UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOPHYSICAL AND LITHOLOGIC LOGS FOR THIRTEEN HOLES DRILLED IN THE BOOK CLIFFS COAL FIELD, RANGE CREEK AND WOODSIDE QUADRANGLES, EMERY COUNTY, UTAH

By

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This report has not been edited for conformity
with U.S. Geological Survey editorial standards
or stratigraphic nomenclature.

CONTENTS

ILLUSTRATIONS

TABLE

GEOPHYSICAL AND LITHOLOGIC LOGS FOR THIRTEEN HOLES DRILLED IN THE BOOK CLIFFS COAL FIELD, RANGE CREEK AND WOODSIDE QUADRANGLES, EMERY COUNTY, UTAH

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INTRODUCTION

Thirteen holes, for a total of 15,475.5 feet, were rotary drilled, and five of them were partially cored, in the Book Cliffs coal field, Utah, for the U.S. Geological Survey in October 1978. An additional hole, BC-5-RC, was begun in T. 17 S., R. 15 E., sec. 22, but was abandoned at 750 feet.

The drilling was done by Himes Drilling Company of Grand Junction, Colorado, under contract no. 14-08-0001-17342, awarded by the USGS. The geophysical logging was done by Strata Surveys, Steamboat Springs, Colorado. Permission to drill was granted by officials of the U.S. Bureau of Land Management, Price, Utah.

The purpose of the drilling was to obtain information on the thickness, quality, and extent of coal, and the lithology of the enclosing rocks, in the Upper Cretaceous Blackhawk Formation. The overall goal of the project is to evaluate and classify Federal lands in the public domain.

Drilling was done in the Range Creek and Woodside quadrangles, Emery County, Utah, using truck-mounted rotary drilling and coring rigs. Drilling media were air and foam for the rotary drilling and mud for the coring. Coring was done only in the upper coal-bearing member of the Blackhawk Formation.

All drill holes were logged by geophysical methods which included resistivity, natural gamma, density, and caliper. The logs were run at a scale of 1 inch to 10 feet; but for this report they were reduced to 1 inch to 50 feet.

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

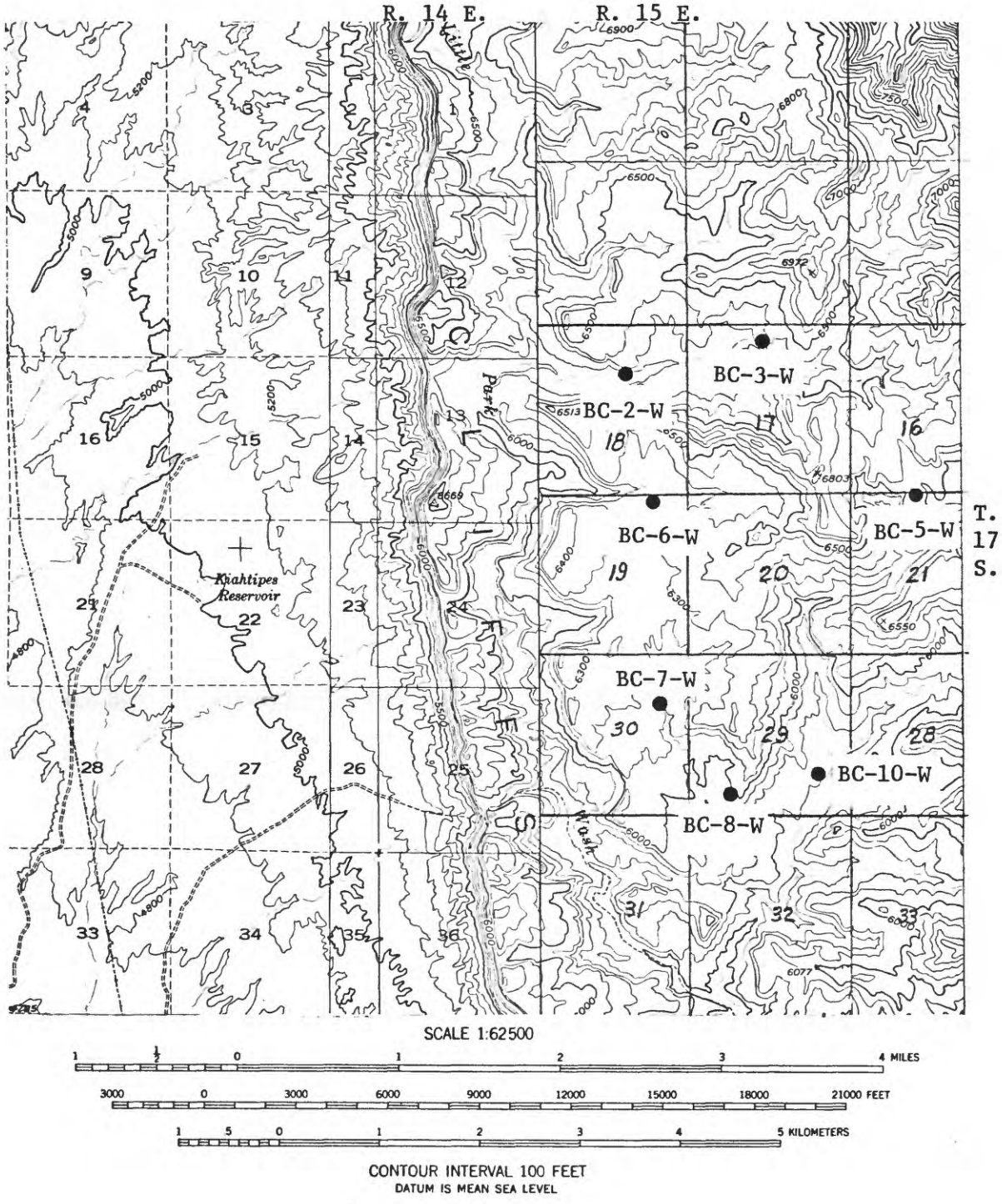


Figure 1.--Drill-hole locations in the Book Cliffs coal field, Woodside quadrangle, Emery County, Utah.

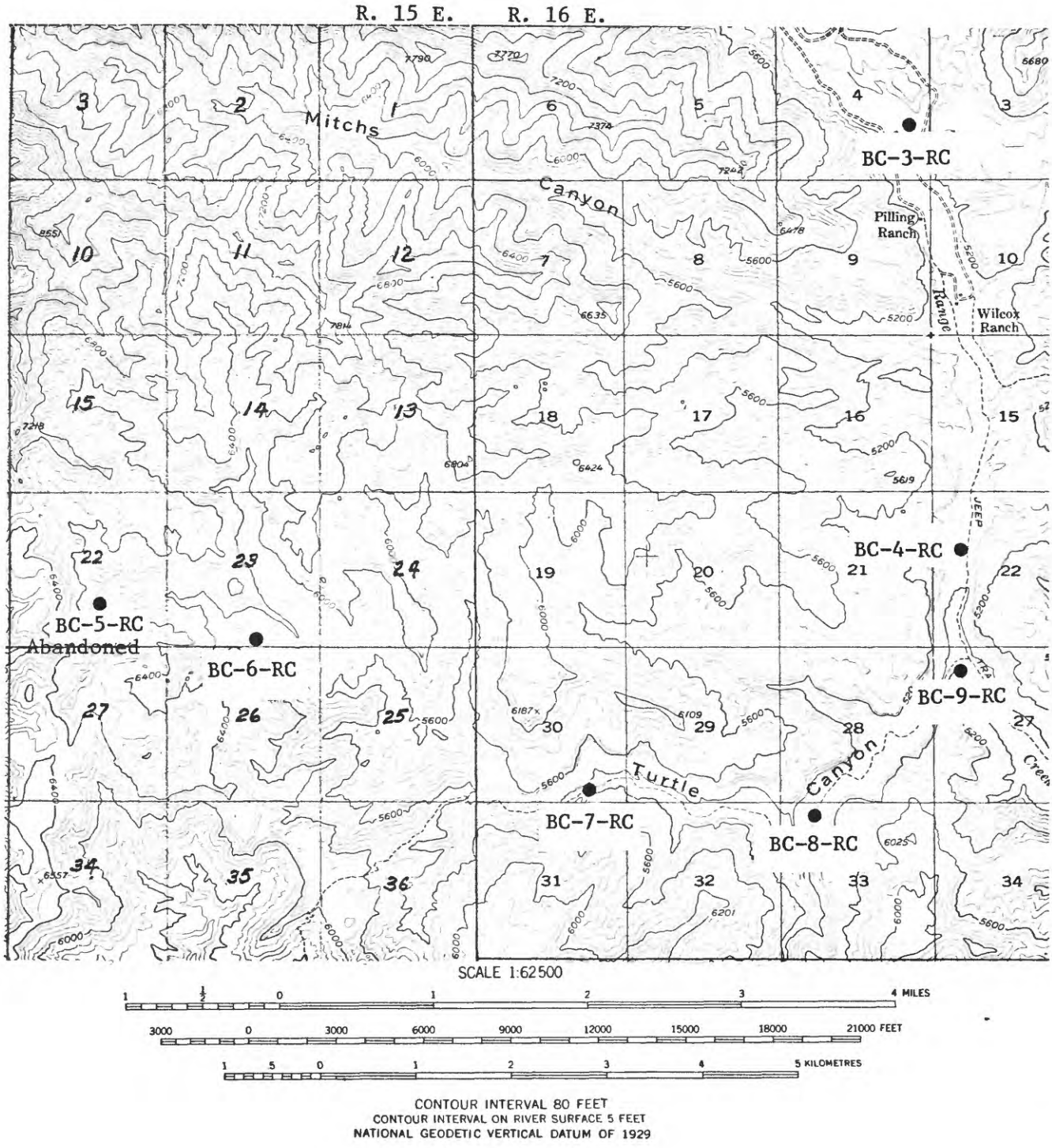


Figure 2.--Drill-hole locations in the Book Cliffs coal field, Range Creek quadrangle, Emery County, Utah.

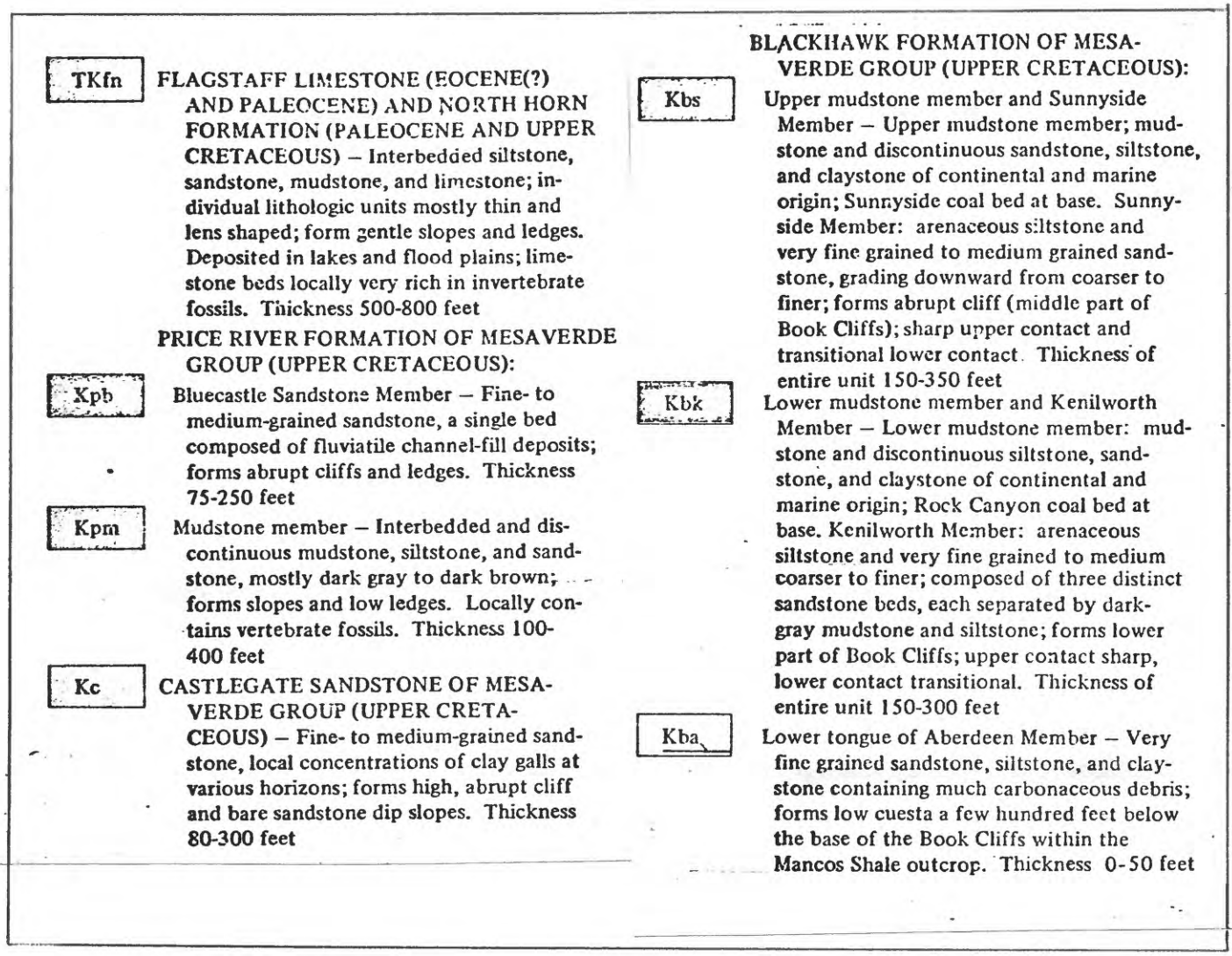


Figure 3.--Description of rocks in the Woodside and Range Creek quadrangles, Emery County, Utah. (Modified from Osterwald and Maberry, 1974.)

REFERENCES

Fisher, D. J., Erdmann, C. E., and Reeside, J. B., Jr., 1960, Cretaceous and Tertiary formations of the Book Cliffs, Carbon, Emery, and Grand Counties, Utah, and Garfield and Mesa Counties, Colorado: U.S. Geological Survey Professional Paper 332, 80 p.

Osterwald, F. W., and Maberry, J. E., 1974, Engineering geologic map of the Woodside quadrangle, Emery and Carbon Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-798, scale 1:48,000.

Table 1.--Summary of information for thirteen holes drilled in the Book Cliffs coal field, Range Creek and Woodside quadrangles, Emery County, Utah

[FEL, from east line; FWL, from west line; FNL, from north line; FSL, from south line. All measurements in feet; to convert to meters, multiply by 0.3048]

Drill-hole No.	Location	Rotary drilled depth	Cored interval	Depth logged	Total depth
BC-3-RC	T. 17 S., R. 16 E., sec. 4 700 FEL, 1,900 FSL	1,700	---	1,691	1,700
BC-4-RC	T. 17 S., R. 16 E., sec. 22 1,000 FWL, 2,050 FNL	1,122.3	1,122.3- 1,272.6	1,270	1,272.6
BC-6-RC	T. 17 S., R. 15 E., sec. 23 300 FSL, 2,000 FEL	1,595	---	1,595	1,595
BC-7-RC	T. 17 S., R. 16 E., sec. 30 300 FSL, 1,200 FEL	931	931- 1,083	1,081	1,083
BC-8-RC	T. 17 S., R. 16 E., sec. 33 700 FWL, 200 FNL	1,020	---	1,019	1,020
BC-9-RC	T. 17 S., R. 16 E., sec. 27 950 FWL, 1,950 FNL	1,224	---	1,222	1,224
BC-2-W	T. 17 S., R. 15 E., sec. 18 1,500 FNL, 2,100 FEL	740	---	738	740
BC-3-W	T. 17 S., R. 15 E., sec. 15 350 FNL, 2,100 FWL	955.7	955.7- 1,212	1,212	1,212
BC-5-W	T. 17 S., R. 15 E., sec. 21 100 FNL, 2,200 FWL	1,750	---	1,722	1,750
BC-6-W	T. 17 S., R. 15 E., sec. 19 450 FNL, 700 FEL	759.4	759.4- 961.8	961	961.8
BC-7-W	T. 17 S., R. 15 E., sec. 30 900 FEL, 1,450 FNL	985	---	984	985
BC-8-W	T. 17 S., R. 15 E., sec. 29 700 FSL, 1,200 FWL	771.3	771.3- 942	942	942.1
BC-10-W	T. 17 S., R. 15 E., sec. 29 700 FSL, 1,150 FEL	990	---	984	990

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-3-RC Quadrangle Range Creek Elevation 5,250 ft

Location: T. 17 S., R. 16 E., sec. 4, 700' FEL 1,900' FSL

Rotary-drilled depth 1,700' Cored interval _____ Logged depth 1,691' Total depth 1,700

Drilling medium Air, water, and foam

Geophysical logs:

Caliper (Cal) - Logging speed: ___ ft/min. Others: 20 ft/min

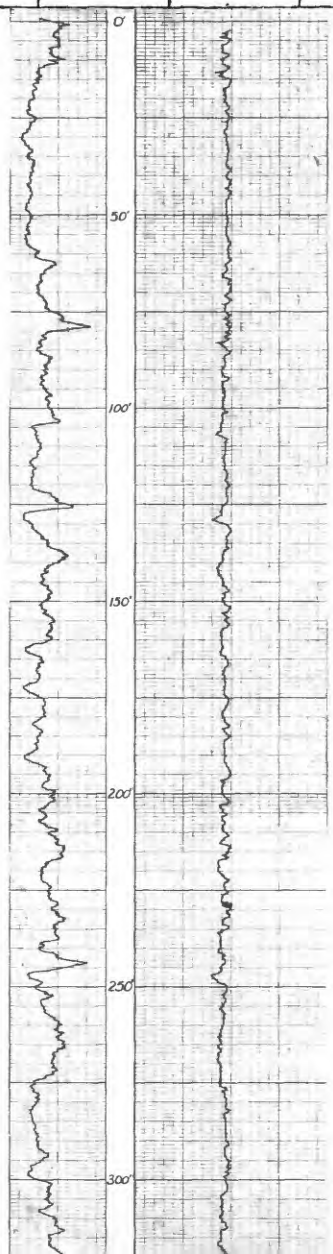
Resistivity (Res): Scale: _____

Gamma (Gam): T.C. 2 sec. Scale: 15 cps/log div.

