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COAL RESOURCES OF THE WATER HOLLOW RIDGE QUADRANGLE SEVIER COUNTY, UTAH

By

AAA Engineering and Drafting, Inc.

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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."

Published and unpublished public information were used as data sources for this study.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 Water Hollow Ridge 7½-minute quadrangle is located in the southwestern part of the Wasatch Plateau coal field in Sevier County in south central Utah. The city of Richfield, the county seat of Sevier County, is located approximately 25 miles (40 km) west and 7 miles (11 km) south of the quadrangle. The towns of Emery, Ferron, and Castle Dale on the east side of the Wasatch Plateau are respectively 14 miles (23 km) east, 21 miles (34 km) northeast, and 30 miles (48 km) northeast of the quadrangle.

The cities of Salina and Manti on the west side of the Wasatch Plateau are respectively 13 miles (48 km) west and 18 miles (29 km) north of the quadrangle.

Accessibility

The Water Hollow Ridge quadrangle is in mountainous terrain and the only paved road, U.S. Interstate 70, runs across the southwest corner of the quadrangle. Numerous unimproved dirt roads and jeep trails provide access into many canyons and upland areas including Water Hollow, Taylor Flat, upper Salina Canyon, Water Hollow Ridge, Dead Horse Ridge, Dry Hollow, and Salina Flats.

The nearest railhead is at Salina on a branch line of the Denver and Rio Grande Western Railroad. The railroad runs in a northerly direction through Sanpete Valley along the west side of the Wasatch Plateau. The railroad makes connections to Salt Lake City, Utah and Denver, Colorado.

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 Water Hollow Ridge quadrangle is located in the high central area of the southern part of the Wasatch Plateau. Most of the quadrangle is a hilly upland area with moderately steep-walled canyons and ravines. The deepest canyon in the quadrangle is the lower part of Salina Canyon. In that area Salina Creek is over 1,600 ft (488 m) below the ridge on the south side of the canyon. Water Hollow Ridge is a long north-south trending ridge in the central part of the quadrangle that forms a drainage divide between Water Hollow on the west and the upper part of Salina Canyon on the east. The area is drained by Salina Creek which flows into the Sevier River near Salina. The area on the western side of the Wasatch Plateau is in the Great Basin drainage system.

The relief in the quadrangle is approximately 4,120 ft (1,256 m) with elevations ranging from 6,440 ft (1,963 m) where Salina Creek leaves the southwest part of the quadrangle to 10,560 ft (3,219 m) on White Mountain in the extreme northeast corner of the quadrangle.

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 Water Hollow Ridge quadrangle ranges from 16 inches (41 cm) in the center of the south side to 31 inches (79 cm) in the high northeast corner (U.S. Department of Commerce, (1964)).

Temperatures on the high plateau are generally cool in the summer and cold in winter. Summertime temperatures may reach a high of 85 degrees F (29 degrees C) and a low of -30 degrees F (-34 degrees C) in winter.

Land Status

The Water Hollow Ridge quadrangle lies in the southwest part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). Approximately 5,100 acres (2,064 ha) of the quadrangle area lies within the KRCRA as shown on figure 1. Table 1 lists the acres of Federal and non-Federal lands in that area.

