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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAP OF THE DEER MESA QUADRANGLE, SANDOVAL COUNTY, NEW MEXICO

[Report includes 11 plates]

by

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CONTENTS

PLATES

TABLES

DEER MESA 7 1/2-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps and the Coal Development Potential (CDP) Map of the Deer Mesa quadrangle, Sandoval 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) in 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 Deer Mesa 7 1/2-minute quadrangle is in north-central Sandoval County, New Mexico. The area is approximately 78 miles (126 km) northwest of Albuquerque and 66 miles (106 km) southeast of Farmington, New Mexico. The Jicarilla Apache Indian Reservation is in the northern third of the quadrangle.

Accessibility

The Deer Mesa quadrangle is accessible by New Mexico State Routes 197 and 44. Direct access to the area is provided by unimproved dirt roads. The Atchison, Topeka, and Santa Fe Railway operates a route which passes through Albuquerque approximately 78 miles (126 km) southeast of the area.

Physiography

The quadrangle is in the southeastern corner of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. The northern portion of the quadrangle is in the Largo Plains physiographic sector, and the southern portion is in the Penistaja Cuestas physiographic sector, as described by Baltz (1967). Elevations range from 6,820 ft (2,079 m) in Torreon Wash to 7,509 ft (2,289 m) on Deer Mesa. Sisnathyel Mesa is a prominent feature in this quadrangle, and several other smaller mesas are scattered throughout much of the area. The intermittent streams of Pena Wash, Tancosa Wash, and Torreon Wash provide the major drainage. The Continental Divide extends generally east-west across the center of the quadrangle.

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 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 southern part of the basin.

Land Status

Approximately 67 percent of the quadrangle is in the southeastern part of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 91 percent of the KRCRA land as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Dane (1936) has mapped the Tertiary strata in the southern part of the quadrangle as part of a study of the geology and the fuel resources of the southern San Juan Basin. Baltz (1967), who was studying the stratigraphy of the southeastern San Juan Basin, mapped the surficial geology of this area. A more recent publication by Fassett and Hinds (1971) includes subsurface interpretations of the Fruitland Formation coal deposits throughout the San Juan Basin.

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 the direction of movement, and the transgressive sequence of nearshore Cliff House Sandstone and marine Lewis Shale was deposited in the quadrangle. Initially, a thin sand wedge of Cliff House Sandstone was deposited over the Menefee. Subsequently, several hundred feet of northwest-southeast-trending beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over the basal Cliff House member in the southern half of the quadrangle. Minor fluctuations of the sea resulted in interfingering and stratigraphic equivalence of the La Ventana (Cliff House) and the basal marine deposits of the Lewis Shale in the northern part of the quadrangle. Finally, the transgressive beach deposits of the Chacra Tongue (Cliff House) were deposited over the La Ventana in the southern third of the quadrangle. The Chacra thins out and intertongues with the marine Lewis Shale in the northern part of the area. The marine facies which developed northeast of the strandline as it moved to the southwest is represented by the Lewis Shale. These marine sediments were deposited in successively higher stratigraphic positions, accounting for their equivalence with both the La Ventana and Chacra Tongues. This thick sequence, which thins to the southwest, overlies the La Ventana Tongue in the center of the area, the Cliff House Sandstone in the north, and marks the last advance of the Late Cretaceous sea.

Depositional 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 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 also 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 then 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 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 (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 the present time.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Eocene in age. They are, in order from oldest to youngest: the Point Lookout Sandstone, Menefee Formation (undifferentiated), and Cliff House Sandstone, (the three formations of the Mesaverde Group); the Lewis Shale, Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and San Jose Formation. A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationships of these formations and is accompanied by lithologic descriptions of the individual formations.

The Point Lookout Sandstone, the basal formation of the Mesaverde Group, is composed of white to buff to cream, micaceous, glauconitic sandstone with interbedded gray shale with plant fossils. The sandstone is fairly massive, averages 195 ft (59 m) in thickness, and displays a distinctive character on geophysical logs. This last characteristic was used by the authors in determining the top of the Point Lookout as a lithologic datum for correlation of the overlying Menefee Formation 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, and an unnamed upper coal-bearing member (Beaumont and others, 1956). These three members are referred to as the undifferentiated Menefee Formation for the purposes of this report only. The Menefee Formation averages 740 ft (226 m) in thickness and is predominantly a dark gray, slightly calcareous, carbonaceous to noncarbonaceous shale with plant fossils, and random coal beds.

Due to a regional dip of 1° to 2° the entire Menefee Formation has more than 3,000 ft (914 m) of overburden (the study limit) in the northern two-thirds of the quadrangle as shown in drill hole 4 (CRO Plate 1). However, the formation rises in elevation to the south, and 732 ft (223 m) of the Menefee Formation are above the 3,000-foot (914-m) study limit in drill hole 6 (CRO Plate 1).

