UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

LITHOLOGIC AND GEOPHYSICAL LOGS OF HOLES DRILLED DURING 1977 IN THE SAVERY QUADRANGLE AND SOUTHEASTERN PART OF THE BAGGS QUADRANGLE, CARBON COUNTY, WYOMING

By

C. S. VENABLE BARCLAY AND LARRY A SHOAFF

Open-File Report 78-660

1978

CONTENTS

ILLUSTRATIONS

[figures 4 and 7-58 in pocket]

LITHOLOGIC AND GEOPHYSICAL LOGS OF HOLES DRILLED DURING 1977 IN THE SAVERY QUADRANGLE AND SOUTHEASTERN PART OF THE BAGGS QUADRANGLE, CARBON COUNTY, WYOMING

By C. S. Venable Barclay and Larry A. Shoaff

INTRODUCTION

The purpose of this report is to present data obtained during a 1977 U.S. Geological Survey coal drilling program in the Little Snake River coal field, southwestern Carbon County, Wyoming. Also presented are geophysical logs of a water well belonging to Robert Grieve of Slater, Colorado, and of three holes (herein designated Dixon-A, -B, and -C) drilled for water by the city of Dixon, Wyoming.

A total of 10 holes were drilled in T. 12 N., Rs. 89 and 90 W., and T. 13 N., R. 90 W., in the Savery and Baggs quadrangles, in the southeastern part of the Little Snake River coal field (figs. 1, 2, and 3), for the U.S. Geological Survey, during the period July-September 1977. 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 privately owned and operated truck-mounted rotary drilling rig. Most drilling was done with 4-3/4-inch roller-cone rock bits. Thick intervals of claystone were commonly drilled with 4-3/4-inch drag bits. Drilling fluids generally used were air and water. Air was used to depths where drill cuttings became too sticky from

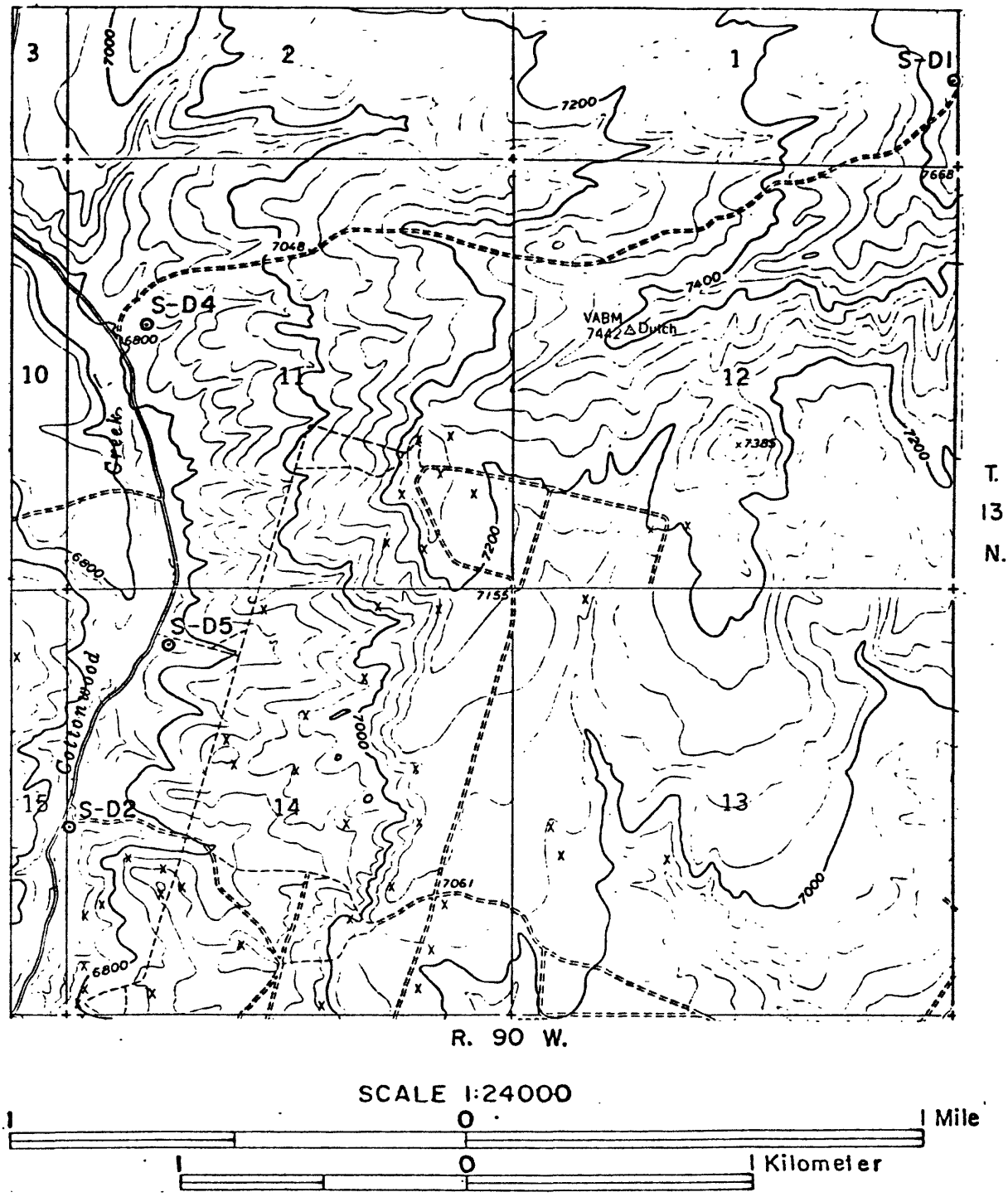
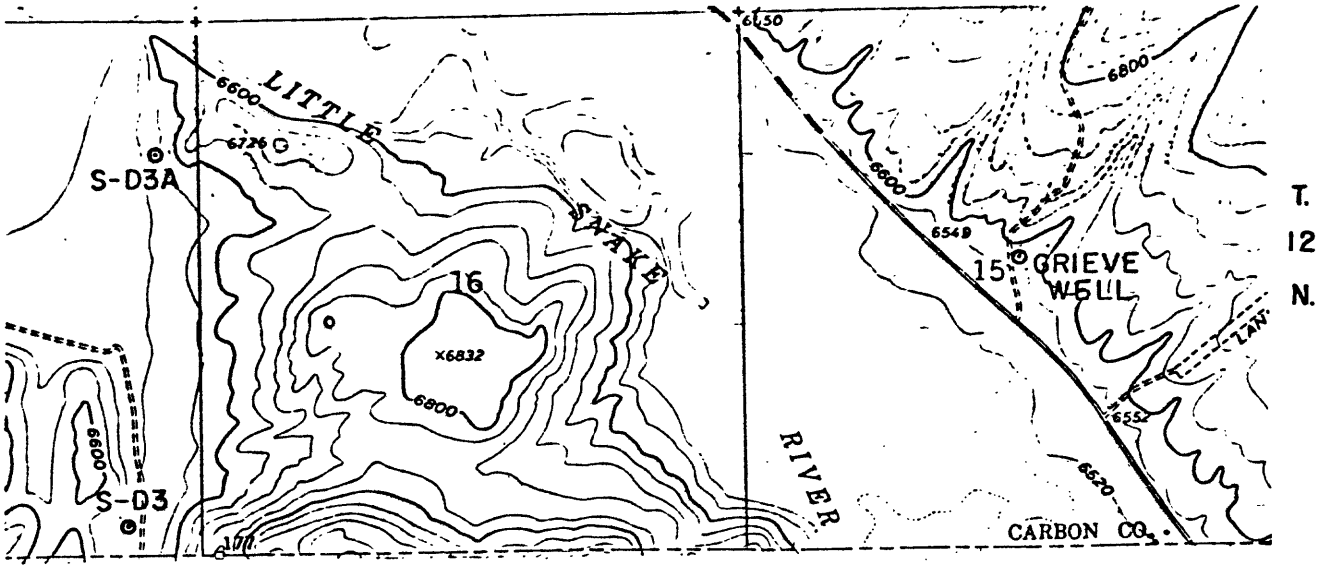


Figure 1.--Map showing location of holes drilled for the U.S. Geological Survey in the northwestern part of the Savery quadrangle, Carbon County, Wyoming, during 1977.



