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Author(s): Marith J. Reheis

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

DRILLING DURING 1977 IN THE DANFORTH HILLS COAL FIELD, EASTON GULCH AND DEVILS HOLE GULCH QUADRANGLES, MOFFAT COUNTY, COLORADO

By Marith J. Reheis

Open-File Report 78-272

1978

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

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DRILLING DURING 1977 IN THE DANFORTH HILLS COAL FIELD, EASTON GULCH AND DEVILS HOLE GULCH QUADRANGLES, MOFFAT COUNTY, COLORADO

By Marith J. Reheis

INTRODUCTION

Eight test holes were drilled in the northern part of the Danforth Hills coal field, Easton Gulch and Devils Hole Gulch quadrangles, Colorado, during 1977. The drilling was done by Geck, Inc. of Rock Springs, Wyoming, under Contract No. 14-08-0001-15794, awarded by the U.S. Geological Survey. The geophysical logging (single-point resistance, density, and natural-gamma) was performed by Century Geophysical Corporation, under contract to Geck, Inc. These eight drill holes, and five additional holes drilled in the adjacent Axial and Ninemile Gap quadrangles (Nutt, 1978), are part of the Survey's continuing effort to obtain information on the thickness and extent of federally owned coal in the Danforth Hills coal field (Reheis, 1976; Reheis and Peterson, 1977). Jill Robinson assisted in the supervision of the drilling and in the lithologic sampling and logging.

Lithologies described in this report were compiled from both the sample logs and the geophysical logs, except where otherwise noted. Because of the similarity of the rock types, full descriptions have been omitted. The sandstones, many of which are carbonaceous, are tan to various shades of gray, fine to very fine grained, and well sorted. The siltstones, shales, and clays are gray; carbonaceous siltstones and shales range from brown to black. Various lithologies on the drill-hole logs have been combined to accommodate the reduced scale of the geophysical logs presented in this report (original logs were run at 1 inch to 10 feet). More detail is given on the correlation chart (fig. 4), drafted at 1 inch to 30 feet.

All of the holes were spudded in the Williams Fork Formation (Upper Cretaceous). Most of them bottomed in or just above the top of the Trout Creek Sandstone Member of the Upper Cretaceous Iles Formation of the Mesaverde Group, providing firm stratigraphic control. The holes that did not penetrate the top of the Trout Creek Sandstone Member were correlated by using nearby measured surface sections and structural information, and by comparing with the nearest drill hole that did bottom in the Trout Creek Sandstone.

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

REFERENCES

Nutt, C. J., 1978, Drilling during 1977 in the Danforth Hills coal field, Axial and Ninemile Gap quadrangles, Moffat and Rio Blanco Counties, Colorado: U.S. Geol. Survey Open-File Report 78-273, 17 p.

Reheis, M. J., 1976, Reconnaissance drilling in the Danforth Hills coal field, Moffat and Rio Blanco Counties, Colorado, August-September 1976: U.S. Geol. Survey Open-File Report 76-870, 74 p.

Reheis, M. J., and Peterson, J. E., 1977, Reconnaissance drilling in the Danforth Hills coal field, Moffat and Rio Blanco Counties, Colorado, September-October 1976: U.S. Geol. Survey Open-File Report 77-42, 67 p.

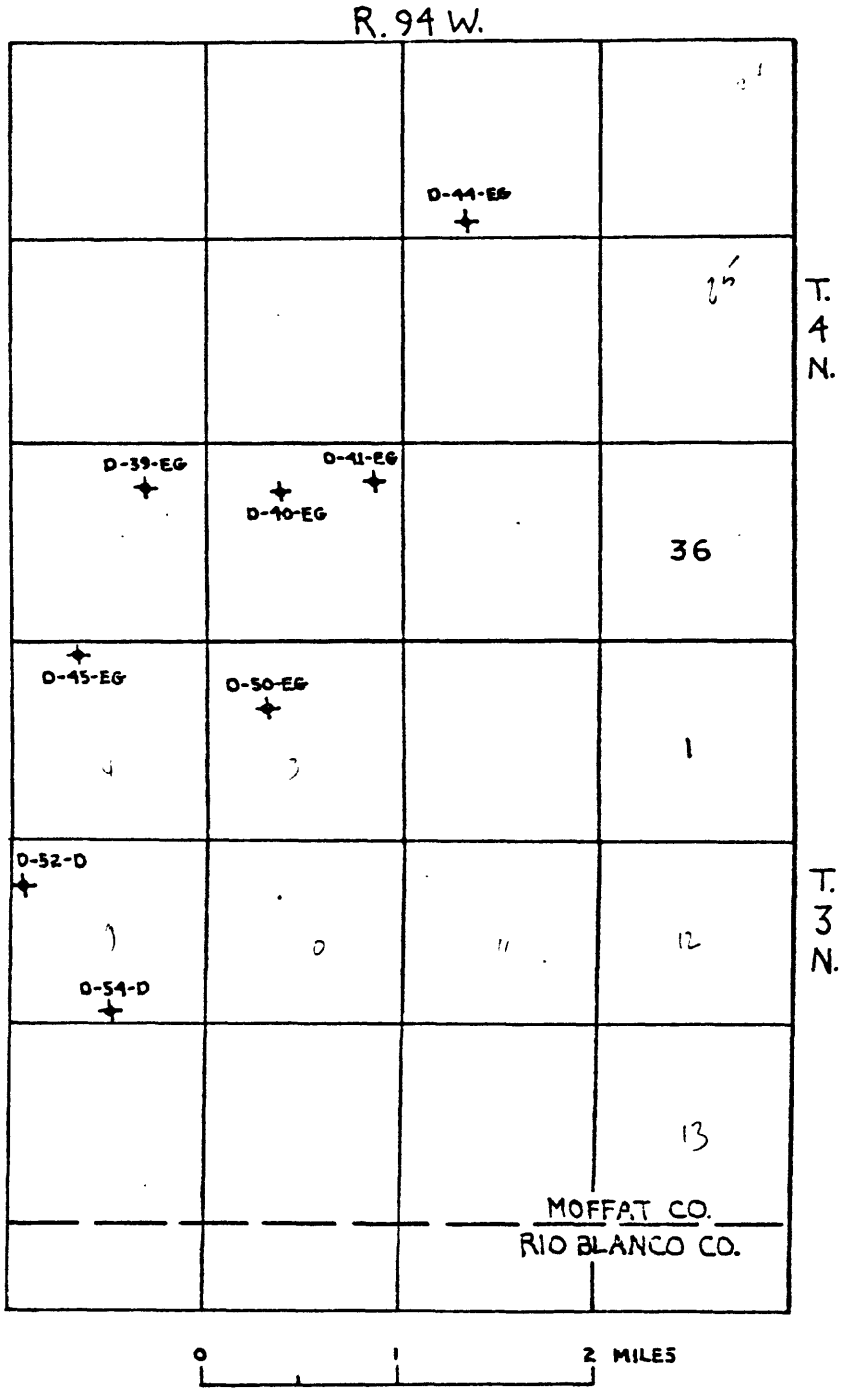


Figure 1.--Regional map showing drill-hole locations in the northern Danforth Hills coal field, Colorado.

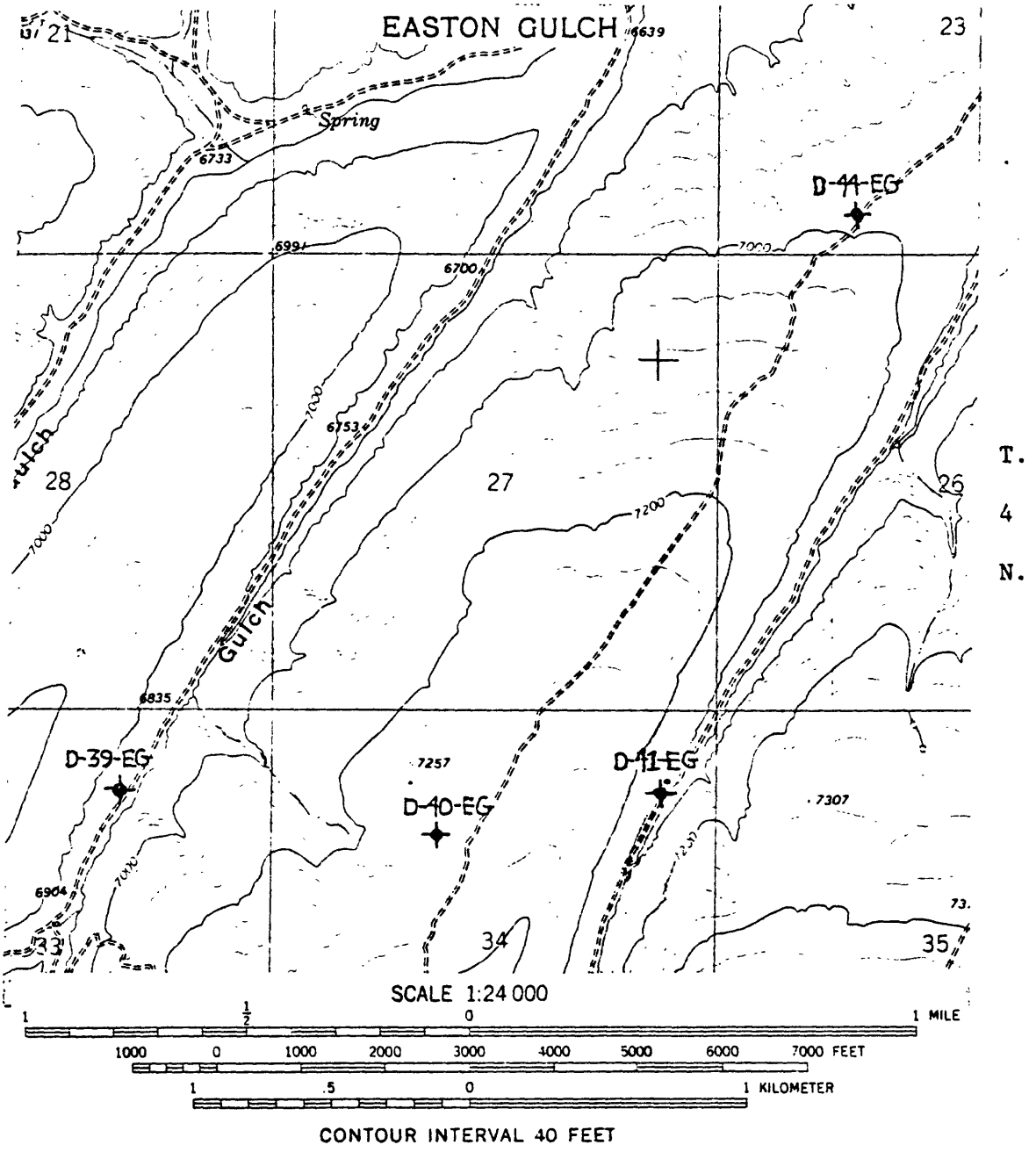


Figure 2.--Locations of drill holes in the Easton Gulch quadrangle, Moffat County, Colorado.

