

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Preliminary Report of Coal Exploration Drilling in the Broadus Area,
Powder River County, Montana, during 1980

By

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and

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OPEN-FILE REPORT 82-828

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Use of trade and company names is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

CONTENTS

	Page
Introduction-----	1
Geologic Setting-----	1
Drilling Equipment and Procedure-----	2
Acknowledgements-----	3
References cited-----	4
Lithologic and Geophysical Logs of the drill holes-----	26

IIIUSTRATIONS

Figure 1.--Index map showing general location of the drill holes-----	5
Figures 2-19.--Location of drill holes on 7.5-minute quadrangles-----	6

TABLES

Table 1.--Drill hole data-----	24
Table 2.--Proximate and ultimate analyses of cored intervals in drill holes 80-MB-E7 and 80-MB-A2b-----	25

Introduction

In September of 1980 the USGS, (U.S. Geological Survey) conducted an exploratory drilling program in western Powder River County, Montana. Figure 1 shows the general location of the project area and drill holes. Figures 2 through 19 show specific locations of the drill holes. The objectives of this program were to gather data for evaluation of coal resources, coal quality, and stratigraphic correlations. This drilling project is a continuation of the study started in 1978 and reported by Hardie (1979), Kirschbaum, Correia, and McPhillips (In Press).

Twenty-three holes were drilled (see Table 1) with selected coal intervals cored at three locations (80-MB-A2b, 80-MB-B7, and 80-MB-E7) resulting in a total footage drilled of 9,610 ft. All drilling was done by USGS-operated drilling rigs and monitored by USGS personnel. Drill cuttings were sampled and recorded every 5 feet whenever possible, though problems with lost circulation and severe washout at some locations made it difficult to maintain the sampling interval. Lithologic logs were prepared for each drill hole and are presented with each geophysical log.

Geophysical logs were run at at twenty-two drill sites with the log suite generally including natural gamma, density, resistivity, and caliper. There was no geophysical log run for drill hole 80-MB-E8. All geophysical logging was done by private companies under contracts issued by the USGS.

Geologic Setting

The project area is located on the northeastern flank of the Powder River Basin. The Powder River flows to the northeast through the project area, which is characterized by rolling grasslands and dissected highlands.

The coal beds of interest in the project area occur in the Tongue River Member of the Fort Union Formation of Paleocene age. The Tongue River Member

is characterized by interbedded light-yellow-gray sandstone, sandy shale, gray shale, carbonaceous shale and coal (Bryson and Bass, 1973). Local stringers of silty to sandy limestone are also present. Some of the thicker coal beds have burned back from the outcrop and the resulting heat has baked overlying rocks into a brittle, resistant red rock called clinker. These clinker beds are prevalent throughout the project area where they cap many of the ridge tops. The regional dip of the rock strata is generally less than 5° to the southwest.

The coal beds present in the drill holes range in thickness from 1 to 25 feet. Previous studies by Matson and Blumer (1973) show that the qualities of the coals in this region vary from lignite A to subbituminous C. Quality analyses of the cores from drill holes 80-MB-E7 and 80-MB-A2b are shown in Table 2 (R. G. Hobbs, unpub. data). The rank of the Cache coal bed increases from lignite A in the eastern part of the project area (drill hole 80-MB-A2) to subbituminous C in the western part (drill hole 80-MB-E7). Quality analysis from drill hole 80-MB-B7 was not available for this report.

Drilling Equipment and Procedure

The drilling in the project area was completed by two truck-mounted drilling rigs; a Gardner-Denver 17W and a Portadrill 524. Air with water injection was the primary circulation medium, although high viscosity mud with drill additives was used at times to control lost circulation through poorly consolidated rock. Twenty feet or more of 6-in. diameter plastic surface casing was generally set at each location to prevent washout of surface material.

Carbide drag bits yielded the best penetration rates for the rotary work, though occasional limestone stringers required the use of rollercone bits. The coring was done with a conventional 15-ft mining barrel producing a 3-in.

diameter core. Non-reusable carbide Chris drill bits were used for the coring and produced good quality core of the coal beds with fast penetration rates.

Acknowledgments

The authors wish to acknowledge the following USGS personnel for their invaluable assistance in making this project successful: project geologist Robert Hobbs; technical field coordinator Richard N. Babcock; geologists Frank Spencer, Maureen McPhillips, and Janet Brown; drillers Art Clark and Stephen Grant; and drill crew members Dave Brown, Dan Downing, John Clough, and Gerald Rott.

Also, we would like to acknowledge Reich Geophysical and Strata Surveys who logged the holes, and a special thank you to the ranchers and residents of Powder River County without whose cooperation this project would not have been possible.

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- Matson, R., E., and Blumer, J. W., 1973, Quality and Reserves of Strippable Coal Deposits, Southeastern Montana: Montana Bureau of Mines and Geology Bulletin 91.

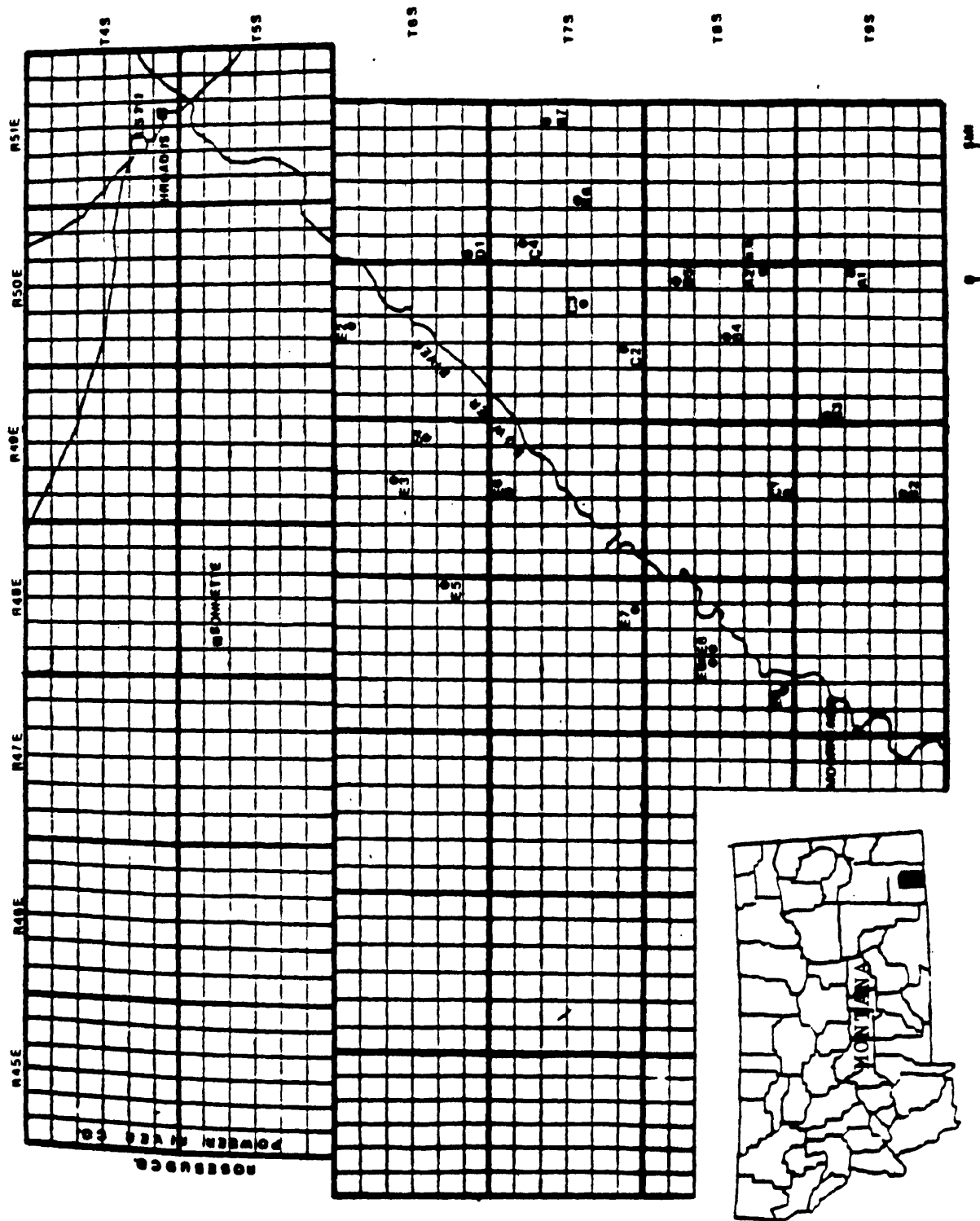
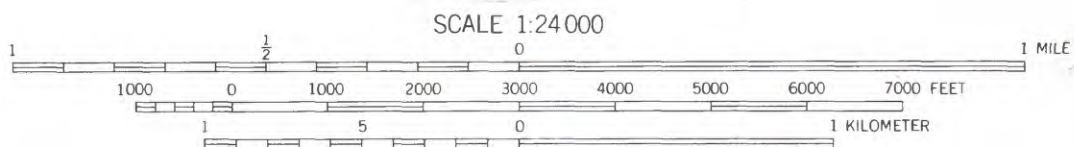
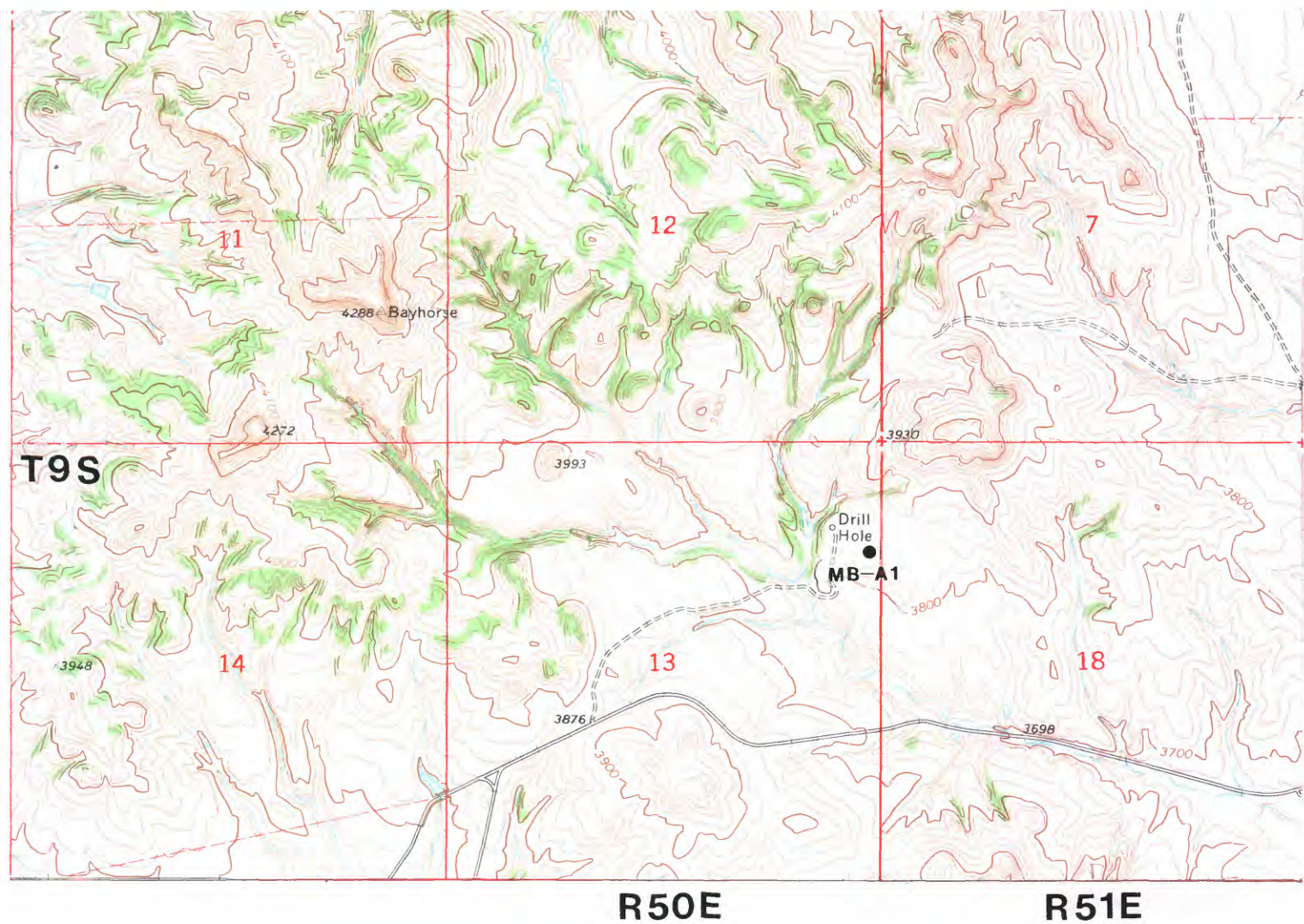


Figure 1. Location of holes drilled in 1980, Powder River County, Montana.



CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Figure 2 Location of drill hole in the Bay Horse quadrangle

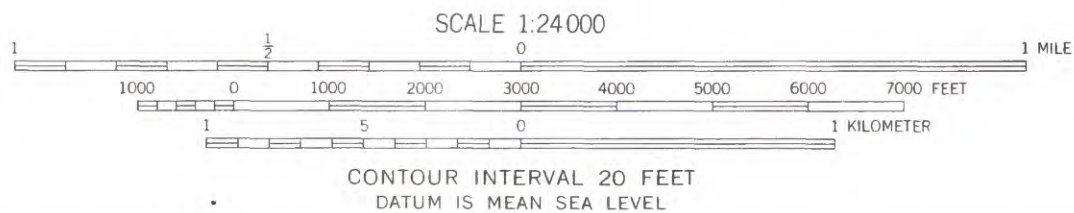
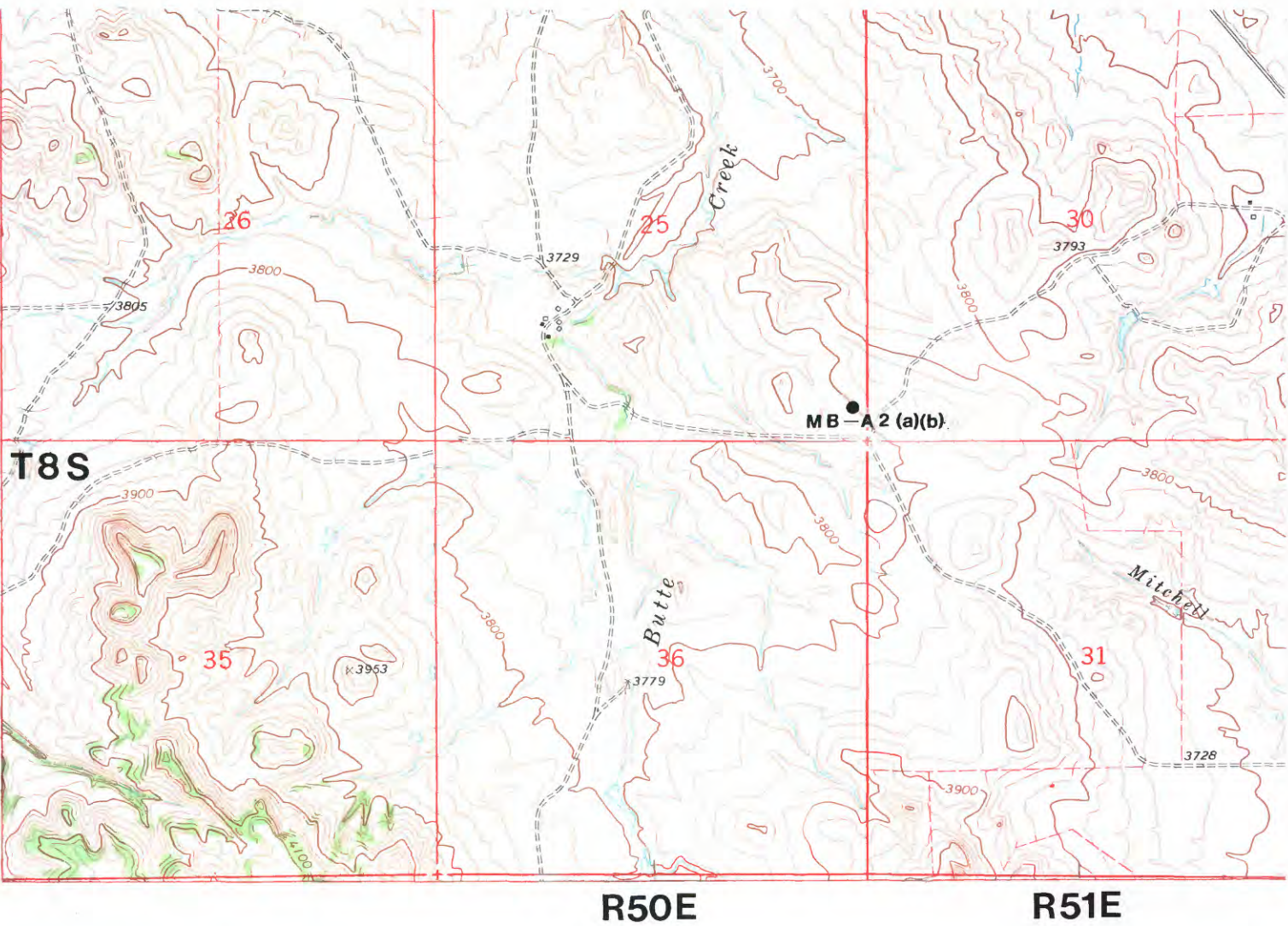


