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Lithologic and geophysical logs of holes drilled in the eastern part of the Doty Mountain quadrangle, Carbon County, Wyoming, by the U.S. Geological Survey during 1975

By

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and

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On headings for each gamma-gamma log (Figures 7, 12, 17, 21, 26, 31, and 36) change Source size:

From: 10 microcuries

To: 10 millicuries

Signed: C. S. Venable Barclay

C. S. Venable Barclay
U.S. Geological Survey

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Lithologic and geophysical logs of holes drilled in the eastern part of the Doty Mountain quadrangle, Carbon County, Wyoming, by the U.S. Geological Survey during 1975

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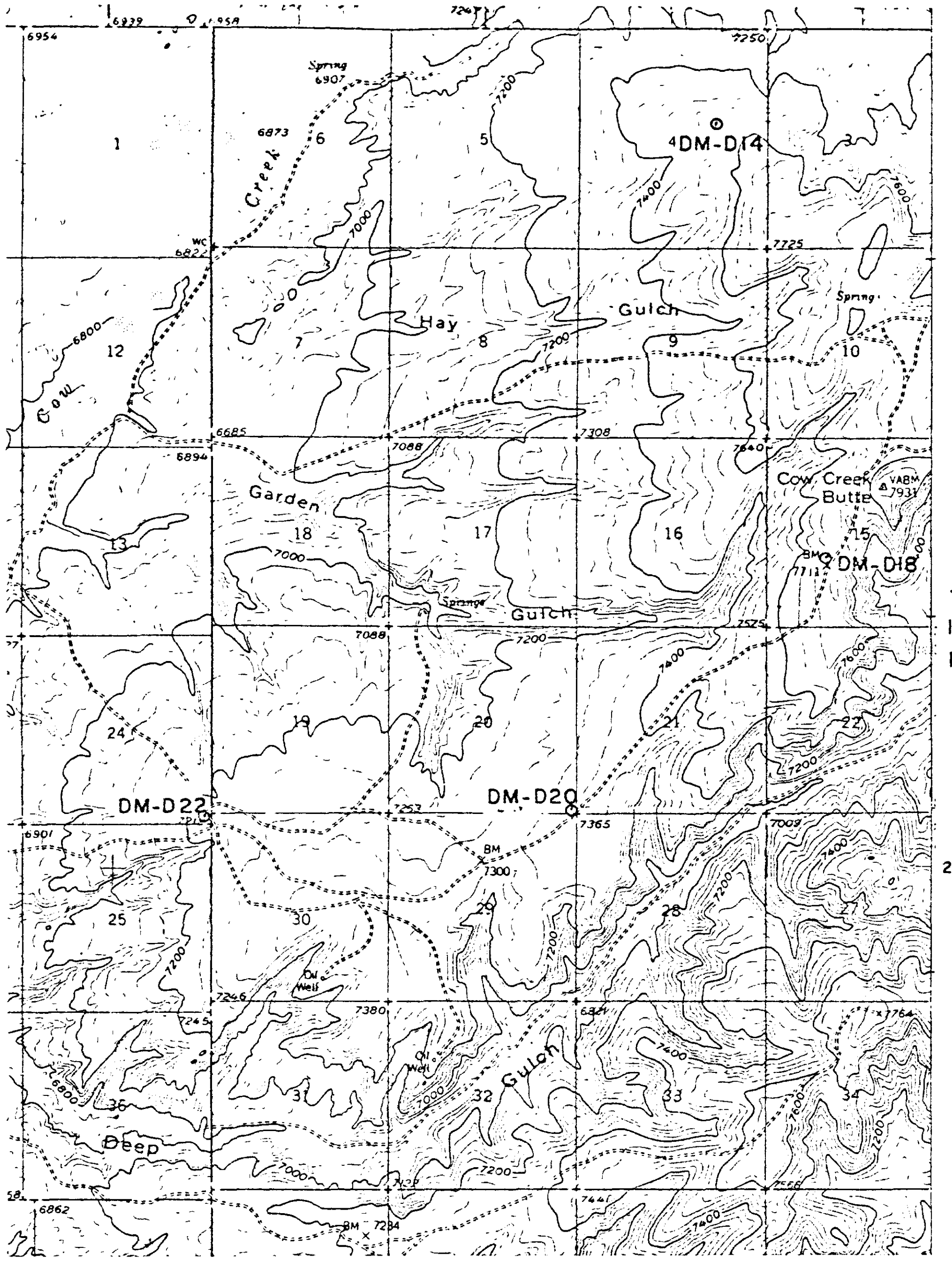
Introduction

Eight holes were drilled in Tps. 15 and 16 N., Rs. 90 and 91 W., Doty Mountain quadrangle, Carbon County, Wyoming (fig. 1), by the U.S. Geological Survey in September and October 1975. 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 or air and water. Air was used to depths where drill cuttings became too sticky from formation water to be blown from 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.


Cow Creek
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DM-D20
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Spring
Springs
Oil Well
T. 16 N.
20'

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Acknowledgments

The drill rig was operated by a U.S. Geological Survey crew consisting of J. D. Cathcart (driller), A. C. Clark and S. B. Roberts, and supervised by J. D. Tucker. J. M. Back assisted in the collection of samples and preparation of sample logs during drilling. L. A. Shoaff assisted in the preparation of data for presentation in this report. Geophysical logging was done by R. A. McCullough.

Stratigraphy of the drilled rock formations

Rock strata intersected by drilling belong to the Mesaverde Group and to the overlying Lewis Shale, both of Late Cretaceous 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). The Haystack Mountain Formation is a marine and marginal marine unit and primarily consists of shale and thick sandstone beds. Single coal beds 1-2 feet (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 marginal marine lagoonal-paludal deposits of thin-bedded sandstone and siltstone, carbonaceous shale, and coal beds as thick as 4 to 6 ft (1.2-1.8 m) in some places. The Pine Ridge Sandstone is a continental deposit consisting mostly of fluviatile sandstone and is unconformable on the Allen Ridge in most places. The Pine Ridge Sandstone has not yet been positively identified in the Little Snake River coal field. 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.

Most of each hole is in the Almond Formation and the marginal marine deposits of the Allen Ridge Formation. Nonmarine rocks of the Allen Ridge were probably reached in drill-holes DM-D26, DM-D27A, and DM-28 near 625 ft (191 m), 675 ft (206 m), and 505 ft (154 m), respectively, and may have been reached in DM-D18 and DM-D20 near 525 ft (160 m) and 630 ft (192 m). In each hole except DM-D27 a 40-60 ft (12.2-18.3 m) interval of sandstone and siltstone with thin interbeds of mudstone generally occurs below the base of the principal coal zone of the Almond (figure 41) and may be the Pine Ridge Sandstone. The uppermost 37 ft (11.3) of drill-hole DM-D27 are in the Lewis Shale.

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. Some low-amplitude folds in the area cause slightly steeper or flatter dips and local dip reversals.

Lithologic logs

Lithologic logs of the drill holes are presented on pages 9-101. 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. Occurrence of formation water was noted where it could be distinguished from injected water.

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 (Goddard, 1970) and the Munsell Soil Color Chart (1954) and refer to dry samples.

The terms subordinate, trace, some, and numerous are used to describe the amount of a rock type or a rock constituent. Subordinate is used in a relative sense and means a lesser amount of; trace is used to designate an amount that is less than 2 or 3 percent by volume; some for an indefinite amount that is as much as 10 or 15 percent by volume; and numerous for an indefinite amount that is as much as 40 percent by volume.

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 marginal marine depositional environment of a large part of the rocks drilled. Both calcareous and noncalcareous cement occurs in sandstone and siltstone. Noncalcareous cement appears to be the more prevalent type and in most cases is believed to be clay

minerals. Calcareous rocks are generally more strongly cemented than noncalcareous ones. Drilled intervals which offered greater or lesser than average resistance to drilling were described as hard or soft. Hard beds are probably calcite cemented. Estimated relative porosity-permeability of sandstone or siltstone is described as tight or open in the lithologic logs. Sandstone and siltstone described as tight were generally strongly cemented and calcareous.

Authigenic minerals (in addition to calcite)found in the rocks include pyrite, limonite, gypsum, and kaolinite. Pyrite occurs as small spherules. Limonite occurs as coatings on and replacements of pyrite (?). Gypsum is commonly in minute, well-formed crystals. Well-crystallized kaolinite, identified by diffractometer analyses, occurs in small light-colored lenticles and patches in some claystone and mudstone.

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-D14

[All measurements in feet; to convert to metres multiply by 0.3048]

Location: Approximately 1,400 ft FEL, 2,600 ft FNL, sec. 4, T. 16 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,570 ft

Drilling started 10-7-75; completed 10-8-75

Total depth: 450 ft

Air injection drilling 0-422 ft; air and water 422-450 ft

Logged by: S. C. Zimmermann

Description	Depth (ft) From	To
Siltstone, very pale brown (10 YR 7/3), noncalcareous; contains some carbonaceous streaks----------	0	5
Siltstone, light-yellowish-brown (10 YR 6/4), non-calcareous, tight; contains some carbonaceous particles----------	5	10
Sandstone, very pale brown (10 YR 7/2) to grayish-orange (10 YR 7/4), fine-grained, noncalcareous, open---------	10	15
Sandstone and claystone. Sandstone is yellowish gray (2.5 Y 7/2), fine grained, noncalcareous, weakly cemented, open. Claystone is brownish gray (5 YR 4/1); contains some coal streaks; probably occurs in thin beds in the sandstone----------	15	20

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Sandstone and claystone. Sandstone is light yellowish brown (10 YR 6/4), very fine grained, noncalcareous, open. Claystone is light brownish gray (10 YR 5/1); contains some carbonaceous laminae and a lesser amount of siltstone laminae; probably occurs as thin beds in the sandstone. Reddish-brown claystone bed near 23 ft----------	20	25
Claystone, medium-light-gray (N6); contains some carbonaceous streaks and a trace of gypsum----------	25	31
Sandstone and siltstone. Sandstone is pale brown (10 YR 6/3), very fine grained, calcareous, strongly cemented, tight; contains a trace of glauconite(?). Siltstone is dark yellowish orange (10 YR 6/6), slightly calcareous; contains some carbonaceous streaks----------	31	35
Claystone, mudstone, and siltstone. Claystone is pale yellowish brown (10 YR 6/2); contains numerous carbonaceous streaks. Mudstone is dark yellowish brown (10 YR 4/2); contains numerous coal streaks and particles. Siltstone is grayish orange (10 YR 7/4); contains some coal and some brown carbonaceous streaks. Dark-yellowish-brown (10 YR 4/2), weakly cemented siltstone occurs near bottom of interval----------	35	43

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Claystone, medium-dark-gray (N4); contains trace of pyrite, and near top, some coal particles----------	43	78.5
Hard bed----------	78.5	79
Siltstone, light-gray (N7); contains some coal laminae and particles----------	79	83
Coal----------	83	87
Claystone, black (NO); contains numerous coal laminae. Brownish-red dust mixed with claystone cuttings occurs in this and each subsequently described interval to a depth of 104.5 ft----------	87	88
Siltstone, very light gray (N8), sandy, noncalcareous, weakly cemented; contains some carbonaceous laminae; with increasing depth grades to light-gray (N7) siltstone that contains some coal laminae----------	88	95
Mudstone, dark-gray (N3); contains some coal particles. Hard bed about 0.5 ft thick near 97 ft----------	95	102
Coal----------	102	104.5
Mudstone, dark-gray (N3); contains some coal particles----	104.5	107
Siltstone, medium- to light-gray (N5-7), noncalcareous; contains numerous coal particles. Hard bed 108-109 ft-	107	110

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Siltstone and claystone. Siltstone is light gray (N7), weakly cemented; contains numerous carbonaceous laminae. Claystone is dark gray (N3); contains numerous coal streaks; probably occurs in thin beds in the siltstone. Hard, thin bed near 114 ft----------	110	115
Siltstone, light-gray (N7), weakly cemented; contains some coal laminae and particles both of which become more abundant with depth----------	115	125
Coal; contains 0.5 ft clayey parting near 120 ft----------	125	130
Sandstone, medium-brownish-gray (5 YR 5/1), very fine grained, weakly cemented----------	130	135
Siltstone, light-gray (N7), noncalcareous, weakly to strongly cemented, open; contains some coal particles and numerous dark mudstone laminae. Hard bed 138.5-139.5 ft----------	135	140
Mudstone and siltstone. Mudstone is grayish black (N2); contains numerous coal laminae. Siltstone is brownish black (5 YR 2/1), weakly cemented; contains some coal particles----------	140	145
Siltstone, claystone, and coal. Siltstone is brownish black (5 YR 2/1), weakly cemented; contains some coal particles. Claystone is black (NO); contains numerous coal laminae. Thin beds of coal near 146 ft----------	145	150

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Siltstone, light-gray (N7), noncalcareous, weakly cemented; contains numerous coal laminae----------	150	155
Claystone and siltstone. Claystone is dark gray (N3); contains some coal particles. Siltstone is brownish black (5 YR 2/1), weakly cemented; may contain coal particles----------	155	157
Coal----------	157	158
Claystone, dark-gray (N3), and brownish-gray (5 YR 4/1); contains some carbonaceous streaks----------	158	170
Coal----------	170	183
Claystone, dark-gray (N3)----------	183	184
Siltstone, light-gray (N7), noncalcareous----------	184	186
Claystone, medium-dark-gray (N4); contains some coal streaks----------	186	192
Coal----------	192	193.5
Claystone, medium-dark-gray (N4); contains some coal streaks----------	193.5	194
Sandstone, light-brownish-gray (5 YR 5/1), very fine grained, weakly cemented; contains some coal particles-	194	205
Siltstone, light-gray (N7), noncalcareous, open; contains numerous coal particles and medium-dark-gray (N4) claystone laminae which contain some coal streaks and which become more abundant with depth----------	205	208

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Claystone, medium-dark-gray (N4); contains some coal streaks	208	210
Mudstone and siltstone. Mudstone is laminated, light and medium dark gray (N7-4). Siltstone is medium light gray (N6), noncalcareous, open; contains numerous coal particles	210	215
Mudstone, dark-gray (N3); contains a trace of pyrite and some coal particles	215	219
Coal	219	223.5
Siltstone, light-gray (N7), noncalcareous, weakly cemented, open	223.5	234.5
Claystone, dark-gray (N3); contains some black coal(?) particles and some siltstone laminae	234.5	241
Coal	241	249
Claystone, black (N0); contains numerous coal laminae	249	250
Siltstone, brownish-gray (5 YR 4/1), sandy, weakly cemented; contains some coal particles	250	274(?)
Mudstone, dark-gray (N3); contains some carbonaceous laminae	274(?)	275(?)
Sandstone and silty sandstone, medium-gray (N5), very fine grained, weakly cemented	275(?)	292
Claystone, very dark gray (5 YR 3/1); contains some coal streaks	292	295