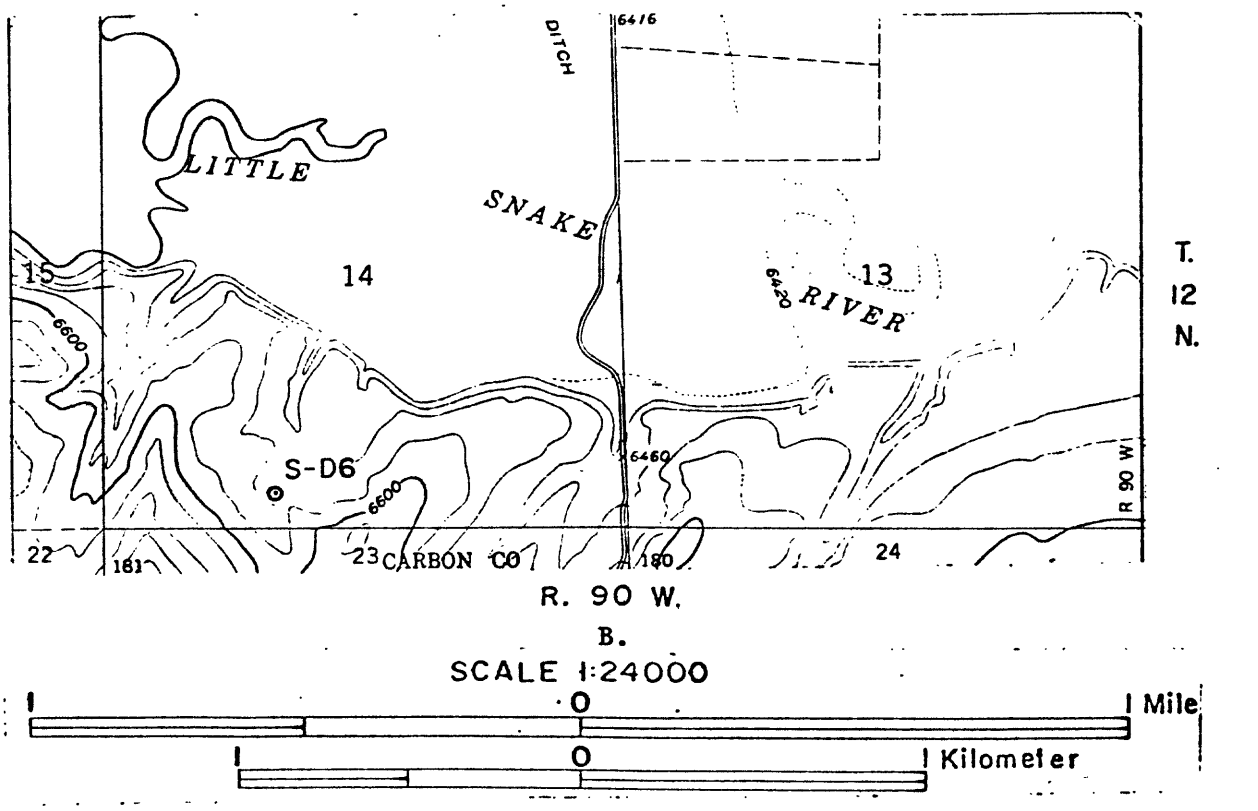
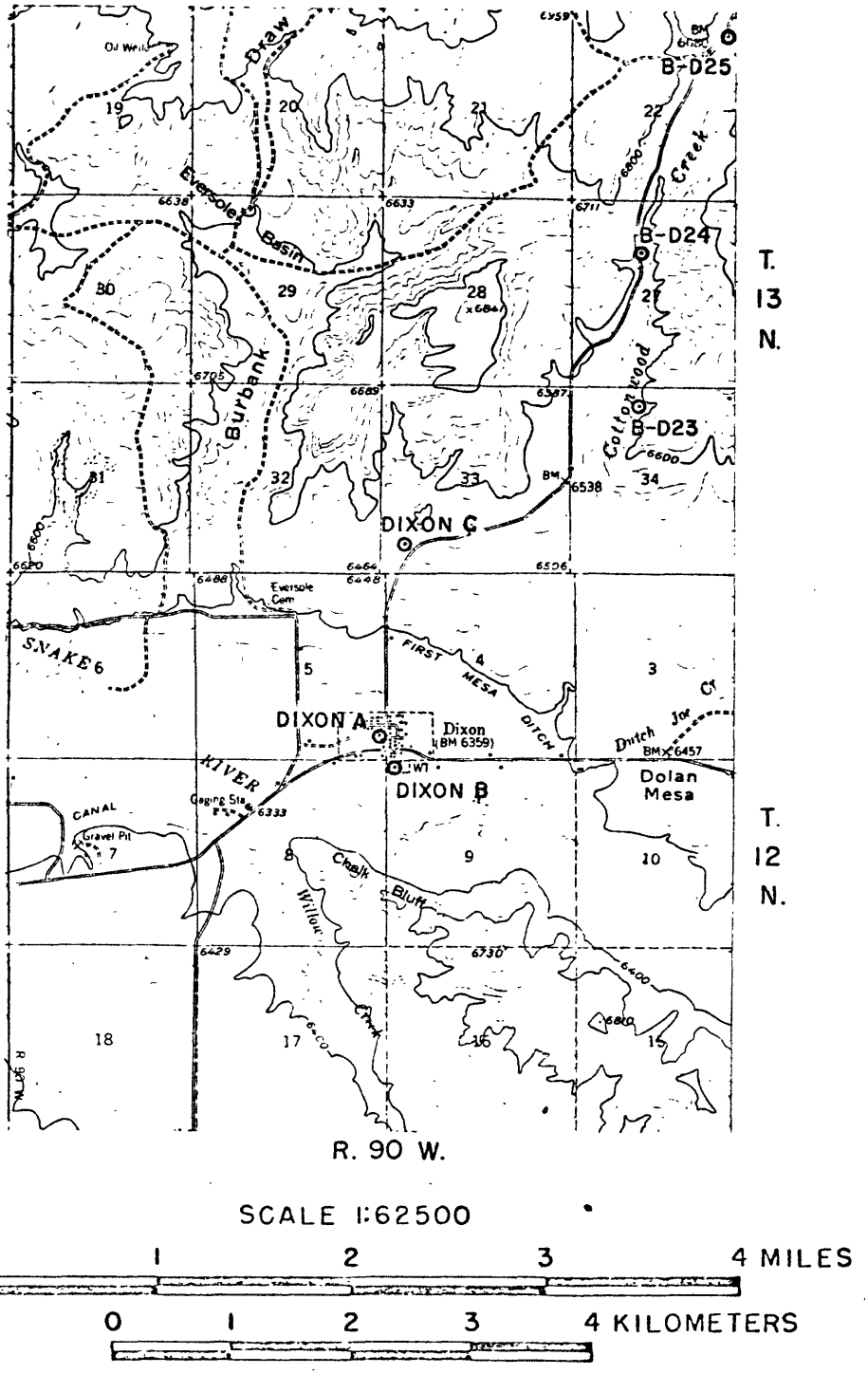


Figure 2.--Map showing location of holes drilled for the U.S. Geological Survey in the southeastern (A) and southwestern (B) parts of the Savery quadrangle, Carbon County, Wyoming, during 1977. Also shown is the location of a water well belonging to Robert Grieve of Slater, Colorado.



SCALE 1:62500

0 1 2 3 4 MILES

0 1 2 3 4 KILOMETERS

Figure 3.--Map showing location of holes drilled for the U.S. Geological Survey in the southeastern part of the Baggs quadrangle, Carbon County, Wyoming, during 1977. Also shown are three water test holes drilled for the city of Dixon, Wyoming.

formation water to be blown from the hole. Then water, or, in some instances water containing a biodegradable foaming agent, was injected with compressed air to aid in transport of cuttings to the surface. Bentonitic drilling mud was used in a few holes. In most instances, 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 water injection. During drilling, cuttings believed to be representative of the rock strata were sampled, examined, logged, and sacked. Later each drill hole was logged by geophysical methods.

ACKNOWLEDGMENTS

Collection of samples, preparation of sample logs during drilling, and most of the geophysical logging was done by personnel of the U.S. Geological Survey. Two holes were logged for the Geological Survey by a private company.

The authors of this report acknowledge the cooperation of the following residents of the Little Snake River Valley who allowed the Geological Survey to drill on their lands or to log private or municipal water wells or test holes: Mr. Robert Grieve of Slater, Colo.; Mr. John Cobb, Jr., Mr. A. T. Morehead, Mrs. K. W. Morehead, all of Savery, Wyo.; and Mr. Robert Armbruster, Mayor of Dixon, Wyo. Finally, we thank Dr. R. W. Davis of Laramie, Wyo., who supplied information on drill-hole Dixon-C.

STRATIGRAPHY OF THE DRILLED FORMATIONS

Rock strata and sediments intersected by the drill holes (including the Grieve well and the city of Dixon water-test holes) belong to the Mesaverde Group and the overlying Lewis Shale, both of Late Cretaceous age; the Upper Cretaceous Lance Formation and/or the overlying Paleocene Fort Union Formation; the Browns Park Formation of probable Miocene age; and unconsolidated surficial deposits of Quaternary age. Correlations of stratigraphic units between drill holes which penetrated Mesaverde Group formations are shown in figure 4 (in pocket) and are based on interpretations of lithologic and geophysical logs.

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 and others, 1970, p. 5). The Haystack Mountain Formation, which was not intersected in any of the drill holes discussed in this report, is a marine and marginal marine formation and overlies the marine Steele Shale of Late Cretaceous age.

The Allen Ridge Formation is largely composed of continental fluviatile sequences of sandstone, siltstone, mudstone, and thin carbonaceous shale and coal beds. In most places in the Little Snake River coal field the uppermost part of the Allen Ridge consists of marginal marine lagoonal-paludal deposits of thick, bioturbated organic-rich brown shales, thin sandstone beds, and coal. The lower nonmarine part of the Allen Ridge Formation is estimated to be 1,000-1,200 ft (305-366 m) thick and the uppermost marginal marine part, 170-200 ft (52-61 m) thick. Drill-holes S-D3A and B-D25 bottomed in the nonmarine portion of the Allen Ridge.

