UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOPHYSICAL AND LITHOLOGIC LOGS OF 11 COAL TEST HOLES DRILLED DURING 1977 IN THE PATS BOTTOM QUADRANGLE, CARBON COUNTY, WYOMING

BY

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INTRODUCTION

Eleven coal test holes were drilled between August 30, 1977, and October 3, 1977, in T. 23 N., Rs. 83-84 W., Pats Bottom quadrangle, Carbon County, Wyo. The purpose of the drilling was to evaluate the thickness and lateral extent of federally owned coal of the Tertiary Ferris and Hanna Formations in the Hanna Basin coal field. The Federal lands investigated are deemed valuable for coal leasing in the near future. For additional information on drilling by the U. S. in the Pats Bottom quadrangle, refer to Blanchard and Pike (1977).

Drill-hole locations were selected and the drilling was supervised by U.S. Geological Survey personnel. Drilling was done by McCabe Bros. Drilling Inc.-Hugh M. Harris Drilling Co. of Idaho Falls, Idaho, under U.S. Geological Survey contract number 14-08-0001-17110. Drill-hole locations are shown on figure 1, and a summary of drill-hole locations and depths is given in table 1.

All holes were drilled by a truck-mounted rotary drilling rig using 4-3/4- to 5-1/8-in. tricone rock bits and three-way blade bits. Drilling fluids used were air, water, air-water biodegradable foam, and mud. Upon completion, all holes were cemented from bottom to top (with the exception of HB-10-PB), reclaimed and reseeded with native grasses. To permit its use as a water observation well, drill-hole HB-10-PB was cased with 4-in. perforated casing to a depth of 240 ft by the Water Resources Division of the U.S. Geological Survey, Cheyenne, Wyo.

Geophysical logging of all drill holes was done by Goodwell, Inc. of Upton, Wyo., and included natural-gamma, spontaneous-potential, gamma-gamma (density), and resistivity. The density log was produced by a separate sonde and, on several logs, was not accurately alined with the other three logs. Geophysical logs were photographically reduced to a vertical scale of 1 in. to 50 ft and a horizontal scale of 1 in. to 5 in. The reduced scale is shown near the top of all geophysical logs. All measurements are in feet; to convert to meters, multiply by 0.3048.

Problems encountered during drilling were minimal. HB-1PB was abandoned after drill-hole circulation was lost and could not be restored; hole HB-1A-PB was drilled as an alternate. In addition, the spontaneous-potential log on hole HB-4-PB was not functioning correctly, and was turned off above 277 ft.

Lithologic interpretations were made by a field examination of drill-hole cuttings at 5-ft intervals and were corrected by a comparison to the geophysical logs. Only very general lithologic descriptions were made so as not to imply a greater degree of accuracy than there actually was.

REFERENCE

Blanchard, L. F., and Pike, Thomas J., 1977, Lithologic and geophysical logs of holes drilled in the Seminoe Dam SE and Pats Bottom quadrangles, Carbon County, Wyoming: Open-File Report 77-119, 40 p.

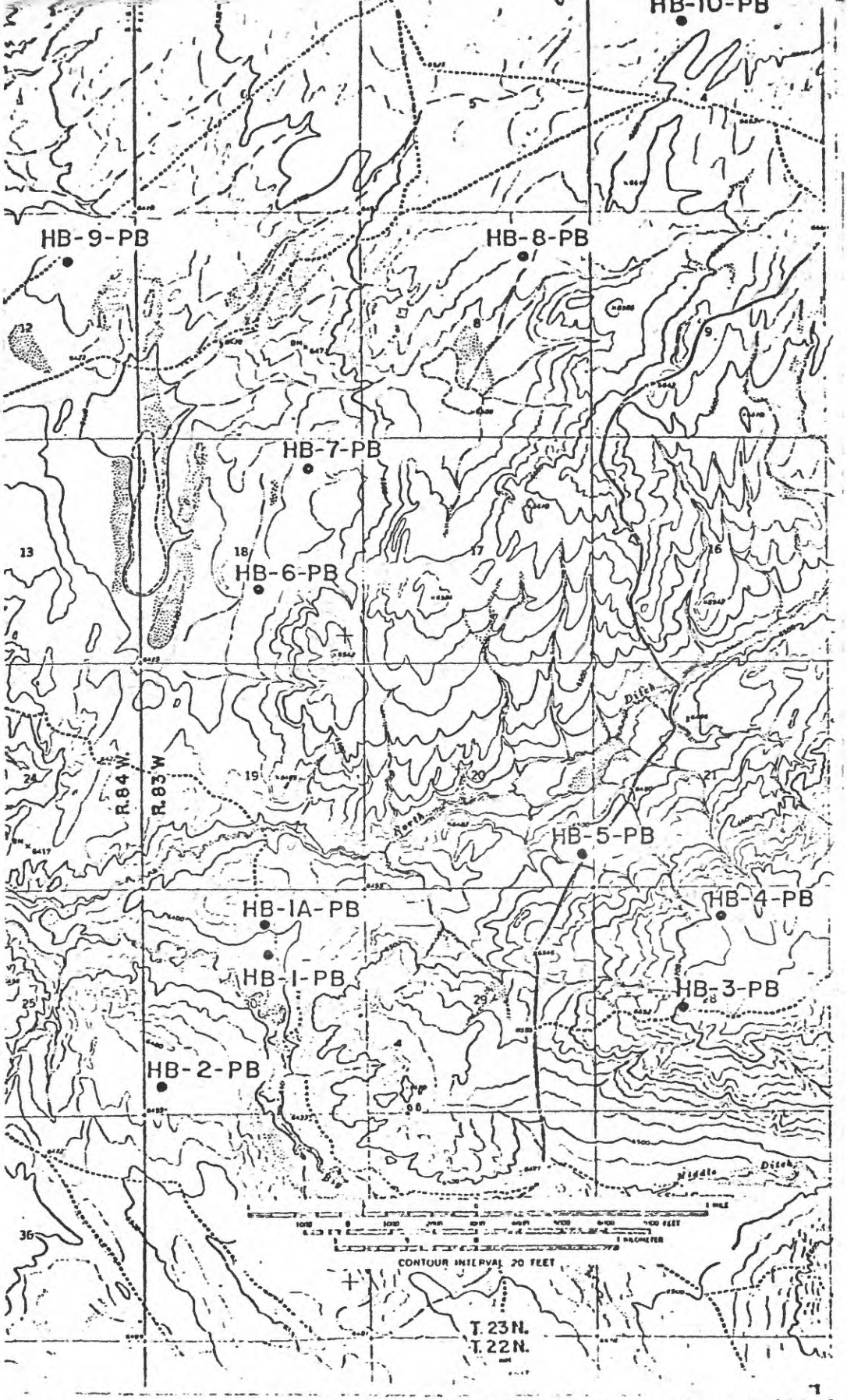


Figure 1.--Map showing U.S. Geol. Survey drill-hole locations drilled during the summer of 1977 in the Pats Bottom quadrangle, Wyoming.

Table 1.--Summary of information for 11 drill holes in the Pats Bottom quadrangle, Carbon County, Wyoming

Drill-hole No.	Location			Depth drilled (feet)	Depth logged (feet)
	T. N.	R. W.	Sec.		
HB-1-PB[1]	23	83	30 NE¼	175	173
HB-1A-PB	23	83	30 NE¼	700	682
HB-2-PB	23	83	30 SW¼	542	542
HB-3-PB	23	83	28 SW¼	620	620
HB-4-PB	23	83	28 NE¼	682	682
HB-5-PB	23	83	20 SE¼	560	552
HB-6-PB	23	83	18 SE¼	663	663
HB-7-PB	23	83	18 NE¼	502	502
HB-8-PB	23	83	8 NE¼	500	500
HB-9-PB	23	84	12 NE¼	423	410
HB-10-PB[2]	23	83	4 NW¼	761	761

[1]Circulation lost at 90 ft; circulation restored and lost again at 170 ft; hole abandoned at 175 ft.

[2]The hole was cased with 4-in. casing from 0 ft to 240 ft by the Water Resources Division of the U.S. Geological Survey to be used as a water observation well. The bottom 180 ft of casing was perforated.

LITHOLOGIC AND GEOPHYSICAL LOGS

Hole no. HB-1-PB **Date logged** 9-6-77 **Surface elevation (ft)** 6,405

Loc.: State Wyo. **Cty.** Carbon **T.** 23 N, **R.** 83 W, **Sec.** 30 ; 1500 **F** NL, 2250 **F** EL

Drilled depth (ft) 175 **Logged depth (ft)** 173 **Water Level (ft)** --

Drilling fluid: [x] Air [x] Water [x] Foam [x] Mud

Geophysical logs:

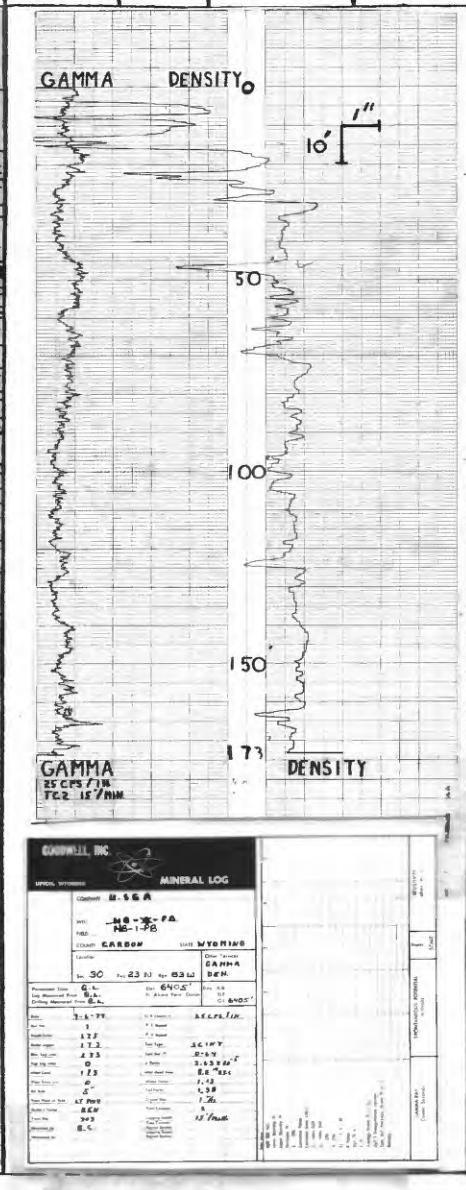
Spontaneous potential: Scale _____ Logging speed _____ fpm