Figure 3 Location of drill holes in the Bay Horse quadrangle

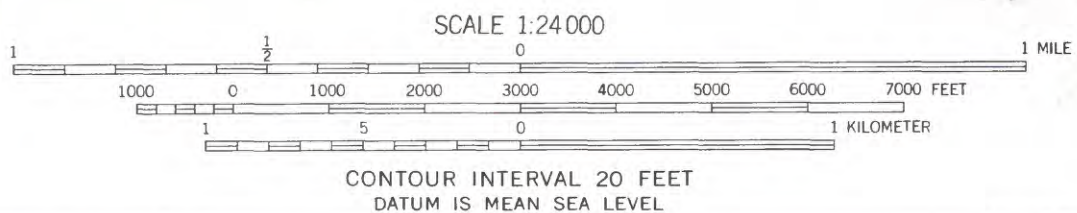
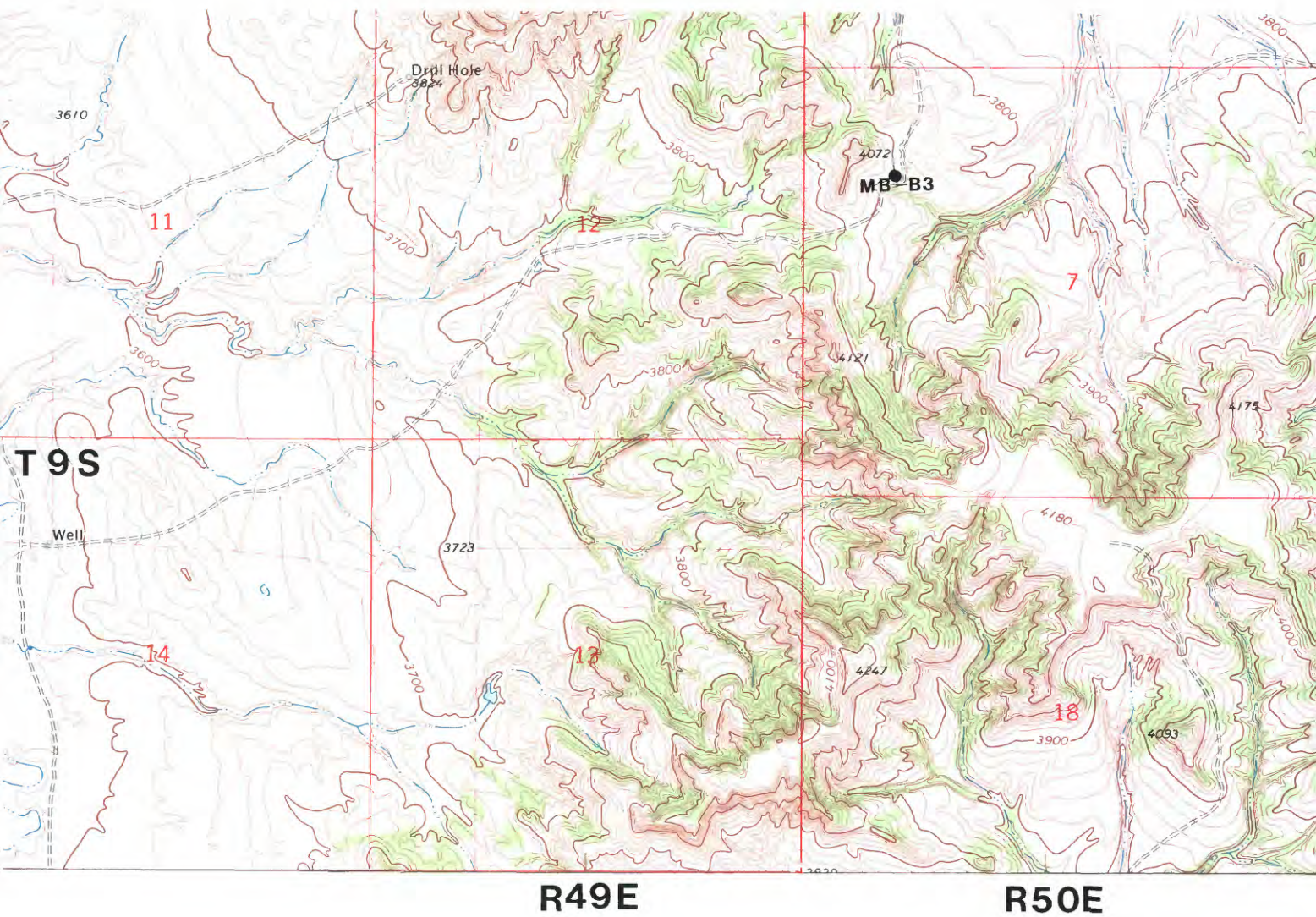


Figure 5 Location of drill hole in the Three Bar Ranch quadrangle

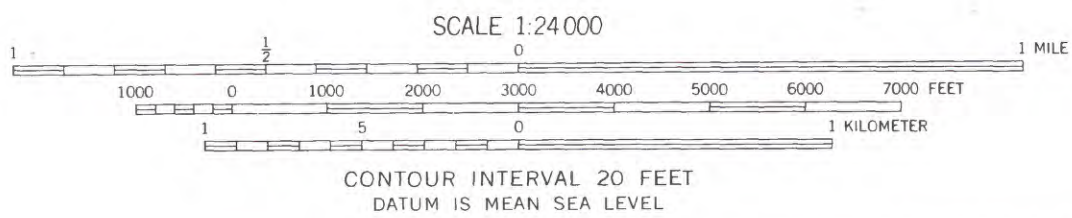
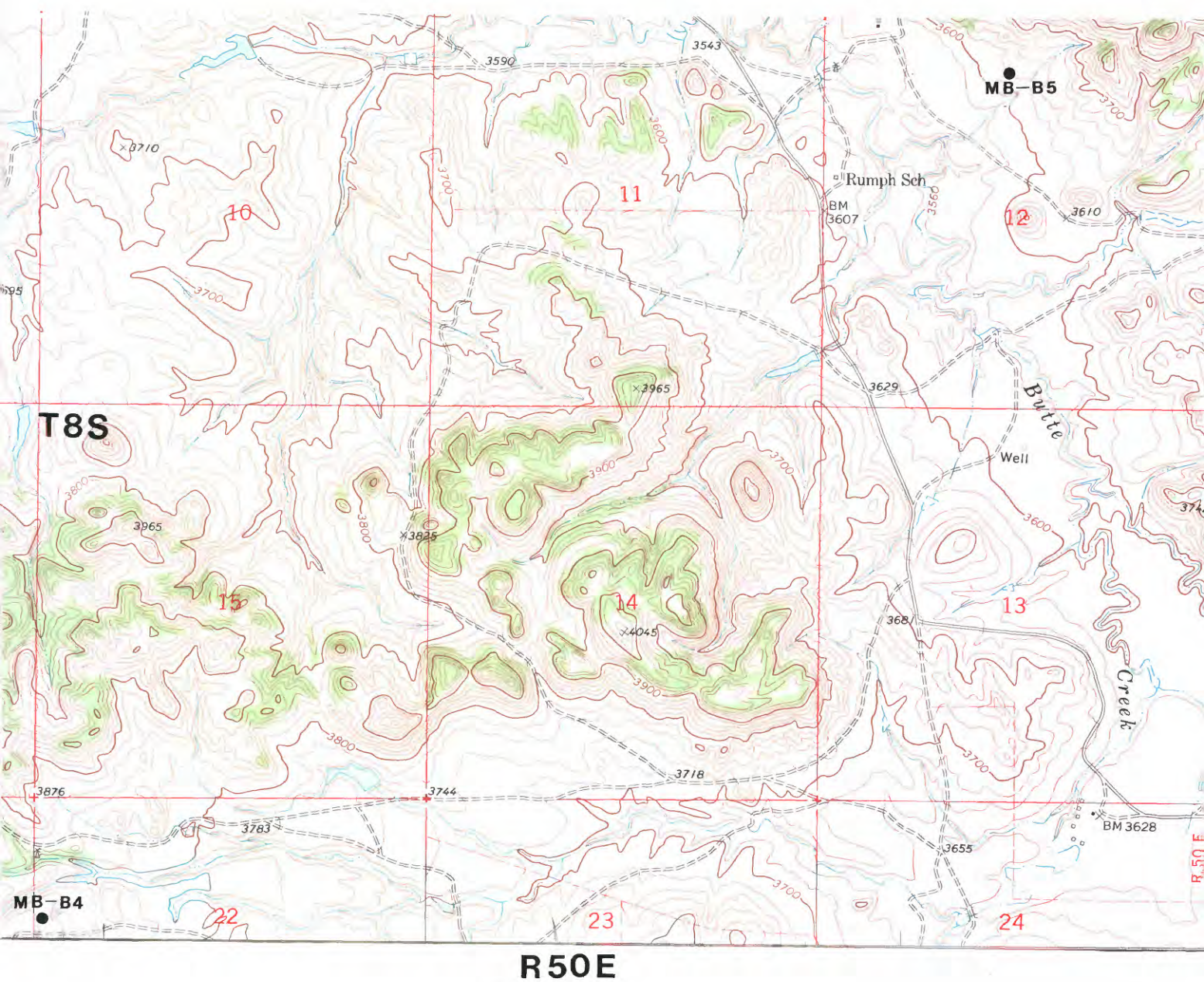


Figure 6 Location of drill holes in the Baldy Peak quadrangle

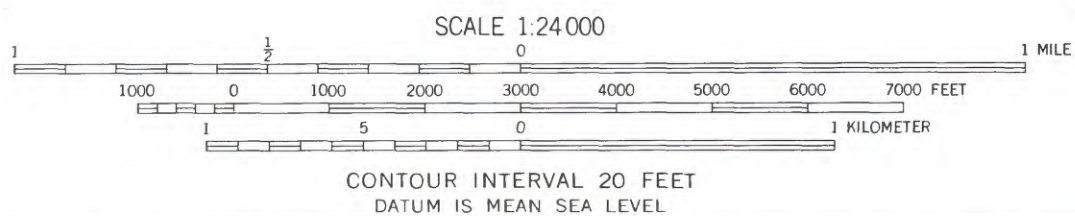
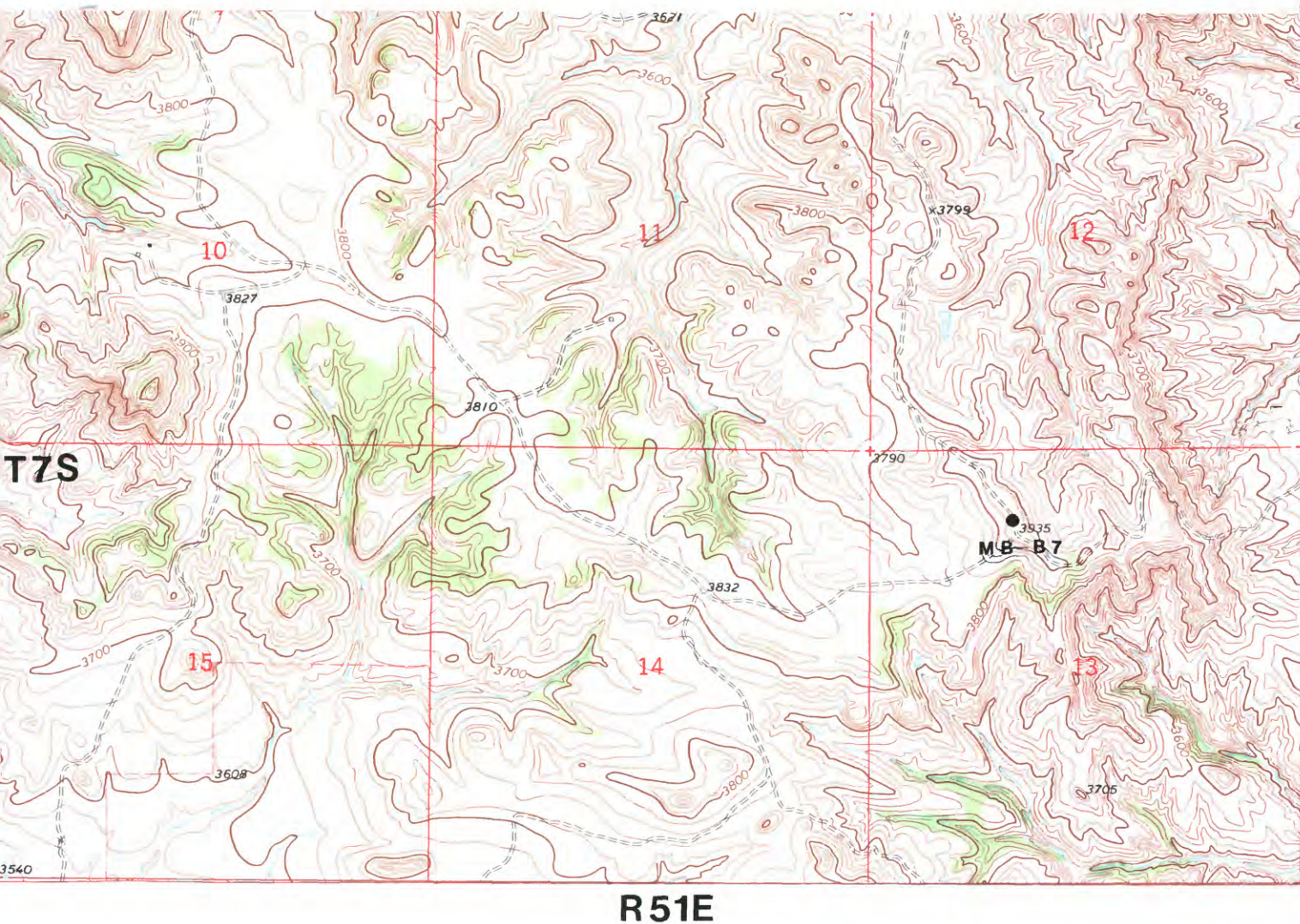


Figure 8 Location of drill hole in the Bear Skull Mountain quadrangle

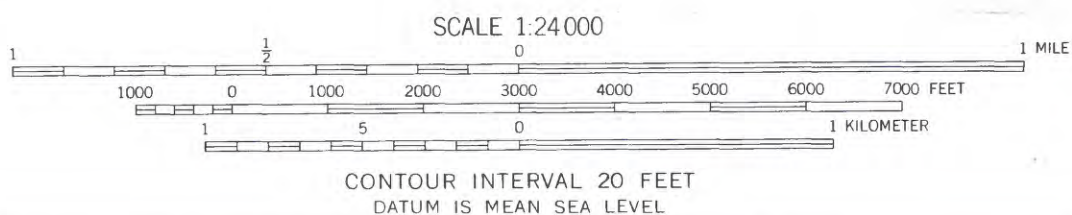
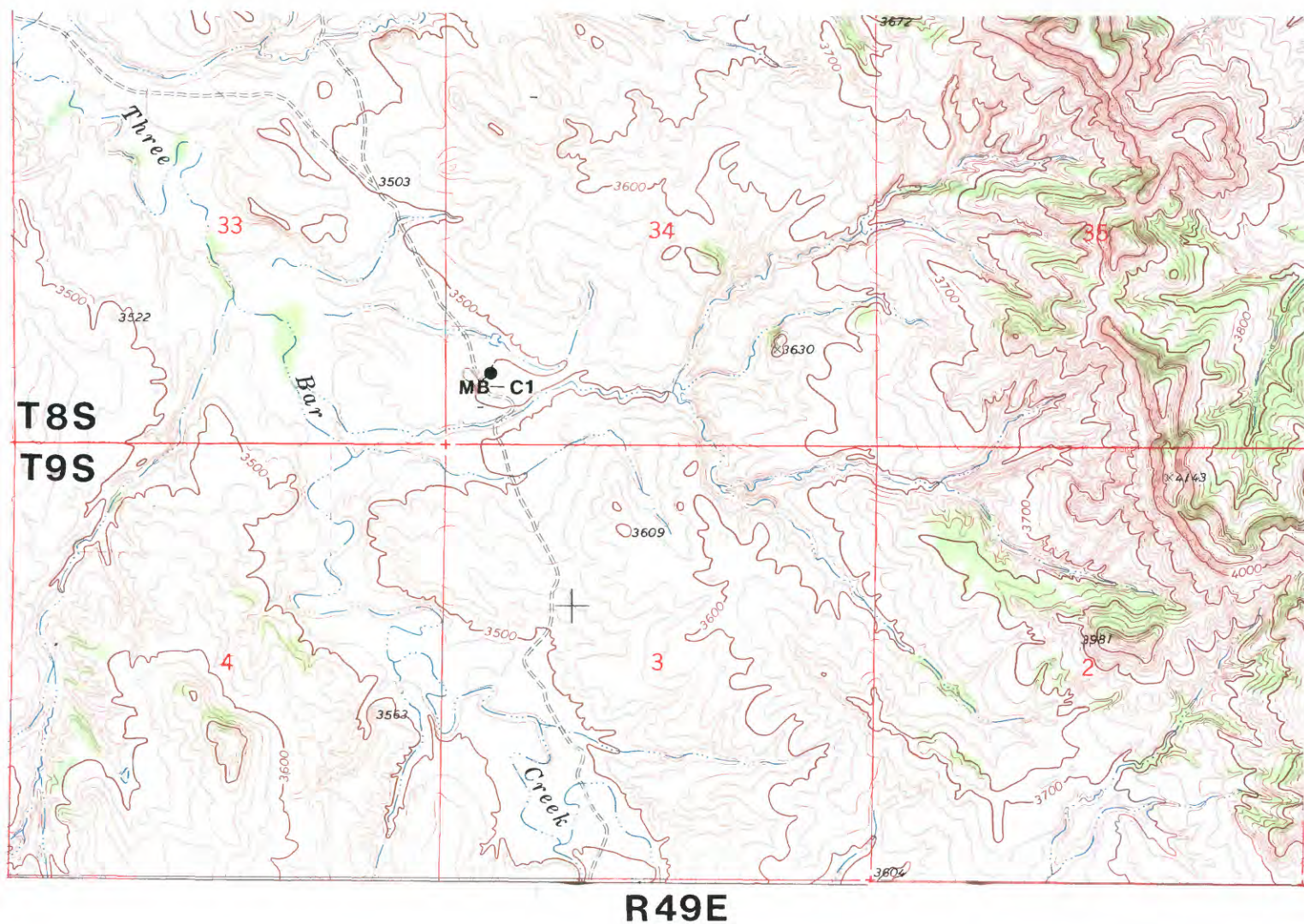
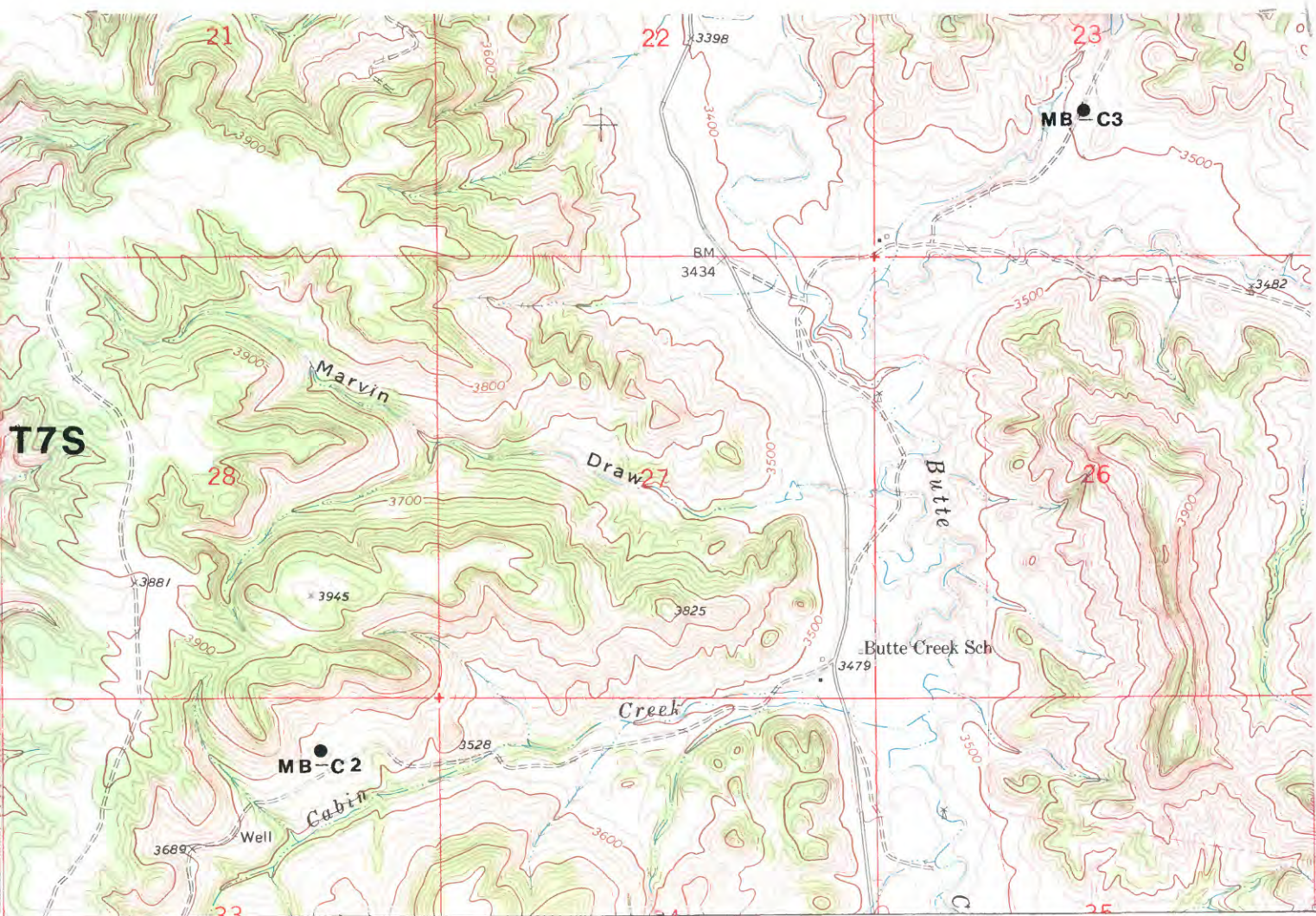


