

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LITHOLOGIC AND GEOPHYSICAL LOGS OF HOLES DRILLED IN THE
DOTY MOUNTAIN, BROWNS HILL, AND BAGGS QUADRANGLES,
CARBON COUNTY, WYOMING, DURING 1976

By
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This report has not been edited
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stratigraphic nomenclature.

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Introduction

The purpose of this report is to present data obtained during a 1976 U.S. Geological Survey drilling program in the Little Snake River coal field, Carbon County, Wyoming. Also presented are geophysical logs of two commercially drilled holes, BH-D2A and BH-D2B, drilled in 1976, and one hole, DM-D28, drilled in 1975 by the U.S. Geological Survey (Barclay and Zimmerman, 1976).

Seven holes were drilled in Tps. 14, 15, and 16 N., R. 90 W., Doty Mountain, Browns Hill, and Baggs quadrangles, Carbon County, Wyo. (fig. 1), by the U.S. Geological Survey in August and September 1976. This drilling was done to obtain information on the depth, thickness, and extent of coal in the Almond Formation and is part of a project to evaluate and classify federally owned coal resources and lands in the Little Snake River coal field and adjacent areas.

Drilling was done with a truck-mounted rotary drilling rig belonging to the U.S. Geological Survey. Drill bits used were 5-1/8-inch roller-cone medium-hard rock bits. Drilling fluids injected were air and water. Air was used to depths where drill cuttings became too sticky from formation water to be blown from

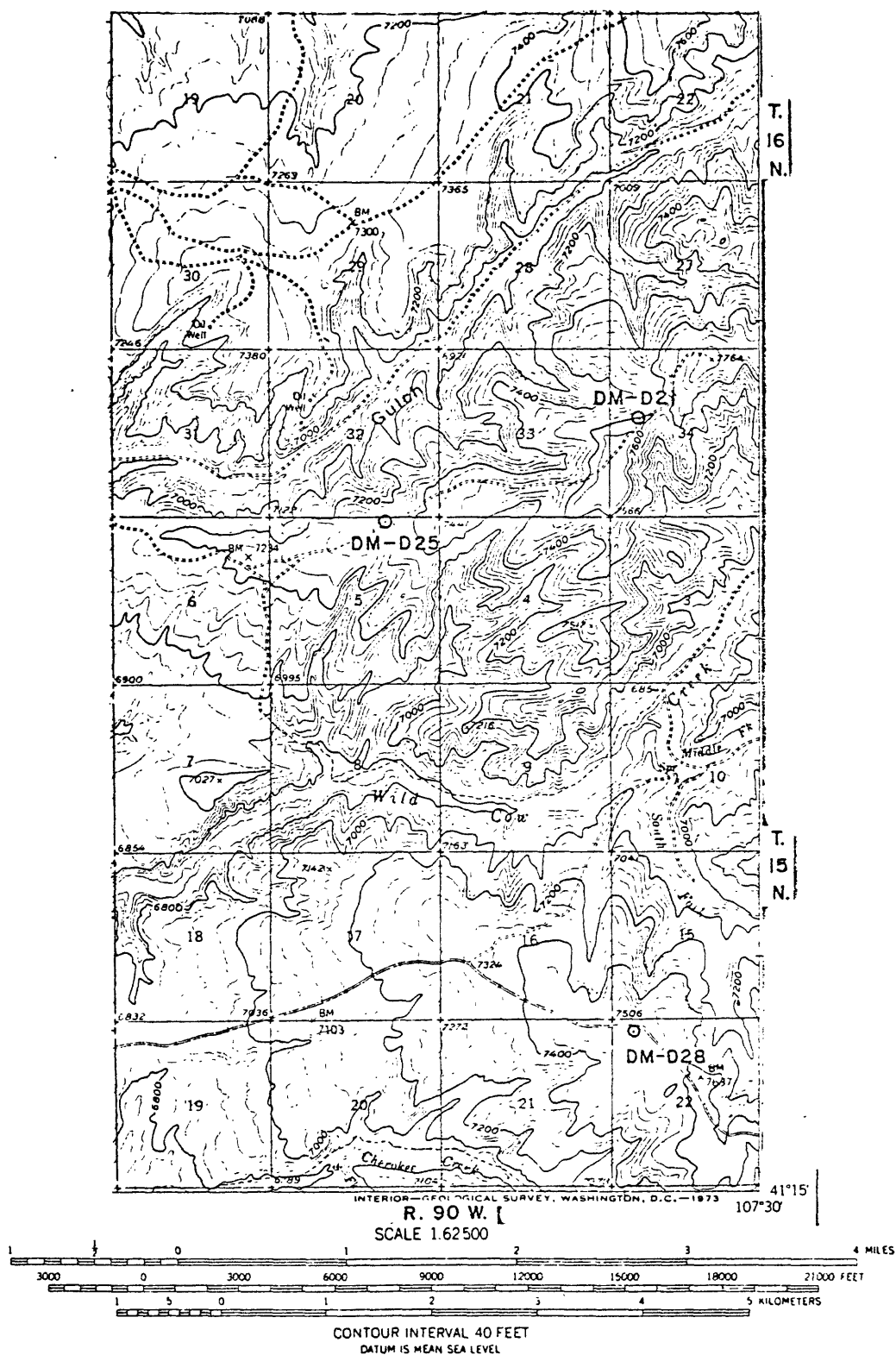


Figure 1.--Map showing location of holes drilled by the U.S. Geological Survey in the Doty Mountain quadrangle, Carbon County, Wyoming, during 1976. Also shown is one hole, DM-D28, drilled in 1975.

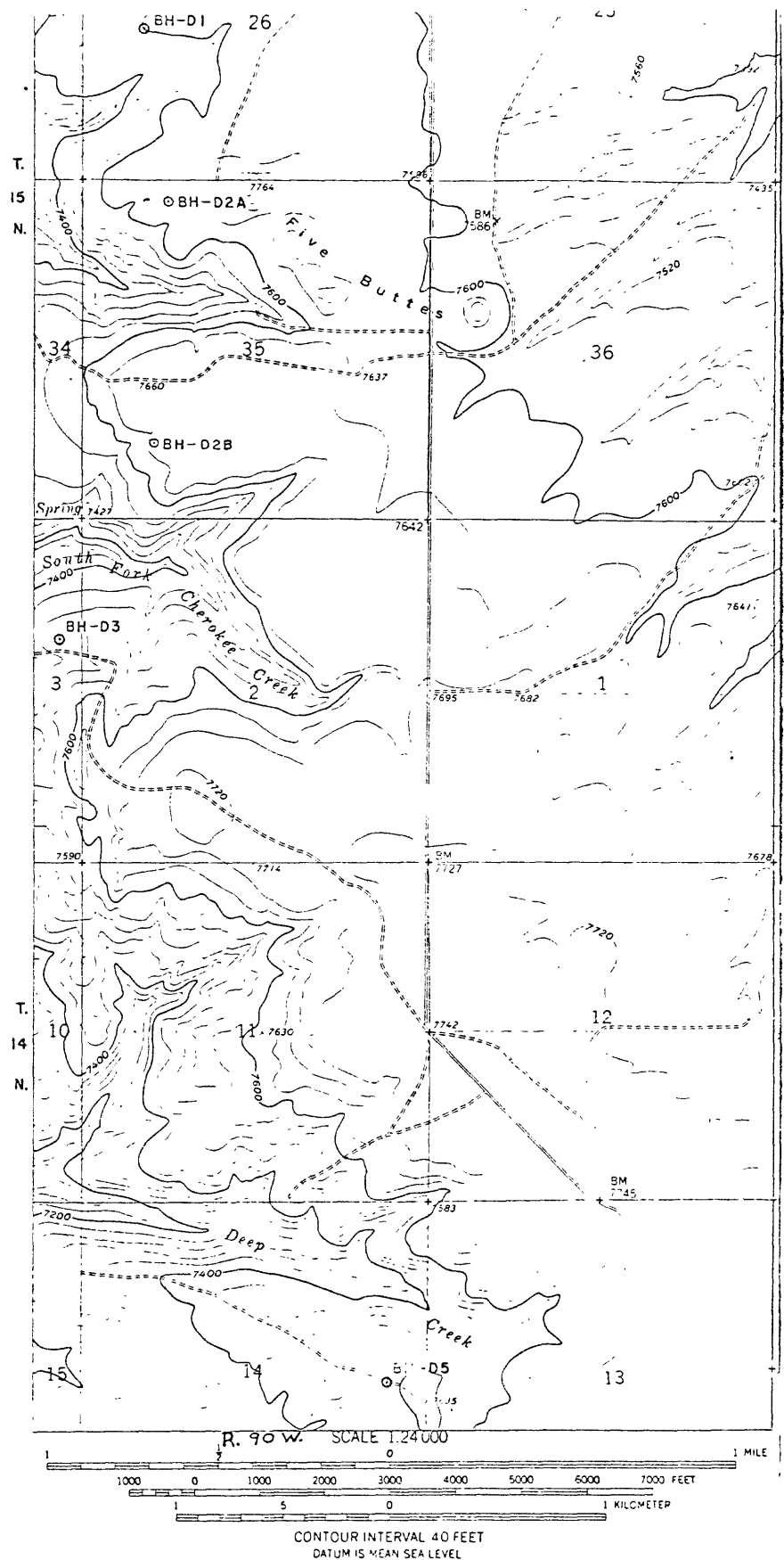


Figure 2.--Map showing location of holes drilled by the U.S. Geological Survey in the Browns Hill quadrangle, Carbon County, Wyoming, during 1976. Also shown are two commercially drilled holes, BH-D2A and BH-D2B.

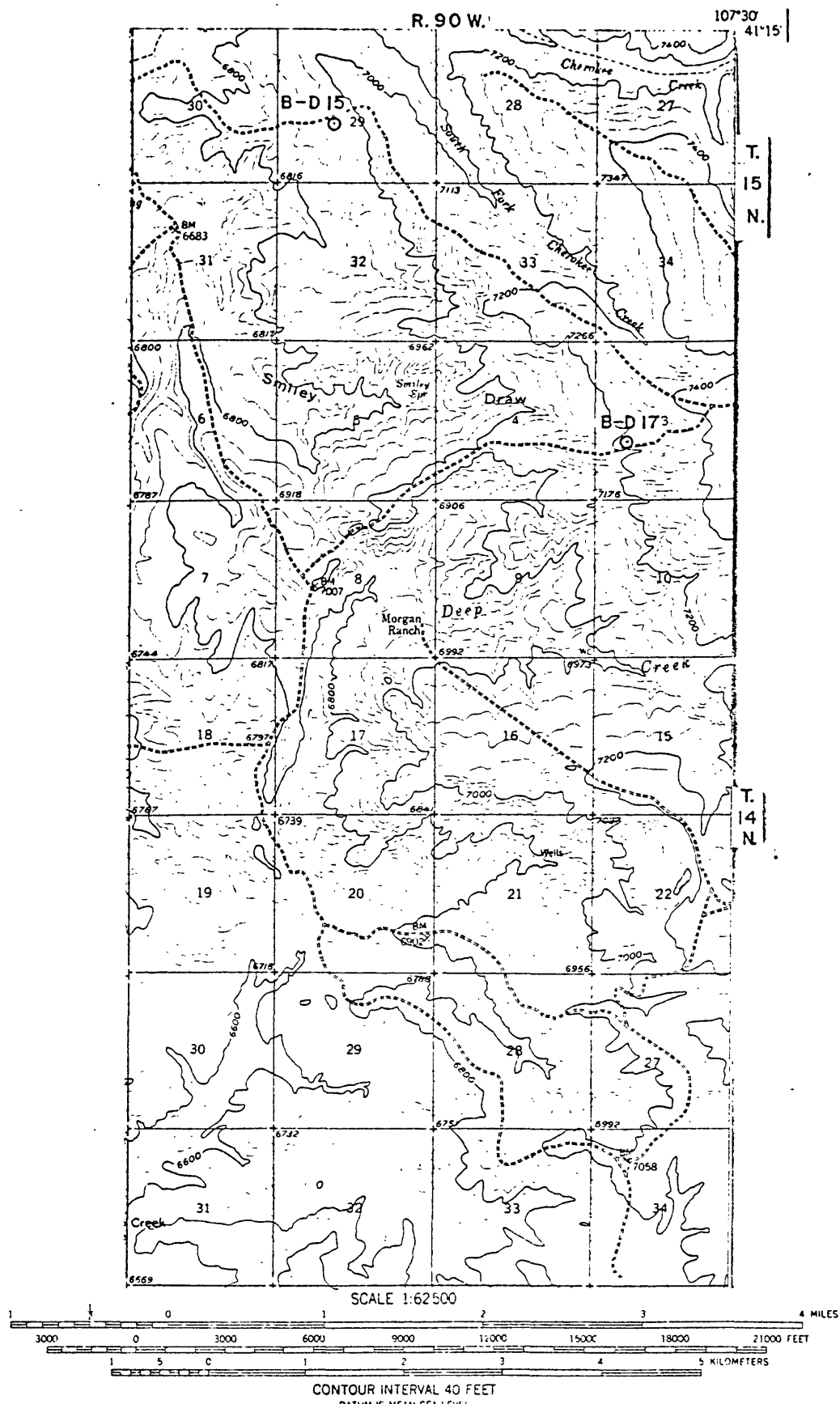


Figure 3.--Map showing location of holes drilled by the U.S. Geological Survey in the Baggs quadrangle, Carbon County, Wyoming, during 1976.

the hole. Then water was injected with compressed air to aid in transport of cuttings to the surface. In most cases, hole erosion and mixing of cuttings with up-hole debris increased and the quantity and quality of cuttings decreased with increasing depth, formation water, and injected water. During drilling, cuttings believed to be representative of the rock strata were sampled, examined, and logged. Later each drill hole was logged by geophysical methods.

