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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE MONCISCO WASH QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 24 plates]

by

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

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MONCISCO WASH 7 1/2-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 Moncisco Wash 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 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 Moncisco Wash 7 1/2-minute quadrangle is located in central San Juan County, New Mexico. The area is approximately 18 miles (29 km) south of Farmington and 66 miles (106 km) northeast of Gallup, New Mexico.

Accessibility

A light-duty road which trends northwest-southeast is the major access route to the area. This road connects with State Route 44, 19 miles (31 km) east of the quadrangle. Numerous unimproved dirt roads diverge from this light-duty road to provide access to more remote parts of the area. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 66 miles (106 km) to the southwest at Gallup, New Mexico, which connects Gallup with Grants and Albuquerque to the east.

Physiography

The quadrangle is located in the Central Basin area (Kelley, 1950) of the San Juan Basin. Total relief in the area is approximately 670 ft (204 m) with elevations which range from 5,900 ft (1,798 m) in the bottom of the West Fork of Gallegos Canyon to 6,576 ft (2,004 m) atop Moncisco Mesa. The topography consists of gentle, northwesterly-sloping plains dissected by intermittent streams. The steep cliffs of Moncisco Mesa (in the northwest) and Black Hill (in the southeast) separate the heavily dissected northeastern part of the area from the less dissected plains to the southwest. The northern half of the quadrangle is drained by Moncisco Wash, the West Fork of Gallegos Canyon, and several other intermittent streams. Drainage is sparse in the southwest, and stabilized sand dunes occur on the plains.

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 with an average of 18 inches (46 cm) in the southwestern part of the basin.

Land Status

The quadrangle is in the west-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 this quadrangle.

GENERAL GEOLOGY

Previous Work

Reeside (1924) mapped the surficial geology of the area 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 the Fruitland Formation coals 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.

After its first basin-wide retreat, the Late Cretaceous sea reversed the direction of movement. As a result, the transgressive sequence of paludal Menefee Formation, nearshore Cliff House Sandstone, and marine Lewis Shale was deposited in the quadrangle. Swamps (Menefee) formed southwest (shoreward) of the transgressing beaches (Cliff House). Organic matter deposited in these swamps ultimately formed coal in the Menefee Formation. Subsequently, beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited above the Menefee over the entire quadrangle. Shoreward (southwest) and contemporaneous with some of the younger La Ventana beach deposits, swamps (Menefee) developed above the basal La Ventana sand in the southwestern part of the quadrangle. Subsequently, coals formed in these deposits of the Hogback Mountain Tongue of the Menefee Formation

(Beaumont, 1971). Minor fluctuations of the sea resulted in interfingering of the La Ventana (Cliff House) and Hogback Mountain (Menefee) Tongues throughout most of the area. More La Ventana beach sands were then deposited on top of the older La Ventana deposits in the northeast and the Hogback Mountain Tongue in the southwest.

Onlap continued as the sea moved southwestward across the basin area. The transgressing northwest-southeast-trending strandline is represented in the lithologic record by the Chacra Tongue (informal name of local usage) of the Cliff House Sandstone. The marine facies which developed northeast of this 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. 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 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 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 erosional processes 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: (two of the three formations of the Mesaverde Group) the Menefee Formation and Cliff House Sandstone; Lewis Shale, 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 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, an unnamed upper coal-bearing member (Beaumont and others, 1956), and the Hogback Mountain Tongue (Beaumont, 1971). The first three members were grouped together as undifferentiated Menefee Formation for the purposes of this report only.

The undifferentiated member consists primarily of gray, carbonaceous to noncarbonaceous shale, interbedded buff to gray sandstone, and lenticular coal beds. This member has a total thickness of approximately 1,150 ft (351 m). Due to the regional dip of approximately 1° to 2° to the northeast, the lower portion of the Menefee Formation is more than 3,000 ft (914 m) below the ground surface (the study limit) over the entire quadrangle area. In the northeastern corner of the area (in drill hole 43 located in section 20, T. 26 N., R. 13 W.), the entire undifferentiated member is deeper than the study limit, but to the south (in drill hole 26 in section 28, T. 25 N., R. 13 W.), only the lower 467 ft (142 m) have more than 3,000 ft (914 m) of overburden.