Resistivity: Scale _____ Logging speed _____ fpm

Gamma: T.C. 2 Scale 25 cps/in Logging speed 15 fpm

Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-16	Soil, yellow-brown, sand, silt, and clay							
16-30	Claystone, gray-brown, sandy							
30-46	Siltstone, gray, sandy. Minor gray, fine-grained sandstone							
46-47.5	Coal							
47.5-75	Claystone, carbonaceous shale and sandstone, interbedded. Claystone is gray and silty. Carbonaceous shale is brown gray and clayey. Sandstone is gray and very fine grained							
75-90	Siltstone, medium-gray, clayey and sandy							
90-110	No sample, circulation lost							
110-120	Claystone, gray, and dark-brown, coaly, carbonaceous shale							
120-175	Sandstone and siltstone, interbedded. Sandstone is light gray, fine grained and silty. Siltstone is gray, sandy, and clayey							
175	Lost circulation, hole abandoned							



Hole no. HB-1A-PB Date logged 9-20-77 Surface elevation (ft) 6,415

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 30 ; 800 FNL, 2300 FEL

Drilled depth (ft) 700 Logged depth (ft) 682 Water Level (ft) --

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

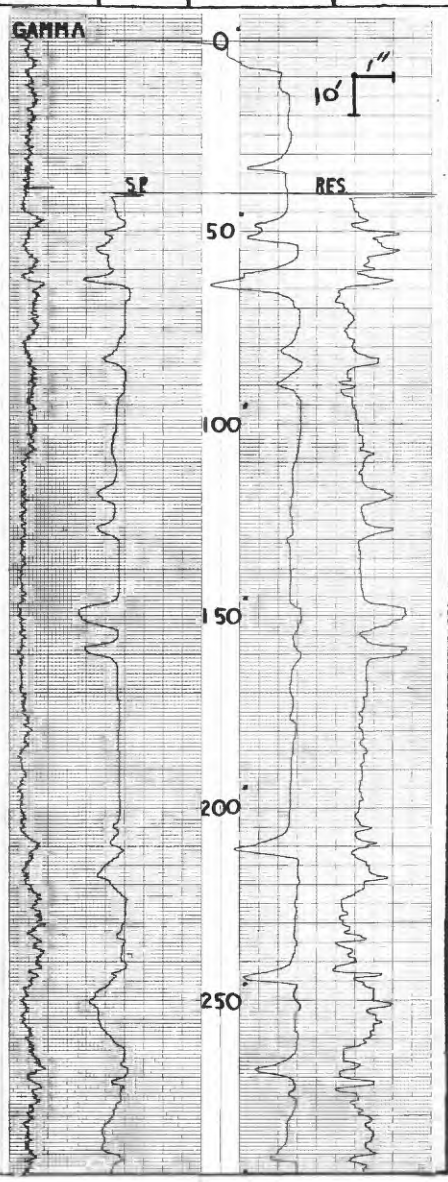
Spontaneous potential: Scale 20 mv/in Logging speed 15 fpm

Resistivity: Scale 50 ohms/in Logging speed 15 fpm

Gamma: T.C. 2 Scale 50 cps/in Logging speed 15 fpm

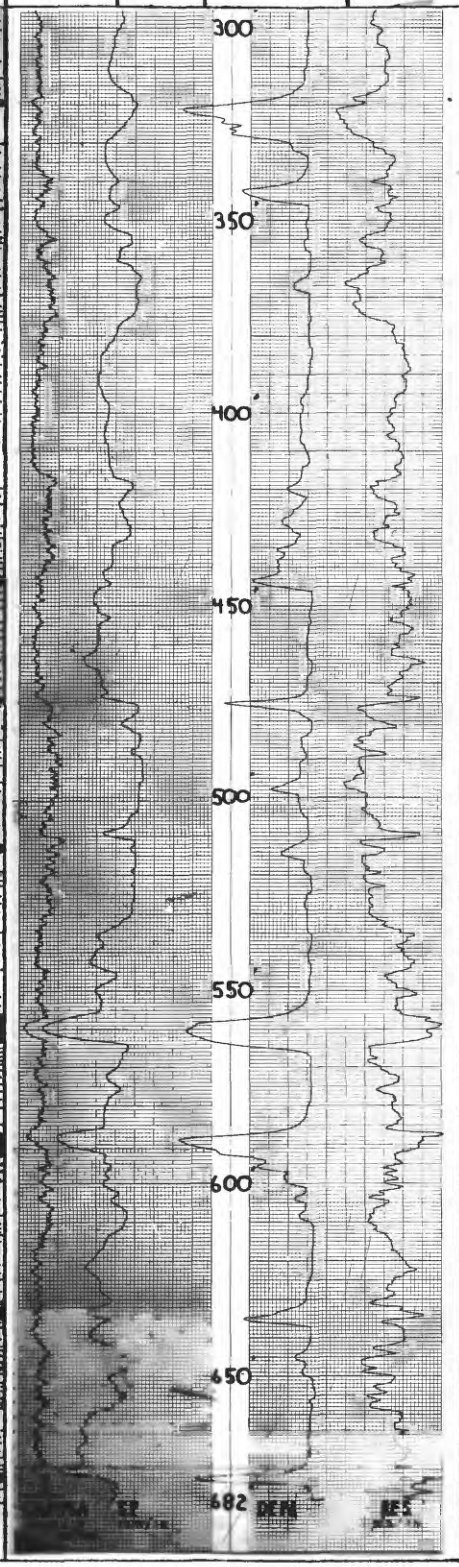
Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-46.5	Sandstone, brown to gray, very fine grained to fine-grained, silty and clayey							
46.5-47.6	Coal							
47.6-50	Carbonaceous shale							
50-51.5	Coal							
51.5-59.4	Sandstone, gray, very fine grained, silty and clayey							
59.4-60.2	Coal							
60.2-62	Sandstone, gray, very fine grained, silty							
62-64	Coal							
64-69	Carbonaceous shale, grayish-brown, coaly							
69-222	Sandstone, brownish-gray to bluish-gray, very fine grained to fine-grained, occasional coarse-grained lenses, slightly silty. Minor siltstone and claystone lenses							
222-240	Claystone, dark-gray, silty							
240-243	Carbonaceous shale							
243-244	Coal							
244-247	Carbonaceous shale							
247-262	Sandstone, blue-gray, fine-grained, silty							
262-266	Carbonaceous shale							
266-268	Coal							
268-274	Carbonaceous shale and sandstone. Carbonaceous shale is dark brown and coaly							
274-319	Siltstone, gray, clayey. Minor interbedded dark-gray claystone and dark-brown, silty, carbonaceous shale							



Hole no. HB-1A-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs: Gamma, S.P., Density, Res.	Depth ft.	Depth m.
274-319	Siltstone, gray, clayey. Minor interbedded dark-gray claystone and dark-brown, silty, carbonaceous shale				
319-320	Coal				
320-330	No sample returned; drill pipe dropped 4 ft and circulation was lost				
330-361	Siltstone, gray, clayey. Minor interbedded gray claystone and dark-brown carbonaceous shale				
361-376	Shale, dark-brownish-gray, carbonaceous, coaly				
376-418	Sandstone, light-gray, very fine grained to fine-grained. Minor interbedded light-gray siltstone				
418-441.5	Siltstone and carbonaceous shale, interbedded				
441.5-442.7	Coal				
442.7-443.5	Carbonaceous shale				
443.5-444	Coal				
444-473.5	Siltstone, light-gray, and light-gray, fine-grained, interbedded sandstone				
473.5-475	Coal				
475-512.5	Siltstone, light-gray, and light-gray, fine-grained, interbedded sandstone				
512.5-515	Coal				
515-533	Claystone, siltstone, and carbonaceous shale, interbedded. Claystone and siltstone are light gray. Carbonaceous shale is dark-brown and silty				
533-556.5	Siltstone, dark-gray, sandy, and light-gray sandstone				
556.5-563.5	Coal				
563.5-569	Carbonaceous shale, dark-brown, silty				
569-586.5	Siltstone, gray, sandy				
586.5-592	Coal				
592-594	Carbonaceous shale				
594-595	Coal				
595-596.3	Carbonaceous shale				



Hole no. HB-1A-PB (Continued)

LITHOLOGY	
596.3-597	Coal
597-598.4	Carbonaceous shale
598.4-599.1	Coal
599.1-613	Siltstone and carbonaceous shale, interbedded
613-630	Siltstone, dark-gray, sandy
630-633	Carbonaceous shale
633-635.2	Coal
635.2-637	Carbonaceous shale
637-642	Siltstone, dark-gray
642-643.5	Carbonaceous shale
643.5-644.5	Coal
644.5-647.7	Carbonaceous shale
647.7-648.5	Coal
648.5-672	Siltstone and carbonaceous shale, interbedded
672-674	Carbonaceous shale
674-676.5	Coal
676.5-682	Siltstone and carbonaceous shale, interbedded

