

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOPHYSICAL LOGS OF COAL TEST DRILL HOLES IN THE
GRAND MESA COAL FIELD, DELTA AND MESA COUNTIES, COLORADO

By

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Open-File Report 78-540

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

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Title: Geophysical logs of coal test drill holes in the
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Page 36, Description column, add: 946½-947' Tan clay

Page 38, Description column, add: 294½-295' Tan clay

Signed:

Jim Murphy (for)
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U.S. Geological Survey

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GEOPHYSICAL LOGS FROM COAL TEST DRILL HOLES IN THE
GRAND MESA COAL FIELD, DELTA AND MESA COUNTIES, COLORADO

By G. Philip Eager

INTRODUCTION

In the fall of 1977, the U.S. Geological Survey drilled 27 coal test holes to evaluate the federally owned coal resources in the Grand Mesa coal field of Delta and Mesa Counties, Colorado.

The coal occurs near the base of the Upper Cretaceous Mesaverde Formation which dips gently to the north or northeast into the Piceance Creek Basin. The primary target of the drilling was the coal above the Rollins Sandstone Member. There is coal stratigraphically below the Rollins Sandstone near the Colorado River, and that coal was also tested.

The contract, no. 14-08-0001-17121, was awarded to the Himes Drilling Company, Inc. of Grand Junction, Colorado. The drilling was started August 25, 1977 near Paonia and was completed December 19, 1977 near Cameo. The drilling was done with truck-mounted rotary and diamond-core drilling rigs using air, air with water injection (air-water), air with water and biodegradable foam injection (foam), water, or mud as the drilling medium.

The geophysical logs were run by Minerals Service Company and Strata Surveys, both of Grand Junction, Colorado. All the holes were logged using combinations of natural gamma radiation (GAM), gamma-gamma density (DEN), single-point resistivity (RES),

spontaneous potential (S.P.), and caliper (CAL).

Beds of coal and impure coal of 1 foot or greater thickness have been interpreted to the nearest $\frac{1}{2}$ foot. Surficial deposits and clay beds of possible stratigraphic significance are also indicated where known. Sandstone on the log descriptions refers to the Rollins Sandstone Member of the Mesaverde Formation. The log interpretation was aided by core and cuttings samples. In this report, the logged depth is considered the total depth (T.D.).

The Water Resources Division, of the U.S. Geological Survey, cased most of the drill holes with 2-inch or 3-inch PVC pipe, completing them as ground-water observation wells. Drill holes GR-77-5, DC-77-1, and IP-77-3 were cemented through the coal zone, filled with cuttings, and plugged with 5 feet of cement at the surface. All drill sites were leveled and reseeded.

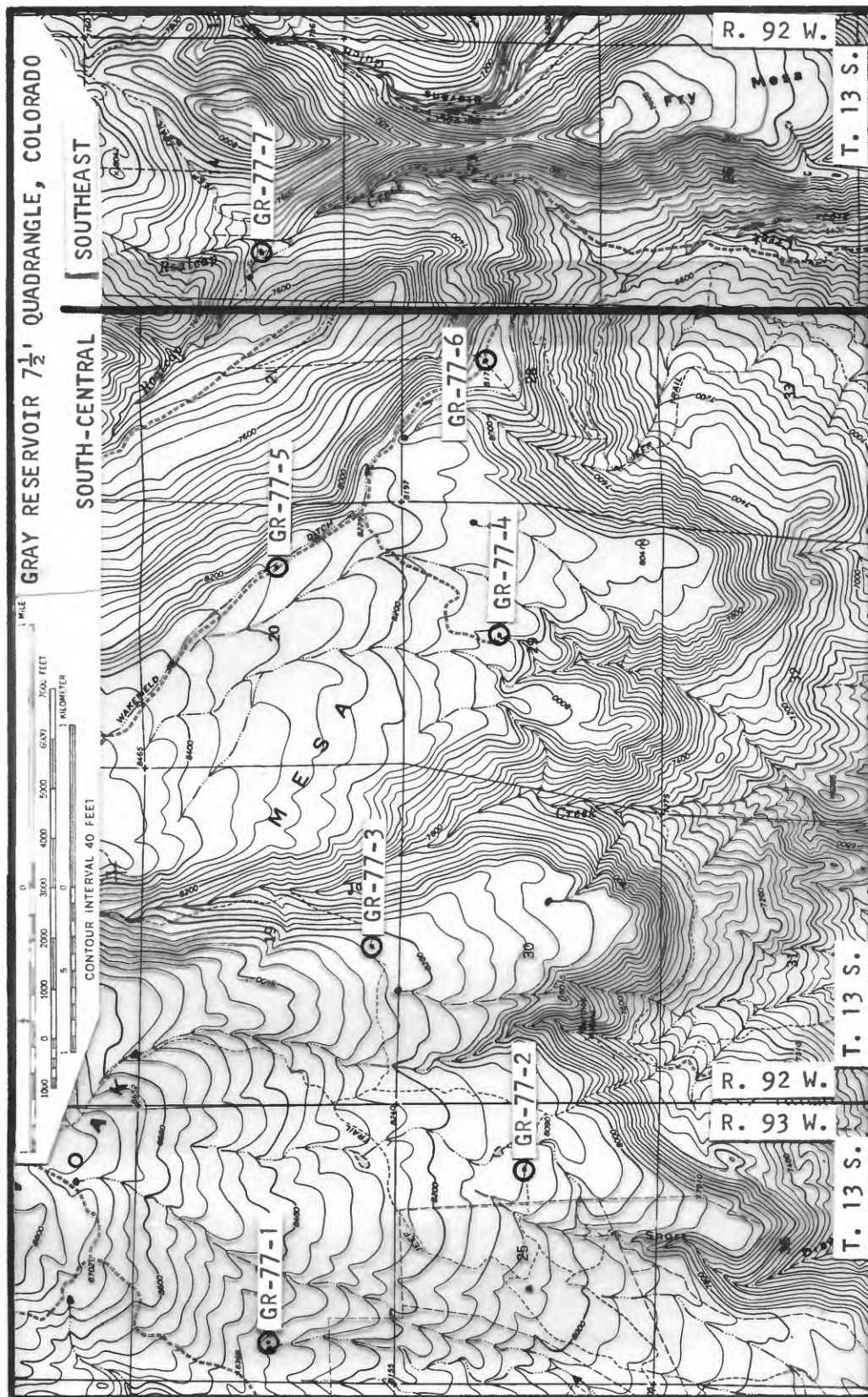


Figure 1.--Map showing U.S.G.S. drill-hole locations in the Gray Reservoir 7½' quadrangle, Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-1 State Colorado County Delta

T. 13 S., R. 93 W., sec. 24, NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 8310

Drilled depth 1038' Cored interval 533-1038'

Logged depth 1044' Logging company Minerals Service Date logged 10-27-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 220'	7.88"	0- 127'	5.0" ID	0- 127'
Foam	220- 533'	5.13"	127- 220'	3.06" ID	0- 533'
Water	533-1038'	4.75"	220- 533'		
		2.98"	533-1038'		

LOGGING DATA

Gamma source Am 241

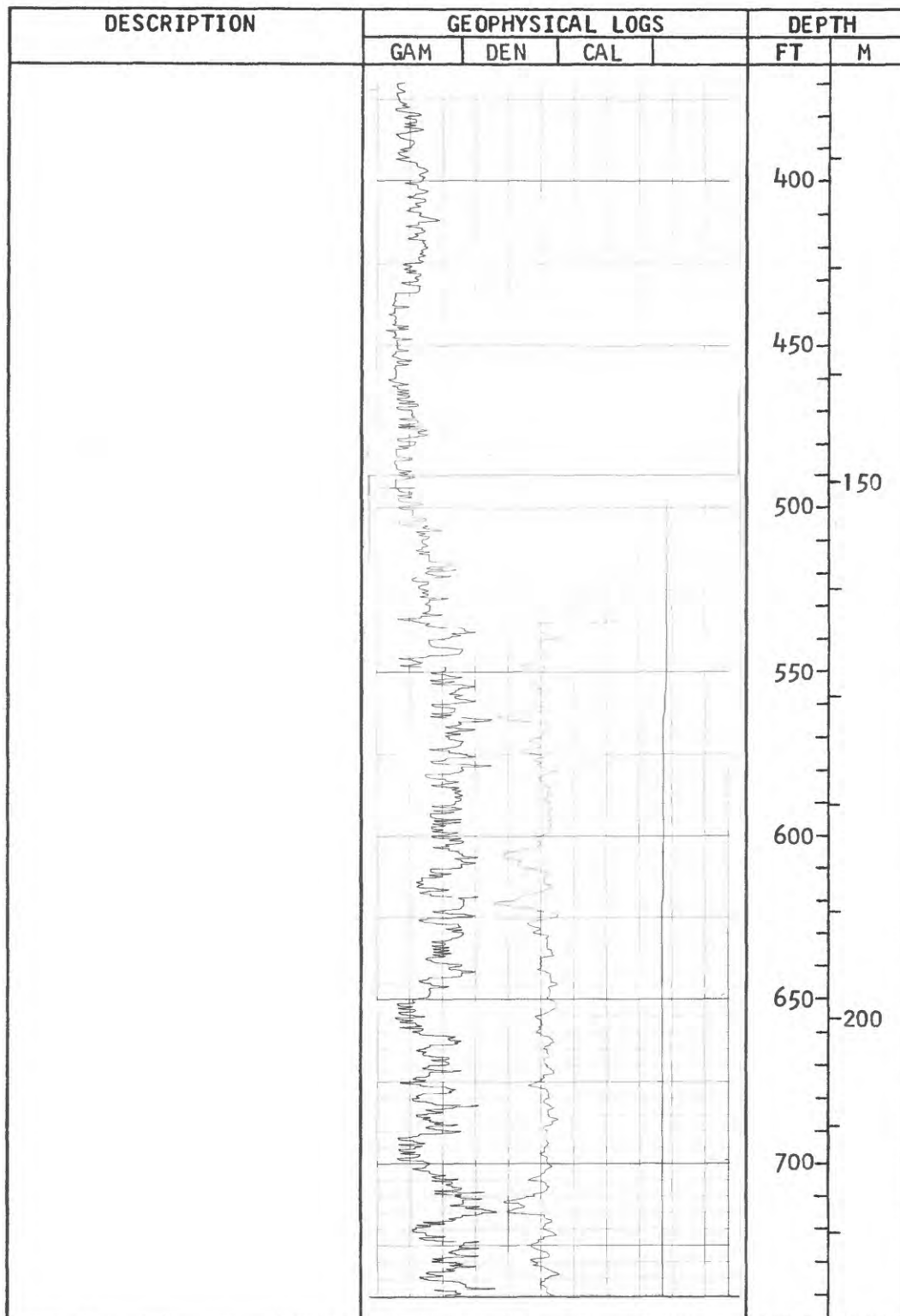
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	1036- 0' 1044- 502' 1039- 498' 1035- 801'	20

Remarks: Gamma is $7\frac{1}{2}'$ too deep; density is 6' too deep; resistivity is 8' too deep.

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM				FT	M
0-144' Surficial deposit					0-0	
					50	
					100	
					150	
					50	
					200	
					250	
					300	
					100	
					350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-1 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
765 $\frac{1}{2}$ -769' Coal					750	
770-771' Impure coal						
790 $\frac{1}{2}$ -794 $\frac{1}{2}$ ' Coal						
796 $\frac{1}{2}$ -799' Coal					800	
879 $\frac{1}{2}$ -880 $\frac{1}{2}$ ' Impure coal					250	
907 $\frac{1}{2}$ -908 $\frac{1}{2}$ ' Coal						
919 $\frac{1}{2}$ -923' Coal					850	
925-931' Coal						
931-931 $\frac{1}{2}$ ' Impure coal						
936 $\frac{1}{2}$ -938' Coal						
943-951 $\frac{1}{2}$ ' Coal					900	
992 $\frac{1}{2}$ -993' Impure coal						
993-996' Coal						
996-998' Impure coal						
998-1003 $\frac{1}{2}$ ' Coal						
1003 $\frac{1}{2}$ -1004 $\frac{1}{2}$ ' Impure coal					950	
1004 $\frac{1}{2}$ -1007' Coal						
1016-1018' Impure coal						
1018-1019' Coal					300	
1019-1020' Impure coal						
1020-1023 $\frac{1}{2}$ ' Coal					1000	
1026-1027 $\frac{1}{2}$ ' Coal						
1027 $\frac{1}{2}$ -1028' Impure coal						
1028-T.D. Sandstone (Rollins)					1044 T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-2 State Colorado County Delta

T. 13 S., R. 93 W., sec. 25, CE 1/2 Approx. elev. (ft) 8120

Drilled depth 566' Cored interval NONE

Logged depth 566' Logging company Minerals Service Date logged 10-19-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 180'	6.13"	0- 80'	5.0" ID	0- 117'
Foam	180- 566'	4.75"	80- 566'		

LOGGING DATA

Gamma source Am 241


Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Resistivity Caliper (1-arm)		100 cps/in. 100 cps/in. 100 Ohms/in. 25 ins./in.	557- 1' 566- 10' 556- 317' 561- 5'	20

Remarks: Resistivity is 1' too deep.

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	RES	CAL	FT	M
0-370' Surficial deposit					0	0
					50	
					100	
					150	
					200	
					250	
					300	
					350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	RES	CAL	FT	M
370-463' Surficial depo.						
					400	
500-503' Coal						
503-506' Impure coal						
506-511' Coal						
511-512' Impure coal						
512-513½' Coal					450	
521-522½' Coal						
522½-523½' Impure coal						
523½-524' Coal						
525-528' Coal					500	150
528½-T.D. Sandstone (Rollins)					550	
					566 T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-3 State Colorado County Delta

T. 13 S., R. 92 W., sec. 19, SE $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 8230

Drilled depth 933' Cored interval 703-933'

Logged depth 941' Logging company Minerals Service Date logged 10-19-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 160'	5.13"	0- 703'	3.06" ID	0- 703'
Foam	160- 420'	2.98"	703- 933'		
Mud	420- 480'				
Foam	480- 703'				
Water	703- 933'				

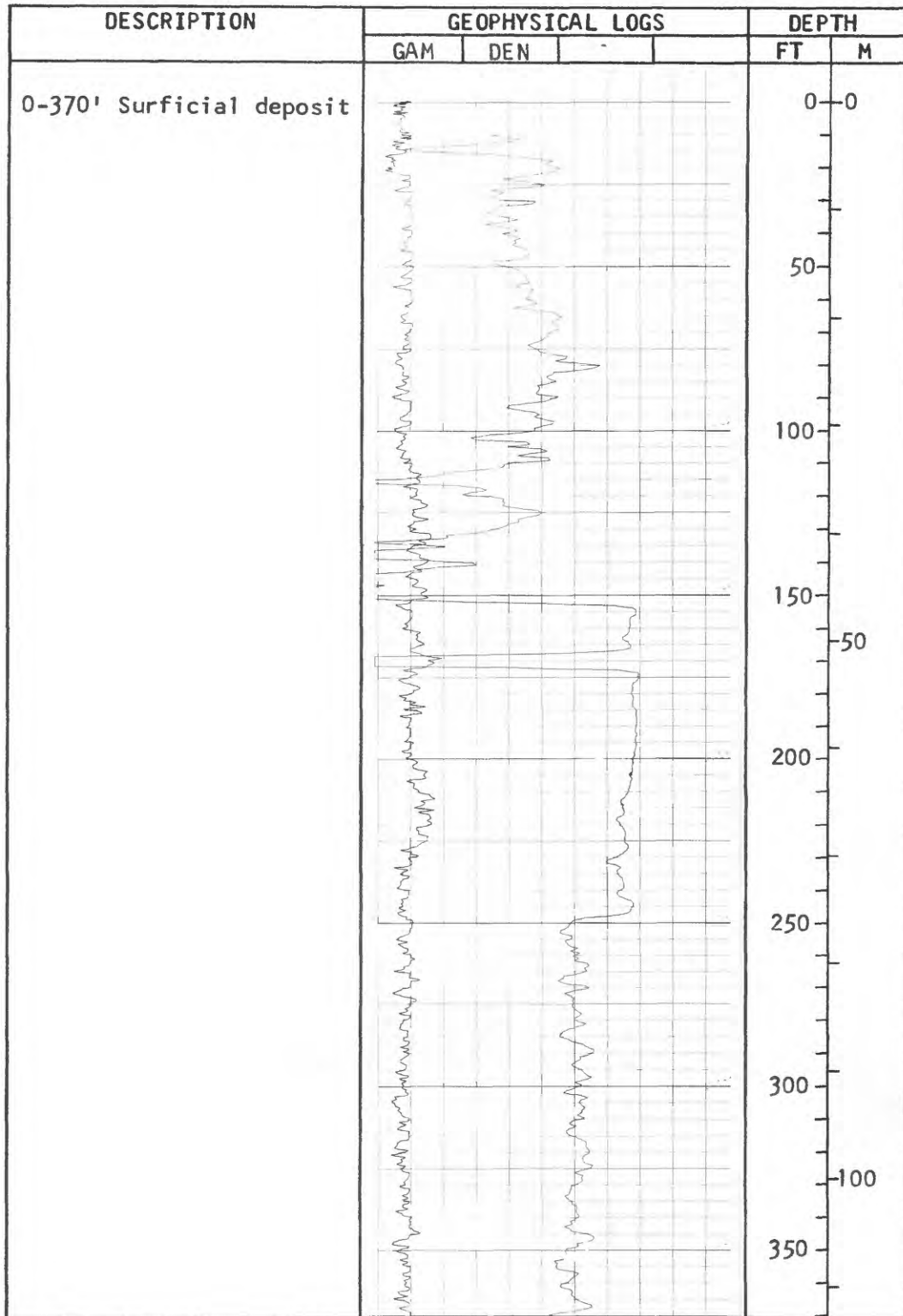
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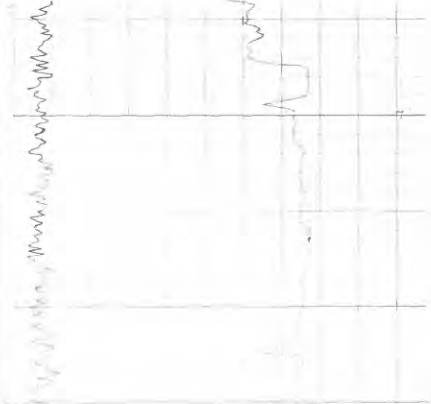

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Resistivity Caliper (1-arm)		100 cps/in. 100 cps/in. 100 Ohms/in. 25 ins./in.	932- 0' 941- 10' 936- 744' 941- 732'	20

Remarks: Gamma is 7 $\frac{1}{2}$ ' too deep; density is 7' too deep;
resistivity is 8' too deep.