Density (Den): T.C. 1 sec. Scale: 62.5 cps/log div.

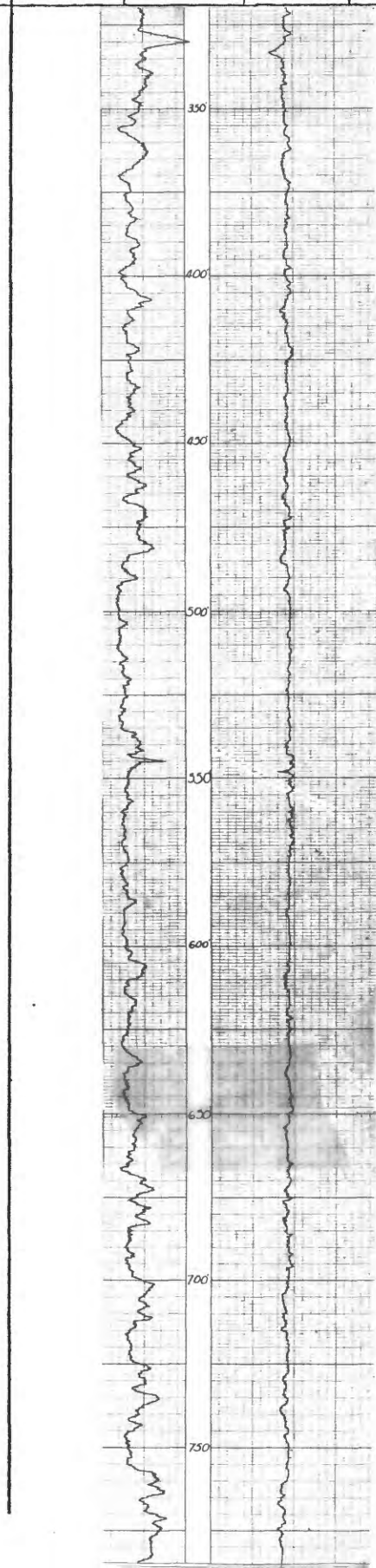
Remarks: Caliper and resistivity logs not run

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam / Den / Cal / Res
0-	60	Alluvium		
		Start drilling in Flagstaff Limestone and North Horn Formation, undifferentiated		
60-	65	Limestone, gray, silty, impure		
65-	80	Limestone, gray, hard, fairly pure		
80-	110	Mudstone, gray, soft		
110-	130	Mudstone, gray, grading to fine siltstone		
130-	160	Mudstone, maroon to reddish-brown, very soft; shale, white		
160-	170	Mudstone and shale, variegated		
170-	280	Mudstone, gray, slightly calcareous		
280-	295	Sandstone, fine- to medium-grained, angular, relatively unclean		
295-	300	Mudstone, gray, semi-hard		
300-	320	Mudstone to siltstone, gray and reddish-brown, calcareous		
320-	340	Mudstone, dark-gray; possibly a limestone bed between 320 ft and 325 ft		
340-	355	Sandstone, brown, medium-grained, angular, unclean		
355-	370	Mudstone, gray		

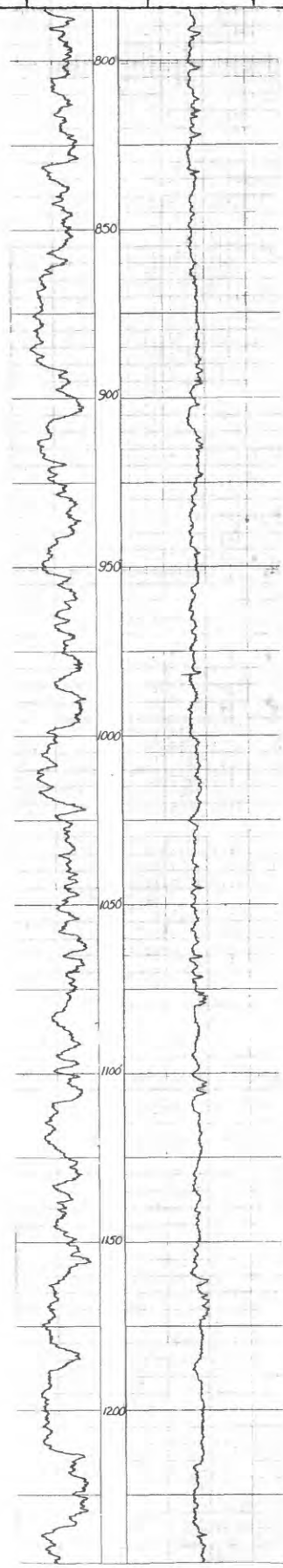


Hole No. BC-3-RC (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
	TOP OF PRICE RIVER FORMATION		
370– 400	Siltstone to sandstone, gray		
400– 465	Sandstone, gray, salt-and-pepper, subangular grains		
465– 480	Mudstone, brown and gray		
480– 580	Sandstone, gray, salt-and-pepper, subangular grains		
580– 655	Sandstone, fine- to medium-grained, alternating clean, with salt-and-pepper appearance		
655– 670	Sandstone, gray, fine- to medium-grained, hard; alternating thin beds of mudstone, gray		
670– 770	Sandstone, gray, fine, with shaly siltstone stringers		
770– 800	Mudstone, gray, hard		
800– 825	Sandstone, medium-grained, alternating with mudstone, gray		
825– 840	Mudstone, dark-gray		
840–1,015	Mudstone, gray, alternating with siltstone, gray		
1,015–1,020	Sandstone, gray, fine- to medium-grained		
1,020–1,160	Mudstone, gray, with siltstone partings		
1,160–1,220	Sandstone, medium- to fine-grained, with mudstone chips		
1,220–1,300	Mudstone, dark-gray, hard		
1,300–1,340	Mudstone, gray, softer than above		
1,340–1,405	Mudstone, gray and brownish-red		
	TOP OF CASTLEGATE SANDSTONE		
1,405–1,425	Sandstone, fine- to medium-grained, fairly clean		
1,425–1,430	Sandstone, gray, fine-grained		
	TOP OF BLACKHAWK FORMATION		
1,430–1,480	Sandstone, medium-grained, fairly well sorted, angular		
1,480–1,515	Mudstone to siltstone, very carbonaceous		

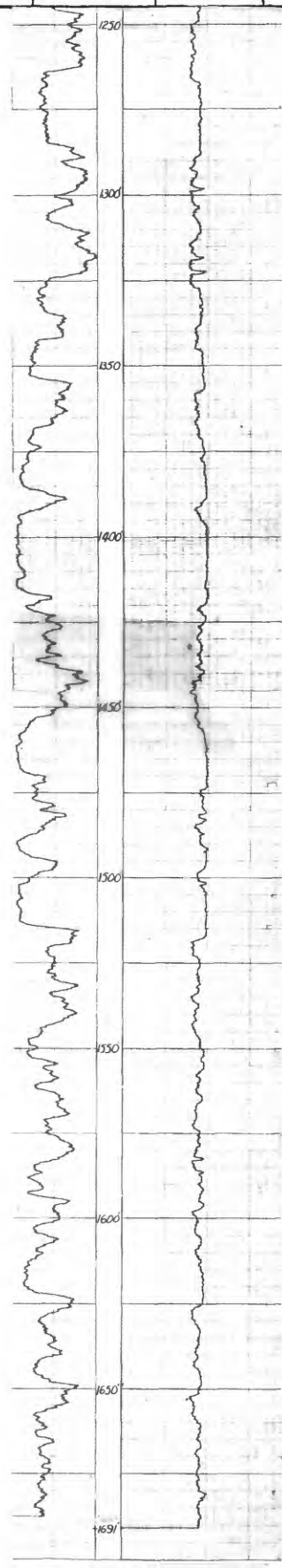


LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
1,515–1,520	Siltstone, fine- to medium-grained, 50% quartzitic, 50% carbonaceous		Gam Den Cal Res
1,520–1,540	Sandstone, fine- to medium-grained, very carbonaceous		
1,540–1,560	Sandstone to siltstone, fine-grained, very carbonaceous		
1,560–1,600	Sandstone to siltstone, fine-grained, with carbonaceous mudstone and shale; 3-ft coal seam at 1,562 ft		
1,600–1,620	Sandstone to siltstone, fine-grained, carbonaceous		
1,620–1,660	Siltstone to sandstone, fine-grained, carbonaceous; 1-ft coal seam at 1,650 ft		
1,660–1,670	Siltstone to sandstone, fine-grained		
1,670–1,700	Sandstone, fine, calcareous cement		
	Total depth: 1,700 ft		



Hole No. BC-3-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-4-RC Quadrangle Range Creek Elevation 4,875 ft

Location: T. 17 S., R. 16 E., sec. 22, 1,000' FWL 2,050' FNL

Rotary-drilled depth 1,122.3' Cored interval 1,122.3-1,272.6' Logged depth 1,270' Total depth 1,272

Drilling medium Water, foam, and mud

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

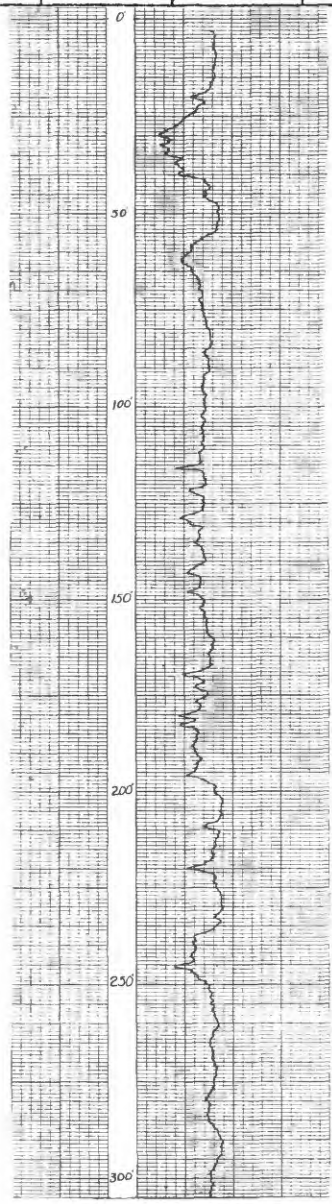
Resistivity (Res): Scale: 25Ω/log div.

Gamma (Gam): T.C. ___ sec. Scale:

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

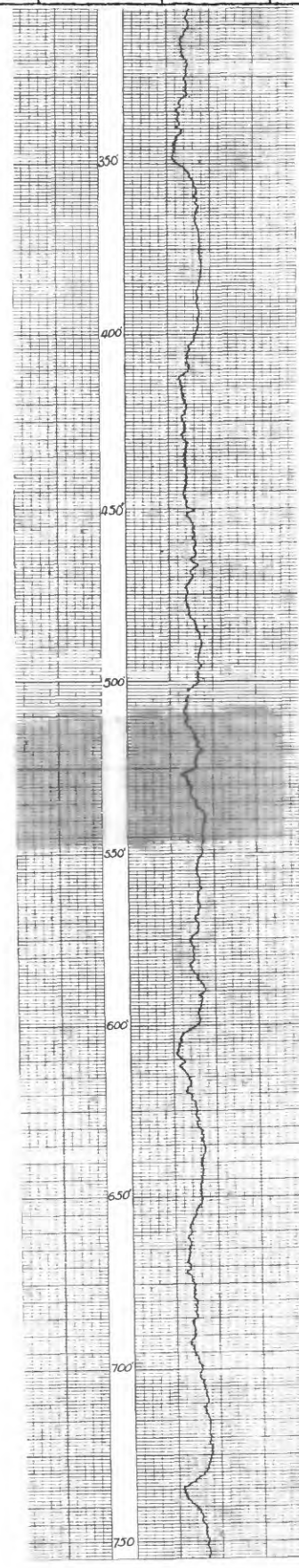
Remarks: Gamma not logged

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam / Den / Cal / Res
0-	80	Alluvium		
80-	100	Siltstone, gray (Kpm on fig. 3)		
100-	120	Sandstone, light-gray, fine-grained, well-indurated		
120-	150	Siltstone, hard		
150-	170	Sandstone, light-gray to white, fine- to medium-grained, subangular, hard		
170-	185	Siltstone, gray		
185-	205	Mudstone, dark-gray		
205-	220	Siltstone, gray		
220-	225	Sandstone, light-gray, fine-grained, well-indurated		
225-	235	Mudstone, dark-gray		
235-	245	Sandstone, gray, fine-grained, hard		
245-	260	Siltstone to mudstone, gray		
260-	270	Sandstone, gray, fine-grained, hard		
270-	280	Mudstone to siltstone, gray to dark-gray, very hard		
280-	300	Siltstone, gray, hard		
300-	325	Sandstone, light-gray, fine-grained, hard		
325-	340	Mudstone, dark-gray		
340-	345	Siltstone, dark-gray		
345-	355	Sandstone, light-gray, fine-grained		



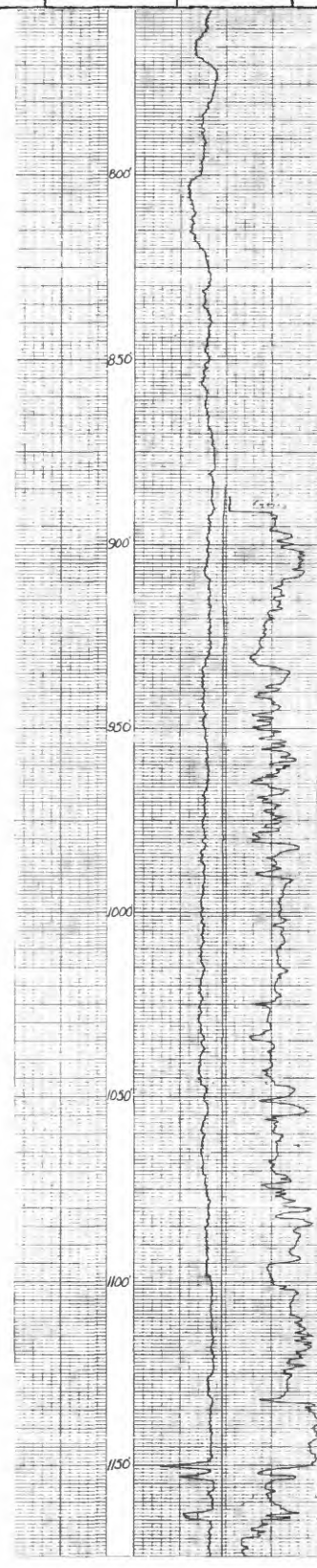
Hole No. BC-4-RC (continued)

