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COAL RESOURCE OCCURRENCE MAPS
OF THE FRUITLAND QUADRANGLE,
SAN JUAN COUNTY, NEW MEXICO

[Report includes 6 plates]

by

Dames & Moore

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FRUITLAND 7 1/2-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps of the Fruitland quadrangle, San Juan County, New Mexico. These maps were compiled to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. The work has been performed under contract with the Conservation Division of the U.S. Geological Survey (Contract No. 14-08-0001-17172).

The resource information gathered in this program is in response to the Federal Coal Leasing Amendments Act of 1976 and is a part of the U.S. Geological Survey's coal program. The information provides basic data on coal resources for land-use planning purposes by the Bureau of Land Management, state and local governments, and the public.

Location

The Fruitland 7 1/2-minute quadrangle is located in northwestern San Juan County, New Mexico. The area is approximately 12 miles (19 km) west of Farmington, New Mexico. The Navajo Indian Reservation encompasses all the quadrangle except a small portion of the area north of the San Juan River.

Accessibility

The Fruitland quadrangle is accessible from New Mexico State Route 550 which extends across the extreme northeastern corner of the area. Light-duty roads leading from State Route 550 provide access to other areas of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 82 miles (131 km) south of the area at Gallup, New Mexico.

Physiography

This quadrangle is in the northwestern portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 5,099 ft (1,554 m) in the northwest corner to 5,767 ft (1,758 m) in the southeast corner. The San Juan River flows from east to west across the northern part of the area and is bounded on the south by a steep-walled terrace. Morgan Lake is located in the west-central part of the area, next to the Four Corners Power Plant. The Utah International Navajo Mine occupies the central part of the area along the north-south-trending Fruitland Formation outcrop. The central part of the area, on either side of the mine, is of low relief and relatively undissected. The southwestern corner of the area exhibits badlands topography, dissected by numerous washes and arroyos.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than 10 inches (25 cm) with slight variations across the basin due to elevational differences. Rainfall is rare in the early summer and winter; most precipitation is received in July and August as intense afternoon thundershowers. Annual temperatures in the basin range from below 0°F (-18°C) to above 100°F (38°C). Snowfall may occur from November to April.

Land Status

Approximately 3 percent of the quadrangle is in the northwestern portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 23 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur in the quadrangle.

GENERAL GEOLOGY

Previous Work

Bauer and Reeside (1921) mapped the Fruitland Formation within the quadrangle, with detailed emphasis on the outcrops of Fruitland coal and clinker. In 1924, Reeside mapped the various formations on a scale of 1:250,000 as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. Hayes and Zapp (1955) published a geologic map of the Barker Dome-Fruitland Area, which includes the area north of the San Juan River within the quadrangle, on a scale of 1:62,500. In addition to mapping the Upper Cretaceous rocks of the area they mapped the exposed

Fruitland Formation coal beds and measured numerous coal-bearing sections. More recently, Fassett and Hinds (1971) made subsurface interpretations of the Fruitland Formation coals as part of a larger San Juan Basin coal study. Utah International is presently operating the Navajo Mine, a strip mine of the basal Fruitland coals, south of the San Juan River on the Navajo Reservation. The limit of mining as of November 1978 is shown on CRO Plate 1.

Geologic History

The San Juan Basin, an area of classic transgressive and regressive sedimentation, provided the ideal environment for formation of coals during Late Cretaceous time. At that time a shallow epeiric sea, which trended northwest-southeast, was northeast of the basin. The sea transgressed southwesterly into the basin area and regressed northeasterly numerous times; consequently, sediments from varying environments were deposited across the basin. Noncarbonaceous terrestrial deposition predominated during Paleocene and Eocene time.

