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

[Report includes 16 plates]

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CONTENTS

CONTENTS

PLATES

CONTENTS

TABLES

SOUTHEAST 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 the Coal Development Potential (CDP) Map of the southeast 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) 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 southeast quarter of the Bloomfield 15-minute quadrangle is located in east-central San Juan County, New Mexico. The area is approximately 20 miles (32 km) southeast of Farmington and 88 miles (141 km) northeast of Gallup, New Mexico.

Accessibility

Access to the area is by a light-duty road which extends across the quadrangle from northeast to southwest and joins State Route 44, 3.5 miles (5.6 km) west of the area. Numerous unimproved dirt roads provide access to the more remote areas. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 86 miles (138 km) to the southwest at Gallup, New Mexico, which extends southeast and southwest.

Physiography

The quadrangle is in the center of the Central Basin area (Kelley, 1950) of the San Juan Basin. Total relief in the area is 1,371 ft (418 m) with elevations ranging from 5,780 ft (1,762 m) in the northwest corner to 7,151 ft (2,180 m) at Huerfanito Peak in the southeast. The intermittent streams and tributaries of Jacques and Armenta Canyons have deeply dissected the broad, vegetated plains of the north and east, leaving remnants such as Harris Mesa to the north and Huerfanito Peak. In contrast, the southwestern corner of the area is mildly dissected and sparsely vegetated.

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 range from 0°F (-18°C) to over 100°F (38°C) in the basin. Snowfall may occur from November to April.

Land Status

The quadrangle is in the east-central portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 92 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 area on a scale of 1:250,000 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.

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 north-south strandline in this part of the basin 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 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 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 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: 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 averages 75 ft (23 m) thick in the area. Because the unit is present throughout most of the San Juan Basin and easily recognized on geophysical logs, the top was used as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a cream to light gray, kaolinitic, calcareous, friable sandstone with inter-bedded gray shale near the base. Intertonguing with the overlying Fruitland

Formation occurs throughout the entire basin and, consequently, minor Fruitland coal beds commonly are present in the upper portion of the Pictured Cliffs Sandstone.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Wide variations in the reported thickness of the Fruitland are common due to an indistinct upper contact with the Kirtland Shale, but the average is about 235 ft (72 m) in this quadrangle. Many authors have used various criteria to establish the upper contact, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation is primarily gray, carbonaceous shale with plant fossils and siderite nodules, interbedded sandstone and siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 550 ft (168 m) in thickness in this area. It consists of freshwater, gray-green to brown siltstone and interbedded sandstone and gray shale. 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 cream, locally conglomeratic, slightly arkosic, poorly indurated sandstone and averages 140 ft (43 m) in thickness in this area.

Approximately 1,200 ft (366 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. Nacimiento rocks are exposed throughout most of the quadrangle area, where they consist of light gray-green claystone and interbedded cream, slightly arkosic, micaceous, locally conglomeratic sandstone with silty stringers.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out in the northeastern corner of the quadrangle and at the top of Huerfanito Peak in the southeast. It consists of buff to yellow, fine- to coarse-grained, locally conglomeratic, arkosic sandstone and brown to gray shale, and includes many lithologies gradational between the two.

Structure

The southeast quarter of the Bloomfield 15-minute quadrangle is located in the Central Basin area (Kelley, 1950) of the major structural depression, the San Juan Basin. The axis of the basin is about 22 miles (35 km) northeast of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Regional dip within the quadrangle is approximately 1° to 2° to the northeast.

COAL GEOLOGY

Three coal beds (Fruitland 1, Fruitland 2, Fruitland 3) 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 Fruitland 2 (Fr 2) coal bed is above the Fruitland 1 (when present); they are separated by a rock interval of 21 to 46 ft (6.4-14.0 m). The Fruitland 2 is separated from the overlying Fruitland 3 by a rock interval of 30 to 99 ft (9.1-30.2 m). Local (L) coal beds which are discontinuous and less than reserve base thickness (5 ft [1.5 m]) occur between the Fruitland 1 and Fruitland 3 beds. Although the coal beds have been correlated and mapped as consistent horizons, they may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous.

The remaining coals in the upper portion of the Fruitland Formation are grouped together as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]); an exception is a 7-ft (2.1-m) coal bed in drill hole 26 (CRO Plate 3). Because of these characteristics, derivative maps were not constructed.

Fruitland Formation coals in the central portion of the San Juan Basin are considered high volatile B to 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 14,696 Btu's per pound (34,183 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 ranging from 1.4 to 4.2 percent, ash content varying from 13.4 to 31.0 percent, sulfur content less than one percent, and heating values on the order of 10,857 Btu's per pound (25,253 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Fassett and Hinds, 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-16695	Century Exploration Mobil-Rudman No. 2	SW¼ 21	25	9	1,620-1,625	A	4.2	31.5	33.3	31.0	0.9	9,280	
						B	---	32.8	34.8	32.4	0.9	9,680	
						C	---	48.6	51.4	----	1.4	14,310	
H-15776	Aztec Oil & Gas Hanks No. 14-D	SW¼ 12	27	10	1,900-1,905	A	2.2	40.4	44.0	13.4	0.6	12,520	
						B	---	41.3	45.1	13.6	0.6	12,790	
						C	---	47.9	52.1	----	0.7	14,820	
H-13063	Aztec Oil & Gas Hudson No. 5-D	NW¼ 29	27	9	2,135-2,145	A	2.7	38.3	40.4	18.6	0.8	11,650	
						B	---	39.3	41.6	19.1	0.8	11,970	
						C	---	48.6	51.4	----	1.0	14,800	
H-12705	Aztec Oil & Gas Whitley No. 6-D	SW¼ 8	27	9	2,215-2,230	A	2.2	36.7	41.2	19.9	0.8	11,440	
						B	---	37.5	42.1	20.4	0.8	11,700	
						C	---	47.1	52.9	----	1.1	14,700	
H-21490	El Paso Nat. Gas Schwerdtfeger No. 20-A	NE¼ 8	27	8	2,800-2,820	A	1.9	29.5	32.9	35.7	0.6	9,170	
						B	---	30.0	33.6	36.4	0.6	9,350	
						C	---	47.2	52.8	----	1.0	14,700	
H-13061	Aztec Oil & Gas Reid No. 23-D	SW¼ 17	28	9	1,985-1,990	A	1.4	36.1	42.1	20.4	0.8	11,670	
						B	---	36.6	42.7	20.7	0.8	11,830	
						C	---	46.2	53.8	----	1.0	14,920	
H-13779	El Paso Nat. Gas Florence No. 10-C	NE¼ 30	28	8	2,185-2,195	A	1.9	33.7	35.1	29.3	0.6	10,270	
						B	---	34.3	35.8	29.9	0.7	10,460	
						C	---	48.9	51.1	----	0.9	14,920	

