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COAL RESOURCE OCCURRENCE MAPS OF THE SARGENT RANCH QUADRANGLE, SAN JUAN AND McKINLEY COUNTIES, NEW MEXICO

[Report includes 9 plates]

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SARGENT RANCH 7 1/2-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps of the Sargent Ranch quadrangle, San Juan and McKinley Counties, New Mexico. These maps were compiled to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) of the western United States. The work 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 Sargent Ranch 7 1/2-minute quadrangle is located in southeastern San Juan County and northeastern McKinley County, New Mexico. The area is approximately 48 miles (77 km) southeast of Farmington and 60 miles (97 km) northeast of Gallup, New Mexico.

Accessibility

The Sargent Ranch quadrangle is accessible by State Route 56 which is approximately 4 miles (6 km) west of the quadrangle. Light-duty and unimproved dirt roads extend into the area, providing further access. The Atchison, Topeka, and Santa Fe Railway operates a route which passes through Gallup approximately 60 miles (97 km) to the southwest.

Physiography

The quadrangle is near the southern boundary of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. Elevations range from 6,200 ft (1,890 m) in Chaco Wash to 6,820 ft (2,079 m) on Chacra Mesa. The topography is characterized by plains which have been gently incised in the north by westerly flowing, intermittent streams. The Chaco River has cut deeply into the southwestern corner of the area to form Chaco Canyon and Chacra Mesa southwest of the river. Drainage in the northern part of the quadrangle is provided by Escavada Wash and by Gallo Wash in the central portion.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than 10 inches (25 cm), but varies across the basin due to elevational differences. Rainfall is rare in the early summer; most precipitation occurs 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 with an average of 18 inches (46 cm) in the southern part of the basin.

Land Status

Approximately 46 percent of the quadrangle is in the south-central part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 54 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. Preference Right Lease applications (NM 3918 and NM 8129) in the northern portion of the quadrangle cover 16 percent of the KRCRA. No Federal coal leases occur within the quadrangle. The Federal Government owns 18 percent of the land outside the KRCRA boundary in the quadrangle.

GENERAL GEOLOGY

Previous Work

Bauer and Reeside (1921) have mapped the Fruitland Formation with detailed emphasis on outcrops of Fruitland coal and clinker. Reeside (1924) has mapped the Upper Cretaceous and Tertiary formations of the San Juan Basin. Dane (1936) studied the geology and fuel resources of the southern part of the San Juan Basin, which includes that portion of the quadrangle south of Alamo Arroyo, and mapped in detail the surface exposures of the Fruitland Formation coal beds and clinker. Shomaker (1971c) has described in detail the surface coal occurrences of the Fruitland Formation within the area and estimated the strippable reserves by township and range. A publication by Fassett and Hinds (1971) includes subsurface interpretations of the Fruitland Formation coal deposits throughout the San Juan Basin. The most recent work in the area has been by Schneider (1978) which contains maps of the geology, Fruitland clinker, and various Fruitland Formation coal zones at a scale of 1:24,000.

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.

The first basin-wide retreat of the Late Cretaceous sea is indicated by the nearshore deposits of the Point Lookout Sandstone. These ancient barrier beaches formed a generally northwest-southeast-trending strandline, behind which swamps developed. Organic material accumulated in the swamps and later became coal in the paludal deposits of the lower Menefee Formation. Deposition of materials which formed the coal beds was influenced by the strandline. This is shown by the more consistent thickness and greater lateral extent of the coals parallel to the strandline and also by the lack of continuity perpendicular to it, to the northeast, where the Menefee and underlying Point Lookout deposits interfinger. Streams which crossed the swamps also influenced deposition of organic matter; stream deposits may terminate even the most continuous coal beds.

During the continued retreat of the sea, the depositional environments in the quadrangle area became more terrestrial. This is evidenced by the transition within the lower Menefee from carbonaceous to noncoal-bearing deposits, in which there is an upward decrease in the occurrence and lateral continuity of the coals. As the sea retreated, the sediments of the Point Lookout Sandstone and overlying Menefee Formation were deposited in successively higher stratigraphic positions to the northeast.