The Pine Ridge Sandstone is a continental fluviatile deposit consisting of sandstone and a subordinate amount of carbonaceous siltstone

and mudstone. According to Gill, Merewether, and Cobban (1970, p. 30), the Pine Ridge is probably unconformable on the Allen Ridge in most places in southern Wyoming. The Pine Ridge is believed to be 50-100 ft (15.2-30.5 m) thick, although its contacts with sub- and superjacent formations are not well known in the Little Snake River coal field.

The Almond Formation is largely composed of marginal marine deposits. In most places the lower part is characterized by thick coal beds, and the upper part by shale and sandstone deposited by alternating transgressive and regressive cycles, respectively, of a Late Cretaceous western interior sea. The Almond Formation is commonly about 450 ft (137 m) thick in most parts of the Little Snake River coal field.

In at least some places in the southeastern part of the Little Snake River coal field -- including that part of the coal field in which drill-holes S-D3 and S-D3A are located--the Pine Ridge Sandstone is believed to be absent. In such places the marginal marine lagoonal-paludal deposits normally included in the Allen Ridge cannot be separated from similar deposits in the lower part of the Almond and are included in the Almond Formation. In these areas, the Almond may be as much as 930 ft (283 m) thick and characteristically contains thick areally persistent, marine sandstone beds. One such sandstone, herein informally referred to as the sandstone of Loco Creek, occurs at the base of the Almond. The sandstone of Loco Creek can be traced into areas where the Pine Ridge is recognized and becomes the base of the marine member of the Allen Ridge Formation. Two other such sandstone beds occur in the middle and upper part of the Almond, and are herein referred to as the sandstone of the Darling mine and the sandstone of Reader Cemetery, respectively.

These two sandstone beds may not be as persistent as the sandstone of Loco Creek, but are useful for correlation purposes in the Savery, Wyo., area.

Drill-holes B-D25 and S-D3A contain all but the uppermost beds of the Almond Formation and intersect the sandstone of Loco Creek in the depth intervals 770-817 ft (235-249 m) and 917-985 ft (280-300 m), respectively. If the Pine Ridge is absent, the Almond is about 790 ft (241 m) thick along the southeastern edge of the Baggs quadrangle and about 930 ft (283 m) thick in the southeastern part of the Savery quadrangle.

The intervals 550-622 ft (168-190 m) in B-D25 and 726-748 ft (221-228 m) in S-D3A could be the Pine Ridge Sandstone. If this is the case, B-D25 and S-D3A contain about 195 ft (59 m) and 237 ft (72 m), respectively, of the marine member of the Allen Ridge, and the Almond is about 535 ft (163 m) thick in the southeastern part of the Baggs quadrangle and about 770 ft (235 m) thick in the southeastern part of the Savery quadrangle. The Pine Ridge may occur in drill-hole B-D24 in the interval 1,142-1,192 ft (348-363 m) below a section of the Almond which may have been thinned by faulting. Drill-holes S-D1, S-D2, S-D3, S-D4, S-D5, and the Grieve water well all contain beds of the Almond but bottom above the stratigraphic interval in which the Pine Ridge should occur.

The sandstone of the Darling mine and the sandstone of Reader Cemetery were only recognized in drill holes in the southeastern part of the Savery quadrangle. The sandstone of the Darling mine occurs in the intervals 1,108-1,280 ft (338-390 m) and 464-635 ft (141-194 m) in S-D3 and S-D3A, respectively, and the sandstone of Reader Cemetery, in the intervals 917-1,049 ft (280-320 m) and 285-400 ft (87-122 m) in S-D3 and S-D3A,

respectively. In the Grieve water well, the top of the sandstone of Reader Cemetery is at a depth of about 64 ft (19.5 m) and the bottom was not reached.

The Lewis Shale is 2,000-2,500 ft (610-762 m) thick in the Little Snake River coal field and consists of marine shale and, in the upper part, sandstone. Considerable thicknesses of the Lewis were penetrated in drill-holes S-D1, S-D2, S-D3, S-D4, S-D5, and B-D24. The Lewis Shale is overlain by the marine Fox Hills Sandstone which was not intersected in any of the drill holes.

The Lance Formation and the superjacent Fort Union Formation are nonmarine and coal beds occur in the lower parts of both formations. In an oil-and-gas test hole in sec. 18, T. 12 N., R. 90 W., near Dixon, Wyoming, the Lance and Fort Union are about 1,150 ft (351 m) and 1,410 ft (430 m) thick, respectively (Cronoble, 1969, Pl. 1). Drill-holes S-D6 and probably Dixon-A and -B bottom in the Fort Union.

The Browns Park Formation is present in many parts of the Little Snake River coal field where it lies with angular unconformity on all older formations. It is nonmarine and consists mostly of sandstone, although in most places it has a thick basal conglomerate. Near the Wyoming-Colorado border in the southeastern part of the Little Snake River coal field it may be as much as 1,600 ft (488 m) thick.

Beds of the Browns Park were intersected in drill-holes S-D2, S-D3, D-D6, B-D23, and Dixon-C. In drill-holes S-D2 the Browns Park overlies beds of the Lewis Shale at a depth of 18 ft (5.5 m). Drill-holes B-D23, S-D6, S-D3, and Dixon-C are situated within and along the margins of a west-northwest-trending graben of post-Browns Park age. Outcrops along the bounding faults of the graben in the Dixon-Savery, Wyoming, area

show beds of the Browns Park Formation within the graben against beds of the Almond Formation, the Lewis Shale, and the Fort Union Formation. In drill-hole S-D3 near the northern edge of the graben, the Browns Park rests on beds of the Lewis Shale at a depth of 115 ft (35 m). Drill-hole B-D23, in the northern part of the graben, bottoms in the uppermost part of the basal conglomerate of the Browns Park. In S-D6, near the southern edge of the graben, the base of the Browns Park was penetrated at 124 ft (38 m) and the underlying rocks are believed to belong to the Fort Union Formation.

Dixon-C, near the center of the graben, was initially drilled in the late 1960's to a depth of about 220 ft (67 m). In December 1977, it was deepened to a depth of about 480 ft (146 m) of which only the upper 400 ft (122 m) was logged by geophysical methods because of caving. Of the 400 ft (122 m) geophysically logged, all but the upper 58-62 ft (17.7-18.9 m) is in the Browns Park Formation. Samples of the drill cuttings from the hole indicate that the basal conglomerate of the Browns Park occurs in the interval 385-425 ft (117-130 m) and that the interval from 425-480 ft (130-146 m) is composed of claystone-siltstone, minor sandstone, and a trace of coal, all probably belonging to the Lance Formation.

Unconsolidated clay-silt, sand, and/or gravel deposits of Quaternary age were encountered at the top of each of the holes. Estimates of the total thickness of these deposits in each drill hole are as follows:

Hole No.	Thickness	Hole No.	Thickness	Hole No.	Thickness
S-D1	4 ft (1.2 m)	S-D5	7 ft (2.1 m)	Dixon-A	21 ft (6.4 m)
S-D2	6 ft (1.8 m)	S-D6	9 ft (2.7 m)	Dixon-B	18 ft (5.5 m)
S-D3	10 ft (3.0 m)	B-D23	26 ft (7.9 m)	Dixon-C	60 ft (18.3 m)
S-D3A	15 ft (4.6 m)	B-D24	20 ft (6.1 m)	Grieve water well	18 ft (5.5 m)
S-D4	10 ft (3.0 m)	B-D25	27 ft (8.2 m)		

STRUCTURE NEAR THE DRILL SITES

On the basis of surface measurements near the drill holes, the maximum angle of dip of any of the formations in each hole probably does not exceed 20°. Beds of the Almond Formation dip about 10° WSW in the vicinity of drill-hole S-D3A but may have steeper dips in the drill hole because of its proximity to a fault zone. The Lewis Shale dips about 10° SW near S-D4 and 15-20° NW near S-D5. The Fort Union Formation near S-D6 dips about 15° SW. The dip of the Browns Park Formation in most areas is generally believed to be less than 10°, although near S-D6 it is probably about 15° NE and may be 10-15° SW near S-D3.

LITHOLOGIC LOGS

Lithologic logs of the holes drilled for the U.S. Geological Survey in 1977 are presented on pages 14-45. 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 or drilling mud. 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. Recorded depths, including total depths of holes, are generally within 5 ft (1.5 m) of the true depths.

Rocks drilled were classified as conglomerate, 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). Coal beds that contain a large amount of non-coal material are described as impure. 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.

The classification scheme used for the unconsolidated surficial sediments of Quaternary age, which were encountered in the uppermost part of each drill hole, is the same as that used for consolidated materials of the older formations with the appropriate substitution of sediment terms for rock terms ("gravel" for "conglomerate," "sand" for "sandstone," etc.).

Colors of the sediments and 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 and sediment color terms used are from the Rock-Color Chart of the Geological Society of America (1970) and Munsell Soil Color Chart (1954) and generally refer to dry samples.