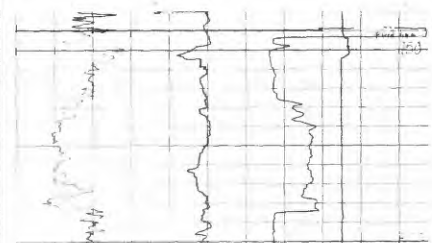




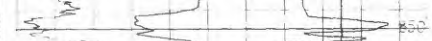
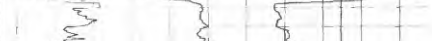
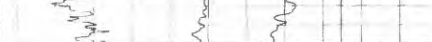







U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-3 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN		CAL	FT	M
370-477' Surficial depo.					400	
					450	
					500	150
					550	
					600	
					650	200
680½-683½' Coal						
688½-689' Impure coal						
689-692' Coal						
692-692½' Impure coal					700	
695-696' Coal						

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	RES	CAL	FT	M
					750	
804-810' Coal					800	
810-811½' Impure coal					250	
845½-846' Impure coal						
846-849½' Coal						
850½-852' Coal					850	
889-892' Coal						
892-892½' Impure coal						
892½-899' Coal						
899-900½' Impure coal						
900½-906' Coal					900	
906½-908' Coal						
915½-917½' Coal						
919-921½' Coal					941	
921½-T.D. Sandstone (Rollins)					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-4 State Colorado County Delta

T. 13 S., R. 92 W., sec. 29, SW $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 8060

Drilled depth 700' Cored interval NONE

Logged depth 700' Logging company Minerals Service Date logged 9-27-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 10'	5.63"	0- 370'	5.0" ID	0- 60'
Mud	10- 700'	5.13"	370- 700'		

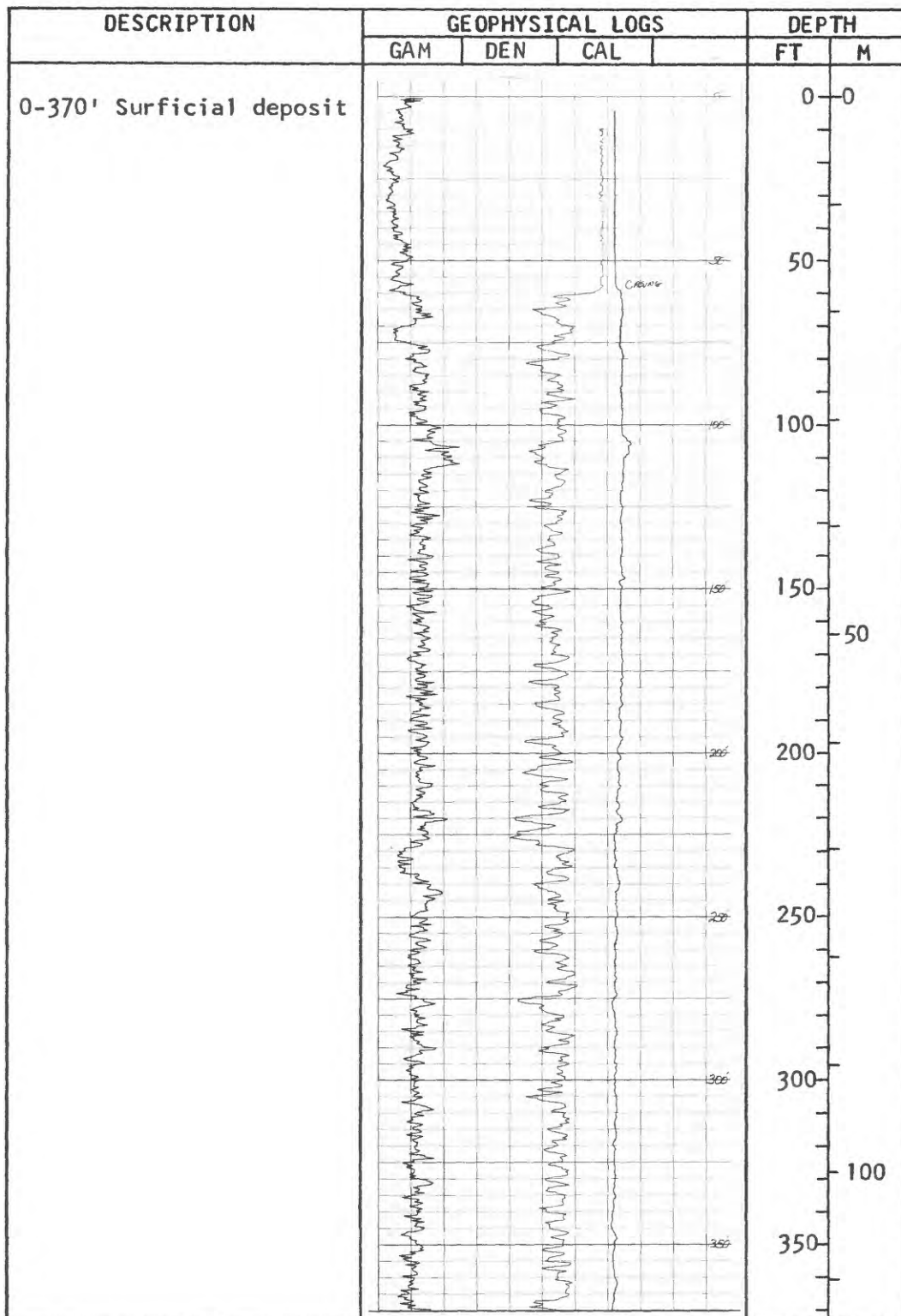
LOGGING DATA

Gamma source Am 241

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	690- 1' 700- 10' 694- 5' 690- 486'	20

Remarks:

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-4 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-4 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH					
	GAM	DEN	CAL	RES	FT	M				
370-459' Surficial depo.					400					
475-482' Coal									450	
548-550½' Coal					500	150				
601-610' Coal					550					
610-611' Impure coal										
611-618' Coal										
631-633½' Impure coal										
633½-634½' Coal					600					
637½-638½' Coal										
655-663½' Coal										
664½-667' Coal										
673-674' Coal					650	200				
674-675' Impure coal										
675-675½' Coal										
677-679½' Coal										
680-T.D. Sandstone (Rollins)					700					
					T.D.					

GAMMA-20 CPS/IN DENSITY-20 LBS/IN RES-25 OHM-IN

LOG # 56-77-4

← CALIPER →

↑ Swath ZONE

GAMMA-20 CPS/gm Density-20 LBS/in³ RES-25 OHM/in

LOG # GR-77-4

← CALIPER →

↑
Lithology
2-66

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-5 State Colorado County Delta

T. 13 S., R. 92 W., sec. 20, CE $\frac{1}{2}$ Approx. elev. (ft) 8320'

Drilled depth 1263' Cored interval 963-1263'

Logged depth 1264' Logging company Minerals Service Date logged 9-28-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 150'	5.13"	0- 963'	3.06" ID	0- 963'
Mud	150- 665'	2.98"	963-1263'		
Air	665- 963'				
Mud	963-1263'				

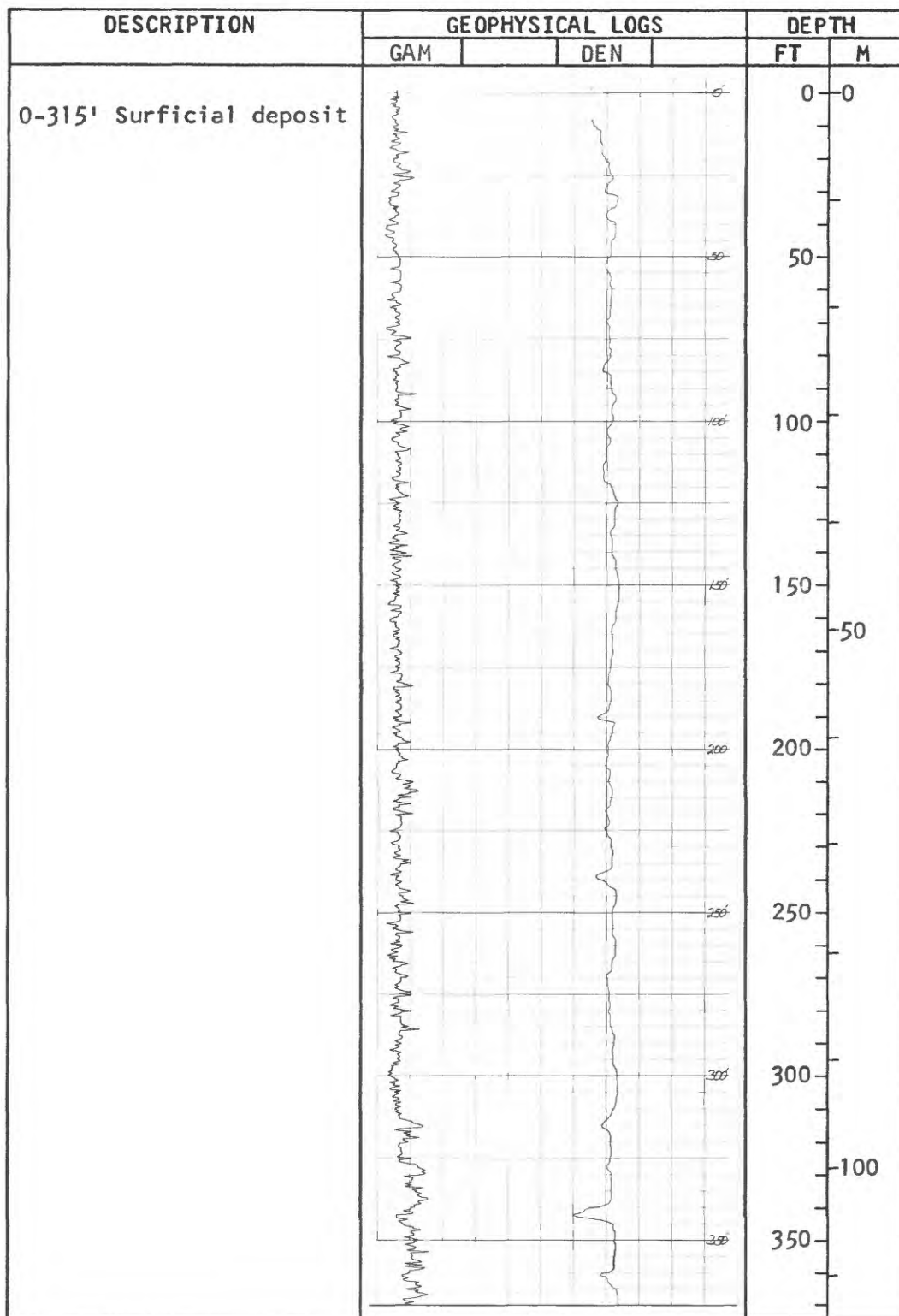
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Gamma source Cs 137

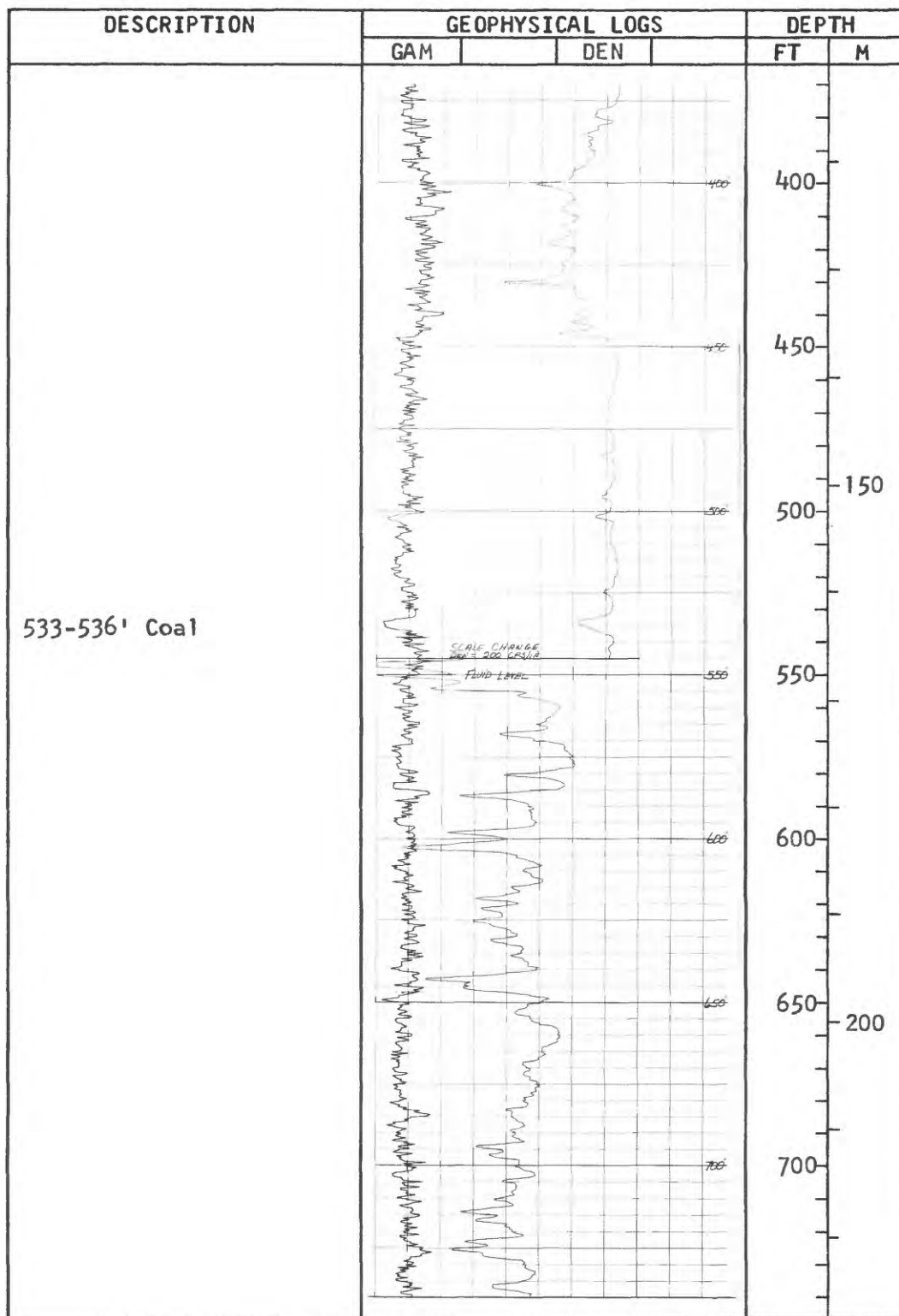
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.63"	Gamma Density Resistivity		100 cps/in. 1000 cps/in. 100 Ohms/in.	1258- 0' 1264- 8' 1259- 940'	20

Remarks: Gamma and density are $9\frac{1}{2}'$ too deep; resistivity is $10\frac{1}{2}'$ too deep.

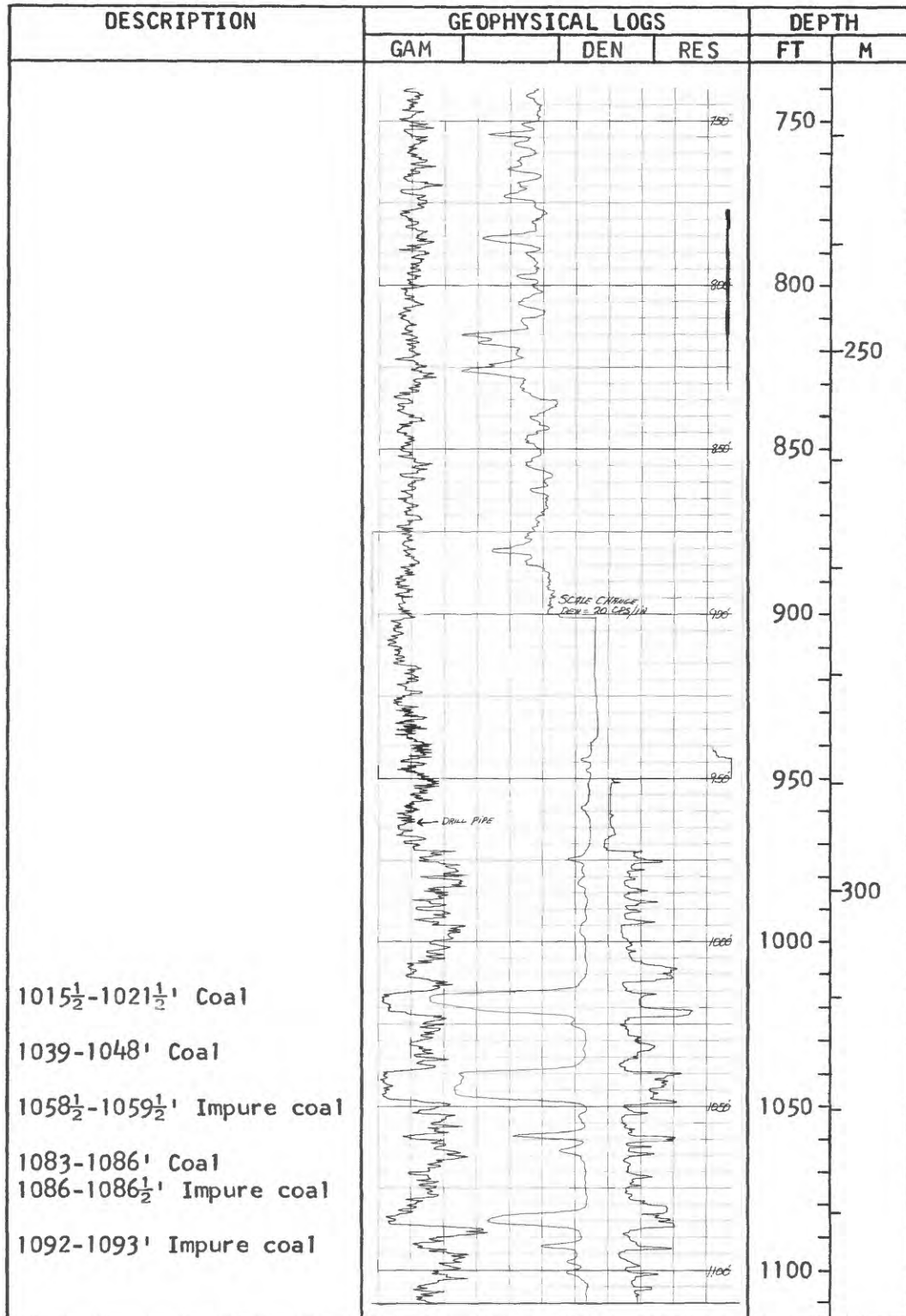
U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-5 continued



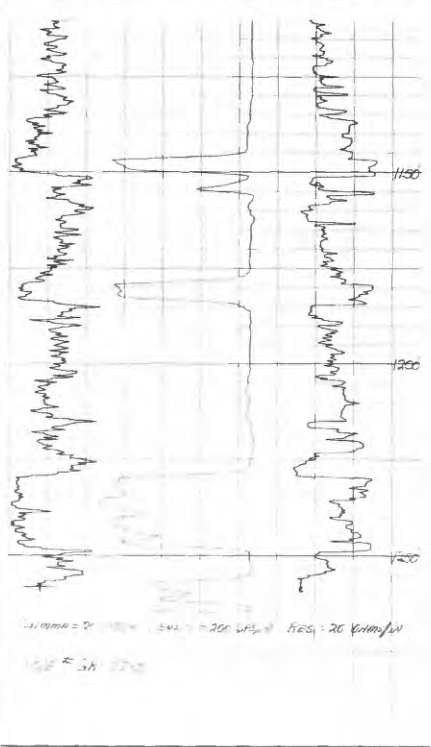
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Drill-hole no. GR-77-5 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-5 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-5 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN	RES	FT	M
1146-1150' Coal					1150	350
1154-1155' Impure coal						
1178 $\frac{1}{2}$ -1183 $\frac{1}{2}$ ' Coal						
1229 $\frac{1}{2}$ -1238' Coal					1200	
1238-1239' Impure coal						
1239-1244 $\frac{1}{2}$ ' Coal						
1244 $\frac{1}{2}$ -1246' Impure coal						
1246-1248' Coal						
1256 $\frac{1}{2}$ -1259' Impure coal					1250	
1260 $\frac{1}{2}$ -1262' Impure coal					1264	
1262 $\frac{1}{2}$ -T.D. Sandstone (Rollins)					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-6 State Colorado County Delta

T. 13 S., R. 92 W., sec. 28, NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 8170

Drilled depth 901' Cored interval NONE

Logged depth 901' Logging company Minerals Service Date logged 9-8-77

Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 720'	6.75"	0- 191'	5.0" ID	0- 206'
Mud	720- 901'	4.75"	191- 901'		