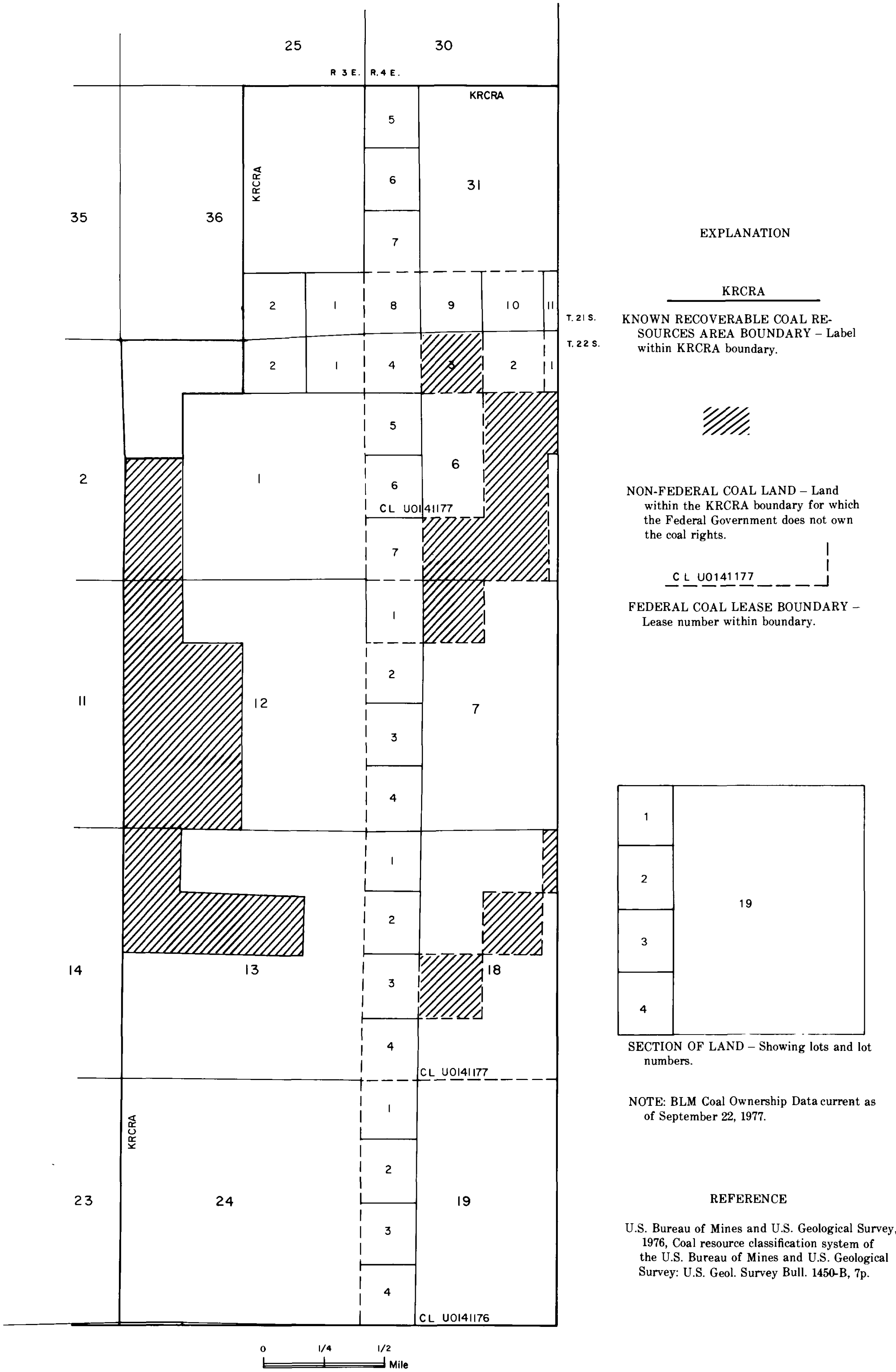

Figure I. Boundary map, Water Hollow Ridge Quadrangle, Sevier County, Utah

Table 1. Approximate distribution of coal lands within the KRCRA in the Water Hollow Ridge quadrangle, Sevier County, Utah.

Category	Approximate Area (acres)*	Percent of KRCRA (%)
Non-Federal land	850	17
Leased Federal coal land	1,700	33
Unleased Federal coal land	2,550	50
Total	5,100	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). Bachman (1959) and Baughman (1959) wrote theses on the Water Hollow fault zone in the Musinia Graben area. In 1972 Doelling compiled the geology and available coal data for the coal field.

The nearby Emery West and Flagstaff Peak quadrangles were recently mapped by Hayes and Sanchez (1977) and Sanchez and Hayes (1977). 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 in those two quadrangles 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 was presented by Marley (1978).

AAA Engineering and Drafting, Inc. (1979a and 1979b) prepared coal resource occurrence and coal development potential maps for the adjoining Acord Lakes quadrangle and Old Woman Plateau quadrangle.

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. This group 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. The strata overlying the Mesaverde Group consist of two formations in the quadrangle: the North Horn Formation (Upper Cretaceous and Paleocene) and the Flagstaff Limestone (Paleocene).

The oldest unit exposed in the quadrangle is the Blackhawk Formation which is approximately 850 ft (259 m) thick (Doelling, 1972). The upper 550 ft (168 m) are exposed in Salina Canyon in the southwest corner of the quadrangle. The formation consists of very fine- to medium-grained sandstone, siltstone, shale, and coal. 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 is a massive, cliff-forming, yellow to gray, medium- to coarse-grained sandstone unit approximately 230 ft (70 m) thick (Doelling, 1972). The Castlegate also contains lenses of conglomerate.

