wyoming: U.S. Geological Survey Open-File Report 78-247.

Roehler, H. W., Swanson, V. E., and Sanchez, J. D., 1977, Summary report of the geology, mineral resources, engineering geology and environmental geochemistry of the Sweetwater-Kemmerer area, Wyoming, part A, geology and mineral resources: U.S. Geological Survey Open-File Report 77-360, 80 p.

Schultz, A. R., 1909, The northern part of the Rock Springs coal field, Sweetwater County, Wyoming, in Coal fields of Wyoming: U.S. Geological Survey Bulletin 341-B, p. 256-282.

______ 1920, Oil possibilities in and around Baxter Basin, in the Rock Springs uplift, Sweetwater County, Wyoming: U.S. Geological Survey Bulletin 702, 107 p.

Smith, J. H., 1961, A summary of stratigraphy and paleontology in upper Colorado and Montanan Groups in south-central Wyoming, northeastern Utah, and northwestern Colorado, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 101-112.

U.S. Bureau of Land Management, 1978, Draft environmental statement, proposed development of coal resources in southwestern Wyoming: U.S. Department of the Interior, v. 1 to 3.

U.S. Bureau of Mines, 1931, Analyses of Wyoming coals: U.S. Bureau of Mines Technical Paper 484, pp. 68-75, 139-150.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

Weimer, R. J., 1960, Upper Cretaceous stratigraphy, Rocky Mountain area: American Association of Petroleum Geologists Bulletin, v. 44, no. 1, p. 1-20.

References--Continued

______ 1961, Uppermost Cretaceous rocks in central and southern Wyoming, and northwest Colorado, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 17-28.

Wyoming Natural Resources Board, 1966, Wyoming weather facts: Cheyenne, p. 34-35.

Wyoming State Highway Commission, 1978, Wyoming 1978 official highway map: Cheyenne, Wyoming, scale 1:1,140,480.