R. 94 W.

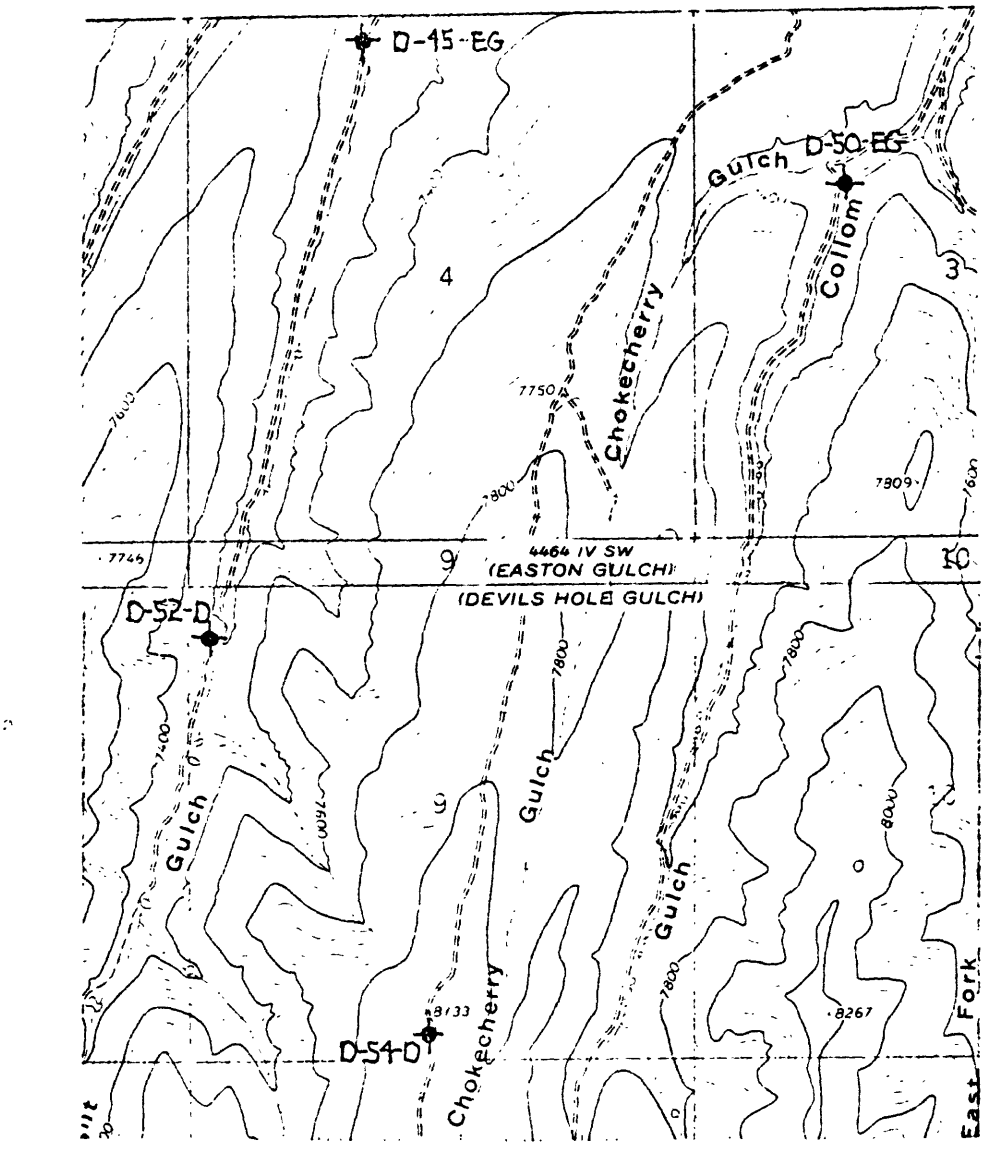


Figure 3.--Locations of drill holes in the Easton Gulch and Devils Hole Gulch quadrangles, Moffat County, Colorado.

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-39-E State Colorado County Moffat Date Logged 8/13/77 Elev.(ft) ~6865

Location: T. 4 N., R. 94 W., sec. 33 NW¼NE¼ Cored: ☐ Yes ☒ No

Drilled depth 800' Logged depth 800' Drilling medium H_2O + mud Fluid level 0'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

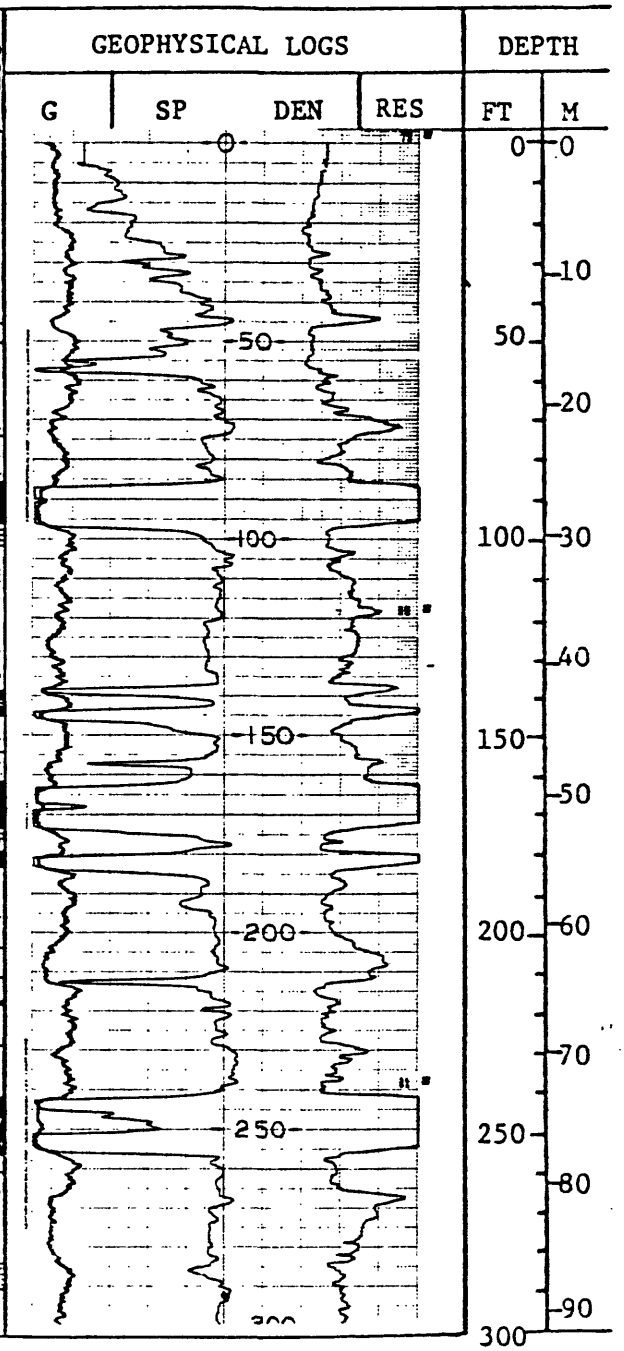
Resistance (RES): Scale 50 Ω/in Logging speed 20 fpm

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

Density (DEN): T.C. 1 Scale 10K cps/in Logging speed 20 fpm

Remarks: Williams Fork Formation

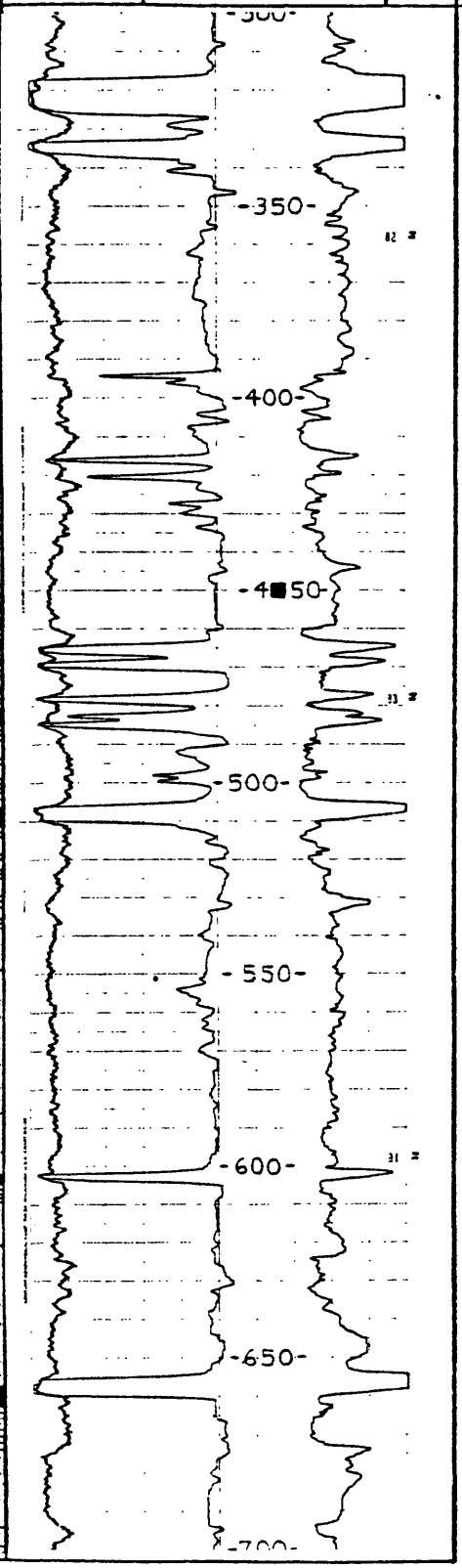
LITHOLOGY		STRIP LOG
0-45	Alluvium, sandy gravel	
45-50	Shale	
50-73	Sandstone, very fine grained to medium-grained, carbonaceous	
73-85.5	Interbedded siltstone, carbonaceous, and very fine grained to medium-grained carbonaceous sandstone	
85.5-96	Coal	
96-102	Shale, carbonaceous	
102-137.5	Sandstone, carbonaceous; thin, carbonaceous siltstone	
137.5-140	Coal	
140-142	Shale, carbonaceous	
142-145.5	Coal	
145.5-153	Siltstone, carbonaceous	
153-161.5	Sandstone, carbonaceous	
161.5-173	Coal	
173-176	Shale, carbonaceous	
176-179	Sandstone, carbonaceous	
179-183	Coal	
183-204	Siltstone, carbonaceous; thin, carbonaceous sandstone	
204-211	Sandstone, carbonaceous	
211-228	Siltstone, carbonaceous; thin, bony coal	
228-240.5	Sandstone, carbonaceous; thin shale	
240.5-255.5	Coal; bony 245.5-250'	
255.5-260	Siltstone, carbonaceous	
260-284	Sandstone, carbonaceous; green micaceous 260-275'	
284-290	Shale, carbonaceous	
290-300	Sandstone, carbonaceous	



