UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-1010

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE EMERY WEST QUADRANGLE SEVIER AND EMERY COUNTIES, UTAH

(Report includes 20 plates)

By

AAA Engineering and Drafting, Inc.

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 report was compiled to support the land planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the Western United States. It supplements the land planning requirements of the Federal Coal Leasing Amendments Act of 1976 (Public Law 94-377) sec. (3)(B) which states, in part, that "Each land-use plan prepared by the Secretary [of the Interior] (or in the case of lands within the National Forest System, the Secretary of Agriculture pursuant to subparagraph (A)(i)) shall include an assessment of the amount of coal deposits in such land, identifying the amount of such coal which is recoverable by deep mining operations and the amount of such coal which is recoverable by surface mining operations."

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps (19 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Emery West quadrangle, Sevier and Emery Counties, Utah (U.S. Geological Survey Open-File Report 79-1010).

Published and unpublished public information were used as data sources for this study. No new drilling or field mapping was done to supplement this study. No confidential or proprietary data were used.

Location

The Emery West 7½-minute quadrangle is located in the southern part of the Wasatch Plateau coal field and is in Sevier and Emery Counties in south-central Utah. The town of Emery is located along the east central edge of the quadrangle. The city of Richfield, the county seat of Sevier

County, is approximately 40 miles (64 km) southwest, and the town of Castle Dale, the county seat of Emery County, is 20 miles (32 km) northeast of the quadrangle.

Accessibility

Utah Highway 10 runs northeast from its junction with U.S. Interstate Highway 70, approximately 12 miles (19 km) southwest of Emery, passing through the southeast quarter of the quadrangle, the town of Emery, and many of the towns along the base of the east side of the Wasatch Plateau. At Price, 58 miles (93 km) northeast of Emery, Utah Highway 10 joins U.S. Highway 6.

Several graveled roads extend from the town of Emery through the farming area in the southeast part of the quadrangle. Unimproved dirt roads provide access into the lower parts of Quitchupah, Link, and Muddy Creek canyons. Jeep trails continue from the ends of these roads in Quitchupah and Link canyons onto the high plateau land where the jeep trails join unimproved dirt roads from the west side of the plateau.

The nearest railroad is 47 highway miles (76 km) from Emery at Salina on the west side of the Wasatch Plateau. A branch line of the Denver and Rio Grande Western Railroad runs through Salina and northward along the west side of the plateau. The main line of the Denver and Rio Grande Western Railroad passes through Price which is 58 highway miles (93 km) north of Emery. This railroad provides rail access to Salt Lake City, Utah and Denver, Colorado.

The Utah Railway Company maintains a short railroad line in the north-eastern part of the Wasatch Plateau that runs northward from the town of Mohrland to the city of Helper. The short line makes connection with the main line of the Denver and Rio Grande Western Railroad at Helper. The south end of the short line is approximately 33 miles (53 km) northeast of the Emery West quadrangle.

Physiography

The eastern margin of the Wasatch Plateau is approximately 80 miles (129 km) long and consists of sparsely vegetated sandstone cliffs and steep shale slopes cut by numerous steep-walled canyons. The rocks are gently dipping, generally less than 10 degrees.

The Emery West quadrangle is located in the southern third of the Wasatch Plateau. The eastern boundary of the plateau crosses the quadrangle diagonally from the northeast corner to the southwest corner. Link Canyon and the canyon of North Fork Quitchupah Creek are located in the central and western parts of the quadrangle. Muddy Creek canyon is located in the northeast corner of the quadrangle and the southern part of the adjoining quadrangle to the north. Quitchupah and Muddy Creeks form the major drainage system in the Emery West quadrangle and are part of the Colorado River drainage system.

The southeast part of the Emery West quadrangle is a low, gently sloping plain. The area immediately below the steep cliffs in the central part of the quadrangle consists of highly dissected pediments and benches of sandstone.

The hills immediately northwest of the town of Emery consist of downfaulted blocks of formations that are present in the plateau to the west.

The quadrangle has a relief of over 3,000 ft (914 m). The highest point (9,029 ft (2,752m)) is in the northwest quarter of the quadrangle on top of the Wildcat Knolls. The lowest point is 6,000 ft (1,824 m) where Quitchupah Creek crosses the south edge of the quadrangle. The coal beds occur between 7,300 and 8,000 ft (2,225 and 2,438 m) except in the fault blocks northwest of Emery where they occur between 6,500 and 7,200 ft (1,981 and 2,195 m).

Climate

The climate of the Wasatch Plateau varies with altitude from semi-arid in the lowest elevations to alpine in the highest. The normal annual precipitation in the Emery West quadrangle ranges from less than 8 inches (20 cm) in the southeast corner to 23 inches (58 cm) in the northwest quarter of the quadrangle (U.S. Department of Commerce, (1964)).