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Sandstone and subordinate siltstone. Sandstone is medium gray (N5), very fine and fine-grained, weakly cemented; contains some coal particles. Siltstone is dark gray (N3); contains numerous coal laminae----------	295	299
Sandstone and mudstone. Sandstone is medium gray (N5), fine and very fine grained near top to light brownish gray (5 YR 6/1), very fine grained toward bottom, weakly cemented; contains some coal particles. Mudstone is medium dark gray (N4); contains some coal laminae and an equivalent to greater amount of siltstone and sandstone laminae----------	299	317
Coal----------	317	319(?)
Claystone, very dark gray (5 YR 3/1); contains numerous coal laminae----------	319(?)	325
Mudstone and siltstone. Mudstone is medium dark gray (N4). Siltstone is very dark gray (5 YR 3/1), weakly cemented----------	325	330
Siltstone, medium-dark-gray (N4); contains numerous coal laminae and some very fine grained sandstone laminae--	330	336.5
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous, weakly to strongly cemented; open; contains numerous coal laminae----------	336.5	338

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Siltstone, dark-gray (N3), noncalcareous; contains some coal particles	338	339(?)
Coal	339(?)	340.2
Claystone and siltstone. Claystone is medium dark gray (N4); contains some coal particles. Siltstone is medium gray (N5), sandy, weakly cemented	340.2	345
Hard bed	345	345.5
Claystone, brownish-black (5 YR 2/1) near top; to dark-gray (N3) near middle, to black (NO) near bottom; contains coal particles, streaks, and laminae, and near top and bottom of interval, thin coal beds	345.5	360
Mudstone, very dark gray (5 YR 3/1); contains some coal laminae	360	375
Siltstone, light-gray (N7), noncalcareous, open; contains some coal and carbonaceous laminae	375	378.5
Siltstone, as in interval above, and claystone. Claystone is dark gray (N3) and contains some coaly layers about 0.2 ft thick	378.5	385
Mudstone, dark-gray (N3), noncalcareous; contains some coal laminae	385	390
Claystone and coal. Claystone is medium dark gray (N4) to black (NO), depending on the abundance of contained coal laminae. Coal bed 392-393 ft	390	395

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Mudstone, dark-gray (N3); contains some coal laminae-----	395	401
Coal?----------	401	402
Claystone, brownish-black (5 YR 2/1); contains some coal particles----------	402	410
Mudstone and sandstone. Mudstone is medium dark gray (N4), contains some coal particles, and occurs near top of interval. Sandstone is light gray (N7), very fine grained, noncalcareous, open; contains some coal particles----------	410	415
Sandstone, brownish-gray (5 YR 4/1), very fine grained, weakly cemented----------	415	422
Sandstone, light-gray (N7), very fine grained; contains some coal laminae----------	422	425
Mudstone, medium-dark-gray (N4), contains numerous coal laminae and particles----------	425	430
Mudstone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained, slightly calcareous, open; contains some coal particles----------	430	435
Claystone, mudstone, and siltstone. Claystone is medium gray (N5); contains some black coal(?) particles. Mudstone is medium dark gray (N4); contains numerous coal streaks. Siltstone is light gray (N7); contains some coal particles----------	435	440

Lithologic log of drill-hole DM-D14 - continued

Description	Depth (ft) From	To
Mudstone, medium-dark-gray (N4); contains numerous coal streaks----------	440	445
Sandstone, very light gray (N8), very fine grained, noncalcareous, open; contains some coal laminae-------	445	450

Total depth - 450 ft.

Lithologic log of drill-hole DM-D18

[Intervals marked with a single askerisk (*) 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 metres, multiply by 0.3048.]

Location: Approximately 1,650 ft FWL and 1,950 ft FSL, sec. 15, T. 16 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,710 ft

Drilling started 9-25-75; completed 9-27-75

Total depth: 610 ft

Air injection drilling 0-378 ft; air and water 378-610 ft

Logged by: S. C. Zimmermann

Description	Depth (ft) From	To
Siltstone, grayish-orange (10 YR 7/4) to pale-yellowish-orange (10 YR 8/6), calcareous; contains carbonaceous particles----------	0	6
Claystone and siltstone. Claystone is yellowish gray (10 YR 7/1) to light yellowish brown (10 YR 6/4), silty; contains carbonaceous streaks and, near bottom of interval, is interlayered(?) with light- to medium-yellowish-brown (10 Y/5-5/5), calcareous siltstone containing carbonaceous streaks----------	6	13
Mudstone, medium-light-gray (N6), with pale-yellowish-orange (10 YR 8/6) streaks----------	13	15
Siltstone, moderate-yellowish-brown (10 YR 5/6), clayey--	15	16

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Claystone, light-olive-gray (5 Y 5/2) to olive-gray (5 Y 3/2), with yellowish-orange-stained partings, silty; contains gypsum----------	16	19
Siltstone and/or mudstone, moderate-yellowish-brown (10 YR 5/5), sandy. Coarse-silt-size material includes carbonaceous particles, gypsum, and glauconite(?)----------	19	22.5
Siltstone, moderate-yellowish-brown (10 YR 5/5), sandy; contains carbonaceous particles and gypsum----------	22.5	25(?)
Mudstone, dark-yellowish-orange (10 YR 6/6) and yellowish-gray (10 YR 7/1); contains some limonitic grains, some carbonaceous particles and, near the top, a trace of gypsum----------	25(?)	35(?)
Siltstone, medium-light-gray (N6); contains carbonaceous particles and limonitic grains----------	35(?)	39
Sandstone, light- to moderate-light-yellowish-brown (10 YR 6/5-5/5), silty; contains some carbonaceous particles and a trace of glauconite(?)----------	39	40
Sandstone and siltstone. Sandstone is very light gray (N8), very fine grained, noncalcareous, weakly cemented; grades to siltstone toward bottom of interval. Thin, grayish-orange (10 YR 7/4) sandy siltstone bed near 48 ft----------	40	57

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Siltstone, medium-gray (N5), very fine grained----------	57	59
Sandstone, light-gray (N7), silty, very fine grained, slightly calcareous----------	59	61
Claystone, medium- to dark-gray (N5-3), silty; contains some light-colored siltstone laminae----------	51	65
Sandstone, light-gray (N7), silty, very fine grained, slightly calcareous, open----------	65	65.5
Siltstone, medium-gray (N5), slightly calcareous, strongly cemented, open; contains some carbonaceous particles----------	65.5	69
Sandstone, medium-gray (N5), silty, very fine grained, slightly calcareous, strongly cemented; contains some carbonaceous particles and a trace of glauconite(?) and pyrite----------	69	71
Siltstone, medium-dark or dark-gray (N4-N3), slightly brown; contains numerous carbonaceous streaks and particles----------	71	75
Claystone, medium-gray (N5); contains some carbonaceous streaks and a trace of pyrite----------	75	104.5
Claystone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained. Sandstone and claystone seem to be interbedded and the sandstone-claystone ratio appears to increase with depth--------	104.5	110

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Sandstone or siltstone and subordinate claystone. Sandstone or siltstone is light gray (N7); contains some carbonaceous particles. Claystone is medium to dark gray (N5-3); contains some carbonaceous streaks and a trace of pyrite. The claystone appears to be interbedded with the sandstone or siltstone. Amount of claystone increases with depth----------	110	115
Siltstone, brownish-gray (5 YR 4/1), clayey, noncalcareous; contains numerous coal particles and some carbonaceous laminae----------	115	117
Coal----------	117	118
Siltstone, brownish-gray (5 YR 4/1), clayey, noncalcareous; contains numerous coal particles and some carbonaceous laminae----------	118	123.5
Coal and black (N0) claystone with numerous coal laminae----------	123.5	124
Siltstone, medium-gray to grayish-black (N5-N2); contains numerous coal laminae----------	124	125

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Sandstone, silty, very fine grained near top of interval, grades to siltstone toward bottom, very light gray (N8), slightly calcareous, weakly cemented, except for hard bed, 127.5-128 ft; contains some carbonaceous streaks----------	125	132
Sandstone and siltstone, as in interval above, and claystone. Claystone is medium dark gray (N4), silty; contains carbonaceous streaks, appears to be interlaminated with the siltstone and sandstone-------	132	133
Claystone and mudstone. Claystone is medium dark gray (N4), silty; contains carbonaceous streaks and some coal particles; grades to dark-gray to medium-dark-gray (N3-4) mudstone with increasing depth----------	133	142
Sandstone, very fine grained, and coarse-grained siltstone, light-gray to medium-gray (N7-5), weakly cemented; contains carbonaceous particles----------	142	173
Coal and black (N0) claystone with numerous coal laminae-	173	176.5
Siltstone, medium-light-gray (N6), noncalcareous; contains numerous coal particles----------	176.5	180
Siltstone, brownish-gray (5 YR 4/1), weakly cemented; contains carbonaceous streaks----------	180	185

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Siltstone and subordinate mudstone. Siltstone is brownish gray (5 YR 4/1), sandy, weakly cemented. Mudstone is medium to medium dark gray (N5-4). Hard bed 188-188.5 ft----------	185	191
Coal----------	191	192.5
Siltstone, sandy, and/or sandstone, light-brownish-gray to gray (5 YR 5/1-6/1), weakly cemented----------	192.5	200
Siltstone, medium-dark-gray (N4); contains some carbonaceous streaks and a trace of pyrite----------	200	201
Mudstone, black (NO), with numerous coal laminae near top, brownish black (5 YR 2/1) toward middle, medium dark gray (N4) near bottom----------	201	210
Siltstone and subordinate mudstone. Siltstone is light brownish gray (5 YR 5/1), weakly cemented. Mudstone is medium gray (N5), very thinly light and dark gray laminated; contains some coal streaks. Hard bed 211-211.5 ft----------	210	215
Mudstone, medium-gray (N5); contains some sandstone laminae----------	215	218
Siltstone, light-gray (N7), slightly calcareous, strongly cemented; contains pyrite----------	218	222

Lithologic drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Siltstone and subordinate mudstone, coal, and claystone. Siltstone is brownish gray (5 YR 4/1), sandy, weakly cemented. Thin coal and black (NO) mudstone beds occur near 225.5 ft and brownish-black (5YR 4/1) silty claystone near bottom of interval----------	222	231
Coal----------	231	247
Siltstone, medium-brownish-gray to brownish-gray (5 YR 5-4/1), weakly cemented, sandy near top----------	247	253
Claystone, dark-gray (N3)----------	253	254
Siltstone, very light gray (N8); contains thin carbonaceous laminae, and, near 256 ft, a trace of pyrite--	254	257
Siltstone and thin coal beds. Most siltstone is brownish gray (5 YR 4/1), weakly cemented; contains some carbonaceous particles. Some siltstone is very light gray (N8), calcareous, strongly cemented. Thin coal beds near 259 ft and 262 ft----------	257	280
Claystone, dark-gray (N3), silty----------	280	288
Coal----------	288	292
Siltstone, black (NO), very coaly----------	292	294*
Claystone, dark-gray (N3), silty----------	294	300*
Mudstone, medium-dark-gray (N4), sandy----------	300	306
Coal----------	306	318
Claystone, brownish-black (5YR 2/1)----------	318	320

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Sandstone or siltstone, and subordinate claystone and mudstone. Silty sandstone or sandy siltstone, in most of interval is brownish gray (5 YR 4/1), weakly cemented; contains some coal particles. Light-gray (N7), non-calcareous, strongly cemented, tight, sandy siltstone, laminated with carbonaceous material occurs between 340 and 345 ft. Thin claystone bed near 333 ft, and dark-brownish-gray (5 YR 3/1) mudstone with coal streaks between 345 to 350 ft----------	320	350
Sandstone (or siltstone), claystone, and mudstone, as in interval above, and medium-light-gray (N6) calcareous siltstone----------	350	355
Siltstone and subordinate claystone. Siltstone is dark brownish gray (5 YR 3/1), sandy, weakly cemented; contains some coal particles. Claystone is black (N0), very coaly, and may occur as thin interbeds in the siltstone----------	355	360
Sandstone and siltstone. Sandstone is brownish gray (5 YR 4/1), sandy, very fine grained, weakly cemented; contains some coal particles. Siltstone is very light gray (N8), sandy; contains some coal laminae----	360	365*
Sandstone, brownish-gray (5 YR 4/1), very fine grained, weakly cemented; contains some coal and a trace of pyrite----------	365	370*
No sample recovery----------	370	375

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Sandstone and claystone. Sandstone is very light gray (N8) with medium-gray (N5) laminations, very fine grained; contains some coal laminae. Claystone is dark gray (N3), silty; contains some thin coal layers; appears to occur in thin beds in the sandstone--------	375	380
Sandstone, light-gray (N7), very fine grained; contains some coal laminae and a trace of pyrite----------	380	390
No sample recovery; rapid formation penetration by drill except for interval 395-396.3 ft occupied by a hard bed----------	390	413
Mudstone, dark-gray (N3), coaly and coal----------	413	417*
Claystone or mudstone, medium-dark-gray (N4), coaly------	417	420
Siltstone and mudstone. Siltstone is light gray (N7); contains carbonaceous laminae. Mudstone is brownish black (5 YR 2/1). Hard bed 422-423 ft----------	420	423
No sample recovery----------	423	451
Claystone, mudstone, and coal. Claystone is black (NO), coaly; contains a trace of gypsum, grades to dark-brownish-gray (5 YR 3/1) claystone. Mudstone is dark gray (N3)----------	451	455***
Claystone, black (NO), with some coaly laminae and a trace of gypsum, and brownish-gray (5 YR 4/1)----------	455	460***
Mudstone, brownish-black (5 YR 2/1); contains coal laminae----------	460	465***

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Claystone, black (N0) to medium-gray (N5); contains some coal laminae	465	470***
Siltstone, medium-dark-gray (N4) near top to brownish-gray (5 YR 4/1) near bottom of interval; contains coal streaks near bottom	470	480
Claystone and subordinate siltstone. Claystone is brownish black (5 YR 2/1); contains coal laminae and particles. Siltstone is light brownish gray (5 YR 6/1); contains coal laminae	480	485
Claystone and subordinate siltstone. Claystone is black (N0), very coaly; contains a trace of gypsum. Siltstone is light brownish gray (5 YR 6/1); contains coal laminae	485	492
Mudstone and siltstone. Mudstone is medium gray (N5) and siltstone is medium light gray (N6); both contain some coal laminae. Soft except for hard bed 494-494.5 ft--	492	495**
Claystone and sandstone. Claystone is brownish black (5 YR 2/1), very coaly. Sandstone is light gray (N7), very fine grained; contains coal laminae	495	500***
Siltstone, medium-gray (N5); contains coal particles. Hard bed 500.5-501.5 ft	500	505
Siltstone, sandy, light-gray (N7), strongly cemented	505	507

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Claystone, medium-gray (N5); contains coal particles-----	507	510
Claystone and siltstone. Claystone is brownish black (5 YR 2/1). Siltstone is medium light gray (N6); contains coaly laminae. Claystone and siltstone appear to be interstratified----------	510	515**
Claystone and/or mudstone, dark-gray (N3); contains some light-gray (N8) siltstone laminae----------	515	520
Claystone, black (NO), very coaly----------	520	525
Claystone and siltstone. Claystone is black (NO), coaly, and medium dark gray (N4), with carbonaceous streaks. Siltstone is dark gray (N3)----------	525	530
Claystone, medium-gray to light-gray (N6) to medium-dark-gray (N4); contains coal streaks and a lesser amount of black (NO), very coaly claystone----------	530	535*
Coal and subordinate claystone. Claystone is similar to claystone in interval above. Mostly coal 535-539 ft.? Hard bed near 539 ft----------	535	540*
Coal, mudstone, and subordinate claystone. Mudstone is medium light gray (N6). Claystone is grayish black (N2), coaly----------	540	545*

Lithologic log of drill-hole DM-D18 - continued

Description	Depth (ft) From	To
Claystone, siltstone, and sandstone. Claystone is black (N0), coaly, and medium gray (N5). Siltstone is very light gray (N8). Sandstone is light gray (N7)----------	545	550*
No sample recovery; rapid formation penetration 578-610 ft----------	550	610
Total depth - 610 ft		

Lithologic log of drill-hole DM-D20

[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 metres, multiply by 0.3048.]

