Text to accompany:

Open-File Report 79-111

1979

COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAP OF THE LYBROOK SE QUADRANGLE, SANDOVAL, MCKINLEY, AND SAN JUAN COUNTIES, NEW MEXICO

[Report includes 15 plates]

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LYBROOK SE 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 Lybrook SE quadrangle, Sandoval, McKinley, and San Juan 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) 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 Lybrook SE 7 1/2-minute quadrangle is in southwestern Sandoval County, southeastern San Juan County, and northeastern McKinley County, New Mexico. The area is approximately 56 miles (90 km) southeast of Farmington and 72 miles (116 km) northeast of Gallup, New Mexico.

Accessibility

The area is accessible by New Mexico State Route 44 which is 8 miles (13 km) northeast of the area. Numerous unimproved dirt roads provide access to the remote parts of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route which passes through Gallup, 72 miles (116 km) to the southwest.

Physiography

The Lybrook SE quadrangle is in the southern portion of the Central Basin area (Kelley, 1950) of the larger structural depression known as the San Juan Basin. Elevations range from 6,580 ft (2,006 m) in Canada Alamos and Canada Alemita to 7,080 ft (2,158 m) in the northeastern corner of the quadrangle. The major drainage in the northern portion of the quadrangle is Canada Alemita, an intermittent stream which flows westward, crossing the northwest corner of the area. Canada Alamos, the major drainage system in the south, is an intermittent southwest-flowing stream which occupies a broad, flat, sandy stream valley. The remainder of the topography is characterized by gently sloping, relatively featureless plains.

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 and winter; most precipitation occurs in July and August as intense afternoon thundershowers. Annual temperatures range from below 0°F (-18°C) to over 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

The Lybrook SE 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 88 percent of the land in the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. Preference Right Lease applications (NM 8130 and NM 8715) in the southwest corner cover less than 1 percent of the quadrangle. There are no Federal coal leases within the area.

GENERAL GEOLOGY

Previous Work

Reeside (1924) has mapped the Upper Cretaceous and Tertiary formations of the San Juan Basin. Dane (1936) has mapped the Upper Cretaceous and Tertiary strata as part of a study of the geology and fuel resources of the southern San Juan Basin. 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 paludal upper 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 the coal in the upper part of the Menefee Formation. Subsequently, several hundred feet of beach sands of the La Ventana Tongue (Cliff House Sandstone) were deposited over the Menefee. Shoreward (southwest) and contemporaneous with the La Ventana beach deposits, swamps developed above the older Menefee deposits. Subsequently coals formed in these younger Menefee deposits of the Hogback Mountain Tongue (Beaumont, 1971). Minor fluctuations of the sea resulted in interfingering of the La Ventana (Cliff House) and Hogback Mountain (Menefee) Tongues. Younger La Ventana sands were then deposited over the Hogback Mountain Tongue.

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 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 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 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 (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 in this quadrangle range from Late Cretaceous to Paleocene in age. They are, in order from oldest to youngest: the Point Lookout Sandstone, Menefee Formation, and Cliff House Sandstone, (the three formations of the Mesaverde Group); the 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 Point Lookout Sandstone, the basal formation of the Mesaverde Group, consists of white to light gray, slightly calcareous, kaolinitic sandstone, interbedded dark gray shale, and local coal beds. The thin, discontinuous coal beds are part of a thin Menefee tongue. The Point Lookout Sandstone is fairly massive, averages 80 ft (24 m) thick in this area, 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 and others, 1956), and the Hogback Mountain Tongue (Beaumont, 1971). The first three members are referred to as a single undifferentiated member of the Menefee for the purposes of this report only.

The undifferentiated member is about 950 to 1,000 ft (290-305 m) thick in this area and is predominantly a dark gray to brown, carbonaceous shale with interbedded dark gray sandstone, and random coal beds. In the southwestern part of the quadrangle, the entire Menefee Formation is overlain by less than 3,000 ft (914 m) of overburden (the study limit) as shown in drill holes 3, 4, and 5 (CRO Plate 1). However, due to the gentle northeast regional dip of 1° to 2°, the lower portion of the Menefee is deeper than the study limit in the northeastern half of the quadrangle, as shown in drill hole 9 (CRO Plate 1) where 540 ft (165 m) of the formation have more than 3,000 ft (914 m) of overburden.