Temperatures on the high plateau are generally cool in the summer and cold in winter. Temperatures may reach a high of 85 degrees F (29 degrees C) in summer and a low of -30 degrees F (-34 degrees C) in winter. The temperatures at the lower elevations around the town of Emery range between 100 degrees F (38 degrees C) in summer and -20 degrees F (-29 degrees C) in winter.

Land Status

The Emery West quadrangle lies in the southern part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). Approximately 14,500 acres (5,868 ha) of the quadrangle are in the KRCRA. Plate 2 shows the distribution, and table 1 lists the acreage of Federal and non-Federal lands in the area.

Table 1. Approximate distribution of coal lands within the KRCRA in the Emery West quadrangle, Sevier and Emery Counties, Utah.

Category	Approximate Area (acres)*	Percent of KRCRA (%)
Non-Federal land	200	1
Leased Federal coal land	400	3
Unleased Federal coal land	13,900	96
Total	14,500	100

*To convert acres to hectares, multiply acres by 0.4047

GENERAL GEOLOGY

Previous Work

Spieker (1931) mapped and described the geology and coal of the Wasatch Plateau. The stratigraphy of the area was described by Spieker and Reeside (1925), Spieker (1949), Katich (1954), and Hayes and others (1977). In 1972 Doelling compiled the geology and available coal data for the coal field.

The Emery West quadrangle was recently mapped by Hayes and Sanchez (1977) and detailed measurements and descriptions of closely spaced stratigraphic sections of the upper part of the Star Point Sandstone and the lower part of the Blackhawk Formation were made by Marley and Flores (1977). Marley, Flores, and Carovac (1978) presented in preliminary form a discussion of depositional environments and origin of rocks within the Blackhawk Formation and the Star Point Sandstone in the Wasatch Plateau. A detailed description of the lithostratigraphy of portions of these two formations has been presented by Marley (1978).

Stratigraphy

The coal beds of economic importance in the Wasatch Plateau coal field are Upper Cretaceous in age and are confined to the Blackhawk Formation of the Mesaverde Group. The Mesaverde includes, in ascending order: Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. The Upper Cretaceous Mancos Shale underlies the Star Point Sandstone and is exposed over a large part of the southern half of the quadrangle. The North Horn Formation (Upper Cretaceous and Paleocene) overlies the Price River Formation.

The oldest sedimentary unit exposed in the quadrangle is the Blue Gate Shale Member of the Mancos Shale of Upper Cretaceous age. The Blue

Gate is composed of bluish-gray silty shale and is overlain by the Emery Sandstone Member of the Mancos Shale. The Emery is 800 ft (244 m) or more in thickness and crops out over a large area in the south part of the quadrangle. The Masuk Shale Member of the Mancos Shale overlies the Emery Sandstone and is similar to the bluish-gray silty shale of the Blue Gate, but is sandier. The Masuk Shale is the youngest member of the Mancos Shale and thickens in the quadrangle from 600 ft (183 m) in the south to 1,000 ft (305 m) in the north (Doelling, 1972).

The Star Point Sandstone overlies the Masuk Shale and is generally cliff-forming in outcrop along the east side of the Wasatch Plateau. It ranges from 200 to 300 ft (61 to 91 m) thick (Doelling, 1972) and is composed of very fine- to medium-grained sandstone, with lesser amounts of siltstone and shale (Marley and Flores, 1977).

The Blackhawk Formation overlies the Star Point Sandstone and consists of very fine- to medium-grained sandstone, siltstone, shale, coal, and minor limestone. The formation is approximately 850 ft (259 m) thick in the quadrangle (Doelling, 1972). Marley and Flores (1977, p. ii and iii) report that "the Blackhawk Formation interfingers laterally with and locally unconformably overlies the Star Point Sandstone. . . The characteristics of the rock types of the Blackhawk Formation suggest that they represent delta-plain deposits, which grade (seaward) into the underlying delta-front and prodelta deposits of the Star Point Sandstone."

The Castlegate Sandstone overlies the Blackhawk Formation and is a massive, cliff-forming, yellow to gray sandstone unit 200 to 250 ft (61 to 76 m) thick. The overlying Price River Formation caps the plateau surface in this quadrangle and is composed of fine- to medium-grained sandstone interbedded with shale. The Price River Formation is less resistant to erosion than the Castlegate Sandstone and forms step-like ledges in its outcrop pattern. The overlying North Horn Formation caps the high point on Wildcat Knolls and consists of variegated shale with subordinate conglomerate, sandstone, and limestone.

Structure

Most of the quadrangle is not faulted. The Joes Valley fault zone is located along the east side of the quadrangle and trends in a northeasterly direction between the town of Emery and the plateau cliffs. There are six or more faults separating down-dropped blocks of the Mesaverde Group in the fault zone. The long, narrow fault blocks range from less than 1,000 ft (305 m) to more than 3,000 ft (914 m) in width. Coal beds are exposed in the fault blocks, but Doelling (1972, p. 133) reports that, "The rocks are badly shattered in many places and the coal may be unminable." The faulted area lies outside the Wasatch Plateau KRCRA.

