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

[Report includes 16 plates]

by

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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NORTHWEST 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) Maps of the northwest 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 northwest quarter of the Bloomfield 15-minute quadrangle is located in north-central San Juan County, New Mexico. The area is approximately 15 miles (24 km) east-southeast of Farmington, New Mexico.

Accessibility

The quadrangle is accessible from both New Mexico State Route 17, which extends east-west across the central part of the area, and New Mexico State Route 44, which extends north-south across the western part of the area. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 93 miles (150 km) to the south 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 5,430 ft (1,655 m) to 6,033 ft (1,839 m) in the San Juan River Valley. The San Juan River flows from east to west through the central part of the quadrangle and river terraces are present on both sides. The remaining portion of the quadrangle area has been carved into canyons by tributaries of the San Juan River; notably Kutz Canyon located in the southwest corner of the area.

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

Land Status

The quadrangle is in the north-central part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 80 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 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 farther to the northeast as the regression continued in that direction. Terrestrial sediments then covered this quadrangle as indicated by the lacustrine, channel, and floodplain sediments 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.

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 from the area.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Paleocene in age. They are, in order from oldest to youngest: the 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 averages 95 ft (29 m) thick. Because the unit is present throughout most of the San Juan Basin and easily recognized on geophysical logs, the top was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a light gray, calcareous, argillaceous sandstone, with interbedded gray, micaceous shale near the base of the unit. Intertonguing of the Pictured Cliffs Sandstone with the overlying Fruitland Formation occurs throughout the entire basin and, consequently, minor Fruitland coals are commonly 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 Fruitland are common due to an indistinct upper contact with the Kirtland Shale, but the average is about 295 ft (90 m) in this quadrangle. Many authors have used various criteria for establishing the upper contact, but, in general, for this study the uppermost Fruitland coal was chosen (after Fassett and Hinds, 1971). The formation primarily consists of gray, carbonaceous shale with plant fossils and siderite nodules, interbedded light gray, calcareous sandstone, interbedded gray siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 765 ft (233 m) in thickness in this area. It consists predominantly of freshwater, gray to gray-green shale, interbedded buff to light gray-green, slightly calcareous sandstone, and interbedded 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, fine-grained to conglomeratic sandstone with interbedded gray shale and averages 170 ft (52 m) in thickness.

A large part of the total thickness of the Paleocene Nacimiento Formation has been eroded from the area; however, Nacimiento rocks are exposed over the entire quadrangle. They consist of gray-green to purple, locally silty shale, and interbedded white to gray, fine- to coarse-grained, locally conglomeratic sandstone with angular grains.

Structure

The northwest quarter of the Bloomfield 15-minute quadrangle is 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 10 miles (16 km) to the north and northwest of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Reeside (1924) stated that the rocks in this area are "nearly horizontal".

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 (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; they are separated by a rock interval of 40 to 84 ft (12.2-25.6 m). The Fruitland 3 (Fr 3) coal bed is above the Fruitland 2; a rock interval of 28 to 83 ft (8.5-25.3 m) separates them.

Although these 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. Occasionally local (L) coals, which are generally noncorrelative and discontinuous, occur between the named Fruitland beds.

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]). Therefore, derivative maps were not constructed.

Fruitland Formation coals in the central part of the San Juan Basin are considered high volatile A bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 14,833 Btu's per pound (34,502 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 1.4 to 2.6 percent, ash content ranging from 9.8 to 20.4 percent, sulfur content of 0.5 to 2.2 percent, and heating values on the order of 12,358 Btu's per pound (28,745 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

Fruitland 1 Coal Bed

The Fruitland 1 coal bed dips less than 1° to the northeast as shown by the structure contour map (CRO Plate 5). As a result of topography and dip, the overburden (CRO Plate 6) varies from less than 1,500 ft (457 m) thick in Kutz Canyon and portions of the San Juan River Valley to more than 2,200 ft (671 m) thick in the extreme northeast corner. The isopach map (CRO Plate 4) indicates that the coal bed is greater than 10 ft (3.0 m) thick in the southern, eastern, and northwestern sections of the quadrangle. There are several small noncoal-bearing areas in the northeastern, central, and western portions of the quadrangle.

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-13061	Aztec Oil & Gas	SW¼ 17	28	9	1,985-1,990	A	1.4	36.1	42.1	20.4	0.8	11,670	
	Reid No. 23-D					B	——	36.6	42.7	20.7	0.8	11,830	
						C	——	46.2	53.8	——	1.0	14,920	
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-12704	Redfern & Herd	SW¼ 10	28	11	1,490-1,500	A	2.1	39.8	43.4	14.7	0.6	12,190	
	Redfern & Herd No. 5					B	——	40.7	44.3	15.0	0.6	12,460	
						C	——	47.9	52.1	——	0.7	14,670	
H-16310	Aztec Oil & Gas	SW¼ 30	29	9	1,985-2,005	A	1.6	41.1	46.6	10.7	0.7	13,310	
	Cain No. 16-D					B	——	41.7	47.5	10.8	0.7	13,520	
						C	——	46.8	53.2	——	0.7	15,160	
H-27541	Aztec Oil & Gas	SW¼ 5	29	10	2,065-2,080	A	2.3	39.1	42.1	16.5	1.9	12,020	
	Grenier "B" No. 3					B	——	40.0	43.1	16.9	2.0	12,300	
						C	——	48.1	51.9	——	2.4	14,800	
H-27540	Aztec Oil & Gas	SW¼ 5	29	10	2,150-2,160	A	2.0	40.6	47.6	9.8	0.5	13,300	
	Grenier "B" No. 3					B	——	41.4	48.6	10.0	0.5	13,560	
						C	——	46.0	54.0	——	0.6	15,070	
H-3028	International Oil	NW¼ 9	29	11	1,905-1,910	A	1.8	39.9	43.9	14.4	0.7	12,360	
	Fogelson No. 1-9					B	——	40.6	44.8	14.6	0.7	12,590	
						C	——	47.6	52.4	——	0.8	14,750	
H-13060	Tidewater	SE¼ 12	29	11	2,065-2,070	A	2.1	38.7	47.9	11.3	0.6	12,830	
	N.M.-Fed. No. 12-E					B	——	39.5	48.9	11.6	0.6	13,100	
						C	——	44.7	55.3	——	0.7	14,820	