The sea then reversed direction of the movement, and the transgressive sequence of paludal upper Menefee Formation, nearshore Cliff House Sandstone, and marine Lewis Shale was deposited in the quadrangle. At the same time that thick La Ventana sands were being deposited over the Menefee Formation northeast of the quadrangle, swamps developed within the quadrangle area. Organic matter deposited in these swamps ultimately formed the coal beds of the Hogback Mountain Tongue (Beaumont, 1971) in the upper part of the Menefee Formation. A thin wedge of beach sands of the La Ventana Tongue (Cliff House Sandstone) was then deposited over the Menefee in this quadrangle.

Onlap continued as the sea moved southwestward across the basin area. The transgressing northwest-southwest-trending strandline is represented in the lithologic record by the Chacra Tongue of the Cliff House Sandstone. The marine facies which developed northeast of the 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.

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

The brackish-water swamp environment of the Fruitland moved northeast of the quadrangle as the regression continued in that direction. Terrestrial freshwater sediments covered the area as indicated by the lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated beyond the limits of the quadrangle area, and modern basin structure began to develop. An erosional unconformity developed in a relatively short time as part of the Cretaceous Kirtland Shale was removed.

Terrestrial deposition resumed in the Paleocene as represented by the Ojo Alamo Sandstone and the overlying Nacimiento Formation. Alluvial plain and floodplain deposits of the Ojo Alamo were followed by the thick, lithologically varied deposits of the Nacimiento during continuous nonmarine deposition. The Nacimiento was later exposed to erosion.

The Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface, reflecting various nonmarine environments which developed across the basin. Deposition and structural deformation of the basin then ceased, and the warped strata of the San Juan Basin have been exposed to erosional processes to the present time. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation, Nacimiento Formation, Ojo Alamo Sandstone, and some of the Kirtland Shale from the area.

Stratigraphy

The formations studied in this quadrangle are Late Cretaceous in age. They are, in order from oldest to youngest: the Point Lookout Sandstone, Menefee Formation, Cliff House Sandstone, Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation, and Kirtland Shale. The first three are the formations of the Mesaverde Group. 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 Point Lookout Sandstone, the basal formation of the Mesaverde Group, consists of light to medium gray, slightly calcareous sandstone and interbedded gray shale. It is massive, averages 140 ft (43 m) thick in this quadrangle, and displays a distinctive character on geophysical logs. This last characteristic was used by the authors in establishing the top of the Point Lookout as a lithologic datum for correlation of the overlying Menefee coals.

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, 1956), and the Hogback Mountain Tongue (Beaumont, 1971). The first three members are referred to as a single undifferentiated member for the purpose of this report only. This member in this area is about 1,090 ft (332 m) thick and is predominantly a gray to brown, carbonaceous to noncarbonaceous, slightly calcareous shale with local plant fossils, interbedded thin, white to tan, calcareous sandstone, and lenticular coal beds.

The informally named Hogback Mountain Tongue (Beaumont, 1971) is recognized as a major coal-bearing unit. The stratigraphic equivalence and complex intertonguing of the Hogback Mountain Tongue with the La Ventana sandstone northeast of the area make it distinguishable from the undifferentiated member. The thickness of the unit is approximately 500 ft (152 m) in the southwestern portion of the area, but decreases in a northeasterly direction as the La Ventana thickens. Similar in lithology to the underlying undifferentiated member, the Hogback Mountain Tongue is composed of dark gray to brown, carbonaceous shale, interbedded thin sandstone, and lenticular coal beds.

Conformably overlying the Menefee Formation is the Cliff House Sandstone. The basal member, a thin wedge of the La Ventana Tongue, averages about 60 ft (18 m) in thickness in this area and is shoreward (southwest) of the major buildup of the La Ventana. The sandstone thins to the southwest and is composed of a light gray, calcareous sandstone with interstitial kaolinite.

The upper member, the Chacra Tongue (informal name of local usage) overlies the La Ventana Tongue and averages 360 ft (110 m) in thickness. The Chacra in this quadrangle is a massive sandstone similar to the type section at Chacra Mesa to the southwest. It is composed of light gray, locally silty, slightly calcareous sandstone with thin interbedded shale and siltstone.

