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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHWEST QUARTER OF THE BLOOMFIELD 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 15 plates]

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SOUTHWEST QUARTER OF THE BLOOMFIELD 15-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps and Coal Development Potential (CDP) Map of the southwest quarter of the Bloomfield 15-minute 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 southwest quarter of the Bloomfield 15-minute quadrangle is located in northeastern San Juan County, New Mexico. The area is approximately 15 miles (24 km) southeast of Farmington and 81 miles (131 km) northeast of Gallup, New Mexico.

Accessibility

The area is accessible by State Route 44 which extends across the southeastern corner of the quadrangle and connects with State Route 17 at Bloomfield, 9 road-miles (15 km) to the north. Several light-duty roads and numerous unimproved dirt roads provide access to the remainder of the area. The Atchison, Topeka, and Santa Fe Railway operates a route which extends southeast and southwest from Gallup, New Mexico.

Physiography

The quadrangle is located in the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Total relief in the area is 1,040 ft (317 m) with elevations which range from 5,680 ft (1,731 m) at the bottom of Kutz Canyon in the north to 6,720 ft (2,048 m) on the southeastern plains. Northwest of State Route 44, the gentle, west-sloping plain, which is characteristic of the Central Basin, has been deeply dissected by Kutz Canyon and its tributary streams. Intermittent streams, some of which are incised more than 600 ft (183 m), drain into Kutz Canyon.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 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 occurs from November to April with an average of 18 inches (46 cm) in the southern part of the basin.

Land Status

The quadrangle is in the central part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 97 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

Reeside (1924) mapped the surficial geology of the quadrangle as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. More recently, Fassett and Hinds (1971) made subsurface interpretations of Fruitland Formation coal occurrences as part of a larger San Juan Basin coal study.

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.

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. 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 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 northeast of the area as the regression continued in that direction. Terrestrial freshwater sediments then covered the 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 to the northeast 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 floodplain deposits of the Nacimiento during continuous nonmarine deposition (Powell, 1973). 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 the present time. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation and some of the Nacimiento Formation from the area.

Stratigraphy

The formations studied within this quadrangle range from Late Cretaceous to Paleocene in age. They are, in order from oldest to youngest: Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, and Nacimiento 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 consists of about 105 ft (32 m) of white to cream, slightly conglomeratic, glauconitic sandstone with interstitial clay, commonly interbedded with gray shale and siltstone near the base of the formation where it grades into the underlying Lewis Shale. The upper contact is more sharply defined than the basal contact. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin and, consequently, minor Fruitland coals commonly are present in the upper portion. Since the Pictured Cliffs Sandstone is present throughout most of the basin and displays a distinctive character on geophysical logs, the authors have used the top as a lithologic datum for correlation of Fruitland coals.

The Fruitland Formation is the major coal-bearing unit in the quadrangle. It has an average thickness of 260 ft (79 m) and consists of gray, carbonaceous shale with plant fossils, interbedded siltstone, 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). Many authors have used various criteria in establishing the upper contact, but, in general, for the purposes of this report the uppermost coal was chosen (after Fassett and Hinds, 1971).

The freshwater deposits of the Kirtland Shale are the youngest Cretaceous strata in the area. They average 670 ft (204 m) in thickness and consist of gray shale, interbedded white to cream, kaolinitic sandstone, and thin, interbedded gray siltstone. The formation has previously been divided into several members by various authors; however, for the purposes of this report the individual members were not differentiated.

Unconformably overlying the Upper Cretaceous strata is the Paleocene Ojo Alamo Sandstone. It is composed primarily of about 110 ft (34 m) of white to cream, coarse-grained to conglomeratic sandstone.

The Nacimiento Formation gradationally overlies the Ojo Alamo. The basal portion of the Nacimiento, the only formation exposed in the area, consists predominantly of gray to green shale and interbedded buff to yellow sandstone and gray siltstone.

Structure

The quadrangle is located in the Central Basin area (Kelley, 1950) of the major structural depression known as the San Juan Basin. The axis of the basin is about 18 miles (29 km) north of the quadrangle area near Farmington, New Mexico, and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Reeside (1924) stated that the rocks in this area are "nearly horizontal".

COAL GEOLOGY

Two coal beds (Fruitland 1, Fruitland zone A) and a coal zone (Fruitland) were identified in the subsurface of this quadrangle (CRO Plate 1). 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 remaining coals of the Fruitland Formation are designated as the Fruitland coal zone (Fr zone) which extends from the top of the Fruitland Formation to the base of the lowermost coal, designated on CRO Plate 3 as a Fruitland zone coal bed. These coals are generally noncorrelative and less than reserve base thickness (5 ft [1.5 m]); exceptions are a 5-ft (1.5-m) coal bed in drill holes 15, 25, 30, and 38 (CRO Plate 1).