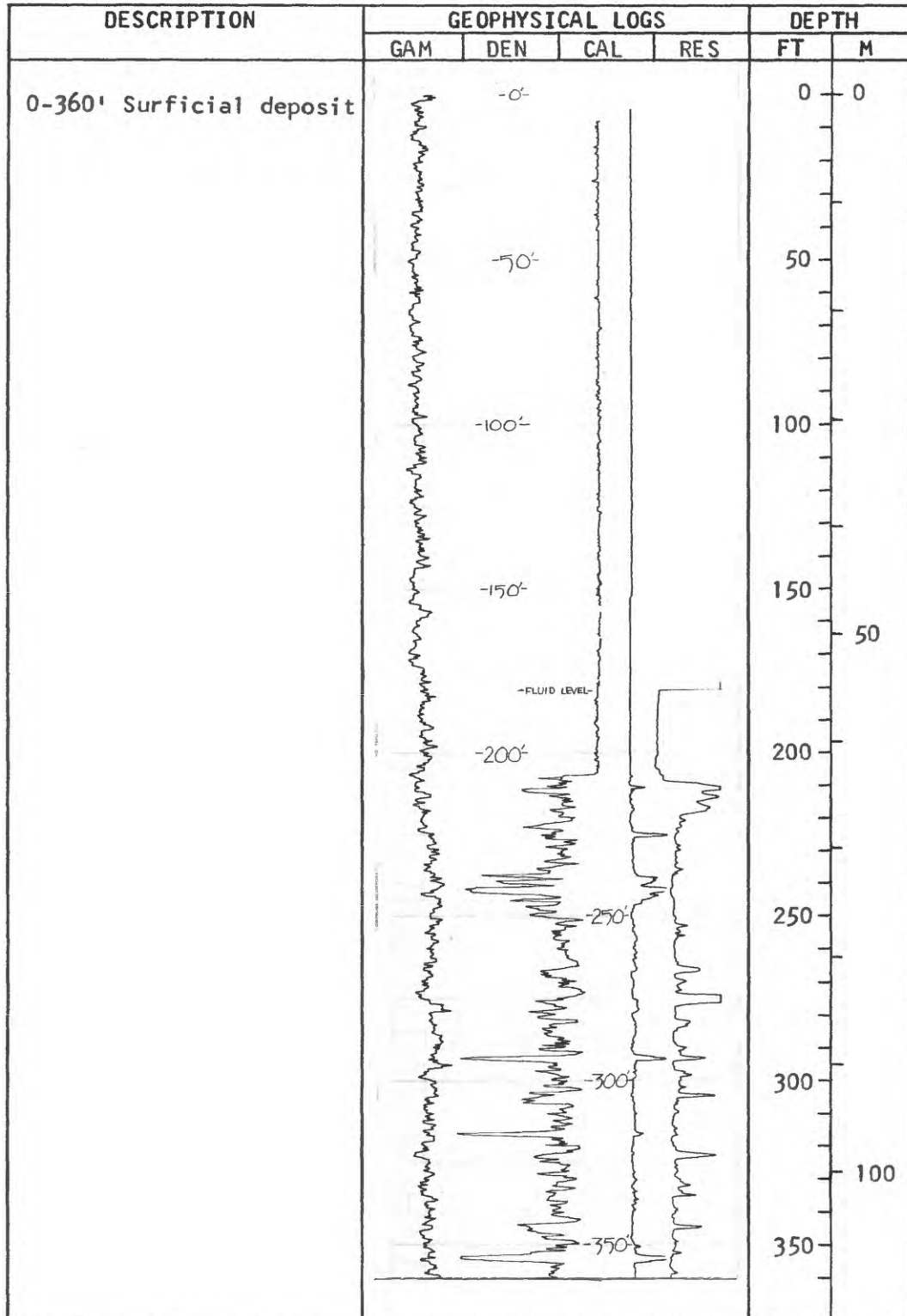
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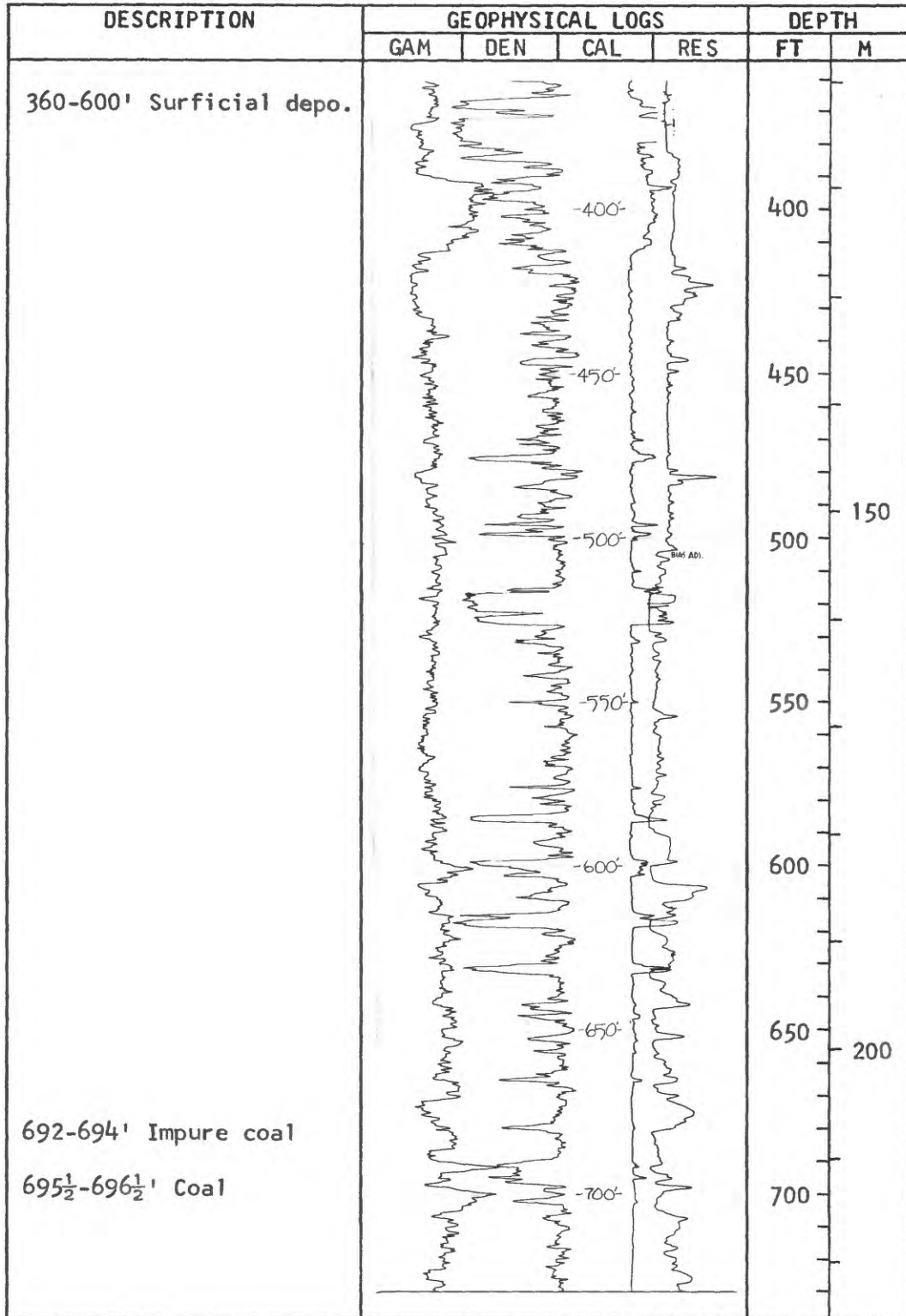
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity	2 2	100 cps/in. 100 cps/in. 40 ins./in. 75 Ohms/in.	893- 0' 901- 8' 898- 5' 893- 181'	20

Remarks: Gamma is 1' too deep; resistivity is 2' too deep.

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-6 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-6 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-6 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
804½-809' Coal 809-810½' Impure coal 810½-815' Coal 826-827' Impure coal 827-828' Coal 882½-886' Coal 887-888' Coal 888½-893½' Coal 898-900' Coal					750	
					800	250
					850	
					901	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. GR-77-7 State Colorado County Delta

T. 13 S., R. 92 W., sec. 14, SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 7460

Drilled depth 683' Cored interval 509-683'

Logged depth 680' Logging company Minerals Service Date logged 9-2-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 18'	6.75"	0- 32'	5.0" ID	0- 32'
Foam	18- 509'	4.75"	32- 509'	3.06" ID	0- 509'
Water	509- 683'	2.98"	509- 683'		

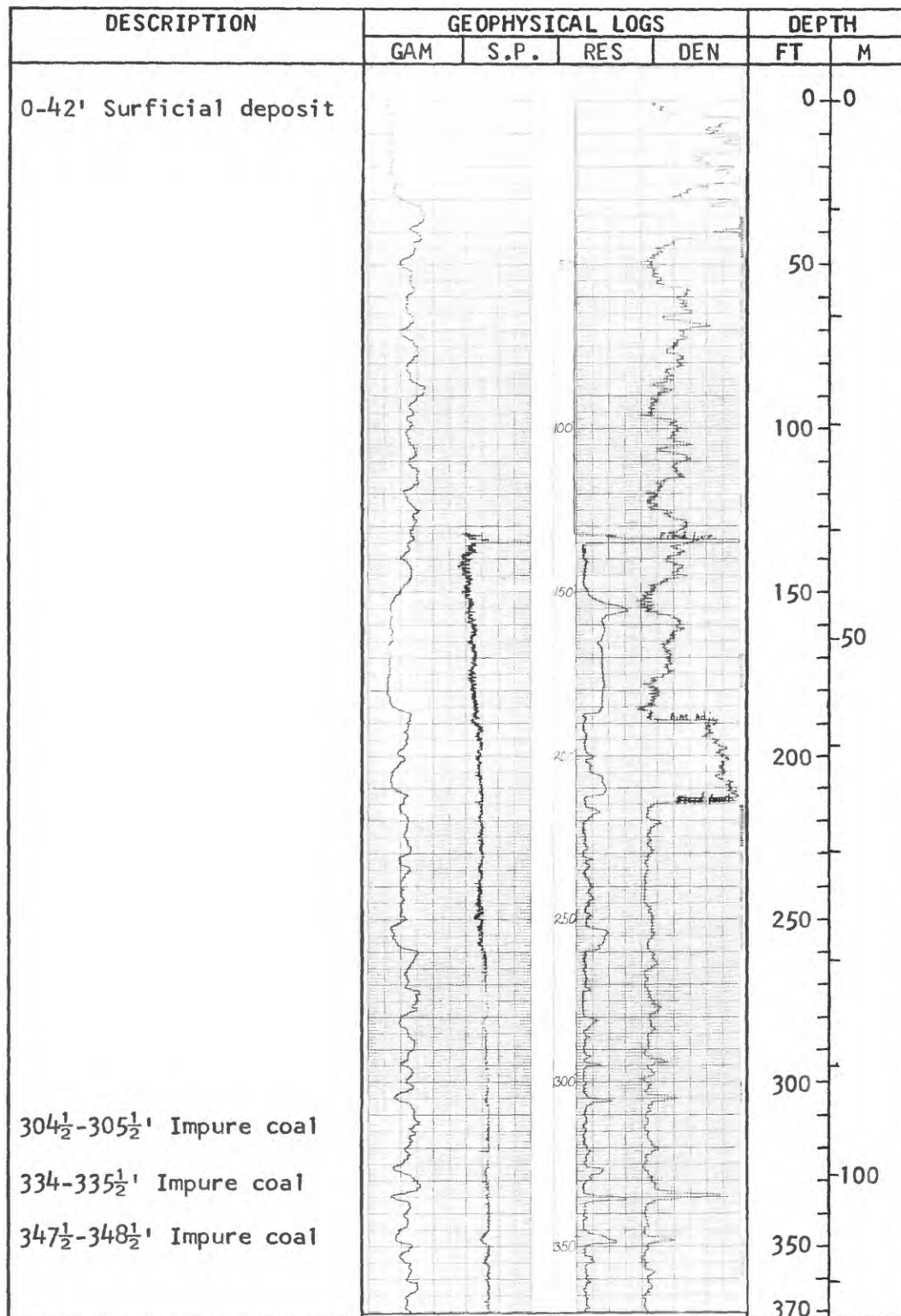
LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Spontaneous-Pot. Resistivity Density		200 cps/in. 250 mv/in. 2000 Ohms/in. 500 cps/in. 200 cps/in.	678- 500' 680- 502' 680- 508' 680- 460' 460- 1'	20
2	1.25"	Gamma Spontaneous-Pot. Resistivity		200 cps/in. 250 mv/in. 2000 Ohms/in.	498- 0' 500- 135' 500- 135'	20

Remarks: Run no.1: Gamma is $2\frac{1}{2}'$ too shallow; resistivity is $1\frac{1}{2}'$ too shallow; density is 1' too shallow.
There is a skip in gamma and resistivity 642-625'.

U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-7 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. GR-77-7 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	S.P.	RES	DEN	FT	M
					400	
484-492½' Coal						
508½-517' Coal					450	
522-524' Impure coal						
558½-561' Coal						150
561-562' Impure coal					500	
562-565' Coal						
571½-573' Impure coal						
580½-585' Coal						
587½-590½' Coal					550	
590½-591½' Impure coal						
591½-595' Coal						
602½-604' Impure coal						
629-631' Impure coal					600	
634-637½' Coal						
645½-649½' Coal						
653-655' Coal					650	200
662-663½' Impure coal						
663½-T.D. Sandstone (Rollins)					680 T.D.	

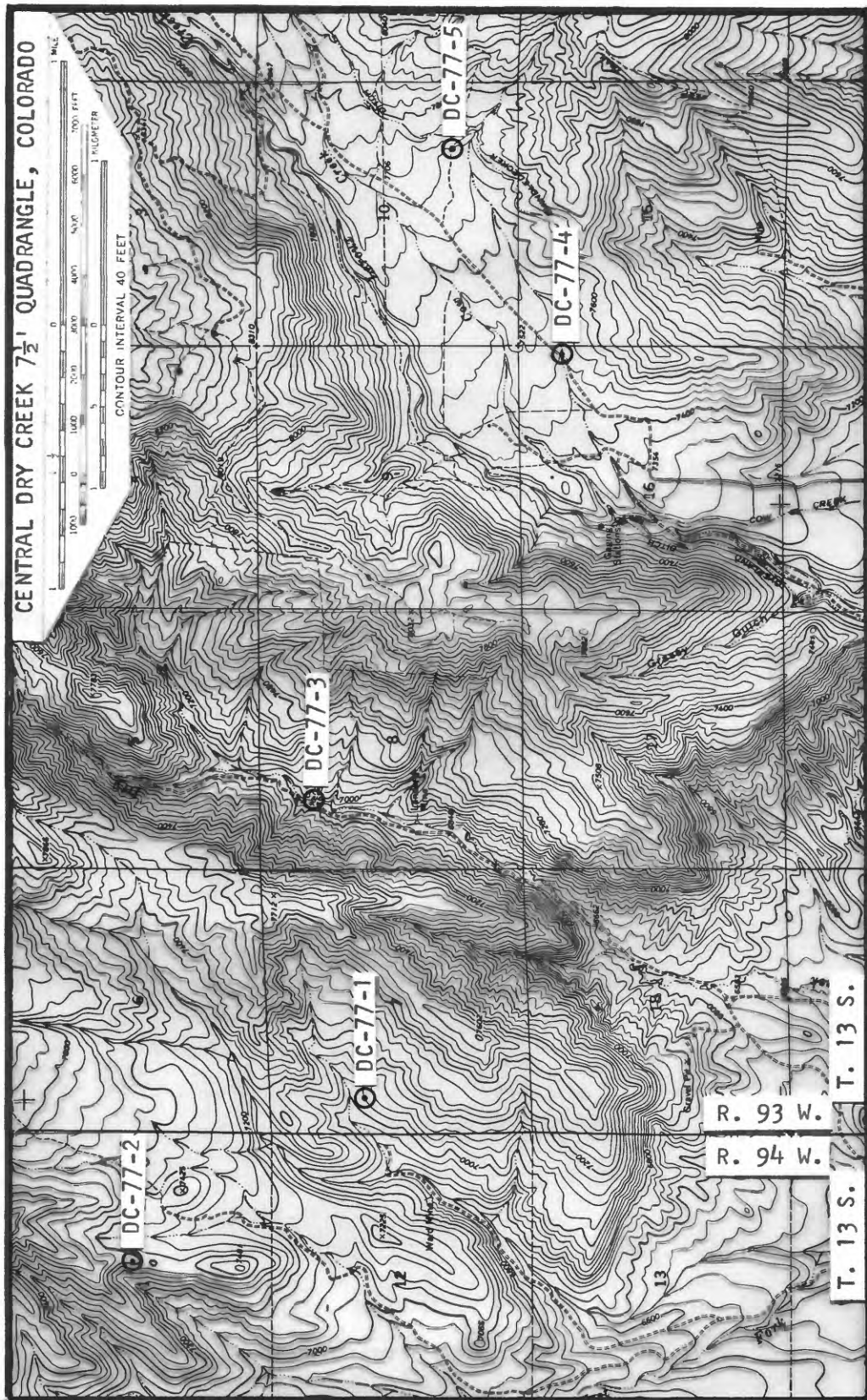


Figure 2.--Map showing U.S.G.S. drill-hole locations in the Dry Creek 7 1/2' quadrangle, Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. DC-77-1 State Colorado County Delta

T. 13 S., R. 93 W., sec. 7, CSW $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 7040

Drilled depth 295' Cored interval NONE

Logged depth 295' Logging company Minerals Service Date logged 9-7-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 295'	6.75"	0- 21'	5.0" ID	0- 21'
		4.75"	21- 295'		

LOGGING DATA

Gamma source Am 241

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma		100 cps/in.	288- 0'	20
		Density		100 cps/in.	295- 13'	
		Caliper (1-arm)		10 ins./in.	290- 2'	
		Resistivity		75 Ohms/in.	287- 155'	

Remarks: Density is 2' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
0-25' Surficial deposit					0-0	
66-68' Coal					50	
89-90' Impure coal						
97-98½' Coal					100	
98½-99' Impure coal						
102-104½' Coal						
104½-105½' Impure coal					150	
166-169' Coal					50	
169-171' Impure coal						
171-176' Coal						
176-176½' Impure coal					200	
176½-181' Coal						
194½-196½' Coal						
196½-198½' Impure coal						
260-264' Impure coal					250	
266½-271' Coal						
271-272' Impure coal						
274½-T.D. Sandstone (Rollins)	<p>GAMMA = 20 cty/cu HOLE # DC 77-1 DENSITY = 20 cty/cu CALIPER = 1/2 26 1/2 1/2 RESISTIVITY = 300</p> <p>NOTE: ALL DENSITY READINGS ARE TWO DIVISIONS HIGHER THAN ACTUAL ELEVATION</p>				295 T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. DC-77-2 State Colorado County Delta

T. 13 S., R. 94 W., sec. 1, SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 7400

Drilled depth 963' Cored interval 803-963'

Logged depth 956' Logging company Strata Surveys Date logged 11-4-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 240'	4.75"	0- 802'	3.06" ID	0- 802'
Air-water	240- 802'	2.98"	802- 963'		
Water	802- 963'				