The Mesaverde Group is conformably overlain by the transgressive marine deposits of the Lewis Shale. The Lewis averages 205 ft (62 m) in thickness and consists of dark gray, calcareous shale with plant fossils and thin, interbedded gray, calcareous sandstone.

The Pictured Cliffs Sandstone conformably overlies the Lewis Shale, and consists of a white to light gray, calcareous sandstone with scattered siderite grains and interbedded grayish-green shale. The lower contact with the Lewis Shale is gradational and may account for variations in the reported thickness; the average thickness is about 100 ft (30.5 m) in this area. The upper contact is more sharply defined than the basal contact, even though intertonguing with the overlying Fruitland Formation results in minor variations in the formational top and the occurrence of local Fruitland coals. 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 of the unit 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 has an average thickness of 290 ft (88 m) and is composed of light olive green to gray, carbonaceous, calcareous, flaky shale, thinly interbedded, gray, calcareous sandstone, and coal beds of varying thicknesses. The coal beds of greatest continuity and thickness occur near the base of the formation, while discontinuous and lenticular coals 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). Previous authors have used various criteria in determining the upper Fruitland 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 about 255 ft (78 m) thick, and consist of gray to gray-brown silty shale. The formation has 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.

A total of five formations crop out within the quadrangle. The outcrop pattern trends in a northwest-southeast direction with the formations becoming successively younger to the northeast. The oldest unit is the Chacra Tongue of the Cliff House Sandstone which is exposed at Chacra Mesa in the southwestern portion of the quadrangle. The entire sections of the Lewis Shale, Pictured Cliffs Sandstone, and Fruitland Formation crop out consecutively across the quadrangle in a northeasterly direction. The lowermost beds of the Kirtland Shale, the youngest formation, are exposed in the northeastern corner of the quadrangle.

Structure

The axis of the San Juan Basin is about 43 miles (69 km) northeast of the Sargent Ranch quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Regional dip within the quadrangle was measured as 1.3° by Bauer and Reeside (1921).

COAL GEOLOGY

Individual coal beds are not continuous across the San Juan Basin because the coal-related strata are progressively younger from southwest to northeast; the strata rise in steps due to minor transgressions which occurred during the overall retreat of the sea.

A lithologic datum was used for correlation of the coals (CRO Plate 3). The primarily marine sandstone units (Point Lookout, Pictured Cliffs) which underlie the coal-bearing formations (Menefee, Fruitland) were used as datums since they represent a more laterally continuous boundary than any of the overlying paludal, fluvial, and lacustrine deposits of the coal-bearing formations. Also, the sandstone units are generally more easily recognized on geophysical logs. As shown on CRO Plate 3, the tops of the sandstone units have been used as datums for each drill hole, and the coals have been plotted in the column and correlated based upon their position relative to the datum. Correlations of Fruitland coals in measured sections are based upon geologic maps (Bauer and Reeside, 1921).

Two coal zones (Menefee, Fruitland) and a coal bed (Fruitland 1) were identified in this quadrangle (CRO Plate 1). All the coal beds of the

Menefee Formation have been designated as the Menefee coal zone (Me zone). These coals are generally noncorrelative and less than reserve base thickness of 5 ft (1.5 m) as set by the U.S. Geological Survey; exceptions are a 5-ft (1.5-m) coal bed in drill holes 5 and 10.

The Menefee Formation coals in this area of the San Juan Basin are considered subbituminous A in rank. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,103 to 11,256 Btu's per pound (25,825-26,181 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. There is no apparent difference between the coals of the upper and lower Menefee Formation. The "as received" analyses indicate moisture content varying from 14.4 to 17.5 percent, sulfur content ranging from 0.6 to 2.2 percent, ash content ranging from 7.5 to 10.2 percent, and heating values on the order of 10,053 Btu's per pound (23,383 kj/kg). Analyses of several Menefee coals are given in Table 1 (Bauer and Reeside, 1921; Beaumont, 1971; Dane, 1936; Lease, 1971; Shomaker, 1971b).