U.S. GEOLOGICAL SURVEY

Hole No. D-39-EG continued

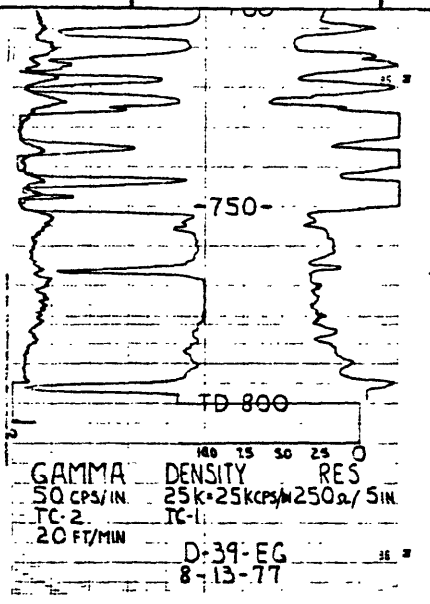
LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS				DEPTH	
			G	SP	DEN	RES	FT	M
300-301	Sandstone, carbonaceous							
301-316	Interbedded sandstone and carbonaceous shale							
316-325.5	Coal							
325.5-331	Shale, carbonaceous							
331-336	Coal							
336-345	Shale, carbonaceous							
345-393	Sandstone							
393-400	Shale, carbonaceous; thin, bony coal							
400-407	Sandstone, carbonaceous							
407-413	Shale, carbonaceous							
413-415.5	Coal							
415.5-420	Shale, carbonaceous; thin, bony coal							
420-441	Interbedded shale, carbonaceous, and thin, carbonaceous sandstone							
441-459	Sandstone							
459-462.5	Shale, carbonaceous							
462.5-465.5	Coal							
465.5-469.5	Shale, carbonaceous; coal							
469.5-476	Sandstone; carbonaceous shale							
476-480.5	Coal; carbonaceous shale							
480.5-485	Coal; bony 480.5-483'							
485-504	Interbedded sandstone and carbonaceous shale							
504-509	Coal							
509-523	Interbedded shale, carbonaceous, and siltstone							
523-537	Interbedded shale, carbonaceous, and sandstone							
537-600.5	Sandstone, carbonaceous							
600.5-603	Coal							
603-608	Shale, carbonaceous							
608-653.5	Sandstone; thin siltstone							
653.5-659	Coal							
659-673	Shale, carbonaceous							
673-693	Sandstone							
693-697	Siltstone							
697-700	Sandstone							



U.S. GEOLOGICAL SURVEY

Hole No. D-39-EG continued

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS				DEPTH	
			G	SP	DEN	RES	FT	M
700-703.5	Sandstone							
703.5-705.5	Coal							
705.5-711	Sandstone, carbonaceous							
711-716	Coal; bony 711-713'							
716-718	Shale, carbonaceous							
718-721.5	Coal							
721.5-724	Shale, carbonaceous							
724-733	Coal; bony 724-725.5'							
733-735	Shale, carbonaceous							
735-740.5	Coal							
740.5-743	Shale, carbonaceous							
743-750.5	Coal; parting 746.5-747.5'							
750.5-755	Shale, carbonaceous							
755-766	Sandstone; thin coal							
766-780	Shale							
780-793.5	Sandstone							
793.5-796	Coal							
796-800	Shale, carbonaceous							



FT: 750, 800, 850, 900, 950, 1000, 1050, 1100

M: 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-40-EG State Colorado County Moffat Date Logged 9/27/77 Elev.(ft) ~7290

Location: T. 4 N., R. 94 W., sec. 34 NE¼NW¼ Cored: ☐ Yes ☒ No

Drilled depth 1453' Logged depth 1453' Drilling medium H_2O + mud Fluid level 10'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

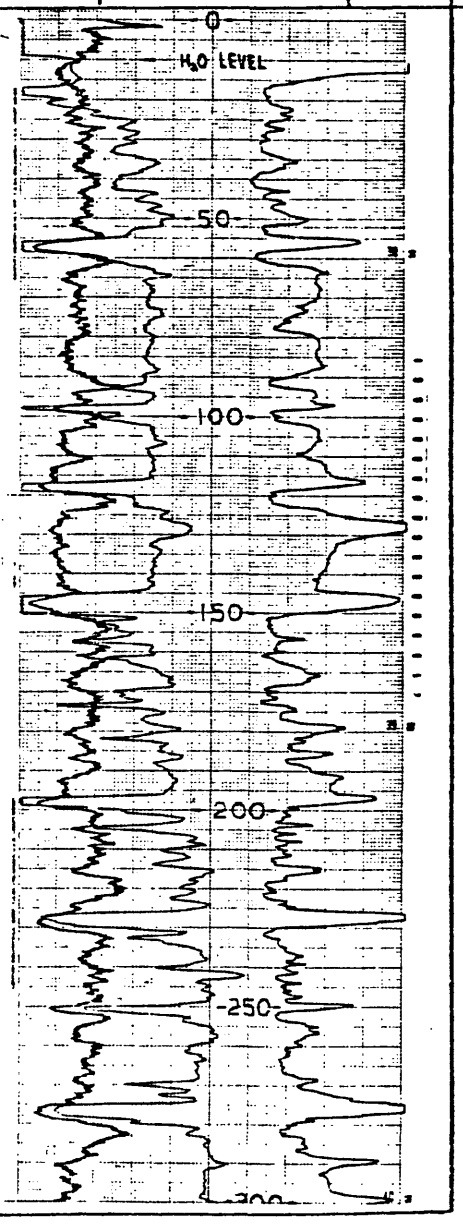
Resistance (RES): Scale 20 Ω/in Logging speed 20 fpm

Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10K cps/in Logging speed 20 fpm

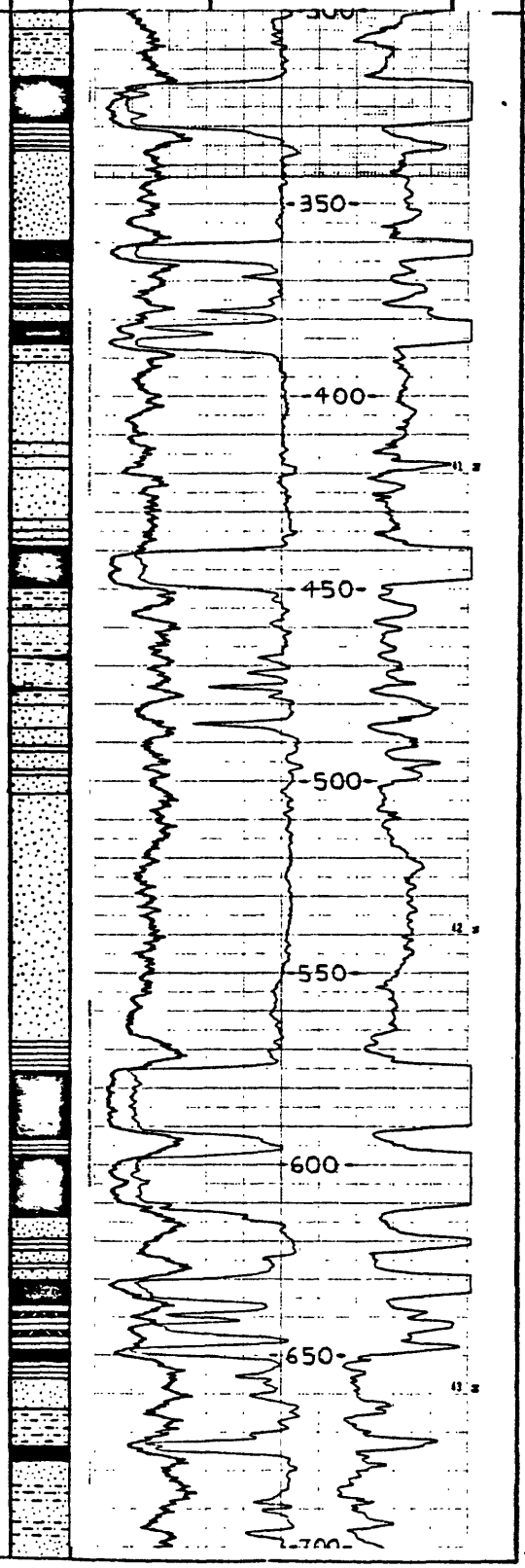
Remarks: Williams Fork Formation and upper part of Iles Formation including Trout Creek Sandstone Member. No samples 560-575', 600-615', 620-625', 660-665', 670-675', 695-700', 780-785'.

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS (G, SP, DEN, RES)	DEPTH FT	DEPTH M
0-21	Colluvium, sandy			0	0
21-25	Shale, carbonaceous				
25-54	Interbedded siltstone and shale				10
54-57.5	Coal			50	
57.5-78	Siltstone, carbonaceous				20
78-90	Sandstone				
90-102	Shale, carbonaceous; thin, bony coal			100	30
102-115	Sandstone				
115-118	Coal				40
118-130	Shale, carbonaceous				
130-144	Sandstone			150	
144-150	Coal				50
150-196	Interbedded shale, carbonaceous, and carbonaceous sandstone				
196-198	Coal				60
198-225	Shale, carbonaceous			200	
225-229.5	Coal				
229.5-249	Shale, carbonaceous				70
249-251	Coal			250	
251-274	Shale, carbonaceous				80
274-278	Coal				
278-283	Siltstone, carbonaceous				
283-300	Sandstone			300	90



Hole No. D-40-EG continued

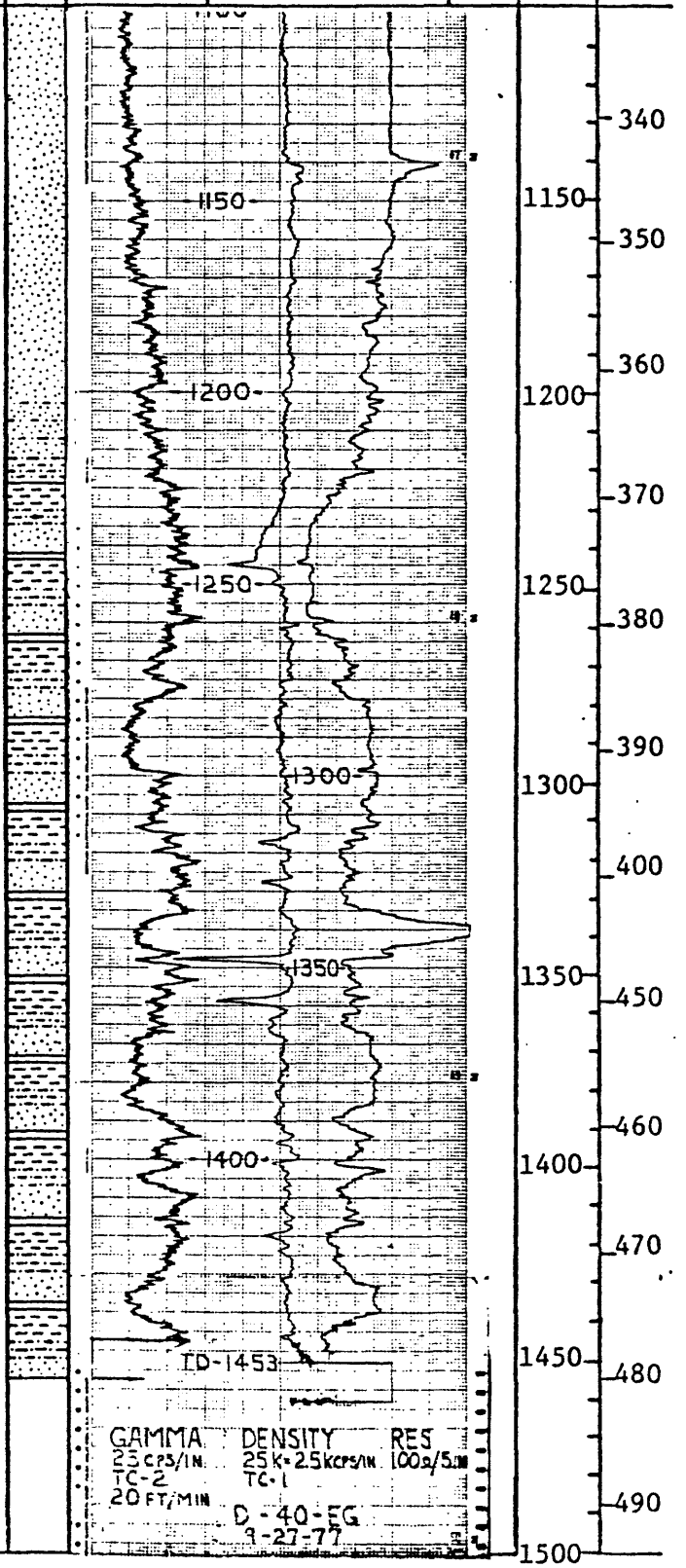
LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS	DEPTH	
			G SP DEN RES	FT	M
300-305	Sandstone				
305-317	Interbedded siltstone, carbonaceous, and carbonaceous sandstone				
317-329	Coal				
329-336	Shale, carbonaceous				
336-359	Sandstone				
359-364	Coal				
364-377.5	Shale, carbonaceous; thin, bony coal				
377.5-380	Sandstone, carbonaceous				
380-386.5	Coal; parting 382-383'				
386.5-390	Siltstone, carbonaceous				
390-438.5	Sandstone; thin, carbonaceous shale near base				
438.5-448	Coal				
448-453	Siltstone, carbonaceous				
453-484	Sandstone; thin, carbonaceous siltstone; thin, bony coals				
484-566	Sandstone, carbonaceous				
566-573	Shale, carbonaceous(?)				
573-590.5	Coal				
590.5-595.5	Shale, carbonaceous				
595.5-611.5	Coal				
611.5-627	Interbedded sandstone, carbonaceous, and carbonaceous shale				
627-634.5	Coal				
634.5-646.5	Shale, carbonaceous; thin, bony coal				
646.5-649	Coal				
649-653	Shale, carbonaceous				
653-662	Sandstone				
662-671	Siltstone				
671-674.5	Coal				
674.5-700	Interbedded sandstone, carbonaceous, and carbonaceous siltstone				