Figure 9 Location of drill hole in the Three Bar Ranch quadrangle



R50E

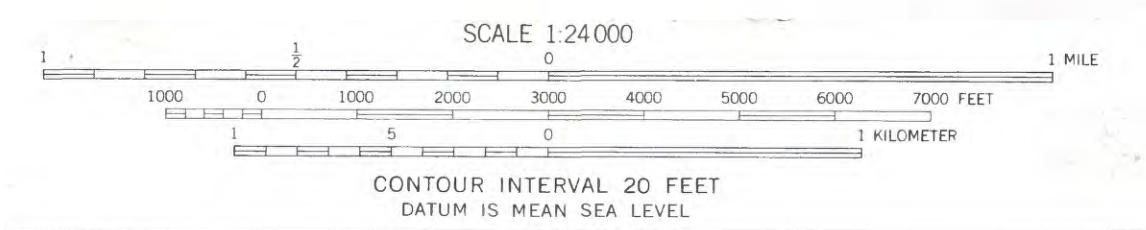


Figure 10 Location of drill holes in the Baldy Peak quadrangle

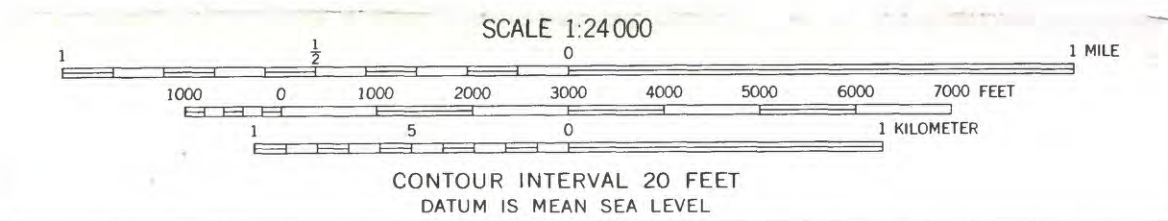
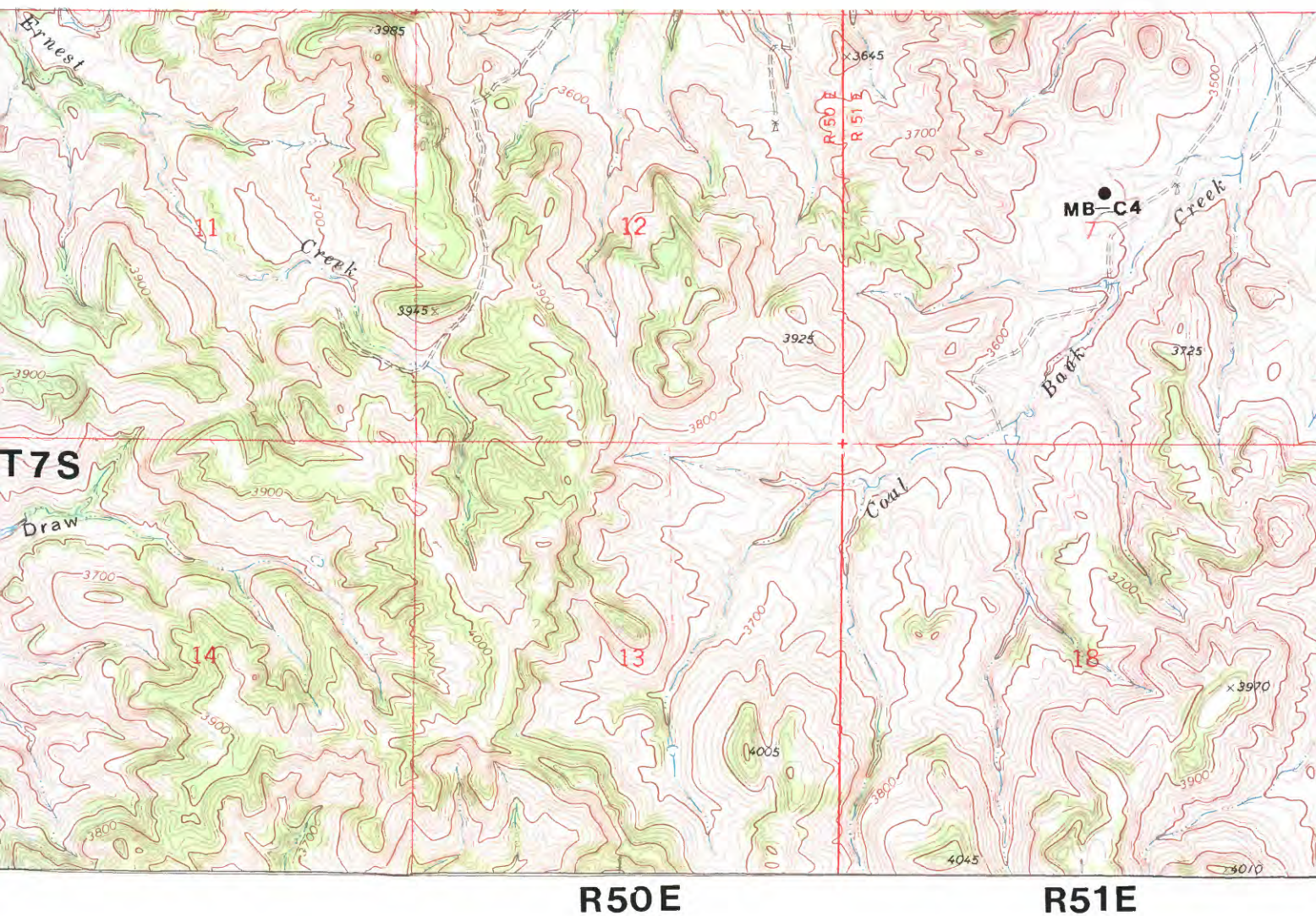
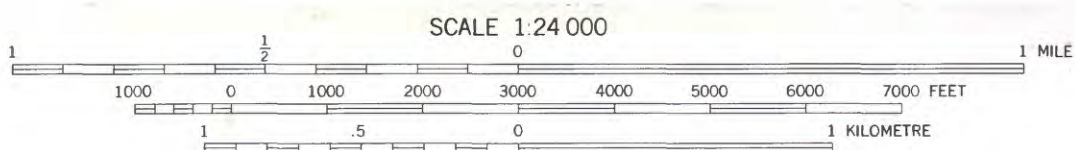
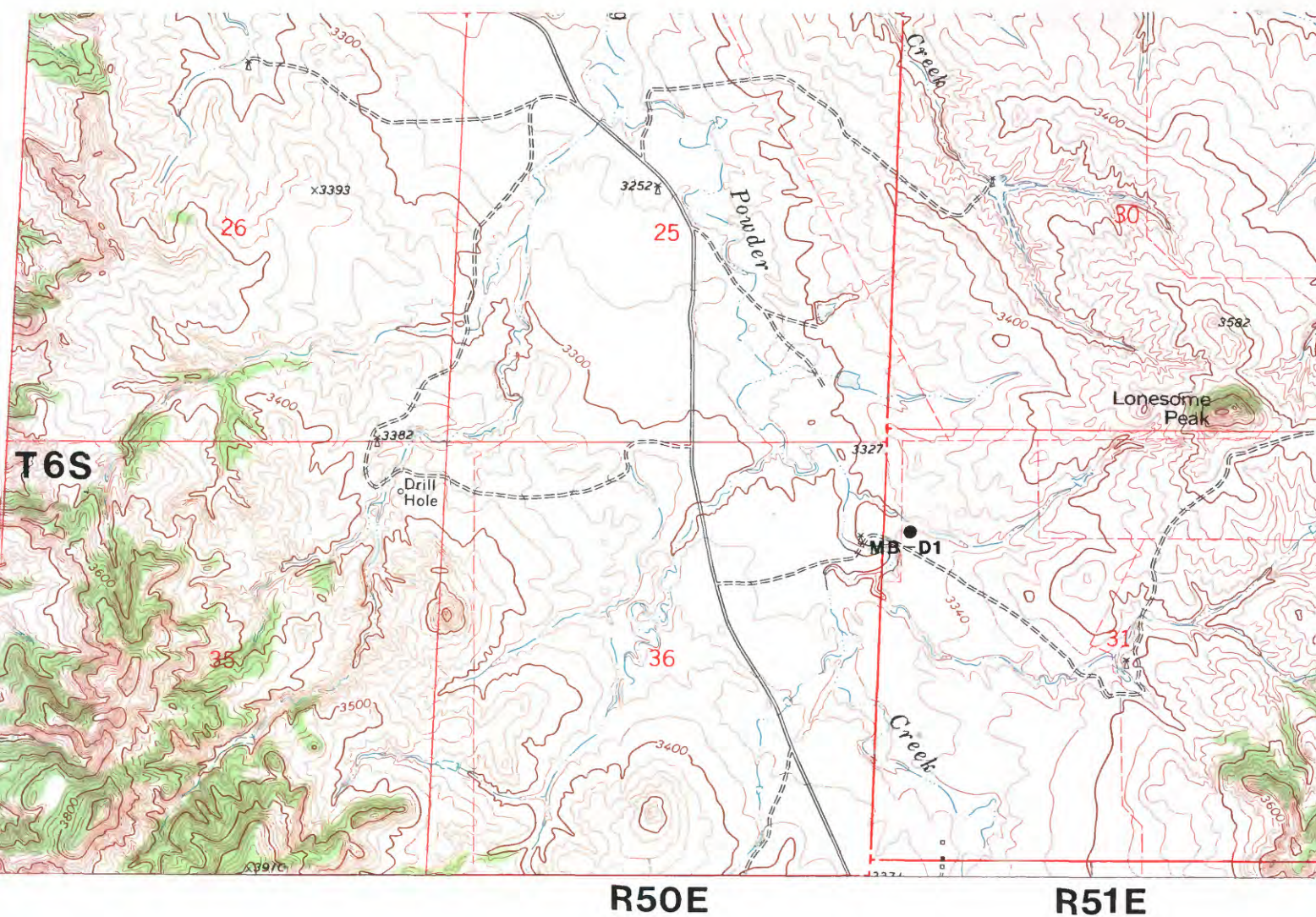


Figure 11 Location of drill hole in the Baldy Peak quadrangle



CONTOUR INTERVAL 20 FEET
 DOTTED LINES REPRESENT 10-FOOT CONTOURS
 NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 12 Location of drill hole in the Lonesome Peak quadrangle

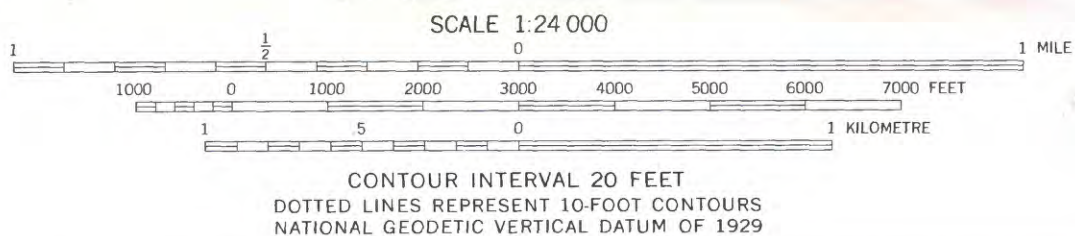
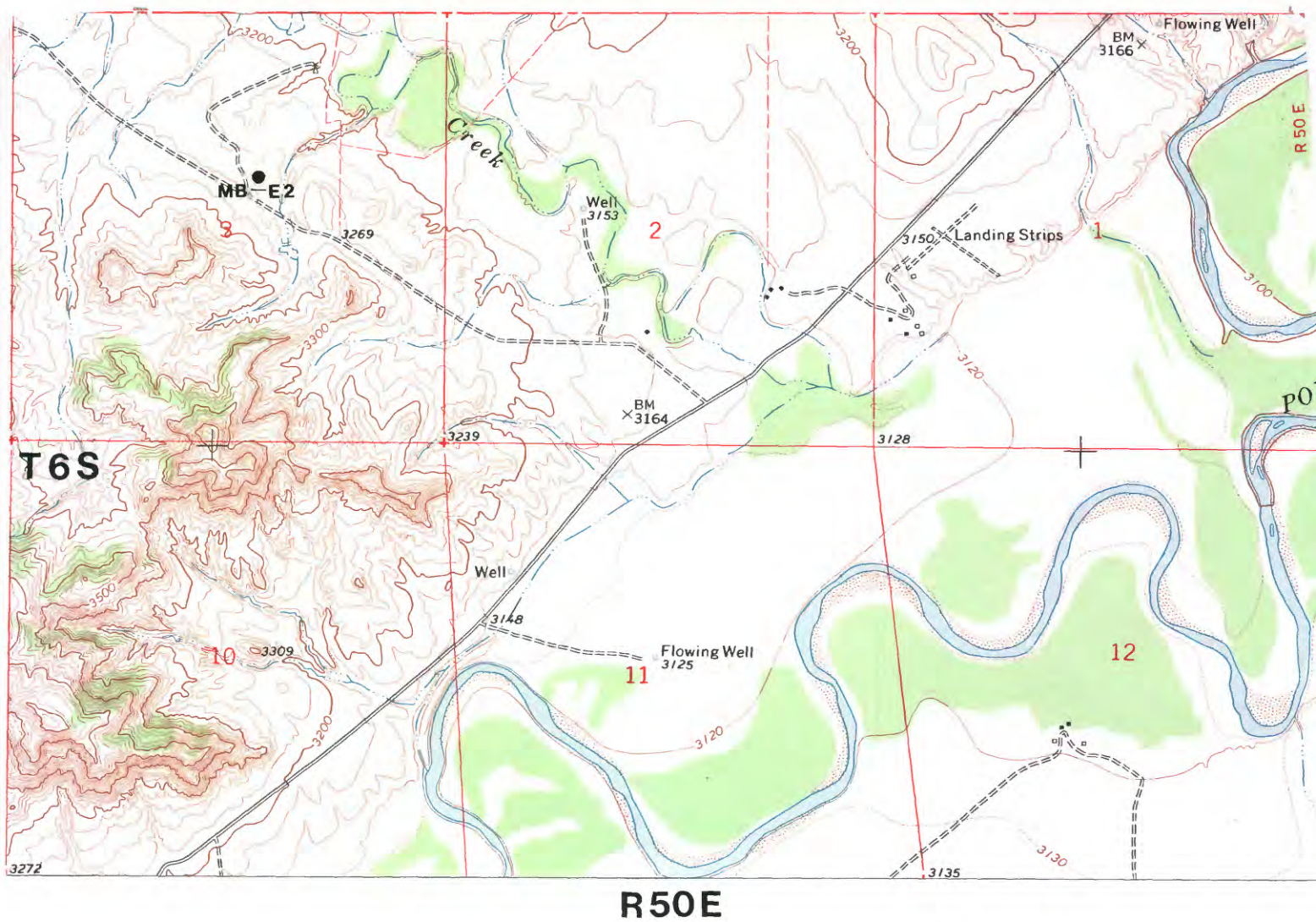


Figure 13 Location of drill hole in the Lonesome Peak quadrangle

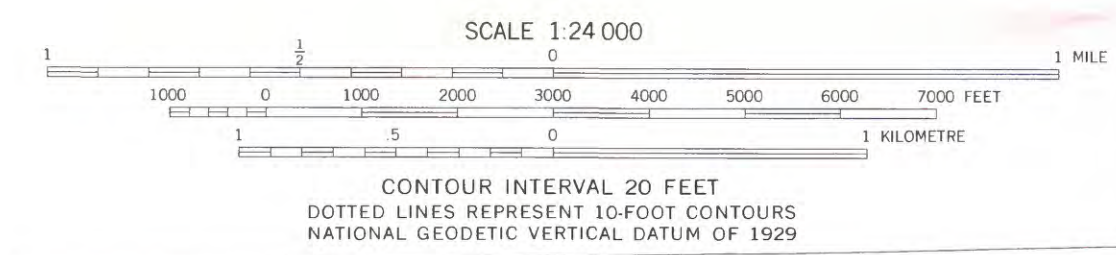
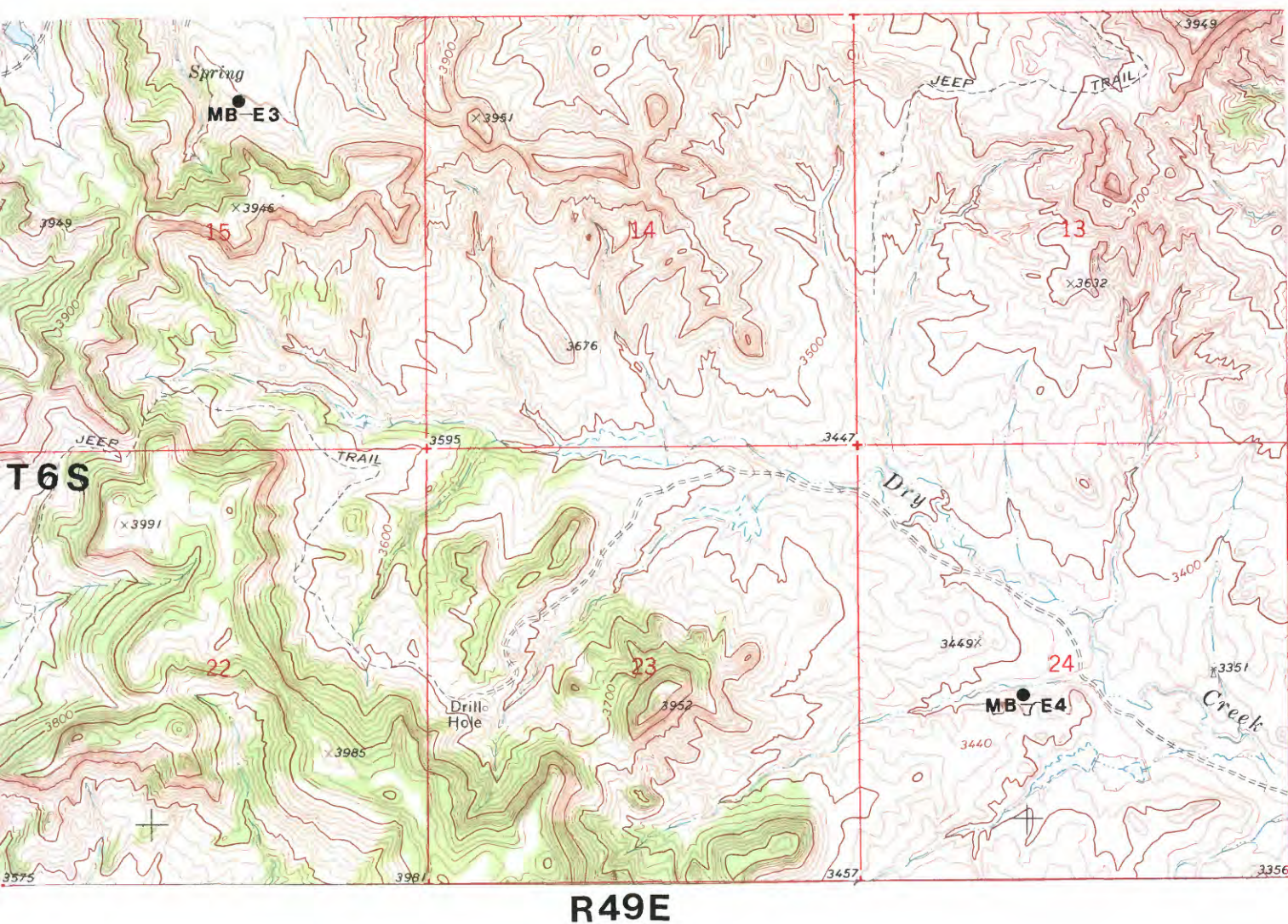