Location: 100 ft FEL, 100 ft FSL, sec. 20, T. 16 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,360 ft

Drilling started 9-29-75; completed 10-1-75

Total depth: 680 ft

Air injection drilling 0-170 ft; air and water 170-680 ft

Logged by: S. C. Zimmermann and J. M. Back

Description	Depth (ft) From	To
Claystone and mudstone, moderate-yellowish-brown (10 YR 5/4)----------	0	3
Mudstone, medium-gray (N5)----------	3	5
Coal, dark-brownish-gray (5 YR 3/1); strongly weathered--	5	6.5
Sandstone and siltstone. Sandstone is very pale orange (10 YR 8/2) to dark yellowish orange (10 YR 6/6), very fine grained, noncalcareous. Siltstone is light gray (N7). Both contain some carbonaceous particles and limonitic grains----------	6.5	16
Siltstone, weak-yellowish-orange (10 YR 7/5), strongly cemented; contains some limonitic grains----------	16	18

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Siltstone, dark-yellowish-orange (10 YR 6/6) and pale-yellowish-orange (10 YR 8/6), medium-dark-gray (N4) near bottom of interval	18	27
Coal	27	27.5
Claystone, olive-gray (5 Y 4/1); contains some limonitic silt-size grains	27.5	30
Siltstone, dark-yellowish-orange (10 YR 6/6) to medium-dark-gray (N4); contains some carbonaceous streaks; water in hole	30	35
Mudstone and claystone, medium-gray (N5) to dark-gray (N3); contains some carbonaceous streaks and a trace of pyrite; becomes black (NO) and coaly at base	35	49
Coal, water-bearing	49	50
Mudstone, very dark gray (5 YR 3/1); contains coal particles and laminae	50	54
Sandstone, light-gray (N7), very fine grained, strongly cemented in uppermost 1 ft; contains carbonaceous particles and coaly laminae	54	58
Claystone, very dark gray (5 YR 3/1); silty and contains carbonaceous streaks near top; thin sandstone bed near 60 ft	58	67
Coal	67	73
Claystone, brownish-black (5 YR 2/1) to dark-gray (N3); contains numerous coal laminae near top	73	75

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Sandstone, light-gray (N7), very fine grained, strongly cemented; contains some coal particles and laminae----	75	77
Sandstone and mudstone. Sandstone is light gray (N7), very fine grained; grades to medium-gray (N5) mudstone near bottom of interval. Both contain some coal particles and laminae----------	77	81.5
Siltstone and mudstone, very light gray (N7) to medium-dark-gray (N4); contain coal particles. Siltstone and mudstone appear to be interlaminated----------	81.5	85
Claystone, medium-dark-gray (N4); contains trace of pyrite. Thin hard beds near 87 ft and 92 ft. Bed near 92 ft is calcareous siltstone----------	85	94
Siltstone, light-gray (N7), and medium-gray (N5) mudstone; both contain some coal particles. Siltstone and mudstone appear to be interlaminated----------	94	95
Claystone, medium-dark-gray (N4); contains a trace of pyrite and some carbonaceous streaks----------	95	101
Siltstone, medium-dark-gray (N4), calcareous, strongly cemented----------	101	102
Sandstone, light-gray (N7), very fine grained, calcareous, open----------	102	113.5

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Siltstone, light-gray (N7), weakly cemented; contains carbonaceous laminae and some soft yellowish-orange (10 YR 6/6) grains which may be iron oxide after pyrite----------	113.5	115
Siltstone, medium-brownish-gray (5 YR 5/1), weakly cemented----------	115	120
Claystone, medium-dark-gray (N4), grades to medium-gray (N5) mudstone near bottom of interval----------	120	132.5
Siltstone, medium-dark-gray (N4), weakly cemented; contains some glauconite(?) and a trace of pyrite. Interval may also contain some medium-brownish-gray (5 YR 5/1) siltstone which becomes sandy near bottom. Hole wet----------	132.5	150
Sandstone, light-gray (N7), very fine grained; contains some coaly laminae and, near top, glauconite(?)--------	150	160*
Siltstone, light-gray (N7) to medium-gray (N5); contains some coal laminae----------	160	165
Claystone, medium-dark-gray (N4); contains carbonaceous streaks and light-gray siltstone laminae----------	165	169(?)
Sandstone, light-gray (N7), very fine grained and fine-grained, calcareous near top of interval, open; contains carbonaceous streaks near bottom----------	169(?)	189
Claystone, medium-brownish-gray (5 YR 5/1). Hard bed 195-195.2 ft; may be light gray, very fine grained calcareous, tight sandstone----------	189	195.2

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Claystone and siltstone. Claystone is medium dark gray (N4); contains carbonaceous material and a trace of pyrite; grades to light-gray (N7) calcareous siltstone-	195.2	199
Hard bed; may be light-gray (N7), very fine grained, calcareous, tight sandstone----------	199	200
Siltstone and claystone. Siltstone is light olive gray (5 Y 6/1); contains carbonaceous particles; grades to dark-gray (N3) claystone----------	200	205
Claystone, medium-dark-gray (N4); contains some pyrite. Hard bed 209-209.5 ft----------	205	229*
Siltstone, light-gray (N7), strongly cemented; contains coal laminae----------	229	232
Claystone, medium-dark-gray (N4), strongly cemented; contains some pyrite----------	232	234
Siltstone, light-gray (N7); contains coal laminae and dark-yellowish-orange (10 YR 6/6) limonitic grains----	234	239
Mudstone and claystone, medium-dark-gray (N4); contains coal laminae----------	239	243
Siltstone and sandstone. Siltstone is medium gray (N5); contains coal laminae and brown carbonaceous laminae; grades to light-gray (N7), very fine grained silty sandstone which contains coal laminae----------	243	247

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Mudstone, dark-gray (N3) to medium-gray (N5); contains coal streaks	247	250
Claystone and siltstone. Claystone is brownish black (5 YR 2/1), grades(?) to medium-dark-gray (N4) siltstone which contains carbonaceous streaks	250	254
Sandstone and siltstone. Sandstone is light gray (N7) and very fine grained, both noncalcareous and calcareous; contains glauconite(?) grains and coal laminae; grades to medium-gray (N5) siltstone with depth	254	259
Hard bed	259	259.5
Claystone, olive-black (5 Y 2/1) and black (NO); contains coal laminae	259.5	263(?)
Mudstone, medium-dark-gray (N4), grades to medium-gray (N5) mudstone with siltstone laminae near bottom of Interval	263(?)	270
Claystone and siltstone. Claystone is brownish black (5 YR 2/1). Siltstone is medium dark gray (N4) where it contains finely divided carbonaceous material and light gray (N7) where it only contains some carbonaceous streaks	270	275
Coal	275	279
Claystone and siltstone. Claystone is black (NO); contains numerous coal laminae; grades to medium-dark-gray (N4) clayey siltstone near bottom of interval	279	282

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Siltstone, dark-gray (N3), clayey, interlaminated with light-gray (N7) coarser siltstone----------	282	290
Claystone, dark-gray (N3)----------	290	299
Siltstone, medium-gray (N5), both calcareous tight and noncalcareous open; contains carbonaceous streaks and light-gray (N7) laminae----------	299	307
Coal----------	307	308
Claystone, mudstone, and siltstone. Claystone is black (N0); contains numerous coal laminae and a trace of pyrite; grades to brownish-black (5 YR 2/1) mudstone, which contains coal particles and carbonized plant fragments. Mudstone grades to light-gray (N7) calcareous siltstone----------	308	315
Coal and subordinate dark-gray (N3) claystone, which contains some coal laminae and a trace of pyrite. The claystone occurs near top of interval----------	315	320
Claystone, black (N0) and contains numerous coal laminae near top of interval; grades to dark-gray (N3) claystone near bottom----------	320	330

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Claystone and siltstone. Claystone is brownish gray (5 YR 4/1) and dark gray (N3); contains some coal laminae and some siltstone laminae. Siltstone is light gray (N7), noncalcareous, open; contains coal particles and laminae. Claystone and siltstone appear to be interbedded with claystone predominant near top and siltstone predominant near bottom of interval-----	330	344
Siltstone, interlaminated light-gray (N7) and medium-gray (N5); becomes clayey near bottom of interval----------	344	355
Mudstone and siltstone. Mudstone is brownish black (5 YR 2/1); contains numerous carbonaceous streaks and a trace of pyrite. Siltstone is medium gray (N5); contains some carbonaceous streaks----------	355	360
Siltstone and claystone. Siltstone is light gray (N7); both noncalcareous with some coal laminae and limonitic grains and calcareous with a trace of pyrite. Claystone is medium dark gray (N4); contains carbonaceous streaks----------	360	365
Siltstone and mudstone. Siltstone is interlaminated, light gray (N7) and medium dark gray (N4); contains numerous carbonaceous streaks in the dark-gray laminae. Mudstone is brownish black (5 YR 2/1)----------	365	370

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Sandstone, siltstone, and claystone. Sandstone is light gray (N7), very fine grained, calcareous. Siltstone is medium gray (N5); contains numerous very thin carbonaceous laminae. Claystone is brownish black (5 YR 2/1); contains pyrite----------	370	375
Siltstone and claystone. Siltstone is medium dark gray (N4); contains pyrite; grades to brownish-black (5 YR 2/1) claystone----------	375	380
Siltstone and sandstone. Siltstone is medium light gray (N6), sandy, slightly calcareous, open; contains carbonaceous particles; grades downward to light-gray (N7), very fine grained, slightly calcareous, open, silty sandstone. Sandstone and siltstone contain thin beds of dark-gray (N3) mudstone, which contains coal and light-colored siltstone laminae, and dark-gray (N3) to brownish-black (5 YR 2/1) claystone. Hard bed 338-390 ft----------	380	390
Mudstone and siltstone. Mudstone, medium-dark-gray (N4); contains coal laminae; appears to be interlaminated with light-gray (N7) siltstone----------	390	395

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Mudstone, claystone, and siltstone. Mudstone is brownish gray (5 YR 4/1); contains white siltstone laminae. Siltstone is medium gray (N5); contains carbonaceous laminae and limonitic grains. Claystone is dark gray (N3)----------	395	400
Siltstone, light-gray (N7), noncalcareous; contains limonitic grains and, below 402 ft, coal laminae------	400	404(?)
Claystone, dark-brownish-gray (5 YR 3/1); contains coal streaks----------	404(?)	407
Coal----------	407	414
Claystone, black (N0); contains numerous coal laminae----	414	417
Siltstone, interlaminated and interbedded(?) medium-light-gray (N6) and medium-dark-gray (N4), sandy; darker layers contain coal laminae and carbonaceous material; lighter layers are noncalcareous, open------	417	420
Sandstone and mudstone. Sandstone, very light gray (N8), very fine grained, appears to be interlaminated with and to grade to dark-gray (N3) sandy mudstone; dark rocks contain coal laminae----------	420	425

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Sandstone and siltstone, and claystone. Very fine grained sandstone or coarse-grained siltstone is light gray (N7), calcareous; contains coal and carbonaceous laminae. Claystone is brownish black (5 YR 2/1); contains coal laminae and some well-crystallized kaolinite----------	425	430
Sandstone and claystone. Sandstone is very light gray (N8), very fine grained, slightly calcareous to very calcareous; contains coal laminae, limonitic grains and glauconite(?). Claystone is dark gray (N3); contains coal streaks----------	430	435*
Sandstone and subordinate claystone. Sandstone is very light gray (N8), very fine grained or fine grained, noncalcareous, open, weakly cemented; contains numerous particles of coal. Claystone is medium dark gray (N4); contains coaly(?) particles and a trace of pyrite----------	435	440*
Claystone, brownish-black (5 YR 2/1); contains numerous coal laminae----------	440	445**
Sandstone and mudstone. Sandstone is light gray (N7), very fine grained, slightly calcareous, open. Mudstone is brownish black (10 YR 2/1). Both contain coal laminae----------	445	450*

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Sandstone and mudstone. Sandstone is light gray (N7), very fine grained, calcareous; contains limonitic grains. Mudstone is medium to medium light gray (N5-6); contains coal and carbonaceous streaks--------	450	462.5*
Sandstone, dark-gray (N3), very fine grained, muddy, noncalcareous, tight; contains coal laminae----------	462.5	464
Sandstone, medium-light-gray (N6), very fine grained, slightly calcareous, strongly cemented, tight---------	464	465
Sandstone and mudstone. Sandstone is very light gray (N8), very fine grained, slightly calcareous. Mudstone is medium gray (N5). Both contain coal laminae. Mudstone and sandstone appear to be interlaminated----	465	484
Claystone and mudstone. Claystone is brownish black (5 YR 2/1); contains numerous coal laminae; near 488 ft grades downward to medium-dark-gray (N4) mudstone with coal particles----------	484	492.5
Siltstone, light-gray (N7), sandy, noncalcareous, tight--	492.5	495
Mudstone, medium-dark-gray (N4); contains light-gray (N4) siltstone laminae, coal particles, and pyrite---------	495	500
Siltstone, very light gray (N8), calcareous, strongly cemented----------	500	503.5
Sandstone, very fine grained----------	503.5	506.5

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Mudstone, claystone, and coal. Mudstone is medium dark gray (N4); contains coal streaks and laminae; grades to brownish-black (5 YR 2/1) to black (N0) coaly claystone near 515 ft. Coal bed 512-514.5 ft----------	506.5	525
Mudstone, siltstone, and a thin coal bed. Mudstone is medium dark gray (N4). Siltstone is light gray (N7); contains coal and carbonaceous laminae and limonitic grains. Coal bed 527.5-532 ft----------	525	532
Claystone, dark-gray (N3) to black (N0) where very coaly----------	532	534
Sandstone, light-gray (N7), very fine grained, calcareous; contains coal laminae and pyrite----------	534	535
Mudstone, dark-brownish-gray (5 YR 3/1); contains coal streaks----------	535	540
Mudstone, dark-gray (N3), and grayish-black (N2) claystone; both contain coal laminae----------	540	546
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous, except near bottom of interval; contains coal laminae near top. Claystone is medium dark gray (N4); contains coal laminae. Siltstone and claystone appear to be interbedded----------	546	566*
Coal----------	566	568(?)