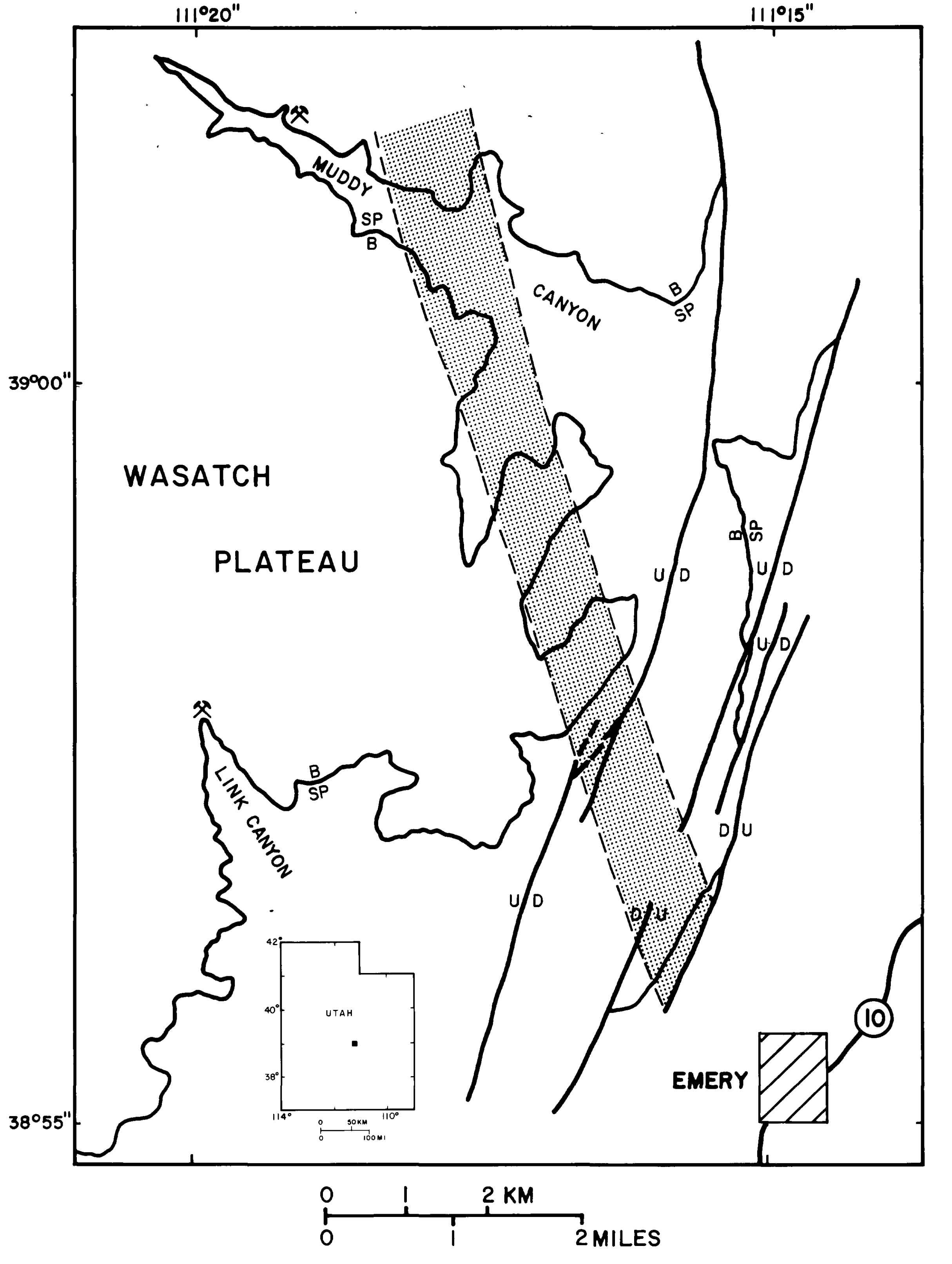
The sedimentary rocks trata in the quadrangle have a dip of 3 degrees or less to the northwest with the exception of the Joes Valley fault zone where dips are as much as 11 degrees. See structure contour maps, plates 5, 9, 13, and 17.

COAL GEOLOGY

Major coal beds in the Wasatch Plateau coal field occur in the lower part of the Blackhawk Formation. Spieker (1931) described the Hiawatha and Upper Hiawatha beds in the lower of two groups of coal beds, and the Muddy No. 1 and Muddy No. 2 beds in the upper group of coal beds in this quadrangle. The Hiawatha bed was recognized as the one immediately above the Star Point Sandstone which was mapped as a continuous ledge-forming unit.

