UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE ACORD LAKES QUADRANGLE SEVIER COUNTY, UTAH

(Report includes 12 plates)

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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 (11 plates) and the Coal Development Potential (CDP) Map (1 plate) of the Acord Lakes quadrangle, Sevier County, Utah (U.S. Geological Survey Open-File Report 79-1009).

Published and unpublished public information were used as data sources for this study. No new drilling nor field mapping were done to supplement this study. No confidential nor proprietary data were used.

Location

The Acord Lakes quadrangle is located in the southern part of the Wasatch Plateau coal field in Sevier County in central Utah. The city of Richfield, the county seat of Sevier County,is located approximately 31 miles (50 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 7 miles (11 km) east, 9 miles (14 km) northeast, and 20 miles (32 km) northeast of the quadrangle. The cities of Salina and Manti on the west side of the Wasatch Plateau are respectively 20 miles (32 km) west and 23 miles (37 km) northwest of the quadrangle.

Accessibility

The Acord Lakes quadrangle is in mountainous terrain and the only paved road extends from the south part of the west side of the quadrangle to the Southern Utah Fuel Company coal mine in the Convulsion Canyon area. Numerous unimproved dirt roads and jeep trails cross the upland plateau area. The steep-walled canyons of Water Hollow and North Fork of Quitchupah Creek are inaccessible, but a jeep trail comes up Convulsion Canyon to Broad Hollow where it joins the paved road which comes part way down the canyon from Interstate Highway 70 approximately 6 miles (10 km) west of the quadrangle. Utah Highway 10 runs nearly parallel to the east side of the Wasatch Plateau and passes the Acord Lakes quadrangle 4 miles (6 km) to the southeast before it joins Interstate Highway 70 at a junction about 8 miles (13 km) southeast of the quadrangle.

The nearest railroad 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 line makes connections to Salt Lake City, Utah and Denver, Colorado.

Physiography

The Wasatch Plateau is a high and deeply dissected tableland. The eastern margin forms a sweeping stretch of barren sandstone cliffs some 80 miles (129 km) long. The strata have gentle dips generally less than 10 degrees and erosion has produced ledges and cliffs along the plateau front and on steep-walled re-entrant canyons.

The Acord Lakes quadrangle is located in the southern part of the Wasatch Plateau coal field. Three deep canyons', North Fork Quitchupah, Convulsion, and Water Hollow canyons, cut into the plateau on the east side of the quadrangle. The canyons are narrow and steep with precipitous sandstone cliffs and ledges forming the walls. The canyons are up to 2,000 ft (610 m) deep at their mouths.

Almost 3/4 of the quadrangle area is over 8,000 ft (2,438 m) in elevation and is a hilly upland plateau area. The total relief in the quadrangle is over 4,240 ft (1,292 m) with elevations ranging from 6,560 ft (1,999 m) where Quitchupah Creek in Convulsion Canyon leaves the southeast part of the quadrangle to over 10,800 ft (3,292 m) on White Mountain in the northwest corner. The coal beds crop out in the deep canyon walls between 7,300 and 7,700 ft (2,225 and 2,347 m) above sea level.

The main drainage system in the quadrangle area is that of Quitchupah Creek which drains eastward and flows into Muddy Creek which subsequently empties into the Dirty Devil River and the Colorado River. A small area in the northwest quarter of the quadrangle drains into Skumpah Creek which flows westward into Salina Creek and then the Sevier River.

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 Acord Lakes quadrangle ranges from 12 inches (29 cm) in the southeast corner to 30 inches (76 cm) in the high northwest 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 -20 degrees F (-29 degrees C) in winter.

Land Status

The Acord Lakes quadrangle lies in the south part of the Wasatch Plateau Known Recoverable Coal Resource Area (KRCRA). Approximately 28,700 acres (11,615 ha) of the quadrangle area lies within the KRCRA and plate 2 shows the distribution, and table 1 lists the acres of Federal and non-Federal lands in that area.

Table 1. Approximate distribution of coal lands within the KRCRA in the Acord Lakes quadrangle, Sevier County, Utah.

Category	Approximate Area (acres)*	Percent of KRCRA (%)
Non-Federal land	3,700	13
Leased Federal coal land	4,700	16
Unleased Federal coal land	20,300	71
Total	28,700	100

*To convert acres to hectares, multiply acres by 0.4047

GENERAL GEOLOGY

Previous Work

Spieker (1931) mapped the geology and coal outcrops of the Wasatch Plateau in detail. The stratigraphy of the area has also been described by Spieker and Reeside (1925), Katich (1954), and Hayes and others (1977). In 1972 Doelling summarized the geology and assembled the available coal data for the coal field.