Figure 14 Location of drill hole in the Yarger Butte quadrangle

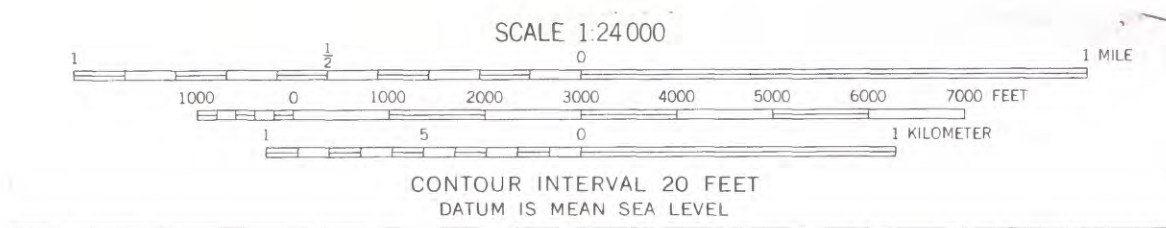
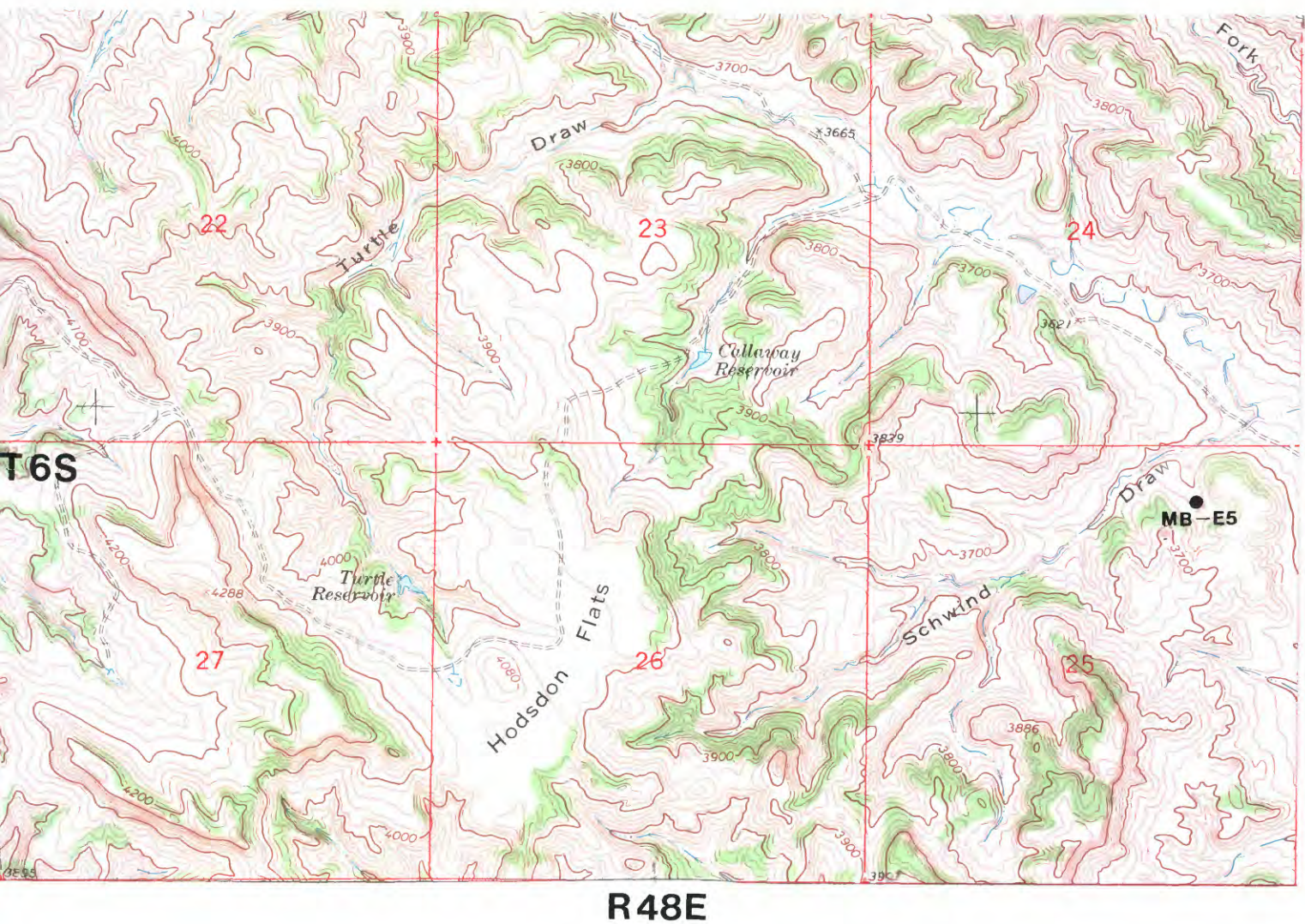


Figure 15 Location of drill hole in the Hodson Flats quadrangle

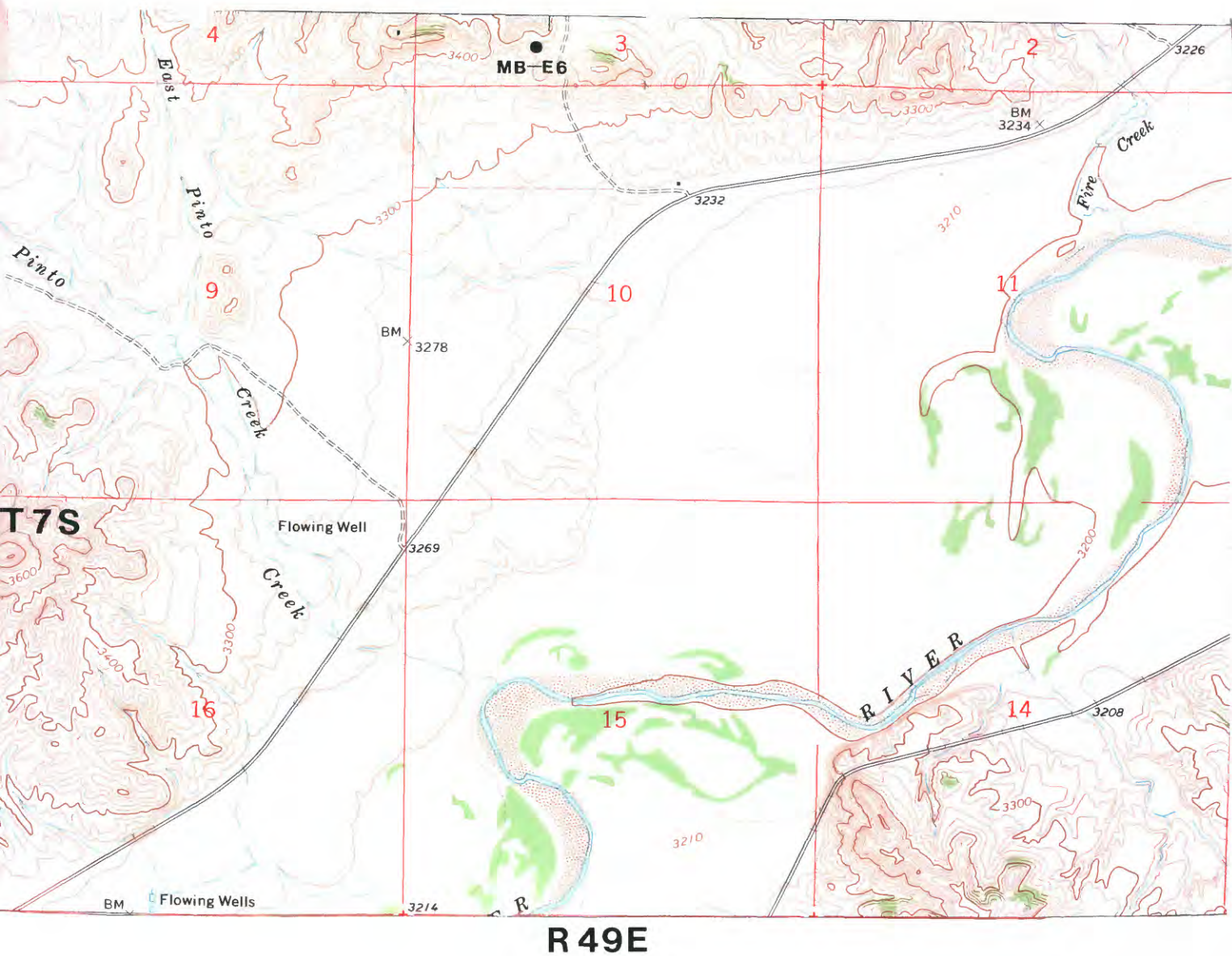


Figure 16 Location of drill hole in the Huckins School quadrangle

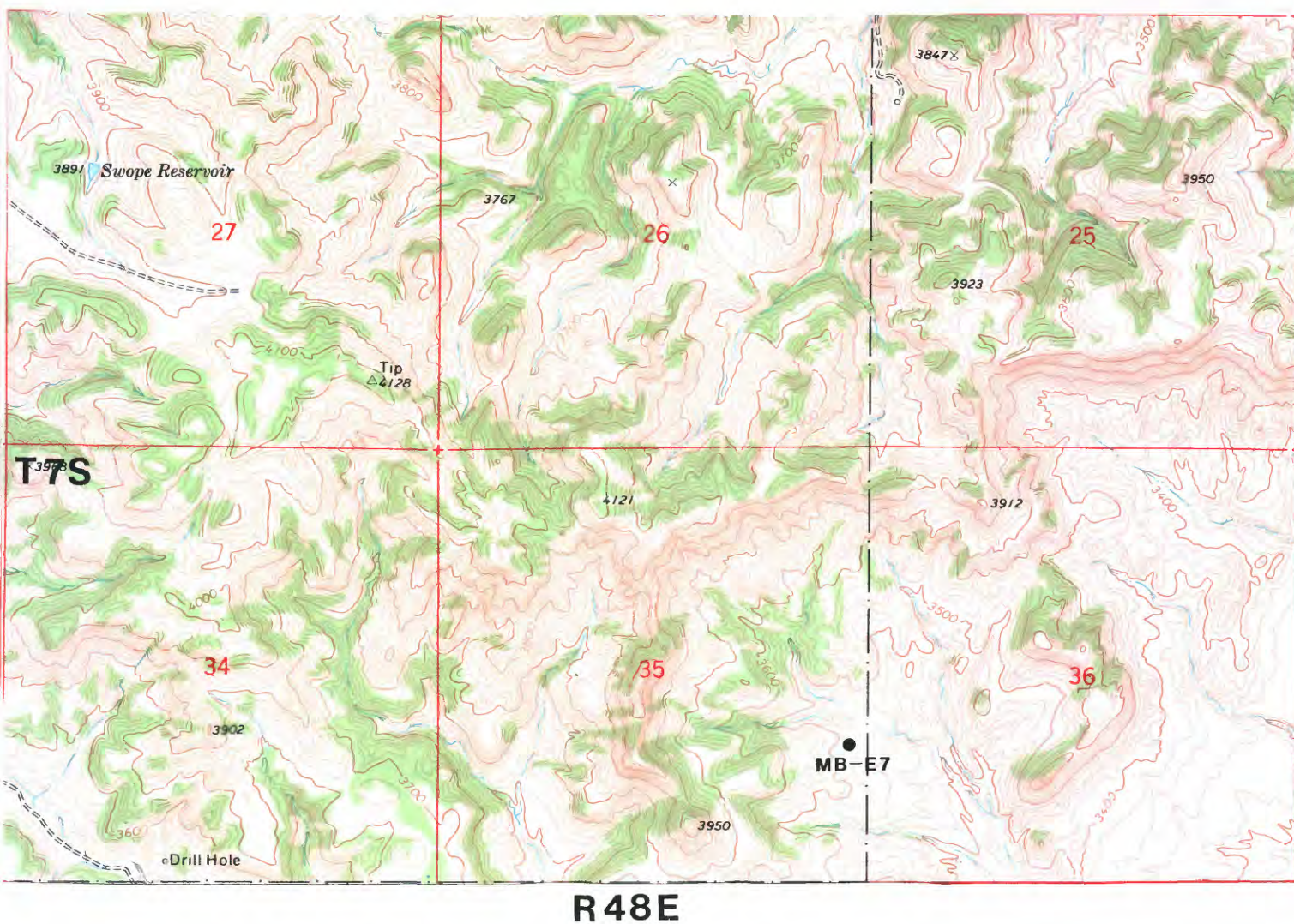


Figure 17 Location of drill hole in the Bloom Creek quadrangle

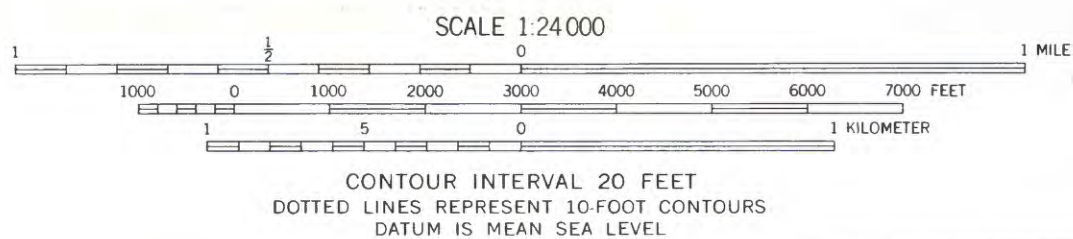
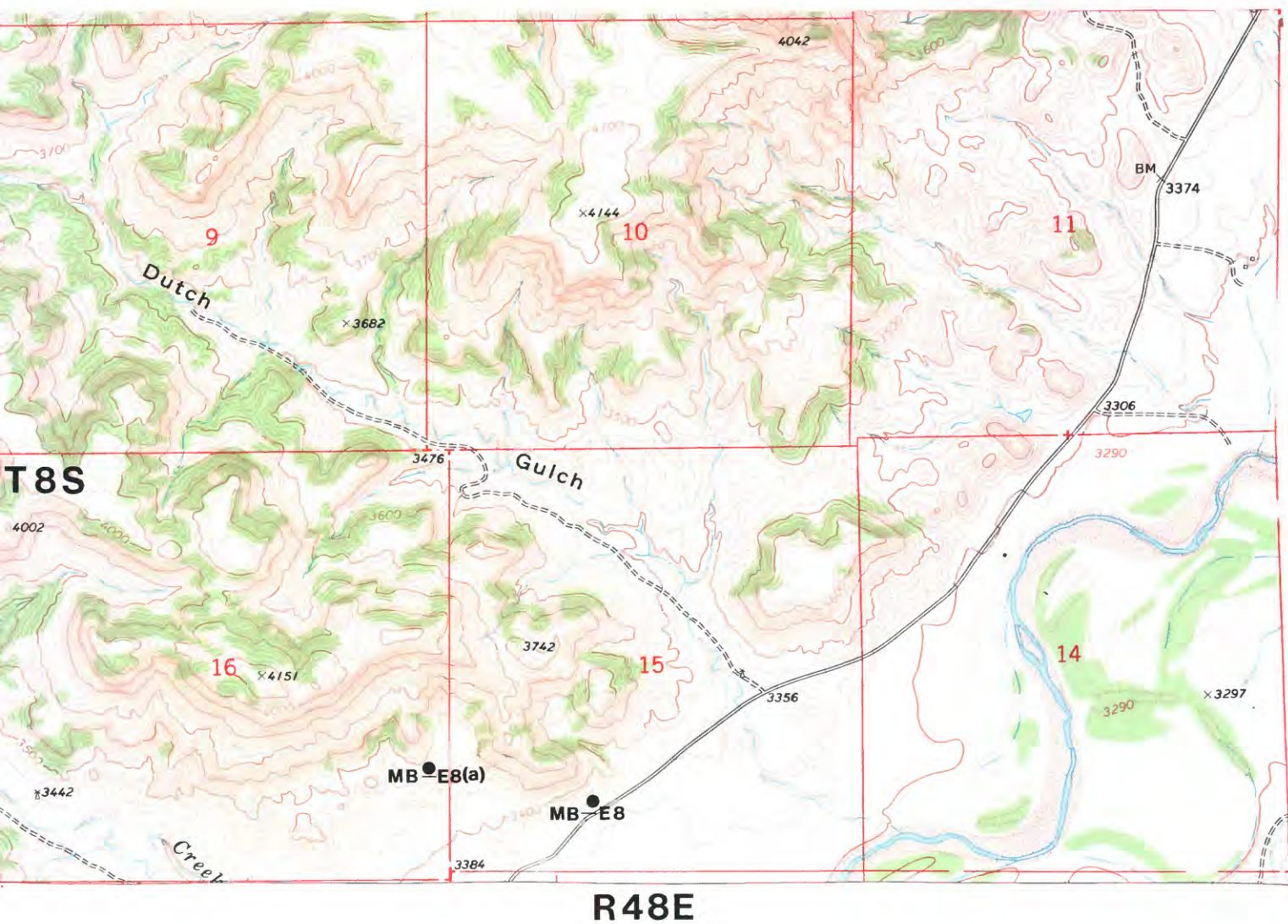


