Text to accompany:

Open-File Report 79-109

1979

COAL RESOURCE OCCURRENCE MAPS

OF THE COUNSELOR QUADRANGLE,

SANDOVAL AND RIO ARRIBA COUNTIES, NEW MEXICO

[Report includes 6 plates]

by

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COUNSELOR 7 1/2-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps of the Counselor quadrangle, Sandoval and Rio Arriba Counties, 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) of the western United States. The work was 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 Counselor 7 1/2-minute quadrangle is in southwestern Rio Arriba County and northwestern Sandoval County, New Mexico. The western boundary of the Jicarilla Apache Indian Reservation is in the eastern half of the quadrangle. The area is located approximately 53 miles (85 km) southeast of Farmington and 82 miles (132 km) northeast of Gallup, New Mexico.

Accessibility

The Counselor quadrangle is accessible by New Mexico State Route 44 which extends east-west across the northern portion of the area. Numerous unimproved dirt roads provide access to remote areas of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route which passes through Gallup approximately 82 miles (132 km) to the southwest.

Physiography

The quadrangle is in the southern portion of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. It is also within the Largo Plains physiographic sector as described by Baltz (1967). Elevations in the quadrangle range from 6,580 ft (2,006 m) in Canon Largo, in the northeast corner, to 7,383 ft (2,250 m) in the south. Sisnathyel Mesa is a prominent feature in the western and southwestern portions of the quadrangle. The topography is typified by gently sloping plains and low mesas, separated by canyons with intermittent streams. The major drainage system in this quadrangle consists of Vernado Canyon, which drains to the north, and its tributaries.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 10 inches (25 cm), but varies across the basin due to elevational differences. Rainfall is rare in the early summer and winter; most precipitation occurs in July and August as intense afternoon thundershowers. Annual temperatures range from below 0°F (-18°C) to over 100°F (38°C) in the basin. Snowfall may occur from November to April with an average of 18 inches (46 cm) in the southern part of the basin.

Land Status

Approximately 73 percent of the quadrangle is in the southeastern portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 90 percent of the KRCRA lands as shown on Plate 2 of the Coal Resource Occurrence maps. No Federal coal leases are within the quadrangle.

GENERAL GEOLOGY

Previous Work

Baltz (1967) has mapped the Tertiary strata which crop out within the Jicarilla Apache Indian Reservation in the eastern portion of the quadrangle. A more recent publication by Fassett and Hinds (1971) includes subsurface interpretations of Fruitland Formation coal deposits throughout the San Juan Basin.

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.

Evidence of the final retreat of the Late Cretaceous sea are the nearshore regressive Pictured Cliffs Sandstone and the overlying paludal Fruitland Formation which were deposited in successively higher stratigraphic positions to the northeast. Southwest (shoreward) of the beach deposits, swamps, which were dissected by streams, accumulated organic matter which later became coals of the Fruitland Formation. Deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the northwest-southeast strandline and their discontinuity perpendicular to it to the northeast.

The brackish-water swamp environment of the Fruitland moved northeast of the quadrangle as the regression continued in that direction. Terrestrial freshwater sediments covered the area, 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. Alluvial plain and floodplain deposits of the Ojo Alamo were followed by the thick, lithologically varied deposits of the Nacimiento during continuous nonmarine deposition. The Nacimiento was later exposed to erosion.

The Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface, reflecting various nonmarine environments which developed across the basin. 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.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Eocene in age. They are, in order from oldest to youngest: the Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and San Jose Formation. 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 Pictured Cliffs Sandstone ranges in thickness from 75 to 120 ft (23-37 m). Since the formation is present throughout most of the basin and easily recognized on geophysical logs, the authors have used the top of the unit as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a white to cream, calcareous, argillaceous, arkosic, friable sandstone with interbedded shale near the base of the unit. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin and, consequently, minor coal beds commonly are present in the upper portion of the Pictured Cliffs.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Wide variations in reported thickness of the formation are common due to an indistinct contact with the overlying Kirtland Shale, but the average in this quadrangle is about 170 ft (52 m). Many authors have utilized various criteria for establishing the upper contact, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation consists primarily of dark gray to brown, carbonaceous shale with plant fossils, interbedded white to light gray, poorly indurated sandstone, green to gray siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 220 ft (67 m) thick in this area. It consists predominantly of freshwater, dark gray to brown shale with plant fossils, with interbedded thin, white to light gray, poorly indurated sandstone and gray siltstone. The formation has previously been divided into several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