Acknowledgments

The U.S. Geological Survey drill rig was operated by a crew consisting of J. D. Cathcart (driller), H. M. Winkler, and H. M. Blevins, III, and supervised by J. D. Tucker. B. A. Rood assisted in the collection of samples and preparation of sample logs during the drilling of some of the holes. Geophysical logging was done by R. A. McCullough and by L. M. MacCary, assisted by Joe Sena, G. B. Leon, and R. E. Hodges.

Stratigraphy of the drilled rock formations

Rock strata intersected by the drill holes (including the commercially drilled holes) belong to the Mesaverde Group and to the overlying Lewis Shale, both of Late Cretaceous age, and the Browns Park Formation of probable Miocene age. In southern Wyoming the Mesaverde Group consists, in ascending order, of the Haystack Mountain Formation, the Allen Ridge Formation, the Pine Ridge Sandstone, and the Almond Formation (Gill, Merewether, and Cobban, 1970, p. 5). The Haystack Mountain Formation is a marine

and marginal marine unit which primarily consists of shale and thick sandstone beds. Single coal beds 1-2 ft (0.3-0.6 m) thick occur above regressive marine sandstone beds in the formation in a few places in the Little Snake River coal field. The Allen Ridge Formation is primarily a continental deposit and consists mostly of thick, lenticular sandstone beds, and thinly to thickly interbedded siltstone, sandstone, mudstone, and carbonaceous shale. Coal beds 1-3 ft (0.3-0.9 m) thick generally occur near the base of the formation. The uppermost part of the formation contains marine sandstone and shale and/or marginal marine lagoonal-paludal deposits of thinly bedded sandstone and siltstone, carbonaceous shale, and coal beds. The Pine Ridge Sandstone is a continental deposit consisting of fluviatile sandstone, a subordinate amount of interbedded carbonaceous shale, and in places, a few coal beds. According to Gill and others (1970, p. 30), the Pine Ridge is probably unconformable on the Allen Ridge in most places in southern Wyoming. The Pine Ridge Formation may not be present in the southernmost part of the Little Snake River coal field and nowhere in the area have the contacts with sub- and superjacent formations been positively identified. The interval consisting of the marginal marine part of the Allen Ridge and of the Pine Ridge contains coal beds as thick as 4 to 6 ft (1.2-1.8 m) in some places. The Almond Formation is largely a sequence of cyclic barrier bar and lagoonal-paludal deposits in which single cycles are commonly represented by thick sandstone beds grading downward into interbedded

siltstone, clay-shale, and mud-shale, and sharply overlain by coal or carbonaceous shale. In many cases lagoonal-paludal deposits are absent and barrier bar sandstone is overlain by marine shale at the base of the next cycle. Coal beds as much as 16 ft (4.9 m) thick occur in the Almond Formation in the Little Snake River coal field.

The thickness of the Mesaverde Group in the Little Snake River coal field is believed to vary between 2,350 and 2,750 ft (716 and 838 m). The Haystack Mountain Formation is 750-950 ft (229-290 m) thick. The lower nonmarine portion of the Allen Ridge Formation is estimated to be 1,000-1,200 ft (305-366 m) thick. The total thickness of the interval between the top of the nonmarine rocks of the Allen Ridge and the base of the Lewis Shale is probably between 650 and 750 ft (198-229 m) in most of the coal field and is thought to be close to 675 ft (206 m) in the southeastern part of the Doty Mountain quadrangle.

The Lewis Shale is 2,000-2,500 ft (610-762 m) thick and consists of marine shale and, in the upper part, sandstone.

The Browns Park Formation lies with angular unconformity on all older formations and consists primarily of a basal conglomerate and tuffaceous sandstone. In the Little Snake River coal field near the Wyoming-Colorado border, the Browns Park Formation may be as thick as 1,600 ft (488 m).

Most of each hole is in the Almond Formation, the Pine Ridge Sandstone, and the marginal marine member of the Allen Ridge Formation. Nonmarine rocks of the Allen Ridge Formation were probably reached in DM-D25 near 555 ft (169 m) and in BH-D1 near 467 ft (142 m). The uppermost 30 ft (9.1 m) of drill-hole BH-D3 and the uppermost 73 ft (22.3 m) of drill-hole BH-D5 are in the Lewis Shale. The uppermost 8.5 ft (2.6 m) of BH-D2A and the uppermost 13.6 ft (4.1 m) of BH-D2B are in the Browns Park Formation.

Structure near the drill sites

Geologic structure exposed at the surface in the area of the drill sites is subdued. Beds of the Almond Formation dip 10° - 20° in westerly directions. The Browns Park Formation in the vicinity of drill-holes BH-D2A and BH-D2B dips easterly at angles of less than 5° .

Lithologic logs

Lithologic logs of the holes drilled by the U.S. Geological Survey in 1976 are presented on pages 11-70. They are based on sample logs made during drilling and on data collected during later microscope-assisted examination of drill cuttings. Sample quantity and quality generally decreased with increasing hole depths and water injection. Consequently, information in the logs for shallow intervals that were drilled using air injection is generally more reliable than that for deep intervals using air and water. Information from geophysical logs was not used and no depth corrections to compensate for up-hole travel time for cuttings were made in the preparation of the lithologic logs.

Rocks drilled were classified as sandstone, siltstone, mudstone, claystone, and coal. "Coal" is applied to readily combustible rocks believed to contain more than 50 percent by weight and more than 70 percent by volume of carbonaceous material (ASTM, p. 70, 1970). Classification of rocks other than coal is based on a scheme by Folk (1954, p. 349-350) with modification of the term mudstone and no use of his terms to describe fissility. Folk uses mudstone for a rock in which the amount of silt and clay is 50 percent or more by weight and the silt:clay ratio is between 2:1 and 1:2. In this paper, the term mudstone is extended to include rocks containing at least 50 percent silt and clay, but in which the silt:clay ratio is unknown. Although most, if not all, of the mudstone and claystone encountered in the drill holes would probably be described as shale in surface exposures, fissility could not generally be determined from drill cuttings and is not described.

Colors of the rocks drilled are principally shades of gray and brown with some yellowish-orange and reddish- or yellowish-brown iron-oxide staining in rocks from the upper parts of the drill holes. Rock color terms used are from the Rock-Color Chart of the Geological Society of America (1970) and the Munsell Soil Color Chart (1954) and refer to dry samples.

Sandstone and siltstone are composed mostly of subangular to subrounded detrital grains of quartz and subordinate black and gray chert. Green grains believed to be glauconite were found in trace amounts in many sandstone or siltstone intervals which would attest

to the marine affinities of a large part of the rocks drilled. Both calcareous and noncalcareous cement occurs in sandstone and siltstone. Noncalcareous cement is probably clay minerals and silica in most cases. In the zone of oxidation iron oxide (limonite) commonly occurs as grain coatings. Gypsum, which was found in claystone in the zone of oxidation in many drill holes, probably occurs as vug fillings and fracture coatings. Calcareous rocks are generally more strongly cemented than noncalcareous ones. Degree of cementation was determined by examination of drill cuttings where possible. Resistance to drilling is determined in part by the degree of cementation of rocks and was noted where this property could not be determined from drill cuttings. Drilled intervals which offered greater or lesser than average resistance to drilling were described as hard or soft. Most hard beds are probably calcite cemented; a few, noncalcarous ones are believed to contain silica cement. Estimated relative porosity-permeability of sandstone or siltstone is described as tight or open. In at least some cases, sandstone and siltstone described as tight were strongly cemented and calcareous.

Carbonaceous material is ubiquitous in most of the rocks that were drilled. Fine-grained rocks, especially mudstone and claystone, commonly contain finely divided carbonaceous material which imparts a brown to brownish-gray color to the rock. Black coal or brown carbonaceous particles, streaks, and/or laminae, are very common in both sandstone and the finer grained rocks. Particles are angular grains, splinters, chips, or flakes. Streaks are discontinuous laminae, shreds, or the edges of chips or flakes.

Lithologic log of drill-hole DM-D21

[All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 900 ft FWL, 2,150 ft FNL, sec. 34, T. 16 N., R. 90 W.,
6th P.M., Carbon County, Wyoming

Collar elevation: 7,610 ft

Drilling started 9-3-76; completed 9-4-76

Total depth: 410 ft

Air injection drilling 0-330 ft; air and water 330-410 ft

Logged by: C. S. V. Barclay and B. A. Rood

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Sandstone and siltstone. Sandstone is very pale brown (10 YR 7/3), fine grained, noncalcareous, open; contains numerous carbonaceous and limonitic grains. Siltstone is weak yellowish orange (2.5 Y 8/4), noncalcareous; contains carbonaceous streaks-----	0	5
Sandstone, as in interval above, and claystone. Clay- stone is light gray (N7) to very light gray (N8) and olive gray (5 Y 4/1)-----	5	8
Coal-----	8	10
Coal, impure-----	10	15
Sandstone, very light gray (N8), very fine grained, silty, noncalcareous, open; contains carbonaceous particles-----	15	16.5
Sandstone, grayish-yellow (5 Y 7/3) and weak-yellowish- orange (2.5 Y 8/4), fine-grained, noncalcareous; con- tains carbonaceous particles-----	16.5	18

Lithologic log of drill-hole DM-D21--continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone and claystone. Siltstone is light olive gray (5 Y 5/1-6/1), noncalcareous; contains some carbonaceous particles and limonitic grains.		
Claystone is dark yellowish orange (10 YR 6/6)-----	18	20
Mudstone and coal. Mudstone is medium dark gray (N5) to grayish black (N2). Coal, 21-22 ft-----	20	25
Claystone and siltstone. Claystone is medium dark gray (N4) to grayish black (N2). Thin layer of weak-yellowish-orange (2.5 Y8/4) siltstone at 26 ft-	25	30
Claystone, medium-gray (N5)-----	30	35
Coal-----	35	37.5
Sandstone, yellowish-gray (2.5 Y 7/2), very fine grained, noncalcareous, soft; contains carbonaceous particles-----	37.5	40
Sandstone, medium-light-gray (N6) to moderate-yellow (2.5 Y 7/6) near bottom of interval, very fine grained, noncalcareous, soft; contains carbonaceous particles-----	40	45
Siltstone, medium-light-gray (N7), noncalcareous, soft; contains carbonaceous particles-----	45	50
Mudstone and siltstone. Mudstone is medium dark gray (N4). Siltstone is light gray (N7), noncalcareous; contains carbonaceous streaks-----	50	52.5