Sanchez and Hayes (1977) mapped the geology of the quadrangle and Marley and Flores (1977) made detailed measurements and descriptions of closely-spaced stratigraphic sections of the upper part of the Star Point Sandstone and the lower part of the Blackhawk Formation. A zone of intertonguing between these two formations was observed at several localities within a 6-mile (10-km)-long and 0.6-mile (1-km)-wide belt extending south-southeastward from the north wall of Muddy Creek Canyon to near the town of Emery (figure 1). "As a result of this intertonguing, the contact between the two formations is about 20 m (66 ft) higher to the east than it is to the west and the coal-bed correlations of Spieker (1931) must be modified." (Flores and others, 1978).

As a consequence of the recognition of the intertonguing, a revision of the correlations of the lower Blackhawk Formation coal beds between the two sides of the intertonguing zone was suggested by Flores and others (1978). They pointed out, for example, that "the upper bed in the abandoned mine of Muddy Canyon and referred to as Muddy No. 2 coal bed by Spieker (1931) is apparently the Hiawatha coal bed. . ." and that "The coal bed mined in the abandoned Link Canyon mine . . . and identified by Doelling (1972) as the Upper Hiawatha coal bed merges laterally eastward into the Star Point Sandstone and must be about 20 m below the stratigraphic position of the Upper Hiawatha coal bed to the areas to the east of the zone of intertonguing" (Flores and others, 1978). Generalized cross sections through the zone of intertonguing are shown in figure 2 and the correlated coal beds are listed in table 2. The names "A" bed, "B" bed, and "C" bed are substituted for Hiawatha, Upper Hiawatha, and Muddy No. 1 of Spieker (1931), consecutively, by the present authors.



EXPLANATION

ZONE OF INTERTONGUING

COAL MINE

B/SP CONTACT BETWEEN BLACKHAWK FORMATION (B) AND STAR POINT SANDSTONE (SP)

U/D FAULT - DASHED WHERE FAULT IS INFERRED, U. UPTHROWN SIDE, D. DOWNTHROWN SIDE

FIGURE 1. Map showing zone of intertonguing (after Flores and others, 1978).