Hole No. D-40-EG continued

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS G SP DEN RES	DEPTH FT	DEPTH M
700-726.5	Interbedded siltstone, carbonaceous; carbonaceous shale and sandstone; thin, bony coals at base				220
726.5-729.5	Coal				
729.5-732	Siltstone, carbonaceous				
732-759	Sandstone, carbonaceous			750	230
759-763	Coal				
763-787	Interbedded siltstone, carbonaceous, and carbonaceous shale; thin sandstone				240
787-794	Coal				
794-810	Interbedded siltstone, carbonaceous, and carbonaceous shale			800	250
810-824	Sandstone, carbonaceous				
824-837	Shale, carbonaceous				
837-849	Sandstone, carbonaceous				
849-856	Coal; carbonaceous shale 851.5-853'; bony on top			850	260
856-881	Siltstone, carbonaceous; sandstone				
881-890	Coal				
890-896	Shale				270
896-910	Sandstone, carbonaceous				
910-919	Shale, carbonaceous, coaly			900	
919-927	Coal; parting 921-922'				280
927-939	Siltstone; carbonaceous sandstone				
939-945	Coal; parting 942-943'				
945-980	Interbedded siltstone, carbonaceous, and carbonaceous sandstone			950	290
980-994	Coal; parting 988.5-989.5'				
994-1011	Sandstone; thin coal				
1011-1019	Siltstone, carbonaceous				300
1019-1028.5	Sandstone				
1028.5-1036.5	Coal; parting 1030.5-1031.5'				
1036.5-1041	Sandstone, carbonaceous			1000	
1041-1046.5	Interbedded siltstone, carbonaceous, and carbonaceous shale				310
1046.5-1050.5	Coal, bony				
1050.5-1071	Interbedded siltstone, carbonaceous, and carbonaceous sandstone and shale			1050	320
1071-1077	Coal				
1077-1095	Interbedded shale, carbonaceous, and carbonaceous sandstone				330
ILES FORMATION					
1095-1100	Sandstone, fine-grained; Trout Creek Sandstone Member			1100	

LITHOLOGY	
1100-1223	Sandstone, fine-grained, fining toward base into siltstone; Trout Creek Sandstone Member, uppermost part of Iles Formation
1223-1453	Interbedded shale; siltstone; sandstone, and carbonaceous shale; upper part of Iles Formation



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-41-EG State Colorado County Moffat Date Logged 10/30/77 Elev. (ft) ~6980

Location: T. 4 N., R. 94 W., sec. 34 NE¼NE¼ Cored: ☐ Yes ☒ No

Drilled depth 820' Logged depth 820' Drilling medium H_2O + mud Fluid level 0

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

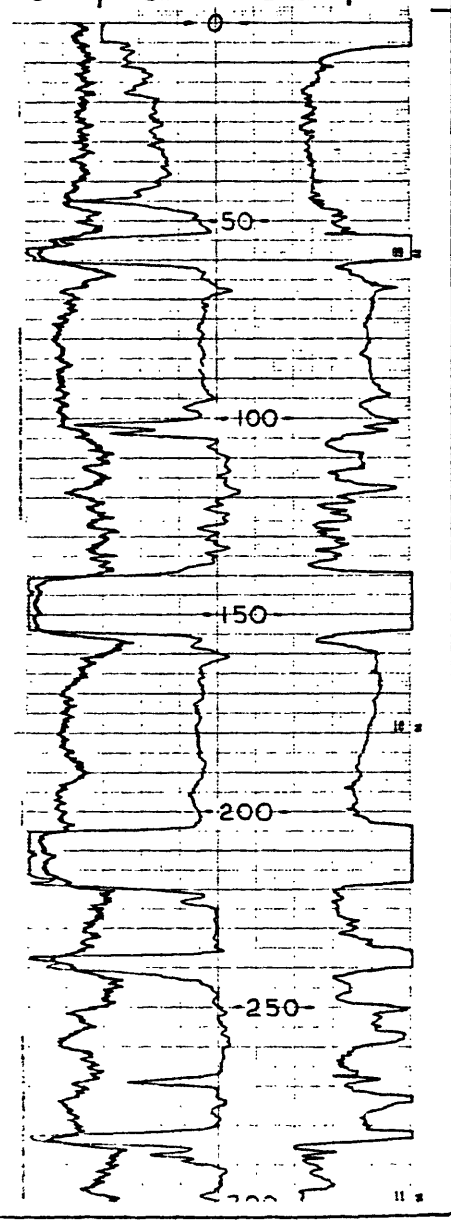
Resistance (RES): Scale 20 Ω/in Logging speed 20 fpm

Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10K cps/in Logging speed 20 fpm

Remarks: Williams Fork Formation and Trout Creek Sandstone Member of Iles Formation.

LITHOLOGY		STRIP LOG
0-47	Alluvium, sandy, gravelly clinker	
47-50	Sandstone	
50-53	Shale, carbonaceous	
53-60	Coal; bony 53-56'	
60-68	Shale, carbonaceous; thin carbonaceous sandstone	
68-100	Sandstone, carbonaceous; plant fragments	
100-104	Coal, bony; shale, carbonaceous 102-103'	
104-139	Interbedded shale, carbonaceous; siltstone, and carbonaceous sandstone	
139-154	Coal	
154-161	Shale, carbonaceous	
161-166	Siltstone	
166-204	Sandstone, carbonaceous; thin carbonaceous shale	
204-218.5	Coal; bony 216.5-217.5'	
218.5-224	Shale, carbonaceous	
224-236	Sandstone, carbonaceous	
236-240.5	Coal; carbonaceous shale 238-239'	
240.5-250	Shale, carbonaceous	
250-260	Sandstone, carbonaceous	
260-273	Shale, carbonaceous; thin, bony coal	
273-280.5	Sandstone, carbonaceous	
280.5-284	Coal	
284-300	Shale, carbonaceous; thin siltstone	



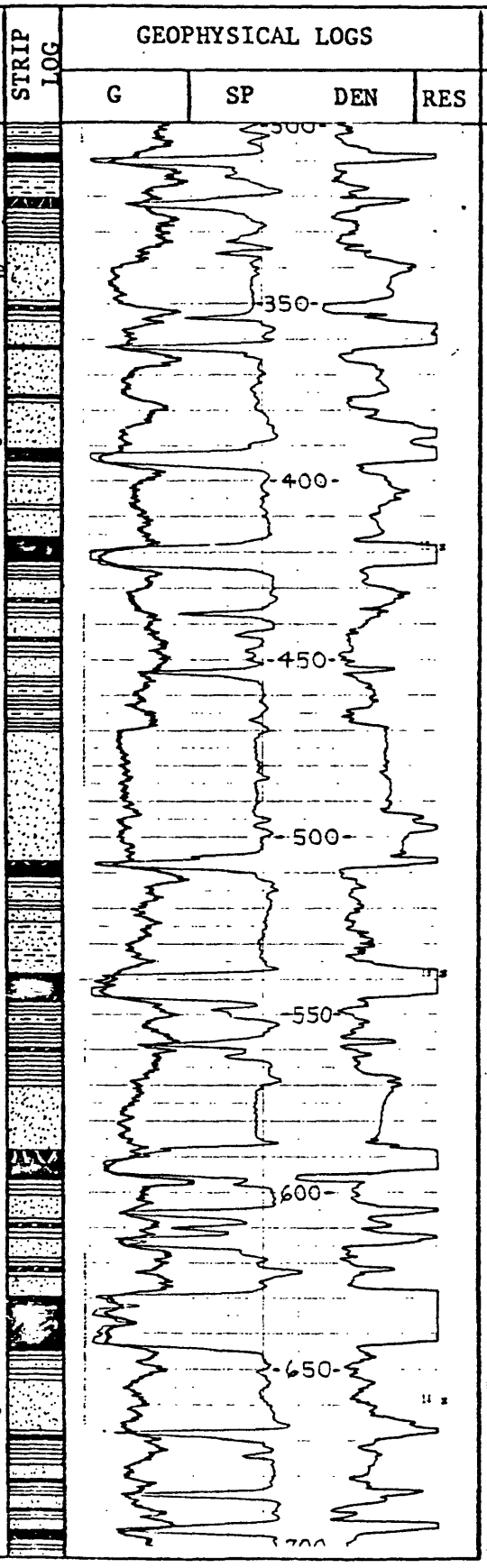
DEPTH

FT	M
0	0
	10
50	
	20
100	30
	40
150	
	50
200	60
	70
250	
	80
300	90

U.S. GEOLOGICAL SURVEY

Hole No. D-41-EG continued

LITHOLOGY		STRIP LOG
300-308	Shale, carbonaceous; thin siltstone and carbonaceous sandstone	
308-310.5	Coal	
310.5-320	Shale, carbonaceous; siltstone	
320-323	Coal, bony	
323-334	Shale, carbonaceous	
334-350	Sandstone, carbonaceous	
350-356	Shale, carbonaceous; thin, bony coal	
356-391	Sandstone, carbonaceous; thin, carbonaceous shale and coal	
391-395	Coal	
395-416.5	Sandstone, carbonaceous; carbonaceous shale	
416.5-423.5	Coal	
423.5-453.5	Interbedded shale, carbonaceous; carbonaceous sandstone and thin bony coal	
453.5-469	Shale, silty, carbonaceous	
469-504.5	Sandstone, carbonaceous	
504.5-508.5	Coal; bony 504.5-506'	
508.5-522.5	Interbedded shale, carbonaceous, and carbonaceous sandstone	
522.5-537	Interbedded siltstone and carbonaceous sandstone	
537-545	Coal	
545-568	Shale, carbonaceous; thin siltstone and bony coal	
568-586.5	Sandstone, carbonaceous	
586.5-594.5	Coal; bony 586.5-590'	
594.5-628	Interbedded shale, carbonaceous; carbonaceous sandstone and bony coals	
628-643	Coal; bony 630.5-631.5' and 635-637.5'	
643-651	Shale, carbonaceous; thin sandstone, carbonaceous	
651-666.5	Sandstone, carbonaceous	
666.5-675.5	Shale, carbonaceous; thin coal	
675.5-692.5	Interbedded sandstone, carbonaceous; carbonaceous shale, and thin coals	
692.5-695.5	Coal	
695.5-700	Interbedded shale, carbonaceous, and carbonaceous sandstone	