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Claystone, black (N0) to medium-gray (N5) near bottom of interval; contains numerous coal laminae near top--	568(?)	570
Siltstone and claystone. Siltstone is very light gray (N8), open, calcareous in upper half of interval, noncalcareous in lower half; contains carbonaceous particles and coal laminae near bottom. Claystone is medium dark gray (N4); contains coaly particles and is very thinly laminated with light-colored siltstone near bottom----------	570	582*
Claystone, black (N0), very coaly, especially near top and bottom of interval----------	582	587(?)
Claystone, medium-dark-gray (N4), black (N0) where very coaly; may contain some siltstone laminae or beds near bottom of interval----------	587(?)	614
Siltstone, light- to medium-light-gray (N7-6); contains coal laminae----------	614	620(?)
Sandstone, light-gray (N7), very fine grained, calcareous, open; contains coal laminae----------	620(*)	622.5(?)
Mudstone in upper part, claystone in lower part of interval. Mudstone is brownish gray (5 YR 4/1) to medium dark gray (N4); contains abundant coal laminae near top. Claystone is medium gray (N5); contains black (coaly?) particles. Soft bed near 628 ft----------	622.5(?)	631**

Lithologic log of drill-hole DM-D20 - continued

Description	Depth (ft) From	To
Sandstone, claystone, mudstone, and coal(?). Sandstone is light gray (N7), very fine grained, calcareous, strongly cemented; contains carbonaceous laminae. Claystone is medium gray (N5). Mudstone is medium dark gray (N4); contains numerous coal laminae. Thin coal near 636 ft?----------	631	642
Siltstone and mudstone. Siltstone is light gray (N7), noncalcareous, open; contains coal laminae. Mudstone is mostly medium light gray (N6) with subordinate dark gray (N3) portion----------	642	655
Claystone, dark-gray (N3); contains coal streaks and pyrite----------	655	660
Mudstone, medium-dark-gray (N4); contains some light-gray siltstone laminae----------	660	665
Siltstone, light-gray (N7), slightly calcareous; contains coal partcles and limonitic grains----------	665	670
Claystone, medium-dark-gray (N4)----------	670	675
Claystone and siltstone. Claystone is medium dark gray (N4). Siltstone is medium light gray (N6), calcareous, open; contains some carbonaceous streaks----------	675	680

Total depth - 680 ft.

Lithologic log of drill-hold DM-D22

[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 metres, multiply by 0.3048.]

Location: 200 ft FEL, 300 ft FSL, sec. 24, T. 16 N., R. 91 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,205 ft

Drilling started 10-2-75; completed 10-6-75

Total depth: 650 ft

Air injection drilling 0-336 ft; air and water 336-650 ft

Logged by: S. C. Zimmermann

Description	Depth (ft) From	To
Sandstone----------	0	1.5*
Siltstone, medium-light-gray (N6), slightly calcareous, strongly cemented; contains some coal particles-------	1.5	3*
Claystone, silty, reddish-brown with medium-gray streaks; becomes yellowish orange to yellowish brown with increasing depth----------	3	8*
Claystone, dark-gray (N3), coaly----------	8	10*
Sandstone, yellowish-orange, very fine grained; contains carbonaceous particles----------	10	12*
Claystone, pale-brown (10 YR 5/2); contains some black (NO) (coaly?) particles----------	12	17
Siltstone, light-reddish-brown, strongly cemented--------	17	18*

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Claystone, medium-dark-gray (N4); contains some black (NO) (coaly?) particles----------	18	26*
Coal----------	26	27
Claystone, medium-dark-gray (N4), coaly near top of interval----------	27	30
Siltstone, light-gray (N7), calcareous; contains some coal and carbonaceous streaks----------	30	31
Siltstone, medium-light-gray (N6), calcareous, strongly cemented----------	31	32
Claystone, brownish-gray (5 YR 4/1); contains numerous coal laminae----------	32	35
Mudstone, medium-gray (N5); contains some coal particles-	35	40
Claystone, medium-dark-gray to dark-gray (N4-3); contains some black (NO) (coaly?) particles and coal streaks---	40	42.5
Coal----------	42.5	48.5
Sandstone and claystone. Sandstone is light gray (N7), very fine grained, noncalcareous. Claystone is medium dark gray (N4)----------	48.5	50

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Sandstone, siltstone, and subordinate (?) claystone. Sandstone is very fine grained and siltstone is coarse grained; both are light gray (N7), calcareous, and appear to be interlaminated with medium-dark-gray (N4) claystone----------	50	62
Claystone, medium-dark-gray (N4)----------	62	65
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7), calcareous, open, and appears to occur as thin beds in the claystone----------	65	70
Claystone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained, slightly calcareous, open, and appears to occur as thin beds in the claystone. Hard, calcareous, very fine grained sandstone near 75 ft----------	70	75
Siltstone and mudstone. Siltstone is light gray (N7), calcareous; contains some mudstone laminae which increase in amount with increasing depth; grades to mudstone near bottom of interval----------	75	90
Mudstone, medium-gray (N5); contains numerous coal streaks----------	90	95
Claystone, medium-dark-gray (N4)----------	95	104
Silstone, medium-gray (N5), noncalcareous; contains some pyrite, coal particles, and a trace of glauconite(?)----------	104	115

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Mudstone or clayey siltstone, medium-gray (N5); contains some coal particles and a trace of pyrite----------	115	120
Sandstone, light-gray (N7), very fine grained, calcareous, open; contains some muddy carbonaceous laminae below 127 ft----------	120	132
Siltstone, medium-dark-gray (N4), calcareous; contains numerous carbonaceous streaks----------	132	133
Sandstone, light-gray (N7), fine-grained, weakly cemented----------	113	138.5(?)
Siltstone, medium-light-gray (N6), calcareous; contains some coal particles----------	138.5(?)	141
Siltstone, as in interval above, and claystone. Claystone is dark gray (N3); contains numerous coal streaks. Claystone appears to occur as laminations in the siltstone and the amount of claystone increases with depth----------	141	146
Siltstone, mudstone, and claystone. Siltstone is medium gray (N5), calcareous; contains numerous carbonaceous laminae, and some coal particles. Mudstone is medium gray (N5); contains some coal particles. Claystone is medium gray (N5); contains numerous coal streaks. Hole wet----------	146	150

Lithologic log of drill-hole DM-D22 - continued

Description	(Depth (ft) From	To
Claystone and subordinate siltstone. Claystone is medium dark gray (N4); contains some coal laminae and a trace of pyrite. Siltstone in thin beds between 184 and 186 ft is light gray (N7), slightly calcareous, and contains a trace of pyrite. Thin hard beds near 151.5 ft, 166 ft, 191 ft, and 195 ft----------	150	196
Siltstone, light-gray (N7); contains numerous coal laminae----------	196	198.5
Coal----------	198.5	201
Siltstone, medium- to light-gray (N5-7); contains numerous mudstone laminae, some coal streaks and laminae----------	201	210
Claystone, black (N0); contains numerous coal laminae near bottom of interval----------	210	212.5
Coal----------	212.5	215
Claystone, black (N0); contains numerous coal laminae-	215	217
Siltstone, weakly cemented, medium-gray (N5)----------	217	220.5
Claystone, silty or sandy, grades to mudstone; dark-gray (N3); contains numerous coal particles near top of interval----------	220.5	226.5

Lithologic log od drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Claystone and coal. Claystone is black (NO) to brownish black (5 YR 2/1); contains numerous coal laminae in upper part of interval. Thin coal bed near 226.5 ft----------	226.5	230
Sandstone and subordinate siltstone. Sandstone is medium gray (N5), very fine grained; contains numerous coal particles and laminae. Siltstone is dark gray (N3), and appears to be interbedded with the sandstone------	230	238.5
Siltstone, medium-gray (N5), calcareous, very well cemented; contains some mudstone laminae----------	238.5	240
Claystone, dark-gray (N3), hard----------	240	243
Claystone and coal. Claystone is black (NO); contains numerous coal laminae. Thin coal bed near 243 ft-----	243	246
Mudstone----------	246	247
Sandstone, medium-brownish-gray (5 YR 5/1), very fine grained, grades downward to fine-grained sandstone near 270 ft; weakly cemented; contains some coal particles----------	247	275
Claystone, grayish-brown (10 YR 5/2), silty or sandy; contains some coal particles----------	275	277
Hard bed----------	277	278(?)
Coal----------	278(?)	279

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Claystone and subordinate mudstone and siltstone. Claystone is black (NO); contains some coal laminae near top of interval; becomes grayish brown (10 YR 5/2) with depth; below 288-288.5 ft claystone grades to brownish-gray (10 YR 4/1) mudstone interlaminated with light-gray (N7) siltstone----------	279	290
Claystone and subordinate coal and siltstone. Claystone is brownish black (5 YR 2/1); contains some coal particles and thin coal beds above 294 ft, and some light-gray (N7), noncalcareous siltstone layers near bottom of interval----------	290	302
Coal, water-bearing----------	302	311
Claystone, grades to mudstone, sandy, dark-gray (N3); contains coal laminae. Hole wet----------	311	318(?)
Siltstone and sandstone. Siltstone is medium dark gray (N4); contains some mudstone laminae; appears to grade to light-gray (N7), very fine grained sandstone, that contains some coal laminae. Hole wet----------	318(?)	325
Siltstone, light-gray (N7), calcareous; contains some mudstone laminae and some coal streaks. Hole wet-----	325	330
Siltstone, as above, and medium-dark-gray (N4) mudstone, which contains some coal laminae. Hole wet----------	330	335

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Siltstone, light-gray (N7), calcareous; strongly cemented 352-356 ft; contains numerous mudstone laminae between 345 ft and 350 ft----------	335	356
Claystone and coal. Claystone is dark gray (N3); contains some coal streaks. Thin coal bed near 358 ft---------	356	360
Claystone and mudstone. Claystone is black (N0); contains some coal laminae, a trace of pyrite and, near top of interval, some dark-gray (N3) mudstone----------	360	384
Coal----------	384	394
Claystone, black (N0); contains some coal laminae--------	394	396(?)
Siltstone, light-gray (N7), noncalcareous, clayey--------	396(?)	400(?)
Claystone to sandy claystone, medium-dark-gray (N4); contains some coal laminae----------	400(?)	405
Siltstone and mudstone. Siltstone is light gray (N7), noncalcareous; contains numerous coaly carbonaceous laminae. Mudstone is dark gray (N3); contains some coal particles----------	405	410
Siltstone and mudstone, as in interval above, and sandstone. Sandstone is light gray (N7), noncalcareous, very fine grained; contains some carbonaceous laminae and a trace of pyrite----------	410	415
Sandstone and siltstone, light-gray (N7), noncalcareous, weakly cemented; contains some carbonaceous laminae and pyrite. Pyrite is more abundant near bottom of interval than top----------	415	425

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Mudstone and interlaminated siltstone and claystone. Mudstone is medium dark gray (N4); contains some coal; laminae near top of interval appears to grade to interlaminated siltstone and claystone. Soft bed near 434 ft----------	425	435
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous, open; contains numerous coal laminae and some coal streaks. Claystone is dark gray (N3); contains some pyrite----------	435	440
Siltstone, light-gray (N7), noncalcareous, open; contains numerous coal laminae and coal streaks----------	440	445
Siltstone, as in interval above, and dark-gray (N3) claystone, which contains some pyrite. Flowing formation water----------	445	450*
Sandstone, siltstone, and claystone. Sandstone is medium gray (N5), very fine grained; contains numerous coal particles and some mudstone laminae. Siltstone is medium light gray (N6); contains numerous mudstone laminae. Claystone is dark gray (N3)----------	450	455
Siltstone, black to medium-gray (N0-5), noncalcareous; contains numerous coal laminae in some parts of the interval and a trace of pyrite----------	455	460

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Interlaminated(?) sandstone, siltstone, mudstone, and claystone, dark- to light-gray (N3-7); contain some coal particles and laminae. Hard bed (sandy siltstone(?) near 470 ft----------	460	478
Claystone, black (NO); contains numerous coal laminae, some light-gray (N7) claystone clasts and coal streaks near top of interval; becomes brownish black (5 YR 2/1) below 480 ft----------	478	490
Mudstone, dark-gray (N3); contains a trace of pyrite. Hard bed (sandy siltstone?) near 493 ft; soft near 494 ft--	490	495
Claystone and coal. Claystone is grayish-black (N2); contains numerous coal particles----------	495	500
Mudstone, medium-dark-gray (N4); contains numerous black (coaly?) particles----------	500	510
Claystone, black (NO); may contain some coal near 517 ft and 525 ft----------	510	525
Claystone, as in interval above, coal(?), and medium-dark-gray (N4) mudstone----------	525	530
Coal and black (NO) claystone with numerous coal laminae-	530	534(?)*
Claystone and siltstone. Claystone is medium gray (N5); contains some coal particles. Siltstone is medium dark gray (N4), noncalcareous; contains numerous coal streaks----------	534(?)	540

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Mudstone, medium-dark-gray (N4); contains some coal particles and fewer limonitic grains. Thin brownish-gray, strongly cemented hard stiltstone bed near 543 ft----------	540	545
Siltstone and claystone. Siltstone is medium gray (N5); contains numerous coal laminae. Claystone is black (NO); contains more coal laminae than siltstone-------	545	550
Claystone, black (NO), coaly, and medium-dark-gray (N4)--	550	555
Claystone and siltstone. Claystone is brownish black (5 YR 2/1); contains some coal. Siltstone is medium light gray (N6), noncalcareous; contains numerous coal streaks. Coal 557-558.5 ft?----------	555	560
Claystone, black (NO) and brownish-black (5 YR 2/1); contains numerous coal laminae where black----------	560	570
Coal, mudstone, and claystone. Mudstone is medium dark gray (N4); contains numerous coal laminae. Claystone is black (NO); contains more coal laminae than the mudstone----------	570	575
Mudstone and claystone, as in interval above, and siltstone. Siltstone is light gray (N7), noncalcareous; contains coal particles----------	575	585

Lithologic log of drill-hole DM-D22 - continued

Description	Depth (ft) From	To
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous; contains some coal particles. Claystone is dark gray to black (N3-0); contains some kaolinitic(?) laminae----------	585	590
Sandstone, claystone, and siltstone. Sandstone is light gray (N7), fine grained, weakly cemented. Claystone is dark gray (N3); contains a trace of pyrite. Siltstone is light gray (N7); contains numerous carbonaceous laminae----------	590	610
Mudstone, medium-gray (N5)----------	610	615
Sandstone, fine-and very fine-grained, weakly cemented---	615	650

Total depth - 650 ft.