The adjoining Emery West and Flagstaff Peak quadrangles were more 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 some lithogenetic variations in the Blackhawk Formation and the Star Point Sandstone in the Wasatch Plateau and a detailed description of the stratigraphic variations in these two formations was made 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 the following four formations in ascending order: the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and the Price River Formation. The Upper Cretaceous Mancos Shale underlies the Mesaverde Group. The Tertiary strata overlying the Mesaverde Group consist of two formations in the quadrangle: the North Horn Formation (Upper Cretaceous and Paleocene) and the Flagstaff Limestone of Paleocene age.

The oldest unit exposed in the quadrangle is the Emery Sandstone Member of the Mancos Shale which crops out in the bottom of Convulsion and Water Hollow canyons in the southeast corner of the quadrangle. The Emery Sandstone is overlain by the Masuk Shale Member of the Mancos Shale and consists of 700 ft (213 m) of dark gray marine shale.

The Star Point Sandstone overlies the Masuk Shale and crops out as a cliff in the lower parts of Convulsion, Water Hollow, and Quitchupah canyons. It is from 200 to 300 ft (61 to 91 m) thick (Doelling, 1972) and is composed of fine- to medium-grained sandstone.

The Blackhawk Formation is approximately 950 ft (290 m) thick (Doelling, 1972) and is exposed in the walls of the main canyons in the quadrangle. The formation consists of very fine- to medium-grained sandstone, siltstone, shale, coal, and limestone; sandstone is the dominant rock type. 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 sandstone unit 90 to 200 ft (27 to 61 m) thick (Doelling, 1972). The overlying Price River Formation is composed of fine- to medium-grained sandstone with some interbedded shale and is approximately 550 ft (168 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. It consists of nearly 1,150 ft (351 m) of variegated shale and subordinate conglomerate, sandstone, and limestone. The Flagstaff Limestone overlies the North Horn Formation and forms the cliffs capping White Mountain in the northwest corner of the quadrangle. The formation is composed of dominant light-colored resistant limestone with subordinate amounts of interbedded sandstone and shale.