DEPTH

FT	M
350	110
400	120
450	130
500	140
550	150
600	160
650	170
700	180
	190
	200
	210

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-44-EG State Colorado County Moffat Date Logged 10/26/77 Elev. (ft) ~6990

Location: T. 4 N., R. 94 W., sec. 23 SE¼SW¼ Cored: ☐ Yes ☒ No

Drilled depth 1320' Logged depth 960' Drilling medium H_2O + mud Fluid level 12'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

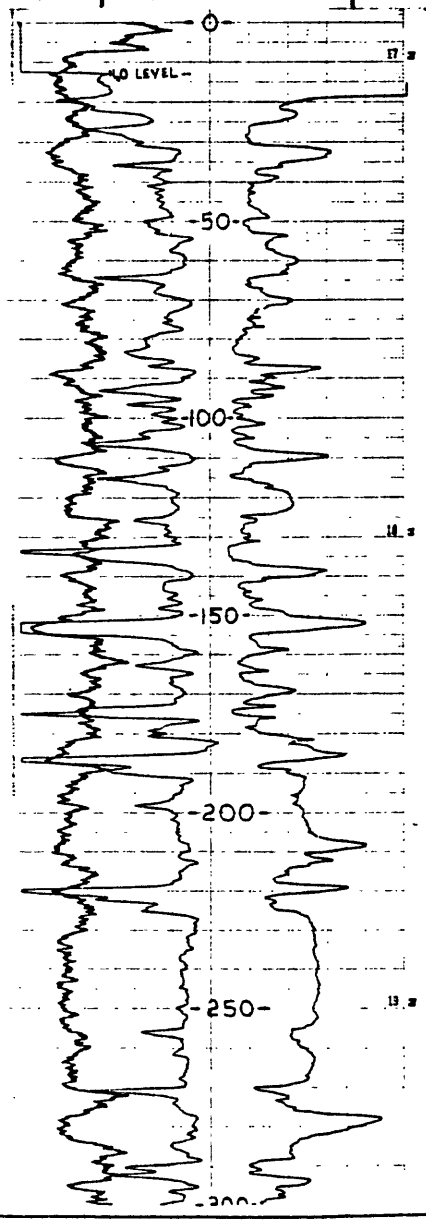
Resistance (RES): Scale 20 Ω/in Logging speed 20 fpm

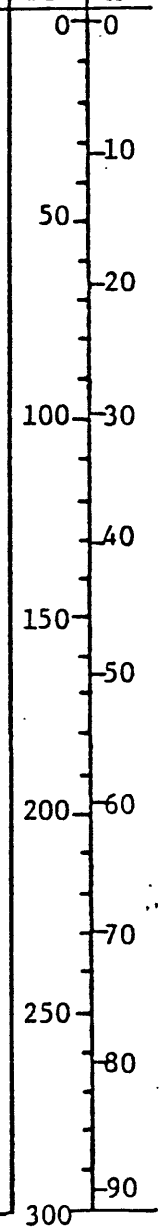
Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10K cps/in Logging speed 20 fpm

Remarks: Lost bottom 360' of pipe in hole. Basal 360' of this log based solely on cutting descriptions. Williams Fork Formation; Trout Creek Sandstone Member of Iles Formation indicated in basal 125' of hole.

LITHOLOGY		STRIP LOG
0–20	Sandstone, weathered	
20–25.5	Shale, carbonaceous	
25.5–29	Shale	
29–36	Sandstone	
36–63	Shale, carbonaceous; thin, carbonaceous sandstone at base	
63–68	Coal, bony; carbonaceous shale	
68–72	Shale	
72–76.5	Sandstone, carbonaceous	
76.5–108	Shale, carbonaceous; thin, carbonaceous sandstone, and bony coal	
108–150	Interbedded shale, silty, carbonaceous, and sandstone	
150–154.5	Coal	
154.5–163.5	Shale, silty, carbonaceous	
163.5–171	Sandstone, carbonaceous	
171–174	Shale, carbonaceous; bony coal	
174–184	Siltstone, sandy, carbonaceous; carbonaceous sandstone	
184–187	Coal	
187–192	Shale, carbonaceous	
192–218	Sandstone, some carbonaceous; thin shale	
218–220.5	Coal	
220.5–230	Siltstone	
230–255	Sandstone	
255–284	Sandstone, carbonaceous; thin, carbonaceous shale	
284–300	Interbedded siltstone, carbonaceous, and carbonaceous sandstone	

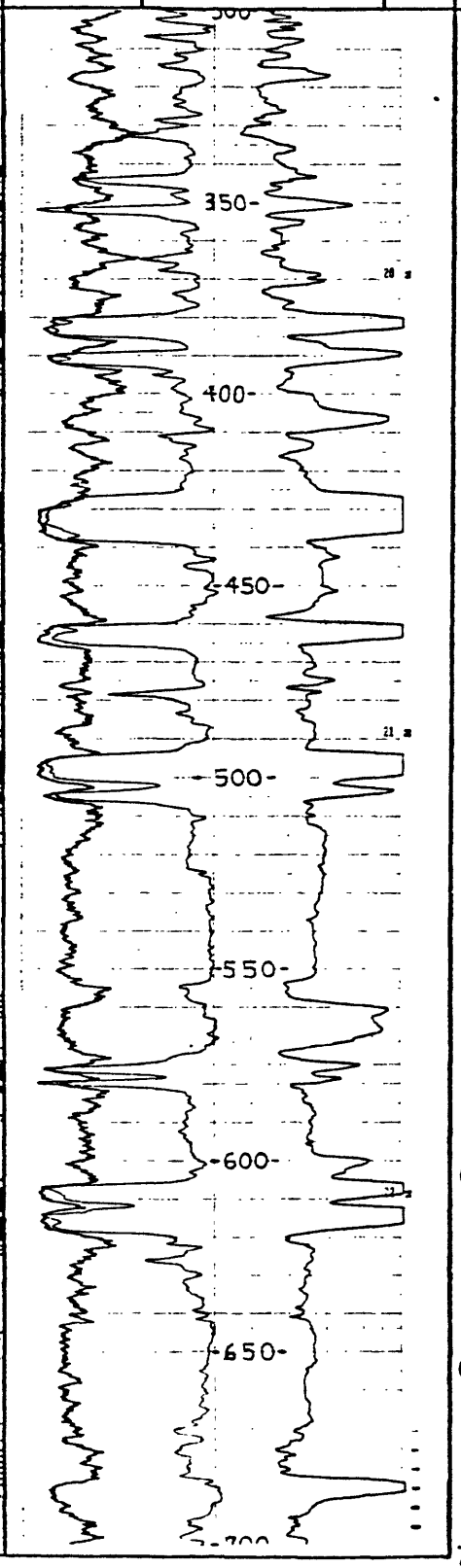




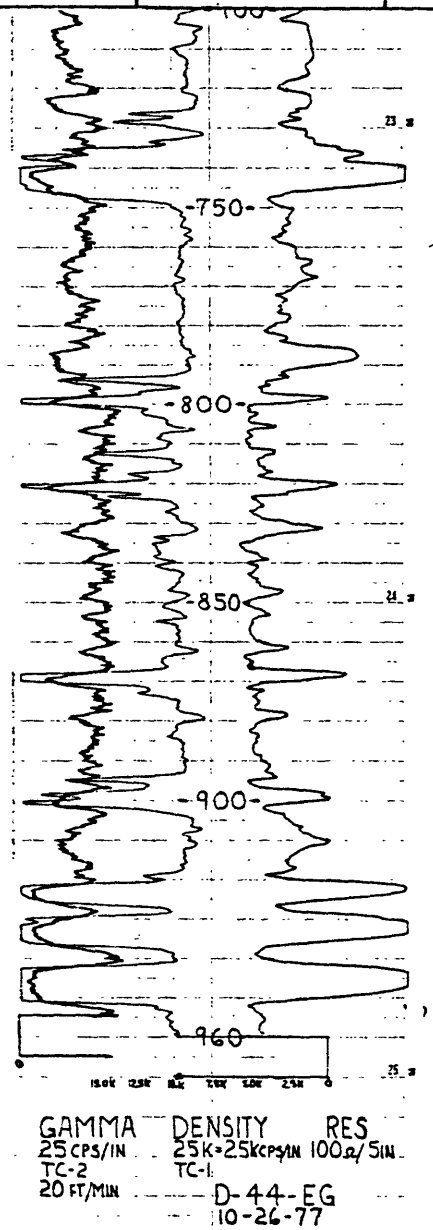
U.S. GEOLOGICAL SURVEY

Hole No. D-44-EG continued

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS				DEPTH	
			G	SP	DEN	RES	FT	M
300-342	Interbedded siltstone, carbonaceous, and carbonaceous sandstone							
342-344.5	Coal							
344.5-350	Interbedded siltstone, carbonaceous, and carbonaceous shale							
350-352.5	Coal							
352.5-373	Interbedded sandstone, some carbonaceous, and carbonaceous shale							
373-378	Siltstone, carbonaceous							
378-384.5	Coal; parting 380.5-381.5'							
384.5-388.5	Siltstone, carbonaceous							
388.5-392	Coal; parting 390-391'							
392-400	Interbedded shale, carbonaceous, and carbonaceous siltstone							
400-425	Interbedded siltstone and sandstone							
425-438	Coal; bony 425-429' and 434.5-438'							
438-440	Shale, carbonaceous							
440-458	Sandstone; thin siltstone							
458-464.5	Coal; parting 461-462'							
464.5-492	Interbedded siltstone, carbonaceous; carbonaceous shale; and carbonaceous sandstone							
492-505.5	Coal; carbonaceous shale 500.5-502.5'							
505.5-516	Interbedded siltstone, carbonaceous, and carbonaceous shale							
516-554	Sandstone							
554-559	Shale, carbonaceous							
559-572	Sandstone, carbonaceous							
572-580	Coal; carbonaceous shale 572-573' and 576.5-578.5'							
580-587	Shale, thin sandstone							
587-604.5	Sandstone							
604.5-618	Coal; carbonaceous shale 610.5-612'							
618-623	Shale, carbonaceous							
623-642.5	Siltstone, carbonaceous; thin sandstone							
642.5-674	Sandstone							
674-683	Shale, carbonaceous							
683-700	Sandstone; thin siltstone							