Cementation in rocks was generally determined by microscope-assisted examination of cuttings. Both calcareous and noncalcareous cement occurs

in sandstone and siltstone. Noncalcareous cement is probably clay minerals and silica in most instances. In the zone of oxidation, iron oxide (limonite) commonly occurs as grain coatings. Calcareous rocks are generally more strongly cemented than noncalcareous ones. Degree of cementation was determined by examination of drill cuttings where possible. Where cementation could not be determined from drill cuttings, resistance to drilling (a crude measure of the degree of cementation of rocks) was noted. Drilled intervals, which offer greater or lesser than average resistance to drilling, were described as hard or soft. Most hard beds are probably calcite cemented; a few, noncalcareous ones are believed to contain silica cement. Estimated relative porosity-permeability of sandstone or siltstone is described as tight or open. In at least some instances, sandstone and siltstone described as tight were strongly cemented and calcareous.

Carbonaceous material is ubiquitous in most of the rocks of the coal-bearing formations 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, and flakes which are generally less than 0.04 in. (1 mm) in largest dimension. Streaks are discontinuous laminae or shreds and the edges of chips or flakes which are generally less than 0.04 in. (1 mm) thick.

Lithologic log of drill-hole S-D1

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

Location: 50 ft FEL,1,050 ft FSL, sec. 1, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 7,650 ft

Drilling started 9-16-77; completed 9-17-77

Total depth: 500 ft

Drilling fluids: air, 0-40 ft; mud, 40-500 ft

Remarks: Resistance probe of hole when drilling completed indicated water at a depth of 50 ft

Logged by: J. Honey and J. Roberts

Description	Depth (ft) From	To
Mud, moderate-brown (7.5 YR 4/4), and gravel----------	0	4
Claystone, light-olive-gray (5 Y 5/2) to olive-gray (5 Y 4/1)----------	4	10
Claystone, olive-gray (5 Y 3/2) and moderate-brown (7.4 YR 4/4)----------	10	45
Claystone, light-yellowish-brown (2.5 Y 6/4)----------	45	50
Claystone, light-olive-brown (5 Y 5/4)----------	50	60
Claystone, light-olive-gray (5 Y 6/2) and minor dark-yellowish-orange (10 YR 6/6); contains trace of pyrite----------	60	75
Claystone, medium-gray (N5) to medium-light-gray (N6), slightly silty----------	75	275
Claystone, medium-dark-gray (N4), less silty than in interval above----------	275	325

Lithologic log of drill-hole S-D1 - continued

Description	Depth (ft) From	To
Claystone, as in interval above, siltstone, and trace of coal. Siltstone is very light gray (N8), calcareous----------	325	335
Sandstone, siltstone, and claystone. Sandstone is very light gray (N8), very fine grained, calcareous; contains a few coal particles. Siltstone is very light gray (N8), calcareous. Claystone is medium dark gray (N4)----------	335	360
Siltstone and claystone. Siltstone is light gray (N7), calcareous; contains some carbonaceous laminae. Claystone is medium light gray (N6)----------	360	365
Claystone, sandstone, and some coal. Claystone is medium gray (N5), silty; contains carbonaceous laminae. Sandstone is very light gray (N8), very fine grained, very calcareous; contains numerous coal and carbonaceous particles----------	365	380
Mudstone and siltstone. Mudstone is grayish black (N2), carbonaceous. Siltstone is light gray (N7), calcareous----------	380	385
Siltstone, as in interval above----------	385	390
Siltstone and sandstone. Siltstone is medium light gray (N6), noncalcareous. Sandstone is very light gray (N8), fine grained, slightly calcareous----------	390	395

Lithologic log of drill-hole S-D1 - continued

Description	Depth (ft) From	To
Claystone and siltstone. Claystone is medium light gray (N6), silty. Siltstone is very light gray (N8), sandy, very calcareous----------	395	410*
Claystone, siltstone, and sandstone. Claystone is medium gray (N5). Siltstone is very light gray (N8), noncalcareous. Sandstone is very light gray (N8), very fine grained, noncalcareous----------	410	430*
Claystone, as in interval above, and siltstone. Siltstone is light olive gray (5 Y 6/1), slightly calcareous----------	430	500

Total depth - 500 ft

Lithologic log of drill-hole S-D2

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

Location: 25 ft FWL, 2,325 ft FSL, sec. 14, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,710 ft

Drilling started 8-10-77; completed 8-11-77

Total depth: 245 ft

Drilling fluid: air

Remarks: Water at 243 ft

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, pale-brown (5 YR 5/2), sandy and clayey----------	0	6
Sandstone and some conglomerate. Sandstone is bluish white (5 B 9/1), coarse grained----------	6	18
Claystone, medium-dark-gray (N4), yellowish at top, silty----------	18	20
Claystone, medium-brownish-gray (5 YR 5/1)----------	20	25
Claystone, as in interval above, and some weak-yellowish-orange (2.5 Y 7/4) claystone----------	25	30
Claystone, moderate-yellowish-brown (10 YR 5/4)--------	30	53
Claystone, medium-dark-gray (N4), slightly silty-------	53	75
Claystone, medium-light-gray (N6), very silty, slightly calcareous. Hard layer near 91 ft----------	75	95
Claystone, medium-dark-gray (N4), slightly silty-------	95	235
Siltstone, light-gray (N7). Hard layer at 243 ft------	235	245

Total depth - 245 ft

Lithologic log of drill-hole S-D3

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

Location: 750 ft FEL, 550 ft FSL, sec. 17, T. 12 N., R. 89 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,530 ft

Drilling started 7-21-77; completed 7-22-77

Total depth: 1,295 ft

Drilling fluid: air, 0-55 ft; air and mud, 55-1,295 ft

Remarks: Gas at 700 ft, water at 740 ft; flow of about 50 gals. water/min. with some flammable gas measured at surface when drilling completed

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, light-brownish-gray (10 YR 6/1), sandy----------	0	10
Sandstone, moderate-yellowish-brown (10 YR 5/6), fine-grained, very soft----------	10	25
Sandstone, light-bluish-gray (5 B 7/1), very fine grained and fine-grained; contains traces of tourmaline and pyrite. Some very thin hard layers----------	25	55
Sandstone, medium-light-gray (N6), fine-grained; contains traces of tourmaline and pyrite. Hard layer, 91-93 ft----------	55	95
Sandstone, as in interval above, but mostly coarse-grained and very coarse grained----------	95	107
Conglomerate, hard----------	107	123
Claystone, moderate-yellowish-brown (10 YR 5/1) and light-greenish-gray (5 G 8/1)----------	123	136

Lithologic log of drill-hole S-D3 - continued

Description	Depth (ft) From	To
Claystone, medium-gray (N5), silty. Hard layer near 405 ft	136	710
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained, calcareous. Siltstone is yellowish gray (10 YR 7/1), calcareous	710	760
Siltstone, as in interval above, and medium-light-gray (N6) claystone	760	820
Claystone, medium-light-gray (N6)	820	830
Claystone, as in interval above, and siltstone. Siltstone is light gray (N7); contains coal particles	830	860
Sandstone, light-gray (N7), fine-grained; contains coal and carbonaceous particles	860	880
Sandstone, as in interval above, and siltstone. Siltstone is medium light gray (N6); contains coal and carbonaceous particles	880	885
Sandstone, light-gray (N7), very fine grained, hard; contains carbonaceous streaks. Thin coal bed near 931 ft	885	955
Claystone and sandstone. Claystone is dark gray (N3). Sandstone is very light gray (N8), fine grained	955	970
Sandstone, as in interval above, and dark-gray (N3) mudstone	970	1,020

Lithologic log of drill-hole S-D3 - continued

Description	Depth (ft) From	To
Claystone and sandstone. Claystone is medium gray (N5). Sandstone is light-gray (N7), very fine grained; contains a few coal particles----------	1,020	1,071
Coal----------	1,071	1,081
Siltstone, medium-light-gray (N6), and medium-gray (N5) claystone----------	1,081	1,120
Sandstone and claystone. Sandstone is bluish-white (5 B 9/1), fine-grained and medium-grained. Claystone is medium light gray (N6)----------	1,120	1,295
Total depth - 1,295 ft		

Lithologic log of drill-hole S-D3A

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

Location: 425 ft FEL, 1,350 ft FNL, sec. 17, T. 12 N., R. 89 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,550 ft

Drilling started 7-23-77; completed 7-25-77

Total depth: 1,100 ft

Drilling fluids: air and water, 0-215 ft; mud, 215-1,100 ft

Remarks: Water and gas near 840 ft; 5-10 gals. water/min. with some gas measured at surface when drilling completed

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, light-yellowish-brown (10 YR 6/4), sandy----------	0	5
Sand, moderate-yellow (2.5 Y 8/6), very fine grained---	5	15
Sandstone, pale-brown (10 YR 5/3), fine-grained and medium-grained; contains traces of pyrite and glauconite----------	15	35
Claystone grades to mudstone in lower part. Claystone is pale brown (10 YR 5/3), silty. Mudstone is dark gray (N3), carbonaceous, coaly----------	35	40
Mudstone, as in interval above, and sandstone. Sandstone is medium light gray (N6), very hard----------	40	45
Siltstone and sandstone. Siltstone is medium gray (N5). Sandstone is light yellowish brown (10 YR 6/4), very soft----------	45	60