The Cliff House Sandstone sequence, which is informally divided into three members, conformably overlies the Menefee Formation. A thin, basal sand member of the Cliff House Sandstone referred to as "the Cliff House Sandstone" by Fassett (1977) correlates with the thin undifferentiated Cliff House Sandstone to the northeast. It is about 75 ft (23 m) thick and consists of white to gray calcareous sandstone with thin interbedded shale. Overlying the basal member in the southern half of the area is the La Ventana Tongue. This member is an approximately 630-ft (192-m) thick sequence of white to gray, slightly calcareous, locally argillaceous sandstone with interbedded gray shale and siltstone which become more common in the lower portion. In the northern part of the quadrangle the La Ventana Tongue disappears where it grades into the marine sediments of the Lewis Shale.

The uppermost Chacra Tongue member (informal name of local usage) consists of gray silty sandstone with interbedded gray to brown siltstone and shale. This lithology indicates a seaward transition in this area from the massive Chacra sandstone at Chacra Mesa, the type section, to the overlying Lewis Shale. The Chacra overlies the La Ventana in the southern third of the area and averages 370 ft (113 m) in thickness. It thins to the northeast and also intertongues with the Lewis Shale, so that in the northern two-thirds of the quadrangle a wedge of Lewis Shale, which is stratigraphically equivalent to the Chacra Tongue, overlies the La Ventana Tongue.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a gray shale with sandstone stringers. The Lewis averages 300 ft (91 m) in thickness in the southern two-thirds of the quadrangle. The basal contact is 1,000 ft (305 m) lower in stratigraphic position in the northern part of the quadrangle as a result of the wedging out of the Chacra and La Ventana Tongues into the Lewis. The upper contact is gradational with the overlying Pictured Cliffs Sandstone and, therefore, is difficult to determine.

The Pictured Cliffs Sandstone consists of approximately 70 ft (21 m) of cream, calcareous sandstone interbedded with thin, gray shale near the base of the formation where it grades into the underlying Lewis. The upper contact of the unit is more sharply defined than the basal contact, even though intertonguing with the overlying Fruitland results in minor fluctuations in the formational top and the local occurrence of coals within the Fruitland tongues. Since the Pictured Cliffs 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 coals.

The Fruitland Formation is the major coal-bearing unit in the quadrangle. It is composed of approximately 170 ft (52 m) of gray to brown, carbonaceous shale with local plant fossils, interbedded gray sandstone, and coal beds of varying thicknesses. The Fruitland coals are generally discontinuous and noncorrelative, but are stratigraphically equivalent in terms of their position relative to the Pictured Cliffs. The thickest and most continuous of the coal beds occur near the base, while discontinuous and lenticular coal beds are characteristic of the upper portion of the formation.

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 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 area. The deposits average 250 ft (76 m) in thickness and consist of gray to green silty shale. The formation has previously been divided into several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

Unconformably overlying the Late Cretaceous deposits is the Paleocene Ojo Alamo Sandstone which is composed of 140 ft (43 m) of gray, locally conglomeratic, poorly indurated sandstone with brown clay stringers.

Floodplain deposits of the Nacimiento Formation conformably overly the alluvial plain deposits of the Ojo Alamo. The Nacimento is approximately 790 ft (241 m) thick in the quadrangle area. It is predominantly gray to brown claystone with sandy stringers and interbedded light gray sandstone. The Nacimiento crops out across the southern one-third of the quadrangle area.

The Eocene San Jose Formation unconformably overlies the Paleocene Nacimiento Formation. It is composed of gray, locally conglomeratic, poorly indurated sandstone, interbedded shale, and lithologies gradational between the two. The San Jose is the youngest formation exposed in the quadrangle and crops out in the northern two-thirds of the quadrangle area.

Structure

The axis of the San Juan Basin is about 18 miles (29 km) to the northeast of the Deer Mesa quadrangle and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Regional dip within the quadrangle is approximately 1° to 2° to the northeast.

COAL GEOLOGY

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. However, for the exclusive purpose of reserve and reserve base calculations, the Fruitland 1 coal bed has been correlated and mapped as if it were a single bed, continuous throughout the basin.

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.

Two coal zones (Menefee and Fruitland) and one coal bed (Fruitland 1) were identified in the subsurface of this quadrangle (CRO Plate 1). The Menefee Formation coal beds are designated as the Menefee coal zone (Me zone) which extends from the top of the La Ventana Tongue to the base of the Menefee Formation. These coal beds are generally noncorrelative and less than the reserve base thickness of 5 ft (1.5 m) as set by the U.S. Geological Survey; an exception is a 6-ft (1.8-m) coal in drill hole 3.