Figure 18 Location of drill holes in the Bloom Creek quadrangle

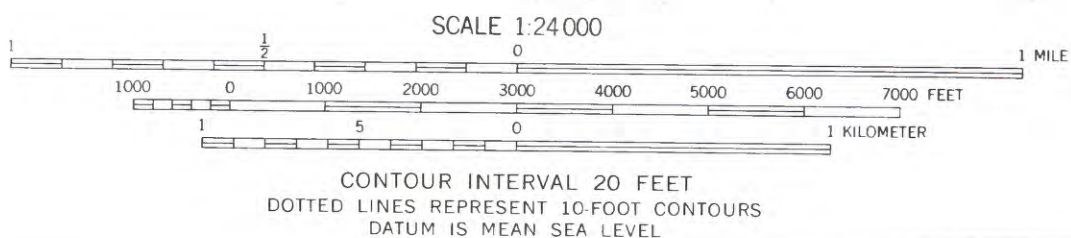
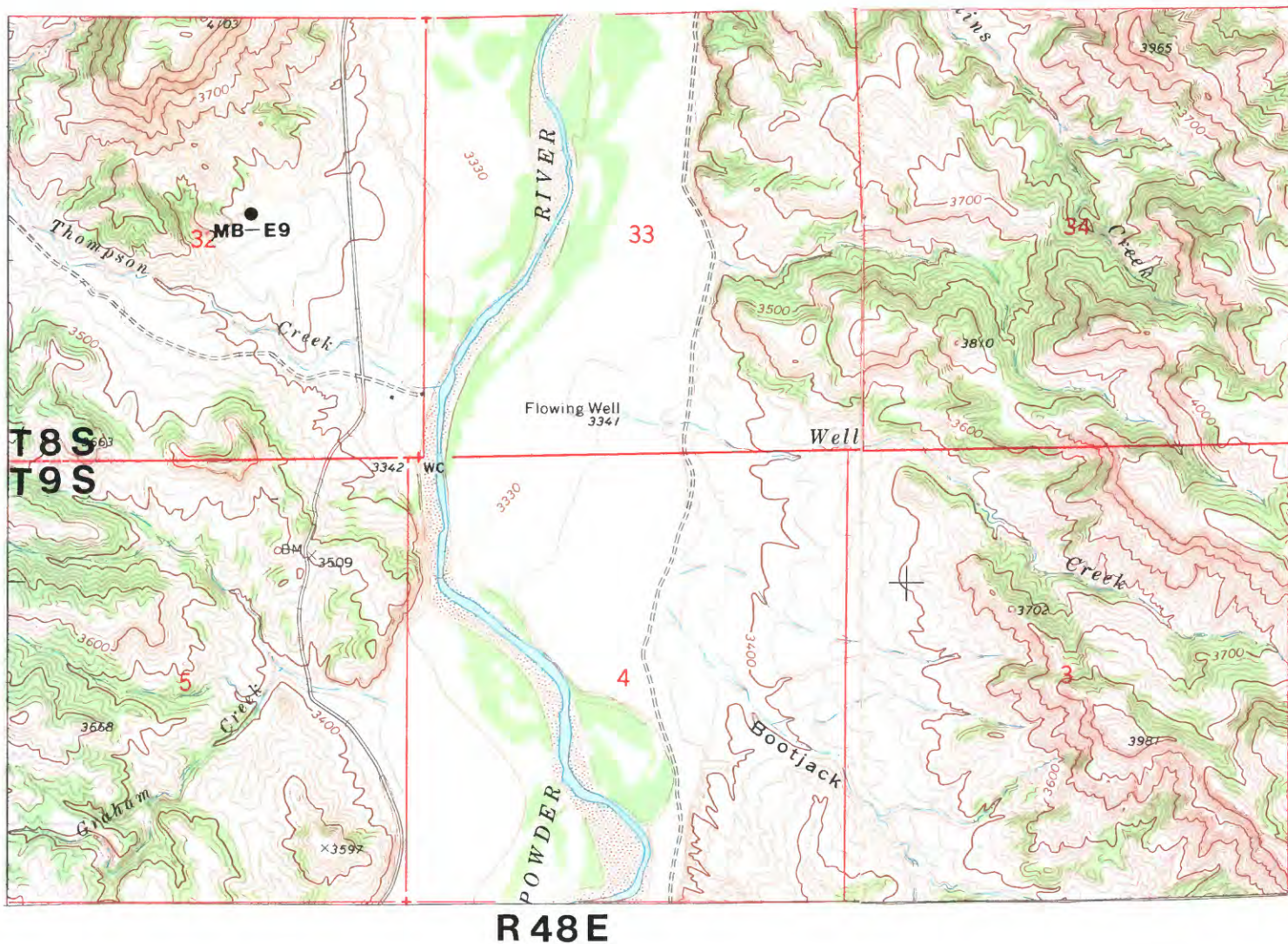


Figure 19 Location of drill hole in the Moorhead quadrangle

Table 1.--Drill Hole Data

Hole No.	Location	Quadrangle	Elevation (feet)	Total depth (feet)	Cored intervals (feet)	Comments
A1	NE 1/4 NE 1/4 sec. 13, T. 9 S., R. 50 E.	Bay Horse	3870	535	N/A	
A2a	SE 1/4 SE 1/4 sec. 25, T. 8 S., R. 50 E.	Bay Horse	3800	235	N/A	Pilot
A2b	SE 1/4 SE 1/4 sec. 25, T. 8 S., R. 50 E.	Bay Horse	3800	95	68.4- 88.5	
B2	SW 1/4 NW 1/4 sec. 27, T. 9 S., R. 49 E.	Three Bar Ranch	3890	495	N/A	
B3	NW 1/4 NW 1/4 sec. 7, T. 9 S., R. 50 E.	Three Bar Ranch	3890	475	N/A	
B4	NW 1/4 NW 1/4 sec. 22, T. 8 S., R. 50 E.	Baldy Peak	3850	435	N/A	
B5	NE 1/4 NW 1/4 sec. 12, T. 8 S., R. 50 E.	Baldy Peak	3620	395	N/A	
B6	NW 1/4 NE 1/4 SW 1/4 sec. 21, T. 7 S., R. 51 E.	Bear Skull Mountain	3670	315	N/A	
B7	NE 1/4 NW 1/4 sec. 13, T. 7 S., R. 51 E.	Bear Skull Mountain	3935	455	105.7-139.85	
C1	SW 1/4 SW 1/4 sec. 34, T. 8 S., R. 49 E.	Three Bar Ranch	3500	275	N/A	
C2	NE 1/4 sec. 33, T. 7 S., R. 50 E.	Baldy Peak	3674	480	N/A	
C3	Ctr. N 1/2 S 1/2 sec. 23, T. 7 S., R. 50 E.	Baldy Peak	3510	215	N/A	
C4	SW 1/4 NE 1/4 sec. 7, T. 7 S., R. 51 E.	Baldy Peak	3520	280	N/A	
D1	NW 1/4 NW 1/4 sec. 31, T. 6 S., R. 50 E.	Lonesome Peak	3320	155	N/A	
E2	SW 1/4 NE 1/4 sec. 3, T. 6 S., R. 50 E.	Lonesome Peak	3250	235	N/A	
E3	NW 1/4 NE 1/4 sec. 15, T. 6 S., R. 49 E.	Yarger Butte	3720	690	N/A	
E4	NE 1/4 SW 1/4 sec. 24 T. 6 S., R. 49 E.	Yarger Butte	3380	575	N/A	
E5	NE 1/4 NE 1/4 sec. 25, T. 6 S., R. 48 E.	Hodson Flats	3615	575	N/A	
E6	SE 1/4 SW 1/4 sec. 3, T. 7 S., R. 49 E.	Huckins School	3356	515	N/A	
E7	NE 1/4 SE 1/4 sec. 35, T. 7 S., R. 48 E.	Bloom Creek	3490	655	25.8- 60.0 120.0-137.5	
E8	SE 1/4 SW 1/4 sec. 15 T. 8 S., R. 48 E.	Bloom Creek	3340	95	N/A	Abandoned and moved to E8a
E8a	SW 1/4 SE 1/4 sec. 16, T. 8 S., R. 48 E.	Bloom Creek	3480	695	N/A	
E9	SW 1/4 NE 1/4 sec. 32, T. 8 S., R. 48 E.	Moorhead	3470	735	N/A	

Table 2.--Proximate and ultimate analyses. 80-MB-E7

Coal bed (core interval) (in feet)	Analysis	H ₂ O	VM	FC	Ash	Btu/lb	H ₂ O	C	H	N	O	S
Pawnee												
(25.8-60.0)	As received	32.20	28.49	31.27	8.04	7,306	32.20	42.84	3.32	0.89	12.61	0.10
	Dry basis	-----	42.02	46.12	11.86	10,855	-----	63.19	4.90	1.32	18.58	0.15
	Ash, moisture free	-----	47.67	52.33	-----	12,316	-----	71.69	5.56	1.50	21.08	0.17
	Equilibrium moisture	31.33	28.86	31.67	8.04	7,454	31.33	43.39	3.36	0.90	12.61	0.10
Cache												
(120.0-137.5)	As received	31.82	27.48	33.87	7.23	7,854	31.82	46.16	2.86	0.74	9.62	1.54
	Dry basis	-----	40.30	49.10	10.6	11,519	-----	67.71	4.19	1.09	14.10	2.26
	Ash, moisture free	-----	45.08	54.92	-----	12,885	-----	75.74	4.69	1.22	15.77	2.53
	Equilibrium moisture	30.71	27.93	34.01	7.35	7,982	30.71	46.90	2.91	0.75	9.78	1.57
Proximate and ultimate analysis. 80-MB-A2b												
Cache												
(68.4- 88.5)	As received	34.56	28.42	31.03	5.99	7,456	34.56	43.67	3.09	0.65	11.66	0.35
	Dry basis	-----	43.43	47.42	9.15	11,394	-----	66.74	4.72	1.00	17.81	0.54
	Ash, moisture free	-----	47.80	52.20	-----	12,541	-----	73.46	5.20	1.10	19.60	0.59
	Equilibrium moisture	33.63	28.42	31.03	5.99	7,562	33.63	43.67	3.09	0.65	11.66	0.35

**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus

Hole No. 80 MB-A1 **Geologist** Frank Spencer

Type log Lithologic **Elev.** 3870' **Total depth** 535'

Location NE¼NE¼ **Sec.** 13 **T.** 9 **S.R.** 50 **E.**

Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Bay Horse

Drilled by: U.S. Geological Survey

Driller(s): Arthur Clark

Drill: Gardner-Denver 17W **Date start** 9/14/80 **Complete** 9/15/80

Non-core intervals and size hole: 5 1/8"

Cored intervals and size: none

Remarks 20 ft. surface casing. Cemented in at 1317 hrs. Hit water 255 ft.
approx. 5 gpm. Hole plugged T.D. to surface cement.

LOG

From	To	Length	Description
(in feet)			
0	9	9	Alluvium, sandy silt with siltstone pieces 1½" diam. and windborn sand
9	13	4	Siltstone, dark brown, sandy
13	35	22	Sandstone, medium to light yellowish brown, very fine to fine grained
35	54	19	Siltstone, medium grained, sandy
54	60	6	Shale, medium gray, interbedded with carbonaceous shale, dark brown
60	69	9	Shale, black, carbonaceous
69	84	15	Siltstone, dark brown, carbonaceous, interbedded with carbonaceous shale dark brown
84	114	30	Siltstone, medium to dark gray, sandy
114	116	2	Carbonaceous shale, dark brown, interbedded with siltstone, medium gray
116	131	15	Siltstone, medium gray
131	150	19	Sandstone, medium brown gray, fine grained, quartz, sub-angular to angular
150	167	17	Siltstone, medium dark gray to dark gray, sandy

LOG

From	To (in feet)	Length	Description
167	184	17	Coal, with \pm 3' parting at 170', 2' parting at 176'
184	189	5	Carbonaceous shale with siltstone, dark brown and sandy
189	193	4	Siltstone, medium brown gray
194	219	25	Siltstone, medium gray, sandy, shale, medium gray
219	227	8	Sandstone, medium brown gray, very fine grained
227	256	29	Sandstone, light yellow brown to yellow brown, fine grained to medium quartz, sub-rounded, much black chert
256	263	7	Siltstone, medium gray, sandstone, medium gray, very fine grained
263	267	4	Coal, with \pm 1' parting at 265'
267	278	11	Sandstone, medium gray, very fine grained
278	281	3	Coal, with \pm .5' parting at 279'
281	293	12	Siltstone, medium to dark gray with carbonaceous shale
293	310	17	Sandstone, medium gray, very fine grained, silty
310	312	2	Shale, medium gray green
312	317	5	Siltstone, medium gray green
317	324	7	Shale, medium gray green
324	345	21	Siltstone, medium to dark gray, shale, medium green gray
345	360	15	Siltstone, medium gray, sandstone medium gray
360	397	37	Sandstone, medium gray to dark gray, very fine grained
397	399	2	Sandstone, medium gray, very fine grained with interbedded shale, carbonaceous, dark gray
399	437	38	Sandstone, medium gray, very fine grained, siltstone, medium gray
			Total depth geophysical log 437'
			Sample log to total depth
437	440	3	Sandstone, medium gray, very fine grained

LOG

From	To (in feet)	Length	Description
440	445	5	Siltstone, medium gray, sandy
445	450	5	Sandstone, medium gray, very fine grained
450	455	5	Sandstone, medium gray, very fine grained
455	460	5	Sandstone, medium gray, very fine grained
460	465	5	Sandstone, medium gray, very fine grained
465	470	5	Siltstone, medium gray, very fine grained
470	475	5	Siltstone, light to medium gray, interbedded with shale, carbonaceous, dark brown
475	480	5	Siltstone, medium gray, interbedded with shale, carbonaceous, dark brown
480	485	5	Shale, medium gray
485	490	5	Carbonaceous shale, dark brown with siltstone, dark brown, carbonaceous
490	495	5	Coal (Drillers call)
495	496	1	Coal
496	500	4	Siltstone, medium to dark gray, interbedded with sandstone, medium gray, very fine grained, silty
500	505	5	Siltstone, medium to dark gray
505	510	5	Siltstone, medium to dark gray
510	515	5	Siltstone, medium to dark gray
515	520	5	Shale, medium gray
520	525	5	Shale, medium gray
525	535	10	No sample

T.D. 535 @ 1120

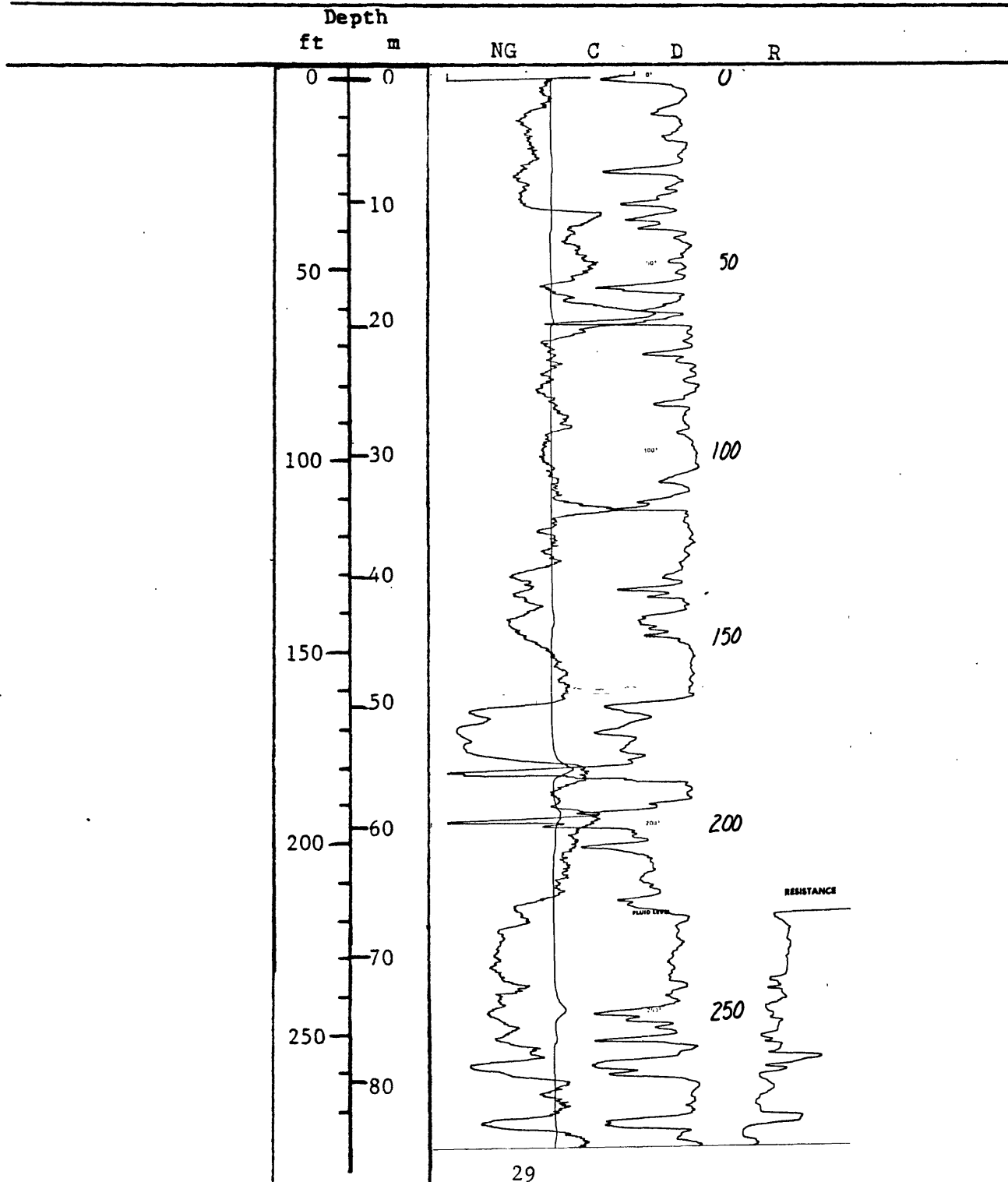
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. A1 Date logged 9/15/80 Surface elevation 3870

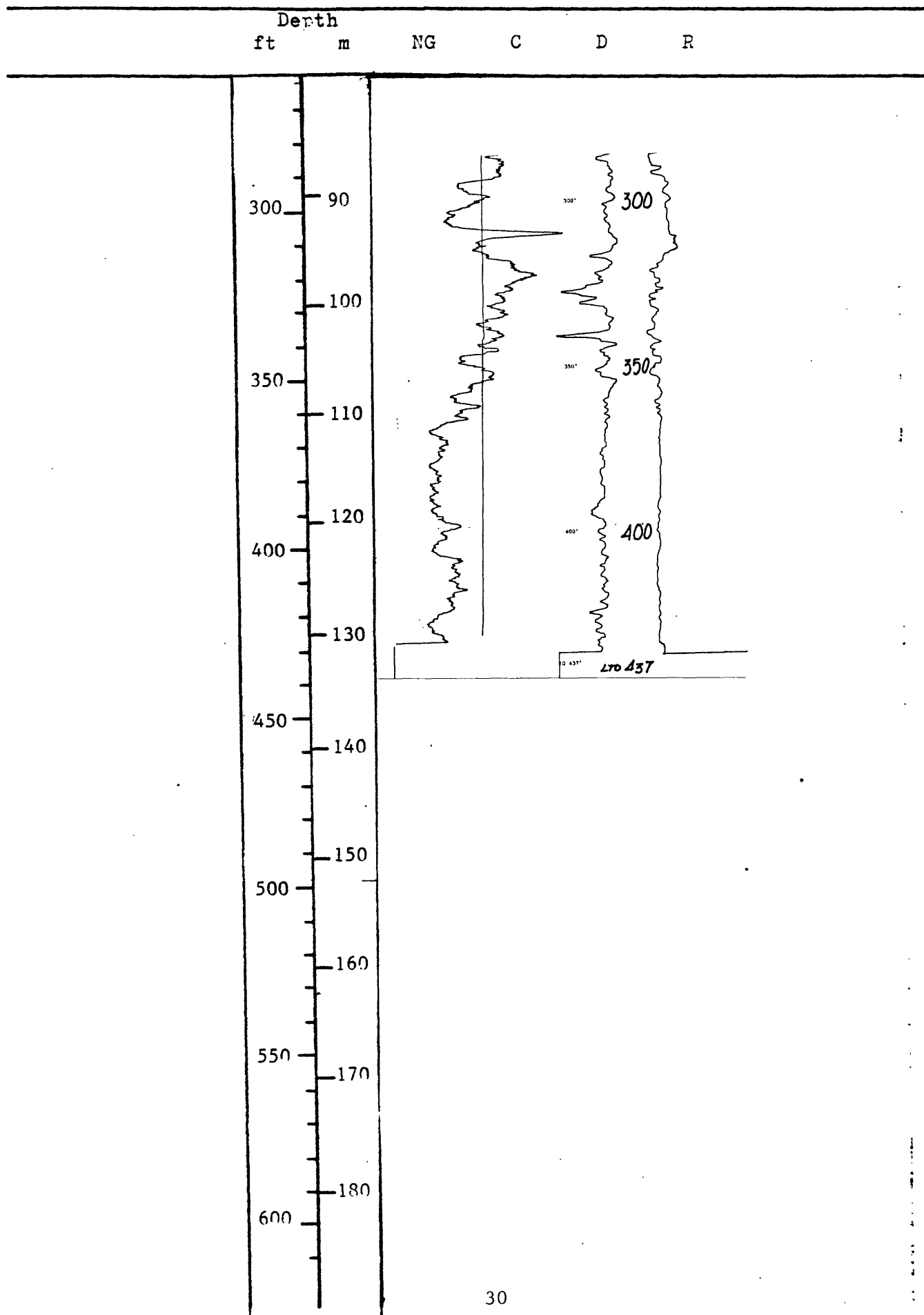
Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 13, T. 9 S., R. 50 E. County Powder River

Drilled depth 535' Logged depth 437' Fluid level 224'

Remarks 20' surface casing. Hole plugged T.D. to surface with cement.