The first basin-wide retreat of the Late Cretaceous sea is indicated by the nearshore deposits of the Point Lookout Sandstone. These ancient barrier beaches formed a generally north-south-trending strandline in this area, behind which swamps developed. Organic material accumulated in the swamps and later became coal in the paludal deposits of the lower Menefee Formation. Deposition of materials which formed the coal beds was influenced by the strandline. This is shown by the more consistent thickness and greater lateral extent of the coals parallel to the strandline and also by the lack of continuity perpendicular to it, to the east, where the Menefee and underlying Point Lookout deposits interfinger. Streams which crossed the swamps also influenced deposition of organic matter; stream deposits may terminate even the most continuous coal beds.

During the continued retreat of the sea, the depositional environments in the quadrangle area became more terrestrial. This is evidenced by the transition within the lower Menefee from carbonaceous to noncoal-bearing deposits, in which there is an upward decrease in the occurrence and lateral continuity of the coals. As the sea retreated, the sediments of the Point Lookout Sandstone and overlying Menefee Formation were deposited in successively higher stratigraphic positions to the northeast.

The sea then reversed the direction of movement, and the transgressive sequence of nearshore Cliff House Sandstone and marine Lewis Shale was deposited in the quadrangle. A thin Cliff House sand was deposited over the Menefee Formation. Subsequently, several hundred feet of beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over the basal Cliff House sand. The marine facies which developed northeast of the strandline as it moved to the southwest is the Lewis Shale. This thick sequence, which thins to the southwest, overlies the Cliff House Sandstone, and marks the last advance of the Late Cretaceous sea.

Depositional evidence of the final retreat of the Late Cretaceous sea is the nearshore regressive Pictured Cliffs Sandstone. Southwest (shoreward) of the beach deposits, swamps, which were dissected by streams, accumulated organic matter which later became coals of the Fruitland Formation. Again, deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the north-south strandline and their discontinuity perpendicular to it to the east. The less continuous Fruitland coals appear to be noncorrelative, but are stratigraphically equivalent in terms of their relative position within the Fruitland Formation.

The brackish-water swamp environment of the Fruitland moved farther to the northeast as the regression continued in that direction. Terrestrial freshwater sediments then covered this quadrangle as indicated by the lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated beyond the limits of the quadrangle area, and modern basin structure began to develop. An erosional unconformity developed in a relatively short time as part of the Cretaceous Kirtland Shale was removed.

Terrestrial deposition resumed in the Paleocene as represented by the Ojo Alamo Sandstone and the overlying Nacimiento Formation and the Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface.

Deposition and structural deformation of the basin then ceased, and the warped strata of the San Juan Basin have been exposed to erosional processes to the present time. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation, Nacimiento Formation, and Ojo Alamo Sandstone from the area.

Stratigraphy

The formations studied in this quadrangle are Late Cretaceous in age. They are, in order from oldest to youngest: (the three formations of the Mesaverde Group) Point Lookout Sandstone, Menefee Formation, and Cliff House Sandstone; Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation and Kirtland Shale. A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationships of these formations and is accompanied by lithologic descriptions of the individual formations.

The Point Lookout Sandstone, the basal formation of the Mesaverde Group, is composed of white to cream, kaolinitic, glauconitic sandstone and interbedded gray shale and siltstone. It is fairly massive, averages 260 ft (79 m) in thickness in this area, and possesses a distinctive and consistent character on geophysical logs. This last characteristic was utilized by the authors to establish the top of the Point Lookout as a lithologic datum for correlation of the overlying Menefee Formation coals.

The oldest coal-bearing formation in the quadrangle is the Menefee Formation of the Mesaverde Group. In previous studies the Menefee has been divided into the Cleary Coal Member, the barren Allison Member, and the upper coal-bearing member (Beaumont and others, 1956). These members were grouped together as undifferentiated Menefee Formation for the purposes of this report only. It consists primarily of gray, carbonaceous to noncarbonaceous shale, interbedded light gray, calcareous sandstone, interbedded gray siltstone and lenticular coal beds. The formation has a total thickness of approximately 970 ft (296 m) in this area.

The Cliff House Sandstone sequence conformably overlies the Menefee Formation. A thin, basal sand, referred to as "the Cliff House Sandstone" by Fassett (1977), correlates with the undifferentiated Cliff House Sandstone to the north. It is about 50 ft (15 m) thick here and consists of light gray, calcareous, kaolinitic sandstone.

