EAST CORTEZ COAL AREA, MONTEZUMA COUNTY, COLORADO

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

U.S. Geological Survey
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65-37

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Introduction

The East Cortez coal area includes approximately 30 square miles in T. 36 N., Rs. 14 and 15 W., and is about 4 miles east of Cortez, Colo., along U.S. Highway 160 (fig. 1, in pocket). The area is located on the south end of the Dolores Plateau, which is a subdivision of the Colorado Plateau. No railroads serve the area, but good all-weather roads are present.

This investigation was part of a cooperative program between the Branch of Mining Operations and the Branch of Mineral Classification, U.S. Geological Survey, to obtain the geologic data necessary to administer leasing activities on Federal lands. A lease application has been filed in the area and several coal-prospecting permits have been issued. This area had been considered as one of several possible thermal power plant sites and in 1955 Empire Electric Association, Inc., drilled approximately 60 holes in the area to gather information on the coal. This company now, however, has relinquished its prospecting permits on Federal lands in the area. Logs of 27 of the holes drilled by Empire Electric Association, Inc., are given on pages 14 to 20.

Method of investigation

No adequate base map of the East Cortez coal field was available at the start of the project so a base was constructed from Bureau of Land Management township plats and aerial photographs by using plane-table triangulation and radial-plot methods. The geologic contacts were mapped directly on aerial photographs and subsequently transferred to the base map by radial plot.

In addition to the formational contacts, certain horizons were mapped within the Dakota Sandstone (generalized columnar section, fig. 1). One of the horizons, "c," at the base of the uppermost sandstone serves as an approximate overburden limit of 95 feet. Horizon "c" was mapped only in the area bounded by faults on the north and west and the Dakota-Mancos contact on the south. The base of the middle sandstone, horizon "b," was mapped and used as the structure contour horizon. This horizon is generally about 2 feet above the main coal, but locally it coincides with the top of the coal. The top of the lowest part of the Dakota sandstone, horizon "a," was mapped to indicate the lower limit of the Dakota coals. Any stripping operations should be confined to beds above horizon "a" as coal will not likely be found below this horizon. All exposed coal beds in the area were mapped, and measurements of coal thickness are shown on the map by a circled number and arrow.

Stratigraphy

The Mancos Shale and the Dakota Sandstone of Late Cretaceous age comprise most of the exposed bedrock in the East Cortez area. The Burro Canyon Formation of Early Cretaceous age and, possibly, the Morrison Formation of Late Jurassic age crop out for a short distance along the fault in the SE¼SW¼ sec. 15, T. 36 N., R. 15 W. The total thickness of the exposed sedimentary rocks is about 345 feet. All coal in the area is in the Dakota Sandstone. The over-all pattern of deposition for rocks exposed in the area is one of general transgression of a marine environment over a continental environment.

The more resistant rocks are fairly well exposed in the walls of the minor canyons, which contain the intermittent streams draining the Dolores Plateau. The southern part of the area, which is underlain by Mancos Shale, has much slope wash or colluvium masking bedrock. The depths of the surficial material in secs. 33, 34, and 35 are generally in excess of 20 feet.

Jurassic and Cretaceous Systems

Upper Jurassic and Lower Cretaceous Series

Morrison and Burro Canyon Formations

Green and red shale exposed in a small cliff along the fault in the SE¼SW¼ sec. 15, T. 36 N., R. 15 W., probably is part of the Upper Jurassic Morrison Formation. The shale, however, was mapped with the Lower Cretaceous Burro Canyon Formation because of the small area involved and the steepness of the topography at this point that causes the Morrison and Burro Canyon contacts to be superimposed upon one another.

Sandstone and red shale, about 60 feet thick, that overlie the green and red shale of the Morrison are tentatively assigned to the Burro Canyon Formation of Early Cretaceous age. The sandstone and shale are poorly exposed in the mapped area and the description of the Burro Canyon given here is based on exposures in Dolores Canyon (SW¼ sec. 8, T. 37 N., R. 15 W.).