Hole no. HB-2-PB Date logged 9-7-77 Surface elevation (ft) 6,449

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 30 ; 650 F S L, 400 F W L

Drilled depth (ft) 542 Logged depth (ft) 542 Water Level (ft) _____

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

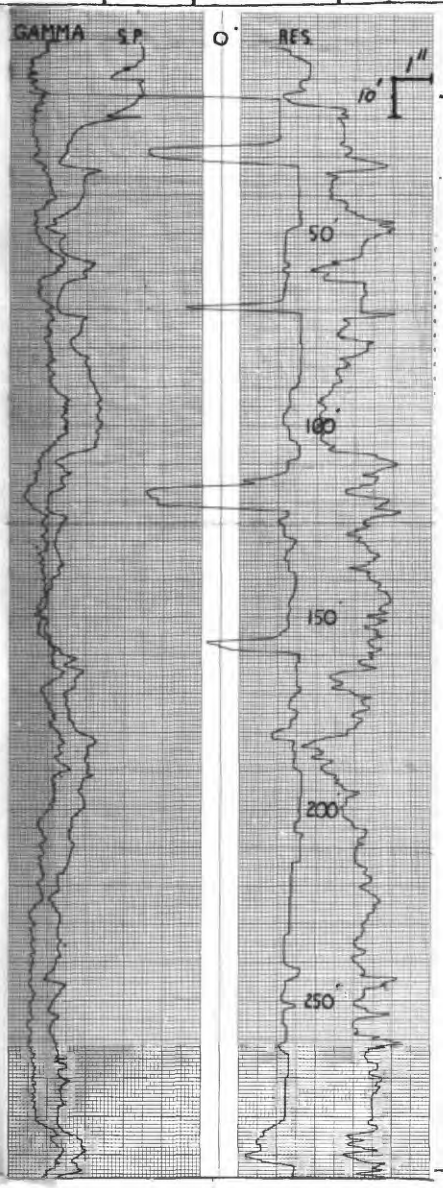
Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

Gamma: T.C. 2 Scale 25 cps/in Logging speed 15 fpm

Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-30	Sandstone, light-brown, fine- to medium-grained, silty. Minor siltstone							
30-33.6	Coal							
33.6-41	Carbonaceous shale, brownish-black, silty							
41-57	Siltstone and sandstone. Siltstone is gray and sandy. Sandstone is brownish gray and fine grained							
57-63	Claystone, brownish-gray							
63-70.6	Sandstone, light-gray, fine-grained, silty							
70.6-72	Coal							
72-107	Claystone, gray, silty. Minor gray siltstone							
107-115	Sandstone, gray, fine-grained, silty. Minor gray clayey siltstone							
115-118.5	Siltstone, gray, clayey							
118.5-120.3	Coal							
120.3-121.6	Carbonaceous shale							
121.6-123.3	Coal							
123.3-164	Sandstone, gray, fine-grained, silty. Minor gray clayey siltstone and claystone. Trace carbonaceous shale							
164-171	Claystone, gray, silty, and brownish-black, silty, carbonaceous shale							
171-181	Siltstone, gray, sandy							
181-205	Carbonaceous shale and siltstone, interbedded. Carbonaceous shale is dark brown and silty. Siltstone is gray and clayey. Minor							

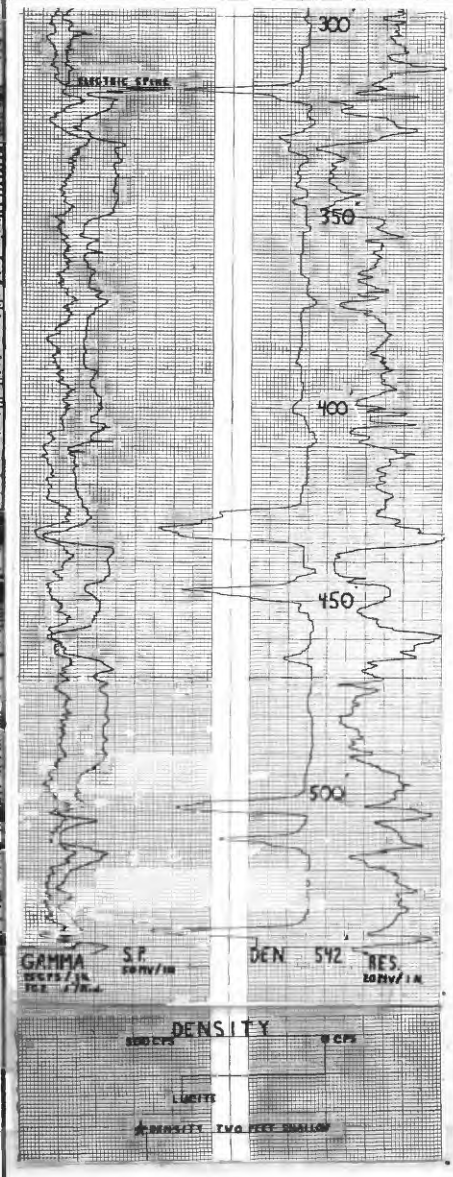


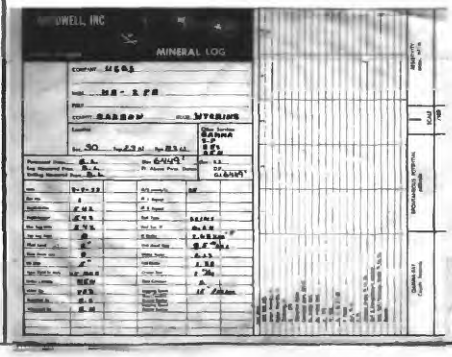
Hole no. HB-2-PB (Continued)

LITHOLOGY	
	gray, fine-grained, silty sandstone
205-284	Sandstone, gray, very fine grained, silty. Minor siltstone and carbonaceous shale
284-318.3	Sandstone, siltstone, and sarbonaceous shale, inter-bedded. Sandstone is gray, fine grained, and silty. Siltstone is gray and clayey. Carbonaceous shale is dark brown and coaly
318.3-319.6	Coal
319.6-324	Carbonaceous shale, brownish-black, silty
324-331	Sandstone, gray, fine-grained, silty
331-350	Claystone, gray and silty. Minor gray and sandy siltstone
350-428.5	Siltstone, claystone, and carbonaceous shale, inter-bedded. Siltstone is gray and clayey. Claystone is gray and silty. Carbon-aceous shale is brownish gray and coaly
428.5-429.8	Coal
429.8-432	Carbonaceous shale
432-435	Coal
435-443.8	Claystone, dark-gray, carbon-aceous, silty
443.8-444.3	Coal
444.3-445.6	Carbonaceous shale, dark-brown, silty
445.6-451	Coal
451-458	Claystone and carbonaceous shale. Claystone is dark gray and silty. Carbon-aceous shale is brownish gray, silty, and coaly
458-466	Sandstone, gray, very fine grained, silty
466-492	Claystone, carbonaceous shale, and siltstone, interbedded. Claystone is gray and silty

Strip log

Geophysical Logs





Depth

ft.	m.
300	100
350	110
	120
400	130
450	140
	150
500	160

Hole no. HB-2-PB (Continued)

	LITHOLOGY
	Carbonaceous shale is dark brown and silty. Siltstone is gray and clayey
492-503	Sandstone, light-gray, very fine grained, silty
503-503.6	Carbonaceous shale
503.6-507	Coal
507-509	Carbonaceous shale
509-513	Siltstone, gray, sandy
513-514.1	Coal
514.1-515	Carbonaceous shale
515-515.5	Coal
515.5-521	Claystone, dark-gray, carbonaceous, silty
521-536	Siltstone, light-gray, and sandstone, light-gray, very fine grained
536-537	Carbonaceous shale
537-539.4	Coal
539.4-542	Carbonaceous shale

Hole no. HB-3-PB Date logged 9-9-77 Surface elevation (ft) 6,704

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 28 ; 2450 FS L, 1950 FW L

Drilled depth (ft) 620 Logged depth (ft) 620 Water Level (ft)

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

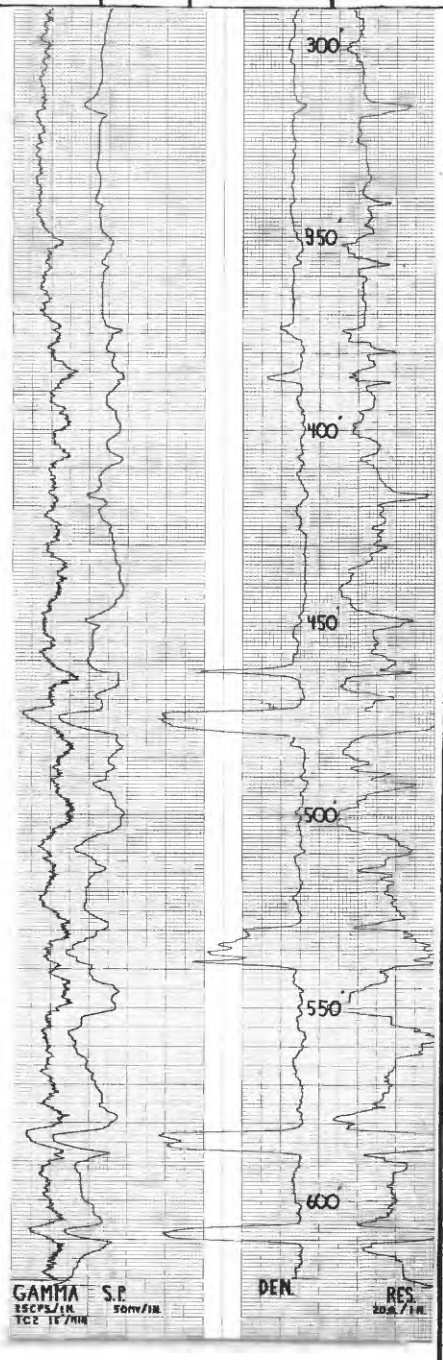
Gamma: T.C. 2 Scale 25 cps/in Logging speed 15 fpm

Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-151	Sandstone, yellow-brown, fine-grained, with coarse-grained lenses from 105-125 ft and 140-151 ft		GAMMA	LUCITE			0	0
151-155	Carbonaceous shale, brownish-gray, silty. Trace dark-gray siltstone		S.P	FLWID		RES		
155-158.5	Coal		1"					
158.5-162	Carbonaceous shale		10'					10
162-164	Coal						50	
164-182.2	Siltstone and sandstone, interbedded. Siltstone is dark gray and clayey. Sandstone is gray, very fine grained and silty					50'		20
182.2-185.6	Coal					100'	100	30
185.6-199	Siltstone, gray, shaly, clayey			1ST FLWID				40
199-221	Siltstone and claystone, interbedded. Siltstone is dark gray and clayey. Claystone is dark gray and silty					150'	150	50
221-435	Sandstone, light- to dark-gray, very fine grained to fine-grained. Minor interbedded light-gray clayey siltstone					200'	200	60
								70
						250'	250	80