LITHOLOGY		STRIP LOG
700-712	Sandstone; thin siltstone	
712-734	Interbedded shale, carbonaceous; carbonaceous sandstone and carbonaceous siltstone	
734-745.5	Coal; partings 735.5-736' and 738-739'; bony at top	
745.5-751	Shale, carbonaceous	
751-792	Sandstone, carbonaceous; thin siltstone	
792-797	Coal, bony; carbonaceous shale	
797-800	Coal	
800-819	Shale, carbonaceous; thin carbonaceous sandstone and bony coal	
819-821.5	Coal	
821.5-829	Shale, carbonaceous	
829-866.5	Interbedded shale, carbonaceous; carbonaceous siltstone and carbonaceous sandstone	
866.5-870	Coal	
870-881	Shale, silty, carbonaceous	
881-897	Sandstone, carbonaceous; thin carbonaceous shale and bony coal	
897-901	Coal; parting 898.5-899.5'	
901-920	Shale, carbonaceous; carbonaceous sandstone	
920-925	Coal	
925-928.5	Shale, carbonaceous	
928.5-936	Coal; parting 930-931'	
936-941	Shale, carbonaceous	
941-951	Coal	
951-982	Sandstone, carbonaceous; thin carbonaceous shale	
GEOPHYSICAL LOGS END AT 960'		
982-985	Coal	
985-1017	Sandstone, carbonaceous; thin carbonaceous shale at top	
1017-1019	Coal	
1019-1044	Sandstone, carbonaceous	
1044-1056	Shale, silty, carbonaceous; thin, carbonaceous sandstone	
1056-1059	Coal	
1059-1066	Shale, carbonaceous	
1066-1085	Interbedded sandstone, carbonaceous, and silty, carbonaceous shale	
1085-1090	Coal	
1090-1098	Shale, carbonaceous	
1098-1100	Sandstone, carbonaceous	



DEPTH FT	DEPTH M
	220
750	230
	240
800	250
	260
850	270
	280
900	290
	300
950	310
1000	320
	330
1050	
1100	

LITHOLOGY	STRIP LOG	GEOPHYSICAL LOGS (G - SP DEN RES)	DEPTH FT	DEPTH M
1100-1125 Sandstone, carbonaceous; thin, carbonaceous siltstone				
1125-1127 Coal				
1127-1145 Sandstone; thin, carbonaceous shale at top				340
1145-1149 Coal			1150	
1149-1199 Interbedded siltstone, carbonaceous; carbonaceous sandstone and shale				350
1199-1202 Coal				
1202-1205 Shale, carbonaceous				360
			1200	
ILES FORMATION				
1205-1320 Sandstone; Trout Creek Sandstone Member(?)				370
			1250	
				380
				390
			1300	
				400
			1350	
				450
				460
			1400	
				470
			1450	
				480
				490
			1500	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-45-EG State Colorado County Moffat Date Logged 9/16/77 Elev.(ft) ~7010

Location: T. 3 N., R. 94 W., sec. 4 NE¼NW¼ Cored: ☐ Yes ☒ No

Drilled depth 840' Logged depth 840' Drilling medium H_2O + mud Fluid level 0'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

Resistance (RES): Scale 20 Ω/in Logging speed 20 fpm

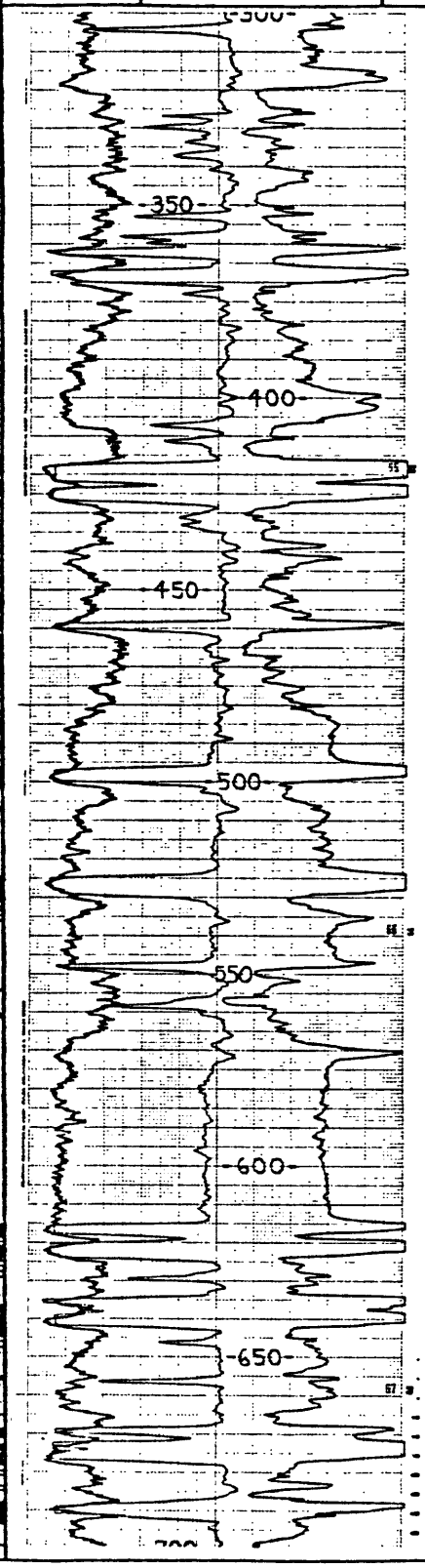
Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10-Kcps/in Logging speed 20 fpm

Remarks: Williams Fork Formation and Trout Creek Sandstone Member of Iles Formation.

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS (G, SP, DEN, RES)	DEPTH FT	DEPTH M
0 - 44	Alluvium and colluvium, gravelly			0	0
44 - 67	Sandstone, carbonaceous, and sandstone; thin siltstone				10
67 - 83	Siltstone, carbonaceous			50	20
83 - 87.5	Shale, carbonaceous				
87.5- 92	Coal				
92 - 93.5	Shale, carbonaceous				
93.5- 97	Coal, bony				
97 -100	Shale, carbonaceous			100	30
100 -104	Sandstone				
104 -110	Coal				
110 -115	Shale, carbonaceous				40
115 -182	Sandstone, carbonaceous; pyritic 125-135'			150	50
182 -192	Coal				
192 -196	Shale, carbonaceous				
196 -201	Coal				
201 -211	Shale, carbonaceous				
211 -272	Sandstone, carbonaceous			200	60
272 -274	Coal, bony				
274 -288	Interbedded shale, carbonaceous, and clay				70
288 -294	Siltstone			250	80
294 -300	Sandstone, carbonaceous; sandstone				
				300	90

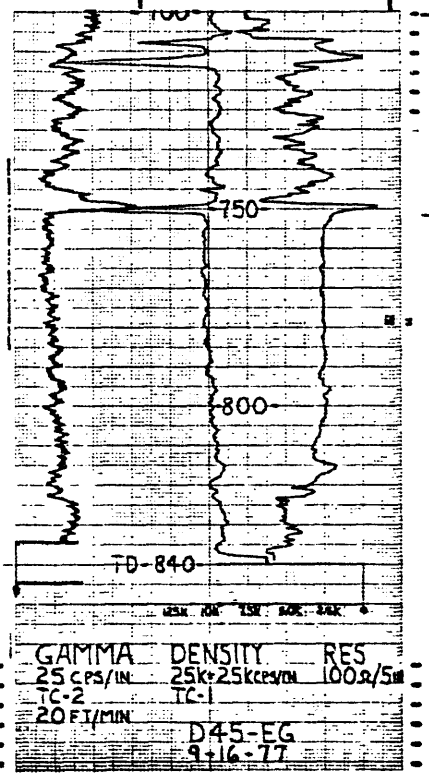
LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS				DEPTH	
			G	SP	DEN	RES	FT	M
300 -325	Sandstone, carbonaceous; thin siltstone and bony coal							
325 -360	Interbedded clay; carbonaceous siltstone and carbonaceous sandstone							
360 -362.5	Coal							
362.5-365.5	Shale, carbonaceous							
365.5-370	Coal							
370 -380	Shale, carbonaceous							
380 -416	Sandstone, carbonaceous; thin, carbonaceous siltstone							
416 -426.5	Coal; carbonaceous shale 421-422.5'							
426.5-438	Interbedded clay and carbonaceous shale							
438 -457.5	Sandstone, carbonaceous; thin shale							
457.5-460	Coal							
460 -475	Interbedded shale, carbonaceous, and carbonaceous siltstone							
475 -494	Sandstone, carbonaceous							
494 -499.5	Coal							
499.5-505	Siltstone, carbonaceous							
505 -522	Sandstone, carbonaceous							
522 -529	Coal							
529 -534	Shale, carbonaceous							
534 -613.5	Sandstone, carbonaceous; thin, carbonaceous siltstone and thin coal							
613.5-617	Coal							
617 -619	Shale, carbonaceous							
619 -623	Coal							
623 -629	Shale, carbonaceous							
629 -633.5	Sandstone							
633.5-642	Coal; parting 636-637.5'							
642 -645	Shale, carbonaceous							
645 -664	Sandstone, carbonaceous; thin, bony coal							
664 -667	Siltstone							
667 -676.5	Coal; carbonaceous shale 669.5-671'							
676.5-686	Interbedded shale, carbonaceous, and carbonaceous sandstone							
686 -691.5	Coal; bony 686-687.5 and 690-691.5'							
691.5-697	Sandstone, carbonaceous							
697 -700	Shale							



LITHOLOGY		
700	-702	Shale
702	-706.5	Sandstone, carbonaceous
706.5	-710	Coal, thin, bony; carbonaceous shale
710	-712.5	Coal
712.5	-720	Shale, carbonaceous
720	-750	Sandstone, carbonaceous; thin shale
		ILES FORMATION
750	-823	Sandstone, fine-grained to very fine-grained; Trout Creek Sandstone Member
823	-840	Interbedded siltstone and shale

STRIP LOG

GEOPHYSICAL LOGS



DEPTH FT	DEPTH M
750	230
800	240
850	260
900	270
950	290
1000	300
1050	320
1100	330

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-50-EG State Colorado County Moffat Date Logged 8/31/77 Elev.(ft) ~7210

Location: T. 3 N., R. 94 W., sec. 3 SE¼NW¼ Cored: ☐ Yes ☒ No

Drilled depth 620' Logged depth 620' Drilling medium H_2O + mud Fluid level 12'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

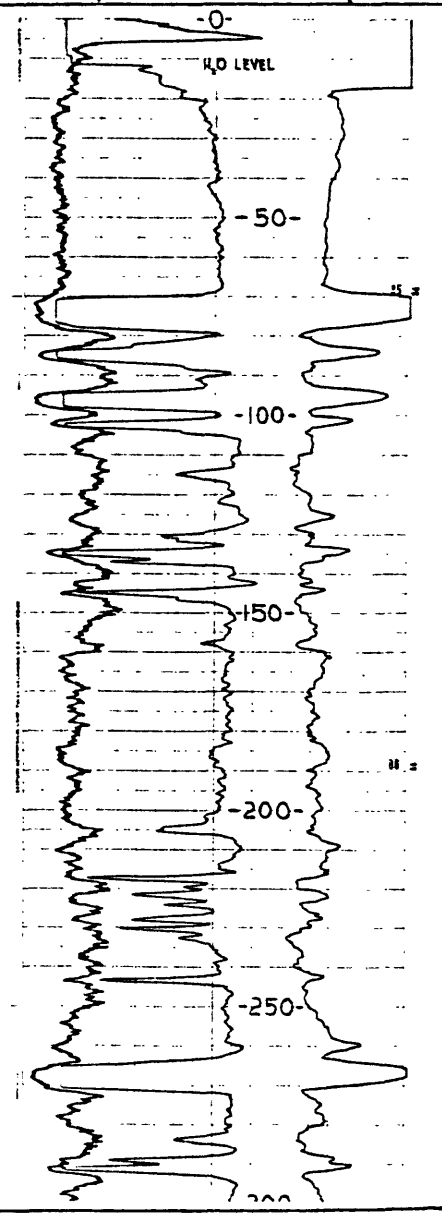
Resistance (RES): Scale 50 Ω/in Logging speed 20 fpm

Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10-Kcps/in Logging speed 20 fpm

Remarks: Williams Fork Formation

LITHOLOGY			STRIP LOG	GEOPHYSICAL LOGS	DEPTH	
				G SP DEN RES	FT	M
0	- 40	Alluvium, brown, sandy			0	0
40	- 68.5	Sandstone, fine- to medium-grained				
68.5	- 78	Coal				
78	- 80	Shale, carbonaceous				
80	- 86	Coal; bony 80-83'				
86	- 93	Shale, carbonaceous				
93	- 98	Coal				
98	-100.5	Shale, carbonaceous				
100.5	-103	Coal				
103	-113	Shale, carbonaceous; thin shale				
113	-133	Shale, carbonaceous				
133	-135.5	Coal				
135.5	-143	Shale, carbonaceous; thin, bony coal				
143	-145	Coal				
145	-150	Shale, carbonaceous				
150	-160	Siltstone, carbonaceous				
160	-203	Sandstone, carbonaceous; thin, medium-grained sandstone				
203	-206	Shale				
206	-212	Shale, carbonaceous				
212	-216	Sandstone				
216	-250	Shale, carbonaceous; thin, bony coal				
250	-259	Sandstone, carbonaceous				
259	-261	Shale, carbonaceous				
261	-271	Coal				
271	-287.5	Interbedded shale, carbonaceous, and carbonaceous siltstone				
287.5	-292	Coal; bony 287.5-289; parting 289-290'				
292	-297	Shale, carbonaceous; thin shale				
297	-300	Sandstone			300	90

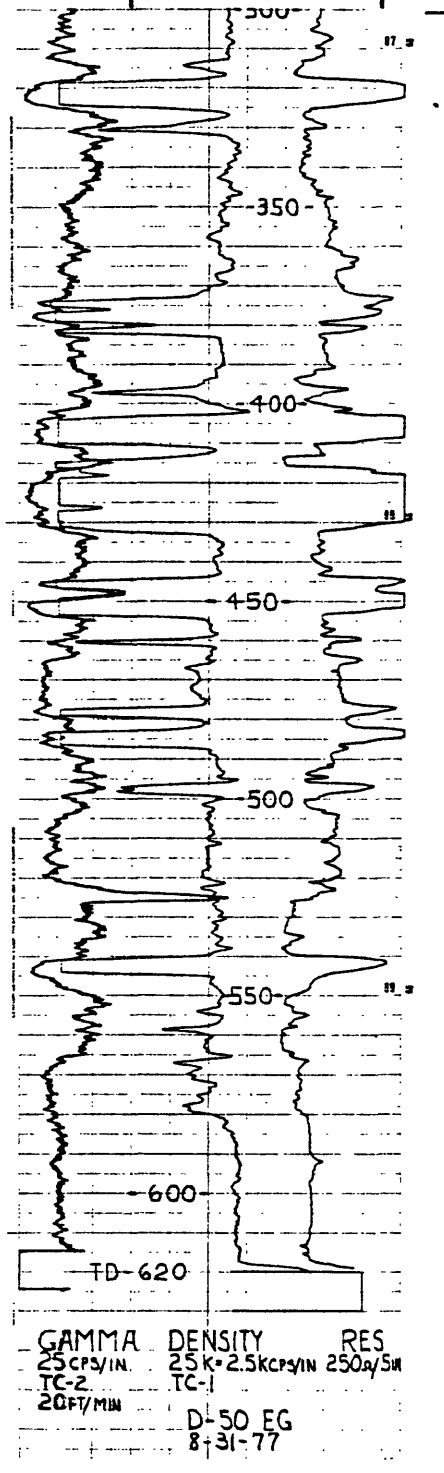


U.S. GEOLOGICAL SURVEY

Hole No. D-50-EG continued

LITHOLOGY		
300	-313	Sandstone
313	-317	Shale, carbonaceous
317	-324	Coal
324	-327.5	Shale, carbonaceous
327.5	-331	Coal, bony
331	-335	Shale, carbonaceous
335	-349	Siltstone; thin sandstone
349	-372	Sandstone
372	-382	Coal; partings 375-376' and 379-380'
382	-384	Shale, carbonaceous
384	-392	Sandstone, carbonaceous
392	-402	Shale, carbonaceous; thin bony coal
402	-410	Coal
410	-412	Shale, carbonaceous
412	-431	Coal; partings 416.5-418', and 425.5-426.5'
431	-434	Shale, carbonaceous
434	-443.5	Sandstone, carbonaceous
443.5	-453.5	Coal; parting 446.5-447.5'
453.5	-460.5	Shale, carbonaceous; thin coal
460.5	-464	Siltstone, carbonaceous
464	-476.5	Sandstone, carbonaceous
476.5	-479	Coal
479	-481.5	Shale, carbonaceous
481.5	-486.5	Coal
486.5	-505	Interbedded shale, carbonaceous; carbonaceous siltstone and carbonaceous sandstone
505	-521	Sandstone, carbonaceous
521	-531	Shale; siltstone
531	-536	Shale, carbonaceous
536	-539.5	Sandstone, carbonaceous
539.5	-544	Coal
544	-553	Shale, carbonaceous
553	-559	Interbedded siltstone and carbonaceous sandstone
559	-565	Shale, carbonaceous
565	-617.5	Sandstone, carbonaceous
617.5	-620	Coal

STRIP LOG



DEPTH

FT	M
	100
350	110
	120
400	130
	140
450	150
	160
500	170
	180
550	190
	200
600	210
650	
700	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-52-D State Colorado County Moffat Date Logged 8/24/77 Elev.(ft) ~7225

Location: T. 3 N., R. 94 W., sec. 9 NW¼NW¼ Cored: ☐ Yes ☒ No

Drilled depth 600' Logged depth 600' Drilling medium H_2O + mud Fluid level 0'

Geophysical logs:

Spontaneous potential (SP): Scale _____ Logging speed _____ fpm

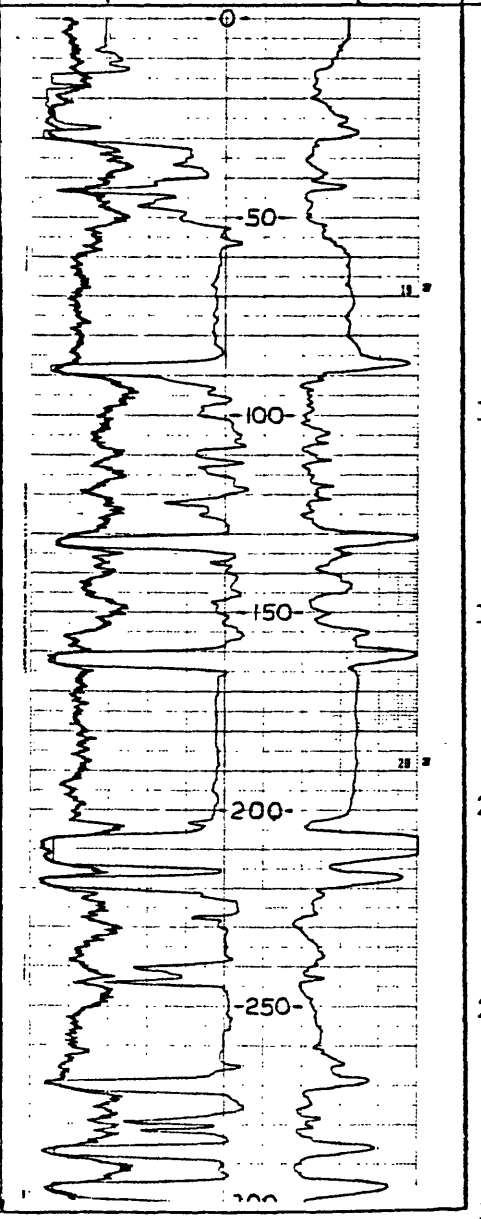
Resistance (RES): Scale 50 Ω/in Logging speed 20 fpm

Gamma (G): T.C. 2 Scale 25 cps/in Logging speed 20 fpm

Density (DEN): T.C. 1 Scale 10-Kcps/in Logging speed 20 fpm

Remarks: Williams Fork Formation and Trout Creek Sandstone Member of Iles Formation.

LITHOLOGY		STRIP LOG
0 - 13	Alluvium, fine-grained, brown	
13 - 30.5	Coal; weathered 13-26'; partings 16.5-17' and 26-27.5'	
30.5- 52	Shale, carbonaceous; thin, bony coals	
52 - 85.5	Sandstone, carbonaceous	
85.5- 89.5	Coal	
89.5-130	Interbedded shale, carbonaceous, coaly; silty shale	
130 -133	Coal	
133 -140	Interbedded siltstone, carbonaceous, and carbonaceous shale	
140 -158	Sandstone, carbonaceous; thin siltstone	
158 -163.5	Coal	
163.5-166	Shale, carbonaceous	
166 -204.5	Sandstone; thin, carbonaceous shale at base	
204.5-214	Coal	
214 -216	Shale, carbonaceous	
216 -219.5	Coal	
219.5-228	Shale, carbonaceous	
228 -232	Siltstone	
232 -238.5	Sandstone, carbonaceous	
238.5-244.5	Interbedded coal, bony, and carbonaceous shale	
244.5-267.5	Sandstone, carbonaceous; thin siltstone at top	
267.5-271.5	Coal	
271.5-284.5	Siltstone; thin, bony coal	
284.5-288	Coal	
288 -293.5	Shale, carbonaceous	
293.5-299	Coal	
299 -300	Shale, carbonaceous	