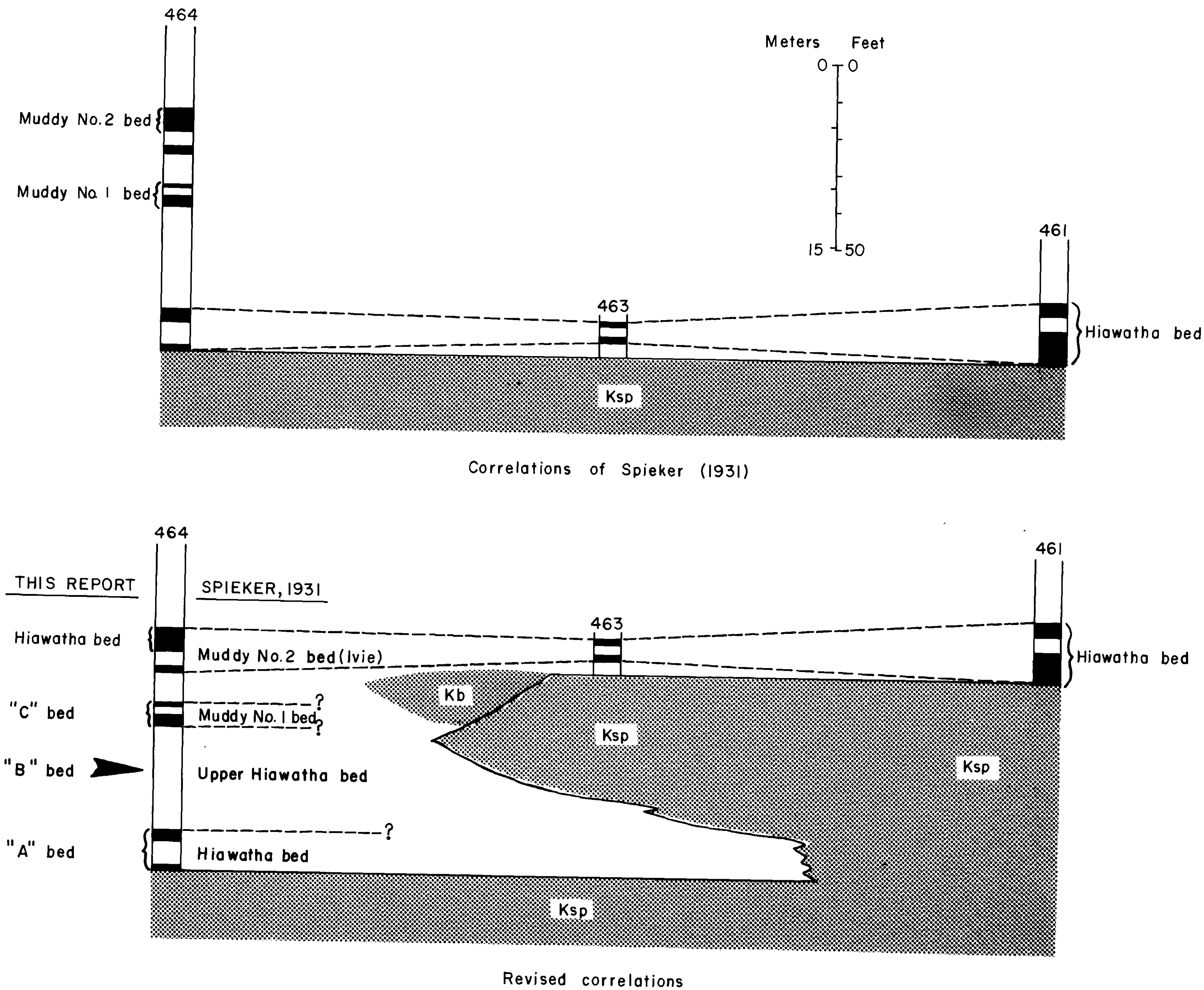


FIGURE 2. Generalized cross sections showing former and revised coal-bed correlations (after Flores and others, 1978).

Table 2. Correlations of coal beds between the east and west sides of the zone of intertonguing, Emery West quadrangle, Sevier and Emery Counties, Utah.

West Side of Zone of Intertonguing		East Side of Zone of Intertonguing
New Correlations Emery West Quadrangle	Spieker (1931) and Doelling (1972)	Spieker (1931) and Doelling (1972)
		Upper Ivie
Muddy No. 2		Muddy No. 2
Muddy No. 1		Muddy No. 1
Upper Hiawatha	Upper Ivie	Upper Hiawatha
Hiawatha	Muddy No. 2	Hiawatha
"C" Bed	Muddy No. 1	
"B" Bed	Upper Hiawatha	
"A" Bed	Hiawatha	

Intervals reported as "bony coal," "bone," "shaly coal," or other similar terms in the data sources are shown as "rock" intervals in this report on plates 1 and 3. These intervals were not included in the coal thicknesses used to construct the coal isopach maps.

"A" Coal Bed

The "A" coal bed occurs westward from the zone of intertonguing (figure 1). The bed in this area is the one formerly called the "Hiawatha" coal bed by Spieker (1931) and Doelling (1972). Based on the work of Flores and others (1978) the bed merges laterally into the Star Point Sandstone in the zone of intertonguing and is approximately 65 ft (20 m) stratigraphically below the Hiawatha coal bed on the east side of the zone.

The "A" bed was measured at numerous points in the quadrangle area (see plate 16). At most of these points the bed was less than 5.0 ft (1.5 m) thick. The bed thickens in the west central part of the quadrangle and on the west side of the North Fork of Quitchupah canyon the bed attains a thickness of over 9.0 ft (2.7 m). The "A" bed extends into the adjoining Acord Lakes quadrangle.

"B" Coal Bed

The "B" coal bed occurs westward from the zone of intertonguing and was formerly called the Upper Hiawatha coal bed by Spieker (1931), Doelling (1972), and others. The "B" bed thickens significantly in a westward direction away from the intertonguing zone in the northeast quarter of the quadrangle. The bed reaches a thickness of 16.0 ft (4.9 m) in two holes drilled in the northwest quarter of the quadrangle. In Quitchupah Canyon on the west edge of the quadrangle, the thickness of the bed exceeds 15.0 ft (4.6 m) in one measured section. The bed thins eastward and southward and is generally less than 5.0 ft (1.5 m) thick in the central part of the quadrangle. The rock interval between the "A" and "B" beds ranges from less than 10 ft (3 m) to more than 50 ft (15 m).

"C" Coal Bed

The "C" coal bed occurs westward from the zone of intertonguing and was formerly called the Muddy No. 1 coal bed by Spieker (1931), Doelling (1972), and others. The bed is lenticular and occurs in the central part of the quadrangle where it ranges in thickness from 0.3 to 10.0 ft (0.1 to 3.0 m). The isopach map of the coal bed is shown on plate 8, and in most of the other measured sections in the quadrangle the coal bed is missing or underlies a covered area in the measured section. The interval between the "B" bed and "C" bed ranges from less than 10 ft (3 m) to more than 20 ft (6 m).

Hiawatha Coal Bed

Based on the field work by Flores and others (1978) the Hiawatha coal bed on the east side of the zone of intertonguing correlates with the coal bed formerly called the Muddy No. 2 coal bed on the west side of the zone by Spieker (1931) and Doelling (1972). In the Ivie Creek area

Spieker (1931, p. 180) suggests the equivalency of the Muddy No. 2 and the Ivie coal beds. In this report, on the west side of the zone of intertonguing, the Hiawatha coal bed is correlated with the Muddy No. 2 coal bed by Spieker (1931).

The Hiawatha bed is lenticular in the quadrangle area. The bed ranges in thickness from less than 1 ft (0.3 m) to more than 7 ft (2.1 m). The isopach map of the coal bed (plate 4) shows the areas where the bed is over 5 ft (1.5 m) thick. The bed thins eastward and westward from the central part of the quadrangle. The interval between the "C" bed and the Hiawatha bed ranges from 6.5 ft (2.0 m) to 14.0 ft (4.3 m). When the "C" bed is not present, the Hiawatha bed is approximately 70 ft (21 m) above the "B" bed.