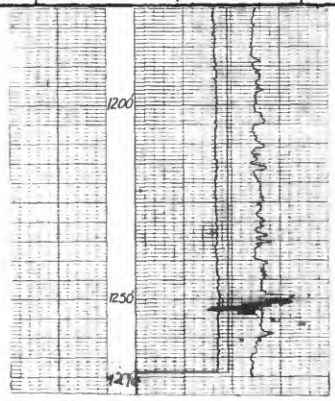
LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam | Den | Cal | Res
355-	360	Siltstone, gray		
360-	370	Sandstone, light-gray, fine-grained		
370-	375	Siltstone, dark-gray		
375-	385	Sandstone, light-gray, fine-grained, alternating with gray siltstone		
385-	425	Sandstone, light-gray, fine-grained; minor thin layers of gray siltstone		
425-	430	Sandstone, gray, clean		
430-	455	Sandstone, fine- to medium-grained; calcite cement. Soft, white cuttings indicate possible gypsum or kaolinite		
455-	460	Siltstone, dark-gray; vein of calcite		
460-	485	Siltstone, gray, black at 480 ft		
485-	510	Sandstone, light-gray, fine- to medium-grained, well-indurated		
510-	550	Siltstone, dark- to medium-gray		
550-	580	Sandstone, medium-gray, medium-grained, well-sorted, well-rounded		
580-	585	Mudstone, dark-gray		
585-	595	Sandstone, medium-gray, medium-grained		
595-	605	Mudstone, dark-gray		
605-	615	Siltstone, light-gray, well-sorted, well-rounded, clean		
615-	625	Mudstone, dark-gray		
625-	635	Siltstone, medium-gray		
635-	640	Mudstone, dark-gray		
640-	645	Siltstone, medium-gray		
645-	660	Mudstone, dark-gray		
660-	670	Siltstone, medium-gray		
670-	685	Mudstone, dark-gray		
685-	690	Mudstone, dark-gray; siltstone, light-gray		



Hole No. BC-4-RC (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam | Den | Cal | Res
690	- 695	Mudstone, dark-gray		
695	- 710	Mudstone, medium-gray		
710	- 745	Mudstone, dark-gray		
745	- 760	Mudstone, dark-gray; siltstone, light-gray		
760	- 770	Siltstone, light-gray, with interbedded carbonaceous material and some mudstone		
770-	- 780	Sandstone, light-gray, very fine grained, poorly cemented		
780	- 795	Siltstone, light-gray, with some carbonaceous material and mudstone		
795	- 805	Mudstone, dark-gray		
805	- 810	Sandstone, light-gray, very fine grained, clean		
810	- 815	Mudstone, dark-gray		
815	- 845	Siltstone, medium-gray, with carbonaceous material and some mudstone		
845	- 850	Shale, carbonaceous		
850	- 875	Sandstone, light-gray, fine-grained, interbedded with carbonaceous shale		
875	- 880	Shale, carbonaceous		
880	- 890	Sandstone, light-gray, very fine grained		
890	- 918	Siltstone, light-gray, with interbedded stringers of shale and coal. Grades downward to shale		
918	- 922	Shale, dark-gray; some interbedded siltstone		
922	- 932	Shale, dark-gray to black		
		TOP OF CASTLEGATE SANDSTONE		
932	-1,034	Sandstone, light- to medium-gray, fine-grained; shale and coal stringers as much as 1 in. thick; some pyrite (Kc on fig. 3)		



LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS			
				Gam	Den	Cal	Res
1,034	-1,035	Silty shale, dark-gray					
1,035	-1,075	Sandstone, light- to medium-gray, fine-grained					
		TOP OF BLACKHAWK FORMATION					
1,075	-1,084	Silty shale, dark-gray, interbedded with light-gray sandstone. About 6 ft of shale and 4 ft of sandstone					
1,084	-1,096	Sandstone, light-gray, medium- to fine-grained, mostly clean; some coaly material in thin stringers					
1,096	-1,126	Siltstone, light-gray; abundant coaly stringers; some thin shale layers; pyrite					
1,126	-1,133.6	Sandstone, light-gray, fine-grained; very few stringers of carbonaceous material					
1,133.6	-1,134.5	Shale, dark-gray					
1,134.5	-1,151.3	Sandstone, light-gray, very fine grained; siltstone; abundant coal stringers					
1,151.3	-1,151.9	Coal and carbonaceous shale					
1,151.9	-1,153.7	Shale, carbonaceous					
1,153.7	-1,153.9	Coal					
1,153.9	-1,155.6	Shale, carbonaceous; some coal stringers					
1,155.6	-1,158.5	Siltstone, medium-gray; abundant carbonaceous material					
1,158.5	-1,166.4	Shale, carbonaceous; minor interbeds of siltstone					
1,166.4	-1,168.2	Coal and carbonaceous shale					
1,168.2	-1,171	Siltstone and silty shale					
1,171	-1,192	Sandstone, light-gray, fine-grained, well-sorted, well-rounded; >10% dark minerals in a matrix of quartz grains; grades downward to siltstone					

Hole No. BC-4-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res
1,192 -1,216.5 Siltstone, light-gray, some stringers of carbonaceous material					
1,216.5-1,218 Siltstone interbedded with shale					
1,218 -1,237.5 Sandstone, light-gray, fine-grained, well-rounded, with some carbonaceous stringers; crossbedded					
1,237.5-1,241 Siltstone, light-gray, well-rounded, with some carbonaceous material					
1,241 -1,272.6 Siltstone with interbedded shale and carbonaceous material. 80% siltstone					
Total depth: 1,272.6					

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-6-RC Quadrangle Range Creek Elevation 5,840 ft

Location: T. 17 S., R. 15 E., sec. 23, 300' FSL 2,000' FEL

Rotary-drilled depth 1,595' Cored interval _____ Logged depth 1,595' Total depth 1,595

Drilling medium Water and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

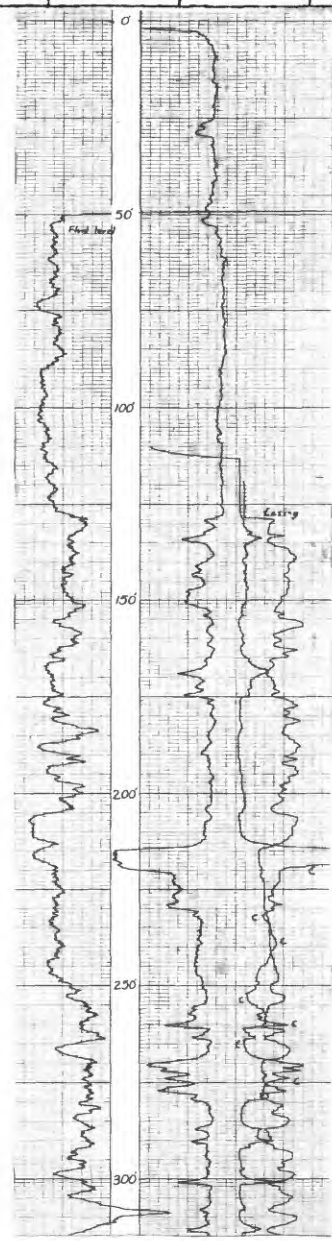
Resistivity (Res): Scale: 4Ω /log div.

Gamma (Gam): T.C. 2 sec. Scale: 15 cps/log div.

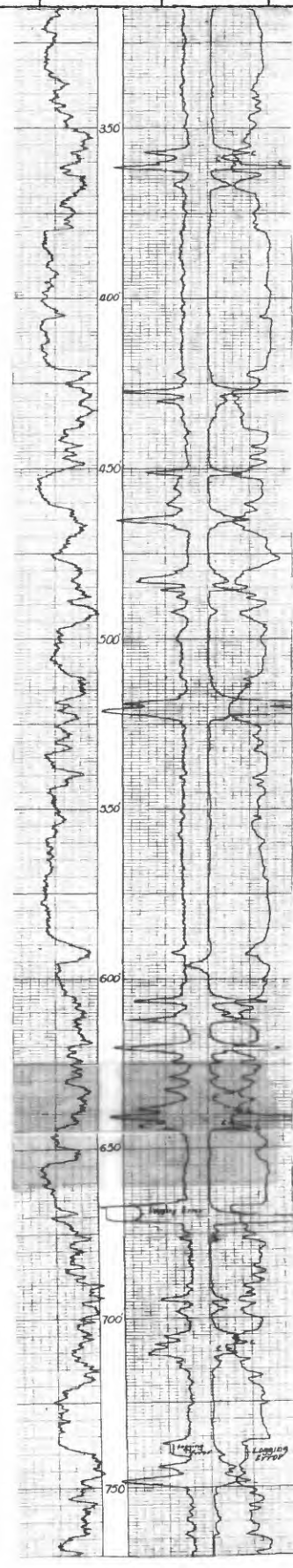
Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

Remarks: _____

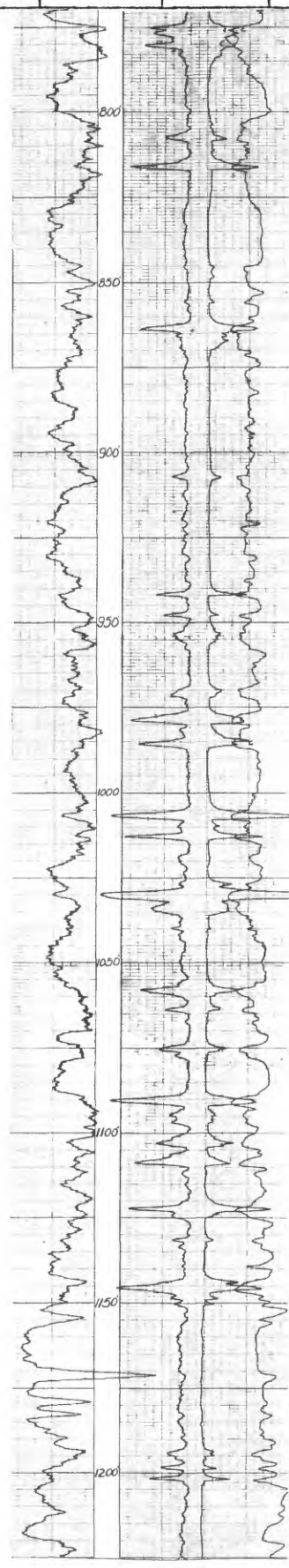
LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
0-	10	Alluvium		
10-	60	Shale, maroon, variegated; limestone bed at 15 ft, gray; thin limestone beds throughout		
60-	80	Shale, reddish-brown		
80-	100	Mudstone, gray, soft		
100-	120	Limestone		
120-	125	Shale, reddish-brown		
125-	135	Shale, gray		
135-	160	Silty limestone, gray		
160-	170	Shale, gray		
170-	180	Shale, reddish-brown		
180-	210	Limestone, white; interbedded with gray shale and mudstone		
210-	250	Mudstone, gray		
250-	280	Mudstone, dark-gray		
280-	300	Siltstone, gray		
300-	305	Sandstone, fine-grained		
305-	320	Sandstone, fine-grained; mudstone, dark-gray		
320-	325	Sandstone, fine- to medium-grained		
325-	330	Sandstone, fine- to medium-grained; mudstone, dark-gray		
330-	335	Sandstone, medium-grained		



LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
335–	340	Mudstone, gray		
340–	360	Shale, brownish-gray		
360–	400	Sandstone, fine- to medium-grained, alternating with shale		
		TOP OF PRICE RIVER FORMATION		
400–	510	Sandstone, gray, salt-and-pepper, medium-grained		
510–	555	Shale, black; siltstone		
555–	585	Sandstone, fine-grained		
585–	590	Shale, dark-gray		
590–	600	Sandstone, very fine grained		
600–	640	Shale, black		
640–	650	Siltstone, fine-grained		
650–	660	Shale, black		
660–	670	Sandstone, medium-grained, angular		
670–	730	Shale, black		
730–	745	Sandstone, black, fine-grained; pink chert		
745–	760	Shale, black		
760–	775	Shale, black; sandstone		
775–	785	Shale, black		
785–	795	Shale, black, carbonaceous		
795–	900	Shale and mudstone, black		
900–	910	Sandstone, medium-grained, clean		
910–	1,055	Shale and sandstone, black		
1,055–	1,060	Siltstone, gray		
1,060–	1,065	Mudstone		
1,065–	1,100	Siltstone, dark-gray, alternating with light-gray mudstone		
1,100–	1,105	Mudstone, dark-gray		
1,105–	1,155	Mudstone, light-gray		
1,155–	1,160	Mudstone, gray		
1,160–	1,165	Siltstone, dark-gray		
1,165–	1,180	Siltstone and mudstone, alternating		

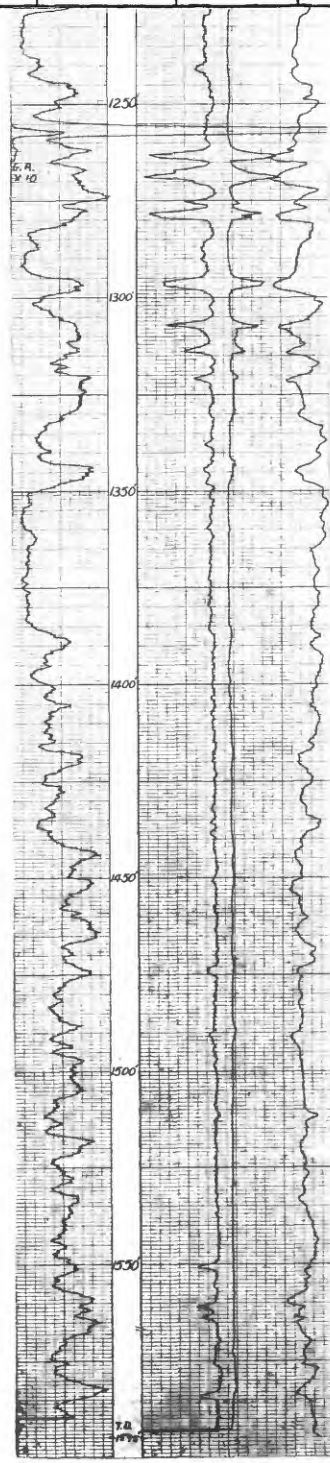


LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
1,180-1,200	Siltstone; Sandstone, gray, medium-grained		
1,200-1,235	Mudstone and siltstone		
	TOP OF CASTLEGATE SANDSTONE		
1,235-1,340	Sandstone, medium-grained		
	TOP OF BLACKHAWK FORMATION		
1,340-1,345	Mudstone, gray		
1,345-1,360	Sandstone, fine- to medium-grained		
1,360-1,380	Siltstone and mudstone, dark-gray, alternating		
1,380-1,400	Mudstone, gray		
1,400-1,530	Mudstone, gray, interbedded with dark-gray to black siltstone and shale. Some carbonaceous shale stringers		
1,530-1,590	Siltstone and fine sandstone		
	Total depth: 1,595 ft		



Hole No. BC-6-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-7-RC Quadrangle Range Creek Elevation 5,200 ft

Location: T. 17 S., R. 16 E., sec. 30, 300' FSL 1,200' FEL

Rotary-drilled depth 931' Cored interval 931-1,083' Logged depth 1,081' Total depth 1,083

Drilling medium Air, form, and mud

Geophysical logs:

Caliper (Cal) - Logging speed: ___ ft/min. Others: ___ ft/min

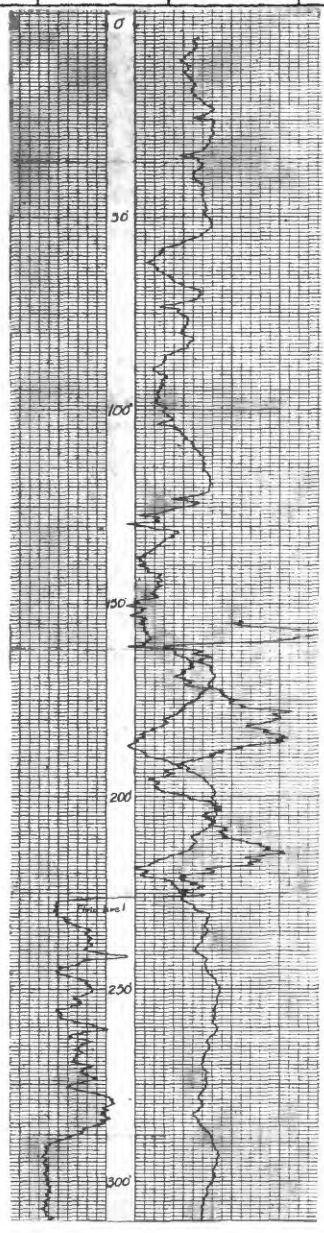
Resistivity (Res): Scale: 12.5 Ω/log div.