Hole no. HB-3-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
221-435	Sandstone, light- to dark-gray, very fine grained to fine-grained. Minor interbedded light-gray clayey siltstone							
435-447	Shale, dark-gray, silty							
447-461	Sandstone, dark-gray, fine-grained							
461-462.6	Carbonaceous shale							
462.6-463.4	Coal							
463.4-473.1	Claystone, gray, silty							
473.1-478.5	Coal							
478.5-505	Claystone, dark-gray, silty, and interbedded sandstone							
505-528	Sandstone and siltstone, interbedded. Sandstone is light gray and very fine grained to fine grained. Siltstone is light gray							
528-529.5	Carbonaceous shale							
529.5-539.5	Coal							
539.5-552	Claystone, carbonaceous shale, and siltstone, interbedded							
552-577	Sandstone, gray, fine-grained, silty							
577-582	Carbonaceous shale, dark-brown, silty							
582-588	Coal							
588-589	Carbonaceous shale							
589-604	Sandstone and siltstone. Sandstone is light gray and very fine grained. Siltstone is light gray and sandy.							
604-606.7	Carbonaceous shale							
606.7-610.6	Coal							
610.6-614	Carbonaceous shale, brownish-gray, silty							
614-622	Sandstone, light-gray, fine-grained, silty							



Hole no. HB-4-PB Date logged 9-16-77 Surface elevation (ft) 6,720

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 28 ; 650 FN L, 2,450 FE L

Drilled depth (ft) 682 Logged depth (ft) 682 Water Level (ft)

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

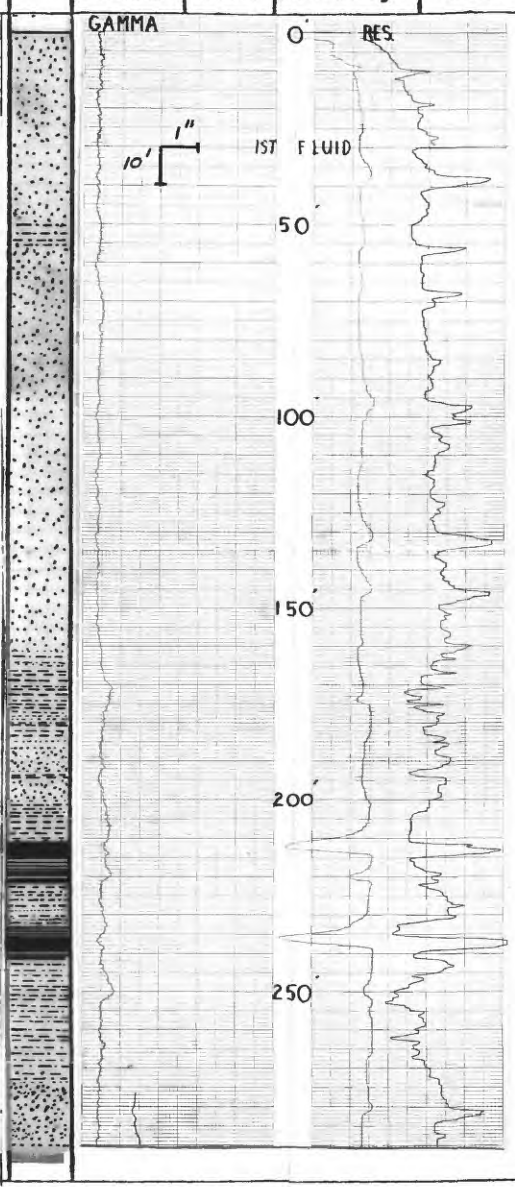
Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

Gamma: T.C. 2 Scale 25 cps/in Logging speed 15 fpm

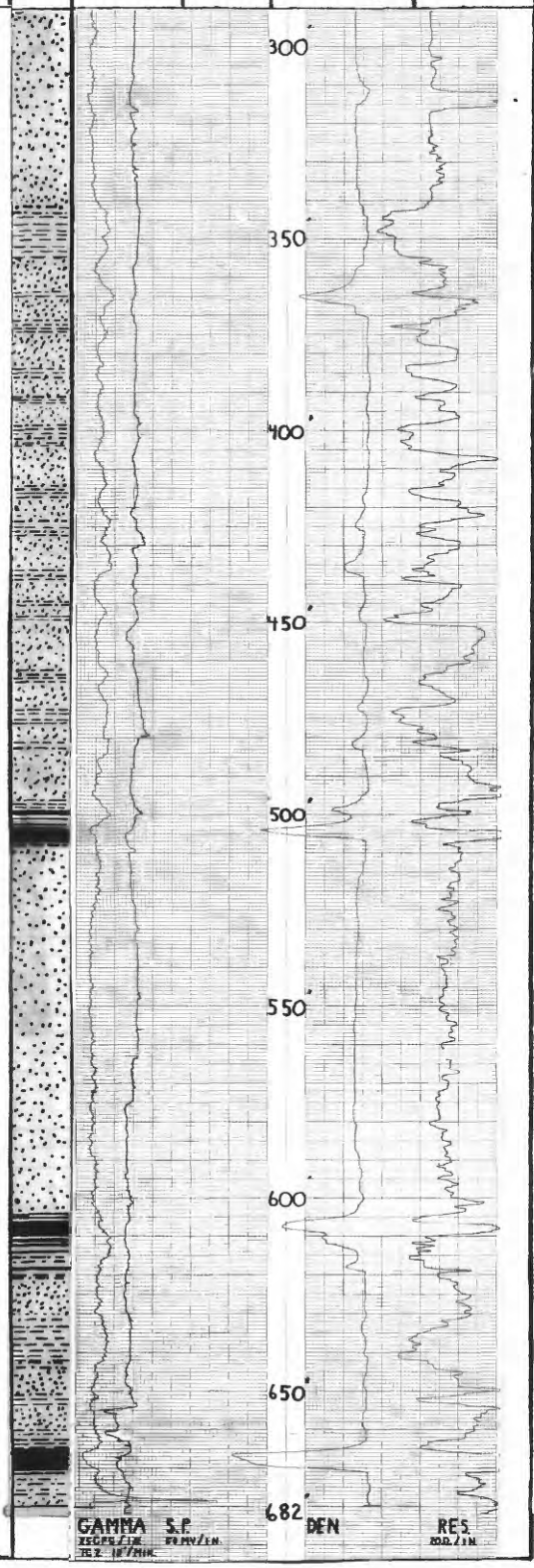
Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY	
0-161	Sandstone, yellow-brown to gray, fine-grained, with medium- to coarse-grained lenses, well-sorted. Minor siltstone and shale lenses
161-183	Siltstone and claystone, interbedded. Siltstone is gray and sandy. Claystone is dark gray and clayey. Minor gray fine-grained sandstone
183-203	Sandstone, gray, very fine grained, silty. Minor gray clayey shale
203-211.2	Claystone, gray, silty
211.2-214.8	Coal
214.8-220.8	Carbonaceous shale, blackish-brown. Minor sandstone
220.8-221.6	Coal
221.6-223	Carbonaceous shale, blackish-brown
223-232	Siltstone, gray, shaly, sandy
232-235.6	Carbonaceous shale, brown, silty
235.6-239.4	Coal
239.4-241	Carbonaceous shale, brown, silty
241-272	Siltstone, gray, shaly
272-343	Sandstone, light-gray, fine-grained, silty



Hole no. HB-4-BB (Continued)

LITHOLOGY	
272-343	Sandstone, light-gray, fine-grained, silty
343-355	Shale, gray, silty. Minor dark-brown carbonaceous shale
355-499	Sandstone, siltstone, and shale, thickly interbedded. Sandstone is light gray, fine grained, and silty. Siltstone is dark gray and clayey. Shale is dark gray and clayey. Minor dark-brown and coaly carbonaceous shale
499-500.2	Coal
500.2-504	Carbonaceous shale, dark-brown
504-507.2	Coal
507.2-604.5	Sandstone, light-gray, very fine grained. Minor light-gray siltstone and minor dark-gray sandy claystone
604.5-606.6	Carbonaceous shale
606.6-609.6	Coal
609.6-610.5	Carbonaceous shale
610.5-611.3	Coal
611.3-612.2	Carbonaceous shale
612.2-612.6	Coal
612.6-613.6	Carbonaceous shale
613.6-614	Coal
614-618.5	Carbonaceous shale and siltstone
618.5-619.2	Coal
619.2-621	Carbonaceous shale
621-633	Sandstone, gray, very fine grained, silty. Minor gray sandy siltstone and gray clayey shale
633-642	Claystone, dark-gray, shaly and silty
642-663	Sandstone, gray, fine-grained, silty. Minor gray sandy siltstone and gray clayey shale
663-666	Carbonaceous shale
666-671.2	Coal
671.2-682	Carbonaceous shale and siltstone, interbedded



Hole no. HB-5-PB Date logged 9-20-77 Surface elevation (ft) 6,520

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 20 ; 750 F S L, 250 F E L

Drilled depth (ft) 560 Logged depth (ft) 552 Water Level (ft)