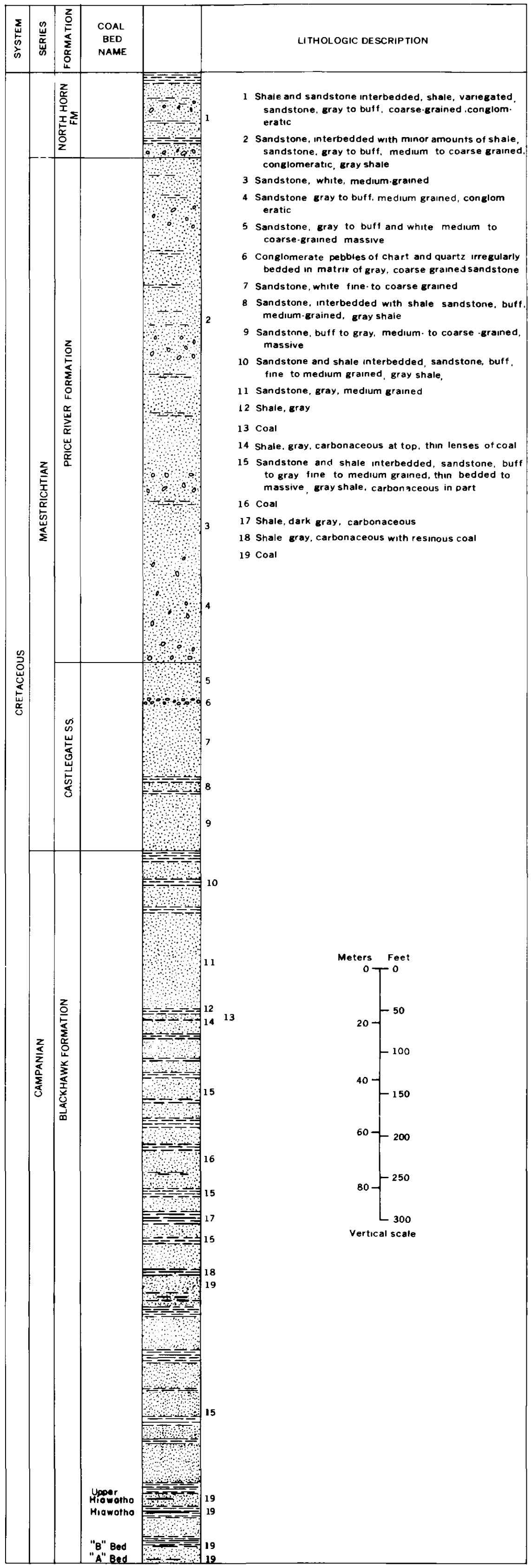

FIGURE 2. Composite columnar section, Water Hollow Ridge Quadrangle, Sevier County, Utah.

Doelling (1972) and Spieker (1931) include the Castlegate as a member of the Price River Formation, but the unit is now generally ranked as a formation throughout the Wasatch Plateau. The overlying Price River Formation is composed of fine- to medium-grained sandstone interbedded with shale and is over 700 ft (213 m) in thickness (Doelling, 1972). The Price River Formation is less resistant to erosion than the Castlegate Sandstone and forms step-like ledges in its outcrop pattern.

The North Horn Formation is Upper Cretaceous and Paleocene in age and consists of up to 1,000 ft (305 m) of variegated shale and subordinate conglomerate, sandstone, and limestone. The Flagstaff Limestone overlies the North Horn Formation and is composed of light-colored resistant limestone with subordinate amounts of interbedded sandstone and shale. This unit occurs in down-dropped fault blocks in the northeastern part of the quadrangle.

Structure

The Musinia fault zone consisting of north-south trending normal faults crosses the Water Hollow Ridge quadrangle. The east Musinia fault has placed the North Horn Formation against the Blackhawk Formation and near the mouth of Skumpah Canyon a maximum displacement of 2,500 (762 m) has been measured (Doelling, 1972). The west Musinia fault on the west side of Taylor Flat has also placed the North Horn against the Blackhawk Formation. Where the fault crosses Salina Creek the displacement is believed to be about 2,000 ft (610 m) (Doelling, 1972). A horst between the two bounding faults is capped with rocks of the Price River Formation. The distance between the bounding faults of the zone is approximately 3 miles (5 km).