Menefee Formation coal beds in the southeastern part of the San Juan Basin vary from subbituminous B 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 ranging from 9,983 to 11,966 Btu's per pound (23,220-27,833 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 12.1 to 20.0 percent, ash content ranging from 4.9 to 9.9 percent, sulfur content ranging from 0.6 to 2.8 percent, and heating values on the order of 10,343 Btu's per pound (24,058 kj/kg). There is no apparent consistent difference between the various Menefee Formation coal beds (Dane, 1936; Shomaker, 1971). Analyses of several Menefee Formation coal beds were included in a report by Shomaker (1971). The results of these analyses are given in Table 1.

The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation; it is generally directly above the Pictured Cliffs Sandstone. The Fruitland 1 coal bed varies from a single bed

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 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
A47085	Mine Sample San Juan Mine	SW¼ 31	19	1	----	A	15.8	34.5	43.8	5.9	0.6	10,900	Cleary Member
						B	----	41.0	52.0	7.0	0.7	12,950	
A46366	Mine Sample San Juan Mine	SW¼ 31	19	1	----	A	15.7	32.0	45.1	7.2	0.6	10,790	Cleary Member
						B	----	38.0	53.5	8.5	0.7	12,800	
						C	----	41.5	58.5	----	0.8	13,990	
A47084	Prospect Pit Wilkins No.2 Prospect	SW¼ 26	19	1	----	A	18.2	34.4	40.8	6.6	0.9	10,280	Cleary Member
						B	----	42.0	49.9	8.1	1.0	12,570	
A60026	Mine Sample Rio Puerco Mine	SE¼ 19	19	1	----	A	12.1	35.8	44.5	7.6	2.8	10,940	Allison Member
						B	----	40.7	50.6	8.7	3.2	12,460	
						C	----	44.6	55.4	----	3.5	13,640	
A64268	Mine Sample Anderson Mine	SE¼ 35	19	2	----	A	20.0	32.5	42.6	4.9	0.7	10,240	Allison Member
						B	----	40.7	53.2	6.1	0.8	12,790	
						C	----	43.3	56.7	----	0.9	13,630	
A46367	Prospect Drift	35	19	2	----	A	14.8	33.9	41.4	9.9	1.2	8,910	Allison Member; Sample may have been somewhat weathered
						B	----	39.8	48.6	11.6	1.4	10,460	
						C	----	45.1	54.9	----	1.6	11,840	

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

in drill holes 1, 2, 5, 7, and 8 to two coal beds separated by a parting in drill holes 10 and 11, and three coal beds separated by partings in drill hole 6 (CRO Plate 1).

The remaining Fruitland Formation coal beds are designated as the Fruitland coal zone (Fr zone). These coals are not laterally extensive and are less than reserve base thickness (5 ft [1.5 m]), so derivative maps were not constructed.

Fruitland Formation coal beds in the southeastern part of the San Juan Basin are considered high volatile C bituminous in rank, although the coals vary from subbituminous A to high volatile B bituminous. The rank of the coal has been determined on a moist, mineral-matter-free basis with calorific values ranging from 11,358 to 13,442 Btu's per pound (26,419-31,226 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 5.8 to 13.48 percent, ash content ranging from 19.86 to 29.60 percent, sulfur content less than one percent, and heating values on the order of 8,725 Btu's per pound (20,294 kj/kg). Analyses of several Fruitland Formation coal beds are given in Table 2 (Dane, 1936; Fassett and Hinds, 1971; Shomaker and Lease, 1971).

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. The La Ventana Tongue is contemporaneous with the coal-bearing Hogback Mountain

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		
+TH-55672	Core Sample	------	19	4	----	A	11.50	36.57	32.07	19.86	0.67	9,473	
						B	-----	41.32	36.24	22.44	0.76	10,704	
+TH-57167	Core Sample	------	19	5	----	A	13.13	32.63	32.46	21.75	0.49	9,003	
						B	-----	37.56	37.37	25.07	0.56	10,364	
+TH-57168	Core Sample	------	19	5	----	A	12.05	30.39	27.96	29.60	0.59	7,870	
						B	-----	34.55	31.79	33.66	0.67	8,948	
+TH-57166	Cuttings Sample	------	19	5	----	A	13.48	29.55	28.05	28.92	0.50	7,829	
						B	-----	34.15	32.42	33.43	0.58	9,049	
I-53220	Pit Sample	SE ¼ 9	19	5	----	A	5.8	35.8	31.0	27.4	0.6	9,450	
						B	-----	38.1	32.8	29.1	0.6	10,040	
						C	-----	53.7	46.3	----	0.9	14,160	

+analysis by Commercial Testing and Eng. Co.