TABLE 1 (Continued)

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-35925	El Paso Nat. Gas Turner No. 3	SE¼ 28	30	9	2,385-2,390	A	1.5	39.9	45.5	13.1	2.2	12,960	
						B	---	40.5	46.2	13.3	2.2	13,150	
						C	---	46.7	53.3	----	2.5	15,170	
H-19832	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,340-2,360	A	2.3	33.1	39.9	24.7	0.7	10,800	
						B	---	33.9	40.9	25.2	0.7	11,060	
						C	---	45.3	54.7	----	0.9	14,790	
H-19883	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,505-2,515	A	2.6	41.7	44.5	11.2	0.6	13,080	
						B	---	42.9	45.6	11.5	0.6	13,420	
						C	---	48.4	51.6	----	0.7	15,160	
H-13062	Aztec Oil & Gas Ruby Jones No. 1	NE¼ 7	30	11	2,020-2,030	A	1.4	37.2	44.1	17.3	0.6	12,010	
						B	---	37.7	44.8	17.5	0.6	12,180	
						C	---	45.7	54.3	----	0.7	14,770	

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

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 Fruitland 2 coal bed dips less than 1° to the northeast, as illustrated by the structure contour map (CRO Plate 9). Due to the topography and dip, the overburden (CRO Plate 10) ranges in thickness from less than 1,400 ft (427 m) in the San Juan River Valley at the western edge of the quadrangle to more than 2,200 ft (671 m) in the northeast corner. The coal bed is more than 10 ft (3.0 m) thick in a small area in the south-central portion of the quadrangle as shown by the isopach map (CRO Plate 8). The thickness decreases in all directions, and the coal bed is absent throughout most of the western half of the map and from an area in 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

As indicated by the structure contour map (CRO Plate 13), the Fruitland 3 coal bed dips less than 1° in a northeasterly direction. Because of topography and dip, the overburden (CRO Plate 14) ranges in thickness from less than 1,400 ft (427 m) in Kutz Canyon and parts of the San Juan River Valley to more than 2,000 ft (610 m) in portions of the north, northeast, and southeast. The isopach map (CRO Plate 12) shows that the coal bed has a thickness of greater than 5 ft (1.5 m) in several areas throughout the north, east, and southeast. The coal bed is absent from areas in the west and northeast parts of the quadrangle.

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 northwest quarter of the Bloomfield 15-minute quadrangle are more than 1,300 ft (396 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 muiltiplied 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 290 million short tons (263 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 northwest 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 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. However, the total tonnage of coal with development potential, shown in Table 2, may vary from the total Reserve Base value by as much as 1 percent due to the differences in the areas planimetered by the two methods.

Development Potential for Surface Mining Methods

All coals studied in the northwest quarter of the Bloomfield 15-minute quadrangle occur more than 1,300 ft (396 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 bed has moderate development potential in the south-southwest, east-central, northeast, and northwest parts of the quadrangle (CDP Plate 16) where the coal thickness is 5 to 12 ft

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE NORTHWEST 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	--	61,020,000	320,000	61,340,000
Fruitland 2	--	13,520,000	--	13,520,000
Fruitland 1	--	149,670,000	66,630,000	216,300,000
TOTAL	--	224,210,000	66,950,000	291,160,000

(1.5-3.7 m) (CRO Plate 4), and the overburden ranges from 1,600 to 2,000 ft (488-610 m) thick (CRO Plate 6). Coal of the Fruitland 2 and Fruitland 3 beds has moderate potential coincident with the Fruitland 1 but to a lesser extent.

The Fruitland 2 coal with moderate potential is limited to three small areas in the eastern half of the quadrangle (as shown on CRO Plate 11). Coal bed thickness in these areas varies from 5 ft (1.5 m) in the east to 5 to 11 ft (1.5-3.4 m) in the central part of the quadrangle (CRO Plate 8), and the overburden is approximately 1,800 ft (549 m) thick (CRO Plate 10).

Coal of the Fruitland 3 bed has moderate development potential in the northeast, east-central, and southern parts of the quadrangle where the coal bed thickness varies from 5 to 7 ft (1.5-2.1 m) (CRO Plate 12), and the overburden ranges from 1,600 to 2,000 ft (488-610 m) thick (CRO Plate 14).

Areas of low potential for the Fruitland 1 bed occur in the southeast, northeast, and northwest where the coal bed thickness varies from 5 to 10 ft (1.5-3.0 m), and the overburden is approximately 2,000 to 2,200 ft (610-671 m) thick. The western half of the quadrangle has unknown development potential where the evaluated coal beds are less than the reserve base thickness of 5 ft (1.5 m). Several isolated areas in the quadrangle (CDP Plate 16) have no Fruitland 1, Fruitland 2, or Fruitland 3 coal and, thus, have no development potential.

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