The rocks in the quadrangle area generally have gentle dips of less than 10 degrees. Bachman (1959) has noted some flexures in the Salina Canyon area west of the Musinia fault zone.

COAL GEOLOGY

This report is confined to the Wasatch Plateau KRCRA in the Water Hollow Ridge quadrangle (figure 1). The central part of the quadrangle divides the Wasatch Plateau coal field on the east from the Sevier-Sanpete region on the west (Doelling, 1972). Therefore coal data for the west side of the quadrangle (approximately 3 miles (5 km) or more away from the KRCRA) are not shown in this report. The coal beds occurring in the Blackhawk Formation in Salina Canyon have local names and correlations with the Wasatch Plateau coal beds are difficult because of the distance between points of measurement and intertonguing relationships.

Major coal beds in the southern part of the Wasatch Plateau coal field occur in the lower part of the Blackhawk Formation. Spieker (1931) listed the following coal beds, in ascending order which occur in the adjoining Acord Lakes quadrangle: Hiawatha, Upper Hiawatha, Muddy No. 2, Upper Ivie, and some local thin upper beds. Spieker (1931, p. 188) mentions a possibility that the Upper Hiawatha bed could be the Muddy No. 1 and that the Muddy No. 2 bed is very close to the position of the Ivie bed in other areas but by tracing the beds there is small doubt of their separate identity.

Sanchez and Hayes (1977) mapped the geology of the Flagstaff Peak quadrangle and the geology of the Emery West quadrangle (Hayes and Sanchez, 1977). 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 in the Flagstaff Peak quadrangle to a point near the town of Emery in the Emery West quadrangle (figure 3). "As a result of this intertonguing, the contact between the two formations is about 20 m 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 point 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 of 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 4.

The Water Hollow Ridge quadrangle lies approximately 11 miles (18 km) west of the zone of intertonguing and the coal-bed names used here