Overlying the basal member is the La Ventana Tongue. This member is here a 630-ft (192-m) thick sequence composed primarily of light gray, kaolinitic, calcareous, silty sandstone, abundunt interbedded gray shale, and gray to gray-green, micaceous siltstone.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is comprised predominantly of gray, micaceous, flaky shale and gray siltsone. The thickness of the Lewis Shale averages 610 ft (186 m) in this area. The upper contact is gradational with the overlying Pictured Cliffs Sandstone, and, therefore, a definite and consistent contact is difficult to establish.

The Pictured Cliffs Sandstone consists of about 290 ft (88 m) of light gray, kaolinitic, slightly calcareous sandstone commonly interbedded with gray shale near the base of the formation where it grades into the Lewis. The upper contact is more sharply defined than the basal contact, although intertonguing with the overlying Fruitland Formation results in minor variations in the formational top and occurrence of local Fruitland coal beds in the sandstone. Since the Pictured Cliffs Sandstone is present throughout the basin and displays a distinctive character on geophysical logs, the authors have used the top of the Pictured Cliffs Sandstone as a lithologic datum for correlation of Fruitland coals.

The Fruitland Formation is the major coal-bearing unit in the quadrangle. It averages 450 ft (137 m) thick and consists of gray, carbonaceous shale with plant fossils, interbedded light gray sandstone, and coal beds of varying thicknesses. The thickest and most continuous coal beds occur near the base of the formation, while discontinuous and lenticular coal beds are characteristic of the upper portion. The upper contact is gradational from nonmarine, lower coastal plain deposits of the Fruitland to upper coastal or alluvial plain deposits of the Kirtland Shale (Molenaar, 1977).

The freshwater deposits of the Kirtland Shale average 490 ft (149 m) in thickness and are composed of gray to brown shale with local plant fossils and interbedded gray-green siltstone beds. The formation has previously been divided into several members by various authors; however, for the purpose of this report it was not necessary to distinguish between the individual members.

Surface exposures in the quadrangle are influenced by the gentle regional dip to the east which causes exposure of younger Cretaceous strata in an easterly direction. The oldest formation exposed is the Lewis Shale which crops out along the western boundary of the quadrangle. Entire sections of the Pictured Cliffs Sandstone and the Fruitland Formation trend north-south across the quadrangle. The lower portion of the Kirtland Shale, the youngest unit in the area, is exposed in the southeastern corner of the quadrangle.

Structure

The Fruitland quadrangle is in the Central Basin area (Kelley, 1950) of the major structural depression known as the San Juan Basin. The western end of the axis of the basin is about 15 miles (24 km) northeast of the quadrangle area and trends eastward in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip measured within the quadrangle ranges from 1° to 3° to the east (Reeside, 1924).

COAL GEOLOGY

Four coal beds (Menefee 5, Fruitland 1, Fruitland 2, Fruitland 3) and a coal zone (Menefee) were identified in the subsurface or on the surface of this quadrangle (CRO Plate 1). The coals of the Menefee Formation are designated as the Menefee coal zone (Me zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]). Therefore, derivative maps were not constructed. The Menefee 5 (Me 5) coal bed is in the upper portion of the Menefee Formation. This coal bed is informally named by the authors and is lithostratigraphically equivalent, although not necessarily laterally continuous, with the Menefee 5 of the Waterflow and Kirtland quadrangles.

Menefee Formation coals in the northwestern part of the San Juan Basin are considered high volatile C bituminous in rank, although they vary from borderline subbituminous A - high volatile C bituminous to high volatile B bituminous. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 12,563 Btu's per pound (29,222 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 5.6 to 11.3 percent, ash content ranging from 3.1 to 6.3 percent, sulfur content less than one percent, and heating values on the order of 11,993 Btu's per pound (27,896 kj/kg). Analyses of several Menefee coals are given in Table 1 (Bauer and Reeside, 1921; Hayes and Zapp, 1955; Shomaker and Whyte, 1977).