The informally named Hogback Mountain Tongue (Beaumont, 1971) represents thick, paludal deposits shoreward of the massive marine sand of the La Ventana Tongue. This member of the Menefee Formation is distinguished as a major coal-bearing unit. The stratigraphic equivalence and complex intertonguing of the Hogback Mountain Tongue with the La Ventana Tongue make it distinguishable in the area of intertonguing. The thickness of the Hogback Mountain Tongue is approximately 500 ft (152 m) in the southwestern portion of the area; however, it thins in a northeasterly direction, and completely disappears in the northeastern part of the quadrangle as it grades laterally into the La Ventana Tongue. Similar in lithology to the underlying undifferentiated member, the Hogback Mountain Tongue is a gray, carbonaceous shale with interbedded thin sandstone and random coal beds.

Conformably underlying, overlying and interfingering with the upper part of the Menefee Formation is the basal member of the Cliff House Sandstone, the La Ventana Tongue. Its basal deposits overlie the undifferentiated member throughout the quadrangle. The La Ventana is thickest in the northeastern portion of the quadrangle, but to the southwest is contemporaneous and interfingers with the Hogback Mountain Tongue. In the extreme southwest it is two sandstone wedges above and below the Hogback Mountain Tongue. The massive sandstone of the La Ventana represents a transgressive sandstone sequence of exceptional thickness (590 to 700 ft [180-213 m]) composed primarily of gray, argillaceous, locally silty, calcareous sandstone.

The uppermost member of the Cliff House Sandstone, the Chacra Tongue (informal name of local usage), is about 350 ft (107 m) thick in this area and overlies the La Ventana Tongue. The Chacra Tongue within the quadrangle has a lithology transitional from the massive sandstone typical of the type section of the Chacra Mesa in the southern part of the area to the marine deposits of the Lewis Shale. The Chacra is composed of gray, argillaceous, silty sandstone with interbedded siltstone and silty shale.

The marine Lewis Shale conformably overlies the Mesaverde Group. In contrast to the underlying Cliff House Sandstone, it is predominantly a gray shale with local plant fossils and limy nodules. The Lewis varies in thickness from 200 to 300 ft (61-91 m) in the quadrangle. The upper contact is gradational with the overlying Pictured Cliffs Sandstone and, therefore, it is difficult to establish.

The Pictured Cliffs Sandstone consists of gray, argillaceous sandstone, interbedded with thin, light gray, micaeous shale near the base of the formation where it grades into the Lewis. The upper contact is more sharply defined than the basal contact, even though intertonguing with the overlying Fruitland Formation results in minor fluctuations in the formational top. 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 has an average thickness in this area of 185 ft (56 m) and consists of gray, carbonaceous shale with plant fossils, interbedded siltstone and sandstone, 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). Several authors have used various criteria in establishing the upper contact, but, in general, for the purposes of this report the uppermost coal (after Fassett and Hinds, 1971).

The freshwater deposits of the Kirtland Shale are the youngest Cretaceous strata in the area. These deposits consist of approximately 180 ft (55 m) of medium gray to brown shale with local plant fossils and sandstone stringers. The formation has previously been divided into several members by various authors; however, for the purpose 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. The Ojo Alamo consists of about 210 ft

(64 m) of white to light gray, coarse-grained to conglomeratic, friable sandstone with quartz and feldspar grains, interbedded with thin gray to brown shale in the lower half. The formation crops out in a thin belt extending across the quadrangle from the northwest to the southeast.

The contact between the Nacimiento Formation and the underlying Ojo Alamo is gradational. The Nacimiento consists of medium gray to brown sandy shale with thin conglomeratic lenses and siltstone. An incomplete section of the Nacimiento crops out over the northeastern half of the quadrangle.

Structure

The axis of the San Juan Basin is about 36 miles (58 km) northeast of the Lybrook SE quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Regional dip in the quadrangle, as measured in T. 21 N., R. 7 W., is 1° to the northeast (Reeside, 1924).

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 and 2 coal beds have been correlated and mapped as if each were single beds, continuous throughout the basin.

A lithologic datum was used for the 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.

A coal bed (Fruitland 1) and two coal zones (Menefee, Fruitland) were identified in the subsurface of this quadrangle (CRO Plate 1). The Menefee Formation coals were designated and mapped as the Menefee coal zone (Me zone). Many of the coals in the Menefee are correlative over short distances; however, most of these coals are less than the reserve base thickness of 5 ft (1.5 m) as set by the U.S. Geological Survey; an exception is a 9-ft (2.7-m) coal in drill hole 1 (CRO Plate 3).

No published analyses of the quality of Menefee Formation coals are available for this quadrangle. However, information on the quality of coals from surrounding areas is assumed to be similar to that of the coals from this quadrangle. There is no apparent consistent difference between the various Menefee Formation coals. In the southern part of the San Juan Basin the coals vary from subbituminous B to high volatile C bituminous. The rank is 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 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 about 12.1 to 20.0 percent, sulfur content between 0.6 and 2.8 percent, ash content ranging between 4.9 and 10.2 percent, and heating values on the order of 10,269 Btu's per pound (23,886 kj/kg) (Bauer and Reeside, 1921; Dane, 1936; Lease, 1971; Shomaker, 1971).