Structure

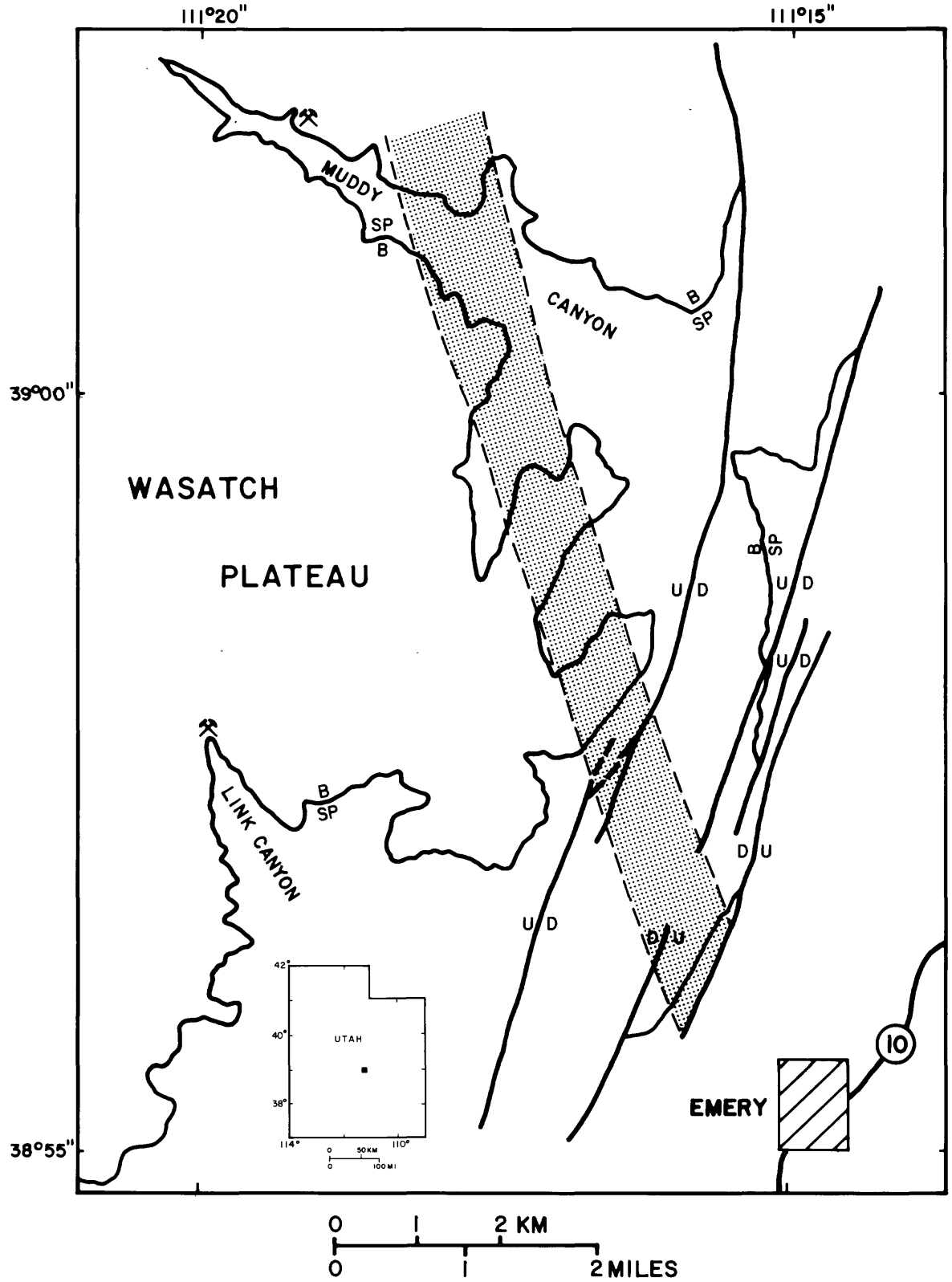
The Acord Lakes fault crosses the western half of the quadrangle in a somewhat northerly direction (see plate 1). Doelling (1972) suggests that the displacement of the fault probably does not exceed the thickness of the Castlegate Sandstone. The west side of the fault is downthrown. Strata in the quadrangle area are gently inclined to the west and northwest with dips of 2 degrees or less.

COAL GEOLOGY

The chief coal beds in the southern part of the Wasatch Plateau coal field occur in the lower section of the Blackhawk Formation. In the area of this quadrangle Spieker (1931) lists the following coal beds, in ascending order: the 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 beds there is small doubt of its 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. During the course of this work 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. See figure 1. "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



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

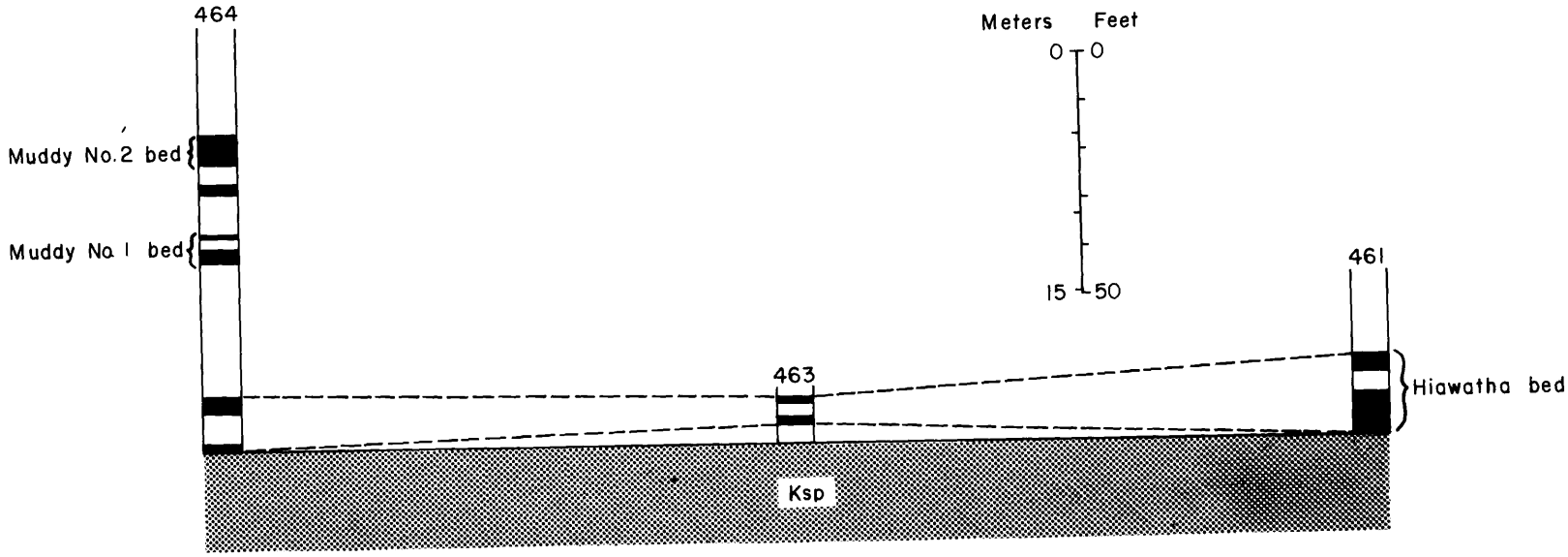
FIGURE 1. Map showing zone of intertonguing (after Flores and others, 1978).