Hole no. A1 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

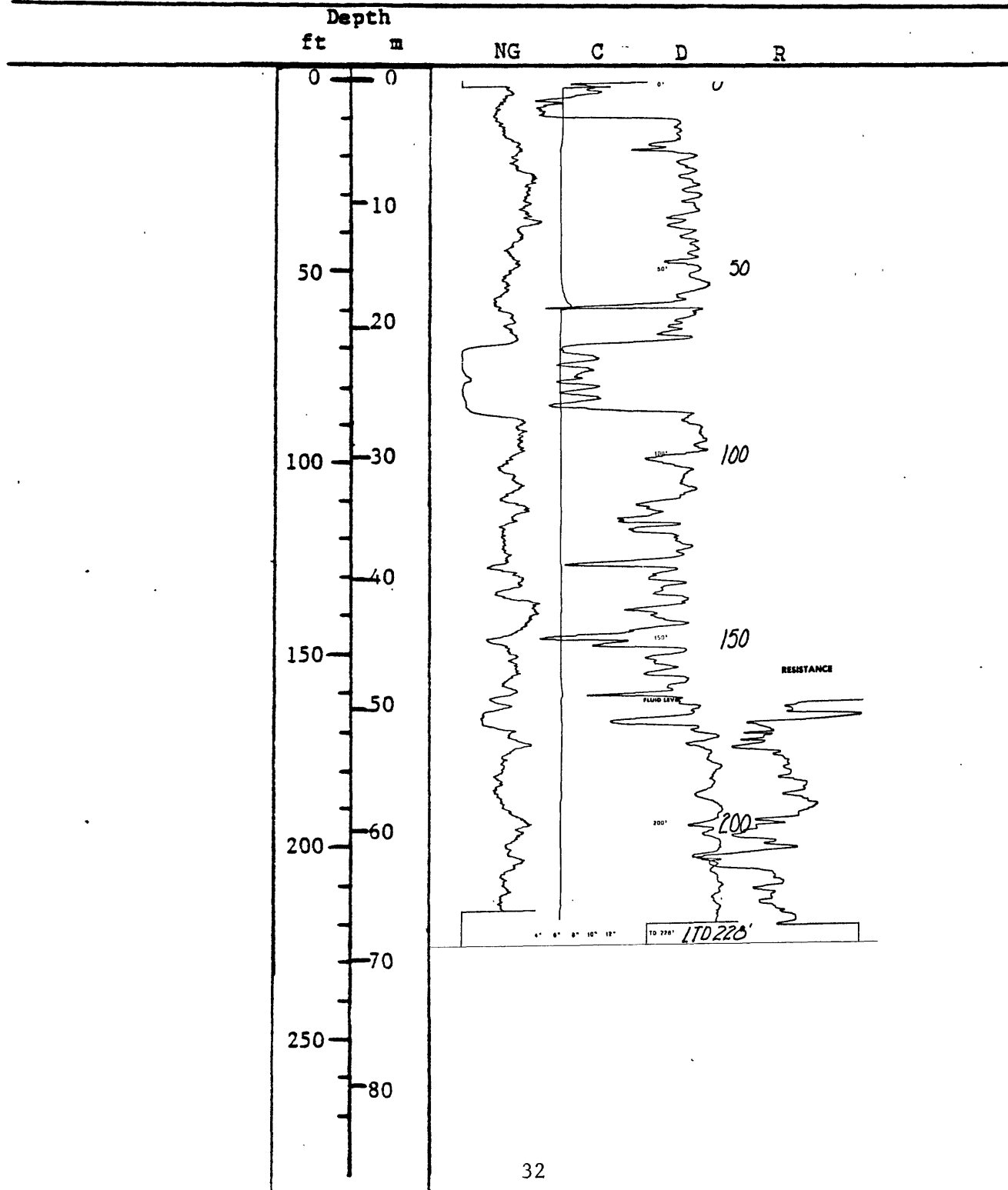
Project Moorhead-Broadus
 Hole No. 80 MB-A2a Geologist Frank Spencer
 Type log Lithologic Elev. 3800' Total depth 235'
 Location SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25 T. 8 S. R. 50 E.
 Nearest town Broadus County Powder River State Mont. Quad. Bay Horse
 Drilled by: U.S. Geological Survey
 Driller(s): Arthur Clark
 Drill: Gardner-Denver 17W Date start 9/15/80 Complete 9/15/80
 Non-core intervals and size hole: 0-235' 5 1/8" Pilot Hole
 Cored intervals and size: _____
 Remarks Casing at 20'

LOG

From	To (in feet)	Length	Description
0	15	15	Alluvium, sand, unindurated, light to medium yellow
15	69	54	Shale, medium gray, sandstone, medium gray, very fine grained, siltstone, medium to light gray
69	88	19	Coal, \pm 2' parting at 72', \pm 2' parting at 76', \pm .5' parting at 79', \pm 1.5' parting at 81', \pm 1.5' parting at 84'
88	128	40	Siltstone, medium gray, sandstone, dark gray, very fine grained, carbonaceous shale, dark brown, \pm 3' at 113'
128	130	2	Coal
130	148	18	Siltstone, medium gray
148	152	4	Coal, with \pm 1' parting at 150'
152	171	19	Siltstone, medium gray
171	173	2	Coal
173	228	55	Siltstone, medium to light gray, shale, medium to light gray, silty, sandstone, medium gray, very fine grained
Total depth geophysical log 228'			
Sample log to depth			
228	230	2	Siltstone, light gray, sandy
230	235	5	Siltstone, light gray, sandy

U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. A2a Date logged 9/15 80 Surface elevation 3800'
Location SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 25, T. 8 S., R. 50 E. County Powder River
Drilled depth 235' Logged depth 228' Fluid level 167'
Remarks Pilot for core hole



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-A2b Geologist Frank Spencer (R. G. Hobbs)
 Type log Core description Elev. 3800' Total depth 95'
 Location SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25 T. 8 S. R. 50 E.
 Nearest town Broadus County Powder River State Mont. Quad. Bay Horse
 Drilled by: U. S. Geological Survey
 Driller(s): Arthur Clark
 Drill: Gardner-Denver 17W Date start 9/15/80 Complete 9/15/80
 Non-core intervals and size hole: 0-68.4' and 88.5-95' 5 1/8"
 Cored intervals and size: 68.4-88.5' 4½ x 3" (3" core)
 Remarks _____

LOG

From	To	Length	Description
(in feet)			
			Core description 68.4-88.5 Cache coal
68.4	69.3	0.9	Siltstone, light to medium gray
69.3	69.5	0.2	Shale, black, carbonaceous with coal spars
69.5	88.3	18.8	Coal, black alternating dull and bright bands, abundant pyrite nodules, pyrite coating fracture 87.0 to 88.3 (removed for separate analysis) minor gypsum rosettes on fractures, bone coal 78.0 to 79.0 ±
88.3	88.5	0.2	Siltstone, light to medium gray

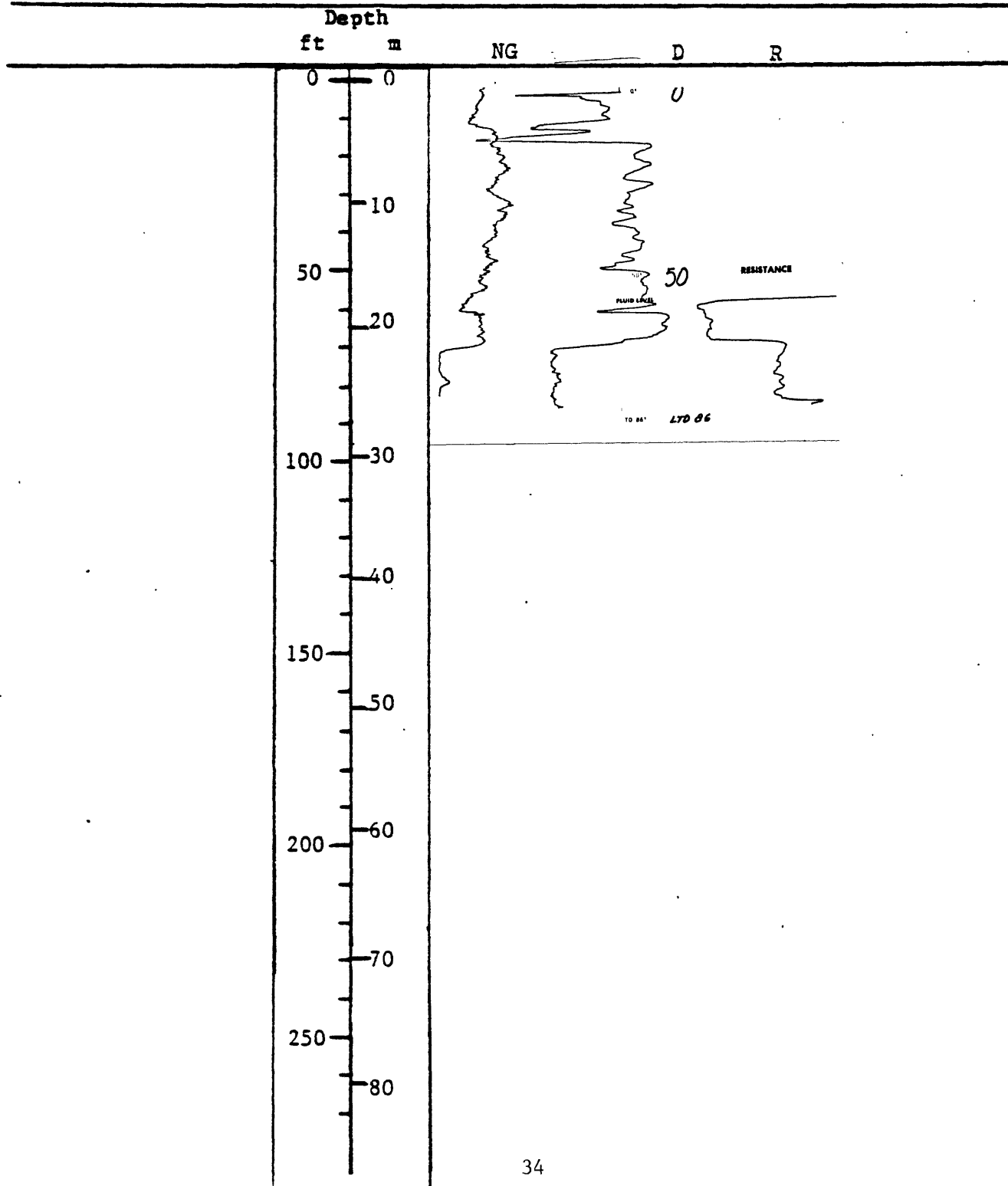
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. A2b Date logged 9/16/80 Surface elevation 3800'

Location SE¹/₄SE¹/₄ sec. 25, T. 8 S., R. 50 E. County Powder River

Drilled depth 95' Logged depth 86' Fluid level 57'

Remarks Cored 68.4 to 88.5' 4¹/₂x3in. (3in. core)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B2 **Geologist** Janet Brown
Type log Lithologic **Elev.** 3890' **Total depth** 495'
Location SW $\frac{1}{4}$ NW $\frac{1}{4}$ **Sec.** 27 **T.** 9 **S.** R. 49 **E.**
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Three Bar Ranch
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant y
Drill: Portadrill 524 **Date start** 9/25/80 **Complete** 9/26/80
Non-core intervals and size hole: 0-495' 5 1/8"
Cored intervals and size: _____
Remarks Hole plugged surface to T.D.- cement

LOG

From	To	Length	Description
(in feet)			
0	7	7	Claystone, (5YR-9/4)
7	8	1	Coal(?), Sand, gray(10YR-7/4), fine grained
8	19	11	Clinker, light brown(5YR-6/4), 100%
19	38	19	Claystone, medium gray(N-5) 50%, dark yellow brown(10YR-4/2)25%, sandstone, light olive gray(5Y-5/2), fine grained 25%
38	47	9	Coal, black(N-1) with carbonaceous shale partings; \pm 2' at 40', \pm 2' at 45'
47	249	202	Sandstone, light olive gray(5Y-6/1)14%, light olive gray(5Y-5/2)11%, Yellow gray(5Y-7/2)26%, medium yellow brown(10YR-5/4)11%, olive gray(5Y-4/1)9%, gray orange(10YR-7/4)6%, medium light gray(23%), fine grained, siltstone, light olive gray(5Y-6/1), olive gray(5Y-4/1), claystone, olive black(5Y-2/1), medium gray(N-5)
249	251	2	Coal, brown black, bony
251	270	19	Sandstone, medium gray, coarse grained, shale, medium light gray, hard, claystone, medium to olive gray
270	306	36	Shale and siltstone, medium to olive gray, some with carbonaceous material
306	308	2	Coal, bony, with pyrite
308	366	58	Claystone, medium gray to olive gray, siltstone, olive gray to medium gray with carbonaceous material

LOG

From	To (in feet)	Length	Description
308	366	58	(cont.) shale, olive gray
366	368	2	Coal(?)
368	430	62	Claystone, medium gray to olive gray, sandstone, olive gray, very fine grained, shale, olive gray, medium yellow brown to brown black, carbonaceous, siltstone, olive gray
430	435	5	Coal, black, silty with \pm .5' parting at 433'
435	462	27	Shale, gray black, brown gray to medium dark gray, carbonaceous
			Total depth geophysical log 462'
			Sample log to T.D.
462	470	8	Shale, brown gray, sandstone, olive gray
470	475	5	Shale, brown gray, sandstone, olive gray
475	495	20	Small samples, sandstone, olive gray, medium light gray to medium gray, fine to very fine grained, thinly laminated
			T.D. 495'

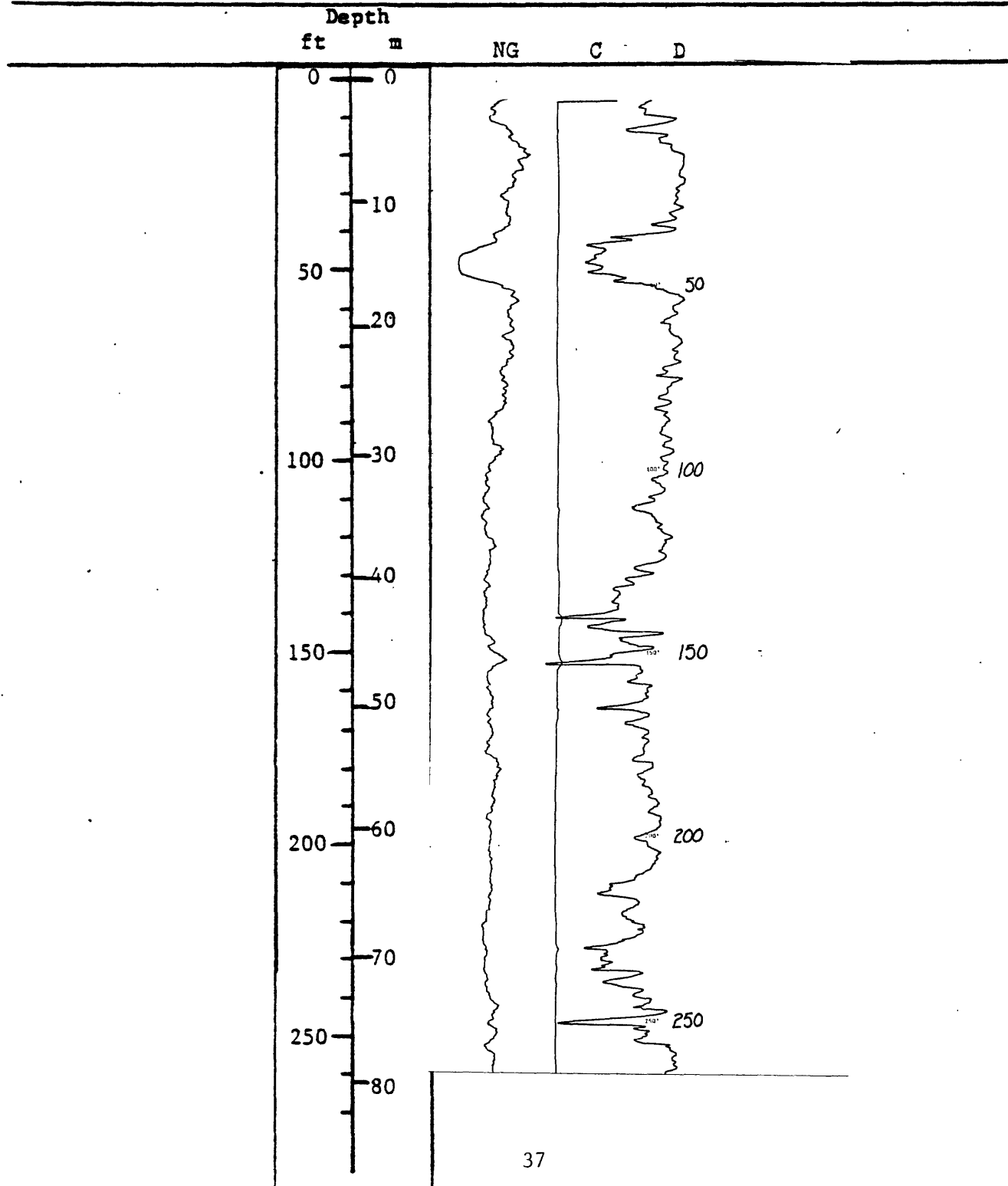
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B2 Date logged 9/26/80 Surface elevation 3890