Upper Hiawatha Coal Bed

The Upper Hiawatha coal bed, formerly the Upper Ivie bed of Spieker (1931) on the west side of the zone of interton ing, is 5 to 15 ft (1.5 to 4.6 m) above the Hiawatha bed. Except on the east side of the quadrangle the Upper Hiawatha is less than 5 ft (1.5 m) thick and in many places it is split by partings into two beds less than 2 ft (0.6 m) thick. The bed thickens in the faulted area on the east side of the quadrangle where it is over 11 ft (3.4 m) thick with numerous thin partings.

The Upper Hiawatha bed was not found to be over 5.0 ft (1.5 m) thick within the KRCRA and therefore a coal isopach and other derivative maps were not made for the bed.

Muddy No. 1 Coal Bed

The Muddy No. 1 coal bed is generally thin where it occurs in the northern part of the quadrangle, but exceeds 5.0 ft (1.5 m) in thickness in the measured section at index number 13 on plate 1. At that point the bed is 8.0 ft (2.4 m) thick. Because of the sparcity of data on this coal bed and the limit to which it can reasonably be projected for Reserve Base computations, coal isopach and other derivative maps were not constructed. Therefore, an isolated map (in U.S. Geological Survey files) was prepared for the Muddy No. 1 coal bed at data point no. 13 on plate 1. The Reserve Base tonnage for this bed has been calculated and is shown separately on plate 2 and is listed in table 4 as a non-isopached coal bed with unknown development potential.

Muddy No. 2 Coal Bed

The Muddy No. 2 coal bed was identified in a limited number of measured sections in the northeast quarter of the quadrangle. The bed is split by partings 1.5 to 13.2 ft (0.5 to 4.0 m) thick into two or three thin beds ranging from 0.3 to 2.3 ft (0.1 to 0.7 m) thick. The bed has not been found in reserve-base thickness in this quadrangle and therefore no derivative maps were made.

Chemical Analyses of the Coal

Doelling (1972) lists 7 coal analyses all of which were made on samples of the "B" coal bed from the Link Canyon mine. The proximate analyses of these samples are summarized in the following table.

Table 3. Average proximate analysis of coal from the "B" coal bed (formerly the Upper Hiawatha bed of Spieker, 1931), Emery West quadrangle, Sevier and Emery Counties, Utah.*

	No. Analyses	As-received (percent) Average	Range
Moisture	7	8.3	7.0-12.9
Volatile matter	5	38.1	37.5-38.6
Fixed carbon	5	46.0	45.3-46.4
Ash	7	8.0	5.4-10.0
Sulfur	7	0.42	0.4- 0.5
Btu/lb**	5	11,674	11,570-11,770

*Doelling, 1972, p. 133
**To convert Btu/lb to Kj/kg multiply by 2.326

Based on the ASTM system of classification, coal with the average analysis shown in table 3 is ranked as high volatile C bituminous (American Society for Testing and Materials, 1977). Analyses of coal from other beds in the quadrangle was not available.

Mining Operations

The only known mine in the quadranfUe is the Link Canyon mine located in Section 26, NW¼, T. 21 S., R. 5 E. The mine is inactive (1979) but produced about 164,000 short tons (148,780 metric tons) of coal during its period of operation from 1940 to 1952 (Doelling, 1972). The mine produced coal from the "B" bed (formerly the Upper Hiawatha bed of Spieker, 1931) which is about 8 ft (2.4 m) thick at the portal (Doelling, 1972).

COAL RESOURCES

The principal sources of data used in the construction of the coal isopach, structure contour, and the coal-data maps were Doelling (1972), Spieker (1931), and Blanchard, Ellis, and Roberts (1977).

Coal resources were calculated for measured, indicated, and inferred categories in unleased areas of Federal coal land within the KRCRA boundary.

Data obtained from the coal isopach maps (plates 4, 8, 12, and 16) were used to calculate the Reserve Base. The area underlain by coal (measured by planimeter) multiplied by the average isopached thickness of coal and a conversion factor of 1,800 short tons of coal per acre foot (13,238 metric tons per hectare-meter) for bituminous coal yielded the resources in short tons for each isopached bed. Reserve Base and Reserve values for the Hiawatha, "C", "B", and "A" beds are shown on plates 7, 11, 15, and 19 and are rounded to the nearest tenth of a million short tons. The Reserve values are based on a subsurface mining recoverability factor of 50 percent. The criteria used in calculating Reserve Base and Reserve tonnages used in this report differ from those stated in U.S. Geological Survey Bulletin 1450-B, which calls for a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 ft (305 m). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by isolated data points in this quadrangle.

Coal Reserve Base for each Federal section are shown on plate 2 and total approximately 170.2 million short tons (154.4 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Emery West quadrangle. The coal Reserve Base data for subsurface mining methods by coal bed are shown in table 4.