Lithologic log of drill-hole S-D3A - continued

Description	Depth (ft) From	To
Claystone, dark-gray (N3), silty	60	68
Mudstone, dark-gray (N3), grades to carbonaceous mudstone with depth	68	75
Sandstone, medium-gray (N5), fine-grained; contains coal and carbonaceous streaks	75	80
Mudstone, medium-gray (N5), and dark-gray (N3) claystone. Lower part of interval carbonaceous, coaly	80	85
Siltstone, medium-gray (N5)	85	90
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained. Siltstone is dusky brown (5 YR 2/2)	90	100
Sandstone, as in interval above	100	115
Mudstone, dark-gray (N3)	115	120
Sandstone, light-gray (N7), fine-grained; contains coal and carbonaceous particles	120	145
Siltstone, medium-gray (N5), hard	145	190
Claystone, medium-dark-gray (N4), silty	190	200
Siltstone, medium-gray (N5), and dark-gray (N3) claystone	200	214
Sandstone, light-gray (N7), fine-grained and very fine grained, very hard	214	215
Claystone, dark-gray (N3), silty	215	250
Sandstone, medium-gray (N5), fine-grained and very fine grained	250	270

Lithologic log of drill-hole S-D3A - continued

Description	Depth (ft) From	To
Sandstone, as in interval above, and medium-gray (N5) claystone	270	280
Siltstone, light-brownish-gray (5 YR 5/1) and medium-gray (N5) claystone	280	285
Claystone, as in interval above, and sandstone. Sandstone is light gray (N7), very fine grained, soft; contains carbonaceous particles	285	300
Claystone, medium-gray (N5)	300	305
Sandstone, light-gray (N7), fine-grained, soft; contains coal particles	305	320
Sandstone, as in interval above, and light-gray (N7) claystone	320	415
Sandstone, light-brownish-gray (10 YR 5/1), fine-grained, hard	415	426
Coal	426	433
Siltstone and claystone. Siltstone is dark gray (N3), carbonaceous. Claystone is light brownish gray (5 YR 5/1)	433	505
Sandstone, light-gray (N7), fine-grained	505	666
Coal	666	681
Sandstone, light-brownish-gray (5 YR 5/1), fine-grained	681	700

Lithologic log of drill-hole S-D3A - continued

Description	Depth (ft) From	To
Sandstone, as in interval above, and light-brownish-gray (5 YR 5/1) claystone	700	704
Coal	704	710
Sandstone and claystone. Sandstone is medium light gray (N6), very fine grained. Claystone is brownish gray (5 YR 5/1)	710	735
Claystone, brownish-gray (5 YR 4/1); some is carbonaceous	735	746
Siltstone, light-brownish-gray (5 YR 4/1), sandy	746	790
Siltstone, medium-light-gray (N6), sandy	790	880
Sandstone, light-gray (N7), fine-grained and very fine grained; contains coal and carbonaceous particles	880	1,000
Sandstone, as in interval above, and light-brownish-gray (5 YR 5/1) claystone and siltstone	1,000	1,100

Total depth - 1,100 ft

Lithologic log of drill-hole S-D4

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

Location: 975 ft FWL, 2,050 ft FNL, sec. 11, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,830 ft

Drilling started 8-11-77; completed 8-15-77

Total depth: 1,220 ft

Drilling fluids: air, 0-695 ft; air and water, 695-1,220 ft

Remarks: Water at 695 ft; 200 gals. water/min. measured at surface when hole drilled to 780 ft; flow of about 400 gals. water/min. with some gas measured at surface when drilling completed

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud to silty clay, light-brown (5 YR 5/3)----------	0	9
Gravel----------	9	10
Claystone, light-brown (7.5 YR 5/4) and grayish-brown (7.5 YR 4/2), yellowish at top----------	10	25
Claystone, medium-gray (N5) to medium-dark-gray (N4), slightly silty----------	25	155
Claystone, as in interval above, and medium-gray (N5) mudstone----------	155	684
Sandstone, medium-light-gray (N6), very fine grained---	684	687
Coal----------	687	688
Claystone, grayish-brown (10 YR 4/3)----------	688	695

Lithologic log of drill-hole S-D4 - continued

Description	Depth (ft) From	To
Sandstone, light-gray (N7), very fine grained; contains coal and carbonaceous particles	695	700
Sandstone, as in interval above, and grayish-brown (10 YR 4/3) claystone	700	715
Claystone, as in interval above, and medium-dark-gray (N4) siltstone	715	720
Sandstone, light-gray (N7), very fine grained	720	735
Mudstone and sandstone. Mudstone is medium dark gray (N4). Sandstone is light gray (N7), very fine grained; contains coal and carbonaceous particles	735	750
Sandstone, as in interval above, and dark-gray (N3), siltstone and claystone	750	763
Coal	763	764
Claystone, medium-gray (N5)	764	780
Sandstone, medium-dark-gray (N4), very fine grained	780	785
Sandstone, as in interval above, and olive-black (5 Y 2/1) siltstone	785	800
Claystone and sandstone. Claystone is olive-black (5 Y 2/1). Sandstone is medium dark gray (N4), very fine grained	800	820
Siltstone and claystone. Siltstone is medium dark gray (N4), slightly sandy. Claystone is olive black (5 Y 2/1), silty	820	835

Lithologic log of drill-hole S-D4 - continued

Description	Depth (ft) From	To
Claystone and mudstone. Claystone is light gray (N7), silty. Mudstone is black (N1)----------	835	850
Claystone, pale-brown (5 YR 5/2) and light-gray (N7)---	850	865
Claystone, as in interval above, and sandstone. Sandstone is medium gray (N5), fine grained----------	865	920
Claystone, pale-brown (5 YR 5/2) and olive-black (5 Y 2/1), coaly (?)----------	920	940
Sandstone and claystone. Sandstone is medium gray (N5), very fine grained. Claystone is olive black (5 Y 2/1), coaly (?)----------	940	989
Coal----------	989	1,000
Claystone and sandstone. Claystone is olive black (5 Y 2/1) and pale brown (5 YR 5/2). Sandstone is medium gray (N4), very fine grained----------	1,000	1,030
Siltstone, medium-light-gray (N6), and dark-gray (N3) to grayish-black (N2) mudstone----------	1,030	1,040
Claystone, pale-brown (5 YR 5/2), olive-black (5 Y 2/1) mudstone, and medium-gray (N4) siltstone---	1,040	1,055
Sandstone and mudstone. Sandstone is medium light gray (N6), very fine grained. Mudstone is black (N1), carbonaceous----------	1,055	1,070

Lithologic log of drill-hole S-D4 - continued

Description	Depth (ft) From	To
Claystone and sandstone. Claystone is olive black (5 Y 2/1) and pale brown (5 YR 2/1). Sandstone is medium light gray (N6), very fine grained. Hard layer near 1,072 ft	1,070	1,079
Coal	1,079	1,084
Sandstone, medium-light-gray (N6), and olive-black (5 Y 2/1) claystone	1,084	1,105
Sandstone and claystone. Sandstone is medium gray (N5), very fine grained; contains some carbonaceous laminae. Claystone is medium dark gray, silty	1,105	1,130
Sandstone, as in interval above, and pale-brown (5 YR 5/2) claystone	1,130	1,140*
Sandstone and claystone. Sandstone is medium light gray (N6), very fine grained. Claystone is brownish gray (5 YR 3/2), silty	1,140	1,200*
Coal	1,200	1,204*
Claystone, grayish-brown (5 YR 3/2), carbonaceous	1,204	1,212*
Sandstone, pale-brown (5 YR 5/2), very fine grained; contains coal fragments and laminae	1,212	1,220*
Total depth - 1,220 ft		

Lithologic log of drill-hole S-D5

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

Location: 1,225 ft FWL, 675 ft FNL, sec. 14, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,755 ft

Drilling started 8-11-77; completed 8-11-77

Total depth: 225 ft

Drilling fluid: air and water

Remarks: Water, 199-216 ft

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, dark-brown (7.5 YR 3/2), sandy----------	0	4
Gravel----------	4	7
Claystone, moderate-brown (7.5 YR 4/4), silty; contains some very light gray (N8) siltstone laminae----------	7	10
Claystone and siltstone. Claystone is dark yellowish orange (10 YR 6/6), silty. Siltstone is pale brown (10 YR 6/2), clayey----------	10	17
Claystone, grayish-brown (7.5 YR 4/2) to moderate-brown (10 YR 4/4), silty----------	17	20
Claystone, dark-gray (N3), silty----------	20	25
Siltstone, medium-dark-gray (N4), clayey----------	25	55
Claystone, dark-gray (N3), silty----------	55	79
Siltstone, medium-dark-gray (N4), clayey----------	79	192
Sandstone, medium-gray (N5), very fine grained---------	192	196

