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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAPS OF THE ALAMO MESA EAST 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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ALAMO MESA EAST 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) Maps of the Alamo Mesa East 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 Alamo Mesa East 7 1/2-minute quadrangle is located in southeastern San Juan County, New Mexico, approximately 25 miles (40 km) south of Farmington and 60 miles (97 km) northeast of Gallup, New Mexico.

Accessibility

The area is accessible by New Mexico State Route 44, 11 miles (18 km) east of the quadrangle. On State Route 44, at Blanco Trading Post, a light-duty road extends southwest and connects with other light-duty roads which lead to various parts of the area. Numerous unimproved dirt roads provide access to the more remote areas of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates an east-west route which is 60 miles (97 km) south of the area at Gallup, New Mexico, and connects Gallup with Grants and Albuquerque to the east.

Physiography

This quadrangle is in the southwestern portion of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. Total relief of the area is low and ranges from 5,980 ft (1,823 m) in the southern portion to 6,620 ft (2,018 m) in the northeast. The entire quadrangle area is characterized by sparsely-vegetated plains. In the central portion of the area these plains display a badlands topography of sinuous incised intermittent drainages. The three small drainage systems in the area, De-na-sin Wash, Alamo Wash, and Willow Wash, are all intermittent streams which drain to the southwest.

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 as intense afternoon thundershowers. Annual temperatures in the basin range from below 0°F (-18°C) to above 100°F (38°C). Snowfall occurs from November to April with an average of 18 inches (46 cm) in the southwestern part of the basin.

Land Status

The quadrangle is in the southwest portion of the San Juan Basin Known Recoverable Coal Resource Area, and the Federal Government owns the coal rights for approximately 89 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. Preference Right Lease Applications (NM 3834, NM 3835, and NM 3838) in the southwest corner cover 23 percent of the area. No Federal coal leases occur within the 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 in this area 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, lay 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 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 beds in the Menefee Formation. Subsequently, several hundred feet of northwest-southeast-trending beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over the Menefee in the quadrangle. Shoreward (southwest) and contemporaneous with the La Ventana beach deposits, swamps developed above the older Menefee deposits. Subsequently, coals formed in the younger deposits, which are informally named the Hogback Mountain Tongue of the Menefee (Beaumont, 1971). Minor fluctuations of the sea resulted in interfingering of the La Ventana (Cliff House) and Hogback Mountain (Menefee) Tongues throughout the area.

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 which overlies the La Ventana Tongue. 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.

The first 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 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 lithostratigraphically 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 covered the quadrangle as indicated by the lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated 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. A significant amount of erosion has occurred, as indicated by the removal of the San Jose Formation and part of the Nacimiento 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 Menefee Formation, and Cliff House Sandstone (two of the three formations of the Mesaverde Group); 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, from the base upward, 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 an undifferentiated member for the purposes of this report only. They were not differentiated due to the difficulty and inaccuracy in determining a consistent division between them on geophysical logs.

The Menefee Formation consists primarily of gray to brown, carbonaceous to noncarbonaceous shale with occasional plant fossils; interbedded light gray to tan, calcareous sandstone with interstitial kaolinite; and lenticular coal beds. The formation has a total thickness of approximately 900 to 1,000 ft (247-305 m). Due to the regional dip of 1° to 2° to the northeast, the lower portion of the Menefee Formation falls below the 3,000-foot (914-m) overburden study limit in all but the southwestern part of the quadrangle area. In drill hole 5, located in the northeastern corner of the area (section 28, T. 25 N., R. 11 W.), 716 ft (218 m) of the Menefee Formation lie below the study limit; however, in drill hole 4 (section 13, T. 24 N., R. 12 W.), only the lower 200 ft (61 m) of the Menefee Formation are below the 3,000-foot (914-m) overburden study limit. The Menefee rises structurally to the southwest and the entire formation is above the study limit in the southwestern part of the quadrangle.

From the southwest, extending northeast across the quadrangle, the informally-named Hogback Mountain Tongue (Beaumont, 1971) of the Menefee Formation represents thick paludal sediments deposited shoreward of the massive La Ventana Tongue marine sands. This member is distinguished for two reasons: (1) it is a major coal-bearing unit as a result of its shoreward (coastal-swamp) relationship with the La Ventana sandstone, and (2) the stratigraphic equivalence and complex intertonguing with the La Ventana make its boundaries distinguishable in the area of intertonguing. The thickness of the Hogback Mountain Tongue is 460 ft (140 m) in the southwestern portion of the area; however, as the La Ventana thickens the Hogback Mountain thins in a northeasterly direction to a thickness of 45 ft (14 m) in drill hole 5 (section 28, T. 24 N., R. 11 W). Similar in lithology to the underlying undifferentiated member, the Hogback Mountain Tongue is composed of gray, carbonaceous shale with plant fossils, interbedded light gray to tan, calcareous sandstone, and random coal beds.

