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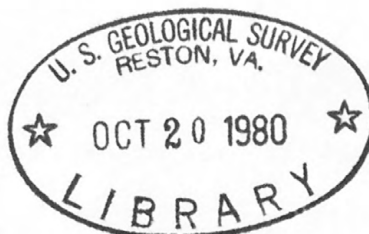
GEOLOGICAL SURVEY

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U.S. Geological Survey,

[Reports-Open file Series]

1976 Coal Exploratory Drilling:
Core Description and Coal Analyses,
Recluse Geologic Analysis Area,
Northern Campbell County, Wyoming

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by

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

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Introduction

In 1976, the U.S. Bureau of Reclamation cored 8 holes in the White Tail Butte quadrangle in conjunction with the U.S. Bureau of Land Management's Energy Minerals Resource Inventory and Analysis (EMRIA) studies. The coring was designed to evaluate the Anderson and Canyon coal beds and their overburden and interburden). As this study area fell within the EMRIA Recluse Geologic Model Area, the U.S. Geological Survey arranged to continue the coring in two of the holes, 76-103 and 76-108, in order to obtain samples of the coal and rocks in the remainder of the coal-bearing section below the Canyon.

This report includes a description of the entire cores of these holes and the results of analyses of the coal beds below the Canyon (Cook through Cache). In addition, the core description and analytical data from a U.S. Bureau of Reclamation shallow hole 76-105 are included to show composition of the coal's in the Anderson, Canyon A, and Canyon B coal beds.

Geology

Coal-bearing rocks underlying the Recluse Geologic Model Area are in the Tongue River Member of the Fort Union Formation of Paleocene age. This member consists of sandstone, mudstone, shale, and thick coal beds.

The seven coal beds cored are, in descending order: Anderson, Canyon (Canyon A, Canyon B), Cook, Blue Marker, Wall, Pawnee, and Cache.

Analytical data and core descriptions

The two holes deepened were spudded above the Anderson coal bed and bottomed below the Cache coal bed. The third hole, 76-105, was spudded above the Anderson coal bed and bottomed below the Canyon coal bed. Core descriptions and analytical data are presented in the appendix.

Coal Analyses

Proximate and ultimate analyses of the coal beds below the Canyon in holes 76-103 and 76-108 are shown in tables 1 and 2. Analytical data on the Anderson and Canyon coal beds in hole 76-105 are shown in table 3. Table 4 gives the sample numbers, named coal beds, and footage drilled. All tables are included in the appendix.

Apparent Rank

The apparent rank of subbituminous coals and lignites is determined by the heat value (Btu/lb), ash, and sulfur values of the coal's; these are calculated from the as-received proximate analyses on a moist mineral-matter-free basis^{1/}. However, the resulting values must agree, as well as possible with the inherent moisture^{2/} values in the coal's. Invariably, as-received analyses do not represent moisture content at equilibrium; the moisture content either is too high or too low. This affects the Btu/lb value input into the calculation and subsequently influences the Btu final rank determination. To minimize the as-received moisture variable, representative equilibrium moisture values^{3/} of coals should be determined, and the as-received proximate analyses should be corrected to those values.

^{1/} American Society Annual for Testing and Material Annual Book of Standards, 1979, part 26, Standard ANSI/ASTM D-388-77, Standard Specification for Classification of Coals by Rank, p. 220-224.

^{2/} Op. cit., Standard ANSI/ASTM D-121-78, Standard Definitions of Terms relating to coal and coke, p. 189.

^{3/} Op. cit., Standard ANSI/ASTM D-1412-74E, Standard Test Method for Equilibrium Moisture of Coal at 96 to 97 percent humidity and 30°C, pp. 258-260.

The only coals available for the equilibrium moisture samples are those from the Anderson, Canyon A, and Canyon B coal beds in holes 76-103 and 76-108. The equilibrium moistures and the specific gravities are shown in table 5; the Btu/lb values, which are based on the determined equilibrium values and indicate the apparent rank (qualified) of the coal beds in hole 76-105, are in table 6. The apparent rank in this case should be qualified because the equilibrium moisture values were determined from representative samples in the area, but not from the actual samples for which the proximate analyses were determined.

Specific gravity

The specific gravities shown in table 5 indicate that these coals vary from 1660 tons per acre-foot (72.2 lbs/ft^3) to 1715 tons per acre-foot (78.7 lbs/ft^3). The average values are:

	<u>g/c³</u>		<u>lbs/ft³</u>
Anderson	1.24	1685 tons/acre-foot	77.4
Canyon A	1.235	1680 tons/acre-foot	77.1
Canyon B	1.23	1670 tons/acre-foot	76.7

Appendix

Table 1. Analytical data for samples of coal beds below the Canyon coal bed in hole 76-103.

2. Analytical data for samples of coal beds below the Canyon coal bed in hole 76-108.

3. Analytical data for samples of coal beds in hole 76-105.

4. Sample numbers, coal beds, and footage cored for analyses shown in tables 1, 2, and 3.

5. Specific gravities and equilibrium moistures selected intervals of Anderson, Canyon A, and Canyon B coal beds in holes 76-103 and 76-108.

6. Btu/lb values indicating apparent ASTM value (qualified) of the Anderson, Canyon A, and Canyon B coal beds in hole 76-105.

Core Descriptions:

Hole 76-103

Hole 76-105

Hole 76-108

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming

[All analyses except Kcal/kg, free-swelling-index and ash fusion temperatures are in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pa. Leaders (---) indicate no data. °C = (°F-32) 5/9; Kcal/kg = 1.80 Btu/lb; wt. avr. = weighted average value of coal samples for each coal bed.]

Drill hole 76-103, Cook coal bed

Sample number	Proximate Analysis					Ultimate Analysis				
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186993	27.7	26.0	22.0	24.3	5.9	34.5	0.6	33.1	1.6	3,370
	---	36.0	30.4	33.6	3.9	47.7	.8	11.7	2.2	4,660
	---	54.2	45.8	---	5.9	71.9	1.3	17.7	3.3	7,020
Sample number	Forms of sulfur				Ash fusion temperature °C					
	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid		
D186993	21.4	0.01	0.81	0.79	0.0	1,180	1,240	1,295		
	---	.01	1.12	1.09						
	---	.02	1.69	1.65						

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-103, Unnamed (Blue Marker) coal bed, depth interval 330.0-341.4 ft

Sample number	Proximate Analysis					Ultimate Analysis				
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186994	29.5	28.4	27.2	14.9	6.4	41.3	0.7	35.9	0.8	4,030
	---	40.3	38.6	21.1	4.4	58.6	1.0	13.7	1.1	5,710
	---	51.1	48.9	---	5.6	74.3	1.3	17.4	1.4	7,250
D186995	30.7	25.4	26.6	17.3	6.1	37.4	.7	37.1	1.3	3,610
	---	36.7	38.4	25.0	3.9	54.0	1.0	14.2	1.9	5,210
	---	48.8	51.2	---	5.2	71.9	1.3	18.9	2.5	6,940
Wt. avr.	30.1	27.0	26.9	16.1	6.3	39.4	.7	36.5	1.0	3,830
	---	38.5	38.5	23.0	4.2	56.4	1.0	13.9	1.5	5,470
	---	50.0	50.0	---	5.4	73.2	1.3	18.1	1.9	7,110

Sample number	Forms of Sulfur				Ash fusion temperature °C			
	Air dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D186994	22.5	0.01	0.08	0.70	0.0	1,380	1,430	1,480
	---	.01	.11	.99				
	---	.02	.14	1.26				
D186995	22.7	.01	.73	.60	.0	1,180	1,235	1,290
	---	.01	1.05	.87				
	---	.02	1.40	1.15				
Wt. avr.	22.6	.01	.39	.65	.0	1,285	1,335	1,390
	---	.01	.56	.93				
	---	.02	.73	1.21				

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-103, Wall coal bed, depth interval 467.8-478.6

Sample number	Proximate Analysis				Ultimate Analysis					
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186996	31.9	26.7	33.9	7.5	6.6	44.8	0.8	39.9	0.4	4,230
	---	39.2	49.8	11.0	4.5	65.8	1.2	17.0	.6	6,210
	---	44.1	55.9	---	5.0	73.9	1.3	19.1	.7	6,980

Sample number	Forms of sulfur				Ash fusion temperature °C			
	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D186996	23.9	0.01	0.09	0.30	0.0	1,090	1,150	1,210
	---	.01	.13	.44				
	---	.02	.15	.50				

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-103, Stray coal bed

Sample number	Proximate Analysis				Ultimate Analysis					
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186997	29.4	26.8	26.4	17.4	6.3	38.1	0.6	35.9	1.8	3,730
	---	38.0	37.4	24.6	4.3	54.0	.8	13.8	2.5	5,290
	---	50.4	49.6	---	5.7	71.6	1.1	18.4	3.4	7,020

Forms of sulfur

Ash fusion temperature °C

Sample number	Air Dried loss	Forms of sulfur			Free swelling	Ash fusion temperature °C		
		Sulfate	Pyritic	Organic		Initial deformation	soften.	fluid
D186997	23.6	0.01	0.79	0.96	0.0	1,200	1,265	1,320
	---	.01	1.12	1.36				
	---	.02	1.48	1.80				

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-103, Pawnee coal bed

Sample number	Proximate Analysis				Ultimate Analysis					
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186998	35.3	26.4	34.4	3.9	6.9	44.8	0.8	43.3	0.2	4,260
	---	40.8	53.2	6.0	4.6	69.2	1.2	18.4	.3	6,580
	---	43.4	56.6	---	4.9	73.7	1.3	19.6	.3	7,000
D186999	33.3	27.0	34.6	5.1	6.7	46.0	.8	41.0	.4	4,360
	---	40.5	51.9	7.6	4.5	69.0	1.2	17.1	.6	6,540
	---	43.8	56.2	---	4.9	74.7	1.3	18.5	.6	7,090
D187001	31.1	28.2	35.3	5.4	6.9	46.9	.7	39.7	.4	4,480
	---	40.9	51.2	7.8	5.0	68.1	1.0	17.5	.6	6,500
	---	44.4	55.6	---	5.4	73.9	1.1	19.0	.6	7,050
D187002	23.5	25.5	22.7	28.3	5.6	34.5	.6	29.4	1.6	3,380
	---	33.3	29.7	37.0	3.9	45.1	.8	11.1	2.1	4,420
	---	52.9	47.1	---	6.2	71.6	1.2	17.7	3.3	7,010
Wt. avr.	32.3	27.2	33.9	6.6	6.7	45.2	.8	40.2	.4	4,310
	---	40.1	50.1	9.7	4.6	66.8	1.1	17.0	.7	6,360
	---	44.5	55.5	---	5.1	74.0	1.2	18.9	.7	7,050