Lithologic log of drill-hole S-D5 - continued

Description	Depth (ft) From	To
Mudstone and impure coal. Mudstone is brownish gray (10 YR 3/1), carbonaceous----------	196	201
Sandstone, medium-light-gray (N6), very fine grained; contains carbonaceous particles----------	201	220
Sandstone, as in interval above, and pale-brown (10 YR 5/2) siltstone----------	220	225
Total depth - 225 ft		

Lithologic log of drill-hole S-D6

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

Location: 1,700 ft FWL, 350 ft FSL, sec. 14, T. 12 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,515 ft

Drilling started 7-28-77; completed 7-29-77

Total depth: 200 ft

Drilling fluid: air, 0-50 ft; air and water, 50-200 ft

Remarks: Formation wet at 50 ft

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Sand, moderate-brown (7.5 YR 4/4), muddy----------	0	13
Sandstone, dark-yellowish-orange (10 YR 6/6) and grayish-orange (10 YR 7/4), fine-grained and very fine grained, clayey in lower 15 ft, very soft; contains traces of pyrite and tourmaline----------	13	75
Sandstone, light-bluish-gray (5 B 7/1), fine-grained and very fine grained, clayey, very soft; contains traces of pyrite and tourmaline----------	75	96
Sandstone, grayish-orange-pink (10 R 8/2) and conglomerate. Grades from very fine and fine-grained sandstone near top to fine- and medium-grained sandstone near middle to sandy conglomerate in basal 10 ft-----	96	124

Lithologic log of drill-hole S-D6 - continued

Description	Depth (ft) From	To
Claystone and sandstone. Claystone is grayish red purple (5 RP 4/2) and grayish brown (7.5 YR 4/2). Sandstone is light gray (N7), very fine grained to fine grained; contains coal and carbonaceous particles----------	124	133
Sandstone, white at top, light-gray (N7) below, very fine grained, very soft; contains numerous coal and carbonaceous particles----------	133	140
Sandstone, as in interval above, and siltstone. Siltstone is pale brown (7.5 YR 6/2), clayey----------	140	145
Siltstone, as in interval above----------	145	150
Claystone, dark-brown (10 YR 3/3)----------	150	165
Claystone, weak-yellowish-orange (10 YR 7/6)----------	165	170
Sandstone and claystone. Sandstone is light gray (N7), fine grained and very fine grained; contains coal and carbonaceous particles. Claystone is pale brown (7.5 YR 5/2)----------	170	185
Claystone, moderate-yellowish-brown (10 YR 5/6), silty-	185	190*
Claystone, medium-dark-gray (N4)----------	190	200
Total depth - 200 ft		

Lithologic log of drill-hole B-D23

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

Location: 1,900 ft FWL, 500 ft FNL, sec. 34, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,565 ft

Drilling started 7-29-77; completed 7-29-77

Total depth: 340 ft

Drilling fluids: air, 0-43 ft; air and water, 43-340 ft

Remarks: Water, 136-139 ft

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Sand, pale-brown (5 YR 5/2), muddy----------	0	5
Sand, grayish-brown (2.5 Y 5/2), very fine grained-----	5	13
Sand, dark-yellowish-orange (10 YR 6/6), very fine grained and fine-grained----------	13	24
Gravel----------	24	26
Sandstone, moderate-yellowish-brown (10 YR 5/6), fine-grained to very fine grained, very soft----------	26	30
Sandstone, dark-yellowish-orange (10 YR 6/6), very fine grained, very soft----------	30	38
Sandstone, light-greenish-gray (5 G 8/1), very fine grained to fine-grained; contains some pyrite and tourmaline grains. Generally soft except for hard layers near 190 ft, 232-238 ft, 267 ft, and 295 ft----------	38	337
Conglomerate----------	337	340

Total depth - 340 ft

Lithologic log of drill-hole B-D24

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

Location: 1,950 ft FWL, 1,400 ft FNL, sec. 27, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,560 ft

Drilling started 8-6-77; completed 8-8-77

Total depth: 1,295 ft

Drilling fluids: air, water, and mud

Remarks: Water at 836-837 ft; gas at 860-880 ft; flow of about 30 gals. water/min. with some gas measured at surface when drilling completed

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, pale-brown (7.5 YR 5/2), sandy----------	0	5
Clay, sand, and gravel. Clay is grayish brown (7.5 YR 4/2), silty----------	5	20.5
Claystone, dark-gray (N3), silty. Hard layer near 256 ft----------	20.5	320
Claystone, medium-dark-gray (N4), silty----------	320	380
Claystone, as in interval above, and siltstone. Siltstone is dark gray (N3), clayey----------	380	390
Claystone and siltstone, as in interval above, and yellowish-gray (10 YR 8/1) bentonite----------	390	400
Claystone, medium-dark-gray (N4), silty. Hard layer near 544 ft----------	400	560

Lithologic log of drill-hole B-D24 - continued

Description	Depth (ft) From	To
Siltstone and mudstone, medium-dark-gray (N4). Medium-gray, hard siltstone layer at 676 ft----------	560	803
Sandstone, light-gray (N7), very fine grained, noncalcareous----------	803	819
Coal----------	819	820
Siltstone and claystone. Siltstone is light brownish gray (5 YR 6/1), sandy. Claystone is medium gray (N5)----------	820	830
Siltstone and claystone, as in interval above, and sandstone. Sandstone is medium light gray (N6), very fine grained, open, noncalcareous. Hard layers 836-837 ft and 852-855 ft----------	830	915
Claystone, light-brownish-gray (5 YR 6/1), and medium-gray (N5) siltstone----------	915	920
Siltstone, medium-dark-gray (N4), very carbonaceous----	920	928*
Coal----------	928	938*
Sandstone, medium-light-gray (N6), very fine grained, hard----------	938	940*
Sandstone, as in interval above, medium-dark-gray (N4) siltstone and very thin coal bed at 942 ft------	940	986*
Coal----------	986	996*
Siltstone, medium-dark-gray (N4), carbonaceous. Thin coal bed at 998 ft----------	996	1,003*
Coal----------	1,003	1,008*

Lithologic log of drill-hole B-D24 - continued

Description	Depth (ft) From	To
Sandstone, light-gray (N7), very fine grained, silty, noncalcareous	1,008	1,065
Sandstone, light-gray (N7), fine- to medium-grained; contains coal and carbonaceous particles	1,065	1,100*
Siltstone and mudstone. Siltstone is medium gray (N5), hard. Mudstone is dark gray (N3), carbonaceous; contains some streaks and laminae	1,100	1,118*
Coal	1,118	1,132
Sandstone and siltstone. Sandstone is light gray (N7), medium grained, noncalcareous. Siltstone is light brownish gray (5 YR 5/1)	1,132	1,185*
Claystone and sandstone. Claystone is medium dark gray (N4), silty. Sandstone is medium gray (N5), fine grained; contains coal and carbonaceous particles	1,185	1,220*
Siltstone and claystone. Siltstone is medium dark gray (N4), clayey. Claystone is light brownish gray (10 YR 5/1)	1,220	1,295*

Total depth - 1,295 ft

Lithologic log of drill-hole B-D25

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

Location: 900 ft FEL, 700 ft FNL, sec. 22, T. 13 N., R. 90 W., 6th P.M., Carbon County, Wyoming

Collar elevation: 6,680 ft

Drilling started 8-3-77; completed 8-4-77

Total depth: 980 ft

Drilling fluids: air, 0-15 ft; mud, 15-980 ft

Remarks: Water 40-55 ft and 70-80 ft; gas 100-140 ft; flow of about 50 gals. water/min. (with trace of gas?) measured at surface when drilling completed

Logged by: L. A. Shoaff

Description	Depth (ft) From	To
Mud, moderate-brown (7.5 YR 4/4), sandy----------	0	12
Sand, moderate-brown (7.5 YR 4/4), medium-grained------	12	15
Sand, as in interval above, and clay. Clay is grayish black (N2), silty----------	15	20
Sand, pale-brown (10 YR 5/3), coarse-grained----------	20	23
Gravel----------	23	27
Sandstone, light-brownish-gray (10 YR 6/2), very fine grained, noncalcareous----------	27	32
Claystone, pale-brown (10 YR 5/2), silty----------	32	38
Siltstone and sandstone. Siltstone is dark brown (7.5 YR 3/2), grading to medium gray (N5) with depth, very hard. Sandstone is medium gray (N5), silty, open, noncalcareous; contains coal particles---------	38	45

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained; contains coal and carbonaceous particles. Siltstone is light gray (N7)----------	45	50
Siltstone, dark-brown (7.5 YR 3/2), clayey; some is carbonaceous----------	50	52
Coal----------	52	54
Claystone and siltstone. Claystone is medium gray (N5), silty. Siltstone is light gray (N7); contains some coal and carbonaceous particles----------	54	60
Coal, impure and carbonaceous siltstone----------	60	62
Sandstone, light-gray (N7), silty----------	62	65
Siltstone, medium-light-gray (N6); contains carbonaceous and coal streaks and laminae, which become more numerous with depth----------	65	75
Sandstone, light-gray (N7), fine-grained to very fine grained, noncalcareous, tight; contains coal and carbonaceous particles----------	75	80
Claystone, medium-gray (N5), silty; becomes carbonaceous near bottom of interval----------	80	92
Siltstone, light-gray (N7), sandy----------	92	95
Sandstone, light-gray (N7), silty----------	95	101
Coal and carbonaceous shale----------	101	103