Lithologic log of drill-hole DM-D21 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Coal-----	52.5	55
Mudstone, medium-gray to medium-dark-gray (N5-N4)-----	55	57.5
Coal-----	57.5	63
Mudstone, medium-gray to medium-dark-gray (N5-N4)-----	63	65
Siltstone, medium-dark-gray (N4), noncalcareous-----	65	70
Mudstone and siltstone. Mudstone is medium dark gray (N4). Siltstone is medium gray (N5), noncalcareous; contains coal particles-----	70	77
Sandstone, weak-yellowish-orange (2.5 Y 8/4), very fine grained, noncalcareous, soft; contains carbonaceous particles-----	77	82.5
Siltstone and claystone. Siltstone is light olive gray (N6), noncalcareous; contains carbonaceous laminae. Claystone is medium dark gray (N4)-----	82.5	93.5
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous, hard-----	93.5	95
Sandstone, light-gray (N7), very fine grained, non- calcareous, soft; contains coal particles-----	95	96
Sandstone, medium-light-gray (N6), fine-grained, noncalcareous, hard-----	96	98
Siltstone, medium-light-gray (N6), noncalcareous, soft; contains carbonaceous laminae-----	98	100

Lithologic log of drill-hole DM-D21 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Sandstone and claystone. Sandstone is light gray (N7), very fine grained, noncalcareous, soft; contains carbonaceous particles. Claystone is medium dark gray (N4)-----	100	105
Claystone, as in interval above, and sandstone. Sandstone is medium light gray (N6), very fine grained, noncalcareous, soft; contains carbonaceous particles-----	105	115
Sandstone, mudstone, and coal. Sandstone is light gray (N7), very fine grained, silty, noncalcareous, soft; contains carbonaceous particles. Mudstone is dark gray (N3). Thin coal bed at 117 ft-----	115	120
Sandstone, as in interval above-----	120	130
Siltstone, light-olive-gray (5 Y 6/1), noncalcareous, very hard; contains carbonaceous and coal laminae---	130	130.5
Sandstone and siltstone. Sandstone is medium gray (N5), very fine grained, noncalcareous, soft; contains carbonaceous particles. Siltstone is medium dark gray (N4), noncalcareous-----	130.5	135
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is medium light gray (N6), noncalcareous, soft; contains carbonaceous particles-----	135	142

Lithologic log of drill-hole DM-D21 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Coal and coaly, grayish-black (N2) claystone-----	142	147
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is medium gray (N5), non-calcareous; contains carbonaceous particles-----	147	155
Mudstone and siltstone. Mudstone is dark gray (N3). Siltstone is medium dark gray (N4)-----	155	165
Sandstone, light-gray (N7), very fine grained, silty, noncalcareous, soft-----	165	175
Sandstone, as in interval above, and olive-gray (5 Y 5/1) claystone-----	175	180
Sandstone, as in interval above-----	180	190
Sandstone and mudstone. Sandstone is medium light gray (N6), very fine grained, noncalcareous; contains carbonaceous particles. Mudstone is medium gray (N5)-----	190	197
Coal-----	197	202
Mudstone, claystone, and siltstone. Mudstone is grayish black (N2); contains coal laminae. Claystone is olive gray (5 Y 4/1). Siltstone is medium dark gray (N4), noncalcareous, soft; contains carbonaceous particles-----	202	207
Siltstone, light-gray (N7), noncalcareous, soft-----	207	220

Lithologic log of drill-hole DM-D21 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, medium-light-gray (N6), noncalcareous, soft; contains coal particles-----	220	230
Sandstone and siltstone. Sandstone is medium gray (N5), very fine grained, noncalcareous, soft; contains coal particles. Siltstone is medium light gray (N6), noncalcareous-----	230	235
Sandstone, light-gray (N7), very fine grained, non- calcareous, soft; contains coal particles-----	235	240
Sandstone, as in interval above, but slightly coarser-	240	245
Sandstone, medium-light-gray (N6), silty, noncal- careous, soft; contains coal particles-----	245	250
Sandstone, as in interval above, and medium-gray (N5) mudstone-----	250	260
No sample recovery-----	260	266
Siltstone, medium-dark-gray (N4), noncalcareous, soft; contains coal particles-----	266	275
Sandstone and siltstone. Sandstone is medium gray (N5), very fine grained, soft. Siltstone is light olive gray (5 Y 5/1), noncalcareous, soft-----	275	280
Siltstone and sandstone. Siltstone is medium dark gray (N4). Sandstone is medium gray (N5), very fine grained, soft-----	280	290

Lithologic log of drill-hole DM-D21 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is medium dark gray (N4); contains coal particles. Siltstone is medium gray (N5), noncalcareous-----	290	295
Mudstone, claystone, and siltstone. Mudstone is grayish black (N2). Claystone is medium gray (N5). Siltstone is medium dark gray (N4), noncalcareous, soft; contains carbonaceous particles-----	295	300
Mudstone, as in interval above, claystone, and siltstone. Claystone is light gray (N7). Siltstone is medium light gray (N6), noncalcareous, soft; contains carbonaceous particles-----	300	305
Sandstone, light-gray (N7), very fine grained, noncalcareous, soft; contains coal particles-----	305	310
Siltstone, medium-gray (N5) to medium-light-gray (N6), noncalcareous. Thin hard layer at 317 ft-----	310	320
Claystone and sandstone. Claystone is medium gray (N5). Sandstone is medium gray (N5), very fine grained, noncalcareous, soft-----	320	328
Mudstone and siltstone. Mudstone is medium dark gray (N4). Siltstone is medium gray (N5)-----	328	330
Mudstone and claystone. Mudstone is dark gray (N3), coaly. Claystone is medium gray (N5); contains coal particles-----	330	335

Lithologic log of drill-hole DM-D21--continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone and claystone. Siltstone is medium light gray (N6), noncalcareous; contains coal particles.		
Claystone is dark gray (N3), carbonaceous-----	335	340
Siltstone, as in interval above, sandstone, and claystone. Sandstone is very light gray (N8), very fine grained, noncalcareous, open; contains carbonaceous particles. Claystone is medium dark gray (N4); contains coal particles-----	340	345
Sandstone and claystone, as in interval above-----	345	350
Claystone, grayish-black (N2), very coaly-----	350	355
Claystone, as in interval above, and medium gray (N5) mudstone-----	355	360
Mudstone, as in interval above-----	360	365
Siltstone, medium-gray (N5)-----	365	370
Mudstone, medium-dark-gray (N4)-----	370	375
Siltstone and mudstone. Siltstone is medium light gray (N6), noncalcareous; contains carbonaceous particles. Mudstone is medium gray (N5)-----	375	380
Mudstone, dark-gray (N3), and medium-dark-gray (N4) claystone-----	380	410
Total depth - 410 ft		

Lithologic log of drill-hole DM-D25

[Intervals marked with a single asterisk (*) are intervals for which lithologic data are less reliable than for other intervals because of poor sample quality or insufficient sample quantity. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 1,700 ft FEL and 100 ft FNL, sec. 5, T. 15 N., R. 90 W.,
6th P.M., Carbon County, Wyoming

Collar elevation: 7,340 ft

Drilling started 9-2-76; completed 9-3-76

Total depth: 610 ft

Air injection drilling 0-290 ft; air and water 290-610 ft

Logged by: C. S. V. Barclay and B. A. Rood

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Sandstone, moderate-yellowish-brown (10 YR 5/6) and grayish-brown (10 YR 4/3), very fine grained, calcareous; contains limonitic particles-----	0	5
Claystone, medium-light-gray (N6) and light-yellowish- brown (2.5 Y 6/4)-----	5	10
Claystone, as in interval above, and siltstone. Silt- stone is yellowish gray (5 Y 7/3) and light yellowish brown (2.5 Y 6/4), noncalcareous, open-----	10	15
Siltstone, yellowish-gray (5 Y 7/3) and weak-yellowish- orange (10 YR 7/8), calcareous-----	15	17.5
Siltstone, light-olive-gray (5 Y 6/1)-----	17.5	20
Claystone and siltstone. Claystone is light olive gray (5 Y 6/2) to olive gray (5 Y 5/1). Siltstone is yellowish gray (5 Y 7/3), calcareous; contains limonitic particles-----	20	25

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Mudstone, medium-gray (N4)-----	25	41
Sandstone, light-olive-gray (5 Y 5/2), very fine grained, calcareous, hard; contains limonitic particles and glauconite-----	41	43
Sandstone, very pale brown (10 YR 7/4), very fine grained, noncalcareous-----	43	45
Sandstone, weak-yellowish-orange (2.5 Y 7/2); contains medium-light-gray (N6) claystone laminae-----	45	50
Siltstone and sandstone. Siltstone is light gray (N7), noncalcareous; contains coal particles. Sandstone is yellowish gray (5 Y 7/2), very fine grained, non- calcareous; contains limonitic and carbonaceous particles-----	50	55
Siltstone, as in interval above-----	55	65
Sandstone and siltstone. Sandstone is yellowish gray (5 Y 7/3), very fine grained, noncalcareous; con- tains carbonaceous particles. Siltstone is medium light gray (N6), noncalcareous; contains carbonaceous particles-----	65	67
Siltstone and sandstone. Siltstone is light gray (N7), calcareous; contains carbonaceous particles. Sand- stone is medium light gray (N6), noncalcareous, tight; forms hard layer, 68-68.5 ft-----	67	70

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained, calcareous, soft. Siltstone is medium light gray (N6), calcareous; contains carbonaceous particles-----	70	74
Sandstone, weak-yellowish-orange (10 YR 7/6), very fine grained, calcareous, soft-----	74	76
Sandstone, light-gray (N7), very fine grained, calcareous, soft-----	76	85
Sandstone, as in interval above, and medium-gray (N5) claystone-----	85	90
Claystone and siltstone, interbedded. Claystone is medium dark gray (N4). Siltstone is medium gray (N5), calcareous, soft-----	90	100
Mudstone and siltstone. Mudstone is medium gray (N5). Siltstone is light gray (N7), calcareous; contains coal particles. Thin hard layer, 101-101.5 ft-----	100	115
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is medium gray (N5), noncalcareous, soft; contains carbonaceous particles. Thin hard layer at 127 ft-----	115	135
Mudstone and siltstone. Mudstone is medium dark gray (N4). Siltstone is medium gray (N5), calcareous; contains carbonaceous particles-----	135	137
Siltstone, grayish-orange (10 YR 7/4), calcareous-----	137	140

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, light-gray (N7), calcareous; contains carbonaceous particles-----	140	143
Claystone, grayish-black (N2), coaly-----	143	148
Siltstone and mudstone. Siltstone is medium light gray (N6), noncalcareous, soft. Mudstone is medium dark gray (N4)-----	148	160
Siltstone, as in interval above-----	160	170
Mudstone, medium-dark-gray (N4) to grayish-black (N2) and coaly near bottom of interval-----	170	175
Coal-----	175	177
Sandstone, light-gray (N7), very fine grained, noncal- careous, soft; contains carbonaceous particles-----	177	184
Coal-----	184	188
Siltstone, medium-light-gray (N6), noncalcareous, soft; contains coal particles-----	188	190
Claystone and siltstone. Claystone is medium dark gray (N4) and light brownish gray (10 YR 6/1). Siltstone is medium light gray (N6), noncalcareous; contains carbonaceous particles-----	190	199
Coal-----	199	200
Siltstone, medium-dark-gray (N4) to grayish-black (N2) at bottom of interval, noncalcareous; contains coal particles-----	200	203

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, light-brownish-gray (10 YR 6/1), non-calcareous, soft; contains carbonaceous particles-----	203	215
Claystone and siltstone. Claystone is medium gray (N5); contains coal laminae. Siltstone is medium light gray (N6), noncalcareous, soft; contains carbonaceous particles-----	215	230
Siltstone, light-gray (N7), noncalcareous, soft; contains carbonaceous particles-----	230	235
Claystone, grayish-black (N2), coaly-----	235	248
Mudstone, medium-dark-gray (N4); contains coal laminae--	248	250
Mudstone, as in interval above, and siltstone. Siltstone is medium dark gray (N4), noncalcareous; contains carbonaceous particles. Thin hard layer at 258 ft-----	250	260
Sandstone, light-gray (N7), very fine grained, non-calcareous, soft; contains carbonaceous laminae-----	260	270
Siltstone, medium-light-gray (N6), noncalcareous, soft; contains carbonaceous particles-----	270	275
Siltstone and sandstone. Siltstone is light-gray (N7), noncalcareous, soft; contains carbonaceous particles; grades to silty sandstone in lower half of interval--	275	290