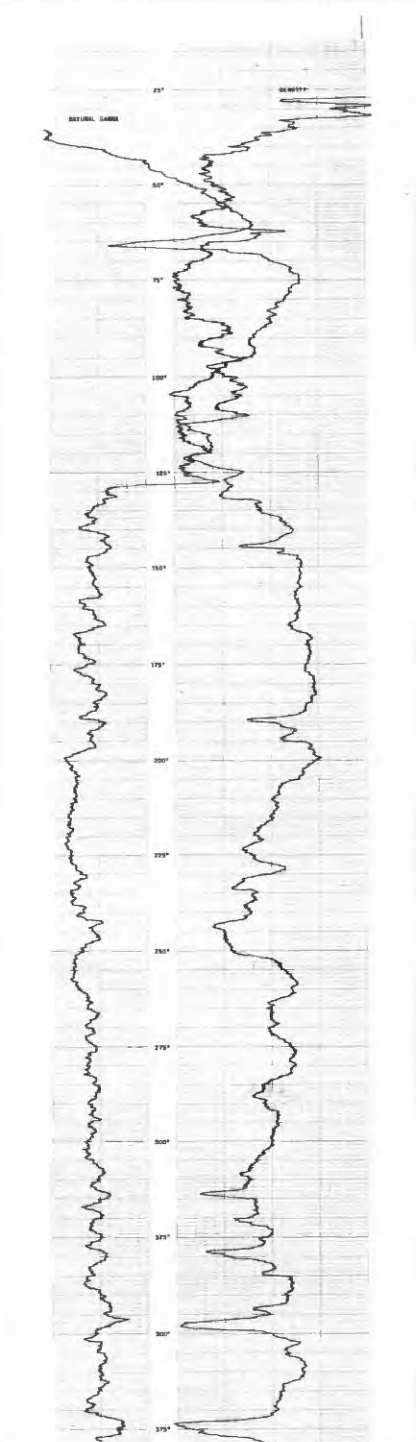
LOGGING DATA

Gamma source Cs 137

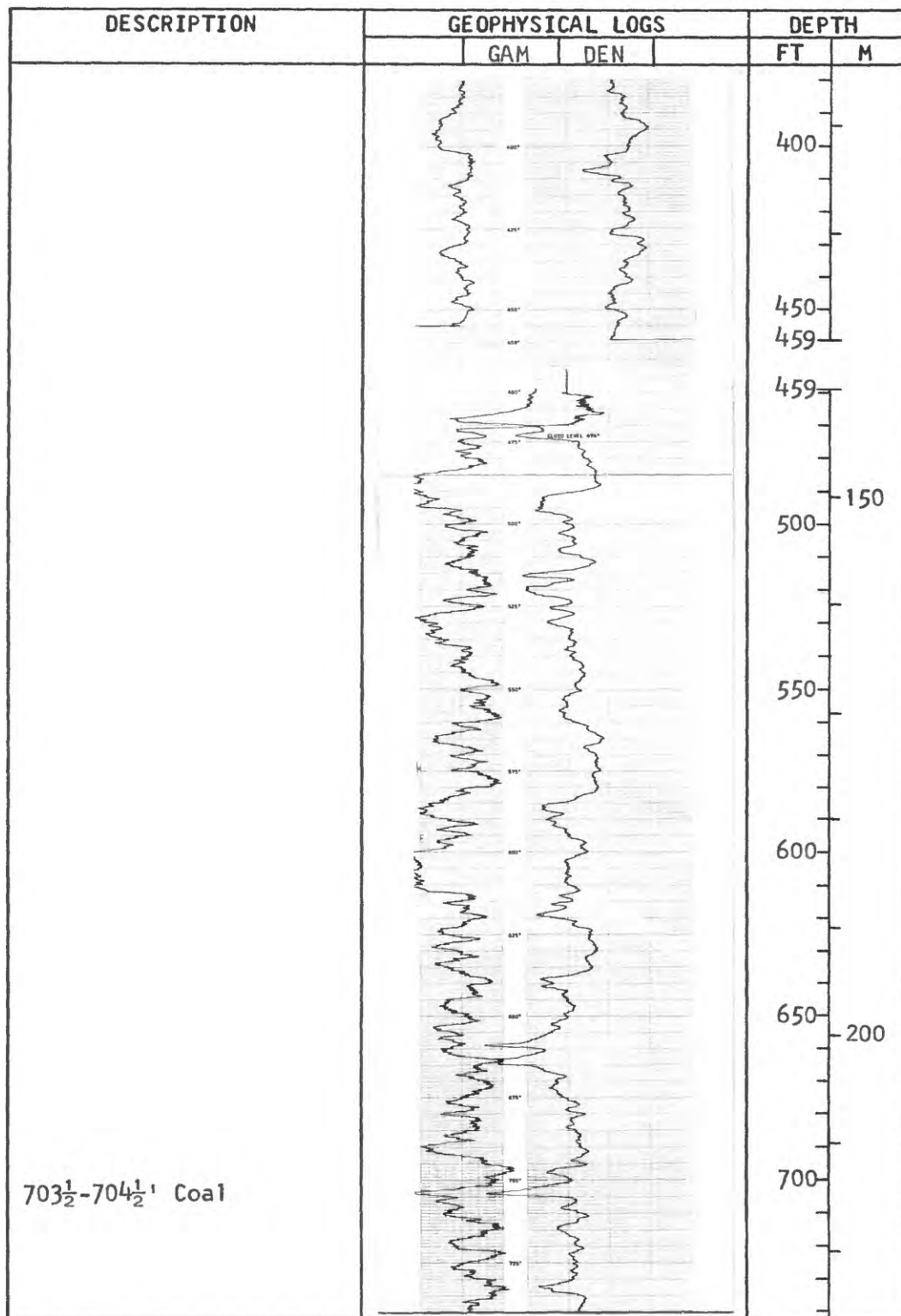
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	400 cps/in. 2500 cps/in.	951- 789' 955- 790' 956- 799'	20
2	1.69"	Gamma Density	3 3	400 cps/in. 2500 cps/in.	795- 460' 799- 460'	20
3	1.69"	Gamma Density	3 3	400 cps/in. 2500 cps/in.	455- 36' 459- 27'	20
4	1.38"	Caliper (3-arm)	1	20 ins./in.	955- 790'	25

Remarks: Run no. 1 is 2' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS			DEPTH	
	GAM	DEN		FT	M
189-190' Impure coal				27	
				50	
				100	
				150	
				50	
				200	
				250	
				300	
				100	
				350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-2 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	CAL	GAM	DEN	RES	FT	M
751-752' Impure coal					750	
					799	
					789	
802½-804½' Impure coal					800	
806-808½' Impure coal						250
809½-813' Coal						
813½-815½' Impure coal						
835½-839½' Coal					850	
839½-840½' Impure coal						
840½-843' Coal						
855½-863' Coal						
880½-883' Coal					900	
883-884½' Impure coal						
884½-888' Coal						
888-889' Impure coal						
924-927' Impure coal						
939-943½' Impure coal					956	
					T.D.	
947½-T.D. Sandstone (Rollins)						

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. DC-77-3 State Colorado County Delta

T. 13 S., R. 93 W., sec. 8, SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 6960

Drilled depth 308' Cored interval 83-308'

Logged depth 305' Logging company Strata Surveys Date logged 11-8-77

Drilling media record		Bore-hole record		Casing record	
Mud	0- 83'	5.13"	0- 83'	3.06" ID	0- 83'
Water	83- 308'	2.98"	83- 308'		

LOGGING DATA
Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	1000 cps/in. 2000 cps/in.	300- 0' 304- 2' 305- 77'	20
2	1.38"	Caliper (3-arm)	1	20 ins./in.	304- 25'	25

Remarks: All logs are 1' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
0-30' Surficial deposit					0-0	
59½-61' Impure coal					50	
81-82½' Impure coal					100	
108½-110' Impure coal					150	
124-127' Coal					50	
127-127½' Impure coal						
160-166½' Coal						
191½-205' Coal					200	
236½-239½' Coal						
239½-240½' Impure coal						
240½-244' Coal					250	
273½-274½' Impure coal						
279½-281½' Impure coal						
282½-289½' Impure coal						
295½-T.D. Sandstone (Rollins)					305 T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. DC-77-4 State Colorado County Delta

T. 13 S., R. 93 W., sec. 16, SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 7480

Drilled depth 603' Cored interval NONE

Logged depth 603' Logging company Minerals Service Date logged 9-28-77

Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 603'	7.13"	0- 20'	5.0" ID	7- 28'
		5.13"	20- 390'		
		4.75"	390- 603'		

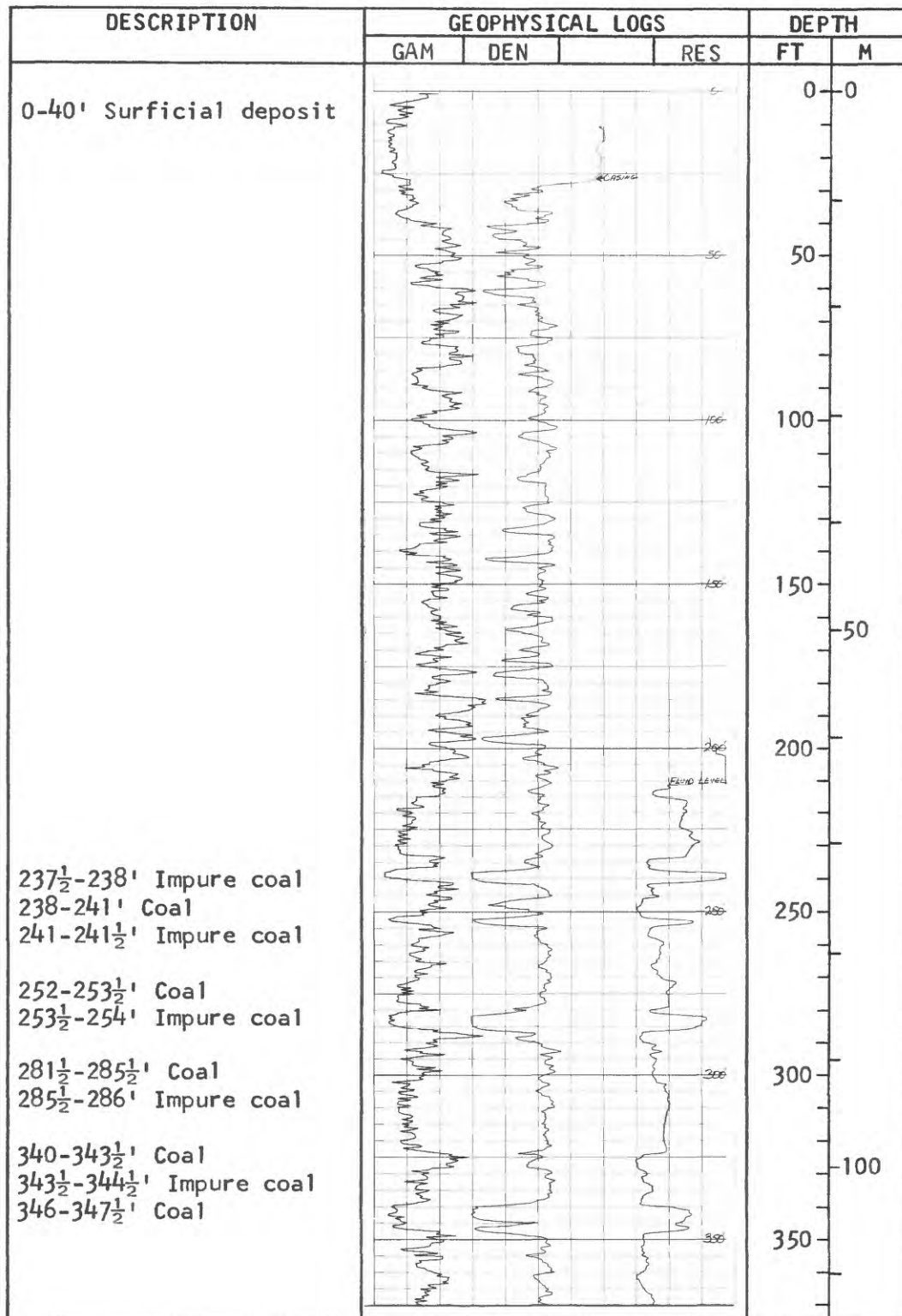
LOGGING DATA

Gamma source Am 241

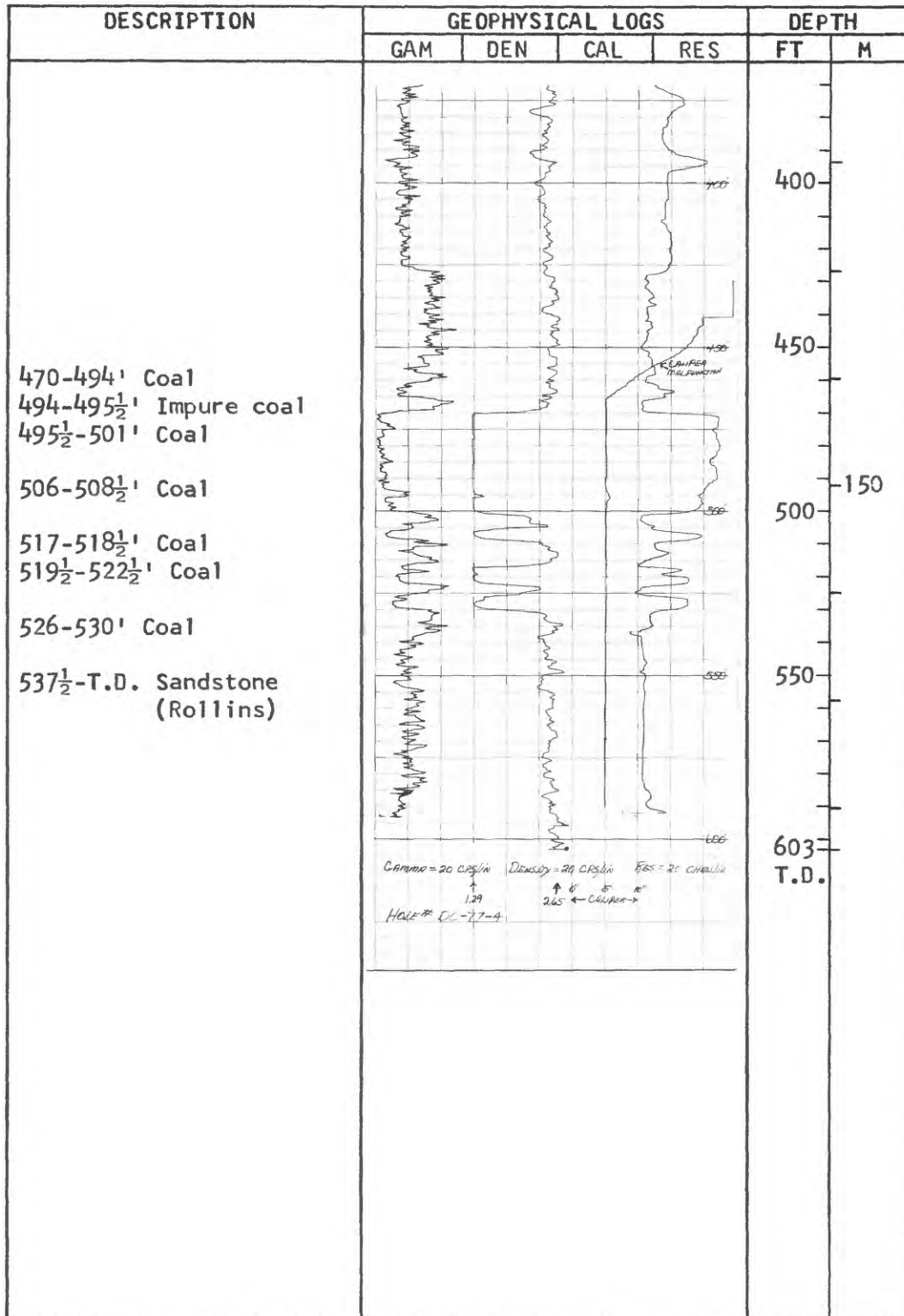
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	593- 1' 603- 11' 590- 466' 592- 212'	20

Remarks:

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-4 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-4 continued



U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. DC-77-5 State Colorado County Delta

T. 13 S., R. 93 W., sec. 10, CSE $\frac{1}{4}$ Approx. elev. (ft) 7680

Drilled depth 862' Cored interval 593-862'

Logged depth 864' Logging company Minerals Service Date logged 10-11-77

Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 230'	7.88"	0- 60'	5.0" ID	0- 90'
Mud	230- 593'	5.13"	60- 533'	3.06" ID	0- 593'
Water	593- 862'	4.75"	533- 593'		
		2.98"	593- 862'		

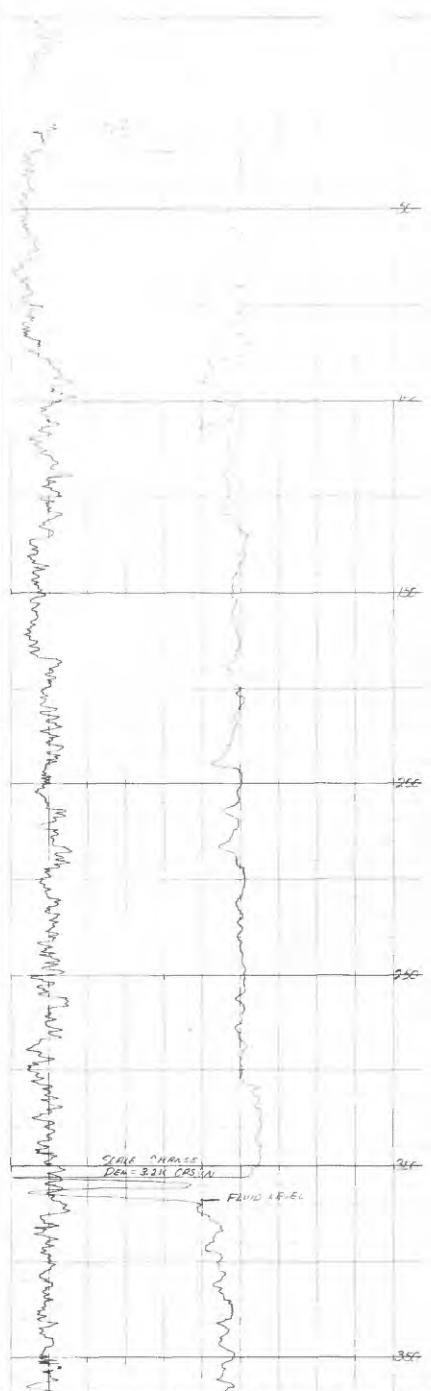
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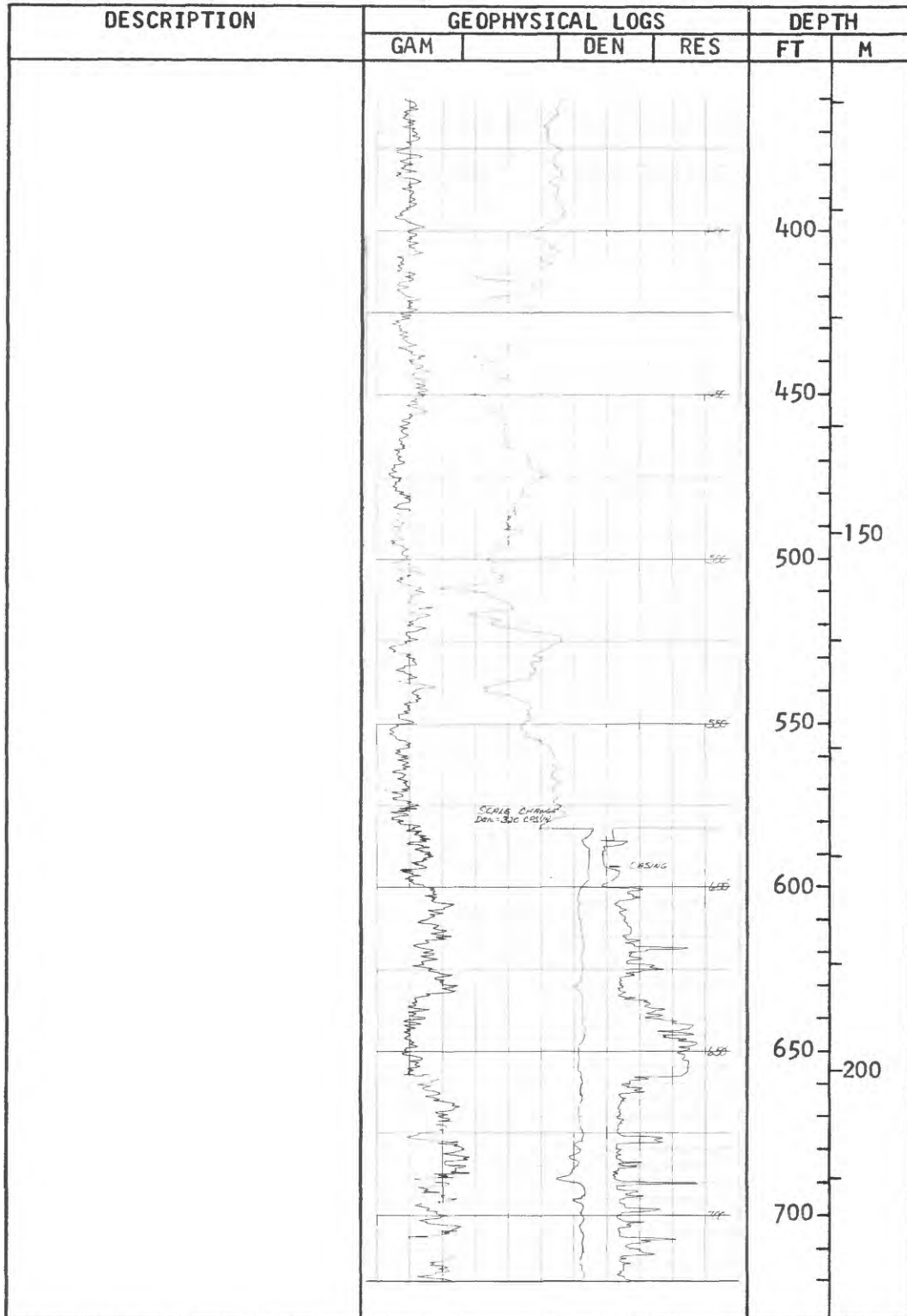
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.63"	Gamma Density		100 cps/in. 16K cps/in. 1600 cps/in.	858- 1' 864- 582' 582- 303'	20
		Resistivity		16K cps/in. 100 Ohms/in.	303- 7' 857- 582'	

Remarks: Gamma and density are 7' too deep; resistivity is $8\frac{1}{2}'$ too deep.