Conformably overlying and intertonguing with the Menefee Formation is the La Ventana Tongue, the basal member of the Cliff House Sandstone; here, it is composed of two sandstone wedges. In the northeastern portion of the quadrangle the basal sandstone tongue overlies the undifferentiated member of the Menefee Formation. In the southwest this basal tongue wedges out into the Hogback Mountain Tongue of the Menefee. The upper tongue of the La Ventana is more persistant and is present throughout the quadrangle. The massive sandstone tongues of the La Ventana represent the shoreward edge of a transgressive sequence composed of cream to light gray, friable, calcareous sandstone.

The uppermost member of the Cliff House Sandstone is the Chacra Tongue (informal name of local usage). It is a transgressive sand deposit exposed at Chacra Mesa, the type section, southwest of the quadrangle. The Chacra sandstone in this area is transitional in lithology from massive nearshore sandstone to marine deposits of the Lewis Shale. It is siltier, with a greater abundance of interbedded sandy shale than the thick, massive sandstone beds of the type section. The 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 gray, calcareous shale with occasional plant fossils. The Lewis averages 212 ft (65 m) in thickness throughout the quadrangle. The upper contact is gradational with the overlying Pictured Cliffs Sandstone and, therefore, a consistent contact between the two is difficult to determine.

The Pictured Cliffs Sandstone is a regressive sandstone of near-shore marine origin consisting of about 90 ft (27 m) of light gray to tan, friable, glauconitic sandstone with intersitital kaolinite, commonly interbedded with shale near the base where it grades into the Lewis. The upper contact of the Pictured Cliffs is more sharply defined than the basal contact. Intertonguing with the overlying Fruitland Formation results in minor variations in the formation top. Nevertheless, 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 determine the top of the Pictured Cliffs as a lithologic datum for correlation of the overlying Fruitland Formation coals.

Conformably overlying the Pictured Cliffs Sandstone is the Fruitland Formation, the major coal-bearing unit in the quadrangle. It consists of an average of 370 ft (113 m) of gray to gray-green to tan, carbonaceous, calcareous shale with plant fossils, interbedded siltstone and sandstone, and coal beds of varying thickness. The thickest and most continuous coal beds 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). Many authors have used various criteria in establishing the boundary between the Fruitland and Kirtland. For the purposes of this report, the uppermost coal bed in the Fruitland Formation was used as the contact (after Fassett and Hinds, 1971).

The freshwater deposits of the Kirtland Shale are the youngest Cretaceous strata in the San Juan Basin. These deposits average 500 ft (152 m) in thickness and are composed of gray shale with local plant fossils and interbedded gray siltstone. The Kirtland Shale 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, which consists of about 100 ft (30 m) of light to dark brown, medium- to coarse-grained, locally conglomeratic, arkosic sandstone.

The Nacimiento Formation gradationally overlies the Ojo Alamo Sandstone due to a gradual change in depositional environment from alluvial plain sedimentation of the Ojo Alamo to floodplain deposition of the Nacimiento (Powell, 1973). The basal 350 ft (107 m) of the Nacimiento Formation are present in the area, consisting of light gray to black shale and interbedded sandstone and siltstone.

A total of three formations crop out in the quadrangle. The outcrop pattern trends in a general northwest-southeast direction, the formations becoming successively younger to the northeast. The oldest formation exposed is the upper portion of the Kirtland Shale in the southwestern two-thirds of the quadrangle. The Ojo Alamo Sandstone crops out in a thin belt across the northern part. The lowermost beds of the Nacimiento Formation, the youngest formation in the area, are exposed in the extreme northeastern corner of the quadrangle.

Structure

The 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 42 miles (68 km) northeast 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 is 1° 20' as measured by Reeside (1924).

COAL GEOLOGY

Two coal zones (Menefee, Fruitland) and six coal beds (Menefee 1, Menefee 2, Menefee 3, Menefee 4, Menefee 5, and Fruitland 1) were identified in the subsurface of this quadrangle. The widely-distributed Menefee Formation coal beds were grouped together into the Menefee coal zone. These coal beds are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]). For these reasons, derivative maps of the Menefee coal zone were not constructed. However, several coal beds of the Menefee Formation which are included in the Hogback Mountain Tongue (Beaumont, 1971) are of greater than reserve base thickness (5 ft [1.5 m]) and some of these are correlative over short distances. These thicker coal beds have been designated as the Menefee 1, 2, 3, 4, and 5. Only the Menefee 1 and 4 are correlated for a short distance. The other designated Menefee beds each occur in only one drill hole; thus, derivative maps were not constructed (refer to CRO Plate 1).