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Sandstone, light-gray (N7), very fine grained, non-calcareous; contains coal and carbonaceous streaks---	103	110
Siltstone and claystone. Siltstone is medium gray (N5). Claystone is medium gray (N5), silty----------	110	115
Claystone and sandstone. Claystone is dark gray (N3). Sandstone is medium gray (N5), very fine grained, noncalcareous; contains coal and carbonaceous particles----------	115	120
Sandstone, light-gray (N7), silty; contains coal particles----------	120	125
Sandstone, as in interval above, and medium-light-gray (N6) claystone----------	125	130
Claystone, as in interval above----------	130	140
Siltstone and claystone, medium-gray (N5)----------	140	180
Sandstone and claystone. Sandstone is light gray (N7), very fine grained, noncalcareous; contains coal and carbonaceous streaks. Claystone is medium gray (N5)-	180	205
Siltstone, light-gray (N7); contains coal particles. Very hard layer, 205-2 ft----------	205	210
Siltstone, medium-gray (N5)----------	210	220
Siltstone and claystone, medium-gray (N5)----------	220	235

Lithologic log of drill-hole B-D25 - continued

Description	Depth (Ft) From	To
Claystone, medium-gray (N5)----------	235	240
Claystone, grayish-black (N2)----------	240	245
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous----------	245	255
Siltstone, light-gray (N7), and light gray claystone---	255	265
Sandstone, light-gray (N7), very fine grained and fine-grained, very soft, noncalcareous----------	265	272
Claystone, dark-brown (7.5 YR 3/2), silty----------	272	285
Sandstone, medium-gray (N5), very fine grained and fine-grained----------	285	290
Sandstone, as in interval above, and medium-dark-gray (N4) claystone----------	290	301
Coal----------	301	303
Sandstone, light-gray (N7), very fine grained; contains coal and carbonaceous particles----------	303	316
Coal----------	316	318
Claystone, medium-gray (N5)----------	318	325
Coal----------	325	328
Siltstone, medium-gray (N5), and gray claystone. Hard layers, 330-333 ft----------	328	345
Sandstone, light-gray (N7), very fine grained and fine-grained, open, noncalcareous----------	345	351
Coal----------	351	352

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Sandstone and claystone. Sandstone is medium gray (N5), very fine grained. Claystone is medium gray (N5). Hard layer, 360-361 ft	352	380
Siltstone, pale-brown (7.5 YR 5/2); contains coal streaks and laminae	380	390
Siltstone, as in interval above, and claystone. Claystone is pale brown (7.5 YR 5/2), silty	390	395
Coal	395	398
Claystone, dark-brown (7.5 YR 3/2), silty	398	407
Coal	407	409
Siltstone and claystone. Siltstone is dark brown (7.5 YR 3/2), clayey. Claystone is moderate brown (7.5 YR 4/4)	409	413
Coal	413	420
Sandstone and some mudstone. Sandstone is medium gray (N5), very fine grained. Mudstone is carbonaceous	420	433
Coal	433	440
Claystone and sandstone. Claystone is brownish gray (5 YR 4/1), silty. Sandstone is light gray (N7), very fine grained	440	462
Coal	462	469
Sandstone, light-gray (N7), fine-grained, open, non-calcareous; contains coal and carbonaceous particles-	469	495
Claystone, moderate-brown (7.5 YR 4/4), silty	495	500
Claystone, grayish-black (N2), silty. Hard layer, 512-513 ft	500	519

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Coal	519	520
Siltstone, grayish-black (N2) and light-gray (N7)	520	530
Coal	530	545
Siltstone, medium-gray (N5), clayey	545	560
Siltstone, light-gray (N7) to grayish-black (N2); contains coal and carbonaceous streaks	560	605
Sandstone and siltstone. Sandstone is light gray (N7), very fine grained; contains coal and carbonaceous particles. Siltstone is grayish brown (7.5 YR 4/2)	605	625
Siltstone and claystone. Siltstone is light gray (N7). Claystone is moderate brown (7.5 YR 4/4); some is carbonaceous	625	635
Sandstone, fine-grained to very fine grained; contains carbonaceous laminae	635	640
Siltstone, grayish-black (N2), carbonaceous	640	649
Coal	649	651
Sandstone and some carbonaceous shale. Sandstone is light gray (N7), very fine grained; contains numerous coal and carbonaceous particles	651	655
Sandstone, as in interval above, but also contains coal and carbonaceous streaks	655	662
Coal	662	671

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Sandstone, light-gray (N7), very fine grained; contains coal and carbonaceous particles	671	680
Coal, carbonaceous shale, and medium-gray (N5) siltstone	680	683
Sandstone and thin coal beds. Sandstone is medium gray (N5), very fine grained and fine-grained, open, noncalcareous; contains coal and carbonaceous particles. Coal, 712-713 ft, 716-716.5 ft, and 718-718.5 ft	683	720
Siltstone, light-gray (N7), sandy	720	724
Coal and carbonaceous shale	724	726
Siltstone, medium-light-gray (N6)	726	729
Coal	729	731
Siltstone, claystone, and a thin coal bed. Siltstone is medium gray (N5). Claystone is grayish brown (7.5 YR 4/2), silty. Coal, 746-747 ft	731	748
Coal and carbonaceous shale	748	749
Claystone and siltstone. Claystone is grayish brown (7.5 YR 4/2), silty. Siltstone is medium gray (N5)	749	759
Coal	759	763
Claystone, medium-gray (N5), silty	763	764.5
Coal	764.5	766

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous; contains coal and carbonaceous particles	766	775
Coal	775	778
Sandstone, medium-light-gray (N6), very fine grained, noncalcareous; contains coal and carbonaceous particles	778	780
Sandstone and a thin coal bed. Sandstone is very light gray (N8), very fine grained, very soft. Coal, 783-784 ft	780	800
Sandstone, light-gray (N7), fine-grained and very fine grained, very soft; contains numerous coal and carbonaceous particles	800	820
Sandstone, medium-gray (N5), fine-grained and very fine grained; contains coal and carbonaceous particles and a very thin coal bed near 837 ft	820	840
Siltstone, grayish-brown (7.5 YR 4/2)	840	850
Claystone and siltstone. Claystone is medium gray (N5). Siltstone is medium light gray (N6), clayey	850	855
Claystone and sandstone. Claystone is medium light gray (N6), silty. Sandstone is medium gray (N5), very fine grained	855	860
Sandstone, light-gray (N7), fine-grained; contains coal and carbonaceous particles	860	880

Lithologic log of drill-hole B-D25 - continued

Description	Depth (ft) From	To
Claystone and siltstone. Claystone is medium dark gray (N4), carbonaceous. Siltstone is grayish brown (2.5 Y 5/2)----------	880	897
Coal----------	897	898
Claystone and siltstone. Claystone is medium dark gray (N4), carbonaceous. Siltstone is grayish brown (2.5 Y 5/2)----------	898	900
Sandstone, light-gray (N7), fine-grained; contains coal and carbonaceous streaks----------	900	905
Sandstone, as in interval above, claystone, and a thin coal bed. Sandstone is medium gray (N5), silty. Coal, 935-936 ft----------	905	945*
Siltstone, light-gray (N7), clayey----------	945	980*
Total depth - 980 ft		

GEOPHYSICAL LOGS

All of the drill holes were logged by geophysical methods and copies of the logs (figs. 7-58) are presented in the pocket of this report. Logs that were run were natural gamma, neutron, gamma-gamma, single-point resistance, spontaneous potential, 16- and 64-inch (41- and 163-cm) normal resistivity, caliper, fluid resistivity, and temperature. Of these, only natural gamma was run in every hole. Drill holes thought to be particularly susceptible to caving were logged through the drill stem with the natural gamma tool.

Calibration curves relating porosity and density to counts per second on the neutron and gamma-gamma logs that were obtained with well reconnaissance logger W-236265 are given in figures 5 and 6, 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 2.65 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.

COAL IN THE DRILLED FORMATIONS

Coal beds occur in the Almond Formation in drill-holes S-D1, S-D3, S-D3A, S-D4, S-D5, B-D24, and B-D25, and possibly in the marine member of the Allen Ridge Formation in drill-holes S-D3A, B-D24, and B-D25.