Lithologic log of drill-hole DM-D26

[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 metres, multiply by 0.3048.]

Location: 375 ft FEL, 1,700 ft FSL, sec. 17, T. 15 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,285 ft

Drilling started 9-11-75; completed 9-12-75

Total depth: 710 ft

Air injection drilling 0-420 ft; air and water 420-710 ft

Logged by: S. C. Zimmermann

Description	Depth (ft) From	To
Siltstone, light-yellowish-brown (10 YR 6/4), and light-gray (N7), calcareous, open; contains some coal particles----------	0	5
Siltstone and claystone. Siltstone is yellowish gray (2.5 Y 7/2), calcareous, tight. Claystone is light brownish bray (10 YR 6/1) and irregularly yellowish-orange (iron-oxide) stained; contains numerous black (coaly?) streaks. Siltstone and claystone appear to be interbedded----------	5	10
Claystone, as in interval above, and siltstone. Siltstone is yellowish brown (10 YR 5/8), calcareous, open, and becomes the predominant lithology near the bottom of the interval----------	10	15

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Claystone and mudstone. Claystone is dark yellowish orange (10 YR 6/6) to medium brownish gray (5 YR 5/1); grades to very dark gray (10 YR 3/1) mudstone with numerous coal streaks with depth----------	15	17
Coal, grades to impure coal near 20 ft and impure coal grades to black (N0) coaly claystone near bottom of interval----------	17	23
Sandstone, weakly yellowish-orange (10 YR 7/6), very fine grained----------	23	25
Siltstone and claystone. Siltstone is pale yellowish orange to dark yellowish orange (10 YR 8-6/6), very light gray (N8), weakly cemented near top of interval; interbedded(?) with black (N0) claystone near bottom. Hard bed of pyritized siltstone near 27 ft----------	25	30
Claystone, medium-gray (N5); contains a trace of pyrite. Hard bed, 36-37 ft----------	30	40.5
Siltstone, light-gray (N7), calcareous, strongly cemented (40.5-42 ft), tight; contains some coal particles----------	40.5	46
Mudstone and claystone. Mudstone is medium gray (N5); contains numerous siltstone laminae and carbonaceous streaks. Claystone is medium dark gray (N4); contains some black (coaly?) streaks. Mudstone and claystone appear to be interbedded----------	46	50

Lithologic log of drill hole DM-D26 -- continued

Description	Depth (ft) From	To
Siltstone and claystone. Siltstone is light gray (N7), calcareous. Claystone is medium dark gray (N4); contains some black (coaly?) streaks. Siltstone and claystone appear to be interbedded----------	50	55
Siltstone and mudstone, interlaminated(?), light gray (N7); mudstone laminae contain some carbonaceous streaks----------	55	60
Claystone, medium-dark-gray (N4); contains some coal streaks and a trace of pyrite----------	60	65
Mudstone, medium-light-gray (N6), laminated light and dark; contains a trace of pyrite. Hard bed, 74.5 ft-75 ft----------	65	75
Mudstone, as in interval above, and claystone. Claystone is medium dark gray (N4); contains a trace of pyrite. Hard bed 81.4 ft-82 ft----------	75	85
Siltstone and mudstone. Siltstone is medium light gray (N6), sandy, weakly cemented; contains some coal particles. Mudstone is medium gray (N5); contains a trace of glauconite(?) and some coal particles----------	85	90
Mudstone, as in interval above----------	90	100
Sandstone, medium-gray (N5), very fine grained, weakly cemented----------	100	106

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Sandstone and claystone. Sandstone is light brownish gray (5 YR 5/1), fine grained, weakly cemented; contains numerous coal particles. Claystone is dark gray (5 YR 2/1), sandy; contains some coal laminae. Sandstone and claystone appear to be interbedded------	106	109
Sandstone, light-brownish-gray (5 YR 5/1), fine-grained (109 ft-120 ft), grades to very fine grained (120 ft-122 ft), weakly cemented; contains some coal particles, grades to very fine grained sandstone in basal 2 ft of interval----------	109	122**
Siltstone, sandy, medium-gray (N5), weakly cemented, interbedded(?) with a lesser amount of medium-gray (N5), noncalcareous, open siltstone in which pyrite is abundant. Hard bed of very fine grained, calcareous sandstone 128-129 ft----------	122	131
Claystone, dark-gray (N3); contains a trace of pyrite---	131	143.5
Hard bed----------	143.5	144.5
Claystone, dark-gray (N3); contains a trace of pyrite---	144.5	145.7
Hard bed----------	145.7	146
Mudstone, brownish-gray (5 YR 4/1); contains many thin hard beds----------	146	155
Claystone, medium-dark-gray (N4); contains a trace of pyrite, some black (coaly?) particles, and numerous hard thin beds----------	155	177

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Sandstone and siltstone. Sandstone is dark gray (N3), fine grained, clayey, noncalcareous. Siltstone is medium gray (N5) overall but is composed of dark- and light-gray (N3-N7) layers. The dark laminae are clayey and contain numerous coal streaks. The siltstone appears to occur below the sandstone----------	177	183
Siltstone, sandstone, and mudstone. Siltstone is medium gray (N5), sandy, weakly cemented, and occurs near the top of the interval; grades to brownish-gray (5 YR 4/1), very fine grained, weakly cemented sandstone, containing numerous coal particles. Thinly interbedded(?) medium-dark-gray (N4) mudstone and light-gray (N7) siltstone, which contain numerous coal streaks, occur between 189 and 192 ft----------	183	192
Coal----------	192	195.5
Siltstone, medium-gray (N5), weakly cemented; contains some coal particles and a lesser amount of medium-gray (N5), noncalcareous siltstone containing numerous coal streaks----------	195.5	200
Mudstone and siltstone. Mudstone is medium dark gray (N4); contains numerous coal streaks. Siltstone is very light gray (N8), slightly calcareous, weakly cemented; contains some coal particles----------	200	204

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Coal, partly oxidized(?) (contains reddish-brown dust)--	204	210
Siltstone, medium-gray (N5), weakly cemented; contains some coal particles----------	210	215
Coal, partly oxidized(?) (contains reddish-brown dust)--	215	218
Siltstone, medium-dark-gray (N4); contains numerous coal streaks----------	218	220
Mudstone, brownish-gray (5 YR 4/1); contains numerous coal streaks----------	220	225
Claystone, brownish-black (5 YR 2/1); contains a trace of pyrite----------	225	233(?)
Siltstone and coal. Siltstone is brownish gray (5 YR 4/1); contains numerous coal particles. Thin coal bed near top of interval----------	233(?)	235
Siltstone, brownish-gray (5 YR 4/1), noncalcareous, weakly cemented----------	235	244
Coal; contains brownish-black (5 YR 2/1), coaly claystone(?) parting at 245.5 ft----------	244	246.5
Siltstone, brownish-gray (5 YR 4/1), noncalcareous, weakly cemented----------	246.5	250
Sandstone, medium-light-gray (N6), very fine grained, weakly cemented----------	250	256
Mudstone, brownish-gray to brownish-black (5 YR 4-2/1); contains numerous coal laminae----------	256	259

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Siltstone, sandy near top of interval, grades to silty sandstone near bottom, medium-brownish-gray (5 YR 5/1), weakly cemented	259	275(?)
Siltstone, light-gray (N7), noncalcareous, open; contains numerous coal and mudstone laminae	275(?)	278
Siltstone, medium-gray (N5), calcareous, strongly cemented, tight; contains some coal particles	278	281.5
Siltstone, sandy, medium-gray (N5), weakly cemented; contains some coal particles	281.5	285
Sandstone, medium-gray (N5), very fine grained, weakly cemented. Hole wet	285	295
Siltstone and mudstone. Siltstone is medium gray (N5), sandy, weakly cemented. Mudstone is grayish black (N3); contains numerous coal and siltstone laminae	295	305(?)
Coal	305(?)	316
Mudstone, brownish-black (5 YR 2/1); contains numerous coal particles	316	320(?)
Siltstone, sandy, very dark gray (5 YR 3/1), weakly cemented; contains some coal particles	320(?)	341
Hard bed (siltstone or sandstone)	341	342
Sandstone(?), silty, medium-gray (N5), weakly cemented	342	344
Claystone, dark-gray (N3); contains a trace of pyrite	344	354

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Siltstone, medium-light-gray (N6), calcareous, very strongly cemented in upper part of interval; very dark gray (5 YR 3/1), sandy; contains numerous coal particles in lower part	354	360
Coal	360	364
Claystone, brownish-black (5 YR 2/1) and siltstone(?). Rapid formation penetration suggests some weakly cemented siltstone between 367 and 376 ft	364	376**
Coal	376	380
Siltstone, sandy, very dark gray (5 YR 3/1) to medium-gray (N5), weakly cemented; contains some coal particles	380	390
Sandstone, medium-gray (N5), very fine grained, weakly cemented	390	403
Coal. Water in hole	403	410(?)
Mudstone and claystone. Mudstone is very dark gray (5 YR 3/1); contains numerous coal particles. Claystone is very dark gray (5 YR 3/1) to black (N0) where it contains numerous coal laminae. Water in hole	410(?)	420*
No sample recovery	420	425
Claystone, black (N0); contains numerous coal laminae	425	426
Sandstone, very fine grained or coarse-grained siltstone, light-gray (N7), noncalcareous, tight; contains some muddly carbonaceous laminae	426	429

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Mudstone, brownish-gray (5 YR 4/1)----------	429	433
Claystone, black (N0); contains numerous coal laminae----	433	435(?)
Mudstone, interlaminated mudstone and siltstone, and claystone. Mudstone is brownish gray (5 YR 4/1). Interlaminated mudstone and siltstone are medium light gray to dark gray (N6-3); mudstone laminae contain some coal laminae and are darker than siltstone laminae. Claystone is dark gray (N3) and occurs in the lower part of the interval----------	435(?)	455
Mudstone, brownish-gray (5 YR 4/1)----------	455	465
Claystone, black (N0), with numerous coal laminae and medium-gray (N5) with some coal streaks----------	465	470
Claystone, black (N0); contains numerous coal laminae----	470	475
Claystone and siltstone. Claystone is brownish gray (5 YR 4/1); contains some coal laminae. Siltstone is light gray (N7), noncalcareous; contains some coal particles----------	475	480
Siltstone, very light gray (N8), noncalcareous; contains some coal particles----------	480	485
Sandstone and claystone. Sandstone is very light gray (N8), fine grained; contains some large soft white grains. Claystone is brownish black (5 YR 2/1); contains numerous coal laminae----------	485	490

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Claystone, dark-gray (N3)----------	490	495
Claystone, black (N0); contains numerous coal laminae----	495	500
Mudstone and siltstone. Mudstone is medium gray (N5); contains some carbonaceous streaks. Siltstone is medium light gray (N6), noncalcareous, tight; contains some coal streaks----------	500	505
Mudstone, medium-gray (N5); contains some carbonaceous streaks. Hard bed 513-515 ft----------	505	515
Siltstone, medium-dark-gray (N4), slightly calcareous, strongly cemented in part; contains some coal particles, streaks, and laminae----------	515	520
Claystone, black (N0); contains numerous coal laminae----	520	525
Claystone and mudstone, very dark gray (5 YR 3/1); contains some coal laminae----------	525	530
Mudstone and siltstone. Siltstone is medium gray (N5), slightly calcareous, strongly cemented; contains some black (coal?) particles. Mudstone is very dark gray (5 YR 3/1); contains some coal laminae----------	530	535
Claystone and coal. Claystone is black (N0); contains numerous coal laminae. Few thin coal beds near bottom of interval----------	535	540
No sample recovery----------	540	545

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Claystone, black (N0), with numerous coal laminae, grades to medium-gray (N5) claystone with some coal streaks and a trace of pyrite near bottom of interval---	545	555
Mudstone, brownish-gray (5 YR 4/1); contains numerous coal particles----------	555	560
Claystone and coal bed. Claystone is dark gray (N3) to grayish black (N2); contains numerous coal laminae. Thin coal bed near 562 ft and a thicker bed between 591 and 595 ft?----------	560	603
Siltstone, medium-light-gray (N6); contains some coal laminae and a trace of pyrite----------	603	605
Claystone, mudstone, and coal. Claystone is dark gray (N3). Mudstone is medium dark gray (N4); contains some coal laminae. Coal bed near 608 ft?---------	605	610
Siltstone, light-gray (N7), noncalcareous, tight; contains carbonaceous laminae----------	610	620
Claystone, dark-gray to medium-gray (N3-5); contains coal laminae----------	620	635
Claystone, medium-dark-gray (N4), sandy, and brownish-gray to brownish-black (5 YR 4/21) claystone. Both contain some coal particles and laminae----------	635	640
Claystone, as in interval above, and sandstone. Sandstone is very light gray (N8), fine grained, slightly calcareous; contains some coal particles----------	640	645

Lithologic log of drill-hole DM-D26 - continued

Description	Depth (ft) From	To
Claystone, medium-dark-gray (N4); contains some coal laminae	645	655
Mudstone, medium-gray (N5); contains some coal streaks	655	660
Mudstone, as in interval above, and siltstone. Siltstone is light gray (N7), noncalcareous; contains some coal streaks	660	665
Siltstone and claystone. Siltstone is light gray (N7), noncalcareous; contains some coal streaks. Claystone is dark gray (N3); contains some coal laminae	665	670
Claystone, medium-gray (N5); contains carbonaceous laminae and a trace of pyrite. No sample recovery 680–690 ft	670	700*
Sandstone, very light gray (N8), very fine grained, noncalcareous; contains some coal laminae	700	705
Sandstone, very light gray (N8), fine-grained and very fine grained, noncalcareous; contains some coal laminae; and medium-light-gray (N6) silty sandstone that contains some carbonaceous laminae	705	710

Total depth - 710 ft.

Lithologic log of drill-hole DM-D27

[Encountered water at 90 ft and, during deeper drilling, hole continually eroded. As a consequence, samples recovered from intervals below 90 ft were generally 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 metres, multiply by 0.3048].