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 2.

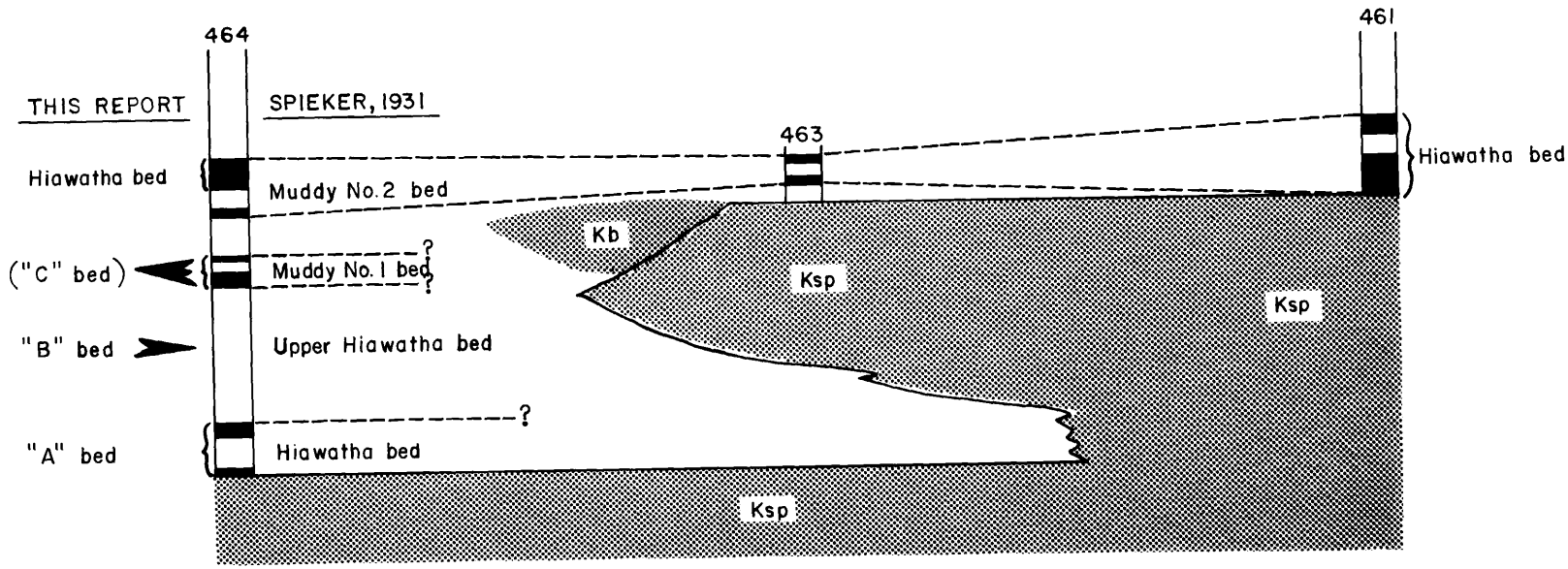
The Acord Lakes quadrangle lies approximately 5 miles (8 km) west of the zone of intertonguing and the coal-bed names used here reflect the stratigraphic correlations suggested by Flores and others (1978) in the Emery West and Flagstaff Peak quadrangles. The names "A" Bed, "B" Bed, and "C" Bed are used tentatively here by the present authors for the lack of other names. Table 2 below shows the coal bed correlations used in this report and in the adjoining 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 Hiawatha Hiawatha (absent) "B" Bed "A" Bed	Upper Hiawatha Hiawatha "C" Bed "B" Bed "A" Bed	Upper Ivie Muddy No. 2 Muddy No. 1 Upper Hiawatha Hiawatha	Upper Ivie Muddy No. 2 Muddy No. 1 Upper Hiawatha Hiawatha