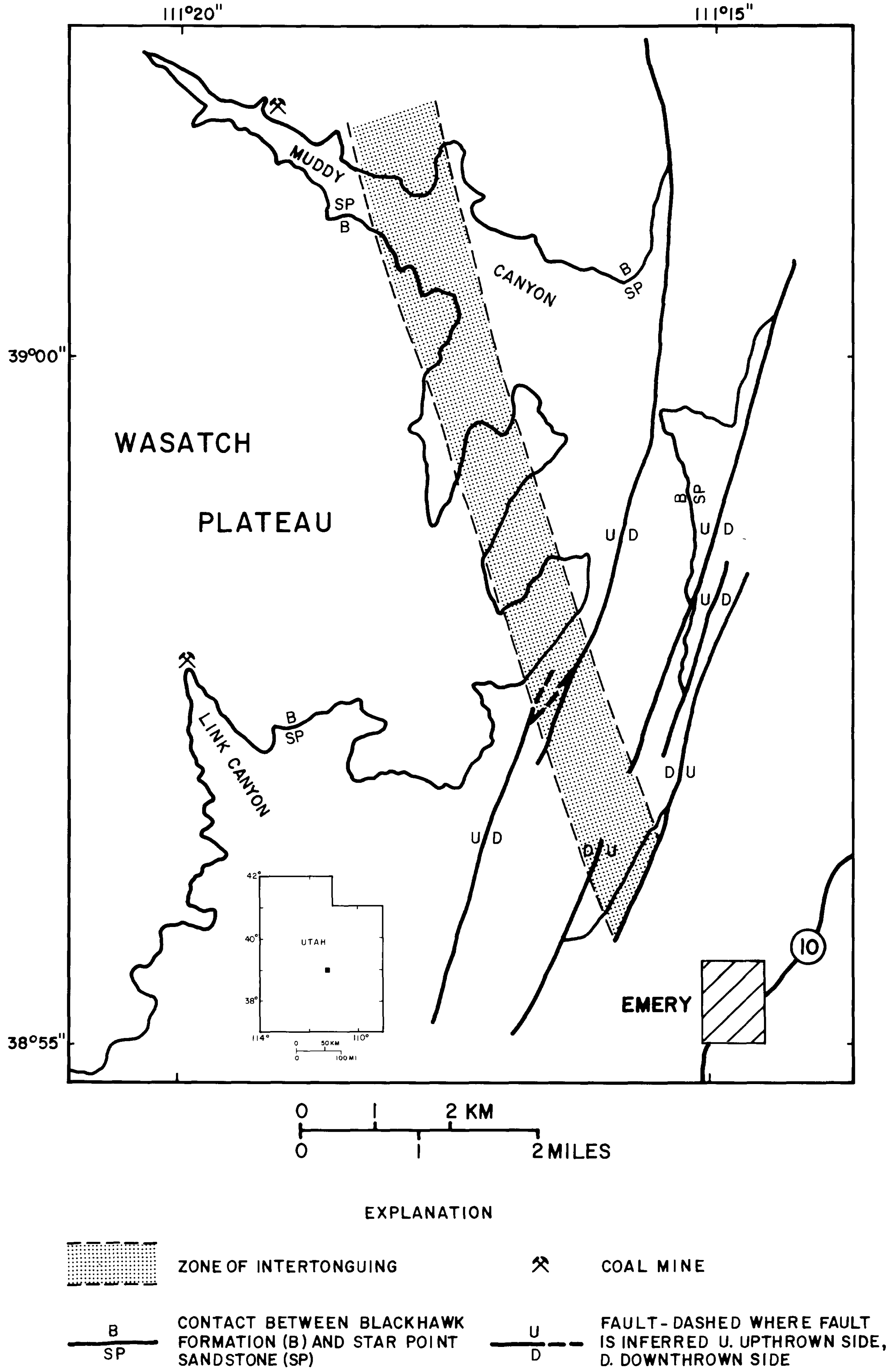

FIGURE 3. Map showing zone of intertonguing (after Flores and others, 1978).