The Burro Canyon Formation in Dolores Canyon consists of a lower sandstone, 18 feet thick, and an upper shale, 41 feet thick. The sandstone is yellow gray, very fine grained, and forms a resistant ledge. The basal part of the sandstone contains chert pebbles and is in sharp contact with the underlying Morrison. This contact is probably unconformable. The upper shale is nonresistant and dominantly red, although it contains beds of green noncalcareous mudstone. The contact between the red beds and the overlying Dakota Sandstone is probably unconformable. The red shale and sandstone suggest a probable continental environment of deposition. For a more extended discussion of the Burro Canyon Formation in nearby areas, see Brown (1950), Stokes (1952), and Simmons (1957).

Upper Cretaceous Series

Dakota Sandstone

The Dakota Sandstone, about 215 feet thick, consists of three major sandstones separated by shales. The sandstones are medium grained, off white to buff, and are generally resistant. Locally, the basal sandstone contains stringers and lenses of chert pebble conglomerate. The shales are carbonaceous, gray, and contain coal and a few thin sandstone beds or lenses. Topographically, the thick sandstones form gentle southward-sloping uplands that reflect the dip of the underlying strata. An arid climate and the gentle dip result in stripping of the nonresistant shale without appreciable erosion of the underlying resistant sandstone. Where stripping has been incomplete, small flat tops of relatively low relief are formed atop these broad uplands.

The Dakota was probably deposited in flood-plain, swamp, and lagoonal environments (Wanek, 1959, p. 680). The present study of the Cortez area tends to substantiate this origin. The Dakota formed in the transitional environment between wholly continental deposits, represented by the Burro Canyon Formation, and wholly marine deposits, represented by the Mancos Shale.

Mancos Shale

A complete section of Mancos Shale is not present in the East Cortez coal area. Wanek (1959, p. 681) indicates that the total thickness of the Mancos near Point Lookout in Mesa Verde National Park is 2,000 feet. The part of the Mancos exposed in the East Cortez coal area consists of gray calcareous shale that contains scattered limestone beds and concretions. A medium-dark-gray microcrystalline limestone bed containing the pelecypod Gryphaea newberryi Stanton occurs about 54 feet above the base of the Mancos Shale. W. A. Cobban (written commun., 1964) reports that the pelecypod Gryphaea newberryi Stanton is "confined to rocks equivalent in age to the basal part of the Bridge Creek Limestone Member of the Greenhorn Limestone of the Great Plains." An Early Colorado age has been assigned to this zone. Pike (1947, p. 24) considered the Greenhorn and Graneros equivalents to comprise the lower 125 feet of the Mancos in this area.

The only bed of possible economic interest in the lower part of the Mancos is the Greenhorn Limestone, or equivalent, which could be used as agricultural lime or as raw material for local cement manufacture.

Unconsolidated deposits

Terrace gravels, colluvium, and alluvium are present in the mapped area but were not studied in detail. The intermittent streams have cut steep-sided ravines as much as 20 feet deep in the unconsolidated deposits.

Structure

The structure is shown in Figure 1 by structure contours drawn on the base of the middle sandstone of the Dakota. Regional dip in the area is south-southwest at about 150 feet per mile. Several noses, troughs, and faults modify the regional monoclinal structure. The most pronounced trough plunges southwest and trends N. 50° E. in secs. 21, 22, and 28. This trough is bounded along the northwest side by a fault that dies out southward in sec. 28 but continues northeastward to sec. 14. In sec. 14, the fault curves eastward and apparently joins an east-trending fault. The fault has a maximum throw in excess of 450 feet in the S½ sec. 15 but displacement decreases northeast and southwest of this area.

Coal resources

Most of the coal in the East Cortez coal area is in the lower shale of the Dakota Sandstone. The most important bed of coal in the area is about 110 feet above the base of the Dakota. The coal averages about 3 feet in thickness and may reach a maximum of 8 feet in secs. 22, 27, and 28. This coal may not be present over all the area. The middle sandstone may increase in thickness because of channeling into the underlying shale and in these places the main coal has been cut out. Also, the main coal in the area is close to the surface in many places (cross section A-A', fig. 1). In places, it is so close to the surface that possibly it has been eroded. Slope wash could fill the depression where the coal was eroded so that structure and topography may indicate that coal should be present when in actuality it is not. The SE¼SE¼ sec. 21 and W½ sec. 22 are places where the coal has possibly been eroded.