Correlations of Spieker (1931)



Revised correlations

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

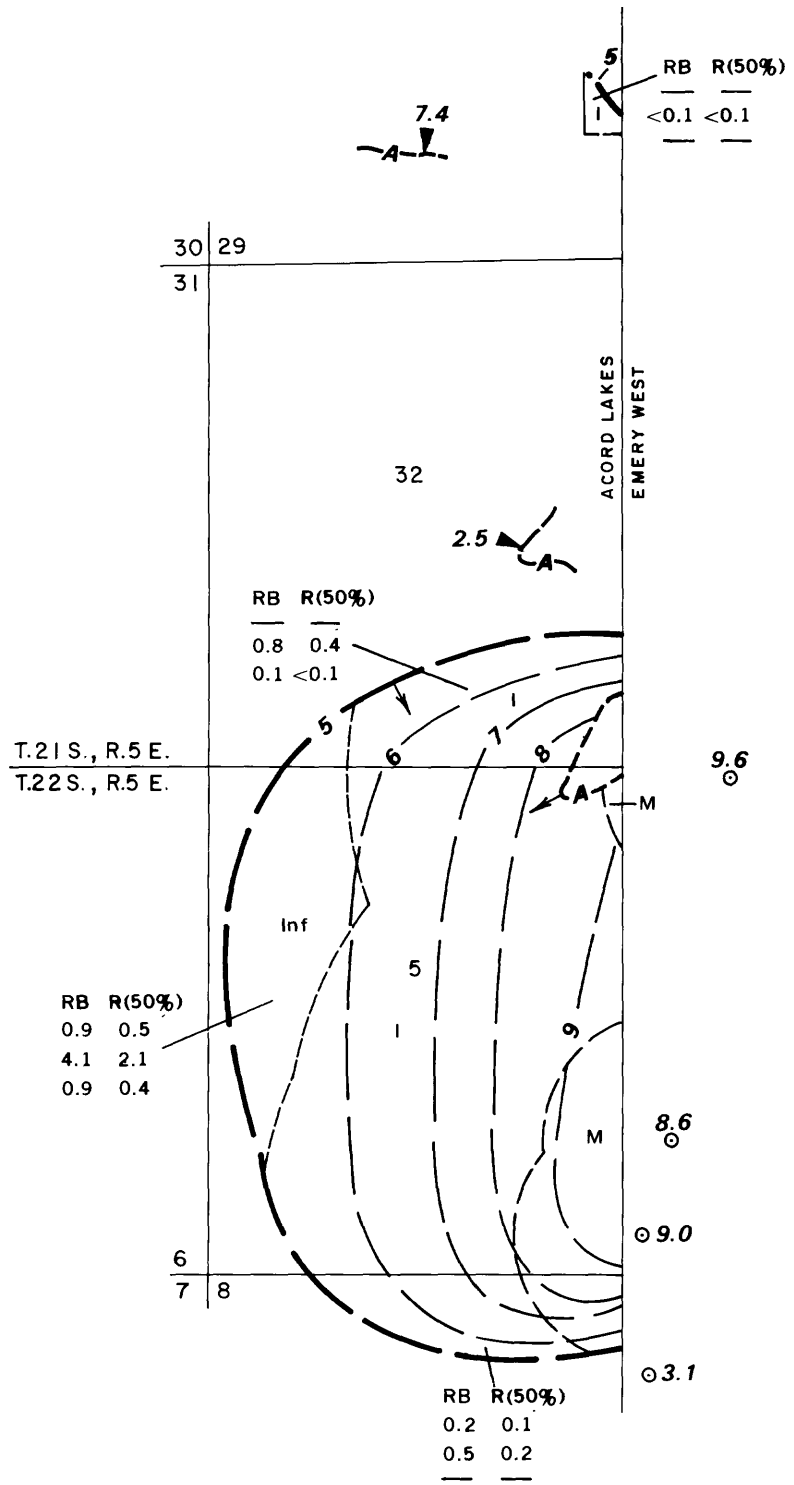
"A" Coal Bed

The "A" coal bed occurs on the west side of the zone of intertonguing and the name is tentatively used here by the present authors because of the lack of another name. The bed in this area is the one formerly called the "Hiawatha" coal bed by Spieker (1931) and Doelling (1972). Based on findings interpreted by Flores and others (1978) the bed merges laterally into the Star Point Sandstone about 5 miles (8 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 has not been measured in the Convulsion Canyon area, but crops out in Quitchupah Canyon on the east of the quadrangle and in the adjoining Emery West quadrangle. The bed crops out in Water Hollow Canyon and was encountered in two holes drilled on the south and northeast sides of the quadrangle. The bed is generally less than 5 ft (1.5 m) thick where it has been found. However, at the location of index number 2 in Quitchupah Canyon the "A" bed includes 7.4 ft (2.2 m) of coal with a 0.1 ft (0.03 m) rock parting. A lens of the bed projects into the east side of the quadrangle from measured points in Quitchupah Canyon in the adjoining quadrangle where the bed is over 9 ft (2.7 m) thick at one point. Figure 3 shows the projected isopach lines and areal distribution and identified resources for the bed.

"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 substantial thickness of over 18 ft (5.5 m) in a mine-measured section in Quitchupah Canyon at the location of index number 3 on the east side of the quadrangle. From that



EXPLANATION

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ISOPACHS–Showing thickness of coal, in feet. Long dashed where inferred, short dashed where projected above land surface. Isopach interval 1 foot.

FEDERAL COAL LEASE BOUNDARY

9.6 ⊙ ▶ 2.5

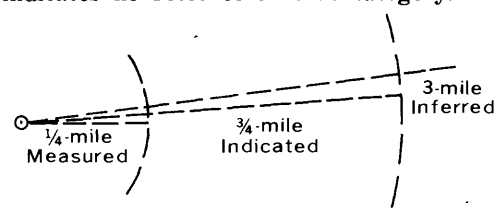
POINT OF MEASUREMENT–Showing thickness of coal, in feet.

A

TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Arrow points toward coal-bearing area. Dashed where inferred by present authors.

RB	R(50%)	