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

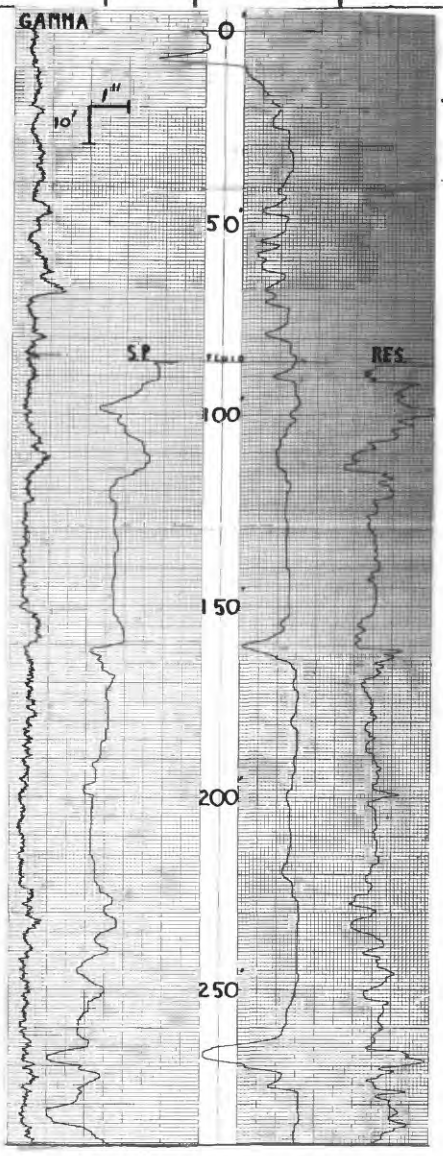
Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

Gamma: T.C. 2 Scale 50 cps/in Logging speed 15 fpm

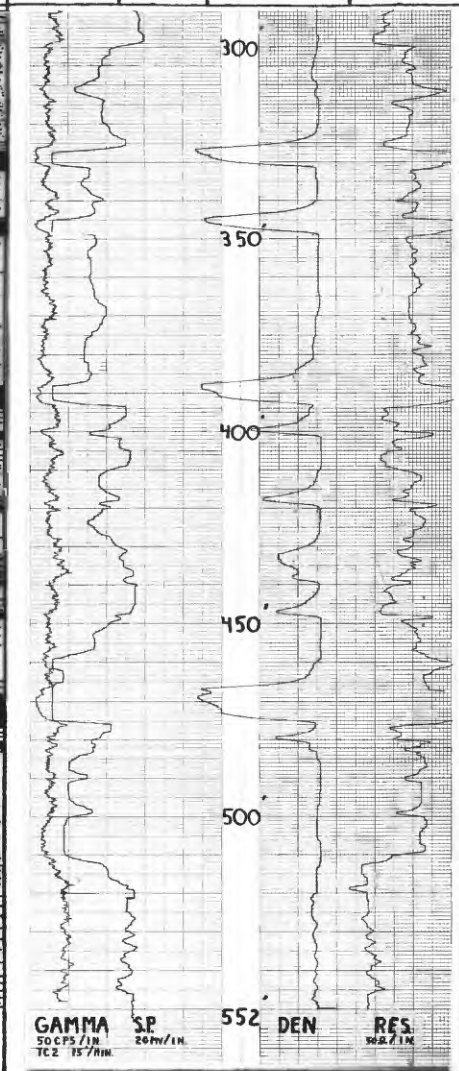
Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-46	Sandstone, yellow-brown, fine- to medium-grained with thick, medium- to coarse-grained lenses. Minor lenses of gray clayey shale							
46-91	Siltstone, claystone, and sandstone, interbedded. Siltstone is dark gray and clayey. Claystone is gray and shaly. Sandstone is light gray and very fine grained. Minor dark-brown, coaly, carbonaceous shale							
91-109	Siltstone and sandstone							
109-114.5	Carbonaceous shale, dark-brown, silty, coaly							
114.5-153	Sandstone, light-gray, very fine grained, silty							
153-161	Carbonaceous shale, dark-brown							
161-162	Coal							
162-162.6	Carbonaceous shale							
162.6-164	Coal							
164-165.2	Carbonaceous shale							
165.2-166	Coal							
166-166.7	Carbonaceous shale							
166.7-167.9	Coal							
167.9-172	Carbonaceous shale							
172-189	Siltstone, light- to dark-gray, sandy							
189-225	Sandstone, light-gray, very fine grained, silty, clayey							
225-265.8	Sandstone and siltstone, interbedded. Sandstone is light gray and very							



Hole no. HB-5-PB (Continued)

LITHOLOGY	Strip log	Geophysical Logs: Gamma, S.P., Density, Res.	Depth ft.	Depth m.
fine grained. Siltstone is gray and sandy. Minor dark-gray clay shale				
265.8-270.5 Coal				
270.5-271.1 Carbonaceous shale				
271.1-272 Coal				
272-276.3 Carbonaceous shale				
276.3-277.2 Coal				
277.2-292 Siltstone and sandstone. Sandstone is light gray, fine grained, and silty. Siltstone is light gray and sandy				
292-300 Siltstone, dark-gray, and dark-gray, silty claystone				
300-324 Sandstone and siltstone. Sandstone is gray, very fine grained and silty. Siltstone is gray and slightly sandy				
324-327 Carbonaceous shale, dark-brown, silty				
327-332 Coal				
332-344.8 Siltstone and carbonaceous shale. Siltstone is gray and sandy. Carbonaceous shale is dark brown and silty				
344.8-349.1 Coal				
349.1-388 Siltstone, gray, sandy and clayey				
388-393 Coal				
393-400.2 Carbonaceous shale, dark-brown, and gray siltstone				
400.2-402 Coal				
402-410 Claystone, brown, shaly, silty				
410-417 Siltstone, gray, clayey				
417-418.4 Carbonaceous shale				
418.4-420.1 Coal				
420.1-434.1 Siltstone, gray, sandy, clayey				
434.1-434.6 Carbonaceous shale				
434.6-435.1 Coal				
435.1-435.5 Carbonaceous shale				
435.5-436 Coal				
436-439 Carbonaceous shale				
439-440.1 Coal				



Hole no. HB-5-PB (Continued)

	LITHOLOGY
440.1-448	Siltstone and carbonaceous shale. Siltstone is gray and clayey. Carbonaceous shale is dark brown and coaly
448-449.2	Coal
449.2-467	Siltstone and sandstone. Siltstone is gray and sandy. Sandstone is whitish gray and very fine grained
467-476	Coal
476-480.2	Carbonaceous shale, dark-brown, coaly
480.2-482	Coal
482-483	Carbonaceous shale
483-502	Siltstone and sandstone. Siltstone is whitish gray and sandy. Sandstone is light gray and very fine grained. Minor carbonaceous shale
502-552	Claystone, dark-gray, silty

Hole no. HB-6-PB Date logged 9-2-77 Surface elevation (ft) 6,430

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 18; 1750 FS L, 2400 FE L

Drilled depth (ft) 663 Logged depth (ft) 663 Water Level (ft)

Drilling fluid: [x] Air [x] Water [x] Foam [x] Mud

Geophysical logs:

Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

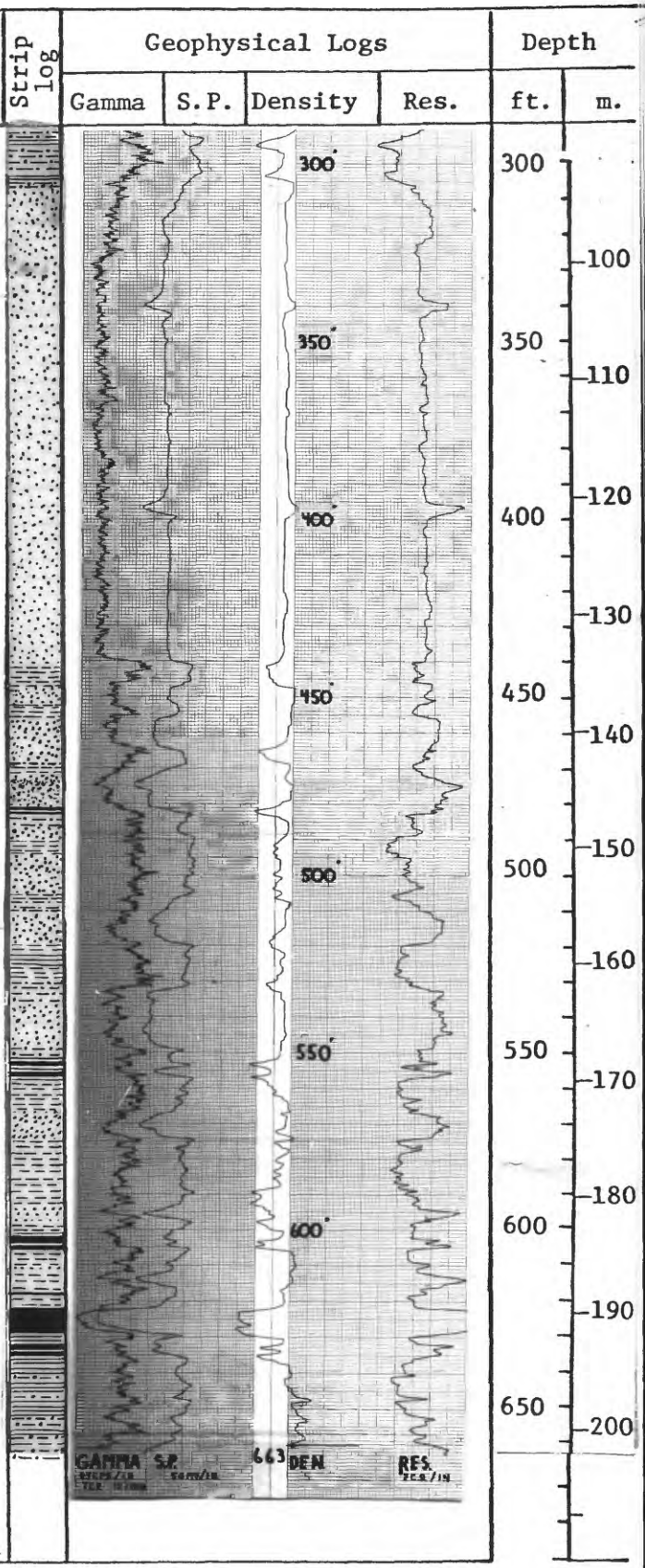
Gamma: T.C. 2 Scale 25 cps/in Logging speed 15 fpm

Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs	Depth	
			Gamma S.P. Density Res.	ft.	m.
0-5	Soil, medium-brown, sandy, and silty			0	0
5-19	Sandstone, medium-brown, fine-grained, silty. Minor medium-brown claystone				10
19-28	Carbonaceous shale and claystone, light- to dark-brown			50	20
28-39	Sandstone, medium- to dark-brown, very fine grained to fine-grained. Minor gray siltstone.				
39-46.5	Claystone and sandstone, interbedded. Claystone is dark gray and very silty. Sandstone is dark gray and very fine grained. Minor carbonaceous shale			100	30
46.5-48	Coal				40
48-53	Carbonaceous shale, dark-gray to black, coaly. Minor dark-gray claystone			150	50
53-54	Coal				
54-74.4	Claystone and carbonaceous shale			200	60
74.4-75.2	Coal				
75.2-76	Carbonaceous shale				70
76-77.5	Coal			250	
77.5-108	Sandstone, siltstone, and clayshale, interbedded. Sandstone is gray and very fine grained. Siltstone is dark gray and clayey. Clayshale is dark gray, clayey, and silty				80
108-193	Sandstone, gray, fine- to medium-grained, silty,				

Hole no. HB-6-PB (Continued)

LITHOLOGY	
	clayey. Minor dark-gray shale
193-199.5	Claystone, gray and silty
199.5-201	Coal
201-201.5	Carbonaceous shale
201.5-202.3	Coal
202.3-224	Claystone and siltstone, interbedded. Claystone is gray and silty. Siltstone is medium gray
224-245	Sandstone, gray to medium-gray, silty
245-246.5	Carbonaceous shale
246.5-248	Coal
248-279.8	Sandstone, siltstone, and carbonaceous shale, interbedded. Sandstone is gray and fine grained. Siltstone is gray. Carbonaceous shale is dark brown and silty
279.8-281.5	Coal
281.5-284	Carbonaceous shale, dark-brown
284-290	Sandstone, gray, fine-grained
290-306	Carbonaceous shale, dark-brown, and gray siltstone
306-440	Sandstone, medium-gray, fine- to medium-grained. Trace dark-brown carbonaceous shale
440-481	Sandstone and claystone, interbedded. Sandstone is medium gray and fine to medium grained. Claystone is dark gray and carbonaceous
481-481.5	Coal
481.5-482	Carbonaceous shale
482-482.5	Coal
482.5-552.5	Sandstone and claystone, thickly interbedded. Sandstone is medium gray and fine to medium grained. Claystone is dark gray and carbonaceous
552.5-553.2	Coal
553.2-555.1	Carbonaceous shale
555.1-556.4	Coal



Hole no. HB-6-PB (Continued)

LITHOLOGY	
556.4-602.8	Claystone, brownish-gray and carbonaceous shale. Minor thinly interbedded gray, fine-grained sandstone
602.8-605	Coal
605-617	Claystone and sandstone, interbedded. Claystone is dark gray, silty and sandy. Sandstone is gray and fine grained
617-618	Coal
618-622	Shale, dark-gray, silty and sandy
622-629.2	Coal
629.2-632	Carbonaceous shale
632-633	Coal
633-634	Carbonaceous shale
634-634.8	Coal
634.8-663	Carbonaceous shale and siltstone, interbedded. Carbonaceous shale is dark brown and silty. Siltstone is medium gray and sandy

Hole no. HB-7-PB Date logged 9-3-77 Surface elevation (ft) 6,448

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 18 ; 700 FNL, 1250 FEL

Drilled depth (ft) 502 Logged depth (ft) 502 Water Level (ft) _____

Drilling fluid: [x] Air [x] Water [ ] Foam [x] Mud

Geophysical logs:

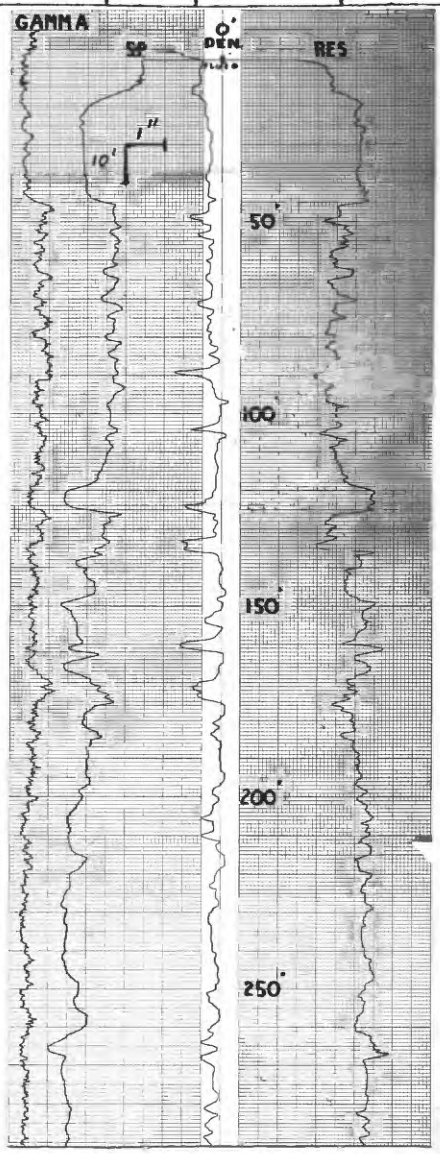
Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

Gamma: T.C. 2 Scale 50 cps/in Logging speed 15 fpm

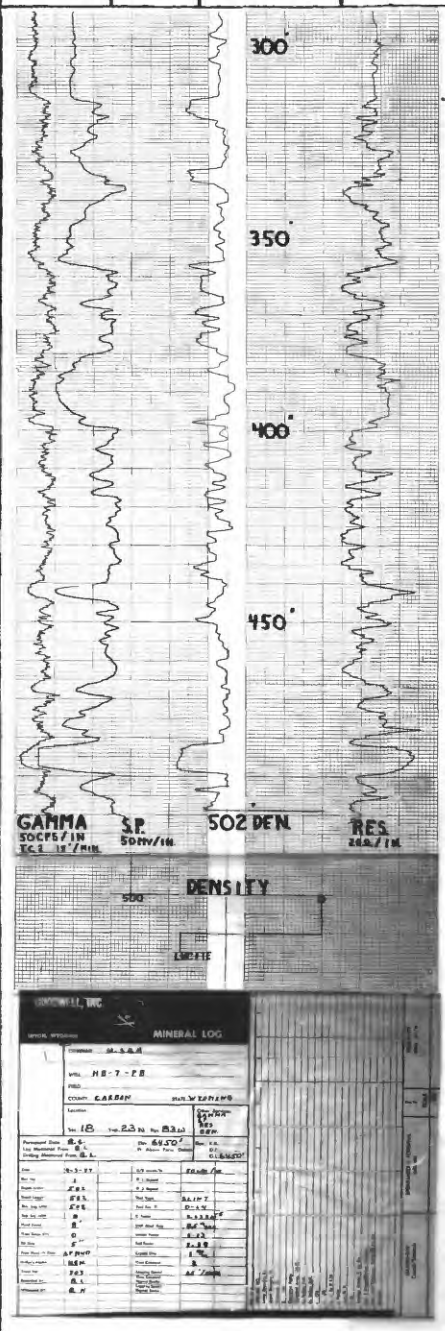
Gamma dens.: T.C. 2 Scale 100 cps/in Logging speed 15 fpm

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-10	Soil, yellow-brown, fine to medium sand							
10-30	Sandstone, yellow-brown, fine- to medium-grained							
30-46	Sandstone, gray, fine- to medium-grained							
46-51	Claystone, blue-gray, silty. Trace coal							
51-53	Siltstone							
53-54	Coal							
54-123.5	Claystone and sandstone, interbedded. Claystone is gray and occasionally carbonaceous. Sandstone is gray and fine grained							
123.5-125	Coal							
125-136	Claystone, gray, and dark-brown, silty, carbonaceous shale							
136-160.1	Siltstone, gray, sandy							
160.1-162.3	Coal							
162.3-219	Siltstone, gray to dark-gray. Minor interbedded, gray, fine-grained sandstone and dark-brown, silty, carbonaceous shale							
219-336	Sandstone, gray, fine-grained, silty. Minor interbedded gray siltstone							



Hole no. HB-7-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
219-336	Sandstone, gray, fine-grained, silty. Minor interbedded gray siltstone							
336-356	Siltstone, gray, and gray, fine-grained sandstone							
356-358	Coal							
358-360	Carbonaceous shale							
360-362	Coal							
362-366	Carbonaceous shale							
366-369	Coal							
369-376	Carbonaceous shale, dark-brown, and gray siltstone							
376-377.5	Coal							
377.5-381	Carbonaceous shale							
381-398	Sandstone, gray, fine-grained							
398-399	Coal							
399-416	Siltstone and carbonaceous shale, interbedded. Siltstone is gray and clayey. Carbonaceous shale is dark-brown and silty							
416-417.2	Coal							
417.2-429.4	Carbonaceous shale and siltstone							
429.4-431	Coal							
431-449	Carbonaceous shale and siltstone							
449-451	Coal							
451-482	Siltstone and sandstone, interbedded. Siltstone is gray. Sandstone is gray and very fine grained to fine grained							
482-489	Coal							
489-493	Claystone, gray to brown-gray, silty							
493-494	Coal							
494-502	Claystone, gray, sandy							



Hole no. HB-8-PB Date logged 9-23-77 Surface elevation (ft) 6,535

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 83 W., Sec. 8 ; 1000 F N L, 1550 F E L