U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-5 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN		FT	M
0-100' Surficial deposit					0	0
					50	
					100	
					150	
					200	
					250	
					300	
					350	
						50
						100
						150
						200

U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-5 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. DC-77-5 continued

DESCRIPTION	GEOPHYSICAL LOGS			DEPTH		
	GAM		DEN	RES	FT	M
739-748' Coal					750	
750-753½' Coal						
816½-821½' Coal					800	
839-T.D. Sandstone (Rollins)					850	250
					864	
	FORMULA - 2L (1000) 2000 3000 4000 5000 6000 7000 8000 9000 10000				T.D.	
	H. = 20' ± 5'					

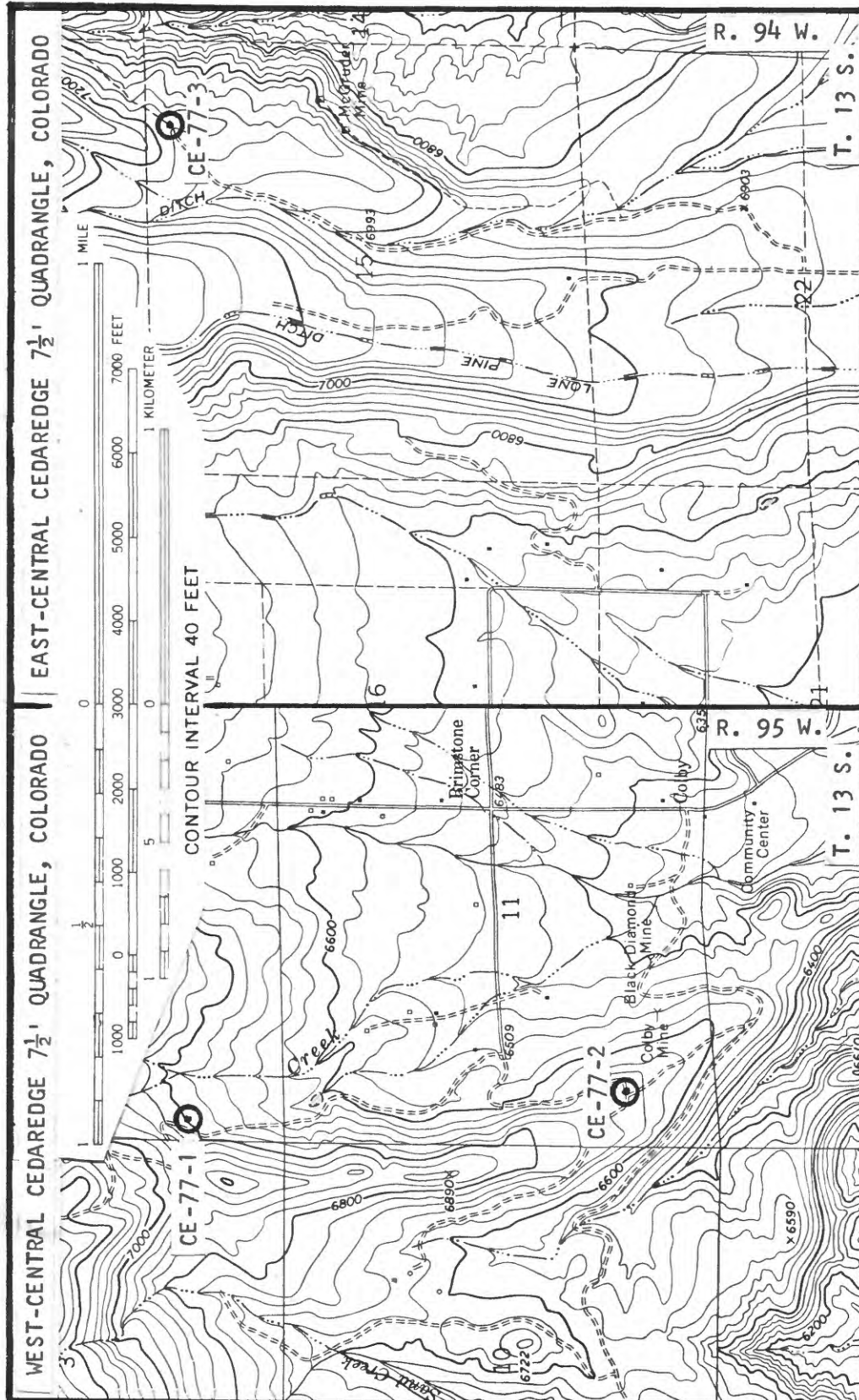


Figure 3.--Map showing U.S.G.S. drill-hole locations in the Cedaredge 7 1/2' quadrangle, Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. CE-77-1 State Colorado County Delta

T. 13 S., R. 95 W., sec. 2, NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 6800

Drilled depth 858' Cored interval 622-858'

Logged depth 854' Logging company Strata Surveys Date logged 11-17-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 140'	6.75"	0- 57'	5.0" ID	0- 57'
Foam	140- 622'	4.75"	57- 622'	3.06" ID	57- 622'
Water	622- 858'	2.98"	622- 858'		

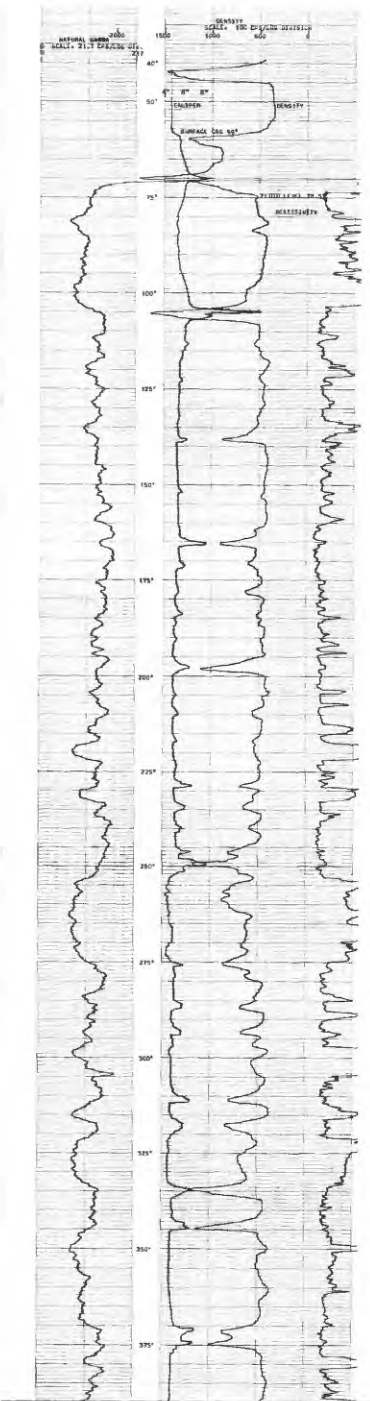
LOGGING DATA

Gamma source Cs 137

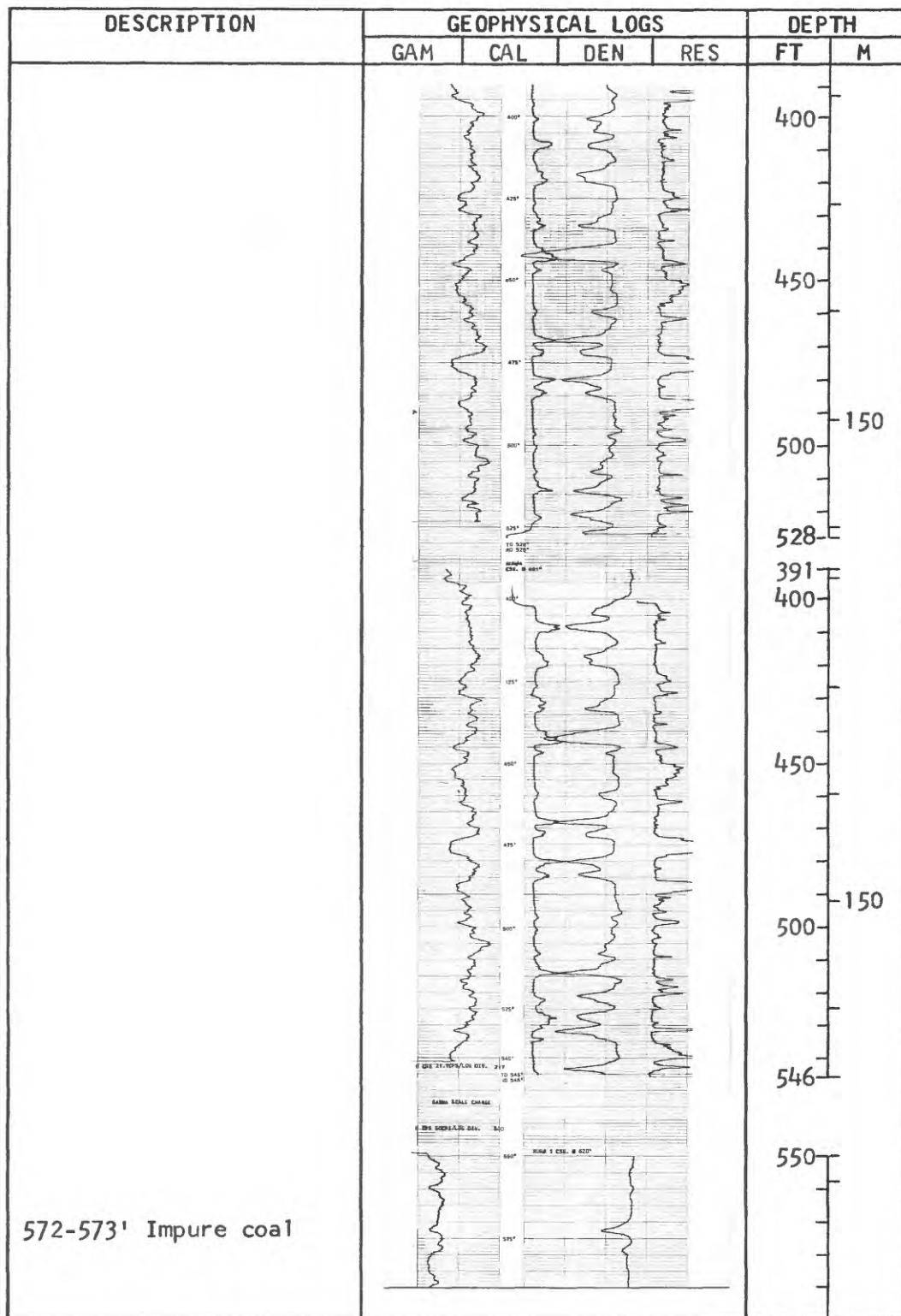
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	1000 cps/in. 2000 cps/in.	849- 550' 853- 550' 854- 609'	20
2	1.69"	Gamma Density Resistivity	3 3	434 cps/in. 2000 cps/in.	523- 72' 527- 39' 528- 74'	20
3	1.38"	Caliper (3-arm)	1	20 ins./in.	528- 42'	25
4	1.69"	Gamma Density Resistivity	3 3	434 cps/in. 2000 cps/in.	541- 391' 545- 391' 546- 401	20
5	1.38"	Caliper (3-arm)	1	20 ins./in.	545- 396'	25

Remarks: Run no. 1 is 2' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
0-45' Surficial deposit					39	
					50	
					100	
					150	
					50	
					200	
					250	
					300	
					100	
					350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-1 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN	RES	FT	M
615-621' Coal					600	
657-658' Impure coal						
672½-674' Coal					650	200
675-678' Coal						
690-691' Impure coal						
736-744½' Coal					700	
753½-757½' Coal						
765-768' Coal						
776-777' Impure coal					750	
778½-783' Coal						
784-784½' Tan clay						
784½-786' Coal						
817½-820' Coal					800	
826-834' Coal						
834-834½' Impure coal					250	
834½-836' Coal						
844½-T.D. Sandstone (Rollins)					854 T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. CE-77-2 State Colorado County Delta

T. 13 S., R. 95 W., sec. 11, CN $\frac{1}{2}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 6700

Drilled depth 460' Cored interval NONE

Logged depth 459' Logging company Strata Surveys Date logged 11-4-77

Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 460'	6.75"	0- 40'	5.0" ID	0- 40'
		4.75"	40- 460'		

LOGGING DATA

Gamma source Cs 137

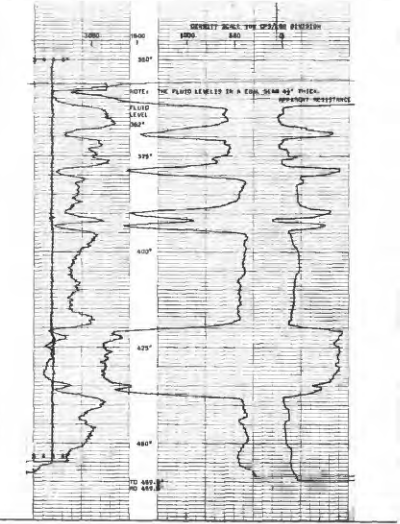
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma	3	434 cps/in.	454- 357'	20
		Density	3	2000 cps/in.	458- 358'	
		Resistivity			459- 362'	
2	1.69"	Gamma	3	434 cps/in.	354- 28'	20
		Density	3	5000 cps/in.	358- 33'	
3	1.38"	Caliper (3-arm)	1	20 ins./in.	457- 25'	25

Remarks: Gamma on run no. 2 has abnormally high cps due to contamination from the density-gamma source.

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	CAL	GAM	DEN		FT	M
0-96' Surficial deposit					28	
					50	
					100	
					150	
156-157' Impure coal					50	
					200	
196 $\frac{1}{2}$ -199' Coal						
201 $\frac{1}{2}$ -202 $\frac{1}{2}$ ' Coal						
202 $\frac{1}{2}$ -203 $\frac{1}{2}$ ' Impure coal						
203 $\frac{1}{2}$ -204 $\frac{1}{2}$ ' Coal						
222-223' Impure coal					250	
278-279' Impure coal						
282 $\frac{1}{2}$ -283 $\frac{1}{2}$ ' Impure coal						
291 $\frac{1}{2}$ -292 $\frac{1}{2}$ ' Impure coal					300	
315-316' Impure coal					100	
					350	
					358	

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	CAL	GAM	DEN	RES	FT	M
357 $\frac{1}{2}$ -362' Coal					357	
367 $\frac{1}{2}$ -368 $\frac{1}{2}$ ' Impure coal						
368 $\frac{1}{2}$ -370 $\frac{1}{2}$ ' Coal						
378-380' Coal						
389-391' Coal						
392 $\frac{1}{2}$ -394' Coal					400	
420-422' Coal						
422-423' Impure coal						
423-434 $\frac{1}{2}$ ' Coal						
434 $\frac{1}{2}$ -435 $\frac{1}{2}$ ' Impure coal						
435 $\frac{1}{2}$ -437 $\frac{1}{2}$ ' Coal		450				
		459				
451-T.D. Sandstone (Rollins)		T.D.				

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. CE-77-3 State Colorado County Delta

T. 13 S., R. 94 W., sec. 15, NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 7170

Drilled depth 360' Cored interval NONE

Logged depth 356' Logging company Strata Surveys Date logged 11-2-77

Drilling media record		Bore-hole record		Casing record
Air	0- 360'	5.13"	0- 360'	NONE

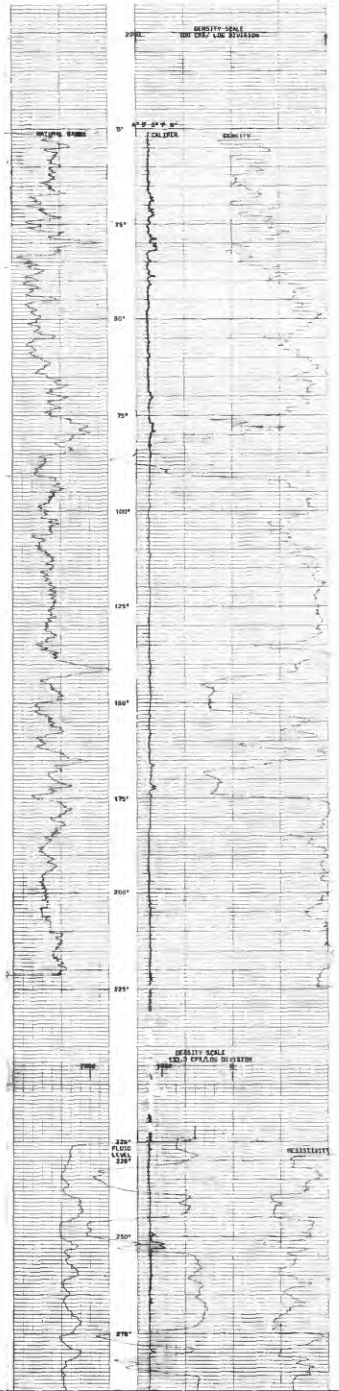
LOGGING DATA

Gamma source Cs 137

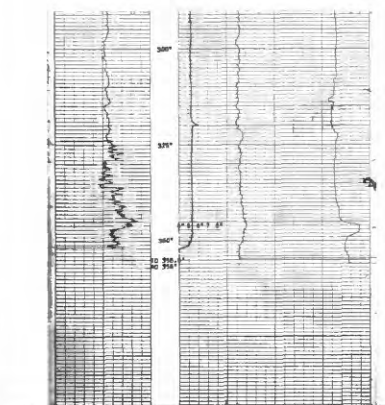
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	2667 cps/in.	351- 226' 354- 225' 356- 229'	20
2	1.69"	Gamma Density	3 3	2000 cps/in.	221- 2' 224- 3'	20
3	1.38"	Caliper (3-arm)	1	20 ins./in.	352- 0'	25

Remarks: Gamma on run no. 2 has abnormally high cps due to contamination from the density-gamma source.

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
0-17' Surficial deposit					0	0
81½-90½' Coal					50	
144½-152½' Coal					100	
160-161' Impure coal					150	
167½-174½' Coal					50	
232-235' Coal					200	
235-239' Impure coal					224	
245½-251½' Coal					225	
253-254' Impure coal					250	
275-277' Coal						
277-278' Impure coal						
281½-282½' Impure coal						
283½-284½' Impure coal						
285½-T.D. Sandstone (Rollins)						

U.S. GEOLOGICAL SURVEY
Drill-hole no. CE-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
290-T.D. Sandstone (Rollins)					300	
					100	
					356 T.D.	