The informally-named Hogback Mountain Tongue (Beaumont, 1971) of the Menefee Formation represents the thick paludal sediments deposited shoreward of the massive marine sand of the La Ventana Tongue (Cliff House

Sandstone). This member is distinguished as a major coal-bearing unit as a result of its deposition in a coastal-swamp environment. The stratigraphic equivalence and complex intertonguing of the Hogback Mountain Tongue with the La Ventana Tongue make it distinguishable in the area of intertonguing. It averages 170 ft (52 m) in thickness across most of the area; but thins in a northeasterly direction and has completely wedged out into the La Ventana Tongue in drill hole 28 in section 8, T. 26 N., R. 12 W. Similar in lithology to the underlying undifferentiated member of the Menefee, the Hogback Mountain Tongue consists of gray, carbonaceous shale with plant fossils, interbedded gray siltstone, and random coal beds.

Conformably overlying and intertonguing with the Menefee Formation is the basal member of the Cliff House Sandstone, the La Ventana Tongue. In the northeastern portion of the quadrangle the La Ventana is present as a thick sand sequence overlying the undifferentiated member of the Menefee and averages 520 ft (158 m) thick in drill hole 28 in section 8, T. 26 N., R. 12 W. However, a short distance to the southwest the La Ventana splits into two distinct sand wedges divided by the Hogback Mountain Tongue of the Menefee Formation. The La Ventana is composed primarily of light gray, micaceous, calcareous, argillaceous, glauconitic sandstone.

The uppermost member of the Cliff House Sandstone is the Chacra Tongue (informal name of local usage). The Chacra sandstone in this area is transitional in lithology from the massive nearshore sandstone of the type section to the southwest at Chacra Mesa to marine deposits of the Lewis Shale. It is composed of silty, gray shale with plant fossils and interbedded light gray sandstone and light gray siltstone containing sandy stringers. This "transition" Chacra is about 400 ft (122 m) thick throughout the quadrangle.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a light gray, silty shale with local plant fossils and interbedded gray siltstone with sandy stringers. The Lewis averages 180 ft (55 m) in thickness throughout the quadrangle. The upper contact is gradational with the overlying Pictured Cliffs Sandstone and, therefore, it is difficult to determine.

The Pictured Cliffs Sandstone consists of about 140 ft (43 m) of gray, slightly calcareous sandstone with feldspar and chert grains, commonly interbedded with 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, the Pictured Cliffs Sandstone is a fairly consistent formation throughout the basin. The authors have used the consistency and distinctive character of the formation on geophysical logs to establish the top of the Pictured Cliffs as a lithologic datum for correlation of the overlying Fruitland Formation coals.

The Fruitland Formation is the major coal-bearing unit in the quadrangle. It averages 325 ft (99 m) 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 San Juan Basin. They average 810 ft (247 m) in thickness and consist of very light green to gray, micaceous, calcareous claystone with sandy stringers and interbedded white to light gray silty sandstone. 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 consists of about 120 ft (37 m) of light to dark brown, medium- to coarse-grained, locally conglomeratic, arkosic sandstone.

The Nacimiento Formation gradationally overlies the Ojo Alamo. The basal few hundred feet of the formation are present in the area and consist of light gray to black shale and interbedded sandstone.

A total of three formations crop out within the quadrangle. The outcrop pattern trends in a general northwest-southeast to east-west direction with the rocks becoming successively younger to the northeast. The oldest formation exposed is the upper portion of the Kirtland Shale in the southwest. The Ojo Alamo Sandstone crops out in a thin belt across the southwestern and northeastern parts of the quadrangle. The lowermost beds of the Nacimiento Formation, the youngest formation in the area, are exposed in the central portion.

Structure

The Moncisco Wash 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 24 miles (39 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). Regional dip within the quadrangle averages 1° to the northeast. Reeside measured the dip of the Fruitland Formation as 2° to the north in Hunter Wash, south of the area. Reeside stated that the rocks in the quadrangle north of Moncisco Wash, are "nearly horizontal".

COAL GEOLOGY

Two coal zones (Menefee, Fruitland) and seven coal beds (Menefee 1, Menefee 2, Menefee 3, Menefee 4, Menefee 5, Fruitland 1, Fruitland 2) were identified in the subsurface of this quadrangle (CRO Plate 1). The coals of the Menefee Formation are grouped together into the Menefee coal zone (Me zone). These coals are noncorrelative and generally less than reserve base thickness (5 ft [1.5 m]); exceptions are a 5-ft (1.5-m) bed and a 7-ft (2.1-m) bed in drill hole 14, an 8-ft (2.4-m) bed and a 5-ft (1.5-m) bed in drill hole 21, two 5-ft (1.5-m) beds and a 9-ft (2.7-m) bed in drill hole 23, and a 5-ft (1.5-m) bed in drill holes 24 and 26 (CRO Plate 1). Since these coals are discontinuous, derivative maps were not constructed.