Location: 1,500 ft FWL, 800 ft FNL, sec. 19, T. 15 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,860 ft

Drilling started 9-16-75; completed 9-17-75

Total depth: 510 ft

Air injection drilling 0-210 ft; air and water 210-510 ft

Logged by S. C. Zimmermann and J. M. Back

Description	Depth (ft) From	To
Mudstone, sandy, very pale brown (10 YR 7/3), irregularly yellowish orange (iron-oxide) stained; contains calcareous coatings, partings, and fracture-fillings near top of interval and trace of gypsum near bottom-------	0	45
Sandstone, very light gray (N8), very fine grained, tight; contains some soft limonitic grains----------	45	46
Claystone, grayish-orange (10 YR 7/4), very thinly laminated----------	46	48
Mudstone, very pale brown (10 YR 8/3)----------	48	49
Sandstone, pinkish-gray (5 YR 8/1) to light-gray (N7), very fine grained, noncalcareous, weakly cemented; contains carbonaceous particles, and near 51 ft, a thin claystone bed----------	49	55

Lithologic log of drill-hole DM-D27 - continued

Description	Depth (ft) From	To
Siltstone, very light gray (N8), slightly calcareous, strongly cemented----------	55	56
Claystone and/or mudstone, medium-gray (N5); contains some black (coaly?) particles and white siltstone laminae--	56	58
Sandstone, very fine grained, and/or siltstone, yellowish-gray (5 Y 7/2), slightly calcareous, open; contains some carbonaceous particles----------	58	58.5
Claystone and/or mudstone, medium-gray (N5); contains some black (coaly?) particles and white siltstone laminae----------	58.5	60
Sandstone, very fine grained, and/or siltstone, yellowish-gray (5 Y 7/2), slightly calcareous, open; contains some carbonaceous grains----------	60	64
Claystone, mudstone, and siltstone. Claystone and/or mudstone is medium gray (N5); contains some black (coaly?) particles and white siltstone laminae. Near bottom of interval grades(?) to very light gray (N8), noncalcareous, tight siltstone----------	64	66(?)
Siltstone, claystone, and coal. Siltstone and/or claystone is black (N0), very coaly; contains some well-crystallized kaolinite and thin beds of coal----------	66(?)	72

Lithologic log of drill-hole DM-D27 - continued

Description	Depth (ft) From	To
Siltstone, very light gray (N8), coarse-grained (fines with depth), noncalcareous, open; contains numerous carbonaceous laminae	72	82
Claystone, medium-dark-gray (N4) near top of interval to black (N0) and coaly near base; contains a trace of pyrite, where coaly, and some well-crystallized kaolinite. Flowing water at 90 ft and in most intervals below	82	92
Sandstone, light-gray, very fine grained, calcareous, strongly cemented	92	95.5
Siltstone and subordinate sandstone and claystone(?) Siltstone is thinly laminated, medium gray and dark gray. Dark laminae become more numerous with depth and siltstone may grade to claystone near bottom of interval. Thin beds of very fine grained sandstone containing dark-gray laminae occur near 96.5 ft	95.5	100
Coal	100	102
Siltstone, sandstone, and claystone(?). Siltstone is dark gray, grades to slightly brownish light gray, very fine grained sandstone near bottom of interval and claystone near top	102	103

Lithologic log of drill-hole DM-D27 - continued

Description	Depth (ft) From	To
Sandstone, slightly brownish light gray, very fine grained	103	104.5
Siltstone, dark-gray	104.5	107
Sandstone, light-gray, very fine grained; contains dark-gray laminae	107	111
Siltstone, dark-gray; may grade to claystone near bottom of interval	111	117
Coal	117	120
Siltstone or claystone, dark-gray	120	121
Sandstone, light-gray, very fine grained	121	128
Siltstone, dark-gray	128	137
Siltstone and sandstone. Siltstone is dark gray, appears to be interbedded with light-gray, very fine grained sandstone, which contains dark-gray laminae	137	137.5
Sandstone, very fine grained; contains carbonaceous material	137.5	138.5
Siltstone, laminated dark- and medium-gray	138.5	148
Siltstone, dark-gray	148	151
Sandstone, very fine grained; contains dark-gray laminae-	151	154
Siltstone, thinly laminated medium-gray and dark-gray in upper part of interval to dark-gray near bottom	154	160.5
Sandstone and siltstone(?). Sandstone is very fine grained, strongly cemented above 162 ft, less strongly cemented below. May grade to siltstone near bottom of interval	160.5	167

Lithologic log of drill-hole DM-D27 - continued

Description	Depth (ft) From	To
Siltstone, dark-gray	167	182
Sandstone and siltstone. Sandstone is greenish gray, very fine grained; contains dark-gray siltstone laminae which becomes more abundant with depth	182	206
Siltstone, medium- to dark-gray	206	210(?)*
No sample recovery	210(?)	215
Sandstone, silty, very fine grained	215	221
Siltstone, medium-gray; contains dark-gray laminae	221	221.5
Sandstone, very fine grained	221.5	232
Siltstone, interlaminated dark-gray and medium-gray	232	236
Siltstone, dark-gray	236	253
Siltstone, dark-gray; contains medium-gray laminae	253	266.5
Hard bed	266.5	270
No sample recovery. Hard beds 282-283 ft and 285-285.5 ft	270	293
Sandstone, medium-gray, very fine grained; contains dark-gray laminae	293	299.5
Coal	299.5	303.5
Sandstone, medium-gray with dark-gray laminae near top of interval becoming darker gray near bottom, very fine grained	303.5	310
Coal?	310	319
Siltstone, sandy, dark-gray	319	323

Lithologic log of drill-hole DM-D27 - continued

Description	From	To
Siltstone and very fine grained sandstone, interlaminated(?)	323	326
Siltstone, dark-gray	326	330
Siltstone, black, very coaly, weakly cemented. H_2S gas odor evolved from drill hole	330	337
Sandstone, gray, very fine grained	337	339
Siltstone and subordinate sandstone. Siltstone is dark gray; contains thin, very fine grained sandstone bed near 342 ft. H_2S gas odor evolved from drill hole	339	357
Siltstone, laminated dark- and medium-gray	357	360
Coal(?) and coaly claystone	360	396(?)
Coal(?), soft	396(?)	404
Siltstone	404	413
Coal and dark-gray siltstone	413	419.5
Sandstone and/or siltstone, light-gray; contains dark-gray (siltstone?) laminae	419.5	425
Siltstone, dark-gray; contains light-gray siltstone laminae	425	428.5
Sandstone, very fine grained	428.5	429
Siltstone, dark-gray; contains light-gray [siltstone] laminae above 437 ft	429	440.5
Sandstone, medium-gray, fine-grained, soft; contains dark-gray laminae below 442 ft	440.5	450
Coal	450	457

Lithologic log of drill-hole DM-D27 - continued

Description	Depth (ft) From	To
Siltstone, dark-gray, very coaly (grades to black claystone?)	457	458
Hard bed	458	458.5
Siltstone, dark-gray	458.5	476.5
Siltstone, dark- and medium-gray	476.5	489
Coal and dark-gray siltstone, interbedded(?)	489	492
Siltstone, mostly dark gray; contains medium-gray laminae	492	495
Coal and dark-gray siltstone	495	498
Siltstone, dark-gray	498	501
Siltstone, dark-gray; contains some medium-gray siltstone layers	501	510

Total depth - 510 ft.

Lithologic log of drill-hole DM-D27A

[Intervals marked with an 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 metres, multiply by 0.3048].

Location: 1,900 ft FEL, 400 ft FNL, sec. 19, T. 15 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,930 ft

Drilling started 9-19-75; completed 9-23-75

Total depth: 710 ft

Air injection drilling 0-170 ft; air and water, 170-710 ft

Logged by S. C. Zimmermann and J. M. Back

Description	Depth (ft) From	To
Sandstone and silty sandstone, light-reddish-brown (5 YR 6/3), grayish-orange (10 YR 7/4), and pinkish-gray (5 YR 8/1), very fine grained, calcareous, strongly to weakly cemented, tight to open; grades to fine-grained sandstone and contains a trace of glauconite(?) below 10 ft	0	14
Claystone and/or mudstone, medium-gray (N5); contains some carbonaceous particles and yellowish-orange laminae	14	17
Sandstone, grayish-orange (10 YR 7/4), very fine grained, calcareous	17	19
Mudstone, medium-gray (N7); contains some carbonaceous streaks	19	22.5
Coal	22.5	23.5

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone, black (NO); contains numerous coal laminae----	23.5	24.5
Coal----------	24.5	25
Claystone, light-brownish-gray (5 YR 6/1), thinly laminated; contains some black (coal?) particles. Also moderate-yellowish-brown (10 YR 5/4) claystone--------	25	27
Coal----------	27	29.5
Siltstone, laminated medium-gray and light-gray (N5-7), noncalcareous, weakly cemented, open; contains numerous coal particles near top of interval and numerous carbonaceous streaks in the darker laminae----------	29.5	37
Mudstone alternating with claystone. Mudstone is medium gray (N5), tight; contains silty laminae. Claystone is medium gray (N5); contains a trace of gypsum----------	37	46
Sandstone, light-gray (N7), very fine grained, silty, calcareous, weakly cemented, open; interval may contain a thin coal bed----------	46	55.5
Coal(?)----------	55.5	56.5
Claystone, black (NO), very coaly----------	56.5	56.7(?)
Sandstone, light-gray (N7), very fine grained, silty, calcareous, weakly cemented, open----------	56.7(?)	64
Siltstone, very light gray (N8), calcareous, strongly cemented, tight----------	64	65

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Siltstone, light-gray (N7), calcareous, weakly cemented; contains some thin claystone layers	65	69
Claystone and mudstone, medium-dark-gray (N4)	69	72
Siltstone, light-gray (N7), calcareous, weakly cemented	72	75(?)
Claystone, dark- to medium-gray (N3-5); contains some carbonaceous streaks	75(?)	80
Coal; contains 0.5-ft parting of medium-gray siltstone	80	86
Claystone, black (N0); contains numerous coal laminae	86	87
Siltstone, light-gray (N7), clayey, carbonaceous	87	93.5
Mudstone and claystone. Mudstone is light gray (N7); contains some carbonaceous streaks. Claystone is medium dark gray (N4); contains some light-gray siltstone laminae	93.5	103.5
Sandstone, medium-light-gray (N6), very fine grained, calcareous, strongly cemented, tight	103.5	108
Siltstone, laminated light- and medium-gray (N7-5), calcareous; contains carbonaceous material in the darker laminae	108	113
Claystone, dark-gray (N3); contains a trace of pyrite and black (coaly?) particles	113	117
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained, weakly cemented; grades to siltstone near bottom of interval. Water in hole	117	120

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone and/or mudstone, medium-dark-gray (N4); contains a trace of pyrite and some carbonaceous streaks. Water in hole?----------	120	128*
Sandstone, medium-light-gray (N6), very fine grained, calcareous, strongly cemented; contains a trace of glauconite(?). Water in hole?----------	128	130*
Siltstone interlaminated with mudstone. Siltstone is light gray (N7), calcareous, open. Mudstone is medium gray (N5), calcareous, contains carbonaceous material. Water in hole?----------	130	145*
Claystone and sandy claystone. Claystone is medium gray (N5); contains some black streaks. Sandy claystone is medium dark gray (N4); contains glauconite(?); grades to clayey sandstone. Water in hole?----------	145	150
Siltstone, medium-gray (N5), sandy, generally weakly cemented; contains a trace of glauconite(?) and coal particles. Some siltstone is calcareous, strongly cemented. Water in hole?----------	150	170
No sample recovery----------	170	175
Clayey sandstone to mudstone, light-gray (N7), very fine grained, noncalcareous, tight; contains a trace of glauconite(?)----------	175	185

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone, dark- to medium-gray (N3-5), slightly sandy. The darker portions of the claystone contain coal laminae	185	190
Sandstone or coarse siltstone, light-gray (N7), very fine grained; contains carbonaceous streaks and limonitic grains	190	193
Siltstone, mudstone, and claystone, interbedded and interlaminated, light-gray to dark-gray (N7-3). Siltstone is calcareous and contains some carbonaceous particles	193	210
Siltstone and very fine grained sandstone, medium-gray (N5), calcareous, strongly cemented; contains a trace of pyrite	210	215
Claystone, medium-dark-gray (N4); contains carbonaceous streaks	215	245
Claystone, as in interval above, and mudstone and/or siltstone, interlaminated with claystone, dark-gray and very light gray (N8 and N3); contains a trace of pyrite	245	255
Mudstone and/or siltstone, interlaminated with claystone, as in interval above, and siltstone. Claystone contains numerous coal laminae. Siltstone is medium light gray (N6); contains some carbonaceous streaks and laminae, and some limonitic grains	255	260

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Siltstone, medium-light-gray (N6); contains numerous coal, carbonaceous, and carbonaceous and coaly mudstone laminae----------	260	263
Claystone, brownish-black (5 YR 2/1); contains a trace of pyrite; becomes black (NO) and coaly near bottom of interval----------	263	267
Coal----------	267	271
Claystone and siltstone. Claystone occurs above 274.5 ft, is black (NO); contains numerous coal laminae and a trace of well-crystallized kaolinite. Siltstone is light gray (N7), calcareous, tight, and comprises the lower part of the interval----------	271	278
Mudstone, medium-dark-gray (N4); contains some coal laminae and limonitic grains----------	278	279
Coal----------	279	289
Claystone, black (NO); contains numerous coal laminae----	289	289.5(?)
Siltstone and claystone. Siltstone is medium to very light gray (N5-8); contains coal laminae near top and bottom of interval. Claystone is brownish black (5 YR 2/1); contains coal laminae near top of interval. Siltstone and claystone appear to be interbedded------	289.5(?)	296

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone, brownish-black (5 YR 2/1), to light-brownish-gray (10 YR 6/2); contains a trace of pyrite and black (coaly?) particles	296	300
Coal	300	303
Claystone, black (N0), grades downward to dark gray (N3), noncalcareous, open siltstone. Both claystone and siltstone contain numerous coal laminae	303	305
Siltstone and mudstone. Siltstone is medium gray (N5); contains some coal particles and numerous clayey carbonaceous layers; appears to be interbedded and interlaminated with medium-dark-gray mudstone, which contains some coal streaks and a trace of pyrite	305	310
Claystone, medium-dark-gray (N4), near top of interval, to brownish-black (5 YR 2/1) and black (N0) near bottom; contains numerous coal laminae below 315 ft	310	324.5
Coal	324.5	326
Claystone, medium-dark-gray to grayish-black (N4-2); contains some coal laminae	326	345
Siltstone, light-gray (N7); contains some coal laminae	345	346
Claystone, brownish-gray (5 YR 4/1); contains some black (coaly?) particles	346	350