—	—	(Measured)
<0.1	<0.1	(Indicated)
—	—	(Inferred)

IDENTIFIED COAL RESOURCES–Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land within the KRCRA. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.



BOUNDARY LINES–Enclosed areas of measured, indicated, and inferred coal resources of the coal bed. Dashed where projected from adjacent quadrangles.

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

To convert feet to meters, multiply feet by 0.3048.

FIGURE 3. Projected isopach and areal distribution and identified resources map of the "A" coal bed.

point the bed thins eastward into the Emery West quadrangle and southward toward Convulsion Canyon. See the coal isopach map, plate 4. The bed then thickens in Convulsion Canyon to 9.5 ft (2.9 m) and thins to less than 3.0 ft (0.9 m) at the south edge of the quadrangle. The "B" bed thins northward somewhat from Quitchupah Canyon to 13.0 ft (4.0 m) in the drill hole in Section 20, T. 21 S., R. 5 E. Inasmuch as there are no non-proprietary drilling data west of Quitchupah Canyon, the thickness trend of the bed to the west is unknown.

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 quadrangle.

Hiawatha Coal Bed

Based on findings interpreted 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 this report the Hiawatha bed was formerly called the Muddy No. 2 coal bed by Spieker (1931). The bed is generally thin in the sections measured in the quadrangle and at only one location (index number 17) was the bed found to be more than 5 ft (1.5 m) thick. 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. Spieker (1931,

p. 188) reports that this bed in places "is so near the position of the Ivie bed that correlations unsupported by tracing are not as sure as might be desired, but on the whole it appears to be a distinct bed, and in Convulsion Canyon there is small doubt of its separate identity."

A lens of the Hiawatha coal bed over 5 ft (1.5 m) thick projects into the south side of the quadrangle from the adjoining Old Woman Plateau quadrangle where the bed is 8.0 ft (2.4 m) thick. Figure 4 shows the projected isopach lines and areal distribution and identified resources for the bed.