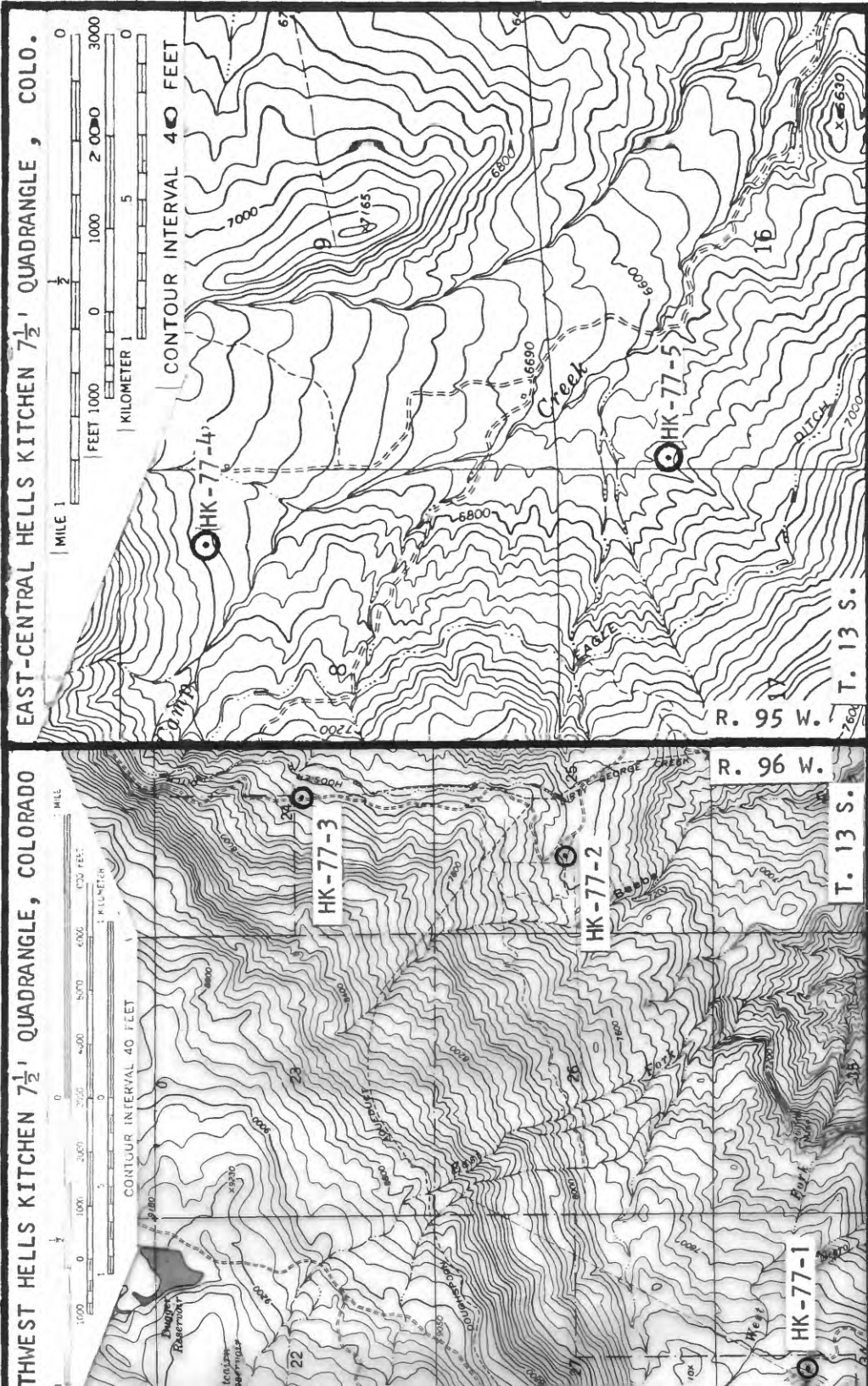


Figure 4.--Map showing U.S.G.S. drill-hole locations in the Hells Kitchen 7 1/2' quadrangle, Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. HK-77-1 State Colorado County Delta

T. 13 S., R. 96 W., sec. 34, NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 8030

Drilled depth 597' Cored interval 411-597'

Logged depth 595' Logging company Strata Surveys Date logged 12-7-77

Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 411'	4.75"	0- 411'	3.06" ID	0- 411'
Water	411- 597'	2.98"	411- 597'		

LOGGING DATA

Gamma source Cs 137

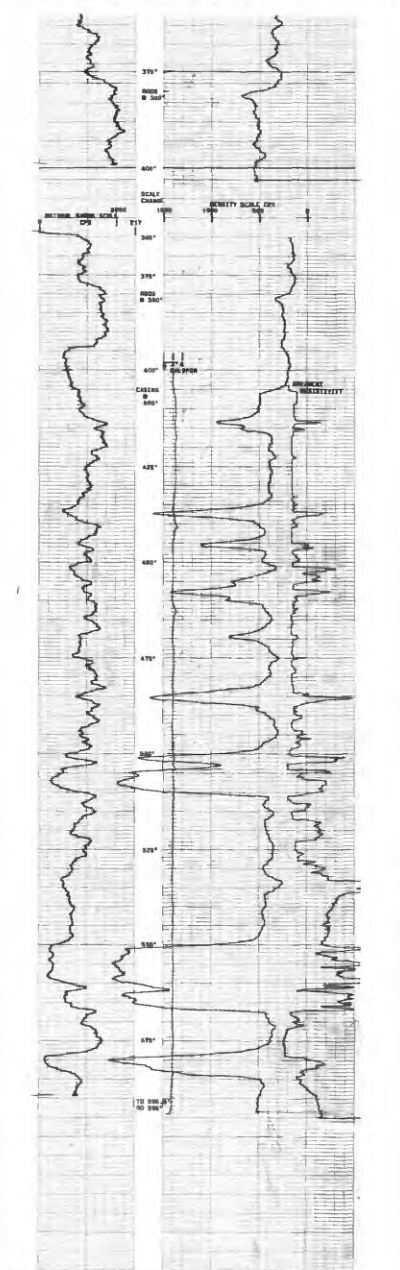
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	434 cps/in. 2000 cps/in.	589- 365' 593- 365' 595- 404'	20
2	1.69"	Gamma Density	3 3	356 cps/in. 1000 cps/in.	399- 3' 403- 3'	20
3	1.38"	Caliper (3-arm)	1	20 ins./in.	594- 400'	25

Remarks: Run no.1: gamma is 2 $\frac{1}{2}$ ' too shallow, density is 2' too shallow, resistivity is 1 $\frac{1}{2}$ ' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS		DEPTH	
	GAM	DEN	FT	M
0-137' Surficial deposit			0	0
			50	
			100	
			150	
			50	
			200	
220 $\frac{1}{2}$ -221 $\frac{1}{2}$ ' Impure coal			200	
			250	
			300	
			100	
			350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
					403	
					365	
					400	
436½-438' Impure coal					450	
445-446' Impure coal						
457-458½' Impure coal						
484½-486½' Impure coal					150	
500½-502½' Coal					500	
503-503½' Tan clay						
504½-510' Coal						
550½-561' Coal					550	
562-566' Coal						
566-567' Impure coal						
579-583½' Coal (w/ ss dike)					595	
583½-T.D. Sandstone (Rollins)					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. HK-77-2 State Colorado County Delta

T. 13 S., R. 96 W., sec. 25, SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 7390

Drilled depth 232' Cored interval 104-232'

Logged depth 225' Logging company Strata Surveys Date logged 12-2-77

Drilling media record		Bore-hole record		Casing record	
Mud	0- 104'	5.63"	0- 104'	4" ID	0- 104'
Water	104- 232'	3.78"	104- 232'		

LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3 3	434 cps/in. 2000 cps/in.	220- 180' 224- 89' 225- 180'	20
2	1.69"	Density	3	1000 cps/in.	97- 2'	20
3	1.69"	Gamma	3	434 cps/in.	180- 83'	20
4	1.69"	Gamma	3	434 cps/in.	95- 0'	20
5	1.38"	Caliper (3-arm)	1	20 ins./in.	225- 96'	25

Remarks: Run no. 1: All logs are 1 $\frac{1}{2}$ ' too shallow.
Run no. 3: Gamma is 2 $\frac{1}{2}$ ' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
0-124' Surficial deposit					0-0	
					50	
					97	
					83	
					100	
146½-148' Coal					150	
176-177' Impure coal					50	
177-186' Coal						
186-188' Impure coal						
195½-196½' Impure coal					200	
208½-210½' Coal					225	
211-T.D. Sandstone (Rollins)					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. HK-77-3 State Colorado County Delta
T. 13 S., R. 96 W., sec. 24, Center Approx. elev. (ft) 7660
Drilled depth 702' Cored interval NONE

Logged depth 702' Logging company Minerals Service Date logged 10-23-77

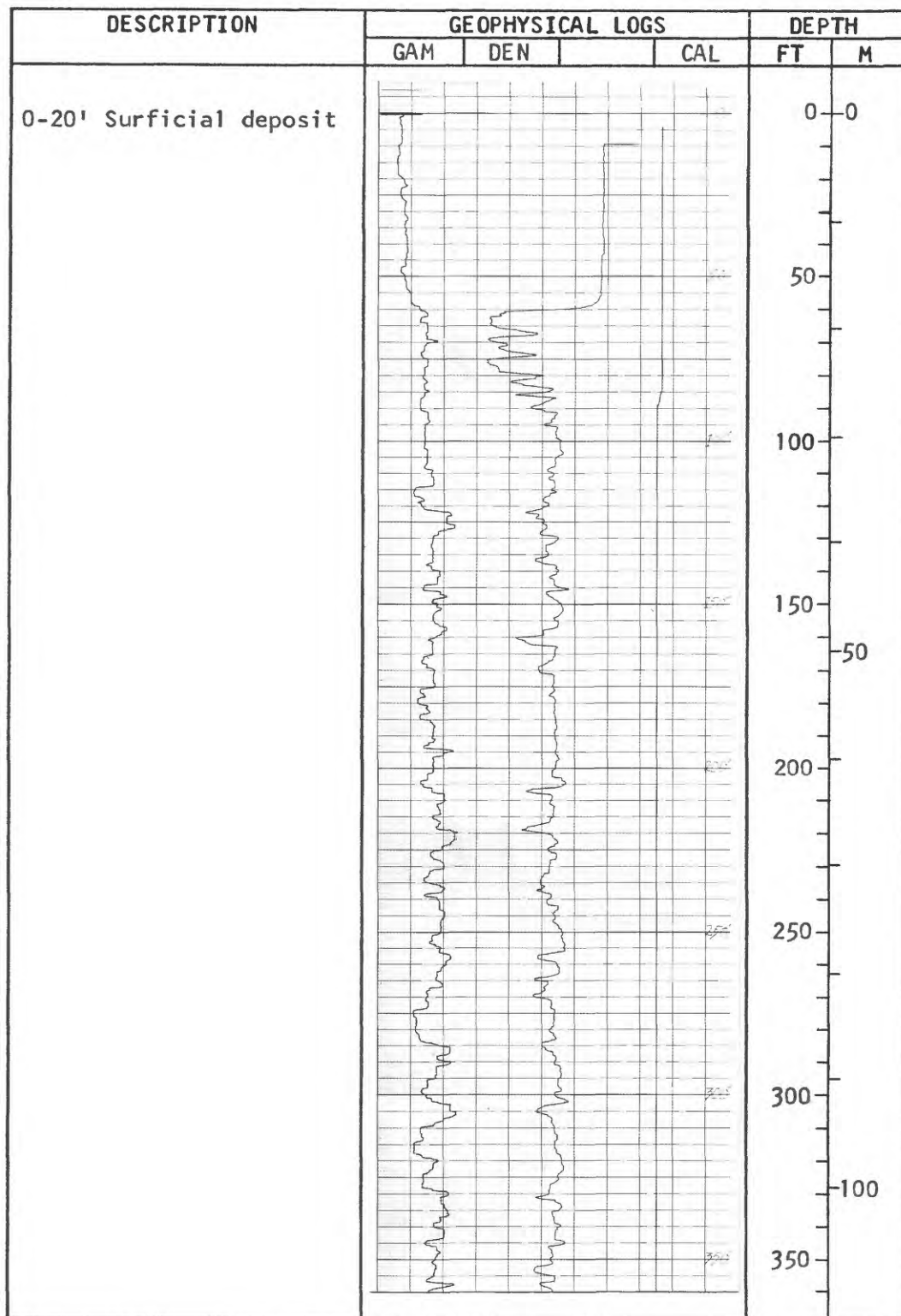
Drilling media record		Bore-hole record		Casing record	
Air/Foam	0- 702'	6.75"	0- 60'	5.0" ID	0- 60'
		4.75"	60- 702'		

LOGGING DATA
Gamma source Am 241

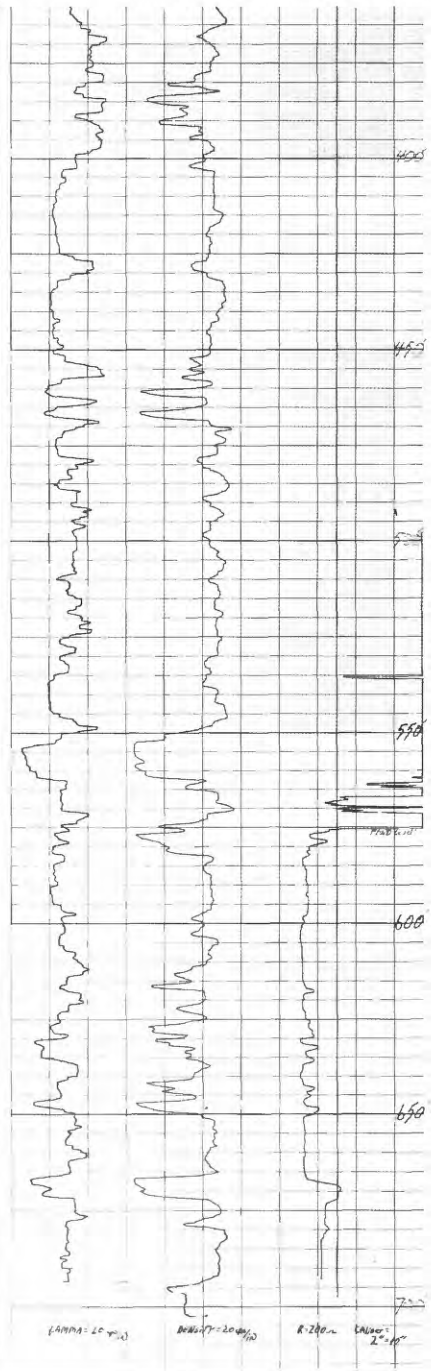
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Resistivity Caliper (1-arm)		100 cps/in. 100 cps/in. 100 Ohms/in. 25 ins./in.	693- 0' 702- 10' 692- 576' 697- 5'	20

Remarks: Resistivity is $1\frac{1}{2}'$ too deep.

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-3 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	RES	CAL	FT	M
					400	
460 $\frac{1}{2}$ -461 $\frac{1}{2}$ ' Impure coal					450	
466-467' Impure coal					150	
					500	
553-562' Coal					550	
576 $\frac{1}{2}$ -578' Impure coal						
616-617' Impure coal					600	
626 $\frac{1}{2}$ -628 $\frac{1}{2}$ ' Impure coal						
630-631' Coal						
646 $\frac{1}{2}$ -648' Coal					650	
666-668 $\frac{1}{2}$ ' Coal					200	
668 $\frac{1}{2}$ -671 $\frac{1}{2}$ ' Impure coal						
696 $\frac{1}{2}$ -T.D. Sandstone (Rollins)					702	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. HK-77-4 State Colorado County Delta

T. 13 S., R. 95 W., sec. 8, SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 6970

Drilled depth 803' Cored interval 680-803'

Logged depth 804' Logging company Minerals Service Date logged 9-21-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 680'	6.75"	0- 85'	5.0" ID	0- 88'
Water	680- 803'	4.75"	85- 680'	3.06" ID	0- 680'
		2.98"	680- 803'		

LOGGING DATA

Gamma source Am 241

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	796- 668' 804- 675' 799- 671' 795- 698'	20
2	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	692- 3' 700- 12' 696- 7' 690- 164'	20

Remarks: Run no. 1: Gamma is 6' too deep; density is 5' too deep; resistivity is 6 $\frac{1}{2}$ ' too deep.

Run no. 2: Density is 1' too shallow; resistivity is $\frac{1}{2}$ ' too deep.

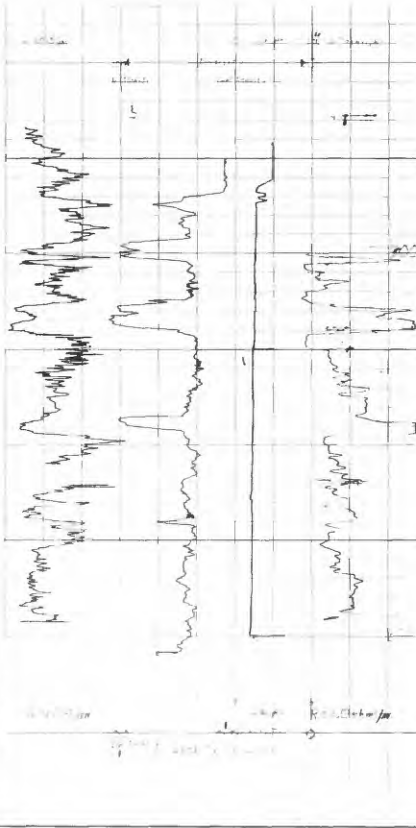
U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-4 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
0-12' Surficial deposit					3	
					50	
					100	
					150	
					50	
					200	
					250	
					300	
					100	
					350	

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-4 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
421½-424' Impure coal					400	
					450	
491½-493½' Impure coal					500	150
510½-511½' Impure coal						
511½-512½' Coal						
512½-513' Impure coal					550	
597-599' Coal					600	
608-610½' Coal						
648½-649½' Impure coal					650	200
663½-666' Coal						
					700	

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-4 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
696 $\frac{1}{2}$ -699' Coal					668	
699-699 $\frac{1}{2}$ ' Tan clay						
699 $\frac{1}{2}$ -701' Coal					700	
712-713' Impure coal						
713-715' Coal						
715-716' Impure coal						
716-719 $\frac{1}{2}$ ' Coal						
742 $\frac{1}{2}$ -745' Coal					750	
745-746' Impure coal						
776 $\frac{1}{2}$ -T.D. Sandstone (Rollins)					804	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. HK-77-5 State Colorado County Delta

T. 13 S., R. 95 W., sec. 16, NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 6760

Drilled depth 405' Cored interval NONE

Logged depth 394' Logging company Minerals Service Date logged 9-10-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 405'	6.75"	0- 30'	5.0" ID	0- 30'
		4.75"	30- 405'		

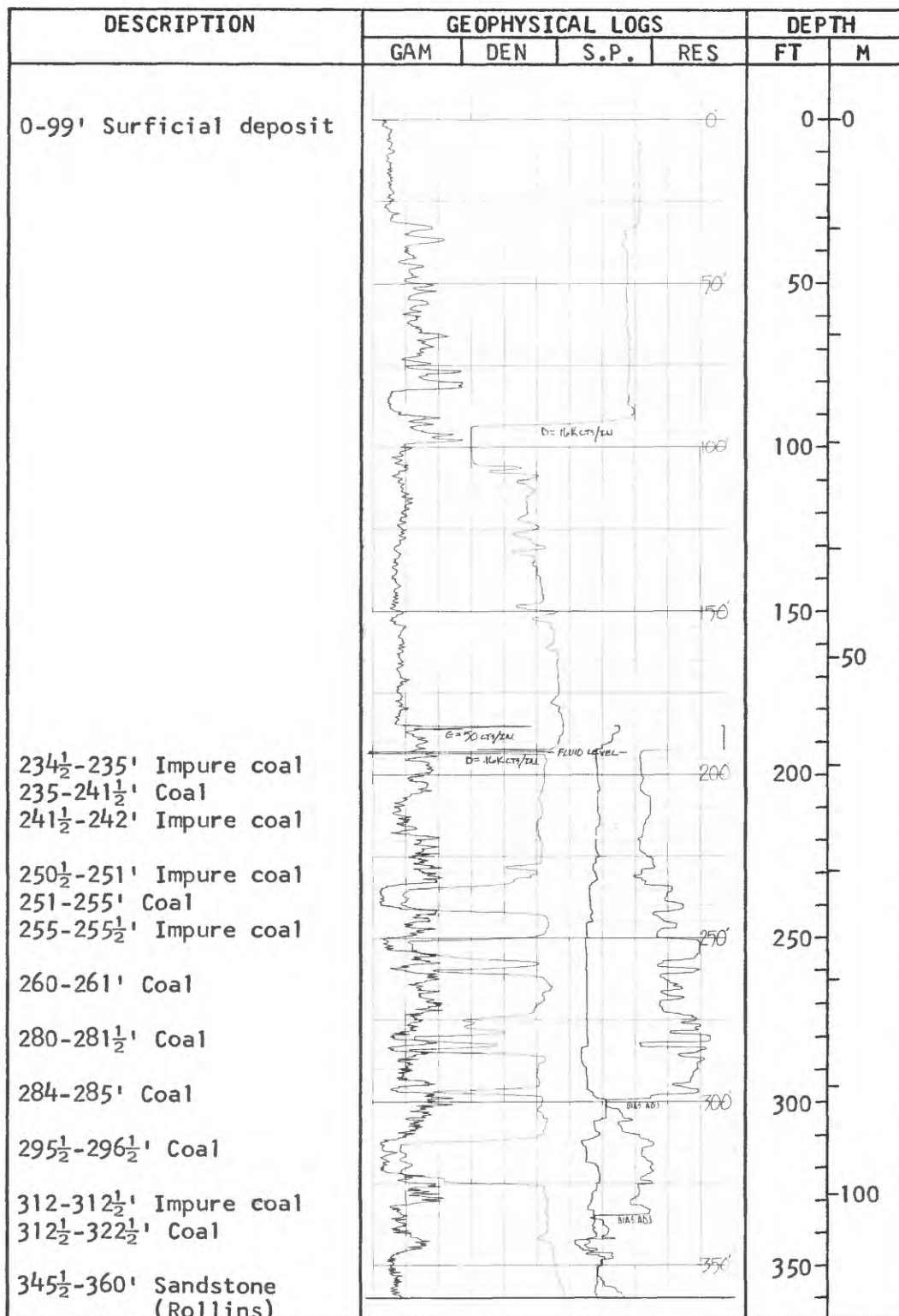
LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.63"	Gamma Density		100 cps/in. 3200 cps/in. 800 cps/in. 80K cps/in.	386- 0' 394- 192' 192- 93' 93- 0'	20
		Spontaneous-Pot. Resistivity		75 mv/in. 50 Ohms/in.	385- 185' 385- 193'	

Remarks: Gamma is 1' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-5 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. HK-77-5 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	S.P.	RES	FT	M
360-T.D. Sandstone (Rollins)	<p>GAMMA = 20.00 g/cc HOLE # HK 77-5 DENSITY = 1.94 g/cc SR 15 mv/cc R = 10.0 ohm-in</p>				394 T.D.	