The Point Lookout Sandstone occasionally contains random Menefee coal beds in the upper portion where the formations interfinger. They have been designated as local beds because they are random, discontinuous, and less than the reserve base thickness of 5 ft (1.5 m).

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. A Fruitland 2 (Fr 2) coal bed has been inferred across the southern part of the map from Fire Rock Well, Pueblo Pintado, and Pueblo Alto Trading Post 7 1/2-minute quadrangles which are to the west, the southwest, and the south, respectively. There are no available data indicating that this coal bed extends beyond the southern corner of the map.

The remaining Fruitland Formation coals are designated as the Fruitland coal zone (Fr zone). None of the Fruitland zone coal beds extend over the entire quadrangle, nor are they greater than the reserve base thickness of 5 ft (1.5 m); therefore, derivative maps were not constructed.

Fruitland Formation coal beds in the southeastern part of the San Juan Basin are considered high volatile C bituminous although they vary in rank from subbituminous A to high volatile B bituminous. The rank is determined on a moist, mineral-matter-free basis with calorific values ranging from 11,207 to 13,494 Btu's per pound (26,067-31,387 kj/kg) (Amer. Soc. for Testing Materials, 1977). The coal is hard, brittle and black with a bright luster. It readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content varying from 5.7 to 13.6 percent, ash content ranging from 14.2 to 30.5 percent, sulfur content less than one percent, and heating values on the order of 9,439 Btu's per pound (21,955 kj/kg) (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 (Cliff House) to the base of the Menefee Formation. Because of its contemporaneous relationship with the coal-bearing Hogback Mountain Tongue of the Menefee Formation, the top of the La Ventana was chosen to represent a mappable surface of the coal zone. It portrays the upper boundary of the coal-bearing zone more consistently than the randomly occurring uppermost Menefee coal.

The structure contour map of the coal zone (CRO Plate 5) was constructed using the top of the La Ventana Tongue. The dip of the coal zone varies from less than 1° to approximately 2° to the northeast. Due to topography and dip, overburden (CRO Plate 6) ranges from less than 800 ft (244 m) in the southwest to greater than 2,000 ft (610 m) in the northeast. 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 1,600 ft (488 m) to greater than 1,750 ft (533 m). The large interburden values are the result of the stratigraphic spread of the coals and reflect the thickness of the Menefee Formation plus the interfingering La Ventana Tongue. The isopach map (CRO Plate 4) illustrates the total combined thickness of the individual coal beds of the Menefee zone. The coals total more than 25 ft (7.6 m) thick in the southwest and a portion of the west. From these areas the coal thickness decreases.

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 quadrangle. Analyses of several Menefee Formation coals are included in reports by Lease (1971) and 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 coal bed dips approximately 1° to the northeast. As a result of dip and topography, the overburden (CRO Plate 9) varies from less than 200 ft (61 m) in the southwest to over 1,200 ft (366 m) in the northeast. The isopach map (CRO Plate 7) shows the coal is greater than 20 ft (6.1 m) thick in a small portion of the southeast. From this area the coal bed thins, and there is no coal in part of the southwest.

Chemical Analyses of the Fruitland 1 Coal Bed - Although there are no known published analyses of Fruitland Formation coals from the Lybrook SE quadrangle, there are several analyses of Fruitland coals from the surrounding area published by Fassett and Hinds (1971) and Shomaker and Lease (1971). The results of these analyses are given in Table 2.

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		
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	
3823	Mine Sample	14	20	11	——	A	17.5	32.9	41.2	8.4	2.2	——	
23004	Outcrop Sample	14	20	11	——	A	14.4	34.8	42.3	7.5	1.5	10,220	
						B	——	40.7	50.5	8.8	1.8	11,940	
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.

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	Proximete, percent Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu)	Remarks
H-16309	Val Reese & Assoc Betty "B" No. 1-15.	NW¼ 15	23	7	2,180-2,195	A	5.7	39.3	40.8	14.2	0.6	11,410	
						B	----	41.7	43.3	15.0	0.7	12,100	
						C	----	49.1	50.9	----	0.8	14,240	
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	
TH-53400 (analysis by Commercial Testing and Eng. Co.)	Core Sample	------	20	6	----	A	12.44	34.95	34.05	18.56	0.56	9,499	
						B	-----	39.91	38.89	21.20	0.64	10,848	
C-14108 (analysis by Illinois Geological Survey)	Core Sample	------	20	6	----	A	10.7	33.4	37.5	18.4	0.65	9,667	
						B	----	37.4	42.0	20.6	0.72	10,826	
						C	----	47.1	52.9	-----	0.91	13,637	

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.