Within the Fruitland zone there is a locally thick accumulation of coal which has been designated by the authors as the Fruitland zone A coal bed. The Fruitland zone A is present in the eastern half of the quadrangle.

Fruitland Formation coals in the central portion of the San Juan Basin are considered high volatile A bituminous in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 14,366 Btu's per pound (33,415 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 (Bauer and Reeside, 1921; Dane, 1936). The "as received" analyses indicate moisture content averaging 2.7 percent, ash content ranging from 12.0 to 19.3 percent, sulfur content less than one percent, and heating values on the order of 12,002 Btu's per pound (27,917 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 1 Coal Bed

Although the Fruitland 1 coal bed is correlated and mapped as a consistent horizon of the lowermost coal of the Fruitland Formation, it may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous.

As illustrated by the structure contour map (CRO Plate 5), the coal bed dips less than 1° to the northeast. Due to dip and topography, overburden (CRO Plate 6) varies from less than 1,600 ft (488 m) in the area of Kutz Canyon to greater than 2,200 ft (671 m) at the eastern edge of the quad-

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: Section	Location: T.N.	Location: R.W.	Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent: Moisture	Proximate, percent: Volatile matter	Proximate, percent: Fixed carbon	Proximate, percent: Ash	Sulfur	Heating Value (Btu)	Remarks
H-12706	Southwest Production	NE¼ 5	26	11	1,700-1,705	A	3.6	40.6	39.3	16.5	0.7	11,540	
	Ted Henderson No. 1					B	---	42.1	40.8	17.1	0.7	11,970	
						C	---	50.8	49.2	----	0.8	14,430	
H-3031	Southwest Production	NE¼ 26	27	12	1,900-1,910	A	2.6	41.2	40.5	15.7	0.6	11,810	
	Cambell No. 2					B	---	42.3	41.6	16.1	0.6	12,120	
						C	---	50.4	49.6	----	0.7	14,440	
H-5021	British-American Oil	NE¼ 14	27	11	1,920-1,930	A	3.3	40.8	43.9	12.0	0.6	12,370	
	Fullerton No. 8					B	---	42.2	45.4	12.4	0.6	12,790	
						C	---	48.1	51.9	----	0.7	14,600	
H-15776	Aztec Oil & Gas	SW¼ 12	27	10	1,900-1,905	A	2.2	40.4	44.0	13.4	0.6	12,520	
	Hanks No. 14-D					B	---	41.3	45.1	13.6	0.6	12,790	
						C	---	47.9	52.1	----	0.7	14,820	
H-5472	Aztec Oil & Gas	NW¼ 16	28	10	1,842-1,853	A	1.6	38.4	40.7	19.3	0.6	11,760	
	Caine No. 13					B	---	39.0	41.4	19.6	0.6	11,950	
						C	---	48.5	51.5	----	0.8	14,870	
H-24567	Sunray Mid-Continent	NW¼ 18	28	12	1,305-1,315	A	3.0	38.9	44.4	13.7	0.6	12,010	
	Gallegos No. 122					B	---	40.1	45.8	14.1	0.6	12,390	
						C	---	46.8	53.2	----	0.7	14,430	

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.

rangle. The isopach map (CRO Plate 4) indicates that the coal bed is greater than 15 ft (4.6 m) thick in the northeast and southeastern parts of the map. The thickness decreases in all directions, and the coal is absent in the southwest portion of the quadrangle.

Chemical Analyses of the Fruitland 1 Coal Bed - Analyses of several Fruitland Formation coals from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland Zone A Coal Bed

The coal bed is limited in extent to the eastern half of the quadrangle. The structure contour map (CRO Plate 9) indicates that the Fruitland zone A coal bed dips less than 1° to the northeast. As a result of topography and dip, the overburden (CRO Plate 10) varies from less than 1,600 ft (488 m) along the western edge of the mapped area to greater than 2,200 ft (671 m) in the southeast. The isopach map (CRO Plate 8) illustrates that the coal is greater than 10 ft (3.0 m) thick in the east-central portion of the map.

Chemical Analyses of the Fruitland Zone A Coal Bed - Analyses of several Fruitland Formation coals from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland Coal Zone

The Fruitland coal zone extends from the top of the Fruitland Formation to the base of the lowermost coal designated on CRO Plate 3 as a

Fruitland zone coal bed. Therefore, the structure contour map (CRO Plate 13) was drawn using the top of the Fruitland Formation and it shows the coal zone dips less than 1° to the northeast. As a result of dip and topography, overburden (CRO Plate 14) varies from less than 1,400 ft (427 m) in the Kutz Canyon area to greater than 2,200 ft (671 m) in the southeast portion of the quadrangle. CRO Plate 14 also shows the total amount of interburden which is the noncoal-bearing portion of the Fruitland coal zone. The interburden values range from zero to greater than 200 ft (61 m) and reflect the stratigraphic spread of the coals within the zone. The isopach map (CRO Plate 12) shows the total thickness of the coals within the Fruitland zone. The greatest cumulative thickness occurs in the northwest where the coals total more than 15 ft (4.6 m) thick. The thickness decreases in all directions, and there are no Fruitland zone coals present in two areas in the central part of the quadrangle (a portion of the east and an area in the north shown on CRO Plate 12).