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole No. 76-103, Pawnee coal bed, continued

Sample number	Air Dried loss	Forms of sulfur			Ash fusion temperature °C			
		Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D186998	27.6	0.01	0.11	0.13	0.0	1,265	1,325	1,380
	---	.02	.17	.20				
	---	.02	.18	.21				
D186999	25.2	.01	.07	.37	.0	1,255	1,315	1,375
	---	.01	.10	.55				
	---	.02	.11	.60				
D187001	22.4	.01	.09	.29	.0	1,185	1,235	1,290
	---	.01	.13	.42				
	---	.02	.14	.46				
D187002	18.3	.01	.92	.65	.0	1,330	1,395	1,440
	---	.01	1.20	.85				
	---	.02	1.91	1.35				
Wt. avr.	24.3	.01	.15	.31	.0	1,240	1,295	1,355
	---	.01	.22	.46				
	---	.02	.24	.51				

Table 1.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-103, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-103, Cache coal bed, depth interval 667.0-683.7

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Sample number	Proximate Analysis					Ultimate Analysis				
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D187003	35.0	24.6	28.4	12.0	6.6	39.0	0.7	41.4	0.3	3,720
	---	37.8	43.7	18.5	4.2	60.0	1.1	15.8	.5	5,720
	---	46.4	53.5	---	5.1	73.6	1.3	19.4	.6	7,010
D187004	35.0	25.3	29.1	10.6	6.7	40.1	.7	41.4	.5	3,820
	---	38.9	44.8	16.3	4.3	61.7	1.1	15.8	.8	5,870
	---	46.5	53.5	---	5.2	73.7	1.3	18.9	.9	7,020
Wt. avr.	35.0	25.0	28.8	11.3	6.7	39.6	.7	41.4	.4	3,770
	---	38.4	44.2	17.4	4.3	60.9	1.1	15.8	.6	5,800
	---	46.5	53.5	---	5.1	73.7	1.3	19.2	.8	7,020

Sample number	Forms of sulfur				Ash fusion temperature °C			
	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D187003	26.8	0.01	0.06	0.21	0.0	1,295	1,340	1,405
	---	.02	.09	.32				
	---	.02	.11	.40				
D187004	27.0	.01	.28	.26	.0	1,165	1,215	1,270
	---	.02	.43	.40				
	---	.02	.51	.48				
Wt. avr.	26.9	.01	.17	.24	.0	1,230	1,275	1,335
	---	.02	.27	.36				
	---	.02	.32	.44				

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming

[All analyses except Kcal/kg, free-swelling-index and ash fusion temperatures are in percent. For each sample number, the analyses are reported three ways; first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pa. Leaders (---) indicate no data. °C = (°F-32) 5/9; Kcal/kg = 1.80 Btu/lb; wt. avr. = weighted average value of coal samples for each coal bed.]

Drill hole 76-108, Cook coal bed, depth interval 361.2-393.6

		Proximate Analysis				Ultimate Analysis					
	Sample number	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
12	D186987	29.3	30.3	24.4	17.0	6.5	40.2	0.7	34.8	0.8	3,960
		---	42.9	34.5	24.0	4.6	56.9	1.0	12.4	1.1	5,610
		---	56.4	45.4	---	6.0	74.9	1.3	16.3	1.5	7,380
	D186988	30.8	23.4	24.8	21.0	6.1	34.8	.6	36.9	.6	3,320
		---	33.8	35.8	30.3	3.9	50.3	.9	13.8	.9	4,800
		---	48.5	51.5	---	5.6	72.2	1.2	19.8	1.2	6,880
	D186989	27.4	26.4	17.9	28.3	5.9	31.5	.5	33.0	.7	3,130
		---	36.4	24.7	39.0	3.9	43.4	.7	11.9	1.0	4,310
		---	59.6	40.4	---	6.4	71.1	1.1	19.5	1.6	7,070
	Wt. avr.	29.2	27.7	22.9	20.7	6.3	36.8	.6	34.9	.7	3,610
		---	39.2	32.3	29.2	4.3	52.0	.9	12.6	1.0	5,100
		---	55.3	45.7	---	6.0	73.4	1.3	17.8	1.5	7,200

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Cook coal bed--Continued

Sample number	Air Dried loss	Forms of sulfur			Ash fusion temperature °C			
		Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D186987	22.0	0.01	0.16	0.66	0.0	1,260	1,310	1,360
	---	.01	.23	.93				
	---	.02	.30	1.23				
D186988	25.5	.01	.28	.30	.0	1,240	1,290	1,340
	---	.01	.40	.43				
	---	.02	.58	.62				
D186989	22.5	.01	.33	.37	.0	1,365	1,415	1,465
	---	.01	.45	.51				
	---	.02	.74	.84				
Wt. avr.	22.9	.01	.23	.50	.0	1,280	1,330	1,380
	---	.01	.32	.71				
	---	.02	.46	1.01				

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Stray coal bed										
Proximate Analysis					Ultimate Analysis					
Sample number	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186991	32.1	27.3	28.5	12.1	6.6	41.1	0.7	39.0	0.5	3,950
	---	40.2	42.0	17.8	4.5	60.5	1.0	15.4	.7	5,810
	---	48.9	51.1	---	5.4	73.7	1.3	18.8	.9	7,070
Forms of sulfur					Ash fusion temperature °C					
Sample number	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid		
D186991	25.9	0.01	0.16	0.32	0.0	1,185	1,240	1,290		
	---	.01	.24	.47						
	---	.02	.29	.57						

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Unnamed (Blue Marker) coal bed										
Proximate Analysis					Ultimate Analysis					
Sample number	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D186992	34.3	26.8	27.1	11.8	6.7	39.7	0.7	40.5	0.6	3,850
	---	40.8	41.2	18.0	4.4	60.4	1.1	15.2	.9	5,860
	---	49.7	50.3	---	5.4	73.7	1.3	18.6	1.1	7,140
Forms of sulfur					Ash fusion temperature °C					
Sample number	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid		
D186992	25.9	0.01	0.20	0.41	0.0	1,200	1,265	1,320		
	---	.02	.30	.62						
	---	.02	.37	.76						

Table 2. Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Wall coal bed										
Proximate Analysis					Ultimate Analysis					
Sample number	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D189707	32.9	28.1	29.6	9.4	6.8	41.9	0.7	40.5	0.7	3,990
	---	41.9	44.1	14.0	4.7	62.4	1.0	16.8	1.0	5,940
	---	48.7	51.3	---	5.4	72.6	1.2	19.5	1.2	6,910
Forms of sulfur					Ash fusion temperature °C					
Sample number	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid		
D189707	14.1	0.01	0.39	0.33	0.0	1,125	1,180	1,235		
	---	.01	.58	.49						
	---	.02	.68	.57						

Table 2. Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Pawnee coal bed										
Sample number	Proximate Analysis					Ultimate Analysis				
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D189708	33.0	20.9	16.9	29.2	6.1	26.2	0.5	0.4	0.4	2,490
	---	31.2	25.2	43.6	3.6	39.1	.7	.0	.6	3,720
	---	55.3	44.7	---	6.4	69.3	1.3	.0	1.1	6,590
D189709	36.9	26.7	26.2	10.2	6.9	38.0	.6	43.2	1.1	3,610
	---	42.3	41.5	16.2	4.4	60.2	1.0	16.5	1.7	5,730
	---	50.5	49.5	---	5.3	71.8	1.1	19.7	2.1	6,830
D189710	31.6	31.0	31.3	6.1	6.8	45.9	.7	39.8	.6	4,410
	---	45.3	45.8	8.9	4.8	67.1	1.0	17.1	.9	6,440
	---	49.8	50.2	---	5.3	73.7	1.1	18.8	1.0	7,070
Wt. avr.	35.2	27.4	26.8	10.6	6.8	39.2	.6	38.9	.9	3,740
	---	42.2	41.1	16.4	4.5	60.4	1.0	11.7	1.4	5,760
	---	50.5	49.5	---	5.4	72.3	1.1	14.0	1.7	6,890

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Cache coal bed

Sample number	Air Dried loss	Forms of sulfur			Ash fusion temperature °C			
		Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D189708	19.4	0.01	0.12	0.31	0.0	1,320	1,375	1,425
	---	.01	.18	.46				
	---	.03	.32	.82				
D189709	21.9	.01	.66	.41	.0	1,125	1,180	1,230
	---	.02	1.05	.65				
	---	.02	1.25	.78				
D189710	13.8	.01	.33	.28	.0	1,180	1,230	1,285
	---	.01	.48	.41				
	---	.02	.53	.45				
Wt. avr.	19.5	.01	.53	.37	.0	1,155	1,210	1,260
	---	.02	.82	.57				
	---	.02	.98	.68				

Table 2.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-108, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-108, Cache coal bed										
Sample number	Proximate Analysis					Ultimate Analysis				
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D189711	31.7	28.6	30.6	9.1	6.6	43.3	0.8	0.8	0.4	4,110
	---	41.9	44.8	13.3	4.5	63.4	1.2	.0	.6	6,020
	---	48.3	51.7	---	5.2	73.1	1.4	.0	.7	6,950
Sample number	Forms of sulfur					Ash fusion temperature °C				
	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid		
D189711	16.5	0.01	0.21	0.18	0.0	1,150	1,195	1,255		
	---	.01	.31	.26						
	---	.02	.35	.30						

Table 3.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-105, Recluse Geologic Analysis Area, Campbell County, Wyoming

[All analyses except Kcal/kg, free-swelling-index, and ash fusion temperatures are in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pa. Leaders (---) indicate no data. °C = (°F-32) 5/9; Kcal/kg = 1.80 Btu/lb; wt. avr. = weighted average value of coal samples for each coal bed.]