The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation which is generally directly above the Pictured Cliffs Sandstone. In this quadrangle, the coal bed is less than reserve base thickness (5 ft [1.5 m]); therefore, derivative maps were not constructed.

The upper Fruitland Formation coals are designated as the Fruitland coal zone (Fr zone). Some of the coals are correlative over short distances; however, most of these coals are less than the reserve base thickness of 5 ft

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.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
J-63534	Core Sample	NE¼ 36	17	10	----	A	16.5	33.4	40.4	9.7	0.6	10,070	
						B	----	40.0	48.3	11.7	0.7	12,060	
						C	----	45.3	54.7	----	0.8	13,650	
3823	Mine Sample	14	20	11	----	A	17.5	32.9	41.2	8.4	2.2	----	
23004	Pueblo Bonito Mine	14	21	11	----	A	14.4	34.8	43.3	7.5	1.54	10,220	Allison Member
						B	-----	40.7	50.5	8.8	1.80	11,940	
						C	-----	44.6	55.4	----	1.97	13,090	
J-57562	Pit Sample	SW¼ 11	22	13	----	A	14.4	32.6	42.8	10.2	0.9	9,870	
						B	----	38.1	50.0	11.9	1.0	11,530	
						C	----	43.3	56.7	----	1.2	13,090	

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

(1.5 m); an exception is a 7-ft (2.1-m) coal in drill hole 10. Several Fruitland zone coals crop out in the northern portion of this quadrangle (CRO Plate 1). The trace of the outcrop has been modified from the original data source to conform with modern topographic maps.

Fruitland Formation coal beds in the southern part of the San Juan Basin vary from subbituminous A to high volatile B bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,207 to 13,211 Btu's per pound (26,067-30,729 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 4.52 to 14.6 percent, ash content ranging from 16.0 to 35.14 percent, sulfur content less than one percent, and heating values on the order of 9,201 Btu's per pound (21,402 kj/kg). Analyses of several Fruitland coals are given in Table 2 (Dane, 1936; Shomaker and Lease, 1971a, 1971b).

Menefee Coal Zone

The Menefee coal zone extends from the top of the La Ventana Tongue of the Cliff House Sandstone to the base of the Menefee Formation. Because the La Ventana is contemporaneous with the coal-bearing Hogback Mountain Tongue of the Menefee Formation and is easily recognized on geophysical logs, the top of this unit was chosen to represent a mappable surface, which portrays the upper boundary of the coal-bearing zone more consistently than the randomly occurring uppermost Menefee coal.

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		
J-62557	Core Sample	SW¼ 26	21	8	----	A	13.6	33.4	35.4	17.6	0.53	9,110	
						B	-----	38.6	41.0	20.4	0.62	10,540	
						C	-----	48.5	51.5	-----	0.77	13,240	
J-62604	Core Sample	SW¼ 26	21	8	----	A	12.6	28.7	28.2	30.5	0.49	7,510	
						B	-----	32.8	32.4	34.8	0.56	8,590	
						C	-----	50.3	49.7	-----	0.86	13,180	
*29	Drill Cuttings	NW¼ 5	22	10	----	A	4.52	-----	-----	13.65	0.59	11,035	
						B	-----	-----	-----	14.30	0.62	11,577	
						C	-----	-----	-----	-----	----	13,485	
+34	Drill Cuttings	SE¼ 9	22	10	----	A	9.28	29.26	38.42	23.04	0.54	9,240	
						B	-----	32.25	42.35	25.40	0.60	10,185	
						C	-----	-----	-----	-----	----	13,653	
J-63526	Core Sample	NE¼ 15	22	10	269.0-290.2	A	12.4	33.9	37.6	16.1	0.49	9,630	
						B	-----	38.7	42.9	18.4	0.56	10,990	
						C	-----	47.5	52.5	-----	0.68	13,470	
*27	Drill Cuttings	NW¼ 12	22	11	104-110	A	5.01	-----	-----	35.14	0.44	7,740	May be
						B	-----	-----	-----	36.99	0.46	8,148	weathered
						C	-----	-----	-----	-----	----	12,931	sample
*	Drill Cuttings	NW¼ 12	22	11	155-159	A	5.42	-----	-----	19.41	0.66	10,427	
						B	-----	-----	-----	20.52	0.70	10,835	
						C	-----	-----	-----	-----	----	13,634	
J-63220	Core Sample	NE¼ 29	23	11	252.5-283.0	A	12.7	31.9	34.3	21.2	0.3	8,680	
						B	-----	36.5	39.3	24.2	0.4	9,940	
						C	-----	48.2	51.8	-----	0.5	13,120	
J-61645	Core Sample	NE¼ 29	23	11	321.5-330.0	A	14.6	30.8	38.6	16.0	0.34	9,440	
						B	-----	36.1	45.2	18.7	0.40	11,050	
						C	-----	44.4	55.6	-----	0.49	13,600	