Gamma (Gam): T.C. 2 sec. Scale: 20 cps/log div.

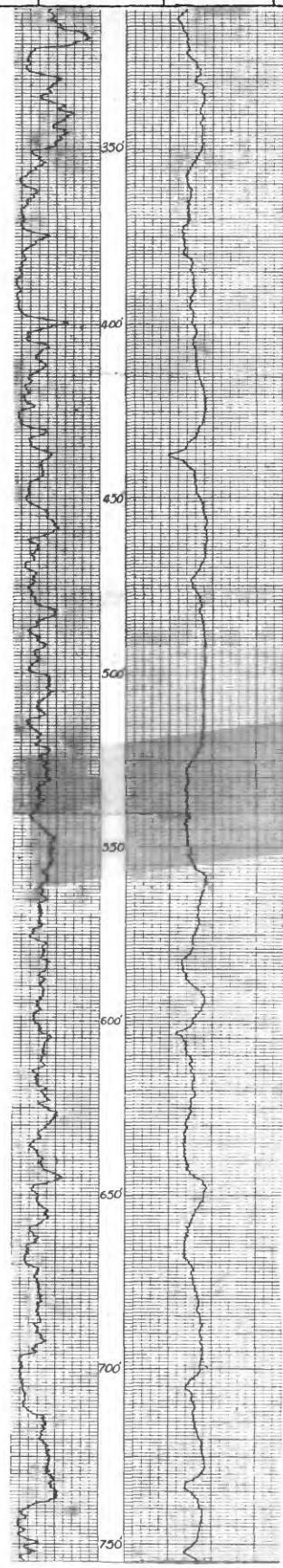
Density (Den): T.C. 2 sec. Scale: 200 cps/log div.

Remarks:

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
0-	30	Silty shale, dark-gray		
30-	50	Sandstone, light-gray, very fine grained, poorly sorted, subangular, soft; abundant dark minerals		
50-	55	Shale, medium-gray, fissile		
55-	60	Siltstone, light-gray, to sandstone, very fine grained, poorly sorted, subangular, soft; abundant dark minerals		
		TOP OF PRICE RIVER FORMATION		
60-	65	Shale, dark-gray, carbonaceous		
65-	70	Shale, medium-gray		
70-	95	Siltstone, light-gray		
95-	105	Shale, dark-gray		
105-	110	Sandstone, light-gray, very fine grained; shale, dark-gray		
110-	125	Shale, dark-gray		
125-	150	Sandstone, light-gray, very fine grained, poorly sorted, subangular, poorly cemented; abundant dark minerals		
150-	185	Silty shale, dark-gray; coal, ferrous, at 170-175 ft		
185-	190	Shale, dark-gray, carbonaceous; siltstone, light-gray		
190-	195	Shale, black, carbonaceous; coal		

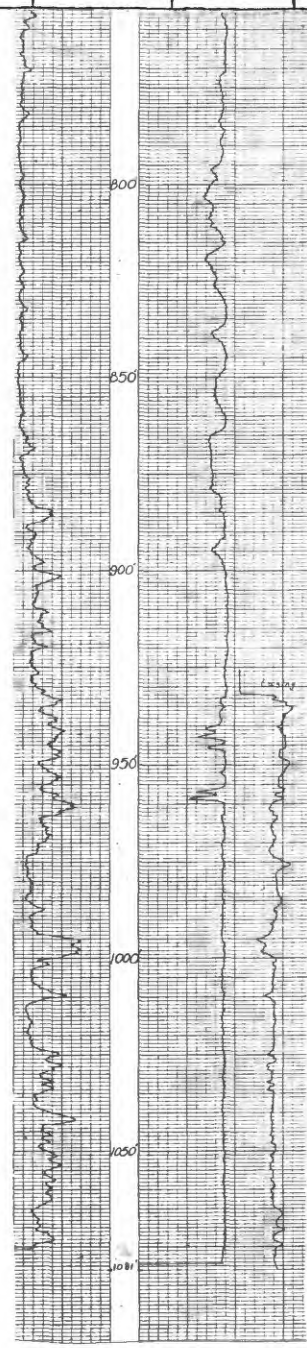


		LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS
				Gam | Den | Cal | Res
195-	200	Sandstone, salt-and-pepper appearance, very fine grained; minor black carbonaceous shale		
200-	205	Shale, medium-gray		
205-	230	Sandstone, light-gray, fine-grained, poorly sorted, sub-angular, poorly cemented		
230-	235	Sandstone, as above, with some dark-gray, silty shale		
235-	250	Silty shale, dark-gray; abundant pyrite		
250-	270	Siltstone, light-gray		
270-	285	Silty shale, dark-gray; coal-bearing at 280-285 ft		
285-	315	Sandstone, light-gray, fine-grained, clean		
315-	340	Siltstone, medium-gray, very hard, pyritic		
340-	360	Silty shale, dark-gray		
360-	405	Sandstone, light-gray, very fine to silt-sized grains; some dark shale from 375 ft to 405 ft		
405-	420	Silty shale, dark-gray		
420-	430	Sandstone, light-gray, very fine grained		
430-	445	Siltstone, dark-gray		
445-	455	Siltstone, light-gray		
455-	500	Siltstone, light-gray, with interbedded coal-bearing carbonaceous shale		
500-	510	Siltstone, dark-gray, to silty shale		
510-	515	Sandstone, light-gray, very fine grained		
515-	565	Silty shale, dark-gray		
565-	605	Siltstone, light-gray, to very fine grained sandstone, interbedded with coal-bearing carbonaceous shale		
605-	630	Silty shale, dark-gray		



Hole No. BC-7-RC (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam | Den | Cal | Res
630 - 645		Sandstone, light-gray, very fine grained		
645 - 720		Sandstone, as above, with some pyrite and interbedded with coal-bearing carbonaceous shale		
720 - 740		Silty shale, dark-gray		
740 - 750		Sandstone and shale, interbedded as above		
		TOP OF CASTLEGATE SANDSTONE		
750 - 885		Sandstone, light-gray, fine-grained, well-rounded		
		TOP OF BLACKHAWK FORMATION		
885 - 890		Shale, dark-gray, with interbedded siltstone		
890 - 915		Sandstone, light-gray, fine-grained, with carbonaceous material		
915 - 932.7		Sandstone, light-gray, very fine to silt-sized grains		
932.7- 932.8		Silty shale to siltstone, dark-gray		
932.8- 939.6		Siltstone, light-gray, with interbedded carbonaceous shale and coal as much as 0.2 ft in thickness		
939.6- 941.2		Shale, carbonaceous; coal at 940.1-940.5 ft		
941.2- 942.9		Shale, carbonaceous; coal		
942.9- 944.7		Siltstone and carbonaceous shale		
944.7- 945.6		Coal and carbonaceous shale		
945.6- 951.5		Siltstone, light-gray		
951.5- 951.7		Coal		
951.7- 955.1		Siltstone		
955.1- 955.8		Coal		
955.8- 956.5		Siltstone, light-gray		
956.5- 957.5		Silty shale and coal-bearing carbonaceous shale		
957.5- 958.7		Shale, carbonaceous, interbedded with coal		



LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS			
				Gam	Den	Cal	Res
958.7-	962.8	Silty shale, dark-gray					
962.8-	964.1	Siltstone, light-gray					
964.1-	973	Sandstone, medium-gray, fine-grained; abundant dark minerals; deformation structures present					
973 -	994.8	Sandstone, light-gray, massive, with some crossbedding					
994.8-	998.6	Shale, dark-gray; some carbonaceous material, interbedded with siltstone					
998.6-	1,083	Sandstone, light-gray, fine-grained; interbedded shales as much as 0.3 ft thick at top, 0.5 ft thick in the middle, and 0.1 ft thick at the bottom; some carbonaceous material					
		Total depth: 1,083 ft					

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-8-RC Quadrangle Range Creek Elevation 4,950 ft

Location: T. 17 S., R. 16 E., sec. 33, 700' FWL 200' FNL

Rotary-drilled depth 1,020' Cored interval 0 Logged depth 1,019' Total depth 1,020

Drilling medium Water and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

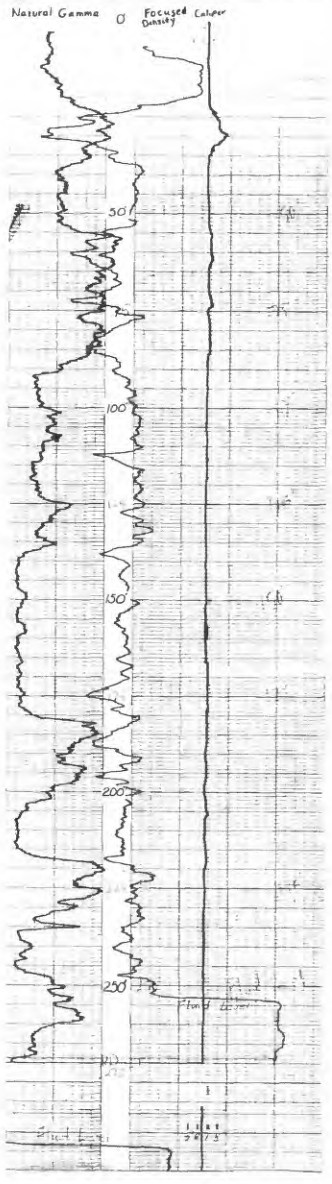
Resistivity (Res): Scale: ---

Gamma (Gam): T.C. 2 sec. Scale: 15 cps/log div.

Density (Den): T.C. 2 sec. Scale: 140 cps/log div.

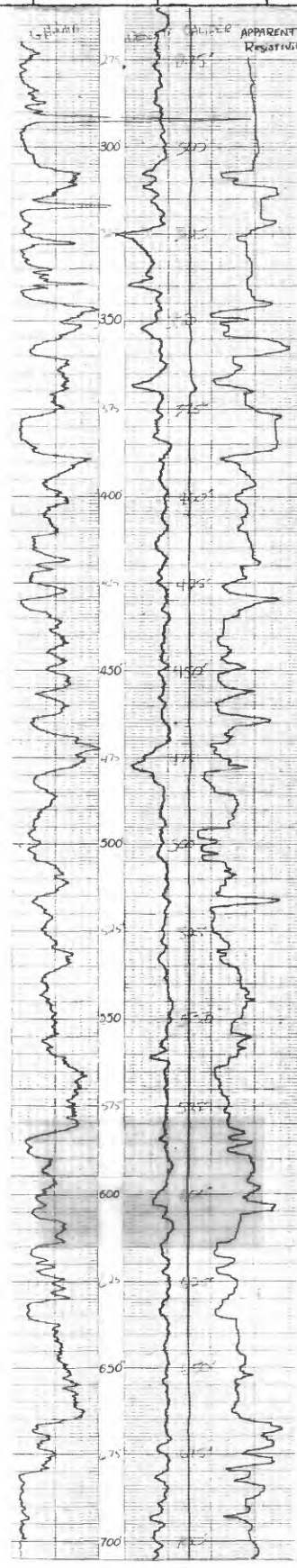
Remarks: Resistivity scale not shown on log

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
0- 15	Alluvium		
15- 16	Shale, dark, carbonaceous; coal streaks		
16- 20	Shale, gray to brown		
20- 30	Sandstone, dark-gray, fine-grained, slightly carbonaceous		
30- 40	Sandstone, medium-grained, clean		
40- 50	Sandstone, fine- to medium-grained, poorly sorted		
50- 65	Siltstone to mudstone, gray, soft; some sandstone beds, fine-grained		
65- 70	Mudstone		
70- 80	Siltstone to sandstone, gray, fine-grained		
80- 85	Sandstone, gray, fine-grained		
85-130	Sandstone, medium-grained		
130-135	Sandstone, medium-grained; thin siltstone bed		
135-180	Sandstone, medium-grained, clean, well-rounded		
180-185	Micaceous siltstone to mudstone, dark-gray to black, very thinly bedded		
185-195	Siltstone, gray		

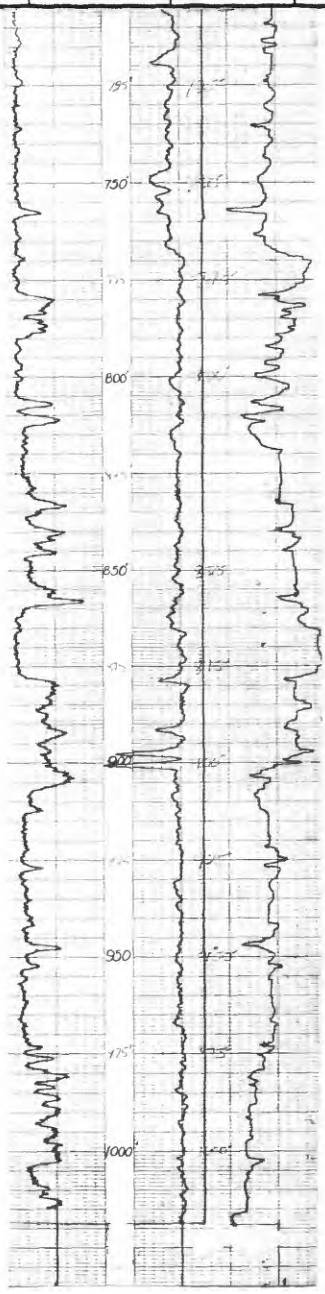


Hole No. BC-8-RC (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam Den Cal Res
195-200	Sandstone, fine- to medium-grained		
200-215	Sandstone, medium-grained, well-sorted, very clean, well-rounded		
215-220	Sandstone, gray, fine-grained, very hard		
220-230	Mudstone to siltstone, gray		
230-250	Sandstone, medium-grained, with siltstone stringers		
250-255	Siltstone, dark-gray		
255-260	Sandstone, dark-gray, fine-grained		
260-300	Sandstone, medium-grained, very clean, well-rounded		
300-315	Mudstone to siltstone, carbonaceous		
315-345	Sandstone, white, medium-grained, clean		
345-375	Siltstone, gray to dark-gray, carbonaceous		
375-385	Sandstone, white, medium-grained		
385-440	Sandstone, medium-grained, alternating with carbonaceous siltstone to mudstone		
	TOP OF CASTLEGATE SANDSTONE		
440-680	Siltstone to mudstone, black, carbonaceous; some carbonaceous sandstone		
680-800	Castlegate Sandstone, medium-grained; thin coal seam less than 1 ft at 682 ft		
	TOP OF BLACKHAWK FORMATION		
800-875	Sandstone, medium-grained, alternating with carbonaceous siltstone to mudstone		
875-878	Coal; carbonaceous shale		
878-885	Siltstone, gray, carbonaceous		
885-890	Shale, carbonaceous; 2-ft coal bed at 885 ft		
890-895	Coal; carbonaceous shale		
895-900	Good coal; some carbonaceous shale. Beckwith coal zone, 875-900 ft		
900-980	Sandstone, medium- to fine-grained, with carbonaceous streaks		
980-985	Shale, carbonaceous; possibly a coal split. Sunnyside coal zone		



Hole No. BC-8-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS
		Gam | Den | Cal | Res
985-1,020 Sandstone, fine-grained, carbonaceous Total depth: 1,020		

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-9-RC Quadrangle Range Creek Elevation 4,760 ft

Location: T. 17 S., R. 16 E., sec. 27, 950' FWL 1,950' FNL

Rotary-drilled depth 1,224 ft Cored interval _____ Logged depth 1,222' Total depth 1,224'

Drilling medium Air and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

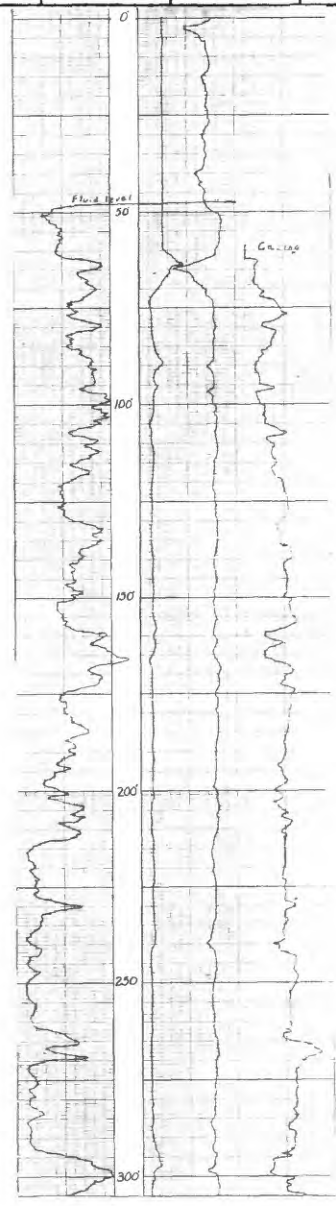
Resistivity (Res): Scale: 14.3 Ω/log div.