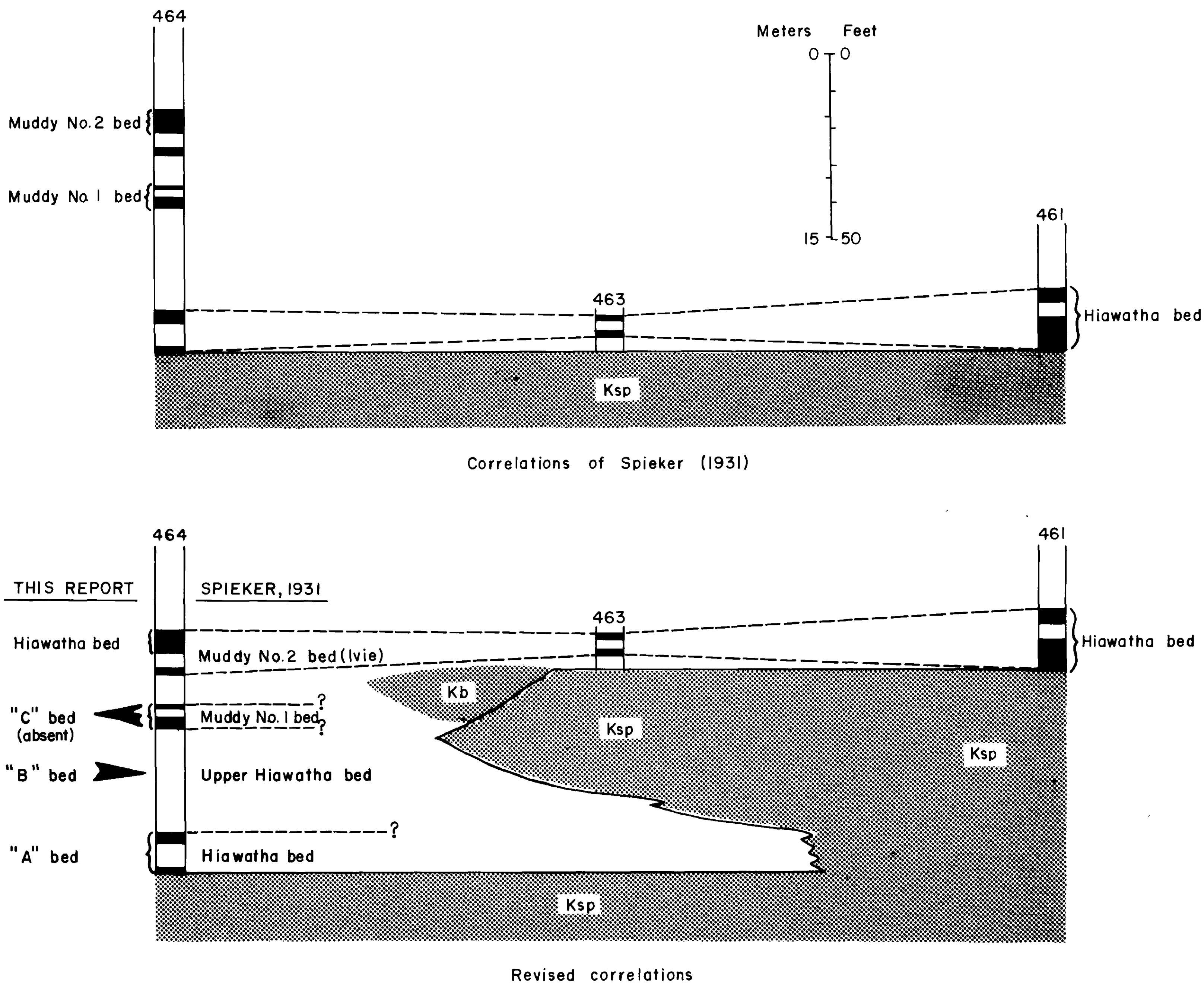

FIGURE 4. Generalized cross sections showing former and revised coal-bed correlations (after Flores and others, 1978).

reflect the stratigraphic correlations suggested by Flores and others (1978) in the Emery West and Flagstaff Peak quadrangles. The names "A" Bed, "B" Bed, and "C" Bed are substituted for the Hiawatha, Upper Hiawatha and Muddy No. 1 of Spieker (1931) consecutively. Table 2 below shows the coal bed correlations used in the adjoining Acord Lakes quadrangle and the Emery West quadrangle.

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

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

"A" Coal Bed

The "A" coal bed occurs on the west side of the zone of intertonguing. The bed in this area is the one formerly called the "Hiawatha" coal bed by Spieker (1931) and Doelling (1972). Based on work by Flores and others (1978) the bed merges laterally into the Star Point Sandstone about 11 miles (18 km) east of the quadrangle 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.

In the Acord Lakes quadrangle the "A" bed is generally less than 5 ft (1.5 m) thick where it has been found. The nearest measurement is in a hole drilled approximately 2.7 miles (4.3 km) east of the Water Hollow Ridge quadrangle in Section 22, T. 22 S., R. 4 E. where the bed is 1.5 ft (0.4 m) thick (AAA Engineering and Drafting, Inc., 1979a). The bed is expected to be thin or absent in the Water Hollow Ridge quadrangle.

"B" Coal Bed

The "B" coal bed occurs on the west side of the zone of intertonguing and was formerly called the Upper Hiawatha coal bed by Spieker (1931), Doelling (1972), and others. The bed reaches a thickness of over 18 ft (5.5 m) on the east side of the Acord Lakes quadrangle but thins westward and was 2.0 ft (0.6 m) thick in a hole drilled 2.7 miles (4.3 km) east of the Water Hollow Ridge quadrangle in Section 22, T. 22 S., R. 4 E.

The "B" bed occurs from less than 10 ft (3 m) to more than 40 ft (12 m) above the "A" bed and from less than 10 ft (3 m) to more than 15 ft (5 m) below the Hiawatha bed.

"C" Coal Bed

The "C" coal bed (formerly called the Muddy No. 1 coal bed by Spieker, 1931) occurs in the Emery West quadrangle but evidently pinches out westward and has not yet been encountered in the Acord Lakes and Water Hollow Ridge quadrangles.

Hiawatha Coal Bed

Based on 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). The bed is generally thin in the sections measured in the Acord Lakes quadrangle and at only one location was the bed found to be more than 5 ft (1.5 m) thick. The bed was 2.5 ft (0.8 m) thick in the hole drilled 2.7 miles (4.3 km) east of the Water Hollow Ridge quadrangle in Section 22, T. 22 S., R. 4 E. The Hiawatha bed on the east side of the zone of intertonguing rests on or immediately above the Star Point Sandstone. West of the intertonguing the bed occurs 55 to 65 ft (17 to 20 m) above the Star Point Sandstone.