Drilled depth (ft) 500 Logged depth (ft) 500 Water Level (ft) _____

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

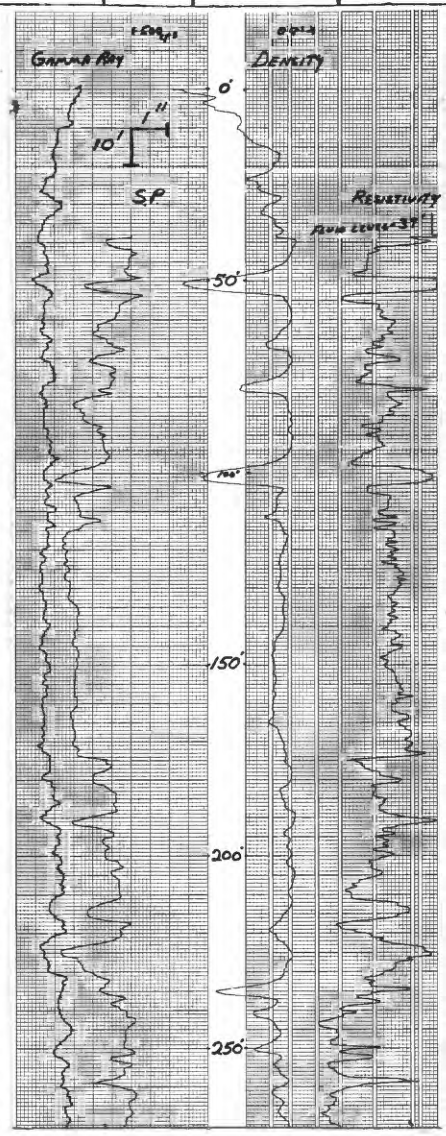
Spontaneous potential: Scale 50 mv/in Logging speed 15 fpm

Resistivity: Scale 20 ohms/in Logging speed 15 fpm

Gamma: T.C. 3 Scale 25 cps/in Logging speed 15 fpm

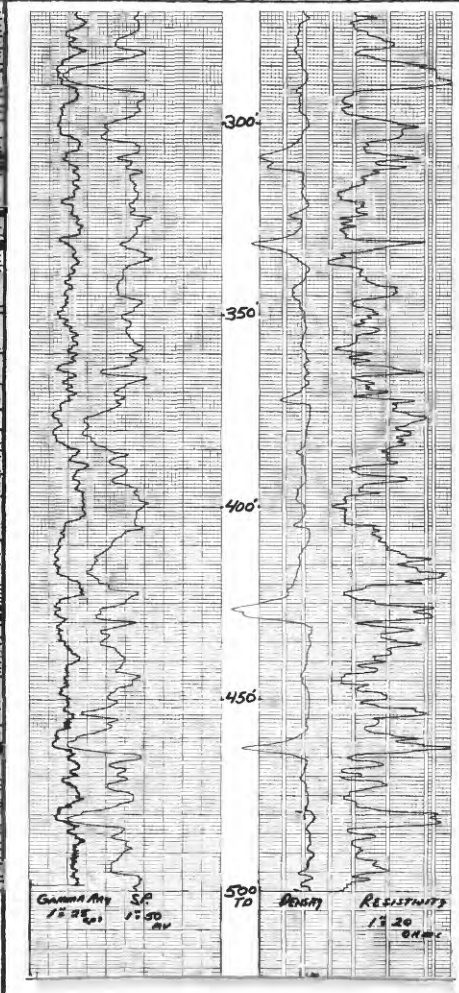
Gamma dens.: T.C. 3 Scale 106 cps/in Logging speed 15 fpm

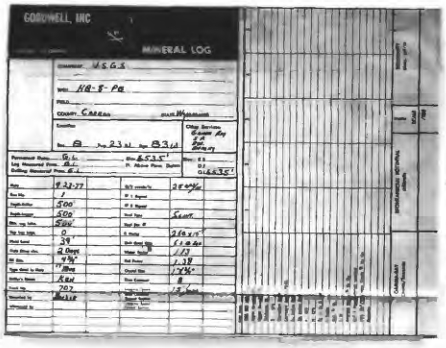
LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
0-5	Claystone, brown, silty							
5-49	Siltstone, gray to brown, shaly and clayey. Minor light-gray, silty, fine-grained sandstone							
49-53	Coal							
53-77.8	Siltstone and sandstone, interbedded. Siltstone is grayish brown to dark gray, and clayey. Sandstone is gray, fine grained, and silty							
77.8-78.6	Coal							
78.6-95	Sandstone, gray to dark-gray, silty, and clayey. Minor siltstone							
95-98	Carbonaceous shale, dark-brown, silty							
98-103	Coal							
103-106	Carbonaceous shale							
106-174	Sandstone, light-gray to gray, very fine grained to fine-grained with medium- to coarse-grained lenses from 165 to 174 ft. Minor claystone and siltstone							
174-212	Siltstone, claystone, carbonaceous shale, and sandstone, interbedded. Siltstone is gray and sandy. Claystone is gray. Carbonaceous shale is dark brown and coaly. Sandstone is light gray and very fine grained							
212-217	Sandstone, gray, fine-grained							



Hole no. HB-8-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
217-220	Claystone, brown-gray							
220-231	Siltstone and sandstone. Siltstone is gray and sandy. Sandstone is gray and very fine grained							
231-234	Carbonaceous shale, grayish-black, coaly							
234-235	Coal							
235-240.1	Carbonaceous shale and siltstone. Carbonaceous shale is grayish brown. Siltstone is gray and sandy							
240.1-242	Coal							
242-249.4	Carbonaceous shale, grayish-brown, coaly, and gray and sandy siltstone							
249.4-250.1	Coal							
250.1-284	Claystone, dark-gray, silty. Minor interbedded sandstone and siltstone							
284-291	Sandstone, gray, medium-grained							
291-299	Claystone, dark-gray, silty							
299-305	Siltstone, gray, sandy							
305-308	Claystone, dark-gray, silty							
308-309.8	Coal							
309.8-311	Carbonaceous shale							
311-312	Coal							
312-323.5	Claystone, gray, silty							
323.5-324.1	Coal							
324.1-330.5	Claystone, gray, silty							
330.5-333.2	Coal							
333.2-413	Siltstone, sandstone, and claystone, interbedded. Siltstone is light gray and sandy. Sandstone is light gray and very fine grained. Claystone is gray and silty. Trace of dark-brown carbonaceous shale							
413-420	Sandstone, gray, fine-grained, silty							
420-425.5	Carbonaceous shale, brownish-gray, silty, clayey							
425.5-429.3	Coal							





Hole no. HB-8-PB (Continued)

LITHOLOGY	
429.3-461.3	Sandstone, siltstone, and claystone, interbedded. Sandstone is light gray, and very fine grained to fine grained. Siltstone is light gray and clayey. Claystone is gray and silty
461.3-464	Coal
464-500	Siltstone, claystone, carbonaceous shale, and sandstone, interbedded. Siltstone is light gray and sandy. Claystone is brownish gray and silty. Carbonaceous shale is blackish brown and coaly. Sandstone is light gray and very fine grained

Hole no. HB-9-PB Date logged 10-3-77 Surface elevation (ft) 6,430

Loc.: State Wyo. Cty. Carbon T. 23 N., R. 84 W., Sec. 12 ; 1100 F NL, 1600 F EL

Drilled depth (ft) 423 Logged depth (ft) 410 Water Level (ft)

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

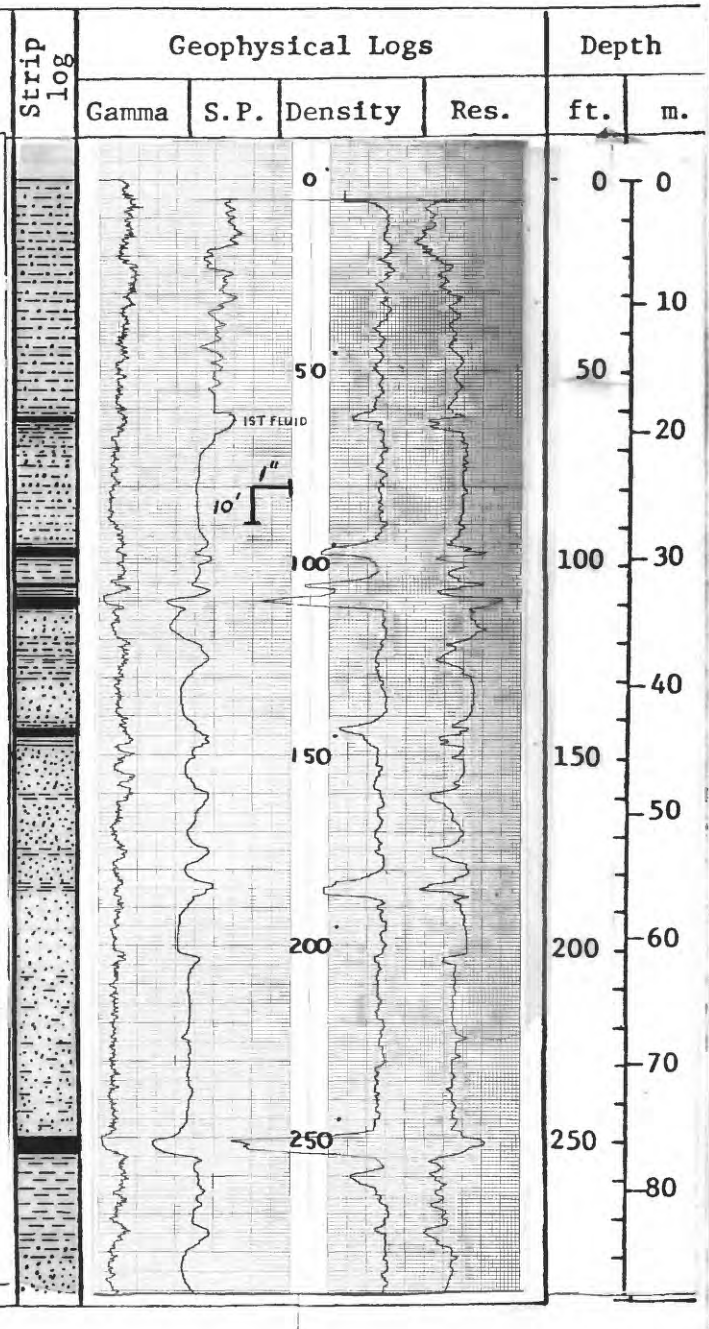
Spontaneous potential: Scale 10 mv/in Logging speed 20 fpm