Gamma (Gam): T.C. 2 sec. Scale: 15 cps/log div.

Density (Den): T.C. 2 sec. Scale: 125 cps/log div.

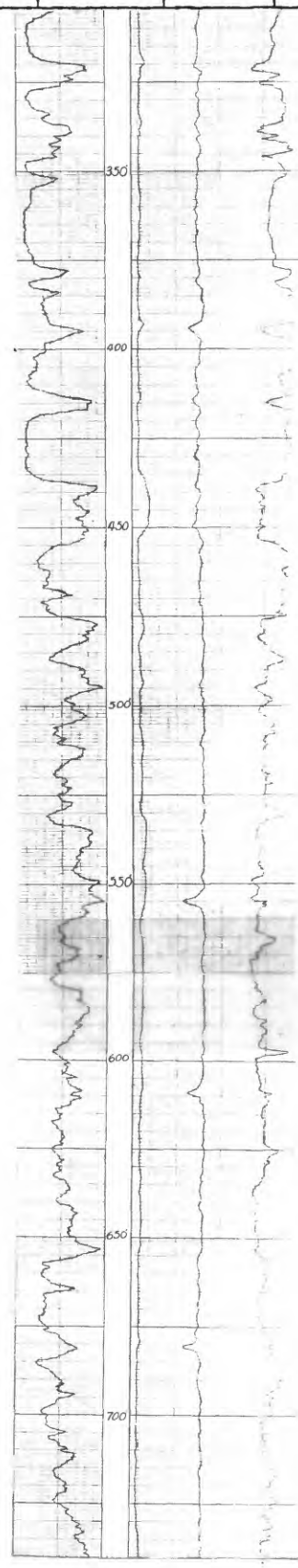
Remarks: Collared 400 ft below top of Price River Formation

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
0-	55	Alluvium		
55-	85	Sandstone, light-gray, fine-grained; interbedded gray mudstone		
85-	115	Mudstone, dark-gray		
115-	135	Mudstone, medium- to dark-gray, with some interbedded sandstone		
135-	140	Sandstone, light-gray, medium-grained		
140-	160	Sandstone, medium-gray, medium- to fine-grained; rare mudstone partings		
160-	220	Mudstone, dark-gray		
220-	225	Sandstone, light-gray, medium-grained		
225-	245	Sandstone, light-gray, medium-grained, with some mudstone partings		
245-	260	Sandstone, gray, medium- to coarse-grained		
260-	270	Mudstone, dark-gray		
270-	290	Sandstone, light-gray, well-sorted, medium- to fine-grained		
290-	295	Sandstone, medium-grained		
295-	305	Mudstone, dark-gray, carbonaceous		



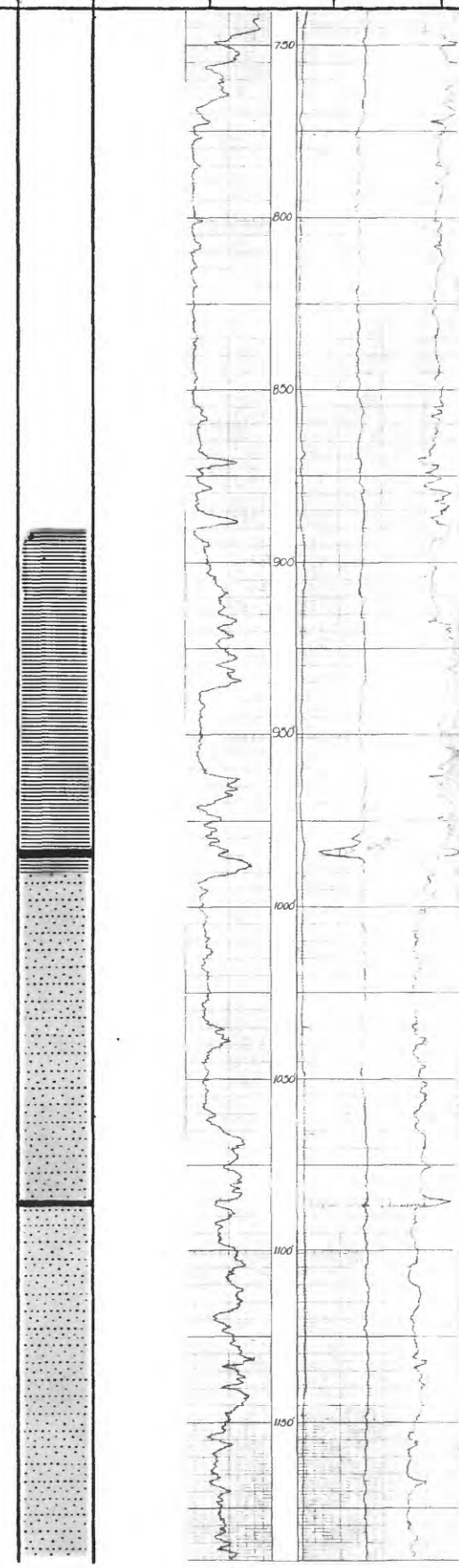
Hole No. BC-9-RC (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
305-	320	Sandstone, gray, medium-grained		
320-	330	Mudstone, gray		
330-	340	Sandstone, medium-grained		
340-	345	Mudstone, carbonaceous		
345-	380	Sandstone, light-gray, medium-grained		
380-	400	Mudstone, dark-gray; rare sandstone streaks		
400-	410	Sandstone, gray, medium-grained		
410-	420	Mudstone, carbonaceous		
420-	435	Sandstone, gray, medium-grained; specks of coal		
435-	450	Mudstone, dark-gray		
450-	510	Sandstone, dark-gray, with interbedded carbonaceous shale		
510-	760	Mudstone, dark-gray, carbonaceous		
		TOP OF CASTLEGATE SANDSTONE		
760-	890	Sandstone, light-gray, medium-grained, well-rounded		
		TOP OF BLACKHAWK FORMATION		
890-	983	Mudstone, gray, carbonaceous		
983-	985	Coal - Beckwith coal zone		
985-	990	Mudstone, dark-gray, carbonaceous		
990-	1,010	Sandstone, light-gray, fine- to medium-grained		
1,010-	1,095	Sandstone, light-gray, fine-grained to silt size. Carbonaceous material from 1,040 to 1,095 with stringers of coal at 1,085-1,087. Sunnyside coal zone		
1,095-	1,224	Sandstone, light-gray, very fine grained; calcareous cement		
		Total Depth: 1,224 ft		



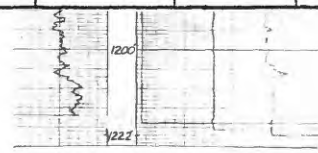
Hole No. BC-9-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



Hole No. BC-9-RC (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-2-W Quadrangle Woodside Elevation 6,150 ft

Location: T. 17 S., R. 15 E., sec. 18, 1,500'FNL 2,100'FEL

Rotary-drilled depth 740' Cored interval _____ Logged depth 738' Total depth 740'

Drilling medium Air, foam, and water

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

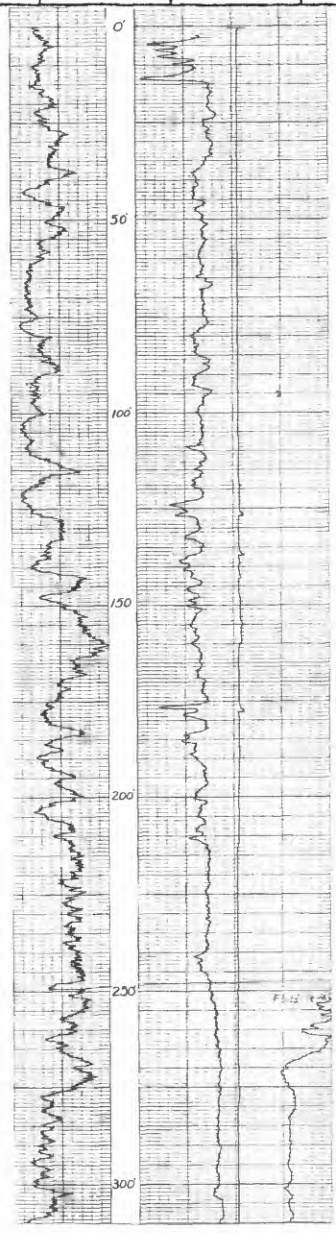
Resistivity (Res): Scale: 10Ω/log div.

Gamma (Gam): T.C. 1 sec. Scale: 20 cps/log div.

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

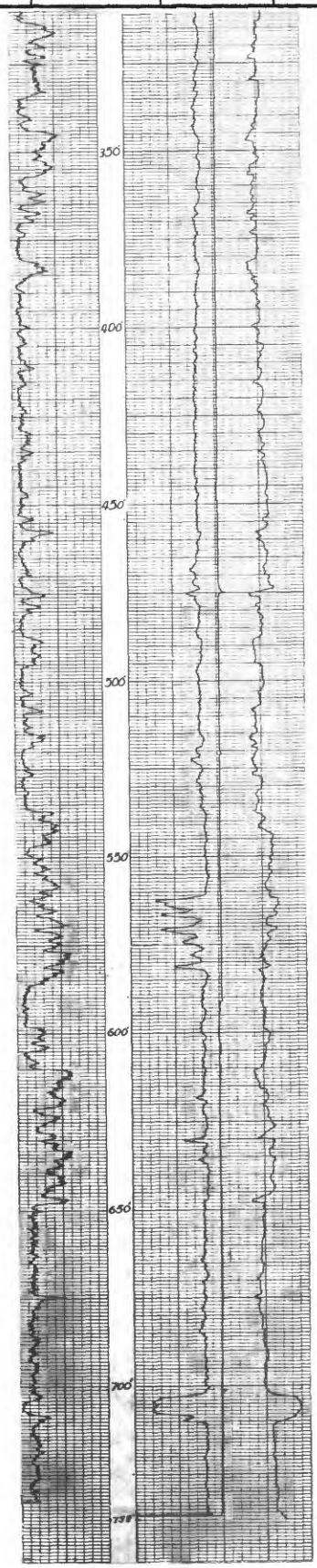
Remarks: No lithologic log on this hole

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



Hole No. BC-2-W (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



702-718 Coal

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-3-W Quadrangle Woodside Elevation 6,400 ft

Location: T. 17 S., R. 15 E., sec. 15, 350' FNL 2,100' FWL

Rotary-drilled depth 955.7' Cored interval 955.7-1,212 ft Logged depth 1,212 Total depth 1,212

Drilling medium Air, foam, and mud

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

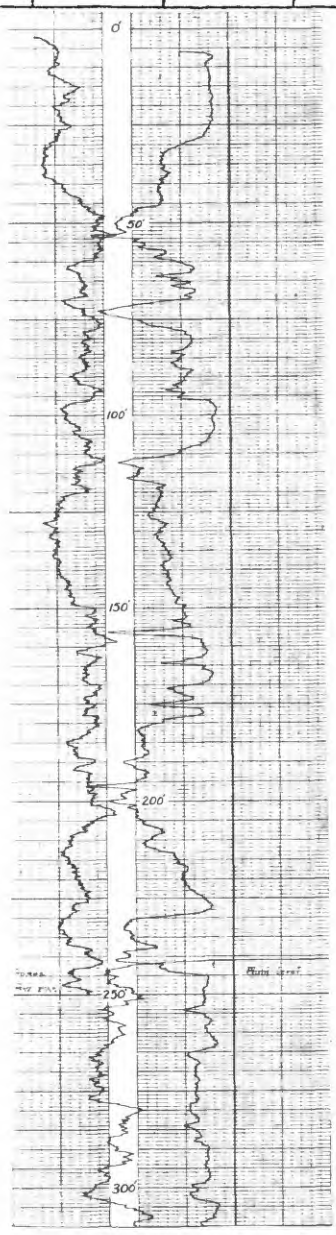
Resistivity (Res): Scale: 16.7 Ω/log div.

Gamma (Gam): T.C. ___ sec. Scale: 15 cps/log div.

Density (Den): T.C. ___ sec. Scale: 200 cps/log div.

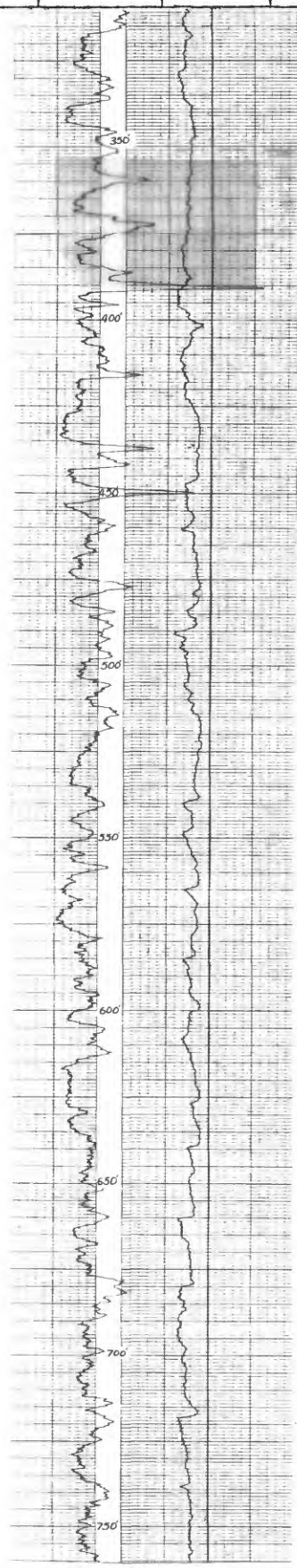
Remarks: Time constant not indicated. Subtract 2 ft. from geophysical log depths.