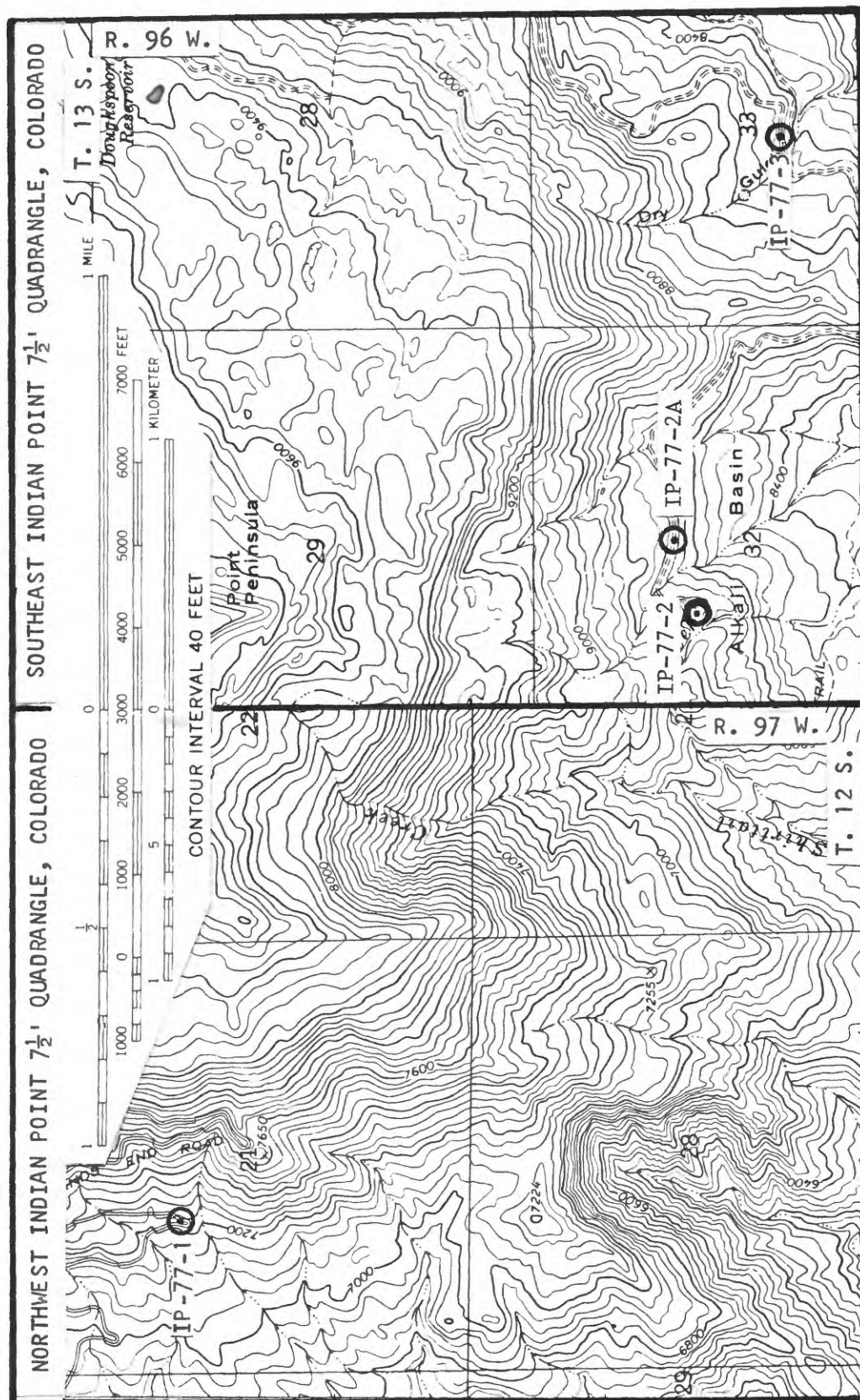


Figure 5.--Map showing U.S.G.S. drill-hole locations in the Indian Point 7 1/2' quadrangle, Colorado. No log for drill-hole IP-77-2; from 0 to 200 ft is surficial deposit.

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. IP-77-1 State Colorado County Mesa

T. 12 S., R. 97 W., sec. 21, NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ Approx. elev. (ft) 7230

Drilled depth 562' Cored interval 361- 562'

Logged depth 561' Logging company Strata Surveys Date logged 12-7-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 120'	6.75"	0- 30'	5.0" ID	0- 80'
Foam	120- 361'	4.75"	30- 361'	3.06" ID	0- 361'
Water	361- 562'	2.98"	361- 562'		

LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma	3	434 cps/in.	556- 341'	20
		Density	3	2000 cps/in.	560- 345'	
		Resistivity			561- 357'	
2	1.69"	Gamma	3	303 cps/in.	370- 88'	20
		Density	3	1000 cps/in.	373- 92'	
		Resistivity			375- 344'	
3	1.38"	Caliper (3-arm)	1	20 ins./in.	560- 350'	25

Remarks:

U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN	RES	FT	M
0-166' Surficial deposit					88	
					100	
					150	
					50	
184 $\frac{1}{2}$ -187' Coal					200	
					250	
					300	
					100	
368 $\frac{1}{2}$ -369 $\frac{1}{2}$ ' Impure coal					350	
					375	

U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
					341	
					350	
368½-369½' Impure coal						
400-401' Impure coal					400	
455½-459' Coal						
493-494½' Coal						
					450	
497½-500' Coal						
506½-508½' Coal						
522-525' Coal						150
525-526' Impure coal					500	
528½-529½' Impure coal						
529½-535' Coal						
540½-547' Coal					550	
547-T.D. Sandstone (Rollins)					561	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. IP-77-2A State Colorado County Delta

T. 13 S., R. 96 W., sec. 32, NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 8700

Drilled depth 1053' Cored interval 810-1053'

Logged depth 1046' Logging company Strata Surveys Date logged 12-2-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 230'	5.13"	0- 665'	3.06" ID	0- 810'
Foam	230- 810'	4.75"	665- 810'		
Water	810-1053'	2.98"	810-1053'		

LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density	3 3	260 cps/in. 1000 cps/in.	1042- 48' 1046- 59'	20

Remarks: Logged through NQ drill rods.

U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-2A continued

DESCRIPTION	GEOPHYSICAL LOGS			DEPTH	
	GAM		DEN	FT	M
				48	
				100	
				150	
				50	
				200	
				250	
				300	
				100	
				350	
				400	

U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-2A continued

[illegible]

U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-2A continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN		FT	M
					800	
						250
					850	
885 $\frac{1}{2}$ -887 $\frac{1}{2}$ ' Coal					900	
927-928 $\frac{1}{2}$ ' Coal					950	
980 $\frac{1}{2}$ -981 $\frac{1}{2}$ ' Impure coal						300
982-982 $\frac{1}{2}$ ' Tan clay					1000	
982 $\frac{1}{2}$ -986' Coal						
1000 $\frac{1}{2}$ -1006' Coal						
					1046	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. IP-77-3 State Colorado County Delta

T. 13 S., R. 96 W., sec. 33, NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ Approx. elev. (ft) 8450

Drilled depth 866' Cored interval NONE

Logged depth 866' Logging company Minerals Service Date logged 10-24-77

Drilling media record		Bore-hole record		Casing record
Air	0- 45'	5.13"	0- 80'	NONE
Foam	45- 866'	5.0"	80- 725'	
		4.75"	725- 866	

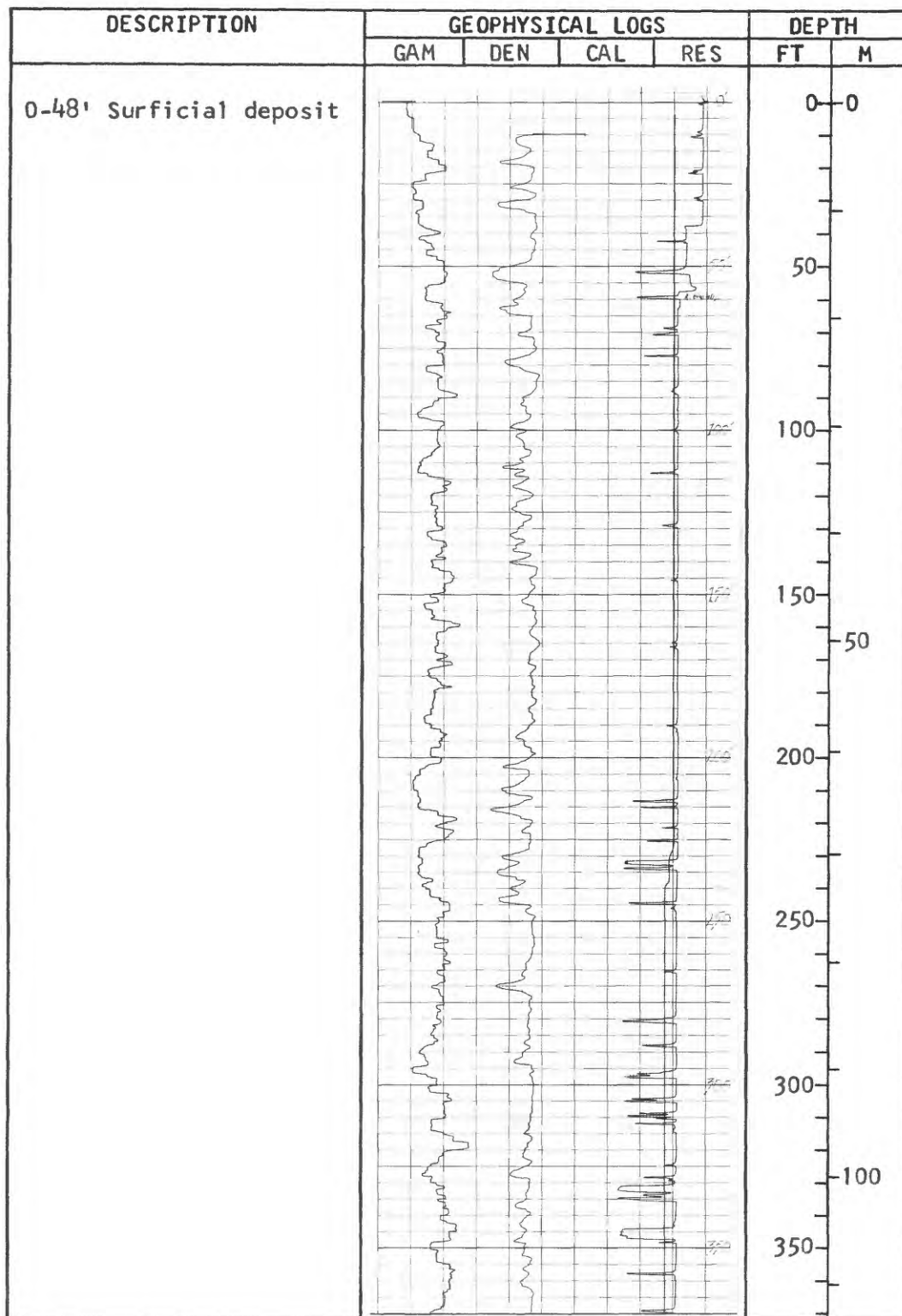
LOGGING DATA

Gamma source Am 241

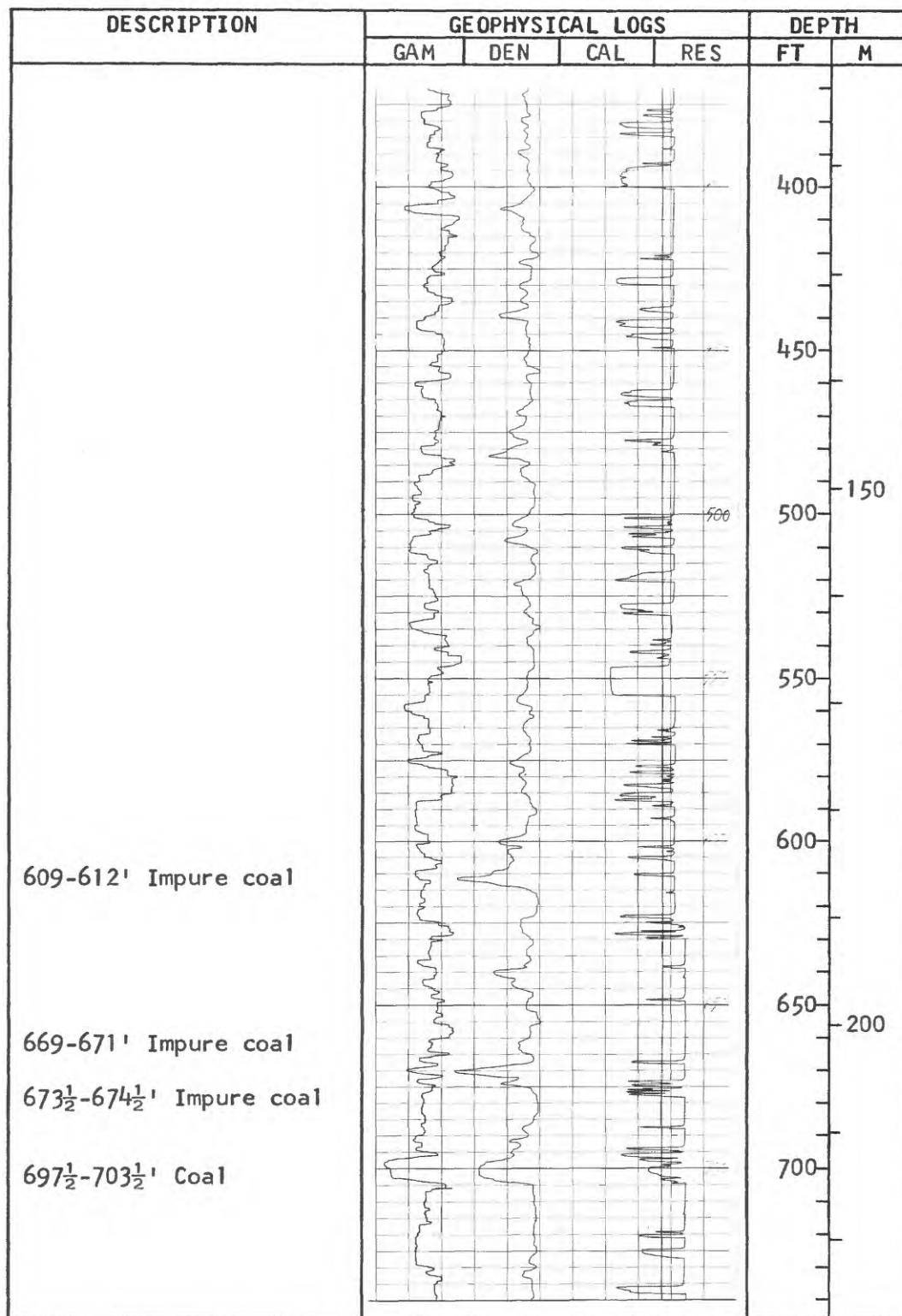
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.25"	Gamma Density Caliper (1-arm) Resistivity		100 cps/in. 100 cps/in. 25 ins./in. 100 Ohms/in.	856- 0' 866- 10' 860- 4' 855- 0'	20

Remarks: Resistivity is no good.

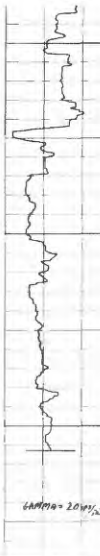



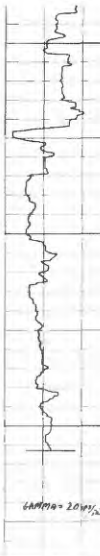



U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-3 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-3 continued



U.S. GEOLOGICAL SURVEY
Drill-hole no. IP-77-3 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	DEN	CAL	RES	FT	M
773 $\frac{1}{2}$ -776 $\frac{1}{2}$ ' Coal					750	
					800	
784 $\frac{1}{2}$ -T.D. Sandstone (Rollins)					250	
					850	
					866	
					T.D.	