Upper Hiawatha Coal Bed

The coal bed called the Upper Hiawatha in this report was formerly called the Upper Ivie coal bed by Spieker (1931) on the west side of the zone of intertonguing. However, Spieker (1931, p. 189) said that in this area, "It is not certain that the bed here called Upper Ivie is different from the Ivie bed defined in the Saleratus area. . ."

The bed reaches a thickness of 13.5 ft (4.1 m) in the eastern part of the Acord Lakes quadrangle and thins southwestward. The bed was 2.5 ft (0.8 m) thick in a hole drilled 2.7 miles (4.3 km) east of the Water Hollow Ridge quadrangle in Section 22, T. 22 S., R. 4 E. (AAA Engineering and Drafting, Inc., 1979a).

Chemical Analyses of the Coal

Doelling (1972) lists 12 coal analyses all of which were made on samples from the Upper Hiawatha bed (formerly Upper Ivie bed of Spieker, 1931) in the adjoining Acord Lakes quadrangle. The proximate analyses of these samples are summarized in the following table.

Table 3. Average proximate analysis of coal from the Upper Hiawatha coal bed (formerly Upper Ivie bed of Spieker, 1931), Acord Lakes quadrangle, Sevier County, Utah.*

	No. Analyses	As-received (percent) Average	Range
Moisture	12	8.7	5.6-10.4
Volatile Matter	11	38.3	36.2-40.6
Fixed carbon	11	46.6	43.3-50.4
Ash	12	6.5	5.9- 7.1
Sulfur	12	0.46	0.3- 0.6
Btu/lb**	11	11,770	11,390-12,260

*Doelling, 1972, p. 141
**To convert Btu/lb to Kj/kg multiply by 2.326

Based on the ASTM system of classification, the coal analyzed in table 2 ranges in rank from high volatile C bituminous to high volatile B bituminous (American Society for Testing and Materials, 1977). Analyses of coal from the other beds were not available.

Mining Operations

Two known coal mines occur in the Acord Lakes quadrangle. The Queatchappel or Queatch-up-pah Creek mine in Quitchupah Canyon operated intermittently from 1901-1920 and produced about 6,600 short tons (5,988 metric tons) (Doelling, 1972). That mine is now abandoned (1979). The Southern Utah Fuel mine in East Spring Canyon, a tributary of Convulsion Canyon, became active in 1941 and is presently operating (1979). Doelling (1972) reports that the mine had produced 1.1 million short tons (1.0 million metric tons) by 1969 from the Upper Hiawatha bed (formerly the Upper Ivie bed of Spieker, 1931).

COAL RESOURCES AND COAL DEVELOPMENT POTENTIAL

There are no coal bed measurements in the Water Hollow Ridge quadrangle KRCRA and no coal beds of Reserve Base thickness have been projected into the area from adjoining quadrangles. Therefore, no coal resources are shown.

Development Potential for Surface Mining Methods

No development potential for surface mining methods exists in the KRCRA of this quadrangle because of the thick overburden. Based on the depth and dip of the coal beds in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a) depths to the lower Blackhawk Formation coal beds are estimated to range from 1,000 to 3,000 ft (305 to 914 m) in the Water Hollow Ridge quadrangle KRCRA.

Development Potential for Subsurface Mining and In Situ Coal Gasification Methods

The coal development potential for subsurface mining of coal is based on thickness of overburden for beds dipping less than 15 degrees. 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 such beds are overlain by 1,000 to 2,000 ft (305 to 610 m) and 2,000 to 3,000 ft (610 to 914 m) of overburden are classified as having moderate and low development potentials, 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.

There are no known coal bed measurements in the Water Hollow Ridge quadrangle KRCRA. Projections of coal bed thicknesses into the quadrangle from adjoining quadrangles indicate that several coal beds probably occur in the lower part of the Blackhawk Formation in the southeast corner of the quadrangle and that these beds may be more or less than 5 ft (1.5 m) in thickness. These coal beds are overlain by more than 1,000 ft (348 m) of overburden. Even though this area may contain coal thicker than 5 ft (1.5 m) the limited knowledge of the areal distribution of the coal prevents an accurate evaluation of development potential and therefore, all the unleased Federal coal land in the KRCRA in the Water Hollow Ridge quadrangle is classified as having an unknown development potential.

Classification of development potential for in situ coal gasification was not done because dips are less than 15 degrees within the quadrangle KRCRA. 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).

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

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