Resistivity: Scale 20 ohms/in Logging speed 20 fpm

Gamma: T.C. 2 Scale 50 cps/in Logging speed 20 fpm

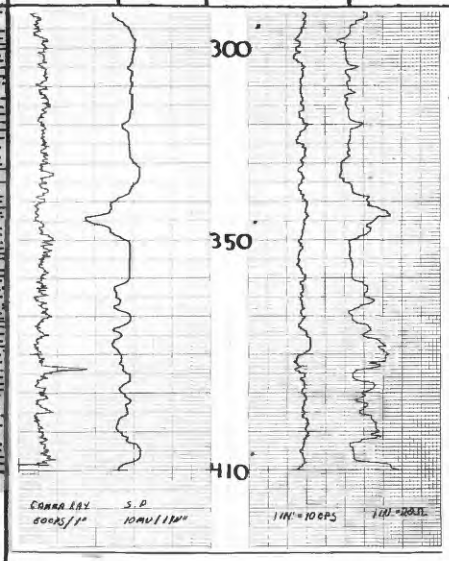
Gamma dens.: T.C. 2 Scale 10 cps/in Logging speed 20 fpm

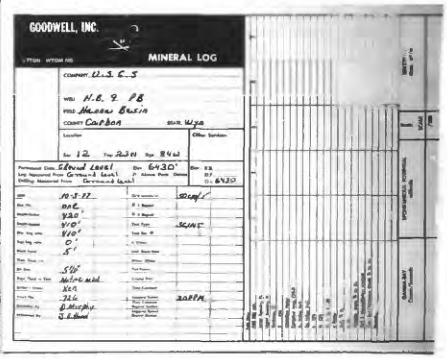
LITHOLOGY	
0-61.2	Siltstone and sandstone, interbedded. Siltstone is grayish brown and sandy. Sandstone is gray and very fine grained. Minor blackish-brown carbonaceous shale. Trace of coal in samples at 45 to 50 ft
61.2-62	Coal
62-95	Siltstone and sandstone, interbedded. Siltstone is grayish brown and sandy. Sandstone is gray and very fine grained. Trace of coal in samples at 75 and 90 ft
95-95.6	Carbonaceous shale
95.6-98	Coal
98-100	Carbonaceous shale
100-105.1	Claystone, dark-gray, silty
105.1-106	Coal
106-109	Carbonaceous shale, dark-brown, silty
109-111	Coal
111-143	Sandstone, claystone, and siltstone. Sandstone is gray, very fine grained, and silty. Claystone is brownish gray and silty. Siltstone is gray and sandy
143-144.8	Coal
144.8-148	Carbonaceous shale
148-250	Sandstone, light-gray, very fine grained, and silty
250-254	Coal



Hole no. HB-9-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs: Gamma, S.P., Density, Res.	Depth ft.	Depth m.
254-276	Claystone and siltstone, interbedded. Claystone is dark gray and silty. Siltstone is gray and sandy			300	90
276-294	Sandstone, light-gray, very fine grained, silty				100
294-338	Claystone, dark-gray, silty, and gray sandy siltstone			350	110
338-350	Sandstone, gray, very fine grained, silty				
350-361	Claystone, dark-gray, silty. Minor dark-gray siltstone				120
361-410	Siltstone, sandstone, and claystone, interbedded			400	





Hole no. HB-10-PB Date logged 10-3-77 Surface elevation (ft) 6540

Loc.: State Wyo. Cty. Carbon T. 23N., R. 83 W., Sec. 4 ; 850 FN L, 2100 FW L

Drilled depth (ft) 761 Logged depth (ft) 761 Water Level (ft)

Drilling fluid: ☐ Air ☒ Water ☐ Foam ☒ Mud

Geophysical logs:

Spontaneous potential: Scale 10 mv/in Logging speed 20 fpm

Resistivity: Scale 20 ohms/in Logging speed 20 fpm

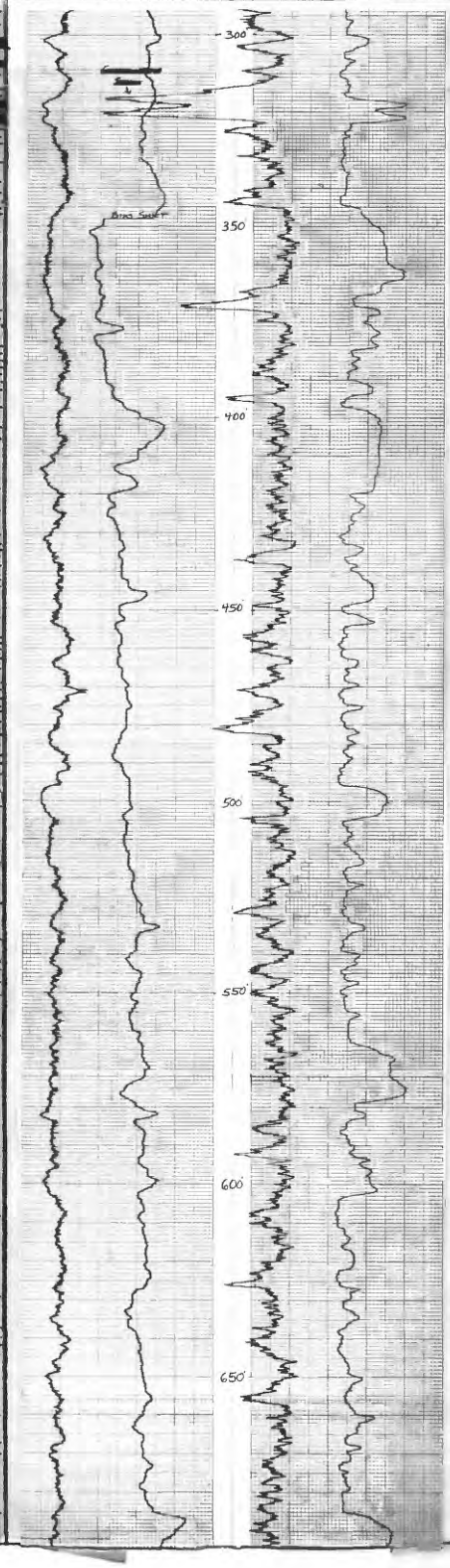
Gamma: T.C. 2 Scale 50 cps/in Logging speed 20 fpm

Gamma dens.: T.C. 2 Scale 10 cps/in Logging speed 20 fpm

LITHOLOGY		Strip log	Geophysical Logs: Gamma, S.P., Density, Res.	Depth ft.	Depth m.
0-20	Siltstone, brown to dark-gray, clayey; minor dark-gray, silty claystone			0	0
20-35	Sandstone, brown to light-brown, fine-grained with coarse-grained lenses at 27 ft. Minor light-brown, sandy siltstone			10	
35-85	Siltstone, brown to gray; minor brownish-gray claystone and minor light-brown, medium- to coarse-grained sandstone. Trace of coaly carbonaceous shale at 50 to 55 ft and 75 to 80 ft			50	20
85-102	Sandstone, gray to light-gray, fine-grained, silty; minor dark-gray silty shale			100	30
102-109	Siltstone, medium- to dark-gray, and grayish-brown			150	40
109-119	Sandstone, light- to medium-gray, fine-grained, silty				50
119-201	Siltstone, claystone, and sandstone, interbedded. Siltstone is gray to dark gray and grayish brown. Claystone is medium gray and silty. Sandstone is light gray and silty. Minor brown, coaly, carbonaceous shale at 130 ft, 160-165 ft, 170-175 ft as seen in drill cuttings			200	60
201-203.5	Coal				70
203.5-205	Carbonaceous shale			250	80
205-206	Coal				

Hole no. HB-10-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs				Depth	
			Gamma	S.P.	Density	Res.	ft.	m.
206-227	Sandstone, light-gray to yellow-brown, very fine grained, silty							
227-228.5	Carbonaceous shale							
228.5-229.5	Coal							
229.5-234	Carbonaceous shale							
234-235	Coal							
235-256	Siltstone, gray, sandy, clayey							
256-285	Sandstone, light-gray, silty, clayey							
285-300.5	Claystone, brown-gray, and dark-gray siltstone							
300.5-303	Coal							
303-306.5	Siltstone							
306.5-307.5	Coal							
307.5-317	Claystone and siltstone, interbedded. Claystone is dark brown and shaly. Siltstone is brownish gray							
317-319	Coal							
319-321	Carbonaceous shale, dark-brown, coaly							
321-322.2	Coal							
322.2-345	Claystone and siltstone. Claystone is grayish brown and silty. Siltstone is dark gray and sandy. Minor gray very fine grained sandstone							
345-368	Sandstone, yellow-brown, very fine grained, silty and clayey							
368-398	Siltstone, claystone, and sandstone, interbedded. Siltstone is gray and sandy. Claystone is yellow brown to dark brown. Sandstone is gray very fine grained. Minor carbonaceous shale							
398-420	Sandstone, gray, very fine grained, silty							
420-496	Siltstone and sandstone, thinly interbedded. Siltstone is gray. Sandstone is gray, very fine grained, and silty							
496-504	Sandstone							



Hole no. HB-10-PB (Continued)

LITHOLOGY		Strip log	Geophysical Logs: Gamma	S.P.	Density	Res.	Depth: ft.	m.
504-564	Siltstone and sandstone, thinly interbedded. Siltstone is dark gray. Sandstone is dark gray, fine grained, and silty						700	220
564-579	Sandstone, dark-gray, very fine grained to fine-grained, silty						750	230
579-603	Siltstone and sandstone, thinly interbedded. Siltstone is gray to dark gray. Sandstone is dark gray, fine-grained to very fine grained							
603-686	Claystone, gray to brown-gray, silty							
686-707	Sandstone, gray, coarsr-grained, conglomeratic, quartz pebbles							
707-712.2	Siltstone							
712.2-713.5	Coal							
713.5-761	Claystone, sandstone, and siltstone, thinly interbedded. Claystone is dark gray and silty. Siltstone is gray and clayey. Sandstone is gray and fine grained