Drill hole 76-105, Anderson coal bed

Proximate Analysis					Ultimate Analysis						
Sample number	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg	
20	D187005	34.6	28.0	30.9	6.5	6.8	42.3	0.7	43.2	0.4	3,970
		---	42.8	47.2	9.9	4.5	64.7	1.1	19.0	.6	6,070
		---	47.5	52.5	---	5.0	71.8	1.2	21.1	.7	6,740
	D187006	39.4	26.2	29.0	5.4	7.2	40.0	.6	46.6	.3	3,790
		---	43.2	47.9	8.9	4.7	66.0	1.0	19.1	.5	6,260
		---	47.5	52.5	---	5.1	72.5	1.1	21.0	.5	6,870
	Wt. avr.	37.2	27.0	29.9	5.9	7.0	41.0	.6	45.1	.3	3,870
		---	43.0	47.6	9.4	4.6	65.4	1.0	19.1	.5	6,170
		---	47.5	52.5	---	5.1	72.2	1.1	21.0	.6	6,810
Forms of sulfur					Ash fusion temperature °C						
Sample number	Air Dried loss	Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid			
D187005	25.7	0.01	0.09	0.33	0.0	1,235	1,285	1,345			
	---	.02	.14	.50							
	---	.02	.15	.56							
D187006	31.3	.01	.05	.22	.0	1,125	1,180	1,240			
	---	.02	.08	.36							
	---	.02	.12	.47							

Table 3.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-105, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-105, Canyon A coal bed										
Sample number	Proximate Analysis				Ultimate Analysis					
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D187007	32.0	22.5	21.8	23.7	5.9	31.8	0.5	37.2	0.9	3,000
	---	33.1	32.1	34.9	3.4	46.8	.7	12.9	1.3	4,420
	---	50.8	49.2	---	5.3	71.8	1.1	19.8	2.0	6,780
D187008	34.7	26.4	32.0	6.9	6.7	43.4	.7	41.7	.7	4,070
	---	40.4	49.0	10.6	4.4	66.5	1.1	16.6	1.1	6,230
	---	45.2	54.8	---	4.9	74.3	1.2	18.6	1.2	6,970
D187009	38.2	26.1	32.4	3.3	7.1	42.8	.6	46.0	.3	4,050
	---	42.2	52.4	5.3	4.6	69.3	1.0	19.5	.5	6,560
	---	44.6	55.4	---	4.9	73.2	1.0	20.6	.5	6,930
D187010	37.6	25.5	27.1	7.8	7.0	39.6	.5	44.6	.5	3,770
	---	40.9	43.4	12.5	4.5	63.5	.8	17.9	.8	6,050
	---	46.7	49.6	---	5.2	72.5	.9	20.5	.9	6,910
Wt. avr.	35.9	25.1	29.0	9.8	6.7	39.7	.6	42.8	.5	3,750
	---	39.2	45.2	15.2	4.2	61.9	.9	17.0	.9	5,850
	---	46.3	53.3	---	5.0	73.0	1.1	20.0	1.0	6,900

Table 3.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-105, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-105, Canyon A coal bed--continued								
Sample number	Air Dried loss	Forms of sulfur			Free swelling	Ash fusion temperature °C		
		Sulfate	Pyritic	Organic		Initial deformation	soften.	fluid
D187007	24.9	0.01	0.35	0.51	0.0	1,230	1,290	1,340
	---	.01	.51	.75				
	---	.02	.79	1.15				
D187008	26.8	.01	.23	.44	.0	1,200	1,205	1,265
	---	.02	.35	.67				
	---	.02	.39	.75				
D187009	28.9	.01	.06	.23	.0	1,320	1,375	1,425
	---	.02	.10	.37				
	---	.02	.10	.39				
D187010	29.9	.01	.18	.32	.0	1,180	1,235	1,285
	---	.02	.29	.51				
	---	.02	.33	.59				
Wt. avr.	27.6	.01	.18	.35	.0	1,260	1,310	1,360
	---	.02	.28	.54				
	---	.02	.33	.64				

Table 3.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-105, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-105, Canyon B coal bed

Sample number	Proximate Analysis				Ultimate Analysis					
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg
D187011	26.0	29.2	36.8	8.0	6.0	48.3	0.8	36.5	0.4	4,500
	---	39.5	49.7	10.8	4.2	65.3	1.1	18.1	.5	6,080
	---	44.2	55.8	---	4.7	73.2	1.2	20.3	.6	6,820
D187012	33.3	27.8	35.0	3.9	6.7	46.0	.8	42.5	.2	4,320
	---	41.7	52.5	5.8	4.5	69.0	1.2	19.3	.3	6,480
	---	44.3	55.7	---	4.8	73.2	1.3	20.5	.3	6,880
D187013	30.4	26.5	22.8	20.3	6.3	35.2	.6	37.0	.5	3,420
	---	38.1	32.8	29.2	4.2	50.6	.9	14.3	.7	4,920
	---	53.8	46.2	---	5.9	71.4	1.2	20.2	1.0	6,940
Wt. avr.	31.8	28.1	35.3	4.8	6.6	46.4	.8	41.2	.2	4,350
	---	41.2	51.7	7.1	4.4	68.0	1.2	19.0	.4	6,380
	---	44.3	55.7	---	4.8	73.2	1.3	20.5	.4	6,860

Table 3.--Proximate and ultimate analyses, heat content, forms-of-sulfur, free-swelling index, and ash fusion temperature determinations for samples of coal beds below the Canyon coal bed in hole 76-105, Recluse Geologic Analysis Area, Campbell County, Wyoming--continued

Drill hole 76-105, Canyon B coal bed--continued

Sample number	Air Dried loss	Forms of sulfur			Ash fusion temperature °C			
		Sulfate	Pyritic	Organic	Free swelling	Initial deformation	soften.	fluid
D187011	18.0	0.00	0.10	0.26	0.0	1,125	1,180	1,235
	---	.00	.14	.35				
	---	.00	.15	.39				
D187012	26.0	.01	.05	.13	.0	1,265	1,320	1,380
	---	.01	.07	.19				
	---	.02	.08	.21				
D187013	23.1	.01	.07	.45	.0	1,295	1,345	1,395
	---	.01	.10	.65				
	---	.02	.14	.91				
Wt. avr.	24.3	.01	.06	.16	.0	1,235	1,290	1,350
	---	.01	.09	.23				
	---	.02	.10	.25				

Table 4.--Sample numbers, coal beds, and footage cored for analyses
shown in tables 1, 2, and 3

Sample no.	Coal bed	Depth Interval (ft)	Thickness (ft)
Drill hole 76-103			
D186993	Cook-----	262.2-267.5	5.3
D186994	Unnamed (Blue Marker)	330.0-335.9	5.9
D186995	-----do-----	335.9-341.4	5.5
D186996	Wall-----	467.8-478.6	10.8
D186997	Stray-----	534.6-536.6	2.0
D186998	Pawnee-----	565.5-571.0	5.5
D186999	-----do-----	571.0-581.0	9.3
D187000	Parting (Rock)-	578.3-579.0	0.7
D187001	Pawnee-----	581.0-589.3	8.3
D187002	-----do-----	591.0-592.8	1.8
D187003	Cache-----	667.0-675.0	8.0
D187004	-----do-----	675.3-683.7	8.4
Drill hole 76-108			
D186987	Cook-----	361.2-365.3	4.1
D186988	-----do-----	381.3-383.1	1.8
D186989	-----do-----	386.2-388.1	1.9
D186990	-----do-----	392.5-393.6	1.1
D186991	Stray-----	409.8-411.6	1.8
D186992	Unnamed (Blue Marker)-	436.4-449.9	13.5
D189707	Wall-----	560.0-570.0	10.0
D189708	Pawnee Rider----	649.6-651.6	2.0
D189709	Pawnee-----	665.0-681.3	16.3
	Parting (rock)--	681.3-686.5	5.2
D189710	Pawnee-----	686.5-693.2	6.7
D189711	Cache-----	766.9-781.5	14.6
Drill hole 76-105			
D187005	Anderson	67.5- 81.3	13.8
D187006	---do---	81.3- 98.3	17.0
D187007	Canyon A	176.5-183.8	7.3
D187008	---do---	183.8-188.5	4.7
D187009	---do---	188.5-201.3	12.8
D187010	---do---	201.3-204.3	3.0
D187011	Canyon B	239.5-242.7	3.2
D187012	---do---	242.7-254.6	11.9
D187013	---do---	254.6-259.3	4.7

Table 5.--Specific gravities and equilibrium moistures of selected intervals of Anderson, Canyon A, and Canyon B coal beds in holes 76-103 and 76-108

Hole no.	Interval analyzed (ft)	Coal bed represented	Specific gravity at equilibrium moisture g/c ³	Equilibrium moisture (%)
76-103	63.2- 63.4	Anderson	1.22	30.48
	155.5-155.6	Canyon A	1.23	27.44
76-108	93.2- 93.4	Anderson	1.26	29.01

Average values (in percent)

Anderson	29.75 = 29.8
Canyon A	29.32 = 29.3
Canyon B	29.88 = 29.9

Analysis by Core Lab. Inc., Casper, Wyoming

Table 6.--Btu/lb values indicating apparent ASTM rank (qualified) of the Anderson, Canyon A, and Canyon B coal beds in hole 76-105

Btu/lb values ¹					
Hole no.	Coal bed	As received (analysis)	As received (equilibrium moisture)	Moist, mineral-matter free ²	Apparent rank ³ (qualified)
1976 Drilling					
76-105	Anderson	6970	7800	8330	Subbituminous "C"
	Canyon A	6750	7440	8320	Subbituminous "C"
	Canyon B	7830	8050	8490	Subbituminous "C"

¹Rounded off to nearest 10 Btu/lb.

²Calculated from ASTM Standard D-388-77, Section 8.2, equation 3.

³Based on ASTM Standard D-388-77, table 1.

U.S. Geological Survey
Branch of Coal Resources

Project Recluse Geologic Analysis & BLM-EMRIA No. 13

Hole No. 76-103 Geologist G. Taucher, USBR & R. Hobbs, USGS

Type log. Core Description Elev. 4150 Total depth 710.2

Location 330 FEL & 1000' FSL Sec. 31 T. 56 N. R. 72 W.

Nearest town Recluse County Campbell State Wyoming Quad. White Tail Butte

Drilled by: U.S. Bureau of Reclamation

Drillers(s): George Shaw

Drill: Failing 314 (1500) Core Date start 7/29/76 Complete 9/16/76

Non-core intervals and size hole: None

Cored intervals and size: HQ WL 0' to 330.0; NXWL 330.0 to 710.2

Remarks: Core descriptions by: G. Taucher, 0 to 233.0; R. Hobbs, 233.0 to 411.7;
D. Haddock, 411.7 to 499.7; S. Goolsby, 499.7 to 710.2. Other logs - Natural Gamma &
Gamma-Gamma Density. Completed as research water for WRD-USGS Cheyenne 1/2" x 4" slots -
667.0 to 2" I.D. steel casing.