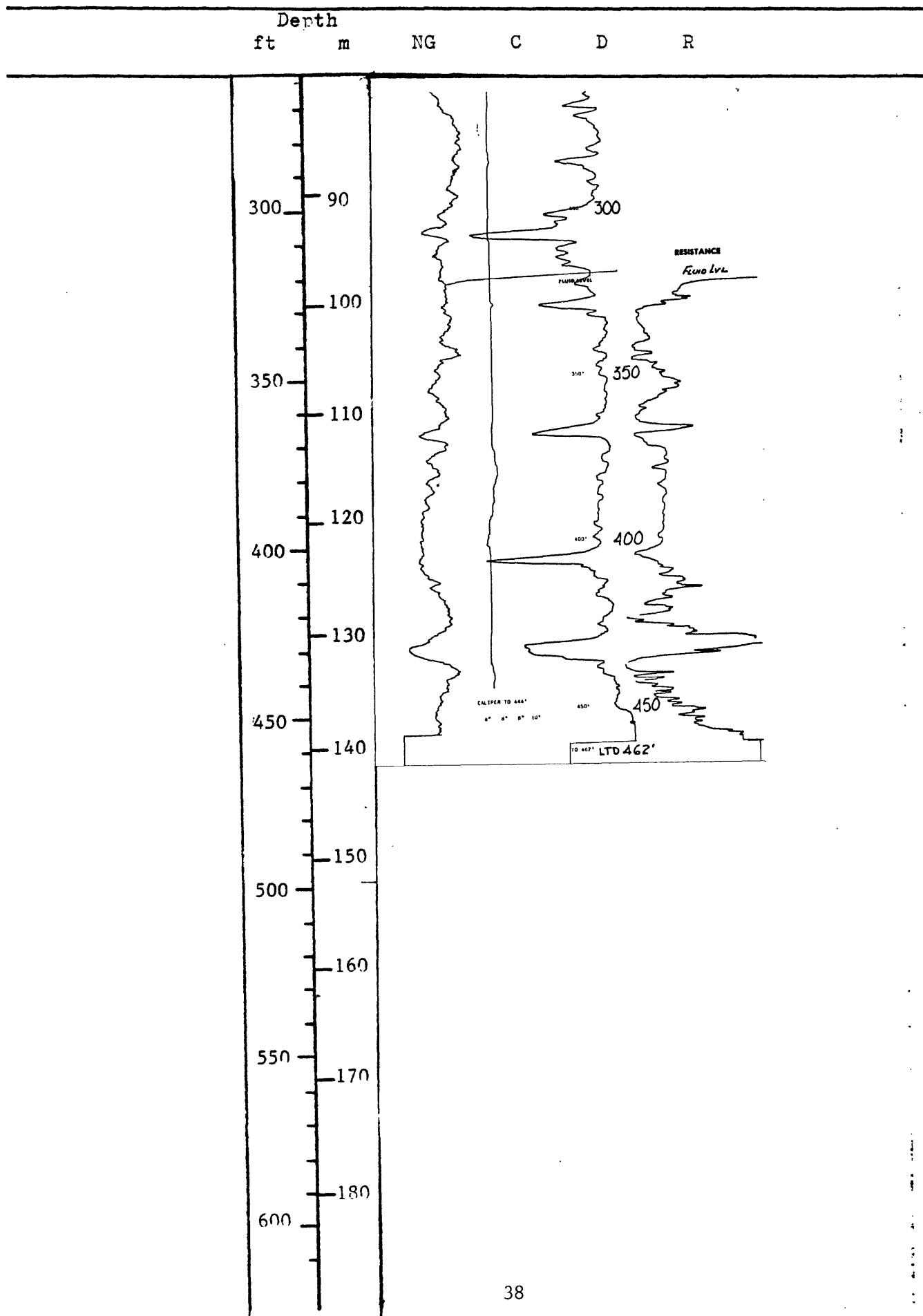
Location SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 9 S., R. 49 E. County Powder River

Drilled depth 495' Logged depth 462' Fluid level 322'

Remarks Hole plugged surface to T.D.- cement



Hole no. B2 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B3 **Geologist** Frank Spencer
Type log Lithologic **Elev.** 3899' **Total depth** 475'
Location NW¼NW¼ **Sec.** 7 **T.** 9 **S.** R. 50 **E.**
Nearst town Biddle **County** Powder River **State** Mont. **Quad.** Three Bar Ranch
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 1 W **Date start** 9/25/80 **Complete** 9/25/80
Non-core intervals and size hole: 0-475' 5 1/8"
Cored intervals and size: _____
Remarks _____

LOG

From	To (in feet)	Length	Description
0	3	3	Siltstone, medium gray to dark gray, oxide staining
3	5	2	Carbonaceous shale, dark brown
5	9	4	Coal, dark brown bloom
9	13	4	Coal and carbonaceous shale
13	20	7	Carbonaceous shale, shale, medium gray, siltstone, dark brown
20	36	16	Siltstone, light to medium gray
36	80	44	Sandstone, medium gray to medium brown, fine to very fine grained, siltstone, medium brown gray to light gray
80	116	36	Sandstone, light gray, very fine grained, quartz angular
116	128	12	Sandstone, medium gray, very fine grained, silty
128	192	64	Sandstone, light to medium gray, fine grained, some quartz sub-angular
192	246	54	Sandstone, medium to light gray, fine to very fine grained, silty, calcareous
246	260	14	Siltstone, medium gray
260	278	18	Sandstone, medium gray, very fine grained
278	288	10	Siltstone, medium gray, sandy

LOG

From	To (in feet)	Length	Description
288	290	2	Coal, (Driller call)
290	294	4	Carbonaceous shale with siltstone, dark gray
294	312	18	Sandstone, medium gray, very fine grained, siltstone, medium gray
312	314	2	Coal
314	376	62	Siltstone, medium gray, sandstone, medium to dark gray, very fine grained
376	379	3	Shale, light to medium gray
379	390	11	Coal, with \pm 1' parting at 388'
390	392	2	Shale, carbonaceous dark brown interbedded with siltstone, medium olive gray
392	428	36	Sandstone, medium gray to medium brown gray, siltstone, medium gray, sandy
428	432	4	Carbonaceous shale, dark brown
432	434	2	Coal (Driller call)
434	447	13	Siltstone, light to medium gray
447	449	2	Coal (Driller call)
449	465	16	Sandstone, light to medium gray, very fine grained, Siltstone, medium gray, sandy
Total depth geophysical log 465'			
Sample log to total depth			
465	470	5	Siltstone, medium brown gray
470	475	5	Siltstone, medium brown gray

T.D. 475' @ 1505 hrs.
Circulate until steel out of hole, 1538 hrs.

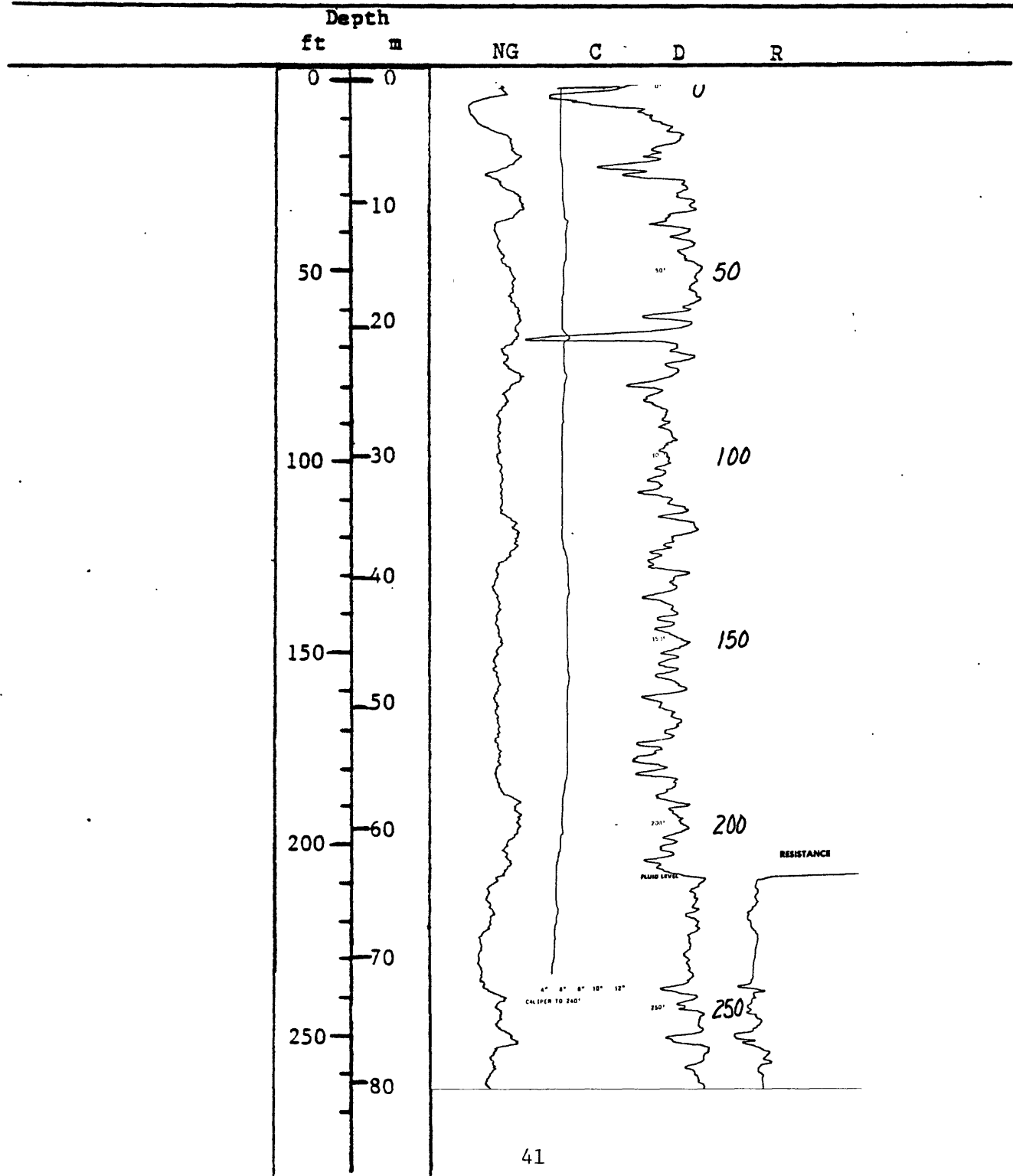
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B3 Date logged 9/25/80 Surface elevation 3890'

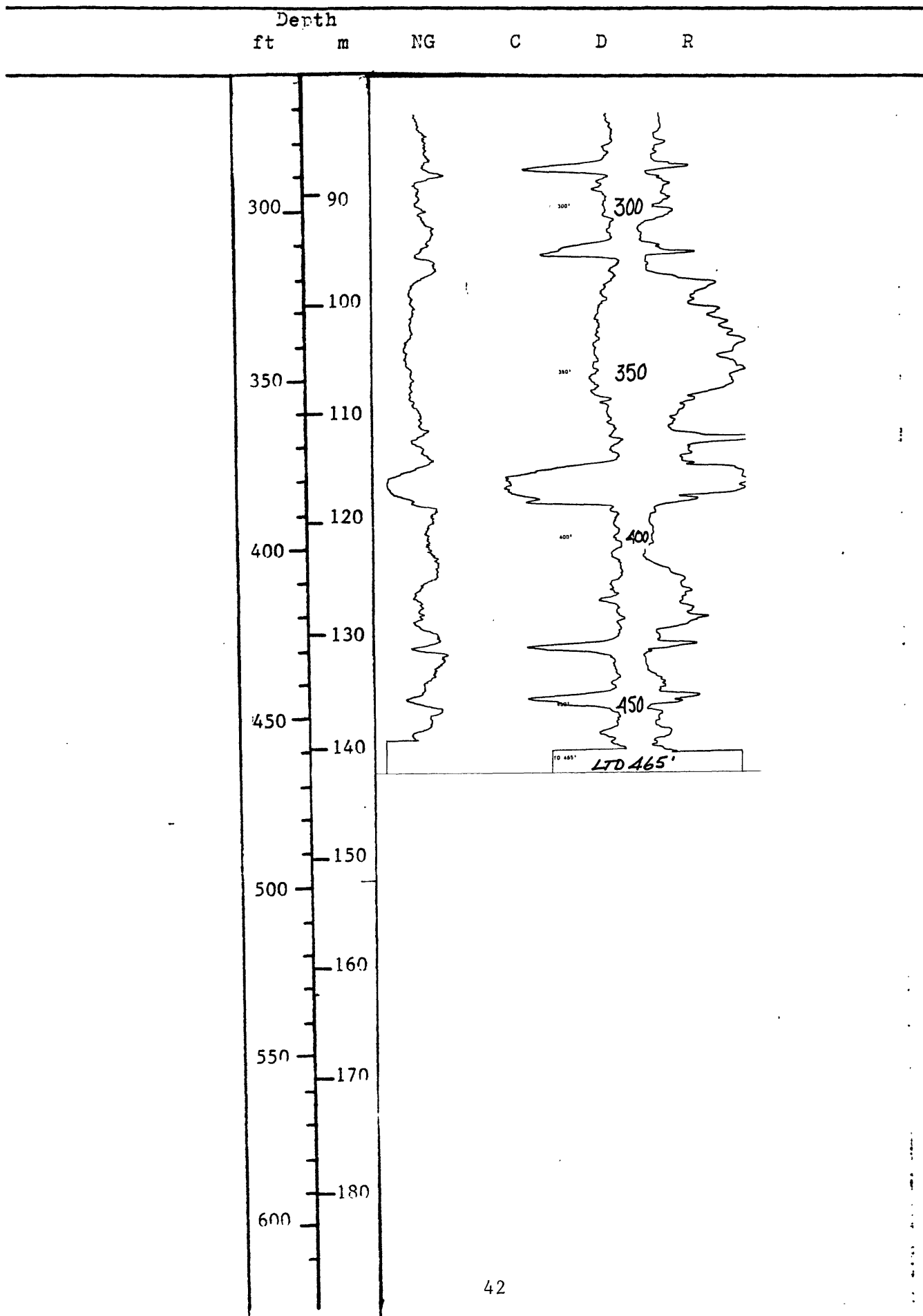
Location NW¼NW¼ sec. 7, T. 9 S., R. 50 E. County Powder River

Drilled depth 475' Logged depth 465' Fluid level 215'

Remarks _____



Hole no. B3 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B4 **Geologist** Frank Spencer
Type log Lithologic **Elev.** 3850' **Total depth** 435'
Location NW¼NW¼ **Sec.** 22 **T.** 8 **S. R.** 50 **E.**
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Baldy Peak
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/24/80 **Complete** 9/24/80
Non-core intervals and size hole: 0-435' 5 1/8"
Cored intervals and size: _____
Remarks Surface casing in at 1535 hrs.- 20' cemented at 1540 hrs. drilling at 1545 hrs.

LOG

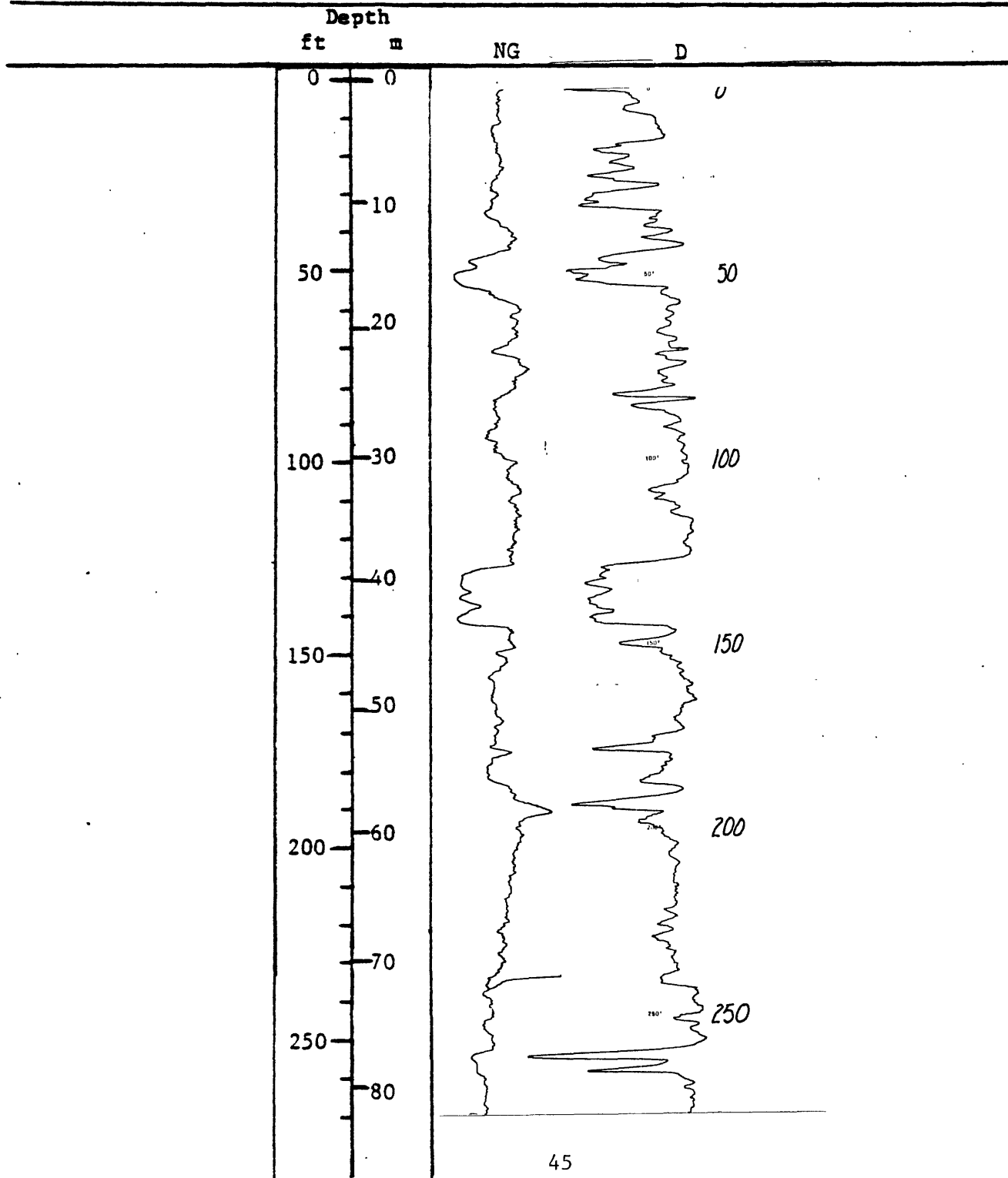
From	To	Length	Description
(in feet)			
0	32	32	Alluvium, sandy silt, silty sand, light yellow brown to medium yellow brown, some clinker
32	43	11	Sandstone, light red brown to light brown, fine grained with clinker, sandstone interbedded with siltstone, medium gray
43	53	10	Coal, with brown blossom, <u>±</u> 1' parting at 49'
53	81	28	Siltstone, medium gray interbedded with carbonaceous shale, sandstone, light to medium gray, fine to very fine grained
81	86	5	Carbonaceous shale, dark brown
86	128	42	Sandstone, medium gray, very fine grained with calcareous interbeds or concretions, siltstone, medium gray, sandy, carbonaceous shale <u>±</u> 2' at 114'
128	145	17	Coal with <u>±</u> .5' parting at 132', <u>±</u> 1' parting at 140'
145	150	5	Carbonaceous shale, dark brown
150	177	27	Siltstone, dark gray brown with carbonaceous shale interbedded
177	179	4	Coal(Driller call)
179	193	14	Siltstone, medium to dark gray interbedded with carbonaceous shale, dark brown