"Measured resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coals are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of the coal differs from region to region according to the character of the coal beds, the points of observation are no greater than ½ mile (0.8 km) apart. Measured coal is projected to extend as a ¼ mile (0.4 km) wide belt from the outcrop or points of observation or measurement.

"Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are ½ (0.8 km) to 1½ miles (2.4 km) apart. Indicated coal is projected to extend as a ½ mile (0.8 km) wide belt that lies more than ¼ mile (0.4 km) from the outcrop or points of observation or measurement.

"Inferred quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and where a few measurements of bed thickness are available. The estimates are based primarily on an assumed continuation from Demonstrated coal for which there is geologic evidence. The points of observation are 1½ (2.4 km) to 6 miles (9.6 km) apart. Inferred coal is projected to extend as a 2¼ mile (3.6 km) wide belt that lies more than 3/4 mile (1.2 km) from the outcrop or points of observation or measurement." (U.S. Bureau of Mines and U.S. Geological Survey, 1976).

Table 4. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Emery West quadrangle, Sevier and Emery Counties, Utah.

(To convert short tons to metric tons, multiply by 0.9072)

Coal Bed Name	High development potential	Moderate development potential	Unknown development potential	Total
Hiawatha	24,400,000	-0-	-0-	24,400,000
"C" Bed	6,700,000	-0-	-0-	6,700,000
"B" Bed	128,400,000	2,900,000	-0-	131,300,000
"A" Bed	6,900,000	-0-	-0-	6,900,000
Non-isopached coal bed	-0-	-0-	900,000	900,000
Total	166,400,000	2,900,000	900,000	170,200,000

AAA Engineering & Drafting, Inc. has not made any determination of economic mineability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Development Potential for Surface Mining Methods

No development potential for surface mining methods exist in the area of this quadrangle because of the rugged topography, steep-sided canyons, extreme relief, and thick overburden. There may be very small areas where contour mining could be done, but in general the area is not conducive to surface mining methods.

Development Potential for Subsurface Mining and In Situ Coal Gasification Methods

The coal development potential for subsurface mining of coal is shown on plate 20. In this quadrangle, areas where coal beds 5 ft (1.5 m) or more in thickness are overlain by less than 1,000 ft (305 m) of overburden are classified as having a high development potential for subsurface mining.

Areas where coal beds 5 ft (1.5 m) or m re in thickness are overlain by 1,000 to 2,000 ft (305 to 610 m) and 2,000 and 3,000 ft (610 to 914 m) of overburden are classified as having a moderate and a low development potential, respectively. Areas that contain no known coal in beds 5 ft (1.5 m) or more thick, but coal-bearing units are present at depths of less than 3,000 ft (914 m) are classified as areas of unknown coal development potential. Areas where no coal beds are known to occur or where coal beds are present at depths greater than 3,000 ft (914 m) have no coal development potential. The unleased Federal coal lands in the KRCRA in this quadrangle have high, moderate, and unknown subsurface mining development potentials (see plate 20). There are no known areas of low development potential.

The designation of a coal development potential classification is based on the occurrence of the highest-rated coal-bearing area that may occur within any fractional part of a 40-acre (16-ha) BLM land grid area or lot area of unleased Federal coal land. For example, if a certain 40-acre (16-ha) area is totally underlain by a coal bed with a moderate development potential and is also underlain by another coal bed with a high development potential, the entire 40-acre (16-ha) area is classified as high development potential even though most of the area is classified as moderate development potential by the lower coal bed.

The classification of lands for the development potential of in situ coal gasification mining methods was not done because the dips of coal beds are less than 15 degrees within the KRCRA in the Emery West quadrangle. The criteria for selection of areas suitable for in situ coal gasification are a minimum coal thickness of 5 ft (1.5 m), dips of 15 to 90 degrees and overburden greater than 200 ft (61 m) and less than 3,000 ft (914 m).

Table 5. Sources of data used on plate 1.

Source	Plate 1 Index Number	Data Base: Drill Hole or Measured Section No.	Data Base: Page or Plate No.
Spieker, 1931	1	514	pl. 29
	2	512	pl. 29
	3	511	pl. 29
	4	510	pl. 29
	5	509	pl. 29
	6	508	pl. 29
Blanchard, Ellis, and Roberts, 1977	7	W-TP-2-EW	p. 210-216
	8	W-TP-5-EW	p. 237-245
	9	W-TP-3-EW	p. 217-226
	10	W-TP-4-EW	P. 227-236
Spieker, 1931	11	479	pl. 28
	12	480	pl. 28
	13	481	pl. 28 p. 182,183
	14	482	pl. 28
	15	483	pl. 28
Marley and Flores, 1977	16	WM 82	p. 168-170
	17	WM 18	p. 166,167
	18	WM 83	p. 171,172
Spieker, 1931	19	484	pl. 28
	20	485	pl. 28
Marley and Flores, 1977	21	WM 78	p. 161-163
	22	WM 79	p. 164
	23	WM 77	p. 159,160
	24	WM 76	p. 157,158
Spieker, 1931	25	499	pl. 29
	26	498	pl. 29
	27	497	pl. 29
	28	496	pl. 29
Marley and Flores, 1977	29	WM 28	p. 51
	30	WM 27	p. 50
	31	WM 96	p. 197
	32	WM 29	p. 52-54
	33	WM 30	p. 55-57
	34	WM 32	p. 52-54
Spieker, 1931	35	494	pl. 29