Within the Hogback Mountain Tongue of the Menefee Formation there are several correlative Menefee coal beds. These have been designated as the Menefee 1 (Me 1), Menefee 2 (Me 2), Menefee 3 (Me 3), Menefee 4 (Me 4), and Menefee 5 (Me 5). Since the Menefee 1 and Menefee 5 coal beds are less than reserve base thickness within the quadrangle (an exception is a 5-ft [1.5-m] Menefee 5 bed in drill hole 39), derivative maps were not constructed.

Menefee Formation coals in the western portion of the San Juan Basin are considered subbituminous A to subbituminous B in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 10,837 Btu's per pound (25,207 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 varying from 15.3 to 19.1 percent, ash content ranging from 6.6 to 22.7 percent, sulfur content less than 1.5 percent, and heating values averaging 9,515 Btu's per pound (22,132 kj/kg). Analyses of several Menefee coals are given in Table 1 (Shomaker, 1971).

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. However, since the coals are higher in stratigraphic position to the northeast, the Fruitland 2 (Fr 2) coal bed is the basal coal in the northeast part of this quadrangle. Otherwise, the Fruitland 2 is above the Fruitland 1 (CRO Plate 1). Occasionally there are local (L) coal beds within the Fruitland Formation and Pictured Cliffs Sandstone.

The remaining coals of the upper 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 9-ft (2.7-m) coal bed in drill hole 35. Due to these characteristics, derivative maps were not constructed.

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.			Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur		
J-52142	Channel, Open Pit	SW¼ 27	25	17	-------------	A	17.4	35.5	40.5	6.6	0.6	10,410	Coal may be
						B	----	43.0	49.1	7.9	0.7	12,600	slightly
						C	----	46.7	53.3	----	0.8	13,680	weathered.
J-51245	Channel, Open Pit	NW¼ 9	22	14	-------------	A	19.1	33.4	40.7	6.8	0.9	9,280	Coal probably
						B	----	41.3	50.3	8.4	1.2	11,470	weathered
						C	----	45.1	54.9	---	1.3	12,520	
J-51246	Channel, Open Pit	NE¼ 2	22	16	-------------	A	15.3	33.9	42.7	8.1	1.0	10,310	
						B	----	40.1	50.3	9.6	1.1	12,180	
						C	----	44.3	55.7	---	1.3	13,470	
J-61758	Core Sample	SW¼ 36	25	17	-------------	A	15.8	31.6	39.6	13.0	1.2	9,700	
						B	----	37.5	47.1	15.4	1.4	11,510	
						C	----	44.3	55.7	----	1.6	13,610	
J-61759	Core Sample	SW¼ 36	25	17	-------------	A	17.4	31.5	40.4	10.7	1.4	9,730	
						B	----	38.1	48.9	13.0	1.7	11,780	
						C	----	43.8	56.2	----	2.0	13,540	
J-61757	Core Sample	SW¼ 2	23	17	-------------	A	18.5	27.7	31.1	22.7	0.5	7,660	
						B	----	34.0	38.2	27.8	0.7	9,410	
						C	----	47.2	52.8	----	0.9	13,030	

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.

Although Menefee and Fruitland Formation coals have been correlated and mapped as consistent horizons, they may actually be several different coal beds that are lithostratigraphically equivalent, but not laterally continuous.

Fruitland Formation coals in the western part of the San Juan Basin are considered high volatile A to high volatile C bituminous in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values averaging 13,666 Btu's per pound (31,787 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 2.6 to 9.5 percent, ash content averaging 14.2 percent, sulfur content varying from 0.6 to 1.8 percent, and heating values on the order of 11,560 Btu's per pound (26,889 kj/kg). Analyses of several Fruitland Formation coals are given in Table 2 (Fassett and Hinds, 1971).

Menefee 2 Coal Bed

The coal bed is present only in the center and northwest of the quadrangle. As illustrated by the structure contour map (CRO Plate 5), the coal bed dips less than 1° to the north. As a result of topography and dip, overburden (CRO Plate 6) varies from less than 2,200 ft (671 m) in the central portion of the quadrangle to greater than 2,700 ft (823 m) on Moncisco Mesa. The isopach map (CRO Plate 4) indicates that the coal is greater than 5 ft (1.5 m) thick where present.