Menefee Formation coal beds in the southern part of the San Juan Basin are considered subbituminous A in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values ranging from 10,830 to 11,103 Btu's per pound (25,191-25,826 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 stock fairly well when protected. The "as-received" analyses indicate moisture content varying from 14.4 to 19.0 percent, ash content ranging from 5.4 to 10.2 percent, sulfur content less than one percent, and heating values on the average of 10,030 Btu's per pound (23,330 kj/kg). Analyses of several Menefee Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Lease, 1971).

The Fruitland 1 (Fr 1) coal bed is the lowermost coal of the Fruitland Formation and generally lies directly above the Pictured Cliffs Sandstone (refer to CRO Plate 3). The remaining coals of the Fruitland Formation were grouped together into the Fruitland coal zone (Fr zone). These coals are usually noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]). An exception is a 15-ft (4.6-m) coal bed in drill hole 4 (CRO Plate 1). Due to these characteristics of the coals of the Fruitland zone, derivative maps were not constructed.

The coals of the Fruitland Formation in the southern part of the San Juan Basin are considered high volatile C bituminous in rank. The rank is based on a moist, mineral-matter-free basis with calorific values ranging from 11,729 to 12,782 Btu's per pound (27,282-29,731 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 5.28 to 12.0 percent, ash content ranging from 10.5 to 18.09 percent, sulfur content less than one percent, and heating

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-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	
23003	Mine Sample Blake's Mine	13	22	13	------------	A	19.0	32.4	43.2	5.4	0.92	10,190	
						B	----	40.0	53.3	6.7	1.14	12,590	
						C	----	42.9	57.1	----	1.22	13,490	

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

values on the average of 10,278 Btu's per pound (23,907 kj/kg). Analyses of several Fruitland Formation coals are given in Table 2 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971; Shomaker, 1971).

Menefee 1 Coal Bed

The Menefee 1 coal bed, informally named by the authors, is a locally thick, correlative accumulation of coal occurring within the Hogback Mountain Tongue of the Menefee Formation. Although the Menefee 1 is correlated and mapped as a consistent horizon it may, in fact, be several different beds that are lithostratigraphically equivalent but not laterally continuous.

As illustrated by the structure contour map (CRO Plate 5), the coal bed dips approximately 1° to the northeast. Consequently, overburden (CRO Plate 6) increases from less than 1,200 ft (366 m) in the southwest to greater than 2,600 ft (792 m) in the northeast part of the quadrangle. As shown by the isopach map (CRO Plate 4), the Menefee 1 coal bed varies in thickness from greater than 5 ft (1.5 m) in the central and southeastern portions of the quadrangle and decreases to zero along the western and northeastern boundaries of the map.

Chemical Analyses of the Menefee 1 Coal Bed - Analyses of several undesignated coals of the Menefee Formation from the area surrounding this quadrangle are given in Table 1 (Bauer and Reeside, 1921; Lease, 1971).

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 Section	T.N.	R.W.	Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
*21-A	Drill Cuttings	SW¼ 9	23	12	-------------	A	5.28	-----	-----	18.09	0.59	10,206	
						B	-----	-----	-----	19.10	0.62	10,775	
						C	-----	-----	-----	-----	----	13,319	
*23	Core Sample	NE¼ 10	23	12	-------------	A	9.39	30.11	43.10	17.41	0.72	9,915	
						B	-----	33.23	47.56	19.21	0.79	10,942	
						C	-----	-----	-----	-----	----	13,544	
H-22722	N.M.P.S.C.C. DH-3-2	SW¼ 3	23	13	42-44	A	6.7	35.9	46.9	10.5	0.6	11,320	Coal core
						B	-----	38.5	50.3	11.2	0.6	12,140	not floated
						C	-----	43.4	56.6	-----	0.7	13,680	in CCl_4
H-19885	N.M.P.S.C.C. DH-32-1	NW¼ 32	24	13	100-112	A	12.0	32.5	39.3	16.2	0.5	9,670	Coal core
						B	-----	36.9	44.7	18.4	0.6	10,990	crushed and
						C	-----	45.2	54.8	-----	0.7	13,460	floated in CCl_4

*New Mexico State Bureau of Mines and Mineral Resources

Menefee 4 Coal Bed

The Menefee 4 coal bed, informally named by the authors, is a locally thick, correlative accumulation of coal occurring within the Hogback Mountain Tongue of the Menefee Formation. The Menefee 4 coal bed occurs stratigraphically above the Menefee 3 coal bed, although the two are not present together in any of the drill holes (refer to CRO Plate 1). Although the Menefee 4 is correlated and mapped as a consistent horizon, it may actually be several different beds that are lithostratigraphically equivalent but not laterally continuous.