TABLE 1

Analyses of coal samples from the Menefee Formation

(Form of analysis: A, as received; B, moisture free; C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location			Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent					Heating Value (Btu)	Remarks
		Section	T.N.	R.W.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
J-58561	Merrion & Bayless #1, Union	9	19	15	2,494-2,500	A	5.6	40.4	47.7	6.3	0.8	12,740	
						B	—	42.7	50.7	6.6	0.9	13,490	
						C	—	45.8	54.2	—	1.0	14,450	
17750	Shiprock School Mine(?) (100 ft from entry) (Government Mine)	SW¼ 21	30	16	—	A	10.6	36.7	49.6	3.1	0.64	11,010	
						B	—	41.1	55.4	3.5	0.72	12,310	
						C	—	42.6	57.4	—	0.75	12,750	
A-46364	Shiprock School Mine (250 ft from entry)	21	30	16	—	A	9.8	38.7	46.5	5.0	—	11,870	
						B	—	42.9	51.5	5.6	—	13,170	
						C	—	45.4	54.6	—	1.5	13,940	
29006	Shiprock School Mine (350 ft from entry) (Government Mine)	SW¼ 21	30	16	—	A	10.1	39.9	45.8	4.2	0.85	12,010	
						B	—	44.4	50.9	4.7	0.95	13,370	
						C	—	46.6	53.4	—	1.00	14,020	
A-46365	Joe Duncan Mine (150 ft from entry)	21	30	16	—	A	10.5	39.1	47.2	3.2	—	12,240	
						B	—	43.7	52.7	3.6	—	13,670	
						C	—	45.3	54.7	—	1.0	14,180	
C-31312	Davidson Mine (tipple)	22	30	16	—	A	11.3	39.3	46.0	3.4	—	12,090	
						B	—	44.3	51.9	3.8	—	13,630	
						C	—	46.1	53.9	—	0.8	14,170	

To convert Btu's/lb to kj/kg, multiply Btu's/lb by 2.326.
To convert feet to meters, multiply feet by 0.3048.

The Fruitland 1 (Fr 1) coal bed, informally named by the authors, occurs near the base of the Fruitland Formation. The Fruitland 2 (Fr 2) coal bed is above the Fruitland 1; they are separated by a rock interval averaging 7 ft (2.1 m). The Fruitland 3 (Fr 3) coal bed occurs above the Fruitland 2. The Fruitland 1 and Fruitland 3 beds crop out in the northeast part of this quadrangle. The traces of the outcrop have been adjusted from the original data source to fit modern topographic maps. All of the Fruitland coal beds are less than reserve base thickness (5 ft [1.5 m]) within the KRCRA. Therefore, derivative maps were not constructed.

Fruitland Formation coals in the northwestern part of the San Juan Basin are considered high volatile C to high volatile B bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 12,900 Btu's per pound (30,005 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 4.1 to 11.6 percent, ash content ranging from 8.3 to 15.3 percent, sulfur content varying from 0.60 to 2.32 percent, and heating values on the order of 10,530 to 12,056 Btu's per pound (24,493-28,042 kj/kg). Analyses of several Fruitland Formation coals are given in Table 2 (Bauer and Reeside, 1921; Beach and Jentgen, 1978; Fassett and Hinds, 1971; Hayes and Zapp, 1955).

Menefee 5 Coal Bed

The Menefee 5 Coal Bed has been mapped only in areas outside the Navajo Indian Reservation. As shown by the structure contour map (CRO Plate