Fruitland 2 Coal Bed

As illustrated by the structure contour map (CRO Plate 12) the coal bed dips less than 1° to the northeast. Due to topography and dip, overburden (CRO Plate 13), varies from less than 200 ft (61 m) in the southwest to over 600 ft (183 m) to the north. The isopach map (CRO Plate 11) shows that the coal bed is present only in the southern part of the quadrangle. The coal is greater than 20 ft (6.1 m) thick in the south and the thickness thins to the north.

Chemical Analyses of the Fruitlnd 2 Coal Bed - Although there are no published analyses of Fruitland Formation coals from the Lybrook SE quadrangle, there are several analyses of Fruitland coals from the surrounding area published 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 in Farmington, New Mexico) and coal test holes (Texas Utilities Fuel Co., unpublished well log data, Texas) were utilized in the construction of isopach and structure contour maps of the coals in this quadrangle. All the coal beds in the Lybrook SE quadrangle that are within Federal coal land boundaries 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 and Fruitland 2 coal beds for the determination of coal resources in this quadrangle.

Coals of the Menefee Formation were not evaluated because the thickness of these coal beds is generally less than the reserve base thickness (5 ft [1.5 m]) as established by the U.S. Geological Survey. In addition, the Menefee zone coals are noncorrelative and limited in areal extent.

For Reserve Base and Reserve calculations, each coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plates 10 and 14) 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 7 and 11) and areal distribution maps (CRO Plates 10 and 14) 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 by 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal. This yields the Reserve Base coal, in short tons, for each coal bed. In order to calculate Reserves, a recovery factor of 50 pecent 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); this represents the maximum economically mineable thickness for a single coal bed in this area by current underground mining technology.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1 and Fruitland 2 beds are shown on CRO Plates 10 and 14, respectively. Values 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 202.4 million short tons (183.6 million metric tons).

The coal development potential for each bed is calculated in a manner similar to the Reserve Base calculation, from planimetered measurements, in acres, for areas of high, moderate, and low development potential for subsurface mining methods. The Lybrook SE quadrangle has development potential for subsurface mining methods only (CDP Plate 15).

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) 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 (305-610 m), moderate; and 2,000 to 3,000 ft (610-914 m), low. Table 3 summarizes the coal development.

Development Potential for Surface Mining Methods

All coal beds of the Lybrook SE quadrangle within the Federal land boundaries are overlain by more than 200 ft (61 m) of overburden and 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 in the southeast, southwest, west-central, and northwestern parts of the quadrangle (CDP Plate 15) where the coal ranges from 5 to more than 15 ft (1.5-4.6 m) in thickness, with the exception of the southwest corner

TABLE 3

COAL RESOURCE DATA FOR UNDERGROUND
MINING METHODS FOR FEDERAL COAL LANDS
(in short tons) IN THE LYBROOK SE QUADRANGLE,
SANDOVAL, MCKINLEY, AND SAN JUAN COUNTIES, NEW MEXICO

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland 2	44,080,000	--	--	44,080,000
Fruitland 1	153,820,000	4,460,000	--	158,280,000
Total	197,900,000	4,460,000	--	202,360,000

where the coal is 5 to 7 ft (1.5-2.1 m) thick (CRO Plate 7). The overburden thickness for the Fruitland 1 with high potential in the southwest and southeast varies from 400 to more than 600 ft (122-183 m), and in the west and northwest it is 600 to 900 ft (183-274 m) (CRO Plate 9). Coal of the Fruitland 2 bed has high development potential in the southern part of the quadrangle coincident, in some places, with the high potential of the Fruitland 1. The thickness of the Fruitland 2 coal bed in this area of high development potential ranges from 5 to 20 ft (1.5-6.1 m) (CRO Plate 11), and the overburden increases from 300 to 500 ft (91-152 m) in thickness (CRO Plate 13).

The area of moderate development potential in the northeast (CDP Plate 15) is the result of the Fruitland 1 coal bed only; the Fruitland 2 does not extend into this area (see CRO Plate 11). Most of the remaining area within the quadrangle has unknown development potential where the Fruitland 1 and Fruitland 2 coal beds are less than the reserve base thickness of 5 ft (1.5 m). A small area with no coal development potential occurs in the western part of the quadrangle where there is no Fruitland 1 or Fruitland 2 coal.

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