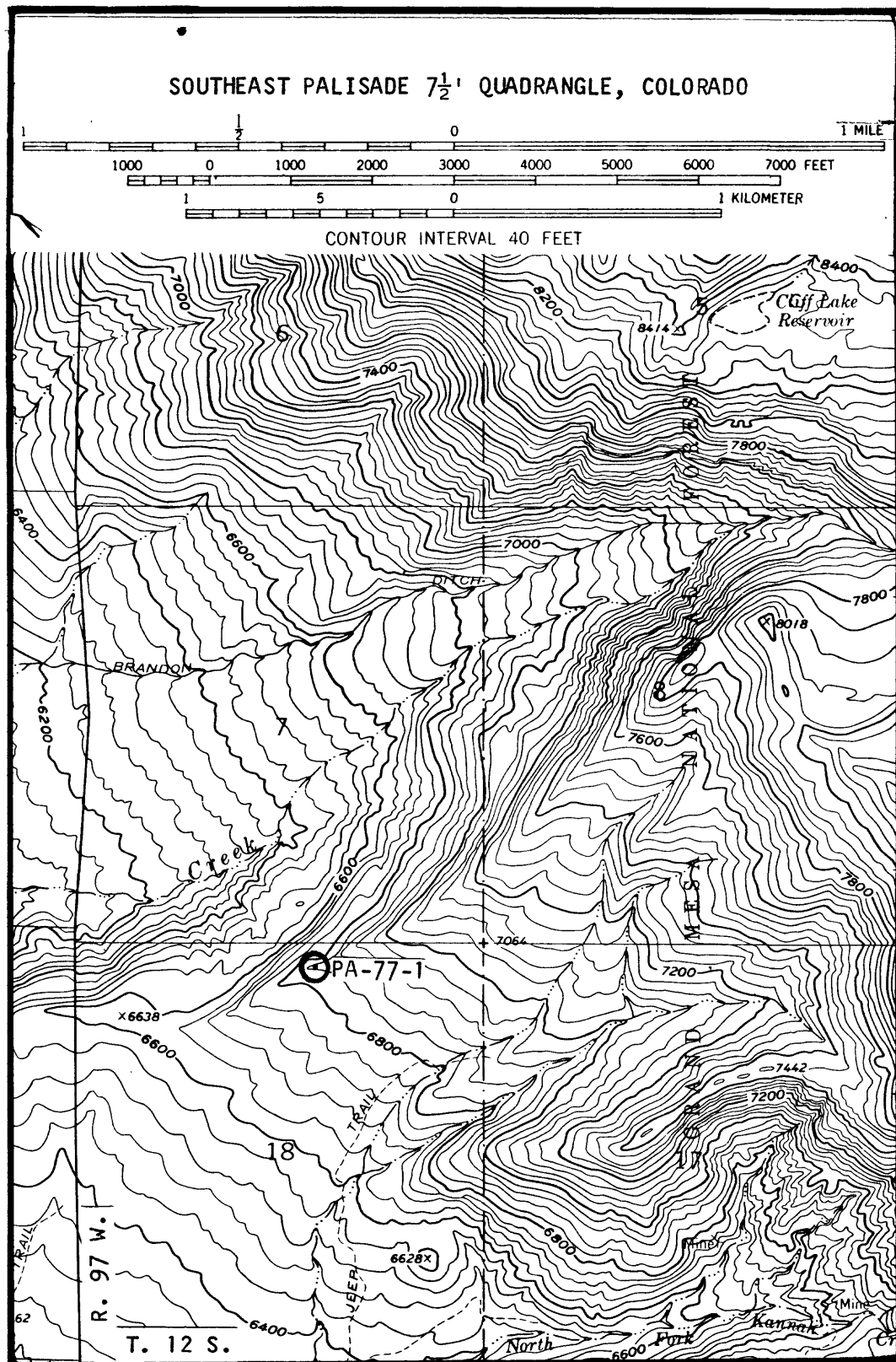


Figure 6.--Map showing U.S.G.S. drill-hole location in the Palisade 7½' quadrangle Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. PA-77-1 State Colorado County Mesa

T. 12 S., R. 97 W., sec. 18, NW $\frac{1}{4}$ NE $\frac{1}{4}$ Approx. elev. (ft) 6840

Drilled depth 160' Cored interval 83-111'

Logged depth 156' Logging company Strata Surveys Date logged 11-15-77

Drilling media record		Bore-hole record		Casing record	
Air	0- 111'	6.75"	0- 73'	5.0" ID	0- 80'
Air-water	111- 160'	4.75"	80- 160'		

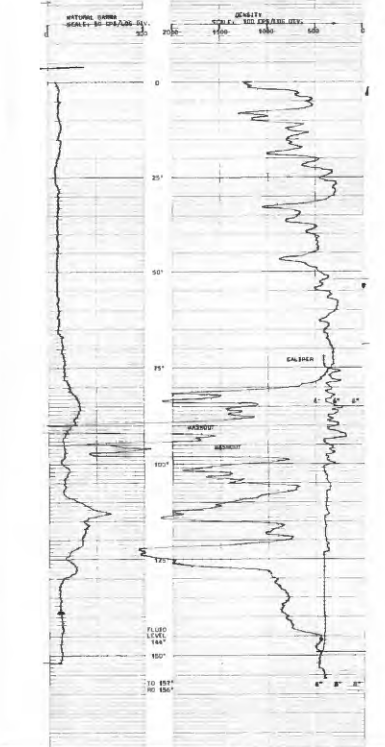
LOGGING DATA

Gamma source Cs 137

Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma	3	1000 cps/in.	152- 0'	20
2	1.69"	Density	3	2000 cps/in.	156- 0'	20
3	1.38"	Caliper (3-arm)	1	20 ins./in.	149- 72'	25

Remarks: Run no. 2: Density is 2' too shallow.
Run no. 3: Caliper is 7' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. PA-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN	CAL	FT	M
0-113' Surficial deposit					0	0
122½-125½' Impure coal					50	
129½-T.D. Sandstone (Rollins)					100	
					156	
					T.D.	

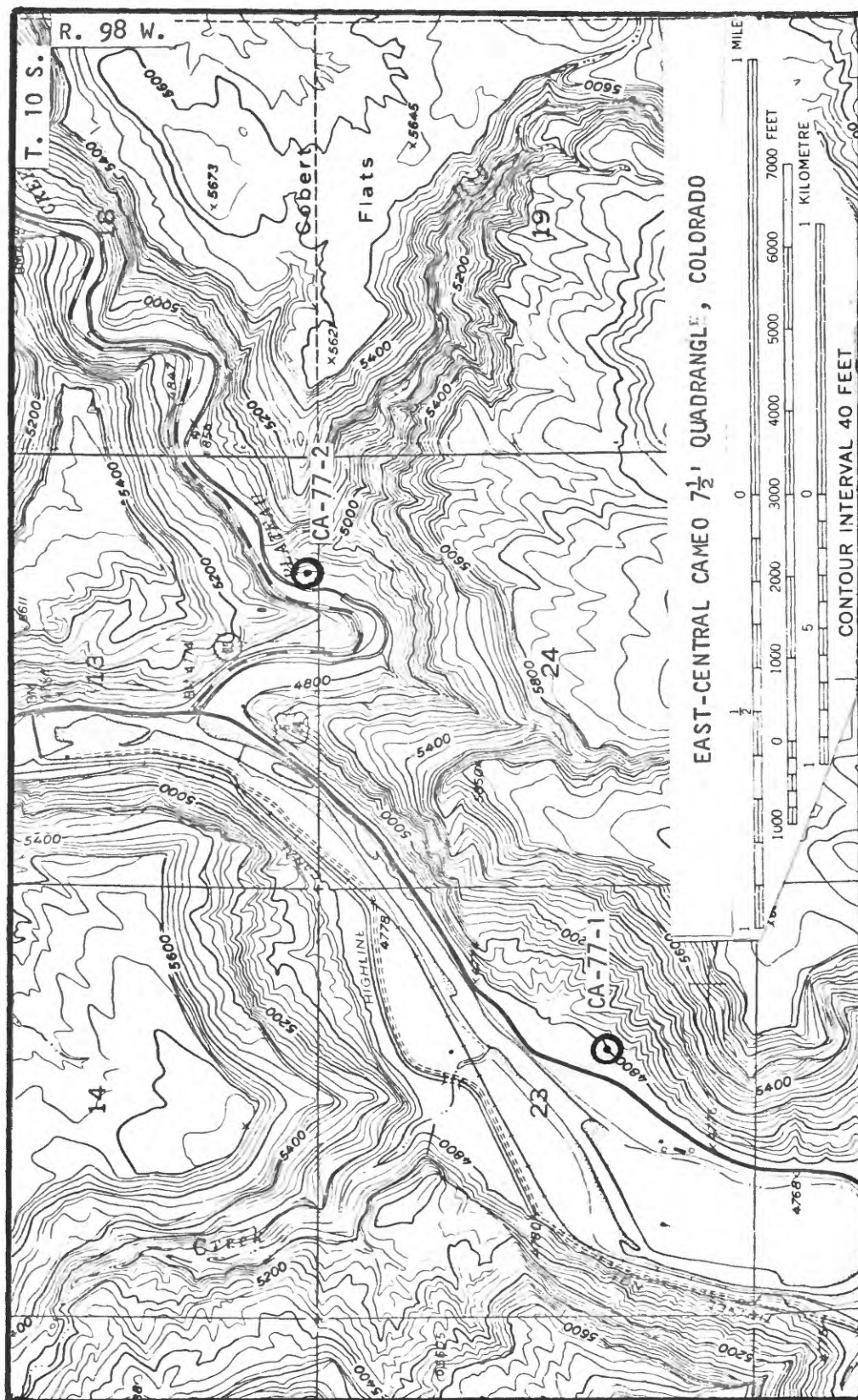


Figure 7.--Map showing U.S.G.S. drill-hole locations in the Cameo 7½' quadrangle, Colorado

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. CA-77-1 State Colorado County Mesa

T. 10 S., R. 98 W., sec. 23, SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ Approx. elev. (ft) 4800

Drilled depth 1020' Cored interval NONE

Logged depth 1020' Logging company Strata Surveys Date logged 11-25-77

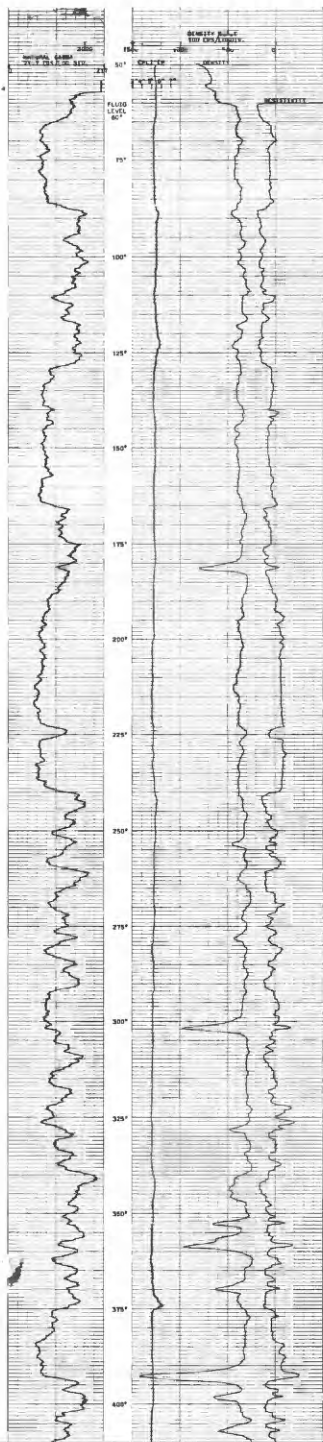
Drilling media record		Bore-hole record		Casing record	
Mud	0-1020'	6.75"	0- 45'	5.0" ID	0- 45'
		4.75"	45-1020'		

LOGGING DATA
Gamma source Cs 137

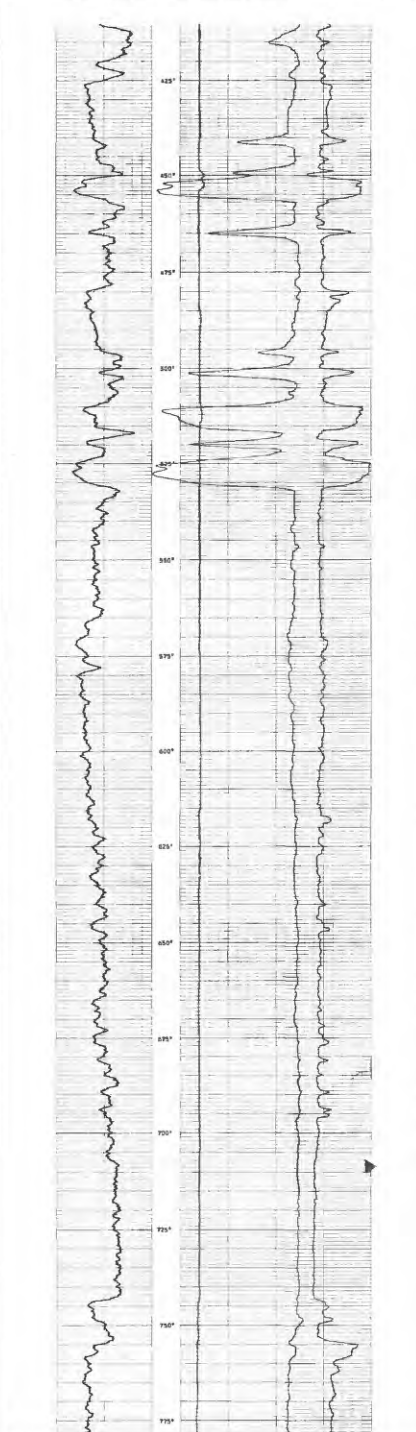
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma	3	434 cps/in.	974- 57'	20
		Density	3	2000 cps/in.	978- 50'	
		Resistivity			979- 61'	
2	1.38"	Caliper (3-arm)	1	20 ins./in.	979- 50'	25
3	1.69"	Gamma	3	434 cps/in.	1015- 900'	20
		Density	3	2000 cps/in.	1019- 900'	
		Resistivity			1020- 899'	

Remarks:

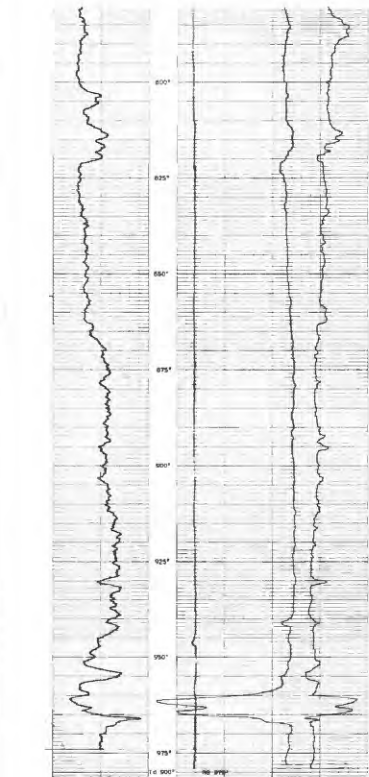
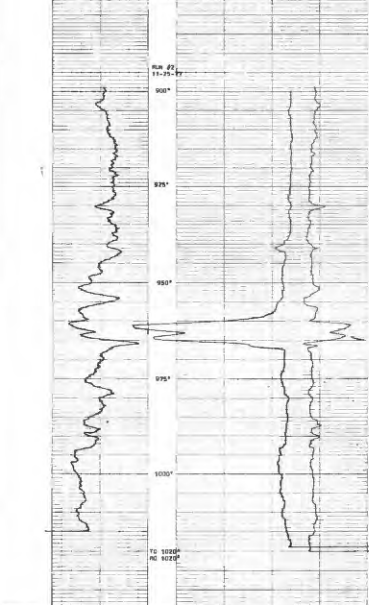
U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
0-42' Surficial deposit					50	
					100	
					150	
					50	
					200	
					250	
					300	
301-302' Impure coal					100	
					350	
					400	
391½-393½' Impure coal						

U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
451-452½' Coal						
452½-453' Impure coal						
453-456' Coal						
464-465½' Impure coal					450	
500-501½' Impure coal						
510-512½' Coal						
512½-516' Impure coal						150
519-520½' Impure coal					500	
523½-524½' Impure coal						
524½-526' Coal						
526-526½' Impure coal						
526½-529' Coal						
529-531' Impure coal					550	
565-619' Sandstone (Rollins)						
					600	
					650	200
					700	
					750	

U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-1 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
960-962½' Coal 963-965' Impure coal					800	
					250	
960-962½' Coal 963-965' Impure coal					850	
					900	
					950	
					979	
					899	
					950	
					300	
					1000	
					1020	
					T.D.	

U.S. GEOLOGICAL SURVEY
DRILL-HOLE LOG, GRAND MESA COAL FIELD

Drill-hole no. CA-77-2 State Colorado County Mesa

T. 10 S., R. 98 W., sec. 13, SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ Approx. elev. (ft) 4840

Drilled depth 1341' Cored interval 683-1341'

Logged depth 1337' Logging company Strata Surveys Date logged 12-19-77

Drilling media record		Bore-hole record		Casing record	
Mud	0- 683'	8.25"	0- 23'	5.0" ID	0- 23'
Water	683-1341'	4.75"	23- 683'	3.06" ID	0- 683'
		2.98"	683-1341'		

LOGGING DATA

Gamma source Cs 137

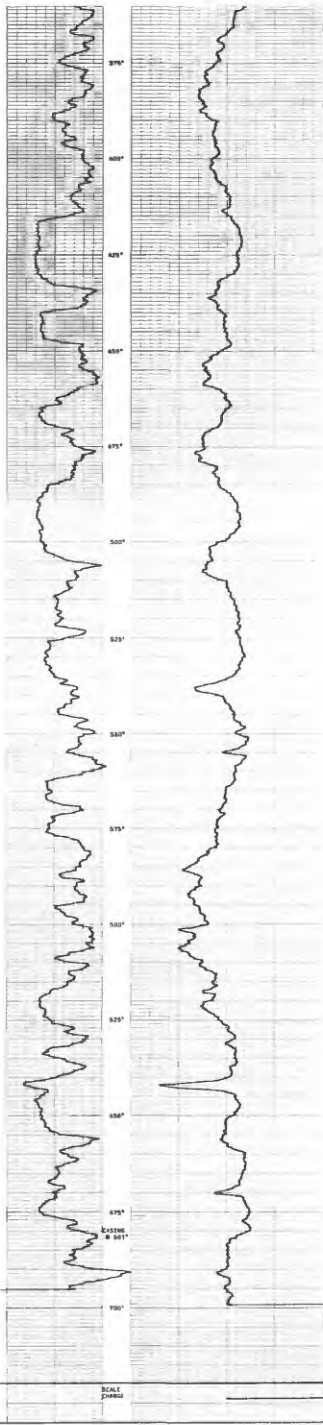
Run no.	Tool diam.	Log run	T.C. (sec)	Scale	Interval	Speed (fpm)
1	1.69"	Gamma Density Resistivity	3	434 cps/in.	1332- 616'	20
			3	2000 cps/in.	1336- 620'	
					1337- 665'	
2	1.69"	Gamma Density	3	303 cps/in.	695- 0'	20
			3	1000 cps/in.	699- 1'	
3	1.38"	Caliper (3-arm)	1	20 ins./in.	1337- 675'	25

Remarks: All logs are 2' too shallow.

U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS			DEPTH	
	GAM		DEN	FT	M
0-21' Surficial deposit				0	0

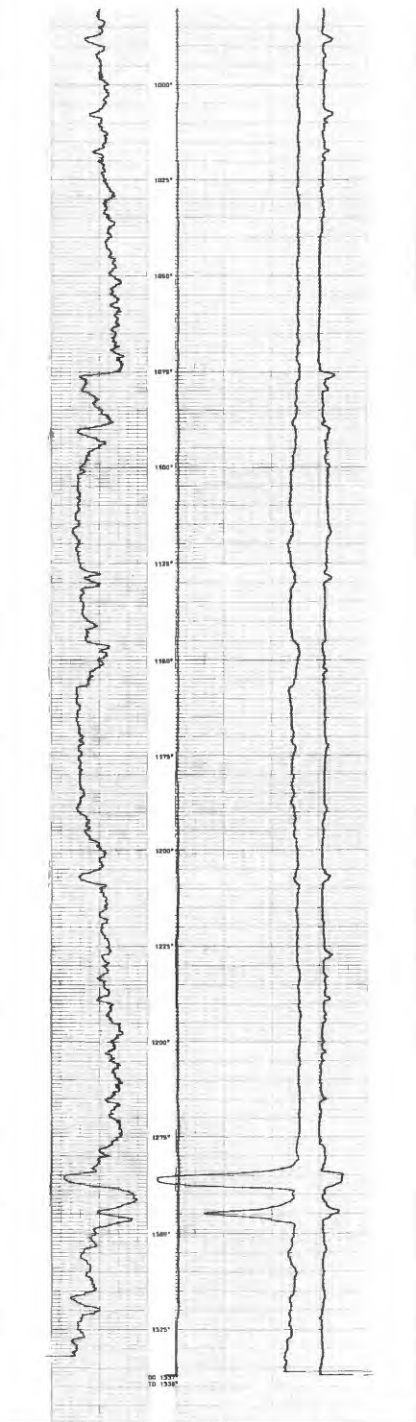
U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM		DEN		FT	M
641-642½' Coal					400	
					450	
					500	150
					550	
					600	
					650	200
					699	

U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
641-642½' Coal					616	
					650	200
721½-723' Coal						
723-724½' Impure coal						
728-729½' Impure coal					700	
742-744½' Coal						
803½-805½' Impure coal						
805½-806½' Tan clay					750	
806½-808½' Coal						
808½-809' Tan clay						
809-811' Coal						
811-813' Impure coal						
813½-814½' Impure coal						
826½-828' Coal					800	
831-832' Impure coal						250
833½-837' Coal						
837-837½' Impure coal					850	
864½-867' Coal						
867-869' Impure coal						
888-959' Sandstone (Rollins)					900	
					950	

U.S. GEOLOGICAL SURVEY
Drill-hole no. CA-77-2 continued

DESCRIPTION	GEOPHYSICAL LOGS				DEPTH	
	GAM	CAL	DEN	RES	FT	M
					300	
					1000	
					1050	
					1100	
					1150	350
					1200	
					1250	
1284½-1288' Coal						
1294½-1295½' Impure coal					1300	400
					1337 T.D.	