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
0- 13	Alluvium		
	Start drilling in Flagstaff Limestone and North Horn Formation, undifferentiated		
13- 19	Shale, brown		
19- 27	Shale, gray		
27- 38	Sandstone, gray, medium-grained, clean		
38- 53	Shale, light-gray		
53- 58	Shale, dark-gray		
58- 60	Silty limestone, gray		
60- 65	Shale, gray		
65- 70	Siltstone to fine sandstone, gray		
70- 80	Shale, gray and black; thin streaks of coaly and carbonaceous material		
80- 85	Silty shale, dark-gray		
85- 90	Shale, brown, with coal stringers		
90- 94	Shale, gray		
94-100	Sandstone, medium-grained		
	TOP OF PRICE RIVER FORMATION		
100-115	Sandstone, gray, fine-grained, well-sorted		
115-145	Sandstone, medium-grained, well-sorted, very angular		
145-150	Sandstone, gray, fine-grained, well-sorted		

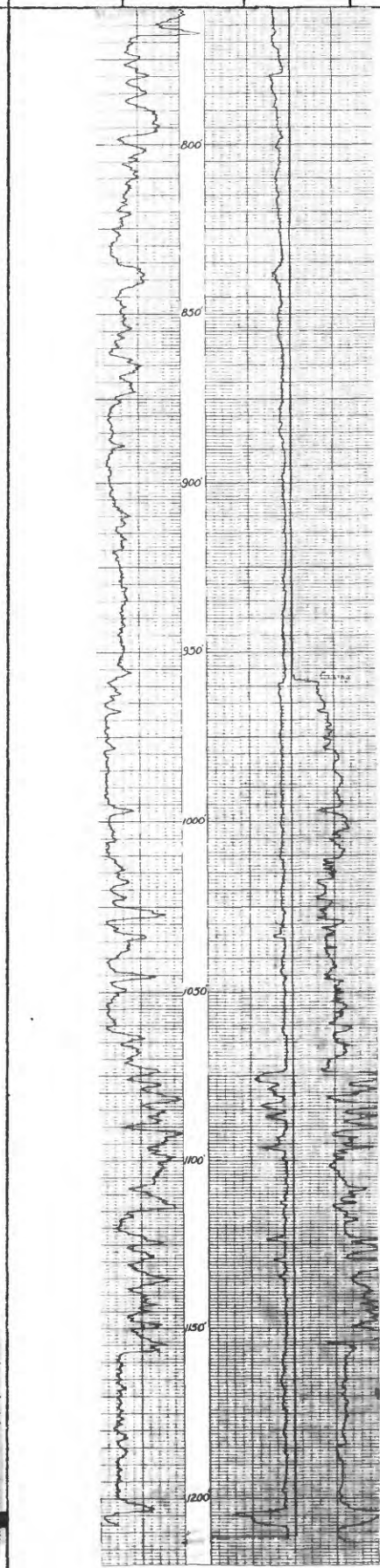


Hole No. BC-3-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
150–155	Sandstone, dark-gray, medium-grained		
155–165	Sandstone, light-gray, fine- to medium-grained		
165–170	Sandstone, dark-gray, fine-grained		
170–205	Sandstone, fine-grained, well-sorted; finely disseminated coal at 190 ft		
205–230	Sandstone, light-gray, medium-grained		
230–250	Sandstone, dark-gray, fine-grained; finely disseminated coal at 240 ft		
250–260	Sandstone, light-gray, fine- to medium-grained		
260–275	Sandstone, light-gray, medium-grained		
275–300	Sandstone, dark-gray, fine-grained		
300–310	Shale, Gray		
310–320	No samples		
320–325	Shale, gray		
325–360	Sandstone, medium-grained		
360–380	Sandstone, medium- to coarse-grained, fairly clean; carbonaceous material from about 370 to 380 ft		
380–410	Sandstone, medium-grained, with interbedded carbonaceous siltstone		
410–445	Sandstone, white, medium-grained, well-sorted, very clean		
445–465	Sandstone, brown, medium-grained, with carbonaceous shale		
465–480	Sandstone, fine-grained to silty, carbonaceous; interbedded with dark-gray mudstone to shale		
480–500	Sandstone, medium-grained, with carbonaceous shale partings		
500–505	Shale, red to gray, with gray siltstone		
505–510	Shale, carbonaceous, with some thin coal stringers		
510–520	Siltstone, dark-gray		
520–530	Sandstone, medium-grained, well-rounded		
530–540	Sandstone, medium-grained, with carbonaceous siltstone		



LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
540 - 565		Sandstone, brown, medium-grained, with siltstone to shale stringers		
565 - 585		Sandstone, brown, medium-grained		
585 - 600		Shale to siltstone, dark-gray		
600 - 695		Siltstone, light-gray		
695 - 700		Shale to carbonaceous siltstone to coal stringers		
700 - 730		Siltstone, light-gray		
730 - 740		Siltstone to shale, carbonaceous		
740 - 790		Sandstone, gray, medium-grained		
790 - 800		Sandstone, medium-grained, with carbonaceous shale and small amount of coal		
800 - 805		Sandstone, brown, medium-grained		
805 - 810		Mudstone, carbonaceous		
810 - 835		Sandstone, gray, medium- to coarse-grained		
835 - 850		Sandstone, medium- to coarse-grained, with carbonaceous shale and coal stringers		
		TOP OF CASTLEGATE SANDSTONE		
850 - 950		Sandstone, gray, medium- to coarse-grained, clean		
950 - 955.7		No samples		
955.7-1,024.2		Sandstone, medium-grained; 1.5-in. coal split at 959.7 ft; some coal and carbonate stringers throughout the Kc (fig. 3)		
		TOP OF BLACKHAWK FORMATION		
1,024.2-1,024.3		Mudstone, carbonaceous		
1,024.3-1,024.9		Sandstone, medium-grained, with carbonaceous stringers		
1,024.9-1,026.3		Mudstone, carbonaceous, to carbonaceous siltstone		
1,026.3-1,029.0		Sandstone, medium-grained, clean		



LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS			
			Gam	Den	Cal	Res
1,029.0-1,031.3	Sandstone, medium-grained, with coal and carbonaceous stringers					
1,031.3-1,031.8	Mudstone, carbonaceous, with coaly material at 1,031.3-1,031.6 ft					
1,031.8-1,032.2	Mudstone, carbonaceous					
1,032.2-1,036.5	Sandstone, fine-grained, with carbonaceous stringers and some thin coal stringers 1/8 in. in thickness					
1,036.5-1,041.8	Sandstone, medium-grained, fairly clean					
1,041.8-1,042.9	Sandstone, medium-grained, with carbonaceous stringers					
1,042.9-1,043.4	Mudstone, carbonaceous, with coal stringers and resin nodules					
1,043.4-1,044.3	Siltstone, carbonaceous					
1,044.3-1,047.3	Sandstone, medium-grained; two carbonaceous stringers at 1,047 ft					
1,047.3-1,047.7	Siltstone, carbonaceous					
1,047.7-1,051.8	Sandstone, medium-grained, clean					
1,051.8-1,061.8	Sandstone, medium-grained, clean, with carbonaceous stringers in lower 2 in.					
1,061.8-1,070.9	Sandstone, medium-grained, with carbonaceous stringers throughout					
1,070.9-1,071.9	Siltstone, dark-gray, with carbonaceous stringers at 1,071.9 ft					
1,071.9-1,072.9	Coal and carbonaceous shale					
1,072.9-1,073	Mudstone, carbonaceous					
1,073 -1,074.7	Coal and carbonaceous shale					
1,074.7-1,076.2	Shale, carbonaceous, with coal stringers					

Hole No. BC-3-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS			
			Gam	Den	Cal	Res
1,076.2-1,077.5	Mudstone, carbonaceous, with 2-in. coal stringers at 1,077.5 ft					
1,077.5-1,079.2	Mudstone, carbonaceous, with 50% coal in lower 1 in.					
1,079.2-1,081.2	Mudstone, carbonaceous, with 0.5-in. coal split at 1,079.2					
1,081.2-1,081.7	Coal					
1,081.7-1,082	Mudstone, carbonaceous, and coal					
1,082 -1,082.8	Coal					
1,082.8-1,083	Mudstone, carbonaceous					
1,083 -1,083.1	Coal split					
1,083.1-1,084.6	Sandstone, gray, fine-grained; siltstone					
1,084.6-1,086.2	Coal in upper 6 in.; carbonaceous shale and mudstone with coal stringers below					
1,086.2-1,087.1	Sandstone, fine-grained; siltstone					
1,087.1-1,089.1	Sandstone, white, medium-grained; carbonaceous stringers					
1,089.1-1,091	Mudstone, dark-gray					
1,091 -1,091.8	Coal and carbonaceous mudstone					
1,091.8-1,093.7	Mudstone, carbonaceous					
1,093.7-1,094.5	Coal with pyrite					
1,094.5-1,101.8	Mudstone, carbonaceous, with coal stringers and pyrite					
1,101.8-1,104.3	Siltstone, grayish-white					
1,104.3-1,104.5	Mudstone, with coal and carbonaceous shale stringers					
1,104.5-1,106.8	Sandstone, light-gray to white, fine-grained					
1,106.8-1,108.2	Sandstone, gray, fine-grained					
1,108.2-1,110	Mudstone to siltstone, carbonaceous, with 1/8-in. coal stringers					

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS			
			Gam	Den	Cal	Res
1,110 -1,110.4	Coal and carbonaceous mudstone					
1,110.4-1,112	Mudstone to siltstone, gray					
1,112 -1,114.8	Sandstone, medium-grained, with carbonaceous stringers					
1,114.8-1,120.2	Sandstone, medium-grained, very clean					
1,120.2-1,120.8	Sandstone, medium-grained, with carbonaceous stringers					
1,120.8-1,121.3	Coal					
1,121.3-1,121.6	Mudstone, carbonaceous					
1,121.6-1,121.9	Sandstone, medium-grained, with carbonaceous stringer					
1,121.9-1,122	Mudstone, carbonaceous					
1,122 -1,122.8	Mudstone, carbonaceous					
1,122.8-1,127.2	Sandstone, fine-grained, with carbonaceous stringers, becoming carbonaceous mudstone; siltstone, bottom 1 in.					
1,127.2-1,127.6	Coal					
1,127.6-1,132	Sandstone, fine- to medium-grained, with carbonaceous stringers					
1,132 -1,132.4	Sandstone, fine-grained, with coal and carbonaceous shale in bottom 1/2 in.					
1,132.4-1,132.8	No samples					
1,132.8-1,142	Siltstone, with carbonaceous stringers					
1,142 -1,144.1	Siltstone, with coal stringers					
1,144.1-1,144.6	Sandstone, dark-gray, fine-grained					
1,144.6-1,147.7	Sandstone, fine-grained, to carbonaceous siltstone					
1,147.7-1,148.4	Sandstone, gray, medium- to fine-grained, with coal stringers					
1,148.4-1,152	Sandstone, banded gray and white, fine-grained					
1,152 -1,152.4	Siltstone, carbonaceous					

Hole No. BC-3-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS			
			Gam	Den	Cal	Res
1,152.4-1,154.5	Sandstone, fine- to medium-grained; carbonaceous stringers					
1,154.5-1,199.7	Sandstone, medium-grained, very clean					
1,199.7-1,199.9	Shale, carbonaceous; coal					
1,199.9-1,201.8	Mudstone, carbonaceous					
1,201.8-1,201.9	Coal					
1,201.9-1,205.9	Coal. Sunnyside coal zone					
1,205.9-1,208.3	Mudstone, carbonaceous; some coal stringers					
1,208.3-1,210.2	Mudstone, carbonaceous; interbedded with sandstone, fine-grained					
1,210.2-1,212	Sandstone, fine-grained, with carbonaceous mudstone stringers					
	Total depth:1,212 ft					

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-5-W Quadrangle Woodside Elevation 6,540 ft

Location: T. 17 S., R. 15 E., sec. 21, 100' FNL 2,200' FWL

Rotary-drilled depth 1,750' Cored interval _____ Logged depth 1,722' Total depth 1,750'

Drilling medium Air and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

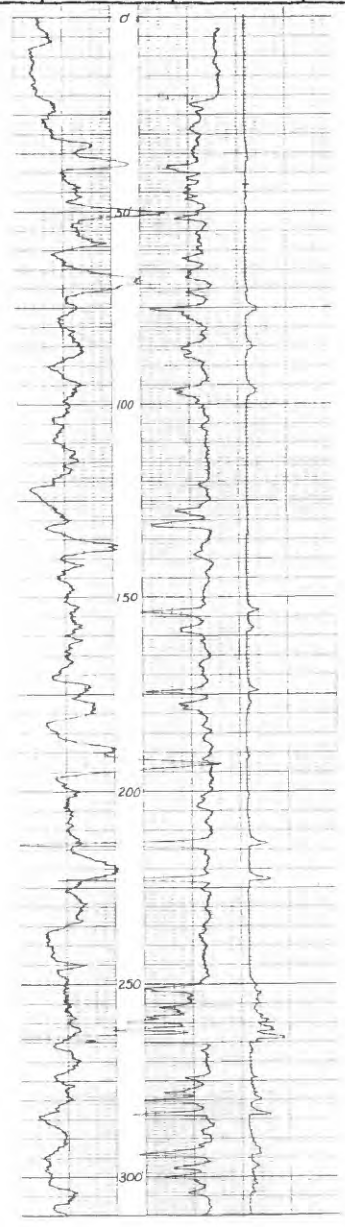
Resistivity (Res): Scale: 16.7 Ω/log div.

Gamma (Gam): T.C. ___ sec. Scale: 20 cps/log div.

Density (Den): T.C. ___ sec. Scale: 200 cps/log div.

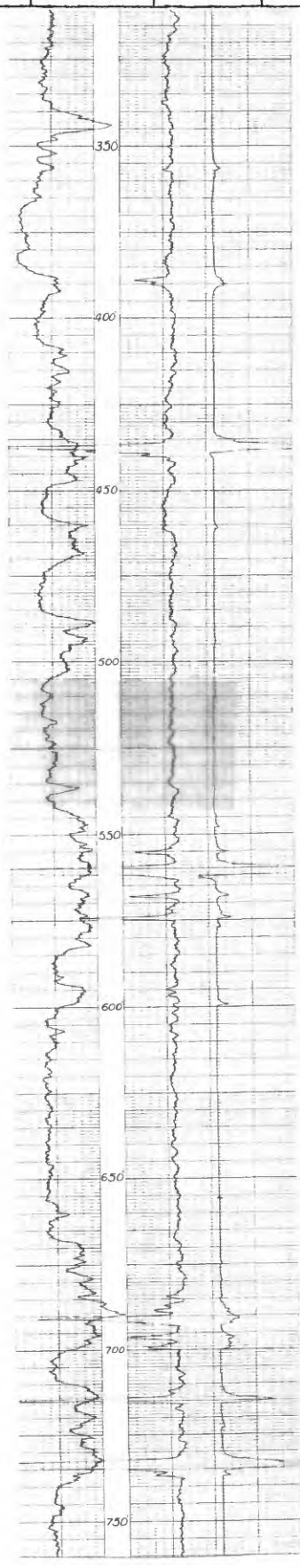
Remarks: Time constant not indicated

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam Den Cal Res
Drilling in Flagstaff Limestone and North Horn Formation, undifferentiated			
0- 5	Shale, maroon and light-gray to white		
5- 10	Limestone		
10- 15	Sandstone, white, fine-grained		
15- 25	Limestone, white		
25- 30	Sandstone, white to light-gray, fine- to medium-grained		
30- 75	Limy siltstone, gray; gray shale at 45 ft		
75- 80	Siltstone to shale, maroon		
80- 85	Siltstone, gray		
85-180	Limy siltstone to limestone, gray		
180-185	Limestone, white, chalky		
185-230	Limy siltstone, gray		
230-250	Sandstone, fine-grained		
250-255	Shale to siltstone, gray to dull-brown		
255-260	Shale, light-maroon		
260-265	Siltstone to shale, gray		
265-275	Sandstone, white, fine-grained		
275-280	Siltstone to shale, dark-gray		
280-310	Limy siltstone, gray		
310-345	Sandstone, medium-grained, well-rounded; dark minerals at 345 ft		



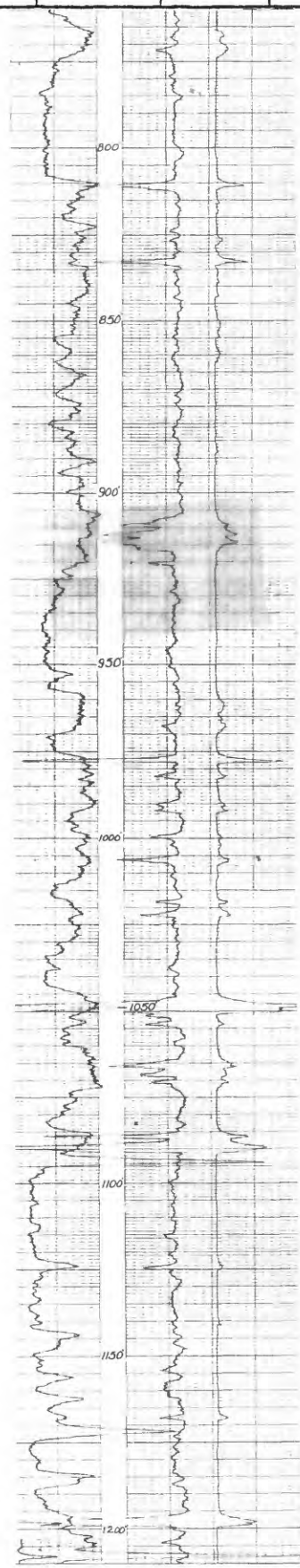
Hole No. BC-5-W (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam Den Cal Res
345–	365	Siltstone to shale, white to gray		
365–	385	Sandstone, medium- to coarse-grained, very well rounded		
385–	390	Sandstone, dark-gray		
390–	430	Sandstone, medium- to coarse-grained		
430–	435	Siltstone, gray		
435–	445	Sandstone, fine-grained		
445–	455	Sandstone, medium-grained, well-rounded		
455–	470	Shale, brownish-gray		
470–	485	Sandstone, very fine grained		
485–	510	Mudstone, light-gray		
510–	540	Siltstone, light-gray		
540–	610	Mudstone, gray		
		TOP OF PRICE RIVER FORMATION		
610–	670	Sandstone, fine-grained		
670–	735	Mudstone, dark-gray		
735–	770	Sandstone to siltstone		
770–	790	Shale, gray, silty		
790–	815	Sandstone, very fine grained		
815–	1,110	Shale, dark-gray, silty; some sandstone, medium-grained		
1,110–	1,170	Sandstone, fine-grained; shale		
1,170–	1,180	Shale, dark-gray		
1,180–	1,200	Sandstone, fine-grained		
1,200–	1,270	Shale, dark-gray		
1,270–	1,315	Sandstone, light-gray, fine-grained		
1,315–	1,350	Shale, gray, silty		
		TOP OF CASTLEGATE SANDSTONE		
1,350–	1,450	Sandstone, light-gray		
1,450–	1,505	Sandstone and shale, dark-gray		
		TOP OF BLACKHAWK FORMATION		
1,505–	1,650	Shale, dark-gray; mudstone, dark-gray		
1,650–	1,750	Shale, gray		
		Total depth: 1,750 ft		