LOG

From	To	Length	Description
			Core Description 0 to 233.0 by Glenn Taucher (Bureau of Reclamation)
			FT. UNION FORMATION - PALEOCENE
0	30.8	30.8	SILTY SHALE; tan and oxidized 0 to 24.5 ft; medium gray becoming dark gray and slightly carbonaceous with depth 24.5 to 28.0 ft; dark gray and carbonaceous 28.0 to 30.8 ft; dry 0 to 5.0 ft; damp to moist 5.0 to 30.8 ft; shattered by drilling and weathering 0 to 5.0 ft; broken in 1.0 to 3 in. core lengths 5.0 to 15.0 ft, 3 to 8 in. core lengths below 15.0 ft moderately firm. Trims easily with knife; moderately plastic becoming plastic with depth; more silty in upper 24 ft; scattered gypsum crystals 0 to 10 ft; 80° joint 12.0 to 13.0 and 16.7 to 17.7 ft; 45° oxidized joint at 28.0 ft; calcareous 0 to 25.0 ft
30.8	32.0	1.2	COAL: black; moist; dull; broken in 1 in. pieces
32.0	50.5	18.5	SHALE: medium to dark gray; moist; firm; carbonaceous; plastic; trims by knife with some difficulty; bedding not readily discernible; very slight HCL reaction; air slaked; 45° joint at 37.0 and 45.9 ft; light gray, uncemented siltstone 32.0 to 33.5 ft; 1/2 in. coal at 33.5 ft; lightgray, silty, fine-grained, uncemented

LOG

From	To	Length	Description
			sandstone 50.0 to 50.5 ft; core lengths 2 to 24 in.
50.5	83.0	32.5	COAL: black; moist; dull; broken: not visible for inspection as coal was sampled and bagged in field
83.0	84.0	1.0	SILTSTONE: light to medium gray; moist; uncemented; crumbles easily between fingers; sandy; slightly carbonaceous; core lengths 1 to 3 in.
84.0	86.5	2.5	COAL: black; moist; dull; broken in 1 in. fragments
86.5	89.8	3.3	SILTY SHALE: medium to dark gray; moist; carbonaceous; moderately firm; air slaked; trims easily by knife; core lengths 3 to 8 in.
89.8	91.5	1.7	COAL: black; moist; dull; broken in 1 in. pieces
91.5	109.2	17.7	SHALE: dark gray and slightly carbonaceous 91.5 to 94.0 ft; light to medium gray 94.0 to 109.2 ft; moist; firm; difficult trimming by knife; plastic; air slaked; very hard, siliceous siltstone with carbonaceous inclusions 96.5 to 97.8 ft; 50° slickenside at 98.3, 104.4 and 106.0 ft; 90° fresh joint at 106.5 ft; core lengths 3 to 18 in.
109.2	133.0	23.8	SHALE WITH COAL: medium to dark gray and carbonaceous; moist; firm; trimmed by knife with some difficulty; plastic; air slaked; bedding not readily discernible; medium gray and non-carbonaceous 119.0 to 120.8 and 129.5 to 132.0 ft; black and coaly 120.6 to 122.2 and 123.8 to 124.3 ft; coal 128.5 to 129.5 ft; scattered slickensides generally in more carbonaceous zones; bedding dips 5° at 119.8 ft; core lengths 1 to 8 in.
133.0	153.0	20.0	SHALE, SILTY SHALE & COAL: medium gray 133.0 to 145.5 ft; dark gray and carbonaceous 145.5 to 153.0 ft with broken coal 146.5 to 148.0 ft; moist; firm; difficult trimming by knife; plastic shale 133.0 to 140.0; 145.5 to 146.5 and 148.0 to 153.0 ft; silty shale cut by light gray siltstone laminations 140.0 to 145.5 ft; 1/2 in. pyrite nodule developed along bedding plane at 144.0 ft; air slaked below 148.0 ft; numerous slickensides 145.5 to 146.5 ft; core lengths 1 to 12 in.

LOG

From	To	Length	Description
153.0	172.2	19.0	COAL: black; moist; dull; broken; not visible for inspection as coal was sampled and bagged in field
172.2	172.5	0.3	SANDSTONE: medium gray; moist; slightly carbonaceous; moderately cemented; fine-grained; unable to crush between fingers
172.5	177.0	4.5	SHALE: medium gray; moist; firm; plastic; trims easily by knife; bedding not readily discernible; core lengths up to 8 in.
177.0	179.2	2.2	SILTY SHALE & SANDSTONE: alternating laminations and thin beds of soft medium gray, silty shale and light gray, uncemented, fine-grained sandstone
179.2	182.2	3.0	SHALE: dark gray; moist; plastic; firm; trims easily by knife; carbonaceous; air slaked; core lengths up to 6 in.
182.2	203.0	0.8	COAL: black; moist; dull; broken; not visible for inspection as coal was sampled and bagged in field
203.0	206.0	3.0	SHALE: medium to dark gray; moist; firm; trims by knife with some difficulty; plastic; air slaked; carbonaceous; highly carbonaceous and brecciated 203.0 to 204.0 ft; slickensides along bedding planes below 204.0 ft; core lengths up to 3 in.
206.0	208.4	2.4	SILTY SANDSTONE: light gray; moist; compact; firm; can't crush between fingers; very fine-grained; approaching sandy siltstone; bedding not readily discernible; core lengths 3 to 6 in.
208.4	213.8	5.4	COAL: black; moist; dull; broken; not visible for inspection as coal was sampled and bagged in field
213.8	233.0	19.2	SHALE WITH COAL: black and carbonaceous 213.0 to 217.8 ft; light to medium gray 217.8 to 231.0 and 232.8 to 233.0 ft; broken coal 231.0 to 232.0 ft; moist; firm to 227.0 ft; moderately soft below 227.0 ft; plastic; air slaked; 45° slickenside at 215.3 ft; core lengths 1 to 6 in.

LOG

From	To	Length	Description
			Core descriptions 233.0 to 410.3 by R. G. Hobbs
233.0	235.1	2.1	Mudstone, medium to dark gray; carbonaceous stems, branches, and fragments grading into:
235.0	242.7		Sandstone, gray, very fine-grained, minor carbonaceous fragments; slickensides (contortion?) at 241.0, bedded 241.7 to 242.7±
242.7	245.0		Mudstone, medium to dark gray with coal (stems & branches), lower part becoming black towards base
245.0	255.0		Sandstone, gray, very fine-grained; some bedding intermixed with non-bedded, very soft, and crumbly sandstone. With mudstone, gray, imbedded stems and leaves 250.0 to 251.0, mudstone 252.0 to 252.6 (0.1' coal, tree branch 252.3)
255.0	257.4		Mudstone, gray, soft, with minor carbonaceous material (stems and leaves), 45' fracture with slickensides 256.2 to 256.9
257.4	259.0		Shale, black, very carbonaceous
259.0	259.6		Shale, brown, carbonaceous, contorted bedding
259.6	262.2		Mudstone, gray, minor carbonaceous fragments
262.2	267.5		Coal, medium hard, thin bands, blocky, uneven fracture breakage 263.6 to 264.5; brown, very hard, vertical filling (clay?) at 263.9 to 265.0 becomes more competent towards base roof and floor contacts sharp, oil shale parting at 266.5; 1.3' coal lost
267.5	269.0		Mudstone, gray, carbonaceous 267.5 to 268.1 (roots)
269.0	283.5		Sandstone, very fine-grained, 1.0 silty streak at 271.2, scattered carbonaceous fragments (coal) 0.01', cross-bedded to 279.1 to 283.5 with scattered small pyrite nodules, very soft (crush core with fingers), silty in parts
283.5	293.5		Recovered 0.5' mudstone, gray, driller reports balance as sandstone from 269.0 to 283.5
293.5	303.5		No core recovered, driller reports sandstone as above
303.5	313.5		As 293.5 to 303.5 (no core recovery)
313.5	323.5		Recovered 3.0 sandstone, gray, very grained, some silty streaks

LOG

From	To	Length	Description
323.5	330.0		No core recovered; driller reports sandstone as above
330.0	341.4		Coal, dull and bright bands, minor pyrite on bedding, upper 1.5', badly broken balance coal core (hard). Silty shale, streak 334.6 to 335.0 coal, silty 338.8 to 339.2, bottom 0.1' coal flakey, floor contact sharp
341.4	350.0		Mudstone, gray, soft, crumbly minor carbonaceous material becomes brownish at 343.8; coal, 0.2' at 344.2, interbedded coal & brown shale 345.0 to 345.4. Several 45' fractures with slickenside at 348.2 to 350.0
350.0	350.9	0.9	Siltstone, gray, with minor very fine-grained sandstone; at 350.0 fracture 45' slickenside
350.9	351.6	0.7	Mudstone, very soft to mud top 1.0 ft
351.6	411.7	61.1	Sandstone, very fine-grained, massive, vertical coaly streak (root) 351.6 to 355.6. Grades into gray mudstone at 355.6 to 356.4. Evenly cross-bedded, with carbonaceous material and sandstone 361.4 to 368.9; 368.9 to 378.2 very soft and crumbly. Heavy carbonaceous material and cross-bedded 372.4 to 373.2, 377.9, and 378.8 to 380.3, becomes very light gray to white 406.2 to 410.3; 410.3 to 411.7: sandstone, gray, fine-grained, some cross-bedding and carbonaceous material, grades into: CORE DESCRIPTION 411.7 to 499.7 DAVID HADDOCK
411.7	412.9	1.2	Mudstone, dark gray with interbedded sandstone
412.9	413.3	0.4	Mudstone, more dense than 411.7 to 412.9, less interbedded sandstone with some carbonaceous material
413.3	414.0	0.7	Mudstone, same as 411.7 to 412.9, increasing sandstone
414.0	422.2	8.2	No core recovery - probably sandstone
422.2	422.7	0.5	Sandstone, light gray, fine-grained, contains clumps of dark gray mudstone
422.7	423.6	0.9	Mudstone, dark gray, cross-bedded with abundant carbonaceous material, thin interbedded sandstone at 423.3

Log Continuation:

Hole No. 76-103Page 6 of 11Project: Recluse Geologic Analysis & BLM-EMRIA No. 13

LOG

From	To	Length	Description
423.6	424.9	1.3	Sandstone, light gray, fine-grained with near vertical interbeds of mudstone and carbonaceous material
424.9	426.4	1.5	Sandstone, light gray, fine-grained with cross-bedded carbonaceous material
426.4	428.2	1.8	Sandstone, as 424.9 to 426.4, becoming more massive, carbonaceous material very abundant
428.2	428.8	0.6	Sandstone, same as 424.9 to 426.4 except no carbonaceous material
428.8	432.2	3.4	Core lost - no recovery
432.2	436.8	4.6	Sandstone, same as 428.2 to 428.8, with pockets of mudstone at 432.2, 433.1 & 435.3
436.8	441.0	4.2	Core lost - no recovery
441.0	441.5	0.5	Mudstone, light gray, very hard, near conchoidal fracture
441.5	444.5	3.0	Core lost - no recovery
444.5	444.9	0.4	Mudstone, dark gray
444.9	447.5	2.6	Sandstone, light gray to light tan, 80% medium-grained - 20% fine-grained, carbonaceous material at 446.4 to 446.6
447.5	450.0	2.5	Core lost - no recovery
450.0	454.0	4.0±	Sandstone, same as 444.9 to 447.5, grading into fine-grained, carbonaceous material at 453.0
454.0	454.5	0.5	Siltstone, light gray, grades into:
454.5	455.5	1.0	Mudstone, dark gray, carbonaceous material 455.4
455.5	456.1	0.6	Sandstone, light gray, very fine to fine-grained. Upper contact with mudstone sharp. Grades into:
456.1	457.6	1.5	Siltstone, light gray with interbedded light gray sandstone & carbonaceous material, abundant carbonaceous material 456.6 to 457.6 grading into:
457.6	458.3	0.7	Sandstone, light gray, very fine-grained, siltstone pockets at 457.6 to 457.8
458.3	459.6	1.3	Siltstone, dark gray, with interbedded very fine-grained sandstone
459.6	461.2	1.6	Mudstone, dark gray, with abundant carbonaceous material
461.2	462.0	0.8	Core lost - no recovery

LOG

From	To	Length	Description
462.0	463.9	1.9	Mudstone with slickenside surfaces and chunks of coal and abundant carbonaceous material 462.3 to 463.9
463.9	464.7	0.8	Mudstone, interbedded with light gray, very fine-grained sandstone, much less carbonaceous material than above
464.7	467.8	3.1	Sandstone, tan, fine-grained, some interbeds of carbonaceous material very abundant 467.0 to 467.8
467.8	468.0	0.2	Coal, bright, banded, hard, appears to have been cut out by sandstone above
468.0	468.3	0.3	Sandstone, gray, very fine-grained, abundant carbonaceous material and pyrite nodules
468.3	478.6	10.3	Coal, badly broken, bright and dull bands in small unbroken pieces
478.6	482.5	3.9	Mudstone, light gray, abundant carbonaceous material, very soft (mudstone almost a clay grading into a light gray clay near 482.0)
482.5	482.7	0.2	Sandstone, light gray, very fine-grained
482.7	483.4	0.7	Siltstone, light gray with interbedded very fine-grained sandstone
483.4	485.6	2.2	Mudstone, dark gray, locally silty with carbonaceous material, very silty lower 0.2 feet
485.6	486.7	1.1	Siltstone, light gray, calcareous, very hard & massive
486.7	487.9	1.2	Sandstone, very fine-grained, soft, locally silty
487.9	490.2	2.3	Mudstone, dark gray, with interbedded siltstone, upper contact with sandstone sharp
490.2	495.6	5.4	Mudstone, dark gray as 487.9 to 490.2, becoming harder, mottled appearance 492.7, some carbonaceous material
495.6	496.6	1.0	Sandstone, light gray, very fine-grained; hard
496.6	499.3	2.6	Mudstone, dark gray, with interbedded sandstone & carbonaceous material
499.3	499.7	0.6	Siltstone, light gray, very hard
CORE DESCRIPTION 499.7 to 710.2 by STEVE GOOLSBY			
499.7	502.4	2.7	Siltstone, light gray, hard, some very fine sand grains
502.4	504.9	2.5	Limestone, gray, very hard, sharp upper contact, irregular, sharp lower contact, dark, sand-sized grains, very fine-grained,

LOG

From	To	Length	Description
			irregular bedding surfaces, irregular finely divided carbonaceous material in rare places, vugular appearing porosity on outside core surface
504.9	507.2	2.3	Sandstone, gray, very fine-grained, soft, loss of from 505.3 to 507.2 in sandstone
507.2	508.0	0.8	Siltstone, light gray, hard, sharp upper contact with sandstone, gray, very fine-grained, as above, sharp, irregular, lower contact with mudstone, as below
508.0	508.4	0.4	Mudstone, gray, hard, carbonaceous, rare plant fragments sharp, irregular upper contact, sharp, irregular lower contact
508.4	512.0	3.6	Sandstone, light gray, very fine-grained, hard, coarsens downward to fine-grained, irregular bedding surfaces, carbonaceous, plant fragments rare at top, increase to common near bottom, loss of 1.5 ft in sandstone at bottom
512.0	527.7	15.7	Sandstone, light gray, fine-grained, carbonaceous, plant fragments common on irregular bedding surfaces, soft, loss of 15.7' in sandstone
527.7	531.5	3.8	Mudstone, gray, hard, slickensided, carbonaceous plant fragments, sandstone in places, fine-grained to very fine-grained, light gray, with carbonaceous plant fragments, upper contact gradational with sandstone, as above, lower contact gradational with sandstone, as below has mottled (bioturbated) appearance
531.5	533.5	2.0	Sandstone, dark gray, very fine-grained, coaly, stems and branches, irregular bedding fines downwards to siltstone, gray coaly, grades into siltstone, gray, hard, with rare, finely divided carbonaceous plant fragments in lower 0.4 ft
533.5	534.6	1.1	Siltstone, gray, hard, as above, carbonaceous, plant fragments become more common near bottom, sharp lower contact
534.6	536.6	2.0	Coal, flaky, soft, stems and branches, bright and dull bands
536.6	542.0	5.4	Siltstone, gray, soft, carbonaceous, plant fragments, common at top becoming more finely divided and less common at 537.6, coarsens into

LOG

From	To	Length	Description
			sandstone, light gray, very fine-grained with finely divided plant fragments, soft irregular bedding
542.0	552.0	10.0	No recovery of core, loss probably in sandstone as above
552.0	563.0	11.0	Mudstone, light gray, silty, rare carbonaceous plant fragments, soft, loss of sample from 552.0 to 557.0(?) in sandstone as above
563.0	565.5	2.5	Mudstone, gray, silty, grades into black mudstone at 564.0, becomes coaly near bottom, bottom gradational with coal
565.5	589.3	3.8	Coal, very fractured, hard with conchoidal fracture in places, flaky and soft in places, bright and dull bands, stems and branches in places
589.3	591.0	1.7	Shale, gray brown, soft, slickensided, friable, upper contact gradational from coal to carbonaceous shale to shale, lower contact gradational from shale to carbonaceous shale to coal
591.0	592.8	1.8	Coal, flaky, stems and branches, shaly, 0.5 of shale at 591.5, gray brown, soft, slickensided, friable, gradational contacts as above, lower contact sharp
592.8	600.4	7.6	Siltstone, light gray, soft, slickensided, pyrite nodules to pebble size "bedded" pyrite, carbonaceous, plant fragments, top 0.5' coaly siltstone, grading into siltstone. Sandy in places (light gray, very fine-grained, pyrite, soft), 15' sandstone at 598.0 as above
600.4	609.0	8.6	Sandstone, light gray, very fine-grained, soft, pyrite nodule pebble-sized, dark bands become more numerous near bottom, some very finely divided carbonaceous plant fragments near bottom, loss of from 600.4 to 603.3 in sandstone as above(?)
609.0	610.4	1.4	Mudstone, gray, hard, silty, top gradational with sandstone above(?), mottled appearance, sandstone in places, medium to fine-grained, light gray, salt & pepper in places, sandstone irregularly interbedded with mudstone
610.4	619.0	8.6	Sandstone, light gray, fine-grained, nearly salt & pepper, loss of 8.0' in sandstone as above(?)
619.0	629.0	10.0	Siltstone, dark gray, black streaks, rare finely divided

LOG

From	To	Length	Description
			carbonaceous plant fragments, hard, loss of 9.6' in sandstone above(?)
629.0	639.0	10.0	Core lost - no recovery
639.0	649.0	10.0	Mudstone, dark gray, hard, silty, rare carbonaceous plant fragments, upper contact gradation with sandstone, very fine-grained, light gray, salt and pepper, lower contact gradational with sandstone, fine-grained, light gray, carbonaceous material, loss of 8.2' of section in sandstone above or below
649.0	659.0	10.0	Sandstone, light gray, fine-grained, salt and pepper, black streaks, "bedded" pyrite, clay clasts pebble to granule-sized (clast appearance may be due to drilling?), core loss of 9.5 ft
659.0	662.0	3.0	Sandstone, light gray, fine-grained, salt and pepper, light green and pink clasts, loss of 2.7' of section at top(?)
662.0	662.2	0.2	Siltstone, dark gray at top, becomes light gray at bottom, hard at top becoming softer at bottom, dark streaks, sharp upper contact with sandstone as above, pyrite along contact, irregular contact, some carbonaceous plant fragments
662.2	667.0	4.8	Shale, dark gray, friable, slickensided, sharp contact at 666.4 with siltstone, light gray, hard, 0.2' thick with carbonaceous material on bottom, loss of 666.6 to 666.7 in carbonaceous material(?) 0.3' shale on bottom dark gray, coaly, upper surface slickensided
667.0	683.7	6.7	Coal, flaky in places, hard in places, gradational from 667.0 to 667.5 with shale, as above, dull and bright bands, vertical fracture, stems and branches, very fractured
683.7	698.5	14.8	Mudstone, light, dark gray, soft, silty, fine pyrite, finely divided carbonaceous plant fragments, slickensided, loss of section, 2.5' at 684.5(?), 1.4' at 690.2(?)
698.5	700.5	2.0	Sandstone, light gray, very fine-grained, "bedded" pyrite, dark streaks, top contact gradational with mudstone, as above, lower contact sharp

Log Continuation:

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LOG

From	To	Length	Description
700.5	701.2	0.7	Mudstone, dark gray, soft, carbonaceous, plant fragments common, grades into siltstone, as below
701.2	702.8	1.6	Siltstone, gray, soft, sandy in places, 0.4' of coaly material at 702.0, rare pyrite, becomes sandier at bottom
702.8	710.2	7.4	Sandstone, light gray, very fine-grained, carbonaceous plant fragments, dark streaks, interbedded with mudstone, dark gray, silty, soft carbonaceous plant fragments, becomes very carbonaceous at 706.0(?), mudstone more prominent near bottom, loss of 2.4' of section at 705.5 in sandstone(?)