The Paleocene Ojo Alamo Sandstone unconformably overlies the Kirtland Shale. It is a white to light gray, poorly indurated, slightly conglomeratic sandstone with interbedded gray to brown siltstone. It averages 120 ft (37 m) in thickness in this area.

Approximately 1,185 ft (361 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. Nacimiento rocks are exposed in the extreme southwestern corner of the quadrangle where they consist of light gray to black shale and white to yellow-brown, fine-grained to conglomeratic, argillaceous, slightly calcareous, silty sandstone with gray to brown claystone.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out over most of the quadrangle area. It consists predominantly of buff to yellow, fine- to coarse-grained, locally conglomeratic, arkosic sandstone, with interbedded gray to brown shale and siltstone.

Structure

The axis of the San Juan Basin is about 25 miles (40 km) northeast of the Counselor quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip within the quadrangle is to the northeast at approximately 1° to 2°.

COAL GEOLOGY

Individual coal beds are not continuous across the San Juan Basin because the coal-related strata are progressively younger from southwest to northeast; the strata rise in steps due to minor transgressions which occurred during the overall retreat of the sea. However, for the exclusive purpose of reserve and reserve base calculations, the Fruitland coal beds have been correlated and mapped as if they were single beds, continuous throughout the basin. These calculations were not determined for this quadrangle; but, for purposes of consistency with adjacent quadrangles for which reserve and reserve base calculations were made, these coal bed correlations have been extended.

A lithologic datum was used for correlation of the coals (CRO Plate 3). The primarily marine sandstone unit (Pictured Cliffs) which underlies the coal-bearing formation (Fruitland) was used as a datum since it represents a more laterally continuous boundary than any of the overlying paludal, fluvial, and lacustrine deposits of the coal-bearing formation. Also, the sandstone unit is generally more easily recognized on geophysical logs. As shown on CRO Plate 3, the top of the Pictured Cliffs Sandstone has been used as a datum for each drill hole, and the coals have been plotted in the column and correlated based upon their position relative to the datum.

A coal bed (Fruitland 1) and a coal zone (Fruitland) were identified in the subsurface of this quadrangle. The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation; it is generally directly above the Pictured Cliffs Sandstone. The upper Fruitland coals are designated as the Fruitland coal zone (Fr zone). Some of the coals in the Fruitland zone are correlative over short distances; however, none of the coal beds are extensive, and they are generally less than the reserve base thickness (5 ft [1.5 m]) as specified by the U.S. Geological Survey; exceptions are a 5-ft (1.5-m) coal in drill holes 9 and 11 (CRO Plate 3).

The Pictured Cliffs Sandstone occasionally contains random Fruitland coal beds within its upper portion. These coals usually occur in the zone of intertonguing of the Pictured Cliffs Sandstone and Fruitland Formation. They have been designated as local coal beds because of their random, discontinuous nature and since they are generally less than the reserve base thickness of 5 ft (1.5 m).

Fruitland Formation coal beds in the southern part of the San Juan Basin are generally considered high volatile C bituminous in rank, although the coals vary from subbituminous A to high volatile A bituminous. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,207 to 14,097 Btu's per pound (26,067-32,790 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The "as received" analyses indicate moisture content varying from 3.6 to 13.6 percent, sulfur content generally less than one percent, ash content ranging from 5.8 to 30.5 percent, and heating values on the average of 10,057 Btu's per pound (23,393 kj/kg). Analyses of several Fruitland coals are given in Table 1 (Fassett and Hinds, 1971; Shomaker and Lease, 1971).