The other coals in the Dakota appear to be rather discontinuous. These coals may reach a maximum thickness of about 2 feet, but in many places only a highly carbonaceous shale is present.

Although no analyses of the coals in the mapped area were made, table 1 gives published analyses (U.S. Bureau of Mines, 1937, p. 108-109) of nearby coals in the Dakota Sandstone, which should be similar to the coals in the mapped area. The analyses are given for three conditions: (1) as received, (2) moisture free, and (3) moisture and ash free. These coals are high volatile, bituminous B or C rank, and noncoking, according to Landis (1959, p. 156). In table 1, the analysis of coal from the Cortez mine indicates that the coal may be a marginal coking coal because the sulfur content is well below the 1.5-percent sulfur content, which is the upper limit for making gas or coke.

A total reserve calculation was not attempted for the mapped area. A rough estimate of the original reserves in the main coal in secs. 21, 22, 23, 27, and 28, T. 36 N., R. 15 W., indicates about 10,500,000 tons of coal in these sections. The estimate was made by using a factor of 1,800 tons per acre-foot. The main bed averages about 5 feet thick in these sections. An 80-percent recoverability factor for stripping operations gives an effective coal thickness of 4 feet, or an average of 7,200 tons of recoverable coal per acre. The results are tabulated in table 2. These figures represent inferred coal tonnage with less than 90 feet of overburden and do not take into account the availability of the land for leasing (i.e., coal under a highway, road, or canal).

Table 1.--Analyses of coal from the Dakota Sandstone Formation in the vicinity of Cortez, Colo.

[Analyses selected from "Analyses of Colorado Coals," U.S. Bureau of Mines Tech. Paper 574, p. 108-109, 1937]

Location	Mine	Condition	Proximate analysis (percent)				Ultimate analysis (percent)					Air drying loss (percent)	Heating value		Softening temperature (°F)
			Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Calories	Btu	
½ mile W of Cortez	Cortez	As received	8.1	32.3	45.4	14.2	0.6	4.7	60.3	1.0	19.2	4.5	5,800	10,440	2,980
		Moisture free	--	35.1	49.5	15.4	0.6	5.2	65.6	1.1	13.1	--	6,306	11,350	--
		Moisture and ash free	--	41.5	58.5	--	0.7	4.9	77.5	1.3	15.6	--	7,456	13,420	--
1½ miles SE of Cortez	Mowry	As received	4.8	34.6	42.3	18.3	7.6	4.9	59.9	1.1	8.2	3.1	6,150	11,070	2,130
		Moisture free	--	36.3	44.5	19.2	7.9	4.5	63.0	1.2	4.2	--	6,461	11,630	--
		Moisture and ash free	--	45.0	55.0	--	9.8	5.6	77.9	1.5	5.2	--	8,000	14,400	--

Table 2.--Estimated original reserves, main coal bed, East Cortez coal area, Montezuma County, Colo.

Location T. 36 N., R. 15 W. Section		Estimated reserves Acre-feet	Tons
21	NE¼	57	102,600
	NW¼	0	0
	SW¼	82	147,600
	SE¼	424	763,200
	Total in section		1,013,400
22	NE¼	398	716,400
	NW¼	362	651,600
	SW¼	636	1,144,800
	SE¼	226	406,800
	Total in section		2,919,600
23	NE¼	507	912,600
	NW¼	348	626,400
	SW¼	259	466,200
	SE¼	400	720,000
	Total in section		2,725,200
27	NE¼	289	520,200
	NW¼	404	727,200
	SW¼	146	262,800
	SE¼	146	262,800
	Total in section		1,773,000
28	NE¼	489	880,200
	NW¼	388	698,400
	SW¼	126	226,800
	SE¼	152	273,600
	Total in section		2,079,000
	Total estimated reserves (rounded)		10,500,000

Selected logs of holes drilled for Empire Electric Association, Inc., are given on the following pages. Some of the coal thicknesses on the drillers' logs appear to be excessive when compared with coal thicknesses measured on the outcrop. Unless a conscious effort was made to underlog the coal, the logged thickness of coal would be greater than the actual thickness because of the tendency of coal to contaminate drill cuttings.