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Mudstone and siltstone. Mudstone is dark gray (N3).		
Siltstone is medium gray (N5), noncalcareous, tight;		
contains carbonaceous particles-----	290	305
Mudstone, grayish-black (N2), coaly-----	305	310
Claystone, dark-gray (N3) to grayish-black (N2) in		
lower 5 ft of interval; contains some coal laminae---	310	325
Mudstone, medium-dark-gray (N4), to grayish-black (N2),		
and coaly at bottom of interval-----	325	340
Claystone, mudstone, and siltstone. Claystone is dark		
gray (N3). Mudstone is medium dark gray (N4). Silt-		
stone is medium gray (N5), noncalcareous; contains		
carbonaceous streaks-----	340	345
Mudstone, grayish-black (N2); contains coal laminae-----	345	350
Siltstone, medium-gray (N5), noncalcareous, tight; con-		
tains coal laminae-----	350	355
Claystone and sandstone. Claystone is dark gray (N3)		
to medium gray (N5); contains some coal laminae.		
Sandstone is very light gray (N8), very fine grained,		
noncalcareous; contains coal laminae-----	355	410*
Claystone, medium-dark-gray (N4) to grayish-black (N2),		
coaly-----	410	445*
Claystone, black (N1), very coaly-----	445	450
Mudstone and siltstone. Mudstone is medium dark gray		
(N4). Siltstone is light gray (N7), noncalcareous,		
hard; contains some carbonaceous particles-----	450	460

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Mudstone and siltstone. Mudstone is grayish black (N2) to medium dark gray (N4); contains coal laminae. Siltstone is medium light gray (N6), noncalcareous; contains carbonaceous particles-----	460	465
Claystone and mudstone. Claystone is medium gray (N5). Mudstone is grayish black (N2); contains some coal laminae-----	465	480
Claystone, grayish black (N2); coaly-----	480	485
Mudstone, medium-dark-gray (N4)-----	485	490
Mudstone, as in interval above, and siltstone. Siltstone is pale brown (2.5 Y 6/2), noncalcareous; contains carbonaceous particles-----	490	500
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is light olive gray (5 Y 6/2), noncalcareous, hard-----	500	507
Sandstone, very light gray (N8), very fine grained, noncalcareous; contains carbonaceous particles-----	507	510
Siltstone and claystone. Siltstone is medium gray (N5), noncalcareous, hard. Claystone is dark gray (N3)----	510	520
Claystone, as in interval above, and sandstone. Sandstone is medium gray (N5), noncalcareous-----	520	530
Claystone and siltstone. Claystone is black (N1), coaly. Siltstone is pale brown (10 YR 6/2), noncalcareous---	530	540

Lithologic log of drill-hole DM-D25 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, as in interval above, and very light gray (N8), noncalcareous, soft claystone-----	540	545
Mudstone and sandstone. Mudstone is medium dark gray (N4). Sandstone is light gray (N8), noncalcareous; contains carbonaceous particles-----	545	550
Mudstone and sandstone. Mudstone is grayish black (N2), coaly. Sandstone is medium light gray (N6), very fine grained, noncalcareous; contains numerous coal particles-----	550	555
Sandstone and mudstone. Sandstone is medium light gray (N6), noncalcareous; contains coal particles. Mudstone is dark gray (N3); both contain coal particles-----	555	565
Claystone and siltstone. Claystone is dark gray (N3). Siltstone is very light gray (N8), noncalcareous-----	565	610
Total depth - 610 ft		

Lithologic log of drill-hole BH-D1

[Intervals marked with a single asterisk (*) are intervals for which lithologic data are less reliable than for other intervals because of poor sample quality or insufficient sample quantity. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 925 ft FWL, 2,325 ft FSL, sec. 26, T. 15 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,600 ft

Drilling started 8-12-76; completed 8-18-76

Total depth: 590 ft

Air injection drilling 0-210 ft; air and water 210-590 ft

Logged by: L. A. Shoaff

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Gravel, sandstone, and claystone. Gravel is in a thin layer at top of interval. Sandstone is weak yellowish orange (10 YR 7/8), fine grained, very calcareous. Claystone is yellow (5 Y 8/8) and medium brown (7.5 YR 4/4)-----	0	4
Claystone, medium-gray (N6); contains some gypsum-----	4	9
Claystone, light-yellowish-brown (10 YR 6/4) and medium-light-gray (N6)-----	9	20
Claystone, dark-gray (N3), carbonaceous; contains some gypsum-----	20	30
Sandstone and claystone. Sandstone is pale brown (10 YR 6/3), very fine grained, noncalcareous, soft. Claystone is light yellowish brown (10 YR 6/4)-----	30	35

Lithologic log of drill-hole BH-D1 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and sandstone. Claystone is dark gray (N3), carbonaceous. Sandstone is weak yellowish orange (10 YR 7/6), very fine grained, calcareous, soft-----	35	38
Coal-----	38	42
Claystone and sandstone. Claystone is dark gray (N3), carbonaceous. Sandstone is weak yellowish orange (10 YR 7/6), very fine grained, calcareous, soft-----	42	50
Coal-----	50	56.5
Claystone, medium-dark-gray (N4); contains some coal laminae-----	56.5	58
Siltstone, grayish-orange (10 YR 7/4) and medium-light- gray (N6), noncalcareous-----	58	62
Sandstone, medium-light-gray (N6), fine to very fine grained, calcareous, strongly cemented; contains coal particles-----	62	66
Sandstone, pale-brown (10 YR 6/3), very fine grained, calcareous, soft-----	66	70
Coal-----	70	73.5
Siltstone, light-olive-gray (5 Y 6/1), noncalcareous, soft-----	73.5	77
Claystone, grayish-black (N2)-----	77	79

Lithologic log of drill-hole BH-D1 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, very light gray (N8) and pale-brown (10 YR 6/3), noncalcareous, soft; contains numerous carbonaceous streaks-----	79	81
Sandstone and claystone. Sandstone is light yellowish brown (10 YR 6/4), fine grained to very fine grained, noncalcareous, soft. Claystone is medium light gray (N6)-----	81	85
Claystone, medium-gray (N5) to dark-gray (N3)-----	85	90
Claystone, medium-light-gray (N6) to medium-dark-gray (N4); contains some gypsum-----	90	94
Sandstone, yellowish-gray (10 YR 7/1) and pale-yellowish- orange (10 YR 8/6), very fine grained, noncalcareous, soft-----	94	110
Sandstone, as in interval above, and medium-gray (N5) claystone-----	110	115
Sandstone, light-brownish-gray (10 YR 5/1), very fine grained, soft; contains coal particles-----	115	120
Coal-----	120	128
Claystone, grayish-black (N2), carbonaceous-----	128	130
Siltstone and claystone. Siltstone is light gray (N7); contains some carbonaceous particles. Claystone is medium gray (N5)-----	130	134
Coal-----	134	146

Lithologic log of drill-hole BH-D1 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone, claystone, and coal. Siltstone is very light gray (N8), noncalcareous; contains carbonaceous streaks. Thin coal bed near 151 ft-----	146	155
Siltstone, medium-light-gray (N6), noncalcareous, soft; contains coal particles-----	155	160
Sandstone and claystone. Sandstone is light gray (N7), fine grained to very fine grained, soft; contains coal particles. Claystone is medium dark gray (N4)--	160	165
Sandstone, as in interval above-----	165	170
Sandstone, as in interval above, and medium-gray (N5) claystone-----	170	175
Claystone, as in interval above-----	175	180
Claystone, sandstone, and coal. Claystone is dark gray (N3), very carbonaceous. Sandstone is light gray (N7). Thin coal bed at 182 ft-----	180	190
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous, soft; contains coal and carbonaceous particles-----	190	210
Claystone and siltstone. Claystone is medium dark gray (N4) and grayish brown (2.5 Y 5/2); contains numerous carbonaceous laminae. Siltstone is light gray (N7), noncalcareous; contains coal and carbonaceous laminae-----	210	215

Lithologic log of drill-hole BH-D1 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, as in interval above, and coal. Coal probably occurs as thin beds in the claystone-----	215	225
Claystone, as in interval above, siltstone and coal.		
Siltstone is light gray (N7), very fine grained; contains coal particles-----	225	240
Sandstone, claystone, and coal. Sandstone is very light gray (N8), very fine grained; contains coal laminae. Claystone is dark gray (N3) with carbonaceous laminae-----	240	245
Coal-----	245	250
Coal and dark-gray (N3) to medium-light-gray (N6) claystone-----	250	275
Claystone and siltstone. Claystone is medium gray (N5). Siltstone is very light gray (N8), noncalcareous; contains carbonaceous streaks-----	275	290
Siltstone, very light gray (N8), noncalcareous; contains carbonaceous streaks-----	290	300
Claystone and siltstone. Claystone is medium dark gray (N4) and dark gray (N3); contains carbonaceous streaks. Siltstone is medium light gray (N6), noncalcareous, strongly cemented-----	300	306
Siltstone, medium-light-gray (N6), noncalcareous, strongly cemented-----	306	310

Lithologic log of drill-hole BH-D1 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is medium gray (N5). Siltstone is medium light gray (N6); contains carbonaceous streaks-----	310	333
Claystone, white (N9)-----	333	338
Sandstone or coarse siltstone, light-gray (N7), strongly cemented; contains carbonaceous particles-----	338	341
Claystone and siltstone. Claystone is medium gray (N5). Siltstone is light gray (N7), noncalcareous, tight; contains coal and carbonaceous particles-----	341	345*
Siltstone, very light gray (N8), noncalcareous; contains numerous coal laminae-----	345	350*
Siltstone, as in interval above, and medium-gray (N5) claystone-----	350	365
Claystone, medium-dark-gray (N4) and dark-gray (N3)-----	365	369
Coal-----	369	370
Claystone, black (N1), coaly-----	370	375
Claystone, as in interval above, and coal-----	375	380
Claystone, medium-dark-gray (N5) and medium-gray (N5)---	380	395*
Claystone, as in interval above, and sandstone. Sandstone is medium light gray (N6), very fine grained, noncalcareous, strongly cemented-----	395	400
Claystone, medium-dark-gray (N4) and medium-gray (N5) to dark-gray (N3) in bottom half of interval-----	400	450

Lithologic log of drill-hole BH-D1--continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Coal and grayish-black (N2), coaly claystone-----	450	455
Claystone, medium-gray (N5) to dark-gray (N3); contains coal laminae-----	455	465
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7); contains coal streaks-----	465	470
Claystone, medium-dark-gray (N4)-----	470	480
Coal and medium-gray (N5) to grayish-black (N2) claystone-----	480	490
Claystone, medium-gray (N5) to grayish-black (N2) and coaly-----	490	590*
Total depth - 590 ft		

Lithologic log of drill-hole BH-D3

[Intervals marked with a single asterisk (*) are intervals for which lithologic data are less reliable than for other intervals because of poor sample quality or insufficient sample quantity. Intervals marked with a double asterisk (**) are intervals in which formation penetration by the drill was more rapid than in other intervals. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 350 ft FEL, 1,850 ft FNL, sec. 3, T. 14 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,500 ft

Drilling started 8-8-76; completed 8-11-76

Total depth: 490 ft

Air injection drilling 0-90 ft; air and water 90-490 ft

Logged by: L. A. Shoaff

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone, light-yellowish-brown (10 YR 6/4) and light-brownish-gray (10 YR 5/1), silty; contains carbonaceous streaks-----	0	10
Claystone, light-olive-brown (2.5 Y 5/4) and light- olive-gray (5 Y 6/1), silty; contains limonitic grains and carbonaceous particles-----	10	12
Claystone, medium-gray (N5); contains gypsum-----	12	16
Claystone, dark-yellowish-orange (10 YR 6/6) and light- olive-gray (5 Y 6/1); contains gypsum-----	16	18
Claystone, strong orange (7.5 YR 5/8) and light-olive- gray (5 Y 6/1)-----	18	20
Claystone, olive-gray (5 Y 4/2) and light-olive-gray (5 Y 6/1)-----	20	30

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is light olive gray (5 Y 5/1) and weak yellowish orange (2.5 Y 7/4); contains limonitic grains. Siltstone is light brownish gray (10 YR 6/1), calcareous-----	30	35
Coal-----	35	38
Siltstone and claystone. Siltstone is grayish brown (2.5 Y 5/2) and yellowish gray (2.5 Y 7/2), sandy. Claystone is yellowish gray (2.5 Y 7/2) to medium gray (N5) at bottom of interval; contains carbonaceous laminae-----	38	45
Coal-----	45	46.5
Siltstone and claystone. Siltstone is grayish brown (2.5 Y 5/2) and yellowish gray (2.5 Y 7/2). Claystone is medium gray (N5); contains carbonaceous laminae; probably occurs as thin beds in the siltstone-----	46.5	53
Siltstone and claystone. Siltstone is light olive gray (5 Y 5/2), weakly cemented, noncalcareous. Claystone is light gray (N7) to medium gray (N5) with white (N9) siltstone laminae-----	53	55
Claystone, medium-light-gray (N6); contains carbonaceous streaks-----	55	60