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	38	WM 44	p. 90-93
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	44	WM 50	p. 107-110
	45	WM 54	p. 120
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	51	WM 67	p. 144
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	54	WM 73	p. 153
	55	RF 3	p. 206-209
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	57	WM 3	p. 5-7
	58	WM 5	p. 11
	59	WM 12	p. 18,19
	60	WM 22	p. 38,39
	61	RF 25	p. 256,257
	62	WM 20	p. 32-35
Spieker, 1931	63	493	pl. 28
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	65	RF 21	p. 49,50
	66	RF 20	p. 48
Spieker, 1931	67	492	pl. 28
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	69	WM 100	p. 200-203
	70	RF 18	p. 245
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Marley and Flores, 1977	72	RF 17	p. 244
	73	RF 16	p. 241-243
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	76	WM 19	p. 31

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	79	WM 17	p. 27,28
Spieker, 1931	80	488	pl. 28
Marley and Flores, 1977	81	RF 12	p. 231
Spieker, 1931	82	487	pl. 28
	83	486	pl. 28

REFERENCES

American Society for Testing and Materials, 1977, Standard Specifications for classification of coals by rank, in Gaseous fuels, coal, and coke; atmospheric analysis: ASTM Publication D 388-77.

Blanchard, L. F., Ellis, E. G., and Roberts, J. V., 1977, Lithologic and geophysical logs of holes drilled in the Wasatch Plateau Known Recoverable Resources Area, Carbon, Emery and Sevier Counties, Utah: U.S. Geological Survey Open-File Report 77-133.

Doelling, H. H., 1972, Wasatch Plateau coal field, in Doelling, H. H., Central Utah coal fields: Utah Geol. and Min. Survey Mon. Ser. no. 3.

Flores, R. M., and others, 1978, Newly delineated intertonguing between the Star Point Sandstone and the coal-bearing Blackhawk Formation requires revision of some coal-bed correlations in southern part of Wasatch Plateau, Utah: U.S. Geol. Survey unpublished report.

Hayes, P. T., and Sanchez, J. D., 1977, Preliminary geologic map of the Emery West quadrangle, Sevier and Emery Counties, Utah: U.S. Geological Survey Open-File Report 77-822.

Hayes, P. T., and others, 1977, Summary of the geology, mineral resources, engineering geology characteristics, and environmental geochemistry of east-central Utah: U.S. Geol. Survey Open-File Report 77-513.

Katich, P. J., Jr., 1954, Cretaceous and early Tertiary stratigraphy of central and south-central Utah with emphasis on the Wasatch Plateau area: Intermtn. Association of Petroleum Geologists Guidebook, 5th Ann. Field Conf.

Marley, W. E., III, 1978, Lithostratigraphy of portions of the Upper Cretaceous Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau, Utah: Unpublished M. S. thesis, North Carolina State Univ.

Marley, W. E., III, and Flores, R. M., 1977, Descriptions of stratigraphic sections, Upper Cretaceous Blackhawk Formation and Star Point Sandstone in the Emery West and Flagstaff Peak quadrangles, Utah: U.S. Geol. Survey Open-File Report 77-833.

Marley, W. E., Flores, R. M., and Cavaroc, V. V., 1978, Lithogenetic variations of the Upper Cretaceous Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau, Utah: Geol. Soc. America Abstracts with Programs, Rocky Mountain Sec. 31st Annual Mtg.

Sanchez, J. D., and Hayes, P. T., 1977, Preliminary geologic map of the Flagstaff Peak quadrangle, Emery, Sanpete, and Sevier Counties, Utah: U.S. Geol. Survey Open-File Report 77-823.

Spieker, E. M., 1931, The Wasatch Plateau coal field, Utah: U.S. Geol. Survey Bull. 819.

Spieker, E. M., 1949, The transition between the Colorado Plateau and the Great Basin in Central Utah: Guidebook to the Geology of Utah No. 4, Utah Geol. Society.

Spieker, E. M., and Reeside, J. B., Jr., 1925, Cretaceous and Tertiary formations of the Wasatch Plateau, Utah: Geol. Soc. of America Bull., v. 36.

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. Geol. Survey Bull. 1450-B.

U.S. Department of Commerce, (1964), Normal annual precipitation in inches, 1931-1960, State of Utah: U.S. Dept. of Commerce Weather Bureau Map WR-1210-A.