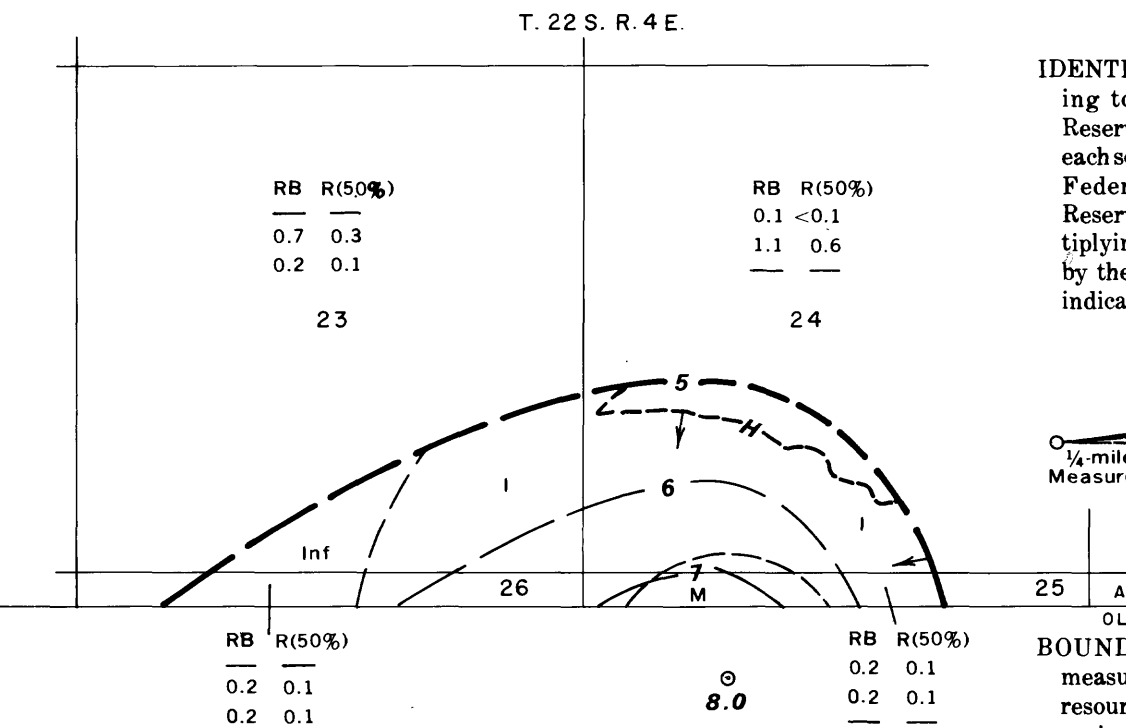
Upper Hiawatha Coal Bed

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. . . "

In Convulsion Canyon the bed is burned in some of the outcrop area. In the Southern Utah Fuel mine in East Spring Canyon the bed is 13.5 ft (4.1 m) thick. A hole drilled less than 2 miles (3 km) northeast of the mine encountered over 12.5 ft (3.8 m) of coal. The bed thins southward and at the location of index number 16 it is 1.9 ft (0.6 m) thick. From that point it then thickens southward to North Water Hollow where it is greater than 6 ft (2 m) thick. See plate 8.

Isolated Data Points

Maps, in U.S. Geological Survey files, were made showing isolated data points where coal beds thicker than 5 ft (1.5 m) have been measured. The sparcity of data on these coal beds limits the extent to which they can



EXPLANATION

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ISOPACHS–Showing thickness of coal, in feet. Long dashed where inferred, short dashed where projected above land surface. Isopach interval 1 foot.

⊙ 8.0

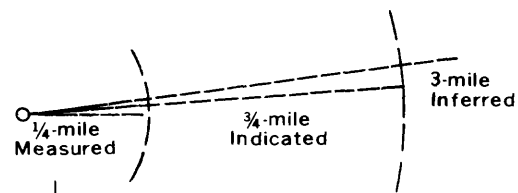
POINT OF MEASUREMENT–Showing thickness of coal, in feet.

H

TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Arrow points toward coal-bearing area. Dashed where inferred by present authors.

RB	R(50%)	
0.1	<0.1	(Measured)
1.1	0.6	(Indicated)
—	—	(Inferred)

IDENTIFIED COAL RESOURCES–Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land within the KRCRA. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.



BOUNDARY LINES–Enclosed areas of measured, indicated, and inferred coal resources of the coal bed. Dashed where projected from adjacent quadrangles.

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

To convert feet to meters, multiply feet by 0.3048.