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.			Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-40806	Standard of Texas State No. 1	SW¼ 16	25	13	1,156-1,208	A	9.5	30.9	43.3	16.3	1.8	10,270	Abnormal moisture content may be due to inadequate drying of sample during preparation process.
						B	---	34.1	47.9	18.0	2.0	11,340	
						C	---	41.6	58.4	----	2.5	13,820	
H-3031	Southwest Production Cambell No. 2	NE¼ 26	27	12	1,900-1,910	A	2.6	41.2	40.5	15.7	0.6	11,810	
						B	---	42.3	41.6	16.1	0.6	12,120	
						C	---	50.4	49.6	----	0.7	14,440	
H-36175	Royal Development Ojo Amarillo No. 2	SW¼ 6	27	13	1,214-1,245	A	4.3	39.7	44.6	11.4	0.7	11,970	
						B	---	41.4	46.7	11.9	0.7	12,500	
						C	---	47.0	53.0	----	0.8	14,190	
H-24567	Sunray Mid-Continent Gallegos No. 122	NW¼ 18	28	12	1,305-1,315	A	3.0	38.9	44.4	13.7	0.6	12,010	
						B	---	40.1	45.8	14.1	0.6	12,390	
						C	---	46.8	53.2	----	0.7	14,430	
H-7225	Pan American Holder No. 7	NW¼ 16	28	13	1,705-1,715	A	4.1	39.4	42.8	13.7	0.6	11,740	
						B	---	41.1	44.6	14.3	0.6	12,240	
						C	---	47.9	52.1	----	0.7	14,290	

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

Chemical Analyses of the Menefee 2 Coal Bed - Analyses of several Menefee Formation coals from the outcrop area west of this quadrangle are given in Table 1 (Shomaker, 1971). These coals are assumed to be similar in quality to the coals of this quadrangle.

Menefee 3 Coal Bed

The coal bed is present only in the central portion of the quadrangle, extending from east to west. The structure contour map (CRO Plate 9) indicates that the coal bed dips less than 1° to the north. As a result of topography and dip, overburden (CRO Plate 10) varies from less than 2,100 ft (640 m) in the southwest and in the West Fork of Gallegos Canyon to greater than 2,600 ft (792 m) on Moncisco Mesa. The isopach map (CRO Plate 8) shows the coal is greater than 10 ft (3.0 m) thick in the west, but thins in all directions.

Chemical Analyses of the Menefee 3 Coal Bed - Analyses of several Menefee Formation coals from the outcrop area west of this quadrangle are given in Table 1 (Shomaker, 1971). These coals are assumed to be similar in quality to the coals of this quadrangle.

Menefee 4 Coal Bed

As illustrated by the structure contour map (CRO Plate 13) the coal bed dips less than 1° to the northeast. Due to topography and dip, overburden (CRO Plate 14) ranges from less than 2,100 ft (640 m) in the southwest and in the Moncisco Wash and West Fork Gallegos Canyon area to greater than

2,600 ft (792 m) on Moncisco Mesa. The isopach map (CRO Plate 12) shows the coal bed is greater than 10 ft (3.0 m) thick in the northwest and southeast parts of the quadrangle. The thickness decreases in all directions, and the coal is absent in the north, south, and parts of the east and west.

Chemical Analyses of the Menefee 4 Coal Bed - Analyses of several Menefee Formation coals from the outcrop area west of this quadrangle are given in Table 1 (Shomaker, 1971). These coals are assumed to be similar in quality to the coals of this quadrangle.

Fruitland 1 Coal Bed

The structure contour map (CRO Plate 17) shows that the coal bed dips less than 1° to the north. As a result of topography and dip, overburden varies from less than 1,000 ft (305 m) in the southwest to greater than 1,600 ft (488 m) on Moncisco Mesa. The isopach map (CRO Plate 16) illustrates that the coal is greater than 10 ft (3.0 m) thick in the north-central part of the quadrangle. The thickness decreases in all directions, and the coal is absent in the northeast and parts of the center and southeast.

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 2 (Fassett and Hinds, 1971).