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
9	NW¼SW¼NE¼ sec. 28	6,276	Sandstone, brown, soft	6
			Sandstone and shale	5
			Coal, clean and good	13
			Sandstone, white, soft	7
			Coal	7
			Shale and coal	10
			Coal	1
			Sandstone, white, soft	31
			Total depth	80
10	NE¼SW¼NE¼ sec. 28	6,289	Soil	1
			Sandstone, light-brown	5
			Coal	8
			Sandstone, light-brown to dark-gray	12
			Shale, light- to dark-gray	7
			Coal and shale	2
			Coal, good	3
			Sandstone and shale	5
			Coal and dark shale	7
			Sandstone, white	4
			Total depth	54
11	SE¼NW¼SE¼ sec. 28	6,298	Shale	2
			Sandstone, brown	13
			Shale, dark	1
			Coal	6
			Coal and shale	4
			Sandstone, some shale	14
			Coal and shale	3
			Coal	5
			Shale with some coal	12
			Shale and sandstone	5
			Total depth	65
12	NW¼NE¼NE¼ sec. 28	6,303	Sandstone, buff	10
			Shale, light to dark	4
			Coal	5
			Shale, carbonaceous and coaly	11
			Coal	7
			Coal, shaly, bony	4
			Total depth	41

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
13	NW¼NE¼NE¼ sec. 28	6,326	Soil	9
			Sandstone, brown, soft	8
			Coal	7
			Coal, shaly	3
			Shale and sandstone	15
			Shale, dark	2
			Coal	8
			Shale, dark	7
			Coal	2
			Coal, shaly	1
			Total depth	62
15	SW¼SW¼SW¼ sec. 22	6,353	Soil	2
			Sandstone, buff	11
			Shale	4
			Coal	8
			Shale, white, soft	3
			Sandstone, buff to gray	19
			Shale	3
			Shale, darker, carboniferous	2
			Coal; bottom 2 ft good coal	6
			Shale	1
			Sandstone, hard	1
			Total depth	60
17	NE¼SW¼SW¼ sec. 22	6,367	Shale, dark, carbonaceous	8
			Sandstone, buff, hard	4
			Shale, soft	8
			Coal, good and clean	7
			Shale, gray	11
			Sandstone, white to gray, hard	3
			Shale, dark	5
			Coal	3
			Sandstone, brown, hard	3
			Shale, brown	4
			Sandstone, very hard	2
			Total depth	58

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
18	SE¼NE¼SW¼ sec. 22	6,394	Shale, gray	17
			Coal	2
			Sandstone, gray, soft	6
			Shale and brown coal	4
			Coal	5
			Shale, coaly	3
			Shale, gray, soft	14
			Coal and small bands of shale	6
			Shale, gray and gray-brown	15
			Total depth	72
19	NW¼NE¼SW¼ sec. 22	6,412	Shale	9
			Coal	1
			Shale	4
			Coal	1
			Shale, some sandstone	9
			Coal	7
			Shale and hard sandstone	15
			Sandstone, white	14
			Shale, very hard	17
			Coal	3
			Shale, dark, with coal	3
			Sandstone, white, hard	3
			Total depth	86
20	NE¼NE¼SW¼ sec. 22	6,428	Shale, gray	10
			Coal	1
			Shale, gray	2
			Coal	1
			Shale, gray, soft	9
			Coal	7
			Shale and sand, hard	18
			Coal	3
			Shale	6
			Total depth	57

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
21	SE¼SE¼NW¼ sec. 22	6,454	Shale, gray	18
			Shale with coal	6
			Coal	1
			Shale and sandstone	9
			Coal	8
			Sandstone, white	6
			Shale	6
			Coal, bands of bone	4
			Shale	15
			Coal, some bone	4
			Shale turning to sand	3
			Total depth	80
22	NW¼SW¼NE¼ sec. 22	6,468	Shale	36
			Coal, core	6
			Shale	13
			Coal, core	6
			Total depth	61
23	NE¼SW¼NE¼ sec. 22	6,446	Soil and shale	8
			Shale with occasional 1-ft sandstones	23
			Coal, some bone	8
			Shale, blue-gray	13
			Coal, bone	4
			Shale, blue-gray	13
			Total depth	69
24	SE¼NW¼NE¼ sec. 22	6,484	Soil and shale with 1-ft bed of sandstone	29
			Coal, good; some bone	8
			Shale	10
			Coal	4
			Shale and coal	5
			Total depth	56
25	SW¼NE¼NE¼ sec. 22	6,508	Shale	21
			Coal, shaly, bony	7
			Shale, soft	14
			Coal	4
			Sandstone, white, hard	4
			Total depth	50