Chemical Analyses of the Fruitland Zone Coal Beds - Analyses of several Fruitland Formation coals from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

COAL RESOURCES

Coal resource data from oil and gas wells and pertinent publications were utilized in the construction of isopach and structure contour maps of coals in this quadrangle. All of the coals studied in the southwest quarter of the Bloomfield 15-minute quadrangle are more than 200 ft (61 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1 and Fruitland zone A coal beds for the determination of coal resources in this quadrangle. Coals of the Fruitland zone were not evaluated because they are discontinuous, noncorrelative, and generally less than the reserve base thickness (5 ft [1.5 m]).

For Reserve Base and Reserve calculations, each coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plates 7 and 11) according to criteria established in U.S. Geological Survey Bulletin 1450-B. Data for calculation of Reserve Base and Reserves for each category were obtained from the respective coal isopach (CRO Plates 4 and 8) and areal distribution maps (CRO Plates 7 and 11) for each coal bed. The surface area of each isopached bed was measured by planimeter, in acres, for each category, then multiplied by both the average isopached thickness of the coal bed and 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal. This yields the Reserve Base coal, in short tons, for each coal bed.

In order to calculate Reserves, a recovery factor of 50 percent was applied to the Reserve Base tonnages for underground coal. However, in areas of underground coal exceeding 12 ft (3.7 m) in thickness, the Reserves (mineable coal) were calculated on the basis of a maximum coal bed thickness of 12 ft (3.7 m), which represents the maximum economically mineable thickness for a single coal bed in this area by current underground mining technology.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1 and Fruitland zone A beds are shown on CRO Plates 7 and 11, respectively, and are rounded to the nearest hundredth of a million short tons. The total coal Reserve Base, by section, is shown on CRO Plate 2 and totals approximately 625 million short tons (567 million metric tons).

The coal development potential for each bed was calculated in a manner similar to the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The southwest quarter of the Bloomfield 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 15).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 to 3,000 ft (61-914 m) of overburden are considered to have potential for underground mining and are designated as having high, moderate, or low development potential according to the overburden thickness: 200 to 1,000 ft (61-305 m), high; 1,000 to 2,000 ft (305-610 m), moderate; and 2,000 to 3,000 ft (610-914 m), low. Table 2 summarizes the coal development potential, in short tons, for underground coal of the Fruitland 1 and Fruitland zone A coal beds.

Development Potential for Surface Mining Methods

All coal studied in the southwest quarter of the Bloomfield 15-minute quadrangle occur more than 200 ft (61 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE SOUTHWEST QUARTER OF THE BLOOMFIELD 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

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

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland Zone A	--	33,080,000	26,740,000	59,820,000
Fruitland 1	--	415,910,000	149,190,000	565,100,000
TOTAL	--	448,990,000	175,930,000	624,920,000

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 coal bed has moderate development potential over most of the quadrangle with the exception of the southeast quadrant (CDP Plate 15). Coal bed thickness ranges from 5 to 15 ft (1.5-4.6 m) (CRO Plate 4), and overburden thickness increases from 1,600 ft (488 m) in the center of the area to 2,000 ft (610 m) in the south and east (CRO Plate 6). The Fruitland zone A coal bed has moderate potential in the east-northeast and in the southeast where the coal bed thickness ranges from 5 to 10 ft (1.5-3.0 m) (CRO Plate 8), and the overburden thickness varies from approximately 1,500 ft (457 m) in the center of the quadrangle to 2,000 ft (610 m) in the east-central and southeast.

Areas of low potential occur in the northeast, east-central, and the southern half of the southeast quadrant, where the Fruitland 1 and Fruitland zone A coal beds are overlain by 2,000 to 2,300 ft (610-701 m) of overburden. In these areas the Fruitland 1 coal bed ranges in thickness from 5 to 18 ft (1.5-5.5 m), and the Fruitland zone A bed has a thickness of 5 to 8 ft (1.5-2.4 m). The northwest, west-central, and southwest parts of the quadrangle are areas of unknown development potential and the evaluated coal beds are less than the reserve base thickness of 5 ft (1.5 m). An area of no coal development potential occurs in the southwest where there is no Fruitland 1 or Fruitland zone A coal.

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