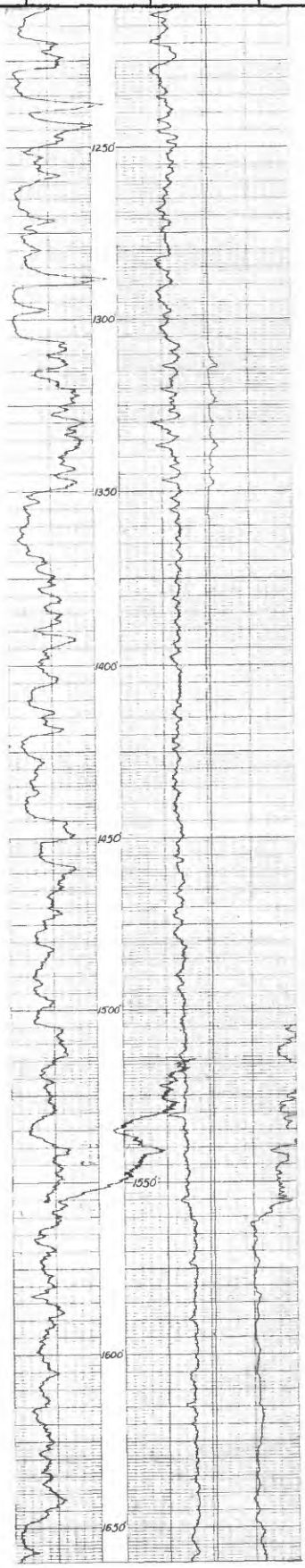
Hole No. BC-5-W (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



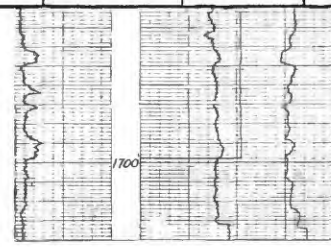
Hole No. BC-5-W (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



Hole No. BC-5-W (continued)

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS			
		Gam	Den	Cal	Res



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-6-W Quadrangle Woodside Elevation 6,250 ft

Location: T. 17 S., R. 15 E., sec. 19, 450' FNL 700'FEL

Rotary-drilled depth 759.4' Cored interval 759.4-961.8' Logged depth 961' Total depth 961.8'

Drilling medium Mud

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

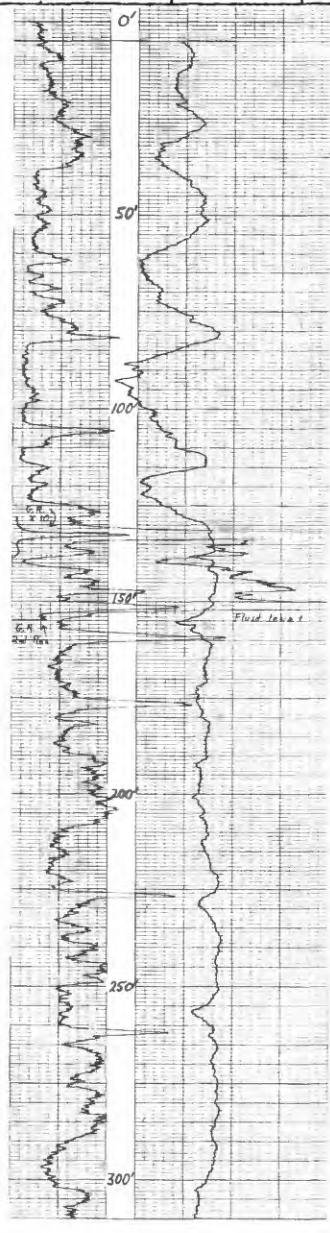
Resistivity (Res): Scale: 2 Ω/log div.

Gamma (Gam): T.C. 1 sec. Scale: 20 cps/log div.

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

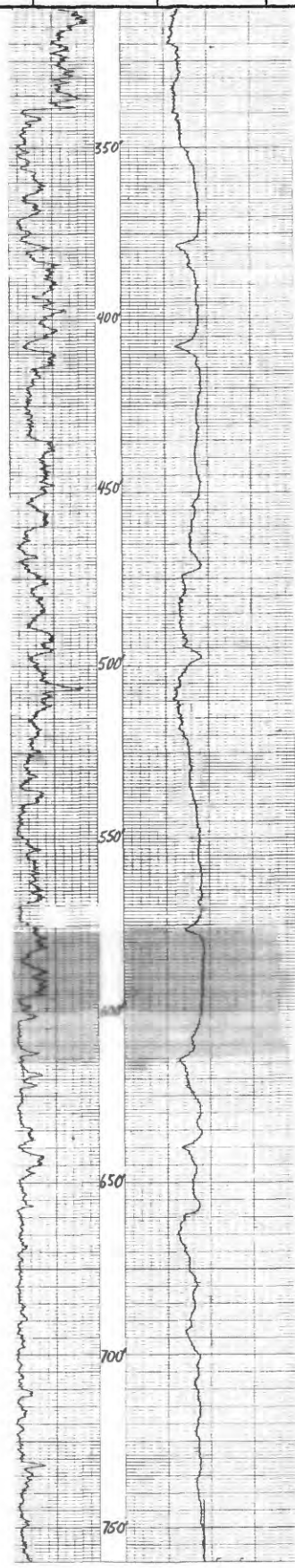
Remarks:

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam Den Cal Res
0- 10	Alluvial sand, yellowish-brown		
10- 20	Shale, brown		
	TOP OF PRICE RIVER FORMATION		
20- 35	Mudstone, medium-gray		
35- 70	Sandstone, yellowish-brown, fine-grained; mostly quartz		
70- 80	Shale, dark-gray, carbonaceous		
80-105	Sandstone, yellowish-brown, as above		
105-110	Mudstone, medium-gray		
110-120	Sandstone, yellowish-brown, as above		
120-130	Mudstone, medium-gray		
130-140	Shale, silty, light-brown		
140-150	Mudstone, dark-gray		
150-155	Sandstone, yellowish-brown, fine-grained		
155-160	Shale, dark-gray, carbonaceous		
160-175	Sandstone, yellowish-brown, fine-grained		
175-205	Mudstone, medium-gray		
205-225	Sandstone, yellowish-brown, fine-grained		
225-250	Mudstone, medium-gray		
250-255	Sandstone, yellowish-brown, fine-grained		
255-260	Shale, chocolate-brown		
260-290	Mudstone, dark-gray		



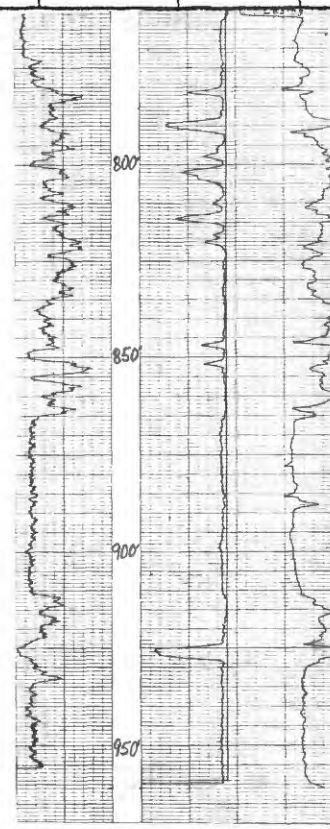
Hole No. BC-6-W (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS			
				Gam	Den	Cal	Res
290	-305	Siltstone, light-gray; mostly quartz					
305	-330	Mudstone, medium-gray					
330	-340	Siltstone, light-gray					
340	-345	Shale, light-gray, silty					
345	-355	Siltstone, light-gray					
355	-380	Mudstone, medium- to dark-gray; some light-gray siltstone					
380	-420	Mudstone and shale, dark-gray					
420	-425	Siltstone, light-gray					
425	-460	Mudstone, dark-gray					
460	-470	Siltstone, light-gray					
470	-525	Mudstone, dark-gray					
525	-555	Siltstone, medium-gray					
555	-605	Mudstone, gray					
		TOP OF CASTLEGATE SANDSTONE					
605	-759.4	Sandstone, light-gray, fine-grained; mostly quartz					
		End Rotary; begin core					
759.4	-772.5	Sandstone as above, becoming finer downward, to siltstone					
		TOP OF BLACKHAWK FORMATION					
772.5	-780.4	Siltstone, light-gray, with interbedded areas of carbonaceous material					
780.5	-780.9	Carbonaceous shale, with minor coal					
780.9	-781.4	Coal, with carbonaceous shale					
781.4	-781.8	Carbonaceous shale, with minor coal					
781.8	-783.6	Mudstone, with abundant silty, carbonaceous material					
783.6	-788.3	Siltstone; abundant carbonaceous material					
788.3	-791.3	Coal and carbonaceous shale (about half and half); resin					
791.3	-791.6	Carbonaceous shale, with pyrite					
791.6	-795.1	Silty mudstone					



Hole No. BC-6-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam | Den | Cal | Res
795.1-795.8	Carbonaceous shale		
795.8-796.1	Silty mudstone		
796.1-797.4	Siltstone, with carbonaceous material		
797.4-798.2	Carbonaceous shale; resin		
798.2-800.1	Siltstone, light-gray		
800.1-803	Carbonaceous shale and coal		
803 -804.5	Siltstone and carbonaceous material		
804.5-804.9	Carbonaceous shale		
804.9-809.4	Siltstone; abundant carbonaceous material		
809.4-810	Carbonaceous shale		
810 -811.4	Silty shale; abundant carbonaceous material		
811.4-812.1	Siltstone; carbonaceous material		
812.1-812.8	Carbonaceous shale		
812.8-813.4	Coal		
813.4-815	Carbonaceous shale		
815 -817.5	Silty shale		
817.5-818.3	Carbonaceous shale		
818.3-819	Silty mudstone; carbonaceous material		
819 -820.4	Carbonaceous shale		
820.4-822.8	Silty mudstone; carbonaceous material		
822.8-846.3	Silty mudstone, with carbonaceous material and interbedded siltstone; more siltstone downward, banded white and black		
846.3-846.6	Carbonaceous shale		
846.3-846.8	Coal		
846.8-847.8	Siltstone and carbonaceous material, banded		
847.8-851	Siltstone, light-gray; some carbonaceous material		
851 -852.1	Carbonaceous shale		
852.1-854.4	Mudstone, dark-gray, with carbonaceous material		



Hole No. BC-6-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS			
			Gam	Den	Cal	Res
854.4-864.8	Siltstone and carbonaceous material, banded					
864.8-911.4	Sandstone, fine-grained, friable; crossbedding; some dark layering					
911.4-924.5	Siltstone and carbonaceous material, interbedded, banded					
924.5-927.6	Coal. Sunnyside bed					
927.6-928.2	Carbonaceous shale					
928.2-961.8	Sandstone, grayish, fine-grained, massive at top; crossbedded at bottom; dark bands; some layering					
	Total depth: 961.8 ft					

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-7-W Quadrangle Woodside Elevation 6,150 ft

Location: T. 17 S., R. 15 E., sec. 30, 900'FEL 1,450' FNL

Rotary-drilled depth 985' Cored interval _____ Logged depth 984' Total depth 985'

Drilling medium Air and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

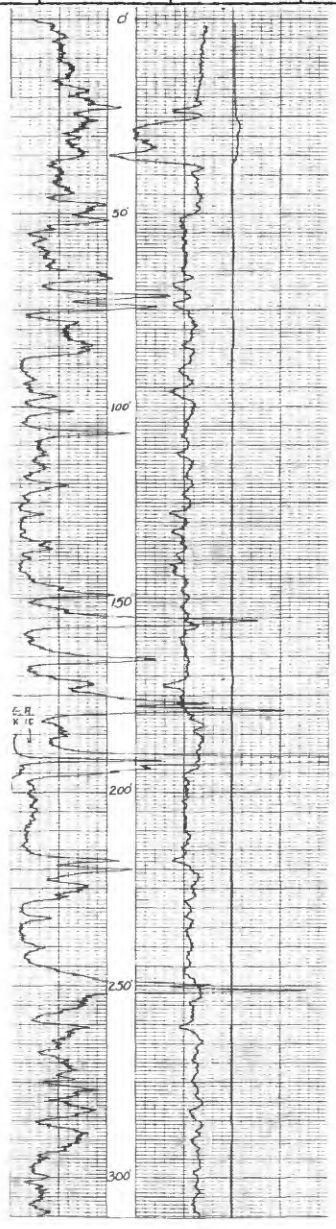
Resistivity (Res): Scale: 10 Ω/log div.

Gamma (Gam): T.C. 1 sec. Scale: 20 cps/log div.

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

Remarks: Drilling in Flagstaff Limestone and North Horn Formation, undifferentiated

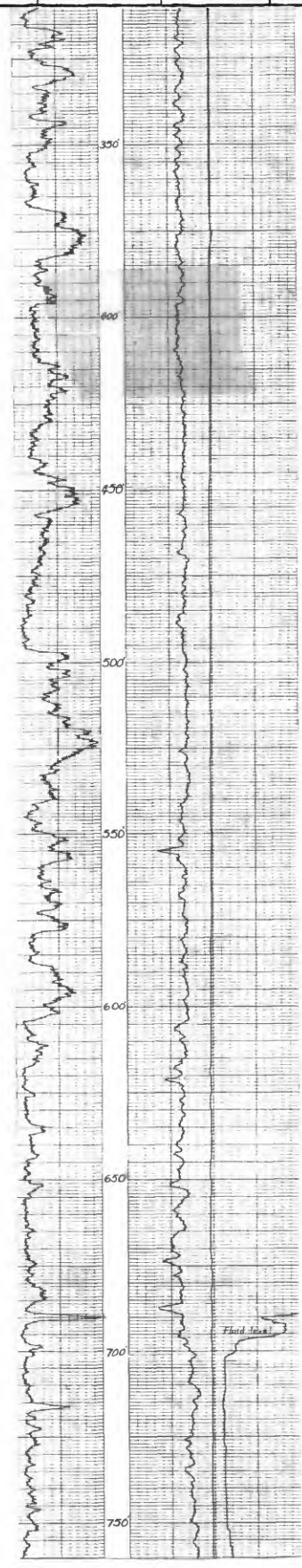
LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
0- 7	Sandstone, brown, medium-grained		
7- 20	Shale, brown		
20- 25	Limestone to limy sandstone, fine-grained		
25- 30	Sandstone, gray, medium- to fine-grained		
30- 40	Sandstone, gray, fine-grained		
40- 47	Limy sandstone, gray		
47- 65	Sandstone, medium-grained, well-rounded, clean		
65- 70	Sandstone, medium-grained; some carbonaceous shale, gray		
70- 75	Sandstone, coarse-grained		
75- 80	Sandstone, fine-grained; gray shale		
80- 85	Siltstone, gray, to carbonaceous siltstone		
	TOP OF PRICE RIVER FORMATION		
85-175	Sandstone, medium-grained, well-sorted, very clean		
175-190	Siltstone, gray		
190-215	Sandstone, medium-grained, well-sorted, clean		
215-225	Siltstone, gray to dark-gray		
225-245	Sandstone, gray, medium-grained		



Hole No. BC-7-W (continued)