*Analysis by New Mexico State Bureau of Mines and Mineral Resources

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.

Consequently, the structure contour map of the coal zone (CRO Plate 5) was constructed using the top of the La Ventana Tongue. This map shows that the zone dips approximately 1° to the northeast. Due to topography and dip, overburden (CRO Plate 6) varies from less than 500 ft (152 m) in the southwest to over 1,200 ft (366 m) in the northeast part of the quadrangle. Also shown on CRO Plate 6 is the total amount of interburden which is the noncoal portion of the coal zone. The interburden thickness varies from less than 1,560 ft (476 m) to over 1,680 ft (512 m). The large interburden values are the result of the stratigraphic spread of the coal beds and reflect the thickness of the Menefee Formation plus the La Ventana. The isopach map (CRO Plate 4) illustrates the total combined thickness of the individual coal beds of the Menefee zone. The total thickness varies from more than 40 ft (12.2 m) in the south-central portion of the quadrangle to less than 5 ft (1.5 m) in the north.

Chemical Analyses of the Menefee Zone Coal Beds - No published analyses of the quality of Menefee Formation coals are available for this quadrangle. However, information from surrounding areas is assumed to be similar to that of the coals from this area. Analyses of several Menefee Formation coals are included in reports by Bauer and Reeside (1921), Beaumont (1971), Lease (1971), and Shomaker (1971a). The results of these analyses are given in Table 1.

Fruitland Coal Zone

The structure contour map of the Fruitland coal zone (CRO Plate 8) in this quadrangle was constructed using the top of the uppermost exposed

Fruitland zone coal bed. The coal zone dips approximately 1° to the northeast. Overburden (CRO Plate 9) increases from zero at the outcrop to greater than 300 ft (91 m) in the northeast. The isopach map (CRO Plate 7) illustrates the total combined thickness of the individual coal beds of the Fruitland zone exposed in this quadrangle. The thickness varies from less than 1 ft (0.3 m) in the northwest to greater than 7 ft (2.1 m) in the northeast part of the quadrangle. There is also a gradual increase in thickness to the south and east where the coal is greater than 6 ft (1.8 m) thick.

Chemical Analyses of the Fruitland Zone Coal Beds - No published analyses of the quality of Fruitland Formation coals are available for this quadrangle. However, information from surrounding areas is assumed to be similar to that for the coals from this area. Analyses of several Fruitland Formation coals are included in reports by Shomaker and Lease (1971a, 1971b). The results of these analyses are given in Table 2.

COAL RESOURCES

Coal resource data from oil and gas wells (El Paso Natural Gas Co., 1978, unpublished data in well log library, Farmington, New Mexico) and geologic maps (Bauer and Reeside, 1921) were used in the construction of isopach and structure contour maps for this quadrangle. Coal resources were not calculated for the Fruitland and Menefee coal beds because the coals are generally noncorrelative over long distances and less than the reserve base thickness of 5 ft (1.5 m).

COAL DEVELOPMENT POTENTIAL

Coal development potential maps were not constructed for this quadrangle because the coal beds are less than the reserve base thickness (5 ft [1.5 m]) and, therefore, have unknown coal development potential.

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