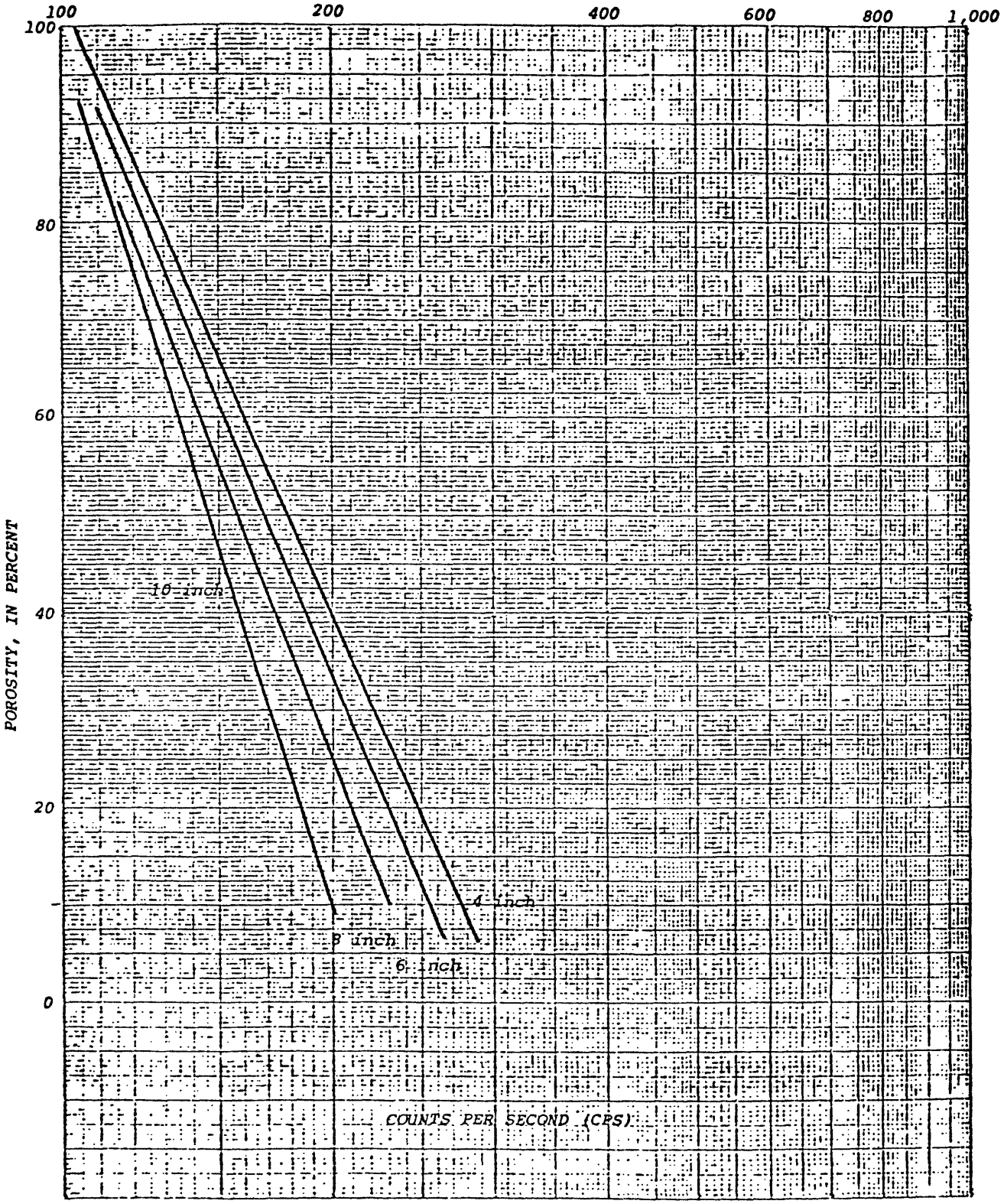


Figure 5.--Calibration curve for neutron log, well reconnaissance logger W-236265: 4-, 6-, 8-, and 10-inch water-filled drill holes.

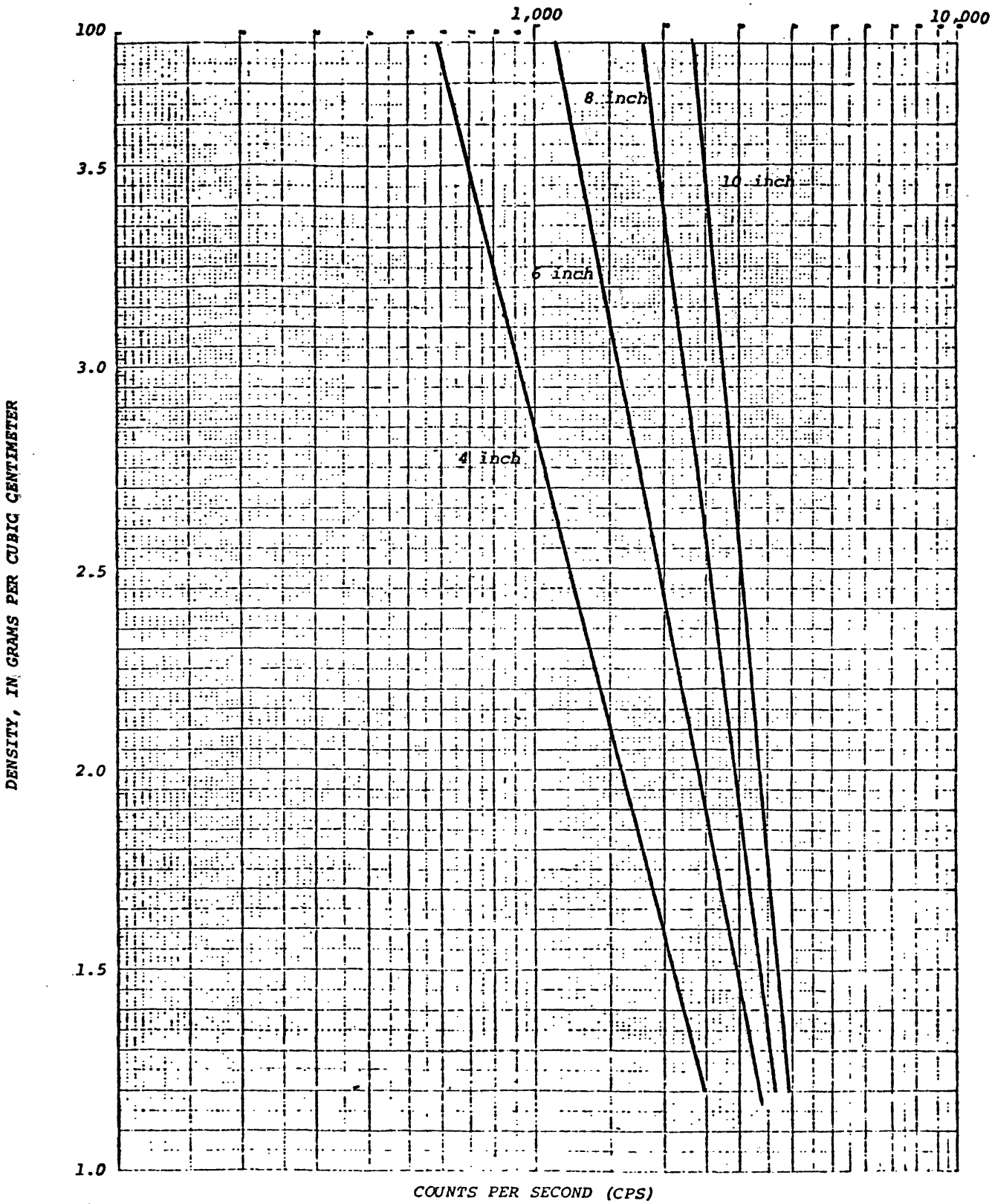


Figure 6.--Calibration curve for gamma-gamma log, well reconnaissance logger W-236265: 4-, 6-, 8-, and 10-inch water-filled drill holes.

Depth and thickness of the coal beds and correlation of stratigraphic units in these holes are shown in figure 4.

Coal in the Mesaverde Group is generally of bituminous rank (Ball and Stebinger, 1910, p. 202). The average analyses (as-received basis) of six coal samples from the Almond Formation in four abandoned mines in T. 12 N., R. 90 W., shows 6.61 percent ash, 0.58 percent sulfur, and a heating value of 10,359 Btu/lb (Ball and Stebinger, 1910, p. 200). An analysis (as-received basis) of a coal sample from the Almond Formation in 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).

REFERENCES

American Society for Testing and Materials, 1970, Annual book of ASTM standards, part 33: Glossary of ASTM definitions and index to ASTM standards. Philadelphia: Am. Soc. for Testing and Materials, 706 p.

Ball, M. W., and Stebinger, Eugene, 1910, The eastern part of the Little Snake River coal field, Wyoming: U.S. Geol. Survey Bull. 381-B, p. 186-213.

Cronoble, J. M., 1969, South Baggs-West Side Canal gas field, Carbon County, Wyoming, and Moffat County, Colorado, in Wyoming Geol. Assoc. Guidebook 21st Field Conf., Symposium on Tertiary rocks of Wyoming: p. 129-138.

Folk, R. L., 1954, The distinction between grain size and mineral composition in sedimentary rock nomenclature: Jour. Geol. v. 62, p. 344-359.

Gill, J. R., Merewether, E. A., and Cobban, W. A., 1970, Stratigraphy and nomenclature of some Upper Cretaceous and lower Tertiary rocks in south-central Wyoming: U.S. Geol. Survey Prof. Paper 667, 53 p.

Goddard, E. N., Chm., and others, 1948, Rock-color chart: National Research Council (Repr. by Geol. Soc. America, 1951, 1970), 6 p.

Munsell Color Company, Inc., 1954, Munsell soil color chart: Baltimore, Maryland.