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Coal----------	350	358(?)
Claystone, black (N0); contains numerous coal laminae----	358(?)	359
Sandstone and siltstone. Sandstone, medium-dark-gray (N4), very fine grained, clayey, noncalcareous; grades to medium-light-gray (N6) clayey siltstone with depth--	359	362
Claystone, medium-dark-gray (N4) near top of interval to black (N0) near bottom; contains numerous coal laminae near bottom----------	362	373
Coal----------	373	375
Claystone and siltstone. Claystone is dark gray (N3). Siltstone is very light gray (N8), noncalcareous; contains some carbonaceous, clayey layers ----------	375	380
Siltstone and mudstone. Siltstone, medium-gray (N5), interlaminated with dark-gray mudstone. Both siltstone and mudstone are noncalcareous; contain some coal particles and a trace of pyrite. Amount of mudstone increases with depth----------	380	390
Claystone, dark-gray (N3); contains some pyrite----------	390	403
Siltstone, light-gray (N7), noncalcareous; contains numerous coaly laminae, some pyrite, limonitic grains, and near bottom of the interval, some coaly mudstone laminae----------	403	410
Coal----------	410	415

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone, brownish-black (5 YR 2/1); becomes black (N0), and contains numerous coal laminae near bottom of interval	415	427
Coal	427	429(?)
Claystone and siltstone. Claystone is black (N0); contains numerous coal laminae. Siltstone is dark gray (N3), clayey	429(?)	431
Mudstone and claystone. Mudstone is dark gray (N3); contains numerous, very thin coal laminae; grades to medium-dark-gray (N4) claystone near bottom of interval	431	436
Siltstone, medium-light-gray (N6), to very light gray (N8), calcareous, very strongly cemented between 444 and 447 ft; contains numerous coal laminae except where strongly cemented	436	452
Coal	452	455
Claystone, dark-gray (N3); contains some coal particles and laminae	455	462.5
Siltstone, medium-gray (N5)	462.5	465
Mudstone, medium-dark-gray (N4); contains numerous coal laminae. Flowing formation water in this and in most of the deeper intervals	465	470*
Claystone and siltstone. Claystone is dark gray (N3). Siltstone is light gray (N7), noncalcareous, open; contains some carbonaceous laminae	470	475*

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone and siltstone, as above, and coal----------	475	480*
Siltstone, very light gray (N8), noncalcareous, open; contains numerous coaly mudstone laminae----------	480	485*
Sandstone and siltstone. Sandstone is very light gray (N8), very fine grained, open, noncalcareous; contains some coal laminae. Siltstone is medium gray (N5), clayey, noncalcareous, tight; contains numerous coal laminae----------	485	490*
Siltstone, light-gray (N7) to yellowish-gray (10 YR 7/1); contains some carbonaceous laminae----------	490	495*
Siltstone, sandstone, and claystone. Siltstone is light gray (N7) to yellowish gray (10 YR 7/1); contains some carbonaceous laminae. Sandstone is light gray (N7), very fine grained, weakly cemented. Claystone is medium gray (N5) to black (NO), very coaly where black----------	495	500*
Sandstone, claystone, and interbedded(?) siltstone and sandstone. Sandstone is light gray (N7), very fine grained, weakly cemented. Claystone is medium light gray (N6). Interbedded(?) siltstone and very fine grained sandstone are very pale brown, calcareous, open. Soft bed near 503 ft----------	500	510*

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Siltstone and mudstone. Siltstone is light brown (5 YR 6/2) to light gray (N7); contains some carbonaceous particles. Mudstone is brownish black (5 YR 2/1)----------	510	515*
Claystone and sandstone. Claystone is dark gray (N3); contains some coal laminae. Sandstone is dark yellowish orange (10 YR 6/6), very fine grained, calcareous, open----------	515	520
Claystone and siltstone. Claystone is dark gray (N3); contains some coal laminae. Siltstone is very pale brown (10 YR 7/3), calcareous, open----------	520	525*
Claystone, brownish-black (5 YR 2/1); contains some coal laminae----------	525	530*
Claystone, as in interval above, and very pale brown (10 YR 7/3), calcareous, siltstone----------	530	540*
Claystone, light-olive-gray (5 YR 6/1) and brownish-black (5 YR 2/1); contains some coal laminae where brownish black----------	540	545*
Claystone, black to medium-gray (NO-5); contains numerous coal laminae where black----------	545	550*
Claystone, as above, and pinkish-gray (5 YR 8/1) claystone, which contains some black (coaly?) streaks-----	550	555*

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone, black to medium-gray (NO-5); contains numerous coal laminae where black----------	555	560*
Claystone, dark-gray (N3); contains numerous coal laminae----------	560	575*
Claystone and coal. Claystone is black to medium gray (NO-5); contains numerous coal laminae where black. Coal beds, 577-579 ft and 585-588 ft----------	575	590*
Claystone, black to medium-gray (NO-5); contains numerous coal laminae where black----------	590	600*
Mudstone, medium-gray (N5); contains some coal streaks---	600	605*
Claystone and coal(?). Claystone is black to dark gray (NO-3); contains numerous coal laminae where black----	605	610(?)*
Claystone, as in interval above. Coal 614-615 ft?-------	610(?)	615*
Claystone, mudstone, and coal. Claystone and mudstone are medium gray (N5); contain some coal particles. Coal 615-618 ft?----------	615	620*
Claystone and mudstone, as in interval above; coal bed 624-625 ft----------	620	625*
Claystone and coal. Claystone is brownish black (5 YR 2/1) to medium dark gray (N4). Soft bed, 625-628 ft--	625	630*
No sample recovery----------	630	635

Lithologic log of drill-hole DM-D27A - continued

Description	Depth (ft) From	To
Claystone and coal. Claystone is brownish black (5 YR 2/1) to medium dark gray (N4). Coal 636(?)-638(?) ft----------	635	640*
No sample recovery. Rapid formation penetration except for hard beds 667-669 ft and 686-687.5 ft----------	640	710

Total depth - 710 ft.

Lithologic log of drill-hole DM-D28

[Intervals marked with an 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 metres, multiply by 0.3048.]

Location: 675 ft FWL, 250 ft FNL, sec. 22, T. 15 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,530 ft

Drilling started 9-8-75; completed 9-10-75

Total depth: 610 ft

Air injection drilling 0-238 ft; air and water 238-610 ft

Logged by: S. C. Zimmermann

Description	Depth (ft) From	To
Sandstone, light-yellowish-brown (10 YR 6/4), very fine grained, calcareous, tight, strongly cemented----------	0	2
Claystone, medium-gray (N5); contains some carbonaceous particles----------	2	3.5
Sandstone, light-yellowish-brown (10 YR 6/4), very fine grained, noncalcareous, limonitic, open----------	3.5	4
Siltstone, light-yellowish-brown (10 YR 6/4), noncalcareous, open----------	4	14.5
Mudstone, grayish-brown (75 YR 4/2)----------	14.5	16
Claystone, light-brownish-gray (5 YR 5/1) and moderate-brown (75 YR 4/4); contains some limonitic grains near bottom of interval----------	16	22
Sandstone, grayish-orange (10 YR 7/4), fine-grained, calcareous, weakly cemented and open to strongly cemented and tight----------	22	26

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Sandstone, pinkish-gray (5 YR 8/1), fine-grained, noncalcareous; contains numerous yellowish-orange limonitic grains	26	29.5
Claystone, medium-dark-gray (N4), slightly silty near top of interval; contains some carbonaceous particles	29.5	36
Claystone, medium-gray (N5); contains a trace of pyrite	36	61
Siltstone, medium-light-gray (N6); contains numerous black (coal?) particles	61	62.5
Claystone, medium-gray (N5); contains a trace of pyrite	62.5	63
Siltstone, light-brownish-gray (5 YR 5/1), weakly cemented	63	64.5
Siltstone, medium-light-gray (N6); contains numerous black (coal?) particles	64.5	65
Siltstone and claystone. Claystone is dark gray (N3); contains carbonized plant (rootlets, stems?) material. Siltstone is light gray (N7) and light brownish gray (5 YR 5/1), noncalcareous, weakly cemented; contains some carbonaceous streaks	65	70
Mudstone, medium-gray (N4), noncalcareous, open; contains some carbonaceous particles	70	72
Siltstone, medium-gray (N5), weakly cemented	72	72.5
Siltstone, as in interval above, and medium-light-gray (N6), noncalcareous, open siltstone with numerous carbonaceous particles and coal streaks	72.5	75

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Coal and subordinate black (N0) to brownish-gray (5 YR 4/1) claystone with numerous coal laminae. Some water near 77 ft	75	80.5*
Siltstone, light-gray (N7), noncalcareous, open; contains some carbonaceous particles	80.5	82
Mudstone, medium-light-gray (N6); contains numerous carbonaceous streaks	82	83
Siltstone, light-gray (N7), noncalcareous, open; contains some carbonaceous particles	83	85.5
Claystone, light-brownish-gray (5 YR 6/1) to black (N0) near bottom of interval; contains coal laminae which increase in abundance with depth	85.5	87
Coal	87	93
Claystone, black (N0) to light-brownish-gray (5 YR 6/1) and silty near bottom of interval; contains numerous coal laminae near top	93	95.5
Siltstone, medium-gray (N5), slightly calcareous, strongly cemented	95.5	96.5
Claystone, medium-dark-gray (N4); contains some black (coaly?) streaks	96.5	99.5
Mudstone, medium-gray (N5) to dark-gray (N3)	99.5	102
Claystone, brownish-gray (5 YR 4/1) to black (N0) near bottom of interval; contains numerous coal laminae near bottom	102	103

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Coal----------	103	106
Claystone, black (N0) to medium-dark-gray (N4); contains numerous coal laminae near top of interval. Hole wet--	106	110
No sample recovery. Hole wet----------	110	112
Siltstone, light-gray (N7), slightly calcareous, tight, strongly cemented; contains some coal laminae----------	112	116
Claystone, grayish-black (N2); contains a trace of pyrite and some coal laminae; becomes medium-gray (N5), silty near bottom of interval----------	116	125
Coal----------	125	126
Claystone, black (N0); contains numerous coal laminae. Hole wet----------	126	130
Siltstone, medium-gray (N5), noncalcareous, open; contains numerous clayey and carbonaceous laminae. Hole wet----------	130	140.5*
Claystone, black (N0); contains numerous coal laminae----	140.5	142.5
Mudstone and siltstone. Mudstone is medium gray (N5) near top of interval to dark gray (N3) near bottom; weakly cemented, especially near bottom; contains numerous coal particles. Siltstone is very dark brown (10 YR 3/3), weakly cemented----------	142.5	148.5

Lithologic log for drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Siltstone and/or thinly interstratified(?) mudstone and coal; overall color is brownish black (5 YR 2/1). Siltstone and/or mudstone is dark gray (N3), weakly cemented; contains numerous coal particles----------	148.5	151.5
Mudstone, medium-dark-gray (N4), weakly cemented; contains some coal particles----------	151.5	155
Siltstone, brownish-gray, weakly cemented----------	155	156
Mudstone, medium-dark-gray (N4), weakly cemented; contains some coal particles----------	156	157
Siltstone, reddish-brown to light-reddish-brown, weakly cemented----------	157	159.5
Mudstone, medium-dark-gray (N4); contains some coal particles and thin coal layers----------	159.5	161.5
Siltstone, medium-brownish-gray (5 YR 5/1), weakly cemented; contains some coal particles----------	161.5	172
Siltstone, medium-dark-gray (N4), noncalcareous, tight, strongly cemented 173-174 ft; contains some coal streaks. Some siltstone is brownish black (5 YR 2/1), weakly cemented and thinly interlayered with coal-----	172	175
Siltstone, brownish-black (5 YR 2/1) to brownish-gray (5 YR 4/1), weakly cemented; contains numerous coal particles; sandy below 200 ft----------	175	210
No sample recovery----------	210	216
Siltstone, as in interval 175-210 ft, and claystone. Claystone is brownish black (5 YR 2/1); contains a trace of pyrite and some coal streaks----------	216	218

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Siltstone, very dark gray (5 YR 2/1), sandy, weakly cemented; contains numerous coal particles----------	218	226
Siltstone, as in interval above, and subordinate claystone and mudstone. Claystone is grayish black (N2). Mudstone is medium gray (N5); contains a trace of pyrite----------	226	230
No sample recovery. Hole wet----------	230	233
Siltstone and mudstone. Siltstone is brownish gray (5 YR 4/1), sandy, weakly cemented. Mudstone is brownish black (5 YR 2/1). Both contain coal particles. Hole wet----------	233	236.5
No sample recovery----------	236.5	245
Siltstone, light-gray (N7), noncalcareous, open---------	245	247
Claystone, medium-gray (N7); contains some carbonaceous streaks and laminae----------	247	252
Coal----------	252	259
Claystone, medium-dark-gray (N4); contains some carbonaceous streaks----------	259	265
Mudstone, medium-dark-gray (N4); contains numerous siltstone and claystone laminae, and numerous carbonaceous and coal streaks----------	265	270
Mudstone, as in interval above, claystone, and siltstone. Claystone is dark gray (N3); contains some coal streaks. Siltstone is very light gray (N7), noncalcareous, open; contains some coal and carbonaceous streaks----------	270	275
Mudstone, medium-dark-gray (N4); contains numerous siltstone and claystone laminae, and numerous carbonaceous and coal streaks----------	275	280
Sample lost. Mudstone(?)----------	280	290

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Mudstone, medium-gray (N5); contains numerous coal laminae----------	290	295
Mudstone, as in interval above, and siltstone. Siltstone is medium light gray (N6), calcareous, tight, strongly cemented; contains some carbonaceous and clayey laminae----------	295	300
Mudstone and siltstone, as in interval above----------	300	305
Claystone, mudstone, siltstone, and coal. Claystone is black (N0); contains numerous coal laminae. Mudstone is medium dark gray (N4); contains some coal laminae. Siltstone is light gray (N7), noncalcareous, tight----	305	311
Claystone and siltstone. Claystone is very dark gray (5 YR 3/1); contains numerous coal laminae. Siltstone is light gray (N7), noncalcareous, tight; contains some coal laminae----------	311	314
Claystone, very dark gray (5 YR 3/1); contains numerous coal laminae----------	314	315
Siltstone and sandstone. Siltstone is medium light gray (N6), calcareous and noncalcareous, very strongly cemented where calcareous; contains coal laminae; more carbonaceous in lower than in upper part. Sandstone is very light gray (N8), very fine grained, noncalcareous, weakly cemented, open; contains some siltstone laminae, and between 320 and 325 ft, some coal laminae----------	315	325