T. D. 710.2 coring completed 9/16/76

U.S. Geological Survey
Branch of Coal Resources

Project Recluse Geologic Analysis Area & BLM - EMRIA No. 13

Sample No. 76-105 Geologist G. Taucher USBR, Billings, Montana

Type log. Core Description Elev. 4187 Total depth 275'

Location 1410 FEL & 1350 FSL Sec. 30 T. 56 N. R. 72 W.

Nearest town Recluse County Campbell State Wyoming Quad. White Tail Butte

Drilled by: U.S. Bureau of Reclamation

Drillers(s): George Shaw

Drill: Failing 315 (1500) core Date start 7/20/76 Complete 7/28/76

Non-core intervals and size hole: None

Core intervals and size: D - 6.5 NX Drive samples 6.5 - 275 HQWL (2.40 in. core)

Remarks: Geophysical logs natural gamma & gamma-gamma density by R. G. Hobbs, USGS - BCR

LOG

From	To	Length	Description
			Core description 0 - 275.0 by Glenn W. Taucher (Bur. of Reclamation)
			FT. UNION FORMATION - PALEOCENE
0.0	45.5	45.5	SILTY SHALE: Tan, oxidized; dry 0 to 2.5'; becoming moist below 2.5'; moderately firm; trims easily with knife; moderate to active acid reaction; silty; very silty (clayey siltstone) 9 to 5.0'; moderately plastic; siliceous cemented siltstone 10.8 to 11.0 & 28.3 to 28.5'; 80°, 1/32 in. gypsum-lined joint 23.5 to 24.5'; alternating tan & gray shale 37.7 to 43.0'; no core 43.0 to 45.5'; core lengths 1 to 8" (average 4")
45.5	47.8	2.3	CARBONACEOUS SHALE & COAL: Black, carbonaceous, plastic shale 45.5 to 46.3 & 46.8 to 47.0'; medium gray, slightly carbonaceous silty sandstone 46.3 to 46.8'; coal 47.0 to 47.8'; moist; firm; some gypsum along bedding planes
47.8	67.5	19.7	SHALE: Medium gray near top grading to dark gray, carbonaceous shale with depth; moist; firm; trims by knife with difficulty; plastic; air slacks; bedding not readily discernible; tan, oxidized silty sandstone 47.8 to 48.6'; carbonaceous with gypsum inclusions 48.6 to 48.7'; gypsum lined 45° joint at 53.2'; 70° joint at 58.0'; several 45° slickensides 61.5 to 61.8'; approaching claystone in places; core lengths 2 to 8"

LOG

From	To	Length	Description
67.5	72.0	4.5	COAL: Black; moist; dull; broken; no sample visible for inspection as core was bagged in the field
72.0	72.8	0.8	SHALE: Black; moist; firm; trims by knife; plastic; carbonaceous; unbroken
72.	98.3	25.5	COAL: Black; moist; dull; broken; not visible for inspection as core was sampled and bagged in field
98.3	113.5	15.2	SHALE: Dark gray & slightly carbonaceous 98.3 to 100.5'; black & highly carbonaceous with thin coal streaks 100.5 to 105.0'; medium gray 105.0 to 113.5'; moist; firm; difficult trimming by knife except soft, carbonaceous zone 100.5 to 105.0'; plastic; occasional pyrite or marcasite nodules developed along bedding planes below 105.0'; 1" pyrite cluster along horizontal bedding plane at 113.5'; air slacks; weak HCl reaction; core lengths 2 to 6"
113.5	133.5	20.0	SANDSTONE & SHALE: Sandstone is light gray, silty, fine-grained & medium gray, silty, moderately plastic to plastic & firm (difficult trimming by knife); moist; slight HCl reaction; core lengths up to 12" (average 6"). 113.5 to 114. silty sandstone with pyrite clusters up to 1 1/2" in diameter: 114.0 to 115.0 - Silty shale with sandstone streaks: 115.0 to 125.0 - Silty sandstone with shale lenses at 115.8 to 116.1, 117.3 to 117.9 & 118.3 to 118.8': 125.0 to 126.0 - Dark gray, plastic carbonaceous shale: 126.0 to 127.6 - Clayey sandstone with silty shale 126.7 to 127.1': 127.6 to 128.5 - Silty shale: 128.5 to 128.8 - Broken coal: 128.8 to 130.0 - Sandstone: 130.0 to 131.0 Silty shale: 131.0 to 133.5 - Sandstone
133.5	175.0	41.5	SANDSTONE, SHALEY SANDSTONE, SANDY SHALE AND SHALE: Sandstones are light gray, fine-grained, uncemented and contain varying amounts of silt and clay; shales are medium gray, firm, plastic, and contain various amounts of fine sand; moist; generally trim easily with knife; weak HCl reaction; scattered pyrite or marcasite nodules generally in more sandy areas; core lengths up to 12".

Log Continuation:

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LOG

From	To	Length	Description
			133.5 to 138.0 - Sandy shale grading to shaley sandstone with depth 138.0 to 139.5 - Sandstone with shaley sandstone 138.5 to 138.9'; 139.5 to 148.0 - Sandy shale: 148.0 to 150.1 - Shaley sandstone 150.1 to 175.0 - Sandy shale with shaley sandstone zones 155.7 to 156.1, 157.5 to 158.2 and 167.5 to 168.5'
175.0	176.5	1.5	CARBONACEOUS SHALE: Dark gray and moderately carbonaceous 175.0 to 176.5'; black and highly carbonaceous 176.5 to 185.0'; moist; firm; trims easily by knife; plastic; air slacks; core lengths 1 to 6"
176.5	183.8	7.3	COAL: Dirty; earthy; roof, abundant pyrite
183.8	204.3	20.5	COAL: Black; moist; dull; no coal visible for inspection as was bagged and sampled in field
204.3	239.5	35.2	SANDY SHALE WITH SHALE AND SANDSTONE: Sandy shale is banded to mottled light to medium gray, firm and difficult trimming by knife; shale is medium gray, plastic, firm and difficult trimming by knife; sandstone is light gray, fine-grained, uncemented and crushes easily between fingers; moist; core lengths up to 12". 204.3 to 205.0 - Dark gray, plastic carbonaceous shale: 205.0 to 208.0 - Medium gray plastic shale: 208.0 to 212.5 - Alternating laminations of shale (65%) and sandstone (35%): 212.5 to 217.0 - Sandstone (75%) with silty shale streaks (25%: 217.0 to 236.2 - Sandy shale with about 20% being sandstone streaks: 236.2 to 239.5 - Dark gray, plastic, carbonaceous shale
239.5	259.0	19.5	COAL: Black; moist; dull; not visible for inspection as coal was sampled and bagged in field
259.0	266.9	7.9	SANDY SHALE: Light to medium gray; moist; firm; trims by knife with some difficulty; sand is fine-grained; core lengths up to 12"
266.9	275.0	8.10	SHALE: Medium gray; moist; firm; trims by knife with some difficulty, plastic; air slacks; core length up to 8"; bedding dips about 10°

U.S. Geological Survey
Branch of Coal Resources

Project Recluse Geologic Analysis area & BLM-EMRIA No. 13
 Hole No. 76-108 Geologist G. Taucher USBR & R. Hobbs USGS
 Type log Core description Elev. 4188 Total depth 785.5
 Location 2200 FEL & 1200 FSL Sec. 24 T. 56 N. R. 73 W.
 Nearest town Recluse County Campbell State Wyoming Quad. White Tail Butte
 Filled by: U.S. Bureau of Reclamation
 Drillers(s): George Shaw
 Drill: Failing 314 (1500) core Date start 10/5/76 Complete 4/6/77
 Non-core intervals and size hole: None
 Corred intervals and size: HQWL, 0 to 340.0; NXWL, 340.0 to 573.0; BXWL, 573.0 to 785.5
 Remarks: Core description logs by G. Taucher (USBR) 0 to 359.7; S. Goolsby (USGS) 359.7 to 482.0; R. Hobbs (USGS) 482.0 to 785.5. Other logs Natural Gamma & Gamma-Gamma Density 0 to ±620' (hole collapsed at 620'; could not geophysical log below 600 to 620').
Operations temporarily suspended 11/16/76; resumed 1/18/77; plugged & abandoned 3/21/77.

LOG

From	To	Length	Description
			Core description 0 to 359.7 by Glenn Taucher (Bur. of Reclamation) FORT UNION FORMATION - PALEOCENE
0	16.5	16.5	SHALE: Tan and oxidized 0 to 12.0 ft; tan to gray and slightly oxidized 12.0 to 16.5 ft; moist; moderately firm 0 to 12.0 ft; becoming more firm 12.0 to 16.5 ft; trims by knife; bedding not readily discernible; plastic; air slacks; active HCl reaction 0 to 5.0 ft (no core 5.0 to 9.0 ft); slight to moderate HCl reaction 9.0 to 16.5 ft; $\frac{1}{2}$ " gypsum-lined bedding plane at 16.0; core lengths 3 to 12".
16.5	21.5	5.0	SANDSTONE: Tan; uncemented; washed away during drilling
21.5	24.3	2.8	SHALE: Dark gray; moist; firm; trims easily by knife; bedding not readily discernible; plastic; air slacks; laminated, slightly oxidized; medium gray, silty shale and clayey siltstone 21.5 ft; 3 to 12" core lengths
24.3	41.5	17.2	SILTY SHALE WITH SILTSTONE: Alternating laminations of medium gray, moderately plastic silty shale and light gray, uncemented clayey to sandy siltstone (70% shale and 30% siltstone); moderately firm; cuts

Log Continuation:

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LOG

From	To	Length	Description
			easily by knife; moist, oxidized 34.7 to 35.7 ft; very hard, calcareous siltstone 35.7 to 38.5 ft; bedding near horizontal; core lengths 1 to 8"
41.5	50.0	8.5	SILTY SANDSTONE: Tan; slightly oxidized; moist; uncemented; generally pulverized by drilling; laminated where structure hasn't been destroyed; very fine-grained; uniform; 15% silt; scattered (5%) silty shale streaks up to 1" thick
50.0	70.0	20.0	SHALE: Medium gray and slightly laminated 50.0 to 55.0 ft; dark gray grading to black with depth 55.0 to 70.0'; carbonaceous; moist; very firm; difficult trimming by knife; near claystone; bedding not readily apparent below 55.0 ft; plastic; air slaked; very slight HCl reaction in zones; broken coal 53.5 to 54.0 ft; core lengths 1 to 18"
70.0	100.5	30.5	COAL: Black; moist; not visible for inspection as coal was bagged and sampled in field
100.5	104.5	4.0	SHALE AND COAL: Black; moist; firm; trims by knife with difficulty; shattered by slickensides; air slacks badly; highly carbonaceous; approaching coal in zones; broken coal 103.5 to 104.5 ft; core lengths under 3"
104.5	135.5	31.0	SILTY TO SANDY SHALE: Light to medium gray; moist; varies from thin-bedded and laminated to almost mottled in appearance; material is generally silty to sandy shale but contains laminations of light gray siltstone or very fine-grained sandstone; shale trims easily with knife; sandstone and siltstone are uncemented and crush between fingers; slightly to moderately plastic; plasticity decreasing with depth; scattered marcasite or pyrite nodules up to 1/2" in diameter developed in sandy zones or along bedding planes; upper part contains about 70% shale and 30% siltstone and sandstone; lower part contains about 50% shale and 50% siltstone and sandstone, 50° joint at 118.6 ft; scattered carbonaceous fragments; core lengths 1 to 6"

LOG

From	To	Length	Description
135.5	144.0	8.5	SILTY SANDSTONE WITH SILTY SHALE: Alternating laminations of light gray, uncemented, silty, fine-grained sandstone (crushes between fingers and low plasticity, medium gray, moderately firm silty shale (cuts easily with knife); sandstone is about 60 percent of material; moist; begins to wash away during drilling; core lengths 1 to 6"
144.0	174.0	30.0	SANDSTONE: Very little core recovered; driller reported sandstone, probably fine-grained and uncemented
174.0	177.5	3.5	SHALY SANDSTONE OR SANDY SHALE: Medium to dark gray; moist; firm; trims by knife with some difficulty; moderately plastic when reworked appears cross-bedded; slightly carbonaceous
177.5	200.0	22.5	SILTY SANDSTONE: Core recovered is light gray; moist; uncemented; crushes easily between fingers; fine-grained; contains about 15% silt; scattered silty shale and carbonaceous silty sandstone laminations; contains marcasite and/or pyrite nodules; washes away during drilling
200.0	254.0	54.0	SHALE: Medium to dark gray; moist, generally firm and difficult to trim by knife; soft and cuts easily by knife 213.0 to 224.0 and 228.0 to 234.0 ft; slightly carbonaceous; cut by numerous slickensides between 204.0 and 214.0 ft; plastic; air slacks; hard; cemented (siliceous) siltstone 208.2 to 209.8 ft; sandy 200.0 to 202.0 ft, pyrite 202.0 to 202.2 ft; bedding not readily discernible; core lengths 6 to 18"
254.0	260.0	6.0	SHALE: Medium to dark gray and slightly carbonaceous 254.0 to 256.0 ft; dark gray to black and carbonaceous below 256.0 ft; moist; very firm; trims by knife with difficulty; plastic; numerous irregular slickensides 256.0 to 260.0 ft; slaked; 1 to 6" core lengths
260.0	263.5	3.5	COAL: Black; wet; not visible for inspection as coal was sampled and bagged in field
263.5	269.5	6.0	SILTSTONE: Light to medium gray; moist; laminated; slightly carbonaceous; trace of clay and fine sand; slightly plastic;

LOG

From	To	Length	Description
			crumbled between fingers with difficulty; slight HCl reaction; core lengths 2 to 6"
269.5	282.9	13.0	COAL: Black; wet; not visible for inspection as coal was sampled and bagged in field
282.9	307.5	24.6	SILTY SHALE WITH SILTSTONE AND SANDSTONE: Light to medium gray; moist; firm; difficult trimming by knife; banded to laminated in places; moderately plastic to plastic; slaked 282.9 to 299.5 - Silty shale with slightly cemented sandstone streaks 289.5 to 289.9 ft; 289.9 ft; 299.5 to 303.5 - Alternating laminations of medium gray, plastic shale and light gray, clayey, siltstone and silty sandstone; scattered pyrite nodules along bedding planes; 303.5 to 307.5 -
307.5	329.0	21.5	Medium gray shale becoming dark gray and carbonaceous with depth COAL: Black; wet; not visible for inspection as coal was sampled and bagged in field
329.0	341.5	12.5	SHALE: Medium gray; moist; soft to moderately firm; cuts easily with knife; plastic; bedding not readily discernible; air slaked; becoming silty shale with carbonaceous stems 329.0 to 334.5 ft; numerous slickensides 334.5 to 335.5 ft; core lengths 3 to 18:
341.5	346.0	4.5	Driller reported SILTY SANDSTONE with pyrite nodules. Most of sample washed away during drilling. Samples recovered consisted of alternating laminations of uncemented silty sandstone and silty shale with scattered pyrite inclusions
346.0	350.5	4.5	SHALE: Black; moist; very firm; near claystone; air slacks; highly carbonaceous; trims by knife with difficulty; bedding not readily discernible
350.5	354.0	3.5	SILTY SANDSTONE AND SILTY SHALE: Alternating laminations of medium to dark gray, plastic silty to sandy shale and light gray, uncemented, fine-grained sandstone; moist; trims easily by knife; scattered pyrite nodules generally lying along bedding planes; 60%

LOG

From	To	Length	Description
			shale 350.5 to 352.5 and 353.4 to 354.0 ft; 30% shale 352.5 to 353.4 ft
354.0	359.7	5.7	SHALE: Dark gray; moist; firm; trims by knife with difficulty; carbonaceous; approaching claystone; air slaked; plastic when reworked
			Core description 359.7 to 482.0 by Steven Goolsby
359.7	361.2	1.5	Shale, medium-dark gray, silty, laminated in places, slickensides, stems and branches, hard, carbonaceous in places, becomes more carbonaceous bottom 4'
361.2	365.3	4.1	Coal, hard, black, slickensides & shaley 365.0 to 365.3
365.3	367.4	2.1	Shale, medium-dark gray, silty in places, hard, stems and leaves; slickensides 365.3 to 365.5; interlaminated with sand 365.9 to 366.3, sand is very fine-grained, light gray, stems and leaves, mottled appearance with shale
367.4	373.2	5.8	Shale, light-medium gray, firm, stems and leaves, become more thinly bedded near bottom; silty, interlaminated with sand; 367.4 to 370.0, sand is very fine-grained, light gray, soft, uncemented, wavy bedding becoming less common below 365.5 ft; slight hydrochloric reaction at 369.3 becoming strong reaction to 370.0, very slow reaction 371.0 to 372.5, scattered slickenside 367.4 to 370.0; trims easily with knife; gradational upper and lower contacts
373.2	374.0	0.8	Sandstone, light to medium gray, very fine-grained to fine-grained, uncemented, laminated, wavy bedding, crushes easily between fingers, interbedded with shale, medium gray, moderately firm, trims by knife, soft and plastic in places; a few stems and leaf fragments; gradational lower contact
374.0	375.8	1.8	Shale, carbonaceous black, firm, trims easily by knife, conchoidal to even fracture, no apparent bedding, several low angle slickensides 375.6 to 375.8, sharp lower contact

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From	To	Length	Description
375.8	381.3	5.5	Shale, medium-dark gray, firm, trims easily by knife, stems and leaves; sand laminations 375.8 to 377.3, sand is very fine-grained, medium gray soft, uncemented silty; shale is silty sandy in places 375.8 to 378.2; scattered low angle slickensides 378.4 to 379.2, many low angle slickensides 379.2 to 381.3, grades into dark gray to almost black carbonaceous, shale below 379.4; becomes soft and plastic 381.0 to 381.3
381.3	383.1	1.8	Coal, black, hard, moist
383.1	386.2	3.1	Mudstone, medium-dark gray, soft-firm, moderately plastic to plastic, scattered stems and leaves, trims easily by knife; dark gray and carbonaceous 383.1 to 383.3 and 385.9 to 386.2; silty 385.1 to 385.9 many scattered slickensides
386.2	388.1	1.9	Coal, black, hard, moist
388.1	392.5	4.4	Shale, medium-dark gray, firm, thinly divided stem and leaf fragments; trims easily with knife; dark gray with many slickensides 388.1 to 388.4; medium gray and silty 388.4 to 391.9; dark gray with many slickensides 391.9 to 392.5; scattered slickensides 389.2 to 391.9; becomes carbonaceous 391.9 to 392.5
392.5	393.6	1.1	Coal, black, hard, moist
393.6	393.8	0.2	Shale, dark gray, carbonaceous firm, stem and leaf fragments, slickensides, trims easily by knife
393.8	399.6	5.8	Sandstone, fine-grained to very fine-grained, medium gray, soft, uncemented, crushes easily by finger, wavy bedding; interbedded with shale, light-medium gray, firm, sandy to silty in places, trims easily by knife; stem and leaf fragments; sharp, even upper and lower contacts, loss probably in sandstone 395.4
399.6	401.0	1.4	Mudstone, dark gray firm, horizontal slickensides, coal laminations, carbonaceous stem and leaf fragments, becomes silty below 400.9, trims easily by knife, slight hydrochloric reaction below 400.9
401.0	402.2	1.2	Siltstone, light gray, firm, reacts readily with hydrochloric, stems