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, as in interval above, and siltstone.		
Siltstone is light gray (N7) and weak yellowish orange (10 YR 7/6), calcareous; contains some carbonaceous laminae. Hard layer 66-66.5 ft-----	60	70
Claystone, medium-gray (N5); contains carbonaceous laminae which become more numerous with depth-----	70	76
Siltstone, olive-gray (5 Y 4/1), calcareous, weakly cemented-----	76	83.5**
Claystone, grayish-black (N2). Hard layer, 84.5-85 ft--	83.5	85
Siltstone, light-gray (N7), calcareous, strongly cemented; contains coal particles. Several hard layers, 85-88 ft-----	85	90
Mudstone, siltstone, and sandstone. Mudstone is medium light gray (N6); contains carbonaceous streaks. Siltstone is very light gray (N8), calcareous; contains carbonaceous laminae. Sandstone is light gray (N7), calcareous; contains coal particles-----	90	95
Claystone, medium-light-gray (N6) at top to medium-gray (N5) and medium-dark-gray (N4) at bottom of interval; contains coal particles-----	95	104
Sandstone, light-gray (N7), very fine grained, calcareous; contains coal particles-----	104	105

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and mudstone. Claystone is light brownish gray (10 YR 6/1) to grayish black (N2) near bottom of interval. Thin medium-light-gray (N6) mudstone bed near 108 ft-----	105	121
Siltstone, light-gray (N7) to medium-gray (N5) with increase in amount of brown carbonaceous laminae; calcareous-----	121	125
Mudstone, medium-light-gray (N6)-----	125	132
Claystone, medium-dark-gray (N4)-----	132	136
Siltstone and sandstone. Siltstone is light gray (N7), calcareous; contains coal particles; grades to very fine grained sandstone at bottom of interval-----	136	140
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is light gray (N7), calcareous; contains coal particles-----	140	145
Mudstone and siltstone. Mudstone is medium gray (N5). Siltstone is light gray (N7), calcareous; contains carbonaceous streaks-----	145	150
Claystone, dark-gray (N3)-----	150	155
Mudstone and siltstone. Mudstone is medium-dark-gray (N4). Siltstone is light gray (N7), calcareous; contains coal particles-----	155	160

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is light gray (N7), calcareous; contains coal particles-----	160	165
Claystone, as in interval above-----	165	170
Mudstone and siltstone. Mudstone is medium gray (N5). Siltstone is light gray (N7), noncalcareous, tight; contains coal particles and glauconite-----	170	175
Sandstone, very light gray (N8) to light-gray (N7), medium-grained to fine-grained; grades to very fine grained sandstone at bottom of interval-----	175	198
Siltstone, medium-light-gray (N6); contains carbonaceous streaks-----	198	205
Siltstone, as in interval above, and medium-gray mudstone-----	205	217
Claystone, dark-gray (N3); contains numerous carbonaceous laminae-----	217	220
Sandstone, light-gray (N7), fine-grained, noncalcareous; contains coal particles, carbonaceous streaks, and glauconite-----	220	225
Claystone, siltstone, and sandstone. Claystone is medium dark gray (N4). Siltstone is light olive gray (5 Y 5/1), tight, calcareous. Sandstone is light gray (N7), very fine grained, noncalcareous; contains coal particles-----	225	245

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, medium-gray (N5); contains some carbonaceous streaks-----	245	255
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous, strongly cemented. Claystone is medium gray (N5); contains carbonaceous streaks.		
Hard layer, 255.5-256.5 ft-----	255	265
Claystone, medium-gray (N5) to dark-gray (N3), with increase in amount of brown carbonaceous laminae-----	265	288
Siltstone, light-gray (N7) to medium-light-gray (N6), noncalcareous-----	288	289
Claystone, dark-gray (N3)-----	289	313
Coal-----	313	315
Claystone, grayish-black (N2)-----	315	320
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7), calcareous; contains some carbonaceous streaks-----	320	329.5
Coal-----	329.5	335
Mudstone, medium-gray (N5)-----	335	338*
Sandstone, light-gray (N7), fine to very fine grained, noncalcareous, strongly cemented; contains coal particles and glauconite-----	338	341
Siltstone, very light gray (N8), noncalcareous, tight; contains some coal laminae-----	341	348
Coal-----	348	351

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, medium-dark-gray (N4)-----	351	355*
Claystone, as in interval above, and siltstone. Siltstone is very light gray (N8), calcareous; contains some carbonaceous streaks-----	355	365
Siltstone, as in interval above, and medium-gray (N5) claystone-----	365	370
Coal-----	370	376
Claystone and siltstone. Claystone is grayish black (N2); contains numerous coal laminae. Siltstone is light gray (N7), tight; contains some carbonaceous streaks-----	376	385*
Siltstone, medium-light-gray (N6) to light-gray (N7), strongly cemented, tight-----	385	394.5
Coal-----	394.5	398
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is light gray (N7); contains carbonaceous streaks-----	398	415* **
No sample recovery-----	415	420
Claystone, medium-dark-gray (N4) to medium-gray (N5)----	420	425
Siltstone and claystone. Siltstone is light gray (N7), calcareous, tight; contains coal particles and carbonaceous laminae. Claystone is medium gray (N5)-	425	430
Siltstone, as in interval above, and grayish-black (N2) and medium-dark-gray (N4) claystone-----	430	435

Lithologic log of drill-hole BH-D3 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, medium-gray (N5); contains carbonaceous laminae-----	435	444
Sandstone, light-gray (N7), noncalcareous, strongly cemented; contains coal particles. Hard layer, 444-445 ft-----	444	450
Coal-----	450	455
Claystone, dark-gray (N3)-----	455	490*
Total depth - 490 ft		

Lithologic log of drill-hole BH-D5

[It was necessary to inject water at 50 ft to dislodge drill. As a consequence, hole continually eroded, and samples recovered from intervals below 270 ft were generally contaminated with material from higher portions of the hole and lithologic data for these intervals are not as reliable as data for other intervals. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 600 ft FEL, 2,450 ft FSL, sec. 14, T. 14 N., R. 90 W.,
6th P.M., Carbon County, Wyoming

Collar elevation: 7,580 ft

Drilling started 8-4-76; completed 8-6-76

Total depth: 470 ft

Air injection drilling 0-50 ft; air and water 50-470 ft

Logged by: L. A. Shoaff

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone, pale-brown (10 YR 5/3); contains gypsum.		
Hard layer about 0.5 ft thick near 13 ft-----	0	24
Mudstone, strong- or orange-brown (7.5 YR 5/6-5/8)-----	24	25
Claystone and mudstone. Claystone is light olive gray (5 Y 5/1); contains some carbonaceous streaks and gypsum. At 34 ft, some iron-oxide coloration.		
Mudstone is strong or orange brown (7.5 YR 5/6-5/8) to moderate yellowish brown (10 YR 5/6) and occurs at bottom of interval-----	25	40
Claystone and mudstone. Claystone is olive gray (5 Y 5/2); contains carbonaceous streaks. Mudstone is dusky yellow (5 Y 6/4)-----	40	45

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone, claystone, and mudstone. Siltstone is yellowish brown (10 YR 5/8), calcareous. Claystone is light brownish gray (10 YR 5/1); contains carbonaceous streaks. Mudstone is grayish brown (2.5 Y 5/2) and dark yellowish brown (10 YR 4/2)-----	45	50
Siltstone, as in interval above, and claystone. Claystone is medium gray (N5) and probably occurs as thin beds in siltstone-----	50	70
Mudstone, medium-gray (N5), and medium-dark-gray claystone (N4)-----	70	75
Mudstone and coal. Mudstone is dark gray (N3); contains coal or carbonaceous streaks. Coal probably occurs as thin beds in the mudstone-----	75	80
Siltstone, claystone, and sandstone. Siltstone is medium light gray to light gray (N6-N7), calcareous; contains carbonaceous streaks. Claystone is medium dark gray to medium gray (N4-N5). Sandstone is light gray (N7), very fine grained to fine-grained, non-calcareous-----	80	100
Claystone, siltstone, and mudstone. Claystone is medium dark gray (N4). Siltstone is white (N9); appears to be interlaminated with claystone. Mudstone is yellowish gray (10 YR 7/1)-----	100	105

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Sandstone and claystone. Sandstone is light gray (N7), very fine grained, very calcareous; contains coal particles and carbonaceous streaks. Claystone is medium dark gray to medium gray (N4-N5)-----	105	115
Sandstone, siltstone, and claystone. Sandstone is light gray, very fine grained, very calcareous; contains glauconite and coal and carbonaceous particles. Siltstone grades from grayish yellow (5 Y 8/4) to light brownish gray (10 YR 6/1) with increasing depth; contains carbonaceous streaks. Claystone is medium gray (N5) and grayish brown (2.5 Y 3/2)----	115	130
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is light gray (N7), calcareous, and appears to be interbedded with claystone; contains carbonaceous streaks-----	130	155
Siltstone, sandstone, and claystone. Siltstone is medium gray (N5), noncalcareous; contains coal and carbonaceous streaks; appears to be interbedded with very light gray (N8), very fine grained, noncalcareous sandstone which contains coal particles. Claystone is medium gray (N5)-----	155	160
Claystone, medium-dark-gray (N4) and grayish-black (N2); contains numerous carbonaceous laminae-----	160	164.5

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Coal-----	164.5	165.5
Siltstone and claystone. Siltstone is medium gray (N5), noncalcareous; contains numerous coal particles.		
Claystone is medium gray (N5)-----	165.5	175
Mudstone, claystone, and siltstone. Mudstone is medium gray (N5). Claystone is medium light gray (N6); contains carbonaceous streaks. Siltstone is very light gray, noncalcareous-----	175	180
Sandstone, claystone, and coal. Sandstone is light gray (N7) to very light gray, very fine grained, noncal- careous; contains coal particles. Claystone is medium dark gray (N4) and light olive gray (5 Y 5/1).		
Very thin coal bed near bottom of interval-----	180	190
Siltstone and claystone. Siltstone is very light gray (N8), slightly calcareous, strongly cemented. Clay- stone is medium gray (N5). Hard layer, 191-191.5 ft-	190	195
Mudstone and siltstone. Mudstone is medium gray (N5). Siltstone is light gray (N7), slightly calcareous----	195	198.5
Claystone, medium-gray (N5); contains carbonaceous streaks-----	198.5	212
Siltstone and sandstone. Siltstone is medium light gray (N6), noncalcareous. Sandstone is light gray (N7), very fine grained, slightly calcareous-----	212	215

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone, siltstone, and sandstone. Claystone is medium dark gray (N4) to medium gray (N5). Siltstone is light gray (N7), slightly calcareous, strongly cemented; contains particles of coal. Sandstone is light gray (N7) to medium light gray (N6), very fine grained, noncalcareous; contains coal particles and glauconite-----	215	220
Siltstone, claystone, and sandstone. Siltstone is light gray (N7), noncalcareous; contains coal particles. Claystone is medium gray (N5), silty. Sandstone is light gray (N7), fine grained to very fine grained, calcareous; contains coal particles and glauconite-----	220	225
Claystone and sandstone. Claystone is light brownish gray (10 YR 4/1). Sandstone is very light gray (N8), very fine grained, very calcareous; contains coal particles and glauconite-----	225	230
Sandstone, as in interval above, claystone, and siltstone. Claystone is medium gray (N5). Siltstone is light gray (N7), sandy, noncalcareous; contains coal particles-----	230	240
Siltstone, as in interval above, and dark-gray (N3) claystone-----	240	245