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
27	NE¼NE¼SW¼ sec. 22	6,400	Sandstone, hard	4
			Shale; some bone	4
			Coal, good	2
			Shale, coaly	4
			Coal; some bone	2
			Shale	8
			Coal	1
			Shale	11
			Coal with 6-in. bone	3
			Shale, hard, with sandstone streaks	17
			Bone and coal	4
			Sandstone	4
			Total depth	64
28	W½SE¼SW¼ sec. 22	6,415	Soil	3
			Sandstone	11
			Shale	3
			Coal	4
			Bone and coal	3
			Shale and occasional sandstone	26
			Coal	4
			Shale and bone	2
			Total depth	56
29	S½SE¼SW¼ sec. 22	6,427	Shale	6
			Sandstone	8
			Shale with coal streaks	6
			Coal, core; some bone	7
			Sandstone	20
			Shale, dark-gray to gray	8
			Coal, core, hard	2
			Sandstone, hard	1
			Total depth	58
38	NE¼NW¼NE¼ sec. 28	6,281	Sandstone, yellow, soft	9
			Shale	15
			Coal	8
			Shale, dark	10
			Coal	9
			Shale, dark; some coal	9
			Shale going to sandstone	4
			Total depth	64

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
39	NE¼NW¼NE¼ sec. 28	6,298	Sandstone, soft	6
			Shale, dark	19
			Coal	5
			Shale	15
			Coal	7
			Shale with much bone	8
			Sandstone	2
			Total depth	62
41	NE¼SE¼SE¼ sec. 21	6,348	Shale, gray	12
			Shale, dark, carbonaceous	6
			Sandstone, white, soft	9
			Coal	1
			Shale, dark, soft	2
			Coal	7
			Shale, dark	6
			Coal	2
			Shale, dark, soft	6
			Coal, good	6
			Shale, dark; sandstone at base	12
			Total depth	69
45	SE¼NE¼NE¼ sec. 28	6,375	Shale, white to yellow, soft	10
			Sandstone	15
			Shale	1
			Coal	1
			Sandstone	15
			Shale, light- to blue-gray	2
			Coal, 1-ft bone	9
			Shale, gray, soft; some bone in top ft	9
			Total depth	62
46	N½NW¼NW¼ sec. 27	6,405	Shale, sandy, soft	10
			Sand, yellow, and shale	11
			Shale, dark, soft; some coal; 1 ft of sandstone	24
			Coal with bone streaks	8
			Shale, blue to dark-blue, soft; coal streak	10
			Shale, white, soft	7
			Total depth	70

Selected logs of holes drilled for Empire Electric Association, Inc., in T. 36 N., R. 15 W., July and August 1955--Continued

Hole	Locality	Ground elevation (feet)	Description	Thickness (feet)
48	N½NW¼SE¼ sec. 28	6,320?	Sandstone, hard	5
			Sandstone, soft	3
			Shale, gray	7
			Coal; some bone	8
			Shale and sandstone	14
			Coal, cored	8
			Total depth	45
50	SE¼NW¼NE¼ sec. 28	6,276	Alluvium	18
			Sandstone	1
			Shale, brown, soft	3
			Sandstone	5
			Shale, dark; 6-in. coal streak	3
			Coal	6
			Shale, soft; streaks of bone; gas odor	13
			Sandstone, blue, hard, gassy	3
			Sandstone with water	1
			Total depth	53
55	SE¼NW¼SW¼ sec. 22	6,388	Shale, brownish, soft	23
			Shale, gray to black	11
			Coal	1
			Shale	1
			Sandstone	7
			Coal	7
			Sandstone	22
			Coal core	4
			Total depth	76
56	SW¼NW¼SW¼ sec. 22	6,393?	Shale, gray; poor coal at base	18
			Sandstone, gray	8
			Shale	3
			Coal	9
			Shale	7.5
			Coal, core	0.5
			Shale, dark, with bone	7.5
			Total depth	53.5

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