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

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 5), the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) varies from less than 2,000 ft (610 m) in Armenta, Jaques, and Reed Canyons to greater than 3,000 ft (914 m) on Harris Mesa. The isopach map (CRO Plate 4) illustrates that the coal bed has a thickness of greater than 20 ft (6.1 m) in the northwest part of the quadrangle. The thickness decreases in all directions, and the coal is absent in the east-central, southwest, and northwest.

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

Fruitland 2 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). The structure contour map (CRO Plate 9) illustrates that the coal bed dips less than 1° to the northeast. Due to topography and dip, overburden ranges from less than 1,800 ft (549 m) in Armenta Canyon to greater than 3,000 ft (914 m) on Harris Mesa. As shown by the isopach map (CRO Plate 8), the coal is greater than 5 ft (1.5 m) thick in the southwest, southeast, and in an area trending from the central to northeast parts of the quadrangle. The coal thins in all directions, and is absent in the west, southwest, and a portion of the southeast.

Chemical Analyses of the Fruitland 2 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 3 Coal Bed

The coal bed has been mapped only in areas with less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 13), the coal bed dips less than 1° to the northeast. As a result of topography and dip (CRO Plate 14), overburden varies from less than 1,800 ft (549 m) in Reed and Armenta Canyons to greater than 3,000 ft (914 m) on Harris Mesa. The isopach map (CRO Plate 12) shows the coal is greater than 5 ft (1.5 m) thick in the western, northeastern, and southeastern parts of the quadrangle. The thickness decreases in all directions, and the coal is absent in the south and north-central parts of the map.

Chemical Analyses of the Fruitland 3 Coal Bed - Analyses of several coals of the Fruitland Formation 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 southeast 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, Fruitland 2, and Fruitland 3 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, 11, and 15) 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, 8, and 12) and areal distribution maps (CRO Plates 7, 11, and 15) 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, Fruitland 2, and Fruitland 3 beds are shown on CRO Plates 7, 11, and 15, 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 573 million short tons (520 million metric tons).

The coal development potential for each bed was calculated in a manner similar to that used for the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The southeast quarter of the Bloomfield 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 16).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 ft 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, Fruitland 2, and Fruitland 3 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the southeast 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 SOUTHEAST 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 3	--	24,190,000	91,350,000	115,540,000
Fruitland 2	--	6,460,000	64,000,000	70,460,000
Fruitland 1	--	65,720,000	321,450,000	387,170,000
TOTAL	--	96,370,000	476,800,000	573,170,000

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 coal bed has moderate development potential in half of the northwest quadrant and in the southeast corner of the quadrangle (CDP Plate 16), where the coal bed thickness is 5 to 17 ft (1.5-5.2 m) in the northwest and 5 to 9 ft (1.5-2.7 m) in the southeast (CRO Plate 4), and the overburden thickness is approximately 1,970 to 2,000 ft (600-610 m) (CRO Plate 6). The Fruitland 2 coal bed has moderate potential along the central part of the eastern quadrangle boundary and in the southeast corner. The coal bed thickness is approximately 5 ft (1.5 m) in both areas (CRO Plate 8), and the overburden is less than 2,000 ft (610 m) thick (CRO Plate 10). Coal of the Fruitland 3 coal bed has moderate potential in the northwest to west-central and in the southeast. The coal bed thickness varies from 5 to 9 ft (1.5-2.7 m) (CRO Plate 12) and overburden increases from approximately 1,770 to 2,000 ft (539-610 m) (CRO Plate 14).

Most of the northern half of the quadrangle has low potential as a result of the Fruitland 1 in the northeast and west-northwest, the Fruitland 2 in the east-northeast, and the Fruitland 3 in the west and northwest. In addition, a small low potential area in the southeast is due to the Fruitland 1 and Fruitland 2 coal beds. Coal bed thicknesses vary from 5 to 20 ft (1.5-6.1 m) for the Fruitland 1 bed, 5 to 8 ft (1.5-2.4 m) for the Fruitland 2 bed, and 5 to 9 ft (1.5-2.7 m) for the Fruitland 3 bed. Overburden thickness for all beds increases from 2,000 ft (610 m) in the northwest, southeast, and east to 3,000 ft (914 m) in the north-central part of the quadrangle.

Several small areas in the north and a large part of the southern half of the quadrangle have unknown development potential. This includes areas where the evaluated coal beds are less than the reserve base thickness of 5 ft (1.5 m) and areas outside the respective 3,000-foot (914-m) overburden study limits for each coal bed. A small area in the southwest has no Fruitland 1, Fruitland 2, or Fruitland 3 coal and, thus, has no development potential.

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