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone, as in interval above, and sandstone.		
Sandstone is medium light gray (N6), very fine grained, strongly cemented; contains numerous coal particles and glauconite-----	245	250
Sandstone, siltstone, and claystone. Sandstone is light gray (N7), very fine grained, noncalcareous; contains coal particles and glauconite. Siltstone is medium light gray (N6), noncalcareous; contains coal particles and glauconite. Claystone is medium gray (N5)-----	250	265
Claystone and sandstone. Claystone is medium light gray (N6) to medium gray (N5); contains numerous coal laminae. Sandstone is very light gray (N8), very fine grained to fine grained, noncalcareous; contains coal particles and glauconite-----	265	270
No sample recovery-----	270	280
Siltstone, medium-gray (N5)-----	280	290
Claystone, siltstone, and sandstone. Claystone is medium dark gray (N4). Siltstone is light gray (N7), very calcareous. Sandstone is medium light gray (N6), very fine grained, slightly calcareous; contains coal particles and glauconite-----	290	300
No sample recovery-----	300	310

Lithologic log of drill-hole BH-D5--continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, medium-dark-gray (N4) to dark-gray (N3)----	310	315
Claystone, as in interval above, and siltstone. Silt-		
stone is medium light gray (N6), noncalcareous;		
contains coal streaks-----	315	320
Siltstone, as in interval above, and medium-gray (N5)		
to medium-dark-gray (N4) claystone-----	320	335
Claystone and siltstone. Claystone is grayish black		
(N2); contains numerous carbonaceous laminae. Silt-		
stone is medium dark gray (N4), noncalcareous; con-		
tains coal streaks-----	335	340
Claystone, as in interval above, coal, and siltstone.		
Coal probably occurs in thin beds. Siltstone is		
very light gray (N8), noncalcareous; contains coal		
particles-----	340	350
Claystone, as in interval above, and sandstone. Sand-		
stone is light gray (N7), fine grained, noncalcareous	350	355
Mudstone, medium-light-gray (N6) to medium-gray (N5)--	355	360
Claystone, medium-gray (N5), and coal-----	360	365
Claystone, as in interval above, and siltstone. Silt-		
stone is very light gray (N8), noncalcareous; con-		
tains coal particles-----	365	375

Lithologic log of drill-hole BH-D5 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is interlaminated medium dark gray (N4) and light gray (N7). Siltstone is light gray (N7), noncalcareous; contains coal laminae-----	375	380
Claystone and siltstone, as in interval above, and sandstone. Sandstone is medium light gray (N6), noncalcareous; contains coal particles and glauconite-----	380	385
Sandstone and siltstone. Sandstone is medium light gray (N6), fine grained, noncalcareous, very strongly cemented-----	385	390
Claystone, medium-gray (N5), and coal-----	390	395
Claystone and sandstone. Claystone is medium gray (N5) and medium dark gray (N4). Sandstone is very light gray (N8) and medium light gray (N6), fine grained to very fine grained, slightly calcareous-----	395	410
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7), slightly calcareous-----	410	415
Claystone, as in interval above, and sandstone and/or siltstone. Sandstone (and/or siltstone) is light gray (N7); contains coal particles and glauconite-----	415	470
Total depth - 470 ft		

Lithologic log of drill-hole B-D15

[Encountered water at 120 ft and during deeper drilling, hole continually eroded. As a consequence, samples recovered from intervals below 300 ft were contaminated with material from higher portions of the drill hole and lithologic data for these intervals are not as reliable as data for other intervals. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 1,950 ft FWL, 2,000 ft FSL, sec. 29, T. 15 N., R. 90 W.,
6th P.M., Carbon County, Wyoming

Collar elevation: 6,960 ft

Drilling started 8-20-76; completed 8-23-76

Total depth: 490 ft

Air injection drilling 0-120 ft; air and water 120-490 ft

Logged by: L. A. Shoaff

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Sandstone, siltstone, and claystone. Sandstone is yellowish gray (2.5 Y 7/2), very fine grained, calcareous, strongly cemented; contains coal and carbonaceous specks. Siltstone is dark yellowish orange (10 YR 6/6), calcareous; contains coal and carbonaceous specks. Claystone is very pale orange (10 YR 8/2)-----	0	3
Siltstone, moderate-yellow (2.5 Y 8/6), calcareous; contains limonitic streaks-----	3	5
Sandstone and siltstone. Sandstone is light gray (N7), irregularly iron-oxide stained, very fine grained, calcareous, strongly cemented; contains carbonaceous particles and glauconite. Siltstone is moderate yellow (2.5 Y 8/6) and yellowish gray (10 YR 7/1); contains carbonaceous particles-----	5	10

Lithologic log of drill-hole B-D15--continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, as in interval above, and light-olive-gray (5 Y 6/1) claystone-----	10	15
Sandstone, light-yellowish-brown (10 YR 6/4), very fine grained, calcareous, soft; contains carbon- aceous particles-----	15	20
Siltstone, dark-yellowish-orange (10 YR 6/6), and medium-light-gray (N6) and medium-gray (N5) clay- stone-----	20	25
Claystone, as in interval above, and sandstone. Sand- stone is light gray (N7), very fine grained, non- calcareous, soft; contains numerous coal particles-----	25	30
Claystone, as in interval above, siltstone, and coal. Siltstone is weak yellowish orange (2.5 Y 7/6) and light gray (N7), noncalcareous; contains coal streaks. Thin coal bed at 34.5 ft-----	30	35
Siltstone and claystone. Siltstone is medium light gray (N6) and light gray (N7), noncalcareous; contains carbonaceous streaks. Claystone is medium gray (N5); contains coal particles-----	35	45
Claystone, as in interval above, and mudstone. Mud- stone is medium light gray (N6); contains carbona- ceous streaks-----	45	50

Lithologic log of drill-hole B-D15 -- continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, mudstone, and claystone. Siltstone is light gray (N7), sandy, noncalcareous; contains coal particles. Mudstone is grayish black (N2); contains coal laminae. Claystone is medium gray (N5) and medium dark gray (N4)-----	50	55
Siltstone and claystone, as in interval above-----	55	60
Siltstone, as in interval above-----	60	64
Claystone, dark-gray (N3), coaly-----	64	65
Siltstone and claystone. Siltstone is light gray (N7) to medium light gray (N6), calcareous; contains carbonaceous laminae. Claystone is medium dark gray (N4)-----	65	70
Siltstone, as in interval above, and mudstone. Mudstone is light brownish gray (10 YR 6/1); contains carbonaceous streaks-----	70	75
Siltstone, as in interval above, and claystone. Claystone is medium gray (N5); contains coal particles----	75	80
Siltstone and claystone. Siltstone is very light gray (N8), calcareous; contains carbonaceous streaks-----	80	85
Claystone, medium-gray (N5); contains very light gray (N8), calcareous siltstone laminae-----	85	91
Coal-----	91	93
Siltstone, very light gray (N8) and light-gray (N7), sandy, noncalcareous; contains carbonaceous particles-	93	95

Lithologic log of drill-hole B-D15 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and siltstone. Claystone is medium gray (N5) to medium dark gray (N4). Siltstone is very light gray (N8), noncalcareous, open; contains carbonaceous particles-----	95	100
Siltstone, as in interval above, claystone, and coal. Claystone is medium dark gray (N4). Coal bed, 101-101.5 ft-----	100	105
Siltstone, light-gray (N7), calcareous; contains carbonaceous particles-----	105	110
Claystone and mudstone. Claystone is medium gray (N5). Mudstone is medium light gray (N6); contains carbonaceous streaks-----	110	115
Claystone and sandstone. Claystone is medium gray (N5). Sandstone is medium light gray (N6), noncalcareous, strongly cemented. Hard layer at 118 ft-----	115	120
Sandstone and siltstone. Sandstone is very light gray (N8), very fine grained, calcareous; contains carbonaceous particles. Siltstone is yellowish gray (10 YR 7/1); contains carbonaceous laminae-----	120	125
Claystone and siltstone. Claystone is medium gray (N5). Siltstone is light gray (N7), calcareous; contains carbonaceous laminae-----	125	130

Lithologic log of drill-hole B-D15 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone, as in interval above, and siltstone.		
Siltstone is yellowish gray (10 YR 7/1), noncalcareous, tight; contains carbonaceous particles-----	130	140
Claystone, as in interval above, siltstone, and claystone. Siltstone is medium light gray (N6), noncalcareous; contains numerous carbonaceous streaks.		
Sandstone is light gray (N7), very fine grained, noncalcareous; contains carbonaceous particles-----	140	145
Claystone and siltstone. Claystone is medium gray (N5).		
Siltstone is yellowish gray (10 YR 7/1), calcareous; contains coal particles-----	145	165
Sandstone, light-gray (N7), very fine grained, noncalcareous; contains carbonaceous particles and glauconite-----	165	175
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous; contains coal and carbonaceous particles-----	175	180
Claystone, as in interval above, and siltstone. Siltstone is medium light gray (N6), noncalcareous, tight; contains carbonaceous particles-----	180	185
Siltstone, as in interval above-----	185	190
Siltstone, as in interval above, and medium-light-gray (N6) claystone-----	190	200

Lithologic log of drill-hole B-D15 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Mudstone and sandstone. Mudstone is medium gray (N5).		
Sandstone is light gray (N7), very fine grained, calcareous; contains carbonaceous streaks-----	200	205
Siltstone and claystone. Siltstone is medium gray (N5).		
Claystone is medium dark gray (N4); contains coal laminae-----	205	210
Claystone, as in interval above, and siltstone. Silt- stone is very light gray (N8); contains carbonaceous and coal laminae-----	210	215
Claystone, medium-dark-gray (N4)-----	215	220
Claystone, as in interval above, and siltstone. Silt- stone is medium light gray (N6), calcareous, open; contains coal and carbonaceous streaks-----	220	225
Siltstone and claystone. Siltstone is yellowish gray (10 YR 7/1), calcareous; contains coal laminae.		
Claystone is dark gray (N3)-----	225	230
Claystone, as in interval above-----	230	260
Claystone, as in interval above, and sandstone. Sand- stone is light gray (N7), very fine grained, non- calcareous; contains carbonaceous streaks-----	260	270
Coal and grayish-black (N2), coaly claystone-----	270	275

Lithologic log of drill-hole B-D15--continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone and claystone. Siltstone is very light gray (N8) to medium light gray (N6), noncalcareous; contains carbonaceous laminae-----	275	280
Coal and grayish-black (N2), coaly claystone-----	280	287
Siltstone, yellowish-gray (10 YR 7/1)-----	287	290
Claystone, medium-dark-gray (N4), and thin coal bed at 292 ft-----	290	295
Claystone, as in interval above, and siltstone. Siltstone is medium light gray (N6); contains coal particles-----	295	300
Sandstone and rudstone. Sandstone is light gray (N7), very fine grained to fine grained, noncalcareous; contains coal particles. Mudstone is medium gray (N5)-----	300	310
Claystone, medium-dark-gray (N4)-----	310	320
Claystone, as in interval above, mudstone, and siltstone. Mudstone is medium light gray (N6). Siltstone is light olive gray (5 Y 6/1); contains coal particles	320	335
Mudstone, medium-gray (N5) to dark-gray (N3); contains coal laminae-----	335	340
Mudstone, as in interval above, and claystone. Claystone is medium dark gray (N4); contains coal laminae-----	340	345

Lithologic log of drill-hole B-D15 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and mudstone, as in interval above, and siltstone. Siltstone is light gray (N7), calcareous; contains coal particles-----	345	350
Claystone, mudstone, and coal. Claystone is medium gray (N5); contains coal laminae. Mudstone is grayish black (N2), coaly-----	350	355
Mudstone and siltstone. Mudstone is medium dark gray (N4); contains coal laminae. Siltstone is light gray (N7); noncalcareous; contains carbonaceous particles-----	355	360
Claystone and siltstone. Claystone is grayish black (N2), coaly. Siltstone is light gray (N7), noncalcareous, tight; contains carbonaceous particles----	360	365
Claystone, grayish-black (N2), coaly-----	365	370
Coal-----	370	375
Coal and mudstone. Mudstone is grayish black (N2); contains coal laminae-----	375	385
Siltstone and coal. Siltstone is light gray (N7), noncalcareous; contains coal laminae-----	385	390
Claystone, dark-gray (N3), and medium-gray (N5), noncalcareous siltstone-----	390	395
Mudstone, medium-dark-gray (N4)-----	395	400