TABLE 2

Analyses of coal samples from the Fruitland Formation

(Form of analysis: A, as received; B, moisture free; C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location			Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent					Heating Value (Btu)	Remarks
		Section	T.N.	R.W.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-4051	Humble Oil & Gas Humble No. L-9	SE¼ 36	29	14	1,490-1,495	A	4.1	40.0	40.6	15.3	0.7	11,600	
						B	——	41.7	42.3	16.0	0.7	12,100	
						C	——	49.7	50.3	——	0.9	14,400	
22509	L.W. Henderickson (Smous) mine	SW¼ 3	29	15	——	A	10.5	38.6	41.7	9.2	0.60	11,210	
						B	——	43.1	46.6	10.3	0.67	12,530	
						C	——	48.0	52.0	——	0.75	13,970	
2464	Black Diamond Mine	SW¼ 4	29	15	——	A	9.9	38.4	41.5	10.2	0.64	11,300	
						B	——	42.7	46.0	11.3	0.71	12,540	
						C	——	48.1	51.9	——	0.80	14,140	
22508	Black Diamond Mine	SW¼ 4	29	15	——	A	11.6	38.6	39.9	9.9	0.60	10,990	
						B	——	43.6	45.2	11.2	0.68	12,430	
						C	——	49.2	50.8	——	0.77	14,000	
B-61218	Stalling mine (tipple)	4	29	15	——	A	10.1	39.1	41.7	9.1	——	11,460	
						B	——	43.5	46.3	10.2	——	12,750	
						C	——	48.4	51.6	——	——	14,200	
29026	Prospect Drift	NW¼ 16	30	15	——	A	9.6	37.2	40.5	12.7	2.36	10,530	
						B	——	41.2	44.8	14.0	2.61	11,660	
						C	——	47.9	52.1	——	3.04	13,560	
H-78945	N.M.P.S.C.C. Core Hole No. 7	21	30	15	69-70	A	5.6	39.7	43.3	11.4	0.7	11,850	Sample from core - not floated in CCl_4. A is air dried analysis
						B	——	42.0	46.0	12.0	0.7	12,540	
						C	——	47.8	52.2	——	0.8	14,260	
Number not available	Open File Report 78-960 drill hole SJ 23-4	23	30	15	589-590	A	4.6	42.6	41.1	11.7	0.6	12,056	
						B	——	44.7	43.1	12.2	0.6	12,639	
						C	——	50.9	49.1	——	0.7	14,402	
29025	Marcelius Mine	SW¼ 28	30	15	——	A	8.8	41.7	41.2	8.3	0.62	11,660	
						B	——	45.7	45.2	9.1	0.68	12,770	
						C	——	50.3	49.7	——	0.75	14,060	

To convert Btu's/lb to kj/kg, multiply Btu's/lb by 2.326.
To convert feet to meters, multiply feet by 0.3048.

5) the coal bed dips in an east-northeasterly direction. The angle of dip is approximately 4° in the western part of the map decreasing to nearly 1° in the east. As a result of topography and dip, the overburden (CRO Plate 6) varies in thickness from less than 1,000 ft (305 m) in the northwest in the San Juan River Valley to more than 1,800 ft (549 m) in the northeast corner of the map. The thickness of the coal bed is greater than 5 ft (1.5 m) in the northeast corner as illustrated by the isopach map (CRO Plate 4). The thickness decreases to the north, west, and south, and the coal is absent from an area in the extreme northeast corner of the map.

Chemical Analyses of the Menefee 5 Coal Bed - Analyses of several coals of the Menefee Formation from this quadrangle and the surrounding area are given in Table 1 (Bauer and Reeside, 1921; Hayes and Zapp, 1955; Shomaker and Whyte, 1977).

COAL RESOURCES

Resources were not evaluated for the coals in this quadrangle. Menefee and Fruitland zone coals are discontinuous, noncorrelative, and less than the reserve base thickness of 5 ft (1.5 m). The Fruitland 1, Fruitland 2, and Fruitland 3 coal beds are less than 5 ft (1.5 m) thick within the KRCRA, and coal of the Menefee 5 bed which is reserve base thickness (5 ft [1.5 m]) or greater occurs in areas which are non-Federal coal lands.

COAL DEVELOPMENT POTENTIAL

Coal development potential maps were not constructed for this quadrangle because all coal on Federal land within the KRCRA is less than the reserve base thickness of 5 ft (1.5 m) and, thus, has unknown coal development potential.

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