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From	To	Length	Description
			and leaf fragments, shaly in places, gradational upper and lower contacts
402.2	409.5	7.3	Sandstone, fine-grained, light-medium gray, soft, uncemented, crushes easily between fingers, stem and leaf fragments, interbedded to interlaminated with mudstone, medium gray, firm, moderately plastic, scattered horizontal slickensides, stems and leaf fragments, trims easily by knife
409.5	409.8	0.3	Shale, dark gray to black, carbonaceous, firm, many slickensides, moderately plastic, becomes progressively more carbonaceous near bottom
409.8	411.6	1.8	Coal, black, hard, moist
411.6	413.1	1.5	Shale, dark gray, soft, plastic, carbonaceous in places, many slickensides, trims with knife
413.1	413.5	0.4	Coal, badly broken, black, moist, driller reports 1.5 ft loss in this or next lower coal
413.5	415.3	1.8	Shale, dark gray - black, firm to soft, moderately plastic to plastic, carbonaceous, scattered horizontal slickensides
415.3	415.7	0.4	Coal, badly broken, black, moist, driller reports 1.5 ft loss in this or 413.1 to 413.5 coal
415.7	420.1	4.4	Shale, light-medium gray, firm, trims by knife, silty in places, stem and leaf fragments finely divided scattered slickensides; dark gray and carbonaceous 415.7 to 415.9; medium gray with many slickensides 418.8 to 419.2, gradational lower contact
420.1	421.0	0.9	Siltstone, light gray, sandy, firm, hard, trims by knife, stem and leaf fragments become sandier near bottom, loss may be in the bottom(?)
421.0	421.8	0.8	Sandstone, fine-grained to very fine-grained, light gray, uncemented shaly laminations, soft, crumbles between fingers with difficulty, uncommon fine carbonaceous plant fragments, sharply gradational lower contact; core loss of 0.8 probably here

LOG

From	To	Length	Description
421.8	431.7	9.9	Shale, light gray 421.8 to 423.6 medium gray 423.6 to 425.6, dark gray 425.6 to 429.3, medium gray 429.3 to 431.7 moderately plastic, trims easily by knife, silty 422.7 to 422.8, fine carbonaceous, plant fragments 421.0 to 425.6, large carbonaceous plant fragments 425.6 to 428.3, fine carbonaceous plant fragments 429.3 to 431.7, abundant randomly oriented slickensides, 425.6 to 428.1, scattered and randomly oriented slickensides 428.1 to 451.7, carbonaceous 425.6 to 428.1, very fine-grained, sandstone laminations 428.7 to 431.7, gradational lower contact
431.7	432.2	0.5	Siltstone, medium gray, very hard, will not trim by knife, carbonaceous, plant fragments, contains abundant chert clasts below 331.9 clasts are 0.01 to 0.1 inches in size, angular, tan, and coated with a white substance, gradational lowr contact
432.2	435.4	3.2	Shale, medium gray, moderately plastic interlaminated with sandstone very fine-grained, light gray, uncemented, laminations are irregular tan fine-grained to coarse-grained chert clasts 433.0 to 433.2, light tan clay clasts 434.2 to 434.4, uncommon carbonaceous plant fragments laminations disrupted as by burrowing or root action in places, gradational lower contact
435.4	436.4	1.0	Shale; medium-dark gray, moderately plastic to plastic, abundant randomly scattered slickensides, rare carbonaceous plant fragments, carbonaceous 436.0 to 436.4
436.4	447.5	11.1	Coal
447.5	447.9	0.4	Shale, dark gray-black, crumbles easily, very carbonaceous, abundant randomly oriented slickensides, coaly in places
447.9	449.9	2.0	Coal
449.9	451.2	1.3	Shale, dark gray-black, carbonaceous, moderately plastic; abundant, randomly oriented slickensides, tirms easily by knife, sharp lower contact

LOG

From	To	Length	Description
451.2	480.0	28.8	Shale, light-medium gray, moderately plastic, soft, trims easily by knife, uncommon scattered carbonaceous plant fragments; abundant, randomly oriented slickensides 452.6 to 454.0, 458.4 to 463.9, 467.0 to 468.4; scattered randomly oriented slickensides elsewhere, silty and firm 451.2 to 452.6, 463.9 to 467.0, carbonaceous shale 462.7 to 462.8, very fine-grained sandstone lamination 465.3
480.0	480.4	0.4	Siltstone, hard but trims by knife with difficulty, light tan-gray, strong hydrochloric reaction, vertical slickensides, extremely irregular lower contact with some of shale below protruding into siltstone
480.4	482.0	1.6	Shale, medium gray, soft-firm, moderately plastic, plastic trims by knife, rare carbonaceous plant fragments, scattered randomly oriented slickensides, silty 481.6 to 482.0, very soft 480.4 to 480.9
Drilling temporarily suspended Nov. 16, 1976 at 482.0; 340' NX Casing left in hole			
Drilling resumed January 18, 1977			
Core description 482.0 to 785.5 by R. G. Hobbs, USGS			
482.0	495.6	13.6	Mudstone, gray, soft; silty and hard from 485.3 to 486.0; 2 ft core loss between 482.0 to 490.0
497.6	511.8	14.2	Shale, dark gray to black, carbonaceous streaks, some thin sandy zones from 500.0 to 500.8, 50/50 becoming less sandy with more carbonaceous streaks below 502.4
511.8	545.3	33.5	Sandstone, light gray to white, very fine-grained, very soft, interbedded with black mudstone 524.0 to 524.9; carbonaceous streaks 533.0 to 538.3; coal streaks and coal reworked fragments 539.5, 539.6, 539.7 to 539.9, 541.0, and 541.9 becomes silty 543.0 to 545.3

LOG

From	To	Length	Description
545.3	546.4	1.1	Mudstone, black, interbedded with sandstone, white, very fine-grained
546.4	547.0	0.6	Sandstone, white, becoming fine-grained
547.0	550.0	3.0	Loss (Shale?)
550.0	558.0	8.0	Sandstone, light gray to white, very fine-grained coal inclusions (reworked) at 551.0, branch (coal) at 552.5 to 553.0; mudstone, dark gray with minor light gray mudstone streaks 554.0 to 555.0, small coal fragments at 556.7
558.0	558.7	0.7	Mudstone, gray, soft, twig and branch fragments
558.7	560.0	1.3	Sandstone, gray, very fine- to fine-grained; silty upper 0.3 ft soft becoming hard at base, pyrite nodules in basal sandstone ± 0.03 ft diameter
560.0	560.2	0.2	Coal, soft, earthy
560.2	569.5	9.3	Coal, badly broken, bright and dull bands apparent cleat and butt fractures. Coal roof appears to have been cut out
569.5	570.0	0.5	Coal, thin bedded, flaky, very soft, some mudstone streaks
570.0	573.3	3.5	Coal (driller) lost
573.5	573.8	0.3	Pyrite nodule zone; nodules up to 0.05 ft in diameter. Matrix more or less washed out, remnants appears to be a soft earthy mudstone
573.8	579.5	5.7	Mudstone gray to dark gray, earthy, carbonaceous plant fragments and rootlets (paleosoil horizon?)
579.5	584.0	4.5	Shale, black carbonaceous
584.0	585.0	1.0	Mudstone, gray, earthy, with $\pm 90\%$ pyrite nodules, size up to 0.05 ft in diameter
585.0	592.5	7.5	Mudstone, gray bedded carbonaceous (branch and twig) pyrite nodule streak at 586.7. Nodules up to 0.03 ft in diameter
592.5	599.9	7.4	Loss
599.9	626.5	26.6	Claystone, light gray, massive, hard to very hard, highly calcareous (strong hydrochloric reaction) even bedding, dark and medium gray, 614.5 to 626.5

LOG

From	To	Length	Description
626.5	627.0	0.5	Limestone, medium gray, very dense and very hard
627.0	633.5	6.5	Mudstone, medium gray, even-bedded
633.5	638.5	5.0	Siltstone calcareous even-bedded; cross-bedded with carbonaceous material 635.7 to 638.5
638.5	648.0	9.5	Siltstone, sandy to silty; sandstone, very fine- to fine-grained
648.0	649.6	1.6	Mudstone, gray, becomes more silty towards base, contact with underlying coal sharp
649.6	650.6	1.0	Coal, bright and dull bands. Hard, top appears to have been washed out by channeling
650.6	651.6	1.0	Coal, soft, flaky, bottom 0.1 ft soft earthy, brownish cast
651.6	657.0	5.4	Mudstone, black, earthy, carbonaceous throughout leaf, branch, twig fragments, rootlets (paleosoil horizon)
657.0	657.6	0.6	Mudstone, light gray, massive
657.6	665.0	7.4	Mudstone, medium gray, 45° slickenside at 658.0; carbonaceous material, twigs, branches, 661.0 to 663.0; mudstone, light gray, at 663.0 grades into very fine-grained sandstone at 665.0
665.0	666.2	1.2	Loss (coal)
666.2	673.0	6.8	Coal, badly broken, bright and dull bands, hard, poor cleat fracture, bedded pyrite nodules at 672.7 up to 0.05 ft in diameter
673.0	681.0	8.0	Coal (driller) lost 7.0 ft
681.0	681.3	0.3	Coal, badly fractured
681.3	681.6	0.3	Mudstone, dark-gray to black, earthy, much carbonaceous material
681.6	683.0	1.4	Mudstone, dark gray to black, massive
683.0	686.6	3.6	Mudstone, gray, interbedded with some sandstone and coaly material
686.6	693.2	6.6	Coal, badly broken
693.2	693.6	0.4	Shale, black, highly carbonaceous
693.6	694.9	1.3	Mudstone, dark gray, carbonaceous, earthy
694.9	695.2	0.3	Mudstone, dark gray to black
695.2	695.5	0.3	Coal, badly broken
695.5	697.0	1.5	Mudstone, black, carbonaceous

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From	To	Length	Description
77.0	729.8	32.8	Claystone, mudstone, light gray, competent in parts with interbedded sandstone 701.0 to 703.0 carbonaceous material 703.5 (branch) becomes more massive 713.0 to 729.8
729.8	730.2	0.4	Sandstone, white to gray, very fine-grained, very hard, interbedded pyrite nodules throughout, thicker at top
730.2	731.5	1.3	Mudstone, gray to medium gray
731.5	760.0	29.5	Core recovery 730.2 to 740.0 about 1.3 ft; 740.0 to 750.0 0.3 ft; 750.0 to 760.0 0.0 ft
760.0	765.0	5.0	Mudstone, dark gray to black, earthy, flaky, with pyrite nodules up to 0.08 ft in diameter
765.0	766.6	1.6	Mudstone, black
766.6	766.9	0.3	Mudstone, black with coal, impure and bony
766.9	781.5	14.6	Coal, badly broken bright, hard, apparent cleat fracture. Recovery: 766.9 to 770.0; 770.0 to 772.0 about 2.5 ft from 772.0 to 781.5 total 6.6 ft
781.5	785.5	4.0	Lost

Total depth 785.5

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