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

Tongue of the Menefee Formation (Beaumont, 1971) and exhibits a distinctive character on geophysical logs. Therefore, it portrays the upper boundary of the coal-bearing Menefee zone more consistently than the randomly-occurring uppermost Menefee coal. The correlation of the top of the La Ventana with the top of the Menefee zone was established for use in the surrounding quadrangles and has been continued into this quadrangle for the purpose of consistency; however, the Hogback Mountain Tongue is indistinguishable in this area.

The structure contour map of the Menefee coal zone (CRO Plate 5) was constructed using the top of the La Ventana Tongue. This map illustrates that the coal zone dips approximately 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) ranges from less than 1,600 ft (488 m) in the southwest to greater than 2,600 ft (792 m) in the northern 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 1,400 ft (427 m) in the east to greater than 1,700 ft (518 m) in the south. The large interburden values are the result of the stratigraphic spread of the coal beds, reflecting the thickness of the Menefee Formation plus the intertonguing sandstones of the La Ventana. The isopach map (CRO Plate 4) illustrates the total combined thicknesses of the individual coal beds of the Menefee zone. The greatest combined thickness occurs in the southwestern portion of the quadrangle where the coals total over 20 ft (6.1 m). In general, the thickness decreases from this area.

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

Fruitland 1 Coal Bed

As illustrated by the structure contour map (CRO Plate 8), the Fruitland 1 coal bed dips approximately 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 9) varies from less than 800 ft (244 m) in the southwest to greater than 2,000 ft (610 m) on a mesa in the north-central part of the quadrangle. The isopach map (CRO Plate 7) shows the coal bed is greater than 5 ft (1.5 m) thick in the west. The thickness decreases from these areas and the coal is absent in a portion of the west-central and northeast.

Chemical Analyses of the Fruitland 1 Coal Bed - No analyses of Fruitland coal within this quadrangle are known to have been made. However, analyses for several undesignated Fruitland coals in the surrounding area are in publications by Fassett and Hinds (1971) and Shomaker and Lease (1971). 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) were utilized in the construction of isopach and structure contour maps for this quadrangle. All the coal beds studied in the Deer Mesa quadrangle are more than 200 ft (61 m) below the ground surface and, therefore, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1 coal bed for the determination of coal resources in this quadrangle. Coals of the Menefee Formation and Fruitland zone were not evaluated because the thickness of these coals is generally less than the reserve base thickness (5 ft [1.5 m]), and they are noncorrelative and limited in areal extent.

For Reserve Base and Reserve calculations, the Fruitland 1 coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plate 10) 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 coal isopach (CRO Plate 7) and areal distribution (CRO Plate 10) maps. The surface area of the isopached Fruitland 1 bed was measured by planimeter, for each category, in acres, then multiplied by both the average isopached thickness of the coal bed and 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal. This yields the Reserve Base coal, in short tons, for the coal bed. In order to calculate Reserves, a recovery factor of 50 percent was applied to the Reserve Base tonnages for underground coal.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1 coal bed are shown on CRO Plate 10, 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 52.4 million short tons (47.5 million metric tons).

The coal development potential for the Fruitland 1 bed is 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 Deer Mesa quadrangle has development potential for subsurface mining methods only (CDP Plate 11).

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 Fruitland 1 coal bed.

Development Potential for Surface Mining Methods

All coal beds studied in the Deer Mesa quadrangle occur more than 200 ft (61 m) below the ground surface and, therefore, have no development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Underground coal of the Fruitland 1 coal bed has high development potential near the southwest corner of the quadrangle (CDP Plate 11) where

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE DEER MESA QUADRANGLE, SANDOVAL COUNTY, NEW MEXICO

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland 1	1,970,000	50,410,000	--	52,380,000
Total	1,970,000	50,410,000	--	52,380,000

coal bed thickness varies from 5 to 6 ft (1.5-1.8 m) (CRO Plate 7), and the overburden ranges from approximately 950 to 1,000 ft (290-305 m) in thickness (CRO Plate 9). The remainder of the Fruitland 1 coal which is greater than the reserve base thickness of 5 ft (1.5 m) has moderate development potential and occurs in the southwest to west-central parts of the area. Coal bed thickness in these areas varies from 5 to 9 ft (1.5-2.7 m), and the overburden ranges from 1,000 to 1,700 ft (305-518 m) thick.

Most of the remaining area within the KRCRA boundary has unknown potential where the Fruitland 1 coal bed is less than the reserve base thickness of 5 ft (1.5 m); however, the area with no coal development potential in the west-central part of the quadrangle is due to the absence of the Fruitland 1 coal bed.

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