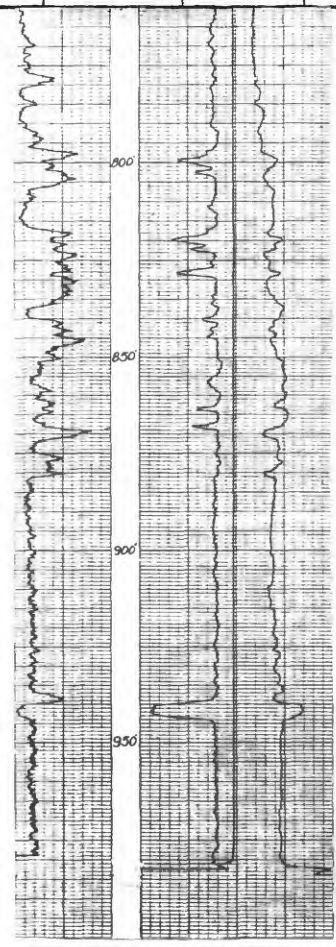
LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
245–250	Siltstone, gray		
250–255	Siltstone, dark-gray to brown; brown shale		
255–260	Sandstone, brown, fine-grained		
260–265	Siltstone, gray		
265–275	Sandstone, gray, fine- to medium-fine-grained		
275–280	Sandstone, fine-grained; maroon shale		
280–295	Sandstone, gray, fine-grained		
295–300	Sandstone, gray, very fine grained, powdery		
300–335	Same as above		
335–350	Siltstone to very fine grained sandstone, very hard		
350–365	Sandstone, white, fine-grained		
365–380	Siltstone, gray to dark-gray, carbonaceous		
380–395	Sandstone, fine-grained, well-indurated		
395–410	Sandstone, medium-grained		
410–445	Shale, carbonaceous; sandstone, fine- to medium-grained, with carbonaceous streaks		
445–465	Shale, dark-gray; dark-gray mudstone		
465–495	Sandstone, medium-grained, with carbonaceous stringers throughout		
495–500	Mudstone, carbonaceous		
500–550	Sandstone, medium-grained, with carbonaceous stringers		
550–605	Shale, carbonaceous, to carbonaceous siltstone		
	TOP OF CASTLEGATE SANDSTONE		
605–785	Sandstone, fine- to medium-grained, very clean		
	TOP OF BLACKHAWK FORMATION		
785–820	Mudstone, carbonaceous, to carbonaceous shale		
820–830	Mudstone, carbonaceous; coal stringers		

Gam | Den | Cal | Res



Hole No. BC-7-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam | Den | Cal | Res
830–880	Shale and sandstone; some carbonaceous stringers		
880–940	Sandstone, medium-grained, clean		
940–945	Coal. Sunnyside bed		
945–984	Sandstone, medium-grained, clean		
	Total depth: 985 ft		



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-8-W Quadrangle Woodside Elevation 5,950 ft

Location: T. 17 S., R. 15 E., sec. 29, 700' FSL 1,200' FWL

Rotary-drilled depth 771.3' Cored interval 771.3-942' Logged depth 942 Total depth 942.1

Drilling medium Air and mud

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

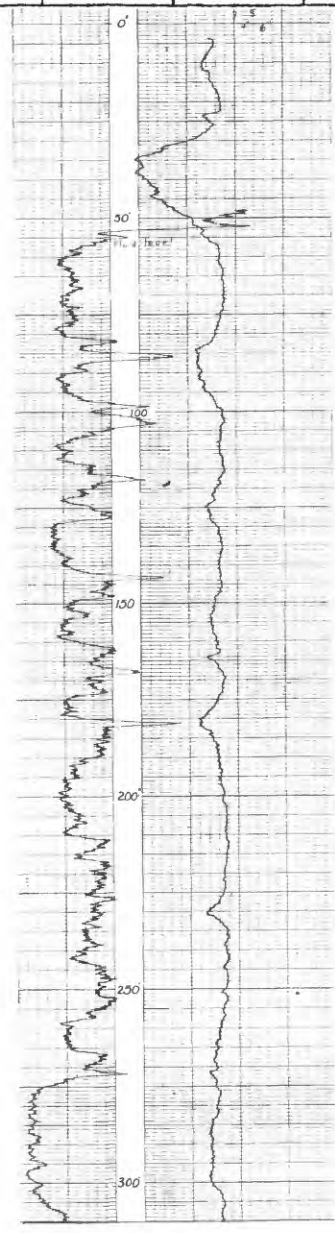
Resistivity (Res): Scale: 15 Ω/log div.

Gamma (Gam): T.C. 1 sec. Scale: 20 cps/log div.

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

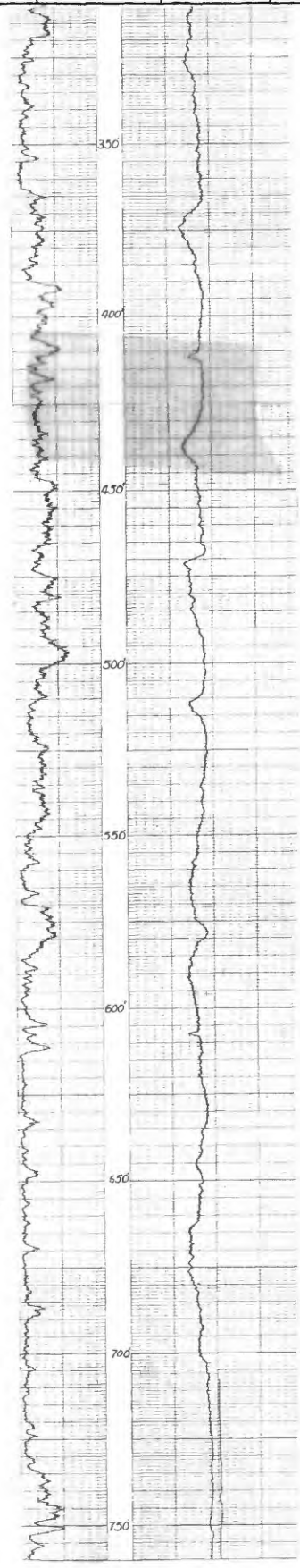
Remarks:

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
0- 25	Sandstone, yellowish-brown		
25- 35	Siltstone and mudstone, light-gray, interbedded		
	TOP OF PRICE RIVER FORMATION		
35-140	Sandstone, yellowish-brown, fine-grained; minor siltstone and mudstone		
140-150	Mudstone, medium-gray, silty		
150-165	Sandstone, yellowish-brown, fine-grained		
165-170	Mudstone, dark-gray		
170-180	Sandstone, yellowish-brown		
180-190	Mudstone, medium-gray		
190-210	Sandstone, light-gray, fine-grained		
210-235	Mudstone, medium-gray		
235-245	Siltstone, light gray; mostly quartz		
245-255	Mudstone, dark-gray		
255-265	Siltstone, light-gray		
265-270	Mudstone, medium-gray		
270-310	Siltstone and mudstone		
310-320	Mudstone, medium-gray		
320-360	Siltstone, light-gray		
360-395	Mudstone, medium-gray		
395-405	Siltstone, light-gray		



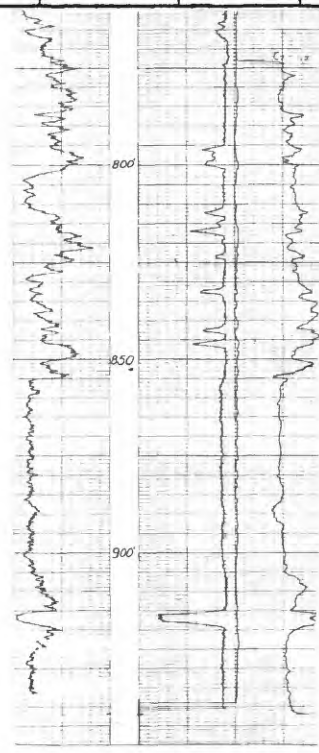
Hole No. BC-8-W (continued)

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS
				Gam | Den | Cal | Res
405	-410	Carbonaceous shale, with minor coal		
410	-550	Mudstone, medium-gray; some carbonaceous material		
550	-570	Siltstone, medium-gray; carbonaceous material		
570	-590	Mudstone, medium-gray		
590	-605	Siltstone, medium-gray		
		TOP OF CASTLEGATE SANDSTONE		
605	-740	Sandstone, light-gray, fine-grained; mostly quartz		
		TOP OF BLACKHAWK FORMATION		
740	745	Mudstone		
745	-755	Sandstone, fine-grained		
755	-771.3	Mudstone, carbonaceous; minor coal		
		End rotary; begin core		
771.3	-795	Siltstone and mudstone, interbedded		
795	-800	Carbonaceous shale, with minor coal (as much as 0.1 ft)		
800	-800.8	Silty mudstone; abundant carbonaceous material		
800.8	-811.4	Siltstone; some carbonaceous material; shows dark bands		
811.4	-812	Carbonaceous shale		
812	-812.1	Coal		
812.1	-812.5	Carbonaceous shale; abundant pyrite		
812.5	-814.2	Silty mudstone; abundant carbonaceous material		
814.2	-814.9	Carbonaceous shale, with minor coal		
814.9	-815.9	Silty mudstone; carbonaceous material		
815.9	-817.2	Carbonaceous shale, with minor coal		
817.2	-819.6	Mudstone; carbonaceous material		
819.6	-819.8	Carbonaceous shale		
819.8	-822.8	Silty mudstone; carbonaceous material		



Hole No. BC-8-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam / Den / Cal / Res
822.8-823.4	Carbonaceous shale		
823.4-831.8	Siltstone, dark- to light-gray		
831.8-832.3	Coal		
832.3-832.5	Carbonaceous shale		
832.5-841.9	Siltstone, banded; some carbonaceous material		
841.9-842.7	Carbonaceous shale		
842.7-845.3	Siltstone, banded		
845.3-845.8	Coal		
845.8-846.6	Carbonaceous shale		
846.6-854.9	Siltstone and mudstone, interbedded		
854.9-905.9	Sandstone, fine-grained, friable; crossbedding; some dark gray beds		
905.9-915	Siltstone and mudstone, interbedded		
915 -917.9	Coal. Sunnyside bed		
917.9-918.6	Siltstone, with minor coal		
918.6-942.1	Sandstone, gray, fine-grained; massive at top, crossbedded at bottom		
	Total depth: 942.1 ft		



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, EMERY COUNTY, UTAH

Hole No. BC-10-W Quadrangle Woodside Elevation 5,700 ft

Location: T. 17 S., R. 15 E., sec. 29, 700' FSL 1,150' FEL

Rotary-drilled depth 990 ft Cored interval _____ Logged depth 984' Total depth 990'

Drilling medium Air and foam

Geophysical logs:

Caliper (Cal) - Logging speed: 40 ft/min. Others: 20 ft/min

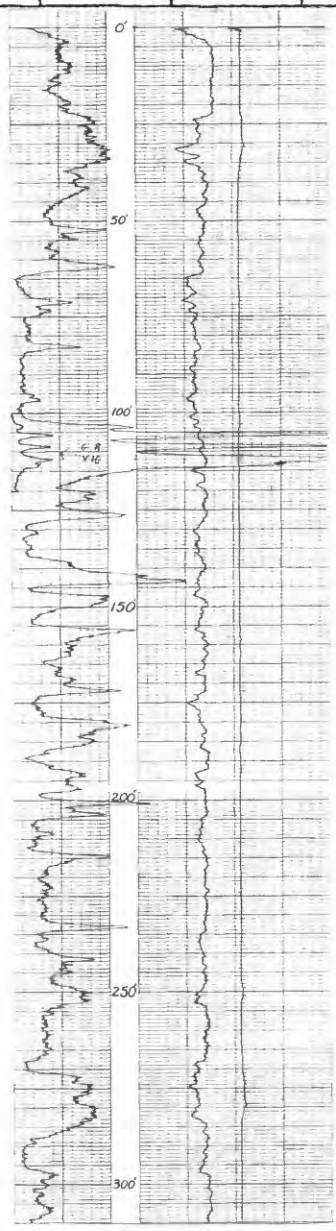
Resistivity (Res): Scale: 16.7 Ω/log div.

Gamma (Gam): T.C. 1 sec. Scale: 20 cps/log div.

Density (Den): T.C. 1 sec. Scale: 200 cps/log div.

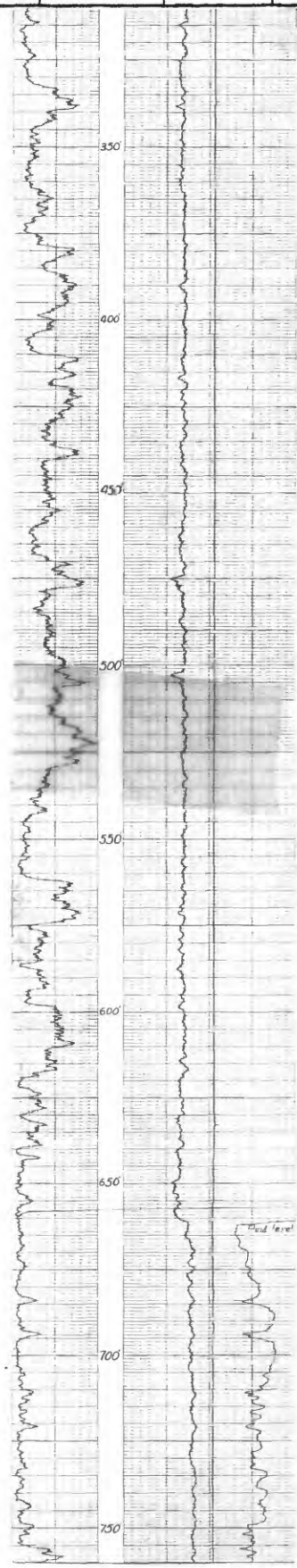
Remarks: _____

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
	Collared in North Horn Formation		
0- 15	Siltstone, greenish-yellow		
15- 40	Siltstone, medium-gray		
40- 50	Shale, medium-gray		
	TOP OF PRICE RIVER FORMATION		
50- 55	Sandstone, light-gray, fine-grained, friable		
55- 65	Sandstone, yellow, medium-grained, well-rounded, friable		
65-115	Sandstone, white, poorly sorted, friable; subangular grains of quartz		
115-125	Sandstone, light-gray, fine-grained, quartzose, friable		
125-130	Sandstone, white, fine-grained, quartzose, friable		
130-135	Sandstone, light-yellowish-brown, medium-grained, subrounded, friable		
135-140	Shale, medium-gray		
140-145	Sandstone, yellow, medium-grained, subrounded, friable		
145-170	Shale, medium- to dark-gray; pyritic at 155 ft		
170-180	Sandstone, light-gray, fine-grained		
180-200	Shale, dark-gray; carbonaceous from 190 to 200 ft		



Hole No. BC-10-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam | Den | Cal | Res
200-240	Sandstone, light-gray, very fine grained		
240-245	Shale, medium-gray		
245-250	Siltstone, light-brownish-gray		
250-265	Shale, medium-gray		
265-270	Sandstone and carbonaceous shale; sandstone is light gray and fine grained		
270-280	Shale, dark-gray, carbonaceous		
280-320	Shale, medium-gray		
320-330	Siltstone, light-gray		
330-340	Shale, medium-gray		
340-360	Silty sandstone, light-gray, very fine grained		
360-400	Shale, dark-gray, carbonaceous		
400-405	Siltstone, light-gray, friable		
405-425	Shale, dark-gray, carbonaceous		
425-440	Shale, medium-gray, with some interbedded light-gray, fine-grained sandstone		
440-470	Shale, light-gray, with sandstone as above		
470-475	Carbonaceous shale and sparse coal		
475-480	Carbonaceous shale		
480-550	Shale, medium-gray, with light-gray, fine-grained sandstone, interbedded		
550-560	Sandstone, light-gray, very fine grained, angular		
560-635	Shale, dark-gray to black		
	TOP OF CASTLEGATE SANDSTONE		
635-650	Silty sandstone, light-gray, very fine grained, friable		
650-665	Sandstone, light-gray, poorly sorted, angular-grained; interbedded black shale		
665-790	Sandstone, light-gray, fine-grained, angular		
	TOP OF BLACKHAWK FORMATION		
790-800	Coal and carbonaceous shale		



Hole No. BC-10-W (continued)

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS
			Gam / Den / Cal / Res
800-805	Sandstone, light-gray, fine-grained, angular, with carbonaceous shale		
805-815	Carbonaceous shale		
815-830	Sandstone, light-gray, very fine grained, with interbedded carbonaceous shale and minor coaly material		
830-835	Sandstone, light-gray, very fine grained, friable		
835-845	Carbonaceous shale		
845-870	Sandstone, light-gray, medium-grained, with interbedded carbonaceous shale		
870-880	Sandstone, medium-gray, poorly sorted, subangular-grained		
880-890	Sandstone, light-gray, fine-grained, with interbedded carbonaceous shale		
890-935	Sandstone, light-gray, fine-grained, with coaly specks from 930 to 935 ft		
935-940	Coal. Sunnyside bed		
940-990	Sandstone, light-gray, fine-grained, subangular		
	Total depth of "E" log: 984 ft