FIGURE 4. Projected isopach and areal distribution and identified resources map of the Hiawatha coal bed.

reasonably be projected for Reserve Base computations and the data is insufficient to construct coal isopach and other derivative maps. Therefore, isolated data points have been drawn on separate sheets and are kept in U.S. Geological Survey files. The coal beds with isolated data points are referred to as non-isopachable coal beds. Reserve Base tonnages have been calculated for these beds where they are more than 5 ft (1.5 m) thick. The tonnages are shown separately by section on plate 2 and are listed in table 4 as non-isopached coal beds under unknown development potential.

The isolated data points for this quadrangle are shown below.

Index Number	Coal bed	Location	Thickness
11	Hiawatha	Sec. 12, T. 22 S., R. 4 E.	5.5 ft (1.7 m)
16	Hiawatha	Sec. 18, T. 22 S., R. 5 E.	5.3 ft (1.6 m)

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). 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 3 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 in the quadrangle 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). The mine was abandoned at this writing (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 it had produced a total of 1.1 million short tons (1.0 million metric tons) by 1969. The mine is producing from the Upper Hiawatha bed (formerly the Upper Ivie bed of Spieker, 1931).

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 resource tonnages 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 and 8) were used to calculate the Reserve Base values. The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times 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 of coal for each isopached coal bed. Reserve Base and Reserve values for the Upper Hiawatha and "B" beds are shown on plates 7 and 11 and

are rounded to the neareast tenth of a million short tons. The Reserve values are based on a subsurface mining recoverability factor of 50 percent. Coal beds thicker than 5 ft (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included, although this criteria differs 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 minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both bituminous and subbituminous coal. Reserve Base tonnages only (designated as inferred resources) are calculated for areas in this quadrangle that are influenced by isolated data points.

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 81.2 million short tons (73.7 million metric tons) for the unleased Federal coal lands within the KRCRA boundary in the Acord Lakes quadrangle. These data 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 Acord Lakes quadrangle, Sevier County, 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
Upper Hiawatha	29,200,000	900,000	--	30,100,000
Hiawatha	2,900,000	--	--	2,900,000
"B" Bed	33,900,000	6,100,000	--	40,000,000
"A" Bed	7,200,000	300,000	--	7,500,000
Non-isopached coal bed	--	--	700,000	700,000
Total	73,200,000	7,300,000	700,000	81,200,000

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 exists 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 some rim stripping 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 the subsurface mining of coal is shown on plate 12. In this quadrangle the 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 considered to have 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 rated 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 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, a certain 40-acre (16-ha) area

is totally underlain by a coal bed with a "moderate" development potential. If a small corner of the same 40-acre (16-ha) area is also underlain by another coal bed with a "high" development potential, the entire 40-acre (16-ha) area is given a "high" development potential rating even though most of the area is rated "moderate" by the lower coal bed. Another possibility is a 40-acre (16-ha) area devoid of any coal except a small corner where a 5 ft (1.5 m) coal bed crops out. In this case the 40-acre (16-ha) area will have a "high" development potential rating.

The in situ coal gasification methods of development potential classification are based on the dip and depth of coal beds having a minimum thickness of 5 ft (1.5 m). There are only two development potential classifications--moderate and low. The criteria for in situ coal gasification include coal bed dips of 15 to 90 degrees and coal bed depths of 200 to 3,000 ft (61 to 914 m).

Inasmuch as the coal beds dip less than 15 degrees in the Acord Lakes quadrangle, the criteria for the classification of in situ coal gasification methods of development potential do not apply.

Table 5. Sources of data used on plate 1.

Source	Plate 1 Index Number	Data Base Drill Hole Measured Section No.	Data Base Plate or Page No.
Blanchard, Ellis, and Roberts, 1977.	1	W-TP-1-AL	197-209
Spieker, 1931	2	501	pl. 29
	3	502	pl. 29
	4	500	pl. 2
	5	503	pl. 29
	6	504	pl. 29
	7	513	pl. 29
	9	520	pl. 29
	10	521	pl. 29
	11	522	pl. 29
	12	518	pl. 29
	13	517	pl. 29
	14	523	pl. 29
	15	524	pl. 29
	16	525	pl. 29
	17	516	pl. 29
	18	515	pl. 29
Blanchard, Ellis, and Roberts, 1977.	19	W-OWP-5-AL	306-317
	20	W-OWP-6-AL	318-324
Spieker, 1931	21	528	pl. 29
	22	527	pl. 29
	23	529	pl. 29
	24	526	pl. 29
Doelling, 1972	25	8	144
Spieker, 1931	26	536	pl. 29
Doelling, 1972	27	37	144

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