TABLE 1

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.			Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-22075	Val Reese & Assoc Bobby "B" No. 2-31.	NE¼ 31	24	6	2,070-2,090	A	3.6	41.1	40.6	14.7	0.7	11,840	
						B	----	42.6	42.2	15.2	0.7	12,280	
						C	----	50.2	49.8	----	0.9	14,480	
H-16309	Val Reese & Assoc Betty "B" No. 1-15.	NW¼ 15	23	7	2,180-2,195	A	5.7	39.3	40.8	14.2	0.6	11,410	
						B	----	41.7	43.3	15.0	0.7	12,100	
						C	----	49.1	50.9	----	0.8	14,240	
J-62557	Core Sample	SW¼ 26	21	8	----	A	13.6	33.4	35.4	17.6	0.53	9,110	
						B	----	38.6	41.0	20.4	0.62	10,540	
						C	----	48.5	51.5	----	0.77	13,240	
J-62604	Core Sample	SW¼ 26	21	8	----	A	12.6	28.7	28.2	30.5	0.49	7,510	
						B	----	32.8	32.4	34.8	0.56	8,590	
						C	----	50.3	49.7	----	0.86	13,180	
TH-53400	Core Sample (analysis by Commercial Testing and Eng. Co.)	------	20	6	----	A	12.44	34.95	34.05	18.56	0.56	9,499	
						B	-----	39.91	38.89	21.20	0.64	10,848	
C-14108	Core Sample (analysis by Illinois Geological Survey)	------	20	6	----	A	10.7	33.4	37.5	18.4	0.65	9,667	
						B	----	37.4	42.0	20.6	0.72	10,826	
						C	----	47.1	52.9	-----	0.91	13,637	
A-23141	Outcrop Sample	NW¼ 11	19	6	----	A	11.2	40.0	43.0	5.8	0.5	11,360	
						B	----	45.1	48.4	6.5	0.5	12,800	
						C	----	48.2	51.8	----	0.6	13,690	

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.

Fruitland 1 Coal Bed and Fruitland Coal Zone

The coal resource data for the Fruitland 1 coal bed and the Fruitland coal zone have been combined for the construction of derivative maps in this quadrangle. The structure contour map of the Fruitland 1 coal bed and the Fruitland coal zone (CRO Plate 5) was constructed using the top of the Fruitland Formation. The Fruitland coal zone has a dip of approximately 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) ranges from less than 1,400 ft (427 m) in the southwest to greater than 2,000 ft (610 m) on several mesas. Also shown on CRO Plate 6 is the interburden, the noncoal portion of the Fruitland coal zone and Fruitland 1 coal bed. The interburden thickness varies from zero to greater than 185 ft (56 m) and reflects the stratigraphic spread of the coals within the formation. The isopach map (CRO Plate 4) shows the coals total to more than 25 ft (7.6 m) in the northeast. The thickness decreases from this area, and there is no coal in a portion of the southwest.

Chemical Analyses of the Fruitland 1 and Fruitland Zone Coal Beds - No published analyses of Fruitland coals from the Counselor quadrangle are known to be available, although several analyses have been made on Fruitland coals in surrounding areas; these coals are assumed to be similar to those of this quadrangle. Analyses of several Fruitland Formation coals were published by Fassett and Hinds (1971) and Shomaker and Lease (1971). The results of these analyses are given in Table 1.

COAL RESOURCES

The isopach and structure contour maps of the combined Fruitland Formation coals were developed from oil and gas drill hole data (El Paso Natural Gas Co., 1978, unpublished data in well log library, Farmington, New Mexico). No coal test hole data were available in this area. Coal resources were not calculated for the Fruitland 1 and Fruitland zone coal beds because all of the coal beds are not greater than the reserve base thickness of 5 ft (1.5 m).

COAL DEVELOPMENT POTENTIAL

Coal development potential maps were not constructed for this quadrangle because the coal beds within the KRCRA are not greater than the reserve base thickness and, therefore, have unknown coal development potential.

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