Fruitland 2 Coal Bed

As indicated by the structure contour map (CRO Plate 21) the coal bed dips less than 1° to the north. As a result of topography and dip, overburden (CRO Plate 22) varies from less than 1,000 ft (305 m) in the southwest and the West Fork of Gallegos Canyon to greater than 1,600 ft (488 m) on Moncisco Mesa. The isopach map (CRO Plate 20) shows the coal bed is greater than 20 ft (6.1 m) thick in several areas throughout the east and northeast of the quadrangle. The coal thickness decreases in the other areas of the map, and the coal is absent in two locations in a part of the northwest and part of the east.

Chemical Analyses of the Fruitland 2 Coal Bed - Analyses of several Fruitland Formation coals from this quadrangle and the surrounding area are given in Table 2 (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 Moncisco Wash quadrangle occur 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 Menefee 2, Menefee 3, Menefee 4, Fruitland 1, and Fruitland 2 coal beds for the determination of coal resources in this quadrangle. Coals of the Menefee and Fruitland zones were not evaluated because they are discontinuous, noncorrelative, and generally less than the reserve base thickness (5 ft [1.5 m]). Although they are each locally correlative, the Menefee 1 and Menefee 5 coal beds were not evaluated because they are less than 5 ft (1.5 m) thick.

For Reserve Base and Reserve calculations, each coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plates 7, 11, 15, 19, and 23) 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, 12, 16, and 20) and areal distribution maps (CRO Plates 7, 11, 15, 19, and 23) 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 a conversion factor for bituminous or subbituminous coal. This yields the Reserve Base coal, in short tons, for each coal bed. The conversion factor for bituminous coal (Fruitland 1 and Fruitland 2) is 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter) and that of subbituminous coal (Menefee 2, Menefee 3, and Menefee 4) is 1,770 short tons of coal per acre-foot (13,018 tons/hectare-meter).

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 each category of coal for the Menefee 2, Menefee 3, Menefee 4, Fruitland 1, and Fruitland 2 beds are shown on CRO Plates 7, 11, 15, 19, and 23, 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 1,088 million short tons (987 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 Moncisco Wash quadrangle has development potential for subsurface mining methods only (CDP Plate 24).

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 3 summarizes the coal development potential, in short tons, for underground coal of the Menefee 2, Menefee 3, Menefee 4, Fruitland 1, and Fruitland 2 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the Moncisco Wash quadrangle occur more than 200 ft (61 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 2 bed results in the only area of high development potential which is in the southwest corner of the quadran-

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS
(in short tons) IN THE MONCISCO WASH 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 2	7,530,000	752,440,000	--	759,970,000
Fruitland 1	--	174,710,000	--	174,710,000
Menefee 4	--	--	51,820,000	51,820,000
Menefee 3	--	--	87,660,000	87,660,000
Menefee 2	--	--	13,710,000	13,710,000
TOTAL	7,530,000	927,150,000	153,190,000	1,087,870,000

gle. Coal bed thickness is 5 to 12 ft (1.5-3.7 m) in this area (CRO Plate 20), and the overburden is approximately 990 ft (302 m) thick (CRO Plate 22).

Most of the quadrangle area has moderate development potential for coal of the Fruitland 1 and Fruitland 2 beds. The Fruitland 1 has moderate potential in the southern and north-central parts of the quadrangle; the Fruitland 2 has moderate potential throughout the quadrangle, with the exception of several small areas where the coal is less than reserve base thickness (5 ft [1.5 m]). Thickness of the coal beds in the moderate potential area is 5 to 9 ft (1.5-2.7 m) for the Fruitland 1 (CRO Plate 16) and 5 to 24 ft (1.5-7.3 m) for the Fruitland 2 (CRO Plate 20), and overburden is 1,000 ft (305 m) to 1,400 ft (427 m) (CRO Plate 18) and 1,600 ft (488 m) (CRO Plate 22), respectively.

The two small areas of low development potential in the northwest and central parts of the quadrangle are the result of the Menefee 2 and Menefee 4 coal beds, respectively. In the northwest the Menefee 2 is 5 ft (1.5 m) thick (CRO Plate 4), and the overburden thickness is approximately 2,650 ft (808 m) (CRO Plate 6). The Menefee 4, in the center of the area, is 5 ft (1.5 m) thick (CRO Plate 12), and the overburden averages 2,100 ft (640 m) thick (CRO Plate 14). Coal of the Menefee 3 bed has low development potential in the west-central and east-central areas; however, the Fruitland 1 and Fruitland 2 beds have a higher potential for development (moderate) in these areas.

Several small isolated areas of unknown potential occur where the individual coal beds are less than 5 ft (1.5 m) thick.

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