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Mudstone and siltstone. Mudstone is medium gray (N5); contains some coal laminae. Siltstone is light brownish gray (5 YR 6/1) to very light gray (N8), noncalcareous; contains some claystone and carbonaceous laminae----------	325	330
Siltstone and/or mudstone, light-brownish-gray (5 YR 6/1 or 10 YR 6/2), noncalcareous; contains numerous contorted coal laminae----------	330	337
Claystone, black (N0) to brownish-black (5 YR 2/1); contains numerous coal laminae and some well-crystallized kaolinite(?)----------	337	340
Sandstone, medium-dark-gray (N4), very fine grained, noncalcareous; contains numerous coal laminae, a trace of pyrite and of glauconite(?) and resinous particles----	340	344
Mudstone, brownish-gray (5 YR 4-3/1); contains some coal laminae and particles, and numerous coaly siltstone laminae----------	344	350
Claystone, medium-dark-gray (N4); contains some coal laminae----------	350	355
Claystone, white (N9); composed of kaolinite, montmorillonite, and quartz----------	355	356
Mudstone, brownish-gray (5 YR 4-3/1); contains some coal laminae----------	356	360
Claystone, medium-dark-gray (N4) to dark-gray (N3); contains some coal laminae and a trace of pyrite------	360	368

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Mudstone, medium-gray (N5); contains a trace of pyrite and some coal laminae	368	370
No sample recovery	370	375
Siltstone, light-gray (N7), noncalcareous, tight; contains some coal and carbonaceous laminae	375	380
Mudstone, medium-dark-gray (N4) to brownish-black (5 YR 2/1), very silty to slightly silty; contains resinous particles	380	383
Siltstone, light-gray (N7), noncalcareous, strongly cemented, tight; contains some coal and carbonaceous laminae	383	385
Claystone, black (N0); contains numerous coal laminae, and traces of gypsum, resin particles, and pyrite	385	391
Claystone, as in interval above, coal, and brownish-gray (5 YR 3/1) claystone with some coal laminae	391	395
Mudstone, medium-gray (N5); contains some carbonaceous particles	395	400
Sandstone, very fine grained, or siltstone and/or black to medium-gray claystone (N0-5) with numerous coal laminae?	400	410*
Coal	410	418

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Claystone and mudstone and/or siltstone. Claystone is black (NO), medium gray (N5) to medium dark gray (N4) and pale brown (7.5 YR 5/2). Black claystone contains numerous coal laminae; other claystone, some coal particles. Mudstone and/or siltstone is medium gray (N5); contains dark clayey laminae and light-colored siltstone laminae between 425 and 435 ft----------	418	445
Coal----------	445	450
Claystone, dark-gray (N3); contains coal streaks--------	450	455
Mudstone, medium-light-gray (N6) to dark-gray (N3) where coaly----------	455	465
Claystone, medium-dark-gray (N4); contains some coal particles and streaks----------	465	473
Coal with some medium-dark-gray (N4) claystone partings(?)-	473	479(?)
Claystone and siltstone. Claystone is black (NO) and medium dark gray (N4); black claystone contains numerous coal laminae. Siltstone is very light gray (N8), noncalcareous, open----------	479(?)	480
Mudstone, medium- to dark-gray (N5-3); contains numerous coal particles and streaks----------	480	486
Claystone, dark-gray to black (N3-0); contains numerous coal laminae where black----------	486	492
Coal----------	492	496(?)

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Claystone, mudstone, and siltstone. Claystone is medium dark gray (N4) to black (NO); contains numerous coal laminae where black; slightly silty. Mudstone is medium dark gray (N4); contains numerous coal laminae and some siltstone laminae. Siltstone is medium to light gray (N5-7)----------	496(?)	510
Coal, claystone, mudstone, and sandstone. Claystone is black (NO); contains numerous coal laminae. Mudstone is brownish gray (5 YR 4/1); contains some coal laminae. Sandstone is very light gray (N8), fine grained, noncalcareous, open----------	510	530
Claystone, black (NO) to medium-gray (N5); contains numerous coal laminae where black----------	530	535
Mudstone, medium-dark-gray (N4); contains some black (coal?) streaks----------	535	540
Claystone, medium-gray to black (N5-0); contains some black (coal?) particles and, in some parts, numerous coal laminae----------	540	542
Coal(?)----------	542	544(?)
Claystone, medium-gray (N5); contains some black (coal?) particles----------	544(?)	548

Lithologic log of drill-hole DM-D28 - continued

Description	Depth (ft) From	To
Sandstone and claystone. Sandstone is white (N9), fine grained, clayey(?), noncalcareous, open, weakly cemented. Claystone is medium gray (N5) and appears to be interbedded with the sandstone. Hard bed near 550 ft----------	548	556
Claystone and mudstone. Claystone is black (NO); contains numerous coal laminae. Mudstone is laminated dark and light gray; average color is medium gray (N5); contains some black (coal?) particles----------	556	572
Sandstone, pinkish-gray (5 YR 8/1), very fine grained, noncalcareous, open----------	572	575
Mudstone and claystone, medium-gray (N5), generally strongly cemented; contains some carbonaceous laminae-	575	581
Sandstone(?) and claystone. Sandstone(?) is very fine grained, weakly cemented in upper part of interval. Claystone is medium gray (N5), black (NO) where it contains numerous coal laminae----------	581	586
Claystone, medium-gray (N5); contains some black (coal?) particles----------	586	589
Sandstone(?) and claystone. Sandstone(?) is very fine grained, silty, weakly cemented. Claystone is medium gray (N5)----------	589	610
Total depth - 610 ft.		

Geophysical logs

All of the drill holes were logged by geophysical methods and copies of the logs (figs. 2-38) are presented in the pocket of this report. A set of seven geophysical logs was run in each hole except DM-D14 and DM-D22. The logs in the set were natural gamma, neutron, gamma-gamma, spontaneous potential, 16-inch and 64-inch normal resistivity, and caliper. All logs except the electric (resistivity and spontaneous potential) and the gamma-gamma were run in DM-D14 and all but the electric logs were run in DM-D22. Electric and gamma-gamma logs were not run in DM-D14 because of hole caving. Electric logs were not run in DM-D22 because most of the accessible part of the hole was above the water table.

Calibration curves relating porosity and density to counts per second on the neutron and gamma-gamma logs are given in figures 39 and 40, 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.

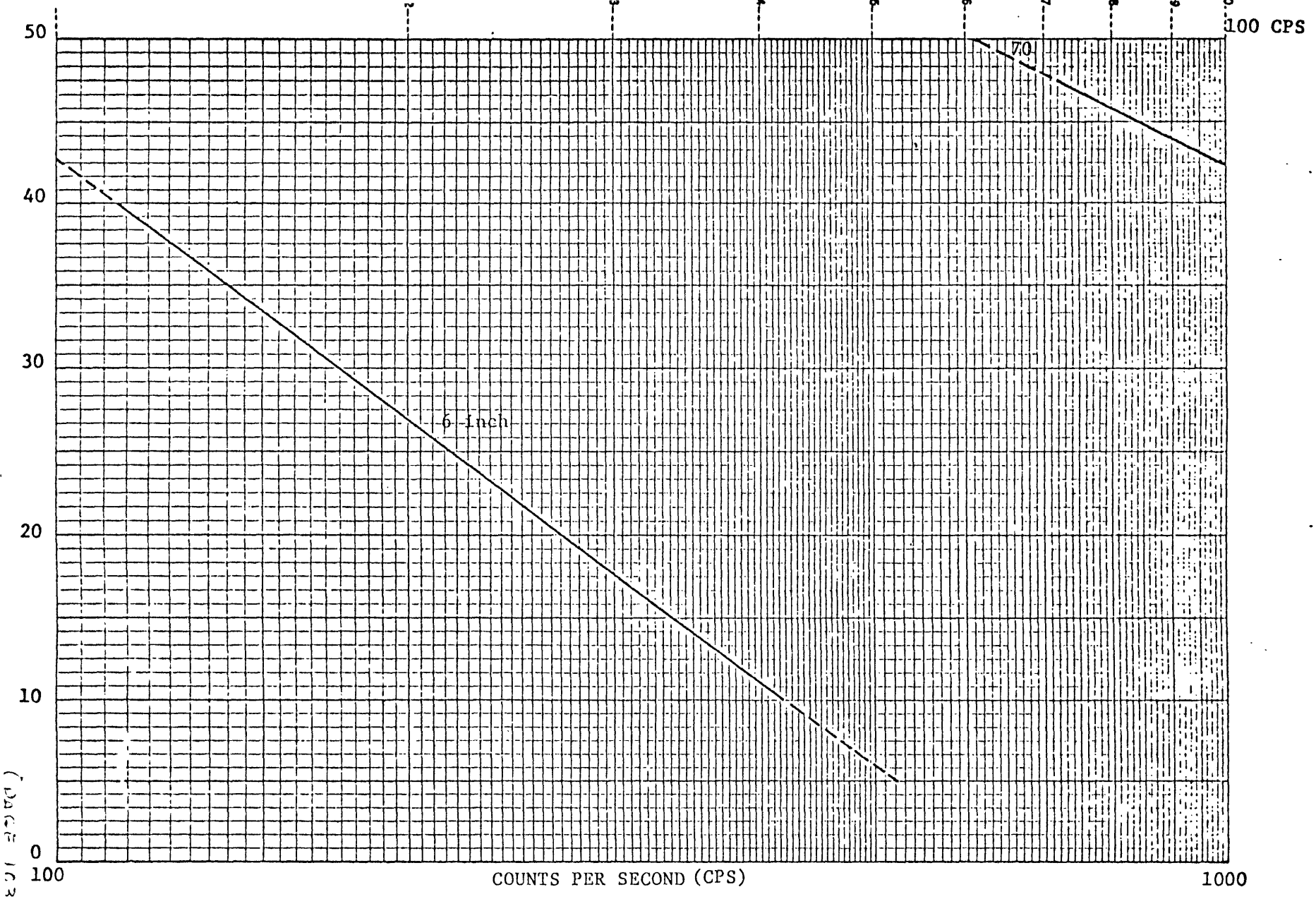

Figure 39.--Calibration curve for neutron log: 6-inch water-filled drill hole.

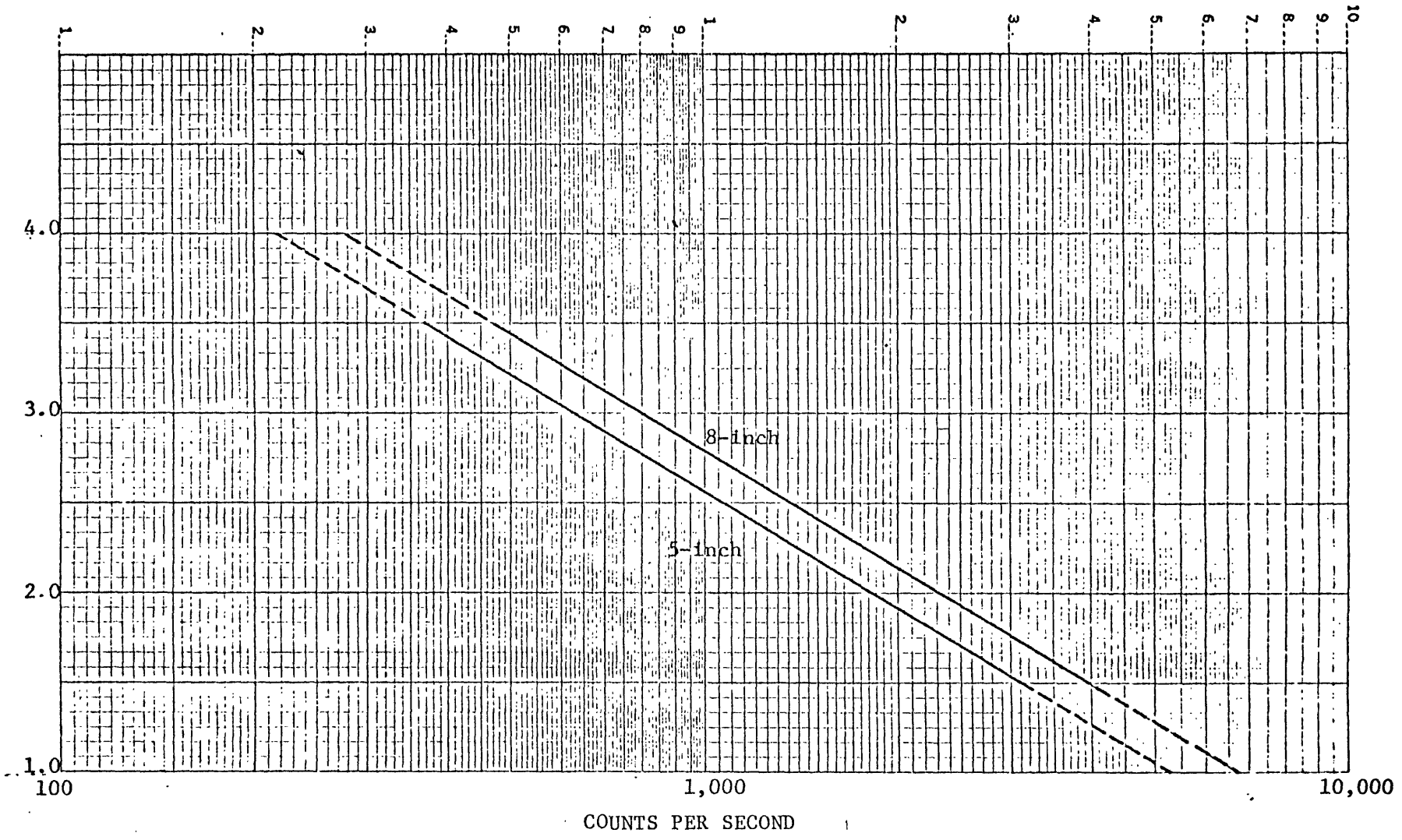

Figure 40.--Calibration curve for gamma-gamma log: 5-inch and 8-inch water-filled drill holes.

Coal in the drilled formations

Coal beds were intersected in each of the eight drill holes. The range in thickness of coal beds for all holes is 1-15 ft (0.3-4.6 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 principal coal beds intersected are based primarily on interpretation of the geophysical logs and are shown in figure 41.

Most of the coals drilled can be informally grouped into three zones which are numbered in ascending stratigraphic order on figure 41. Most of the thin coal beds in the lower part of each of the drill holes, except DM-D27, comprise coal zone 1. The beds in this zone are believed to be in the uppermost, marginal marine part of the Allen Ridge Formation. The beds below coal zone 1 in figure 41 are believed to be in the lower, nonmarine part of the Allen Ridge. The thickest and most persistent of the coal beds are in coal zone 2, a 165-200-ft (50.3-67.1-m) zone in the lower part of the Almond Formation. The top of coal zone 2 is about 250 ft (76.2 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, but at least one of these appears to be 3 to 6 ft (0.9-1.8 m) thick in surface outcrops and drill holes over a large area of the southeastern part of the 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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