As illustrated by the structure contour map (CRO Plate 9), the coal bed dips approximately 1° to the northeast. As a result, overburden (CRO Plate 10) increases from less than 1,700 ft (518 m) in the southwest portion of the map to greater than 2,300 ft (701 m) in the northeast part of the quadrangle.

Chemical Analyses of the Menefee 4 Coal Bed - Analyses of several undesignated coals of the Menefee Formation from the area surrounding this quadrangle are given in Table 1 (Bauer and Reeside, 1921; Lease, 1971).

Fruitland 1 Coal Bed

The Fruitland 1 coal bed, informally named by the authors, represents the lowermost coal of the Fruitland Formation. Although the Fruitland 1 is correlated and mapped as a consistent horizon it may, in fact, be several different beds that are lithostratigraphically equivalent but not laterally continuous.

The structure contour map (CRO Plate 13) indicates a dip of approximately 1° to the northeast. Consequently, overburden (CRO Plate 14) increases from less than 300 ft (91 m) in the southwest to greater than 1,200 ft (366 m) in the northeast portion of the quadrangle. The isopach map (CRO Plate 12) indicates the greatest thickness of the Fruitland 1 occurring in the northeast part of the quadrangle where the coal is greater than 15 ft (4.6 m) thick. The thickness decreases to less than 5 ft (1.5 m) for a large portion of the northwest and central parts of the quadrangle. The coal is also less than 5 ft (1.5 m) in the southwest.

Chemical Analyses of the Fruitland 1 Coal Bed - Analyses of several Fruitland Formation coals from the area surrounding this quadrangle are given in Table 2 (Fassett and Hinds, 1971; Shomaker, 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 Alamo Mesa East quadrangle occur more than 440 ft (134 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Menefee 1, Menefee 4, and Fruitland 1 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]).

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 a conversion factor for bituminous or subbituminous coal, which yields the Reserve Base coal, in short tons, for each coal bed. The conversion factor for bituminous coal (Fruitland 1) is 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter) and that of subbituminous coal (Menefee 1 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 coals. 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 1, Menefee 4, and Fruitland 1 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 197 million short tons (179 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 Alamo Mesa East 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 (61 m) or more 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 (306-610 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 1, Menefee 4, and Fruitland 1 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the Alamo Mesa East quadrangle occur 440 ft (134 m) or more 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 coal bed has high development potential along the eastern border of the quadrangle and in the southeast

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS
(in short tons) IN THE ALAMO MESA EAST 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 1	77,360,000	41,610,000	--	118,970,000
Menefee 4	--	17,600,000	30,900,000	48,500,000
Menefee 1	--	29,390,000	--	29,390,000
TOTAL	77,360,000	88,600,000	30,900,000	196,860,000

and west-central areas (CDP Plate 16). The coal bed thickness varies in these areas from 5 to 10 ft (1.5-3.0 m) (CRO Plate 12) and the overburden ranges from less than 400 ft (122 m) in the southeast to less than 1,000 ft (305 m) in the east (CRO Plate 14). Neither of the Menefee beds have high development potential within the quadrangle; however, both the Menefee 1 and Menefee 4 coal beds have moderate development potential near the center of the area. The Menefee 1 has moderate development potential in a narrow band trending northwest-southeast (southeast quadrant) where the coal bed is 5 to 6 ft (1.5-1.7 m) thick (CRO Plate 4) and overburden thickness varies from 1,750 ft (533 m) at the southeast end of the band to more than 1,900 ft (579 m) to the northwest (CRO Plate 6). Southwest of the low potential zone in the northeast corner of the quadrangle, the Menefee 4 has moderate potential where the coal bed thickness is 5 to 10 ft (1.5-3.0 m) (CRO Plate 8) and the overburden is 1,900 to 2,000 ft (579-610 m) thick (CRO Plate 10). The Fruitland 1 has moderate development potential in the northeast corner of the area where it varies from 5 to 15 ft (1.5-4.6 m) thick and the overburden thickness ranges from 1,000 ft (305 m) to more than 1,240 ft (378 m) in the extreme northeast corner of the area.

The Menefee 4 coal bed is the only coal bed which has low coal development potential in the quadrangle. It occurs in the northeast where the Menefee 4 is 5 to 10 ft thick (1.5-3.0 m) and the overburden thickness varies from 2,000 to 2,100 ft (610-640 m).

The remainder of the quadrangle has unknown development potential where the coal beds are less than the reserve base thickness of 5 ft (1.5 m). In particular, the Fruitland 1 is less than 5 ft (1.5 m) thick in the northwest corner of the quadrangle, but the Menefee 1 and Menefee 4 beds do not extend into that area.

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