Lithologic log of drill-hole B-D15 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone and mudstone. Claystone is dark gray (N3).		
Siltstone is medium light gray (N6); contains		
coal particles-----	400	410
Coal and dark gray (N3), coaly mudstone-----	410	415
Claystone, dark-gray (N3), coaly-----	415	425
Claystone, medium-gray (N5) to dark-gray (N3) and		
coaly-----	425	430
Mudstone and claystone. Mudstone is dark gray (N3),		
coaly. Claystone is medium dark gray (N4)-----	430	440
Mudstone, medium-dark-gray (N4) to dark-gray (N3);		
contains coal laminae-----	440	460
Claystone, medium-gray (N5) and coal-----	460	465
Siltstone and coal. Siltstone is medium light gray		
(N6), noncalcareous; contains coal particles-----	465	470
Mudstone, medium-gray (N5), and coal-----	470	490
Total depth - 490 ft		

Lithologic log of drill-hole B-D17

[Intervals marked with a single asterisk (*) are intervals for which lithologic data are less reliable than for other intervals because of poor sample quality or insufficient sample quantity. All measurements are in feet; to convert to meters, multiply by 0.3048]

Location: 1,050 ft FWL, 1,950 ft FSL, sec. 3, T. 14 N., R. 90 W.,
6th P.M., Carbon County, Wyoming

Collar elevation: 7,220 ft

Drilling started 8-26-76; completed 8-31-76

Total depth: 650 ft

Air injection drilling 0-165 ft; air and water 165-650 ft

Logged by: L. A. Shoaff, C. S. V. Barclay, and B. A. Rood

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone, pale brown (10 YR 6/3) to moderate-yellowish-brown (10 YR 5/4)-----	0	7
Sandstone, yellowish-gray (2.5 Y 7/2), very fine grained to fine-grained, calcareous; contains some carbonaceous particles-----	7	9.5
Siltstone, grayish-yellow (5 Y 7/3) and yellowish-orange (2.5 Y 7/6), calcareous; contains some carbonaceous particles-----	9.5	11
Siltstone, yellowish-gray, (2.5 Y 7/2 and 10 YR 7/1), calcareous; contains some carbonaceous particles-----	11	14
Claystone and siltstone. Claystone is light olive gray (5 Y 5/1). Siltstone is light olive gray (5 Y 6/2) and olive gray (5 Y 4/1), calcareous; contains carbonaceous laminae-----	14	18
Coal-----	18	20

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone and mudstone. Siltstone is very light gray (N8), noncalcareous, open; contains some carbonaceous laminae. Mudstone is medium gray (N5); contains some coal particles-----	20	25
Mudstone, as in interval above, and siltstone. Siltstone is light gray (N7), noncalcareous; contains carbonaceous laminae-----	25	28
Coal-----	28	30
Siltstone and sandstone. Siltstone is light gray (N7), noncalcareous, soft. Sandstone is weak yellowish orange (2.5 Y 8/4), very fine grained, noncalcareous--	30	35
Sandstone, as in interval above, and medium-gray (N5) claystone-----	35	40
Claystone, as in interval above, and siltstone. Siltstone is light olive gray (5 Y 6/1), calcareous; contains coal and carbonaceous laminae-----	40	45
Siltstone, as in interval above, and medium-dark-gray (N4) mudstone-----	45	50
Sandstone, light-gray (N7), fine to very fine grained, calcareous; contains carbonaceous streaks-----	50	55
Sandstone, as in interval above, and olive-gray (5 Y 5/2) mudstone-----	55	60

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Mudstone, siltstone, and coal. Mudstone is medium dark gray (N4). Siltstone is light olive gray (5 Y 6/1), calcareous; contains some carbonaceous particles. Thin coal bed at 62 ft-----	60	65
Sandstone and siltstone. Sandstone is yellowish gray (5 Y 7/1), fine grained, calcareous, soft. Siltstone is yellowish gray (10 YR 7/1), calcareous; contains coal laminae-----	65	70
Claystone and siltstone. Claystone is medium gray (N5) and light olive gray (5 Y 5/1). Siltstone is light brownish gray (10 YR 6/1), calcareous; contains some carbonaceous laminae-----	70	75
Claystone, dark-gray to medium-dark-gray (N3-N4), and coal-----	75	80
Claystone, as in interval above, and siltstone. Siltstone is light olive gray (5 Y 6/1), noncalcareous----	80	90
Siltstone, mudstone, and sandstone. Siltstone is medium light gray (N6), noncalcareous; contains coal streaks. Mudstone is medium dark gray (N4). Sandstone is very light gray (N8), very fine grained, noncalcareous; contains coal particles-----	90	95

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Claystone and coal. Claystone is medium dark gray (N4) and light olive gray (5 Y 5/1). Coal bed 98.0-98.5 ft-----	95	100
Sandstone, yellowish-gray (5 Y 7/3) and medium-light-gray (N6), very fine grained, noncalcareous, soft; contains coal and carbonaceous particles-----	100	110
Sandstone, as in interval above, claystone, and siltstone. Claystone is medium gray (N5). Siltstone is light gray (N7), noncalcareous; contains coal streaks-----	110	115
Siltstone, as in interval above, and medium-dark-gray (N4) claystone-----	115	120
Siltstone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained, slightly calcareous, soft; contains some coal particles-----	120	125
Siltstone, light-brownish-gray (10 YR 6/1), noncalcareous, soft; contains carbonaceous particles-----	125	130
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is medium light gray (N6), very fine grained, noncalcareous, soft; contains some coal particles-----	130	150
Mudstone and siltstone. Mudstone is medium light gray (N6). Siltstone is light brownish gray (10 YR 6/1), noncalcareous, soft-----	150	160

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, as in interval above, and medium-dark-gray (N4) claystone-----	160	165
Mudstone, siltstone, and sandstone. Mudstone is medium dark gray (N4). Siltstone is light brownish gray (10 YR 6/1). Sandstone is very light gray (N8), very fine grained to fine grained, calcareous; contains coal particles and glauconite-----	165	170
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is light gray (N7), very fine grained, noncalcareous; contains numerous coal streaks-----	170	185
Siltstone and mudstone. Siltstone is light gray (N7), noncalcareous. Mudstone is medium dark gray (N4)-----	185	190
Siltstone and mudstone, as in interval above, and sand- stone. Sandstone is very light gray (N8), very fine grained, noncalcareous; contains coal streaks-----	190	195
Sandstone, siltstone, and claystone. Sandstone is light gray (N7), very fine grained, noncalcareous; contains some coal particles. Siltstone is medium light gray (N6), noncalcareous, open. Claystone is yellowish gray (10 YR 7/1)-----	195	205
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is light gray (N7), noncalcareous; contains some carbonaceous laminae-----	205	225

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone, medium-dark-gray (N4)-----	225	234
Sandstone, light-olive-gray (5 Y 6/1), very fine grained, noncalcareous; contains limonitic grains, coal particles, and coal laminae-----	234	240
Claystone and siltstone. Claystone is light brownish gray (10 YR 6/1) and medium gray to medium dark gray (N5-N4). Siltstone is light gray (5 Y 7/1), calcare- ous; contains carbonaceous laminae-----	240	245
Claystone, dark-gray (N3). Thin, hard layers at 259 ft and 266-267 ft-----	245	275
Claystone, medium-dark-gray (N4)-----	275	280
Claystone, very dark gray (5 Y 3/1) and olive-gray (5 Y 4/1)-----	280	285
No sample recovery-----	285	290
Sandstone and claystone. Sandstone is very light gray (N8), very fine grained, noncalcareous. Claystone is medium dark gray (N4)-----	290	295
Claystone, as in interval above-----	295	302
Coal-----	302	315
Claystone, black (N1), coaly-----	315	317
Mudstone, medium-gray (N5)-----	317	319
Sandstone, very light gray (N8), very fine grained, noncalcareous; contains coal streaks-----	319	320

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Sandstone, as in interval above, and black (N1), coaly claystone-----	320	325*
No sample recovery-----	325	327
Coal-----	327	329
Sandstone, light-gray (N7), very fine grained to fine-grained, noncalcareous, soft-----	329	335*
Claystone and siltstone. Claystone is grayish black (N2). Siltstone is light gray (N7), noncalcareous; contains carbonaceous laminae-----	335	340
Siltstone, as in interval above, and medium-gray to dark-gray (N5-N3) claystone-----	340	345*
Claystone, grayish-black (N2) to medium-gray (N5) near bottom of interval-----	345	350
Siltstone and claystone. Siltstone is very light gray (N8), noncalcareous; contains coal and carbonaceous particles. Claystone is medium dark gray (N4)-----	350	355
Sandstone and siltstone. Sandstone is very light gray (N8), very fine grained, calcareous; contains carbonaceous particles-----	355	360*
Siltstone, light-gray (5 Y 7/1) and medium-light-gray (N6), noncalcareous, in alternating hard and soft layers-----	360	365

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone, light-gray (N7), noncalcareous; contains		
coal streaks-----	365	371
Coal-----	371	373
Claystone, dark-gray (N3), carbonaceous; grades to		
medium-light-gray (N6) claystone in bottom half of		
interval-----	373	376
Coal-----	376	377
Claystone and coal. Claystone is medium light gray		
(N6) 378-381 ft, dark gray (N3) in remainder of		
interval; contains some coal laminae. Thin coal bed		
at 384 ft-----	377	385
Claystone, as in interval above, and siltstone. Silt-		
stone is light gray (N7), noncalcareous; contains some		
carbonaceous streaks-----	385	393
Coal-----	393	405
Coal and claystone. Coal is impure and grades to dark-		
gray (N3), coaly, claystone-----	405	410
No sample recovery-----	410	415
Claystone and siltstone. Claystone is medium gray (N5).		
Siltstone is very light gray (N8), noncalcareous; con-		
tains coal laminae-----	415	420*

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Claystone and sandstone. Claystone is medium dark gray (N4). Sandstone is light gray (N7), fine grained, noncalcareous, soft; contains coal and carbonaceous particles-----	420	425
Claystone, dark-gray (N3)-----	425	430
Claystone and siltstone. Claystone is medium gray to medium light gray (N5-N6). Siltstone is light gray (N7), noncalcareous; contains coal laminae-----	430	435
Claystone, grayish-black (N2), coaly-----	435	436
Coal-----	436	440
Claystone, grayish-black (N2), coaly-----	440	445
Mudstone, olive-gray (5 Y 4/1)-----	445	450
Claystone, medium-dark-gray (N4)-----	450	460
Claystone, as in interval above, grades to grayish-black (N2), coaly claystone-----	460	465
Siltstone, medium-light-gray (N6), and medium-dark-gray (N4) claystone-----	465	470
Claystone and sandstone. Claystone is dark gray to medium dark gray (N3-N4). Thin, hard layer of light-gray (N7), very fine grained sandstone at 474 ft-----	470	475*
Claystone and sandstone. Claystone is medium gray (N5). Sandstone is light gray (N7), very fine grained, non-calcareous-----	475	480

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous, tight; contains carbonaceous laminae.		
Claystone is dark gray (N3)-----	480	490
Claystone, siltstone, and sandstone. Claystone is dark gray to grayish black (N3-N2), coaly. Siltstone is light gray (N7), noncalcareous; contains coal particles.		
Sandstone is light olive gray (5 Y 6/1), very fine grained, noncalcareous, soft-----	490	495
Coal-----	495	495.5
Siltstone, grayish-black (N2); contains coal laminae----	495.5	510
Claystone, medium-gray (N5), and grayish-black (N2), coaly mudstone-----	510	515
Sandstone and siltstone. Sandstone is very light gray (N8), calcareous; contains carbonaceous particles.		
Siltstone is light olive gray (5 Y 6/1), noncalcareous; contains coal laminae-----	515	520*
Claystone and siltstone. Claystone is medium gray (N5).		
Siltstone is dark gray (N3); contains coal particles--	520	530
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7), noncalcareous; contains carbonaceous particles-----	530	540
Claystone, medium-dark-gray to dark-gray (N4-N3); contains coal particles-----	540	546