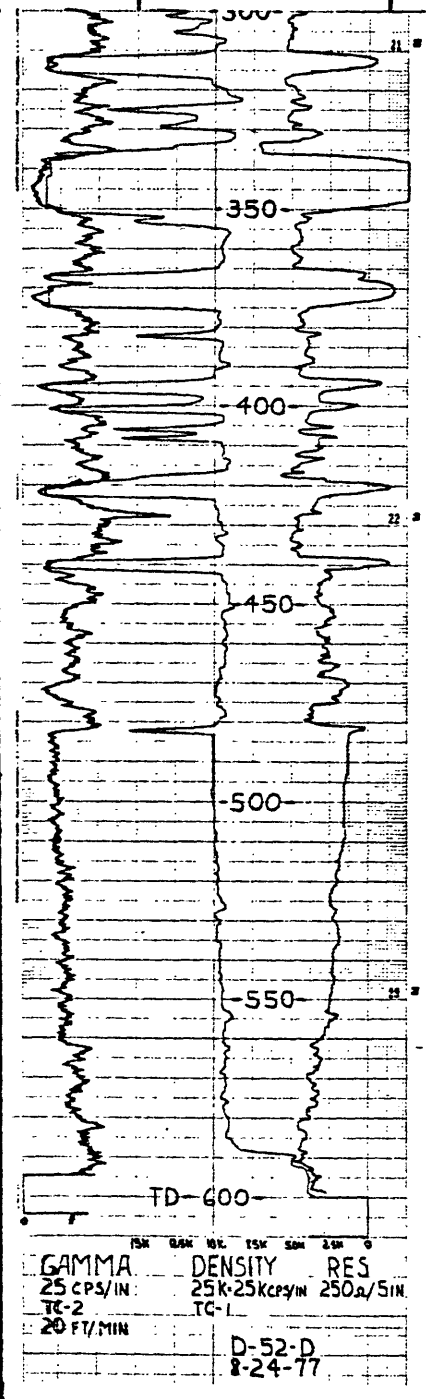


DEPTH

FT	M
0	0
	10
50	
	20
100	30
	40
150	
	50
200	60
	70
250	
	80
300	90

LITHOLOGY		
300	-310	Shale, carbonaceous; thin, carbonaceous sandstone
310	-315.5	Coal
315.5	-323	Shale, carbonaceous; siltstone
323	-335	Shale, carbonaceous; thin, bony coal
335	-353.5	Coal; partings 336-337' and 351-352.5'; bony at base
353.5	-365	Shale, carbonaceous
365	-375	Coal; parting 368-369'
375	-393	Interbedded shale, carbonaceous; carbonaceous siltstone and carbonaceous sandstone
393	-401.5	Coal; carbonaceous shale 396.5-399'
401.5	-416	Interbedded siltstone, carbonaceous; carbonaceous shale and carbonaceous sandstone; thin, bony coal
416	-422.5	Coal; bony 416-418'
422.5	-428	Interbedded siltstone, carbonaceous, and carbonaceous shale
428	-438	Sandstone, carbonaceous
438	-441	Coal
441	-450	Interbedded shale, carbonaceous, and carbonaceous siltstone
450	-477	Sandstone, carbonaceous; thin siltstone
477	-482	Shale, carbonaceous
		ILES FORMATION
482	-562	Sandstone, fine-grained; Trout Creek Sandstone Member
562	-600	Interbedded siltstone, sandstone, and shale

STRIP LOG



DEPTH FT	DEPTH M
350	100
	110
400	120
	130
450	140
	150
500	160
550	170
	180
600	190
650	200
	210
700	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, DANFORTH HILLS COAL FIELD

Hole No. D-54-D State Colorado County Moffat Date Logged 9/19/77 Elev.(ft) ~8130

Location: T. 3 N., R. 94 W., sec. 9 SE¼SW¼ Cored: ☐ Yes ☒ No

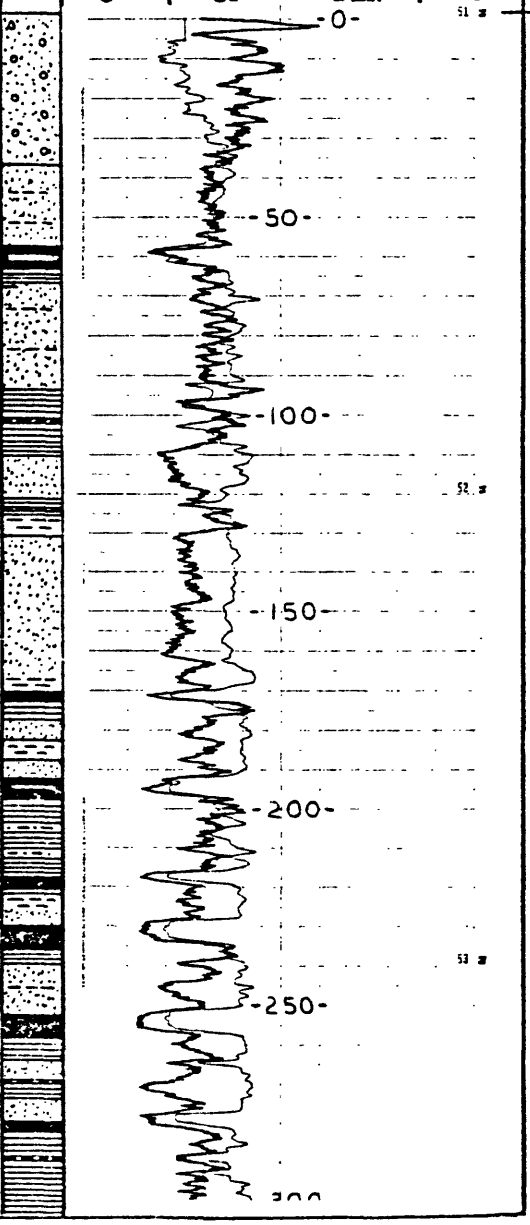
Drilled depth 940' Logged depth 937' Drilling medium H_2O + mud Fluid level 600'

Geophysical logs:

Spontaneous potential (SP):		Scale		Logging speed	fpm
Resistance (RES):		Scale	20 Ω/in	Logging speed	20 fpm
Gamma (G):	T.C. 2	Scale	25 cps/in	Logging speed	20 fpm
Density (DEN):	T.C. 1	Scale	10K cps/in	Logging speed	20 fpm

Remarks: Williams Fork Formation. Poor to no cuttings 20-90', 280-940'; descriptions taken mainly from geophysical logs.

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS	DEPTH	
			G SP DEN RES	FT	M
0-34	Colluvium, tan, sandy			0	0
34-56.5	Sandstone; thin shale				10
56.5-62	Coal; parting 58.5-60.5'; bony at base			50	20
62-65	Shale, carbonaceous				
65-92.5	Sandstone; thin shale				
92.5-108	Shale, carbonaceous; thin, bony coal			100	30
108-119	Sandstone				
119-123	Shale, carbonaceous; thin, bony coal				40
123-129	Shale			150	
129-169	Sandstone; thin shale at base				50
169-171.5	Coal				
171.5-176	Shale, carbonaceous				
176-182	Sandstone, carbonaceous				
182-186	Shale				
186-190.5	Sandstone				
190.5-196	Coal; parting 192.5-193.5'			200	60
196-215	Shale, carbonaceous; thin siltstone				
215-218	Coal				
218-220	Shale, carbonaceous				
220-228	Interbedded sandstone and shale				70
228-234	Coal				
234-238	Shale, carbonaceous			250	
238-250	Sandstone, carbonaceous; thin shale				80
250-256	Coal				
256-277	Interbedded shale, carbonaceous, and sandstone; thin, bony coal				
277-280	Coal				
280-300	Shale, carbonaceous; thin, bony coal			300	90



U.S. GEOLOGICAL SURVEY

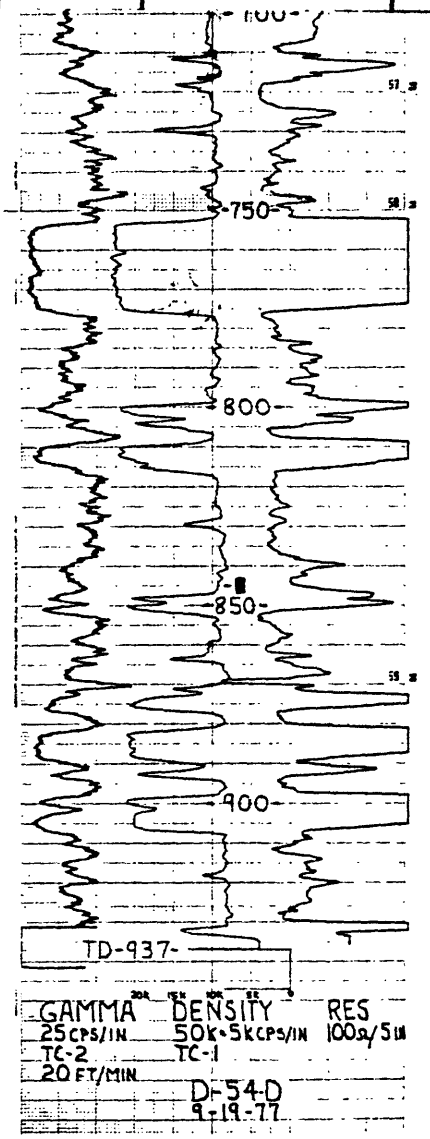
Hole No. D-54-D continued

LITHOLOGY		STRIP LOG	GEOPHYSICAL LOGS	DEPTH	
			G SP DEN RES	FT	M
300-313	Sandstone, carbonaceous				
313-321	Interbedded shale and carbonaceous shale				
321-364	Sandstone; thin shale				100
364-372	Shale				
372-374	Sandstone		350	350	
374-378	Shale, carbonaceous				110
378-401	Interbedded sandstone, shale, and carbonaceous shale				
401-409	Shale				120
409-450	Sandstone		400	400	
450-455	Shale				130
455-459	Siltstone				
459-480	Sandstone				
480-496	Coal; parting 491-492.5'		450	450	
496-506.5	Shale, carbonaceous				140
506.5-517	Interbedded siltstone, carbonaceous, and carbonaceous shale				
517-526	Siltstone				150
526-579.5	Sandstone; part shaly		500	500	
579.5-584	Shale, carbonaceous; thin, bony coal				160
584-592.5	Coal; parting 590.5-591'				
592.5-601	Shale				
601-609.5	Coal; bony 601-604' and 606-608'; carbonaceous shale 605-606'		550	550	170
609.5-614.5	Shale, carbonaceous				
614.5-620	Sandstone				180
620-623	Shale				
623-653	Sandstone				
653-655	Shale, carbonaceous		600 CHANGE SCALES 10kcps/in	600	
655-659.5	Coal; parting 657.5-659'; bony at base				190
659.5-667	Shale, carbonaceous				
667-673	Sandstone				
673-684	Interbedded shale, carbonaceous, and bony coal		650	650	200
684-688	Sandstone				
688-690	Coal				
690-695	Shale, carbonaceous				210
695-700	Sandstone, carbonaceous			700	

U.S. GEOLOGICAL SURVEY

Hole No. D-54-D continued

LITHOLOGY		STRIP LOG
700-710.5	Sandstone, carbonaceous	
710.5-729.5	Interbedded sandstone, carbonaceous; carbonaceous shale and bony coal	
729.5-751	Interbedded shale, carbonaceous, and sandstone	
751-775.5	Coal	
775.5-784	Shale, carbonaceous	
784-799	Sandstone, carbonaceous	
799-804.5	Coal; parting 802-803'; bony at base	
804.5-808	Shale, carbonaceous	
808-815.5	Coal; parting 813-814.5'; bony at base	
815.5-847	Interbedded shale, carbonaceous; carbonaceous siltstone and sandstone	
847-851	Coal; parting 848.5-849.5'	
851-857	Shale, carbonaceous	
857-860	Sandstone	
860-863.5	Shale, carbonaceous; thin, bony coal	
863.5-869	Sandstone, carbonaceous	
869-876	Coal; parting 871.5-872.5'; bony on top	
876-880	Shale, carbonaceous	
880-893	Coal; parting 888.5-890.5'	
893-897.5	Shale, carbonaceous	
897.5-906.5	Coal; parting 900.5-901.5'	
906.5-911	Shale, carbonaceous	
911-930	Sandstone, carbonaceous; thin carbonaceous siltstone	
930-931	Coal, bony	
931-932	Shale, carbonaceous?	
ILES FORMATION(?)		
932-940	Sandstone(?); Trout Creek Sandstone Member(?)	



DEPTH FT	DEPTH M
750	220
	230
800	240
	250
850	260
	270
900	280
950	290
	300
1000	310
1050	320
	330
1100	