Lithologic log of drill-hole B-D17 - continued

<u>Description</u>	<u>Depth (ft)</u>	
	<u>From</u>	<u>To</u>
Siltstone, light-gray (N7), noncalcareous; contains carbonaceous particles-----	546	548
Mudstone, medium-dark-gray to grayish-black (N4-N2), coaly-----	548	550
No sample recovery-----	550	555
Sandstone and siltstone. Sandstone is very light gray (N8), fine grained, calcareous; contains carbonaceous particles. Siltstone is light brownish gray; contains carbonaceous particles-----	555	565*
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is very light gray (N8); contains coal particles-----	565	570
Claystone, as in interval above, and dark-gray to grayish-black (N3-N2) mudstone-----	570	580*
Claystone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained, calcareous; contains carbonaceous particles-----	580	585*
Siltstone, light-brownish-gray (10 YR 6/1)-----	585	587
Siltstone, dark-gray (N3), carbonaceous-----	587	605
Claystone, dark-gray (N3); contains coal laminae-----	605	610
Siltstone and sandstone. Siltstone is medium light gray (N6), noncalcareous. Sandstone is very light gray (N8), very fine grained, noncalcareous; contains carbonaceous particles-----	610	615

Lithologic log of drill-hole B-D17--continued

<u>Description</u>	Depth (ft)	
	<u>From</u>	<u>To</u>
Siltstone and claystone. Siltstone is very light gray (N8), noncalcareous. Claystone is medium light gray (N6)-----	615	620
Sandstone, very light gray (N8), very fine grained, calcareous-----	620	625*
Claystone, medium-dark-gray (N4), and coal-----	625	630*
Siltstone, very light gray (N8), and dark-gray (N3) mudstone-----	630	636
Coal-----	636	637.5
Mudstone, dark-gray (N3), carbonaceous-----	637.5	640
Claystone, grayish-black (N2) and coaly, and coal-----	640	645
Mudstone, dark-gray (N3)-----	645	650
Total depth - 650 ft		

Geophysical logs

All of the drill holes were logged by geophysical methods and copies of the logs (figs. 4-62) are presented in the pocket of this report. Logs that were run were natural gamma, neutron, single- and dual-detector gamma-gamma, spontaneous potential, 16- and 64-inch normal resistivity, caliper, acoustic velocity, fluid resistivity, and temperature. Of these, only caliper and natural gamma were run in every hole except B-D15 which caved before it could be logged. When possible, drill holes thought to be particularly susceptible to caving were logged through the drill stem with the natural gamma tool.

Calibration curves relating porosity and density to counts per second on the neutron and gamma-gamma logs that were obtained with well reconnaissance logger W-236265 are given in figures 63 and 64, respectively. The calibration curves are for water-filled holes and can only be applied to those portions of the logs which were obtained below water level. The calibration curves cannot be used to determine actual porosity or density in coal. The neutron tool measures water-filled porosity by measuring the amount of hydrogen present. Coal, because it is composed largely of hydrocarbons, gives a false porosity value. The calibration curve for the gamma-gamma tool was calibrated in material of densities between 1.65 and 3.3 gm/cc and is probably not accurate for bituminous coals of the Mesaverde Group which presumably have densities in the range of 1.3-1.5 gm/cc.

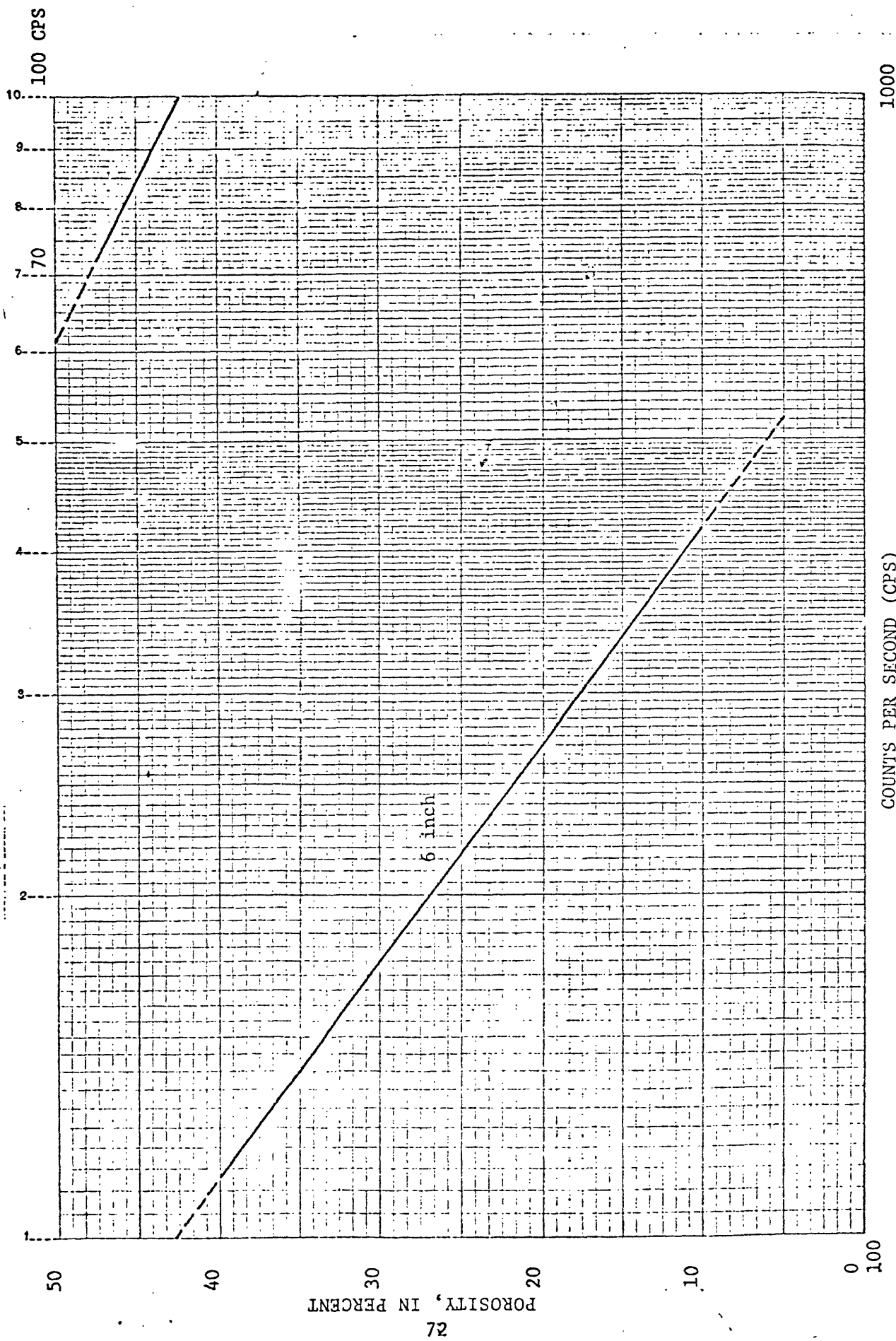


Figure 63.--Calibration curve for neutron log (well reconnaissance logger): 6-inch-water-filled drill hole

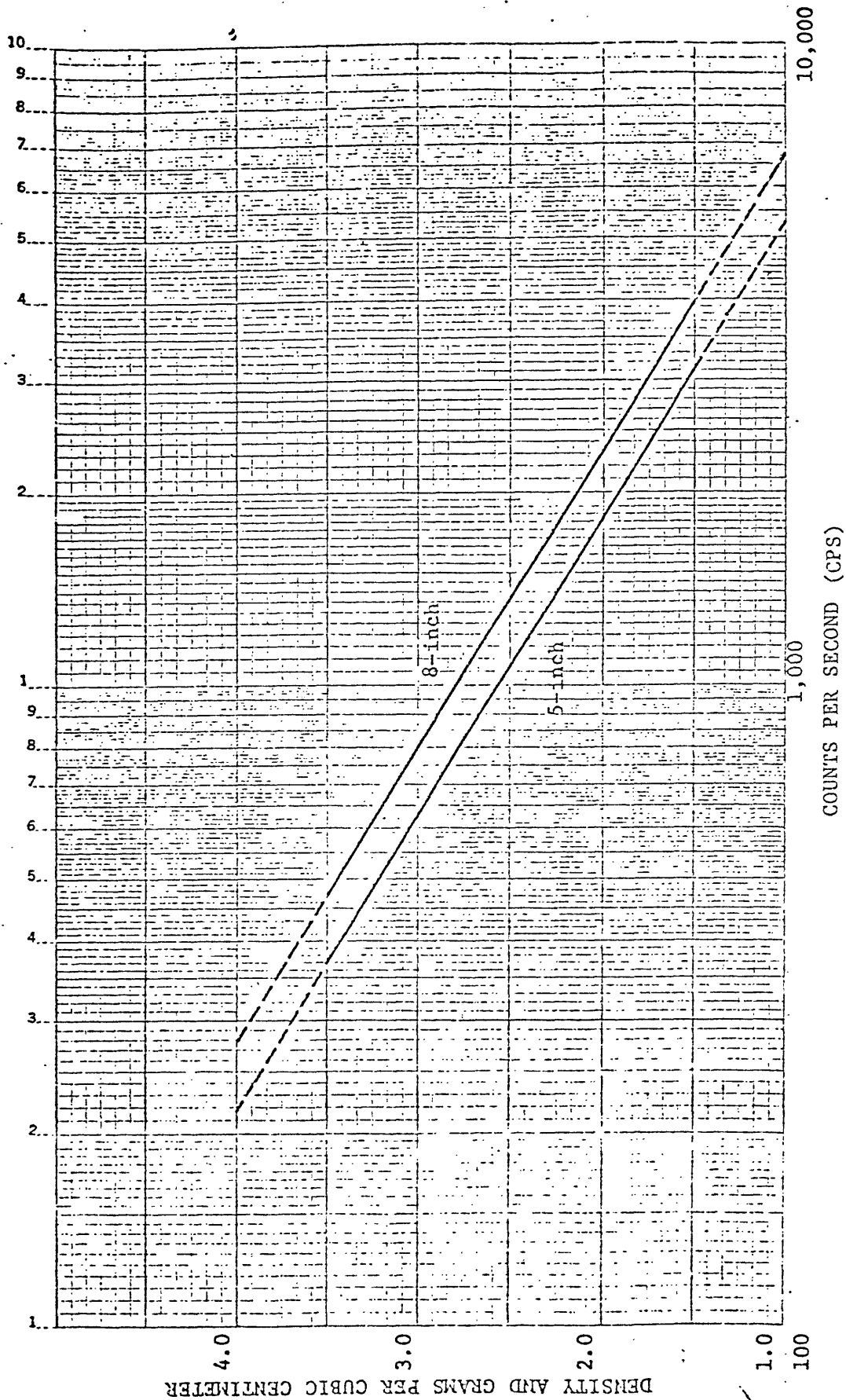


Figure 64.--Calibration curve for gamma-gamma log (well reconnaissance logger): 5-inch and 8-inch water-filled drill holes.

Coal in the drilled formations

Coal beds occur in each of the 10 drill holes for which geophysical and/or lithologic logs are presented. The range in thickness of coal beds for all holes is 1-12 ft (0.3-3.7 m). Most of the coal is believed to have been deposited in lagoonal environments behind barrier bars of a prograding shoreline. Depth, thickness, and correlation of the coal beds are shown in figure 65.

Most of the coal beds can be informally grouped into three zones which are numbered in ascending stratigraphic order on figure 65. The beds in zone 1 which are generally 1-2 ft (0.3-0.6 m) thick, are believed to be in the uppermost, marginal marine part of the Allen Ridge Formation and perhaps, the Pine Ridge Sandstone. The thickest and most persistent of the coal beds are in coal zone 2, a 180-210-ft (54.9-64.0 m) zone in the lower part of the Almond Formation. The top of coal zone 2 is 225-235 ft (68.6-74.7 m) below the top of the Almond Formation in the southeastern part of the Doty Mountain quadrangle. Coal zone 3, near the top of the Almond, contains only a few coals which are generally 1-3 ft (0.3-0.9 m) thick, although as much as 6 ft (1.8 m) of coal in a single bed of this zone have been measured at some surface outcrops in the eastern part of the Doty Mountain quadrangle.

Coal of the Mesaverde Group is generally of bituminous rank (Ball and Stebinger, 1910, p. 202). The average of six analyses (as-received basis) of six coal samples from four abandoned mines in T. 12 N., R. 90 W., show 6.61 percent ash, 0.58 percent sulfur,

and a heating value of 10,359 Btu/lb (Ball and Stebinger, 1910, p. 200). An analyses (as-received basis) of a coal sample from the Robertson Mine in sec. 4, T. 17 N., R. 90 W., shows 8.69 percent ash, 1.44 percent sulfur, and a heating value of 10,339 Btu/lb (Ball and Stebinger, 1910, p. 201, 204).

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