LOG

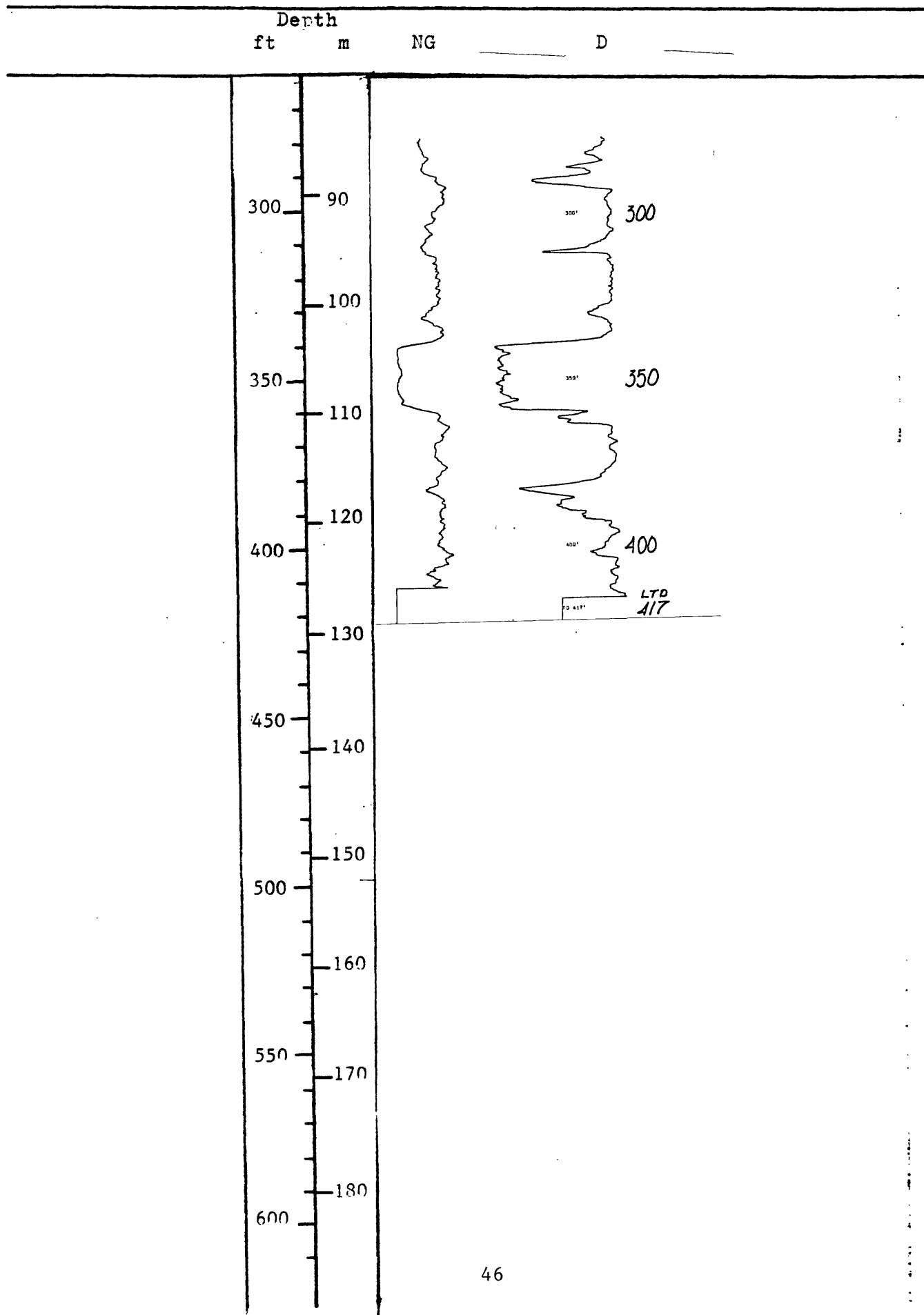
From	To (in feet)	Length	Description
193	195	2	Carbonaceous shale, dark brown
195	260	65	Siltstone, medium to dark gray with carbonaceous shale stringers, sandstone, medium to light gray, very fine grained, shale, medium gray, silty
260	266	6	Coal with \pm 3' parting at 262'
266	291	25	Carbonaceous shale, dark brown, interbedded with siltstone, dark brown
291	338	47	Siltstone, medium to dark brown gray, sandstone, medium gray, very fine grained, shale, carbonaceous, dark brown interbedded with siltstone, dark gray
338	360	22	Coal with \pm .5' parting at 342', \pm 2' parting at 347', \pm 2' parting at 355'
360	364	4	Carbonaceous shale, dark brown
364	382	18	Siltstone, greenish light gray
382	384	2	Coal(Driller call)
384	389	5	Carbonaceous shale, dark brown with siltstone, dark brown gray
389	406	17	Siltstone, medium to light gray
406	417	11	Shale, medium gray
			Total depth geophysical log 417'
			Sample log to depth
417	430	13	Siltstone, medium gray
430	435	5	Siltstone, medium gray
			T.D. 435' @ 1815 hrs.

U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B4 Date logged 9/24/80 Surface elevation 3850'
Location NW¼NW¼ sec. 22, T. 8 S., R. 50 E. County Powder River
Drilled depth 435' Logged depth 417' Fluid level _____
Remarks Dry hole



Hole no. B4 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B5 **Geologist** M. McPhillips
Type log Lithologic **Elev.** 3620' **Total depth** 395'
Location NE $\frac{1}{4}$ NW $\frac{1}{4}$ **Sec.** 12 **T.** 8 **S. R.** 50E.
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Baldy Peak
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant y
Drill: Portadrill 524 **Date start** 9/15/80 **Complete** 9/16/80
Non-core intervals and size hole: 0-395' 5 1/8"
Cored intervals and size: _____
Remarks _____

LOG

From	To (in feet)	Length	Description
0	59	59	Alluvium, dark yellow brown, clayey with some clinker and fine grained sand
59	63	4	Sandstone, medium yellow brown, fine to very fine grained
63	103	40	Claystone, medium light gray to medium dark gray, trace carbonaceous material, clinker, sandstone, medium light gray, very fine grained
103	107	4	Claystone, medium light gray, coal(?), black, dull
107	166	59	Claystone, medium light gray to medium blue gray with shale, brown black, carbonaceous(134-136)
166	179	13	Shale, medium to medium dark gray, carbonaceous with pyrite nodules <u>+ 177'</u>
179	186	7	Coal, black, silky, <u>+ 1'</u> parting at 183'
186	196	10	Claystone, medium light gray
196	199	3	Coal with shale, brown gray, carbonaceous
199	227	28	Claystone, medium blue gray
227	257	30	Siltstone, medium gray, shale, medium gray, silty, sandstone, medium gray, very fine grained
257	262	5	Sandstone, medium gray, very fine grained

LOG

From	To (in feet)	Length	Description
262	291	29	Sandstone, medium gray, medium grained, silty in places, pyrite nodules + 265', becomes fine grained at 266', siltstone increases to 291'
291	322	31	Siltstone, medium light gray, sandy
322	328	6	Sandstone, medium light gray, very fine grained, some calcareous material, sandy at 328'
328	355	27	Claystone, medium blue gray to medium gray Total depth geophysical log 355' Sample log to total depth
355	360	5	Sandstone, medium light gray, very fine grained with carbonaceous material
360	365	5	Small sample, sandstone, medium light gray, very fine grained with carbonaceous material
365	370	5	Siltstone, medium light gray
370	375	5	Small sample-poor
375	380	5	Siltstone, medium gray, sandstone medium gray
380	385	5	Siltstone, medium gray, sandstone, medium gray
385	390	5	Siltstone, light gray, sandstone, medium gray, very fine grained
390	395	5	Sandstone, medium gray, fine grained

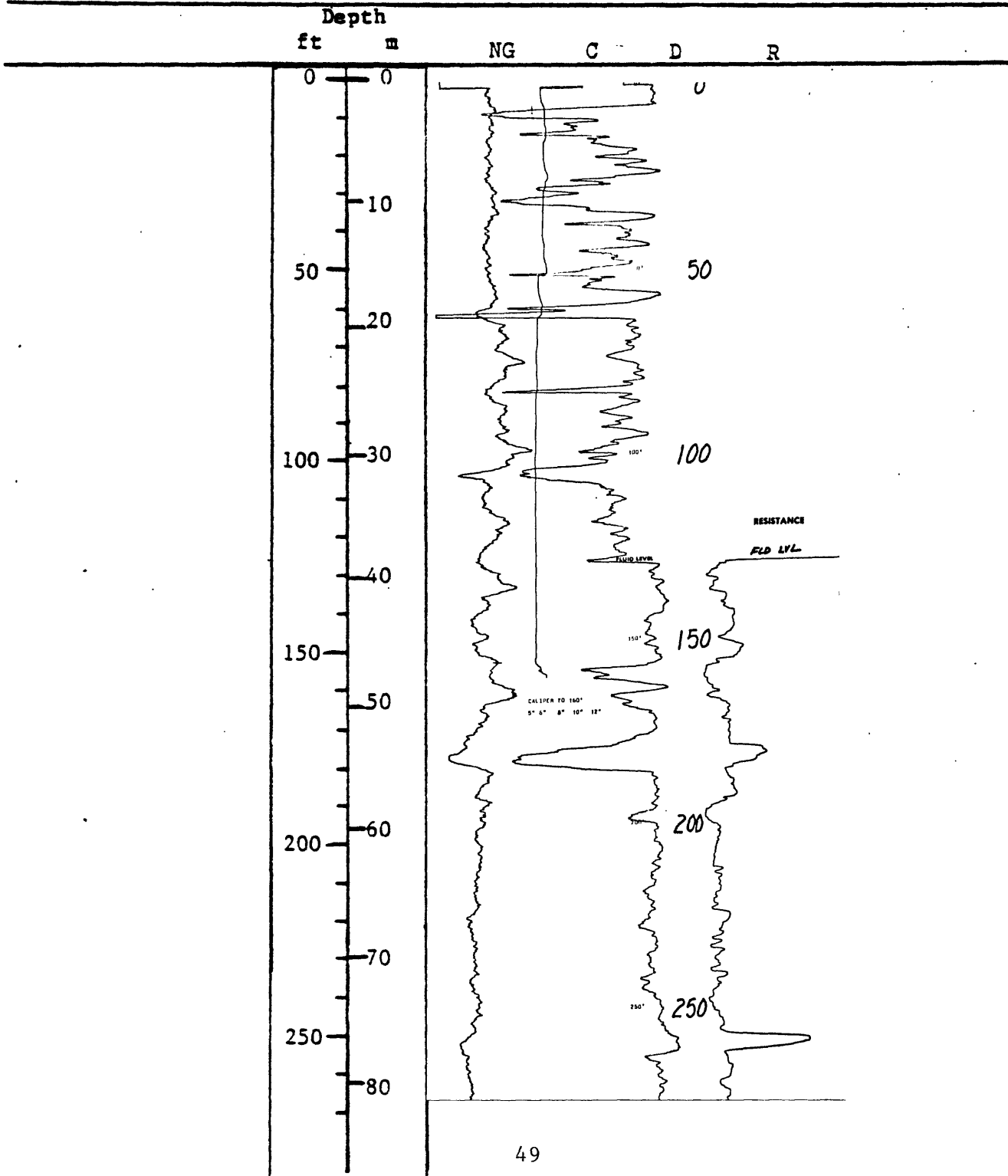
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B5 Date logged 9/16/80 Surface elevation 3620'

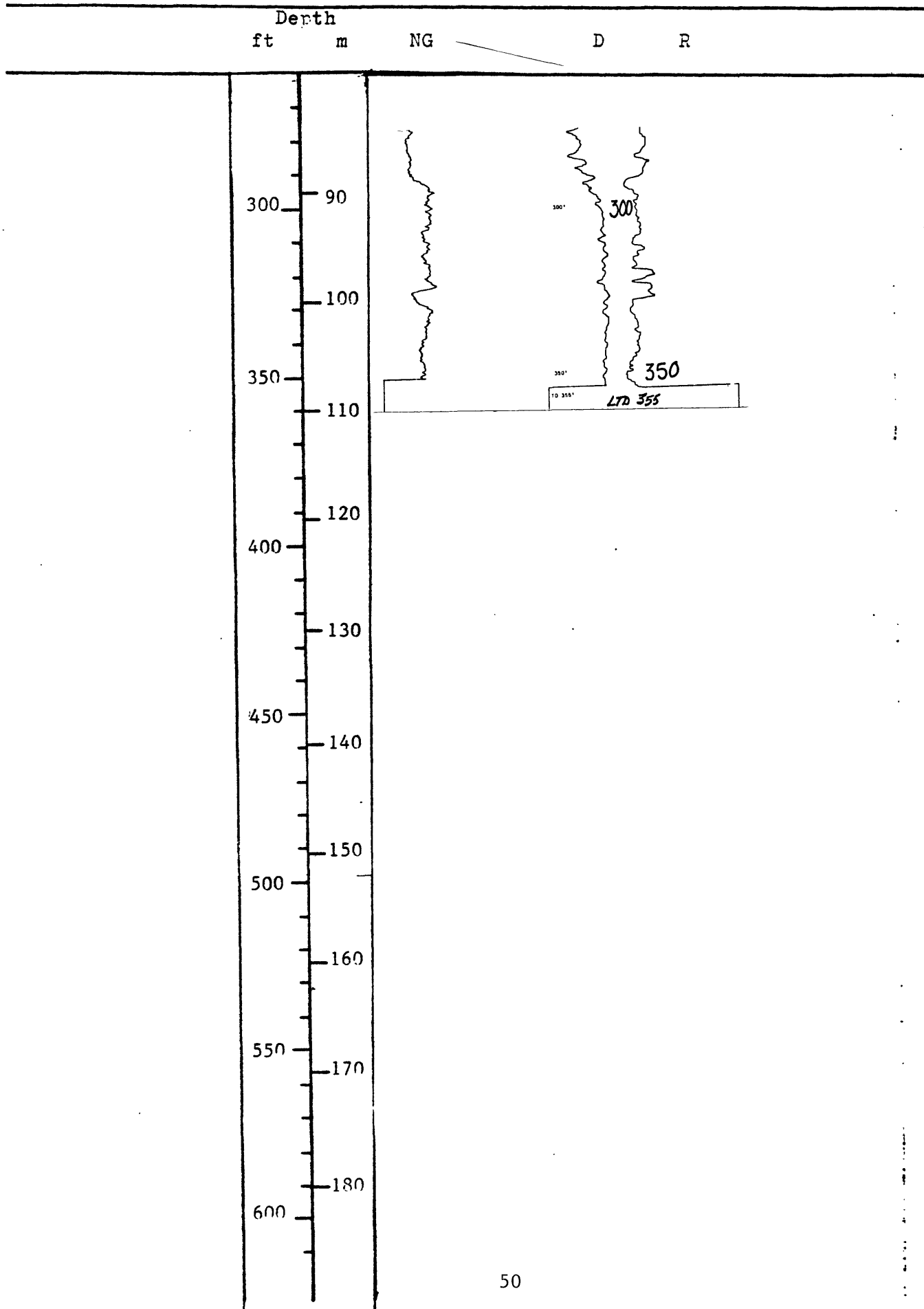
Location NE1/4NW1/4 sec. 12, T. 8 S., R. 50 E. County Powder River

Drilled depth 395' Logged depth 355' Fluid level 129'

Remarks _____



Hole no. B5 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-B6 Geologist Janet Brown
 Type log Lithologic Elev. 3670' Total depth 315'
 Location NW¼NE¼SW¼ Sec. 21 T. 7 S.R. 51 E.
 Nearest town Broadus County Powder River State Mont. Quad. Bear Skull Mt.
 Drilled by: U.S. Geological Survey
 Driller(s): Stephen Grant
 Drill: Portadrill 524 Date start 9/23/80 Complete 9/23/80
 Non-core intervals and size hole: 0-315' 5 1/8"
 Cored intervals and size: Spud to 20' below Cache, burn.
 Remarks _____

LOG

From	To (in feet)	Length	Description
0	10	10	Alluvium, medium brown(5YR-4/6) with clinker(10YR-4/6)
10	101	91	Sandstone, light olive brown(5Y-5/6)31%, yellow gray (5Y-7/2)25%, medium olive brown(5Y-4/4)19%, dusky yellow (5Y-6/4)13%, dark yellow brown(10Y-4/2)6%, grayish orange(10YR-7/4)6%, very fine grained, claystone, gray olive(10YR-4/2) Coal
101	103	2	
103	272	171	Sandstone, pale yellow brown(10YR-6/2), very fine grained, siltstone, olive gray(5Y-4/1)
272	276	4	Coal, olive gray(5Y-4/1)
276	310	34	Siltstone, olive gray(5Y-4/1)
			Total depth geophysical log 310'
			Sample log to total depth
310	315	5	10% 6" coal, friable, dull to silky, medium hardness in siltstone, olive gray (5Y-4/1)
			T.D. 315'

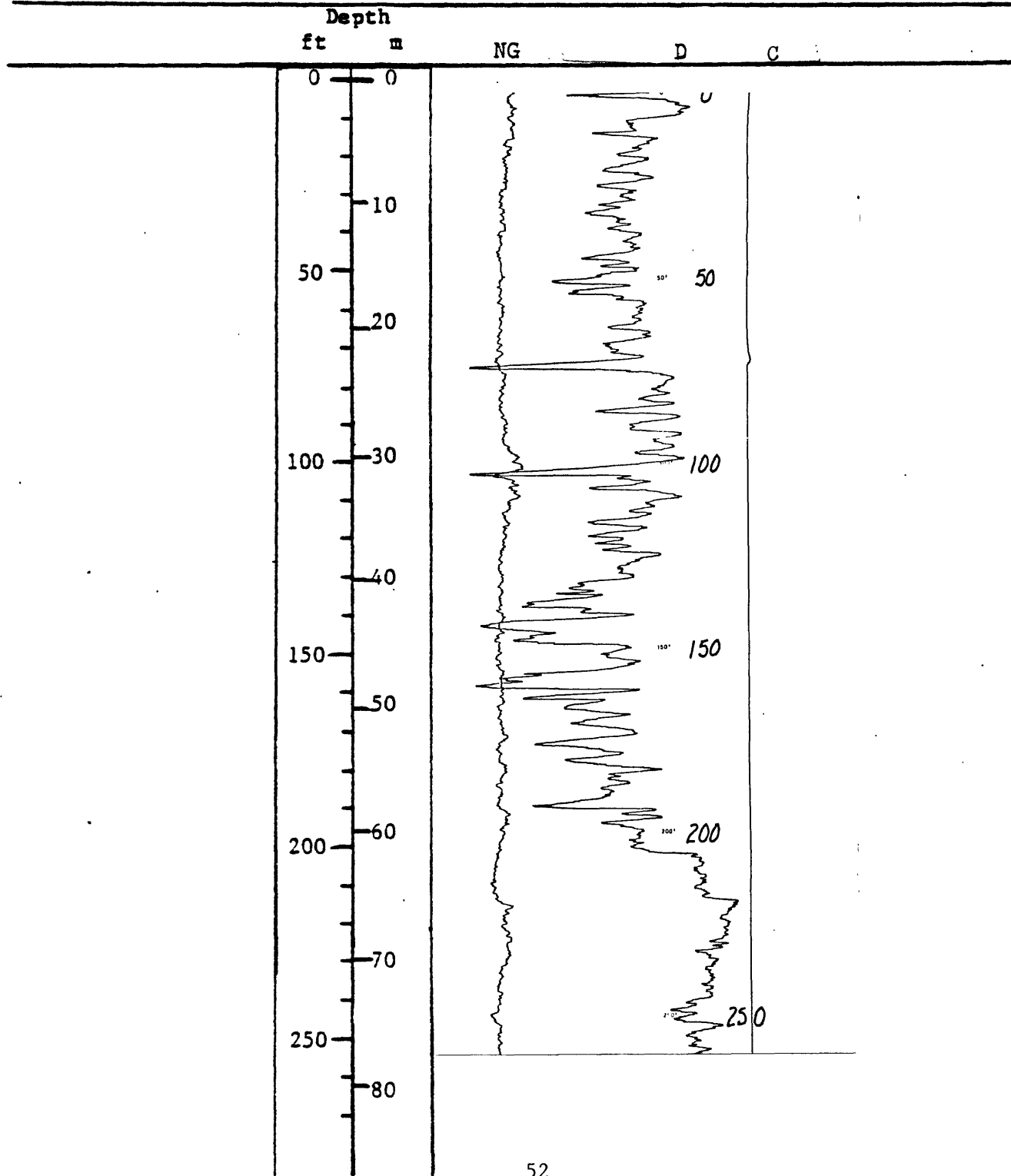
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B6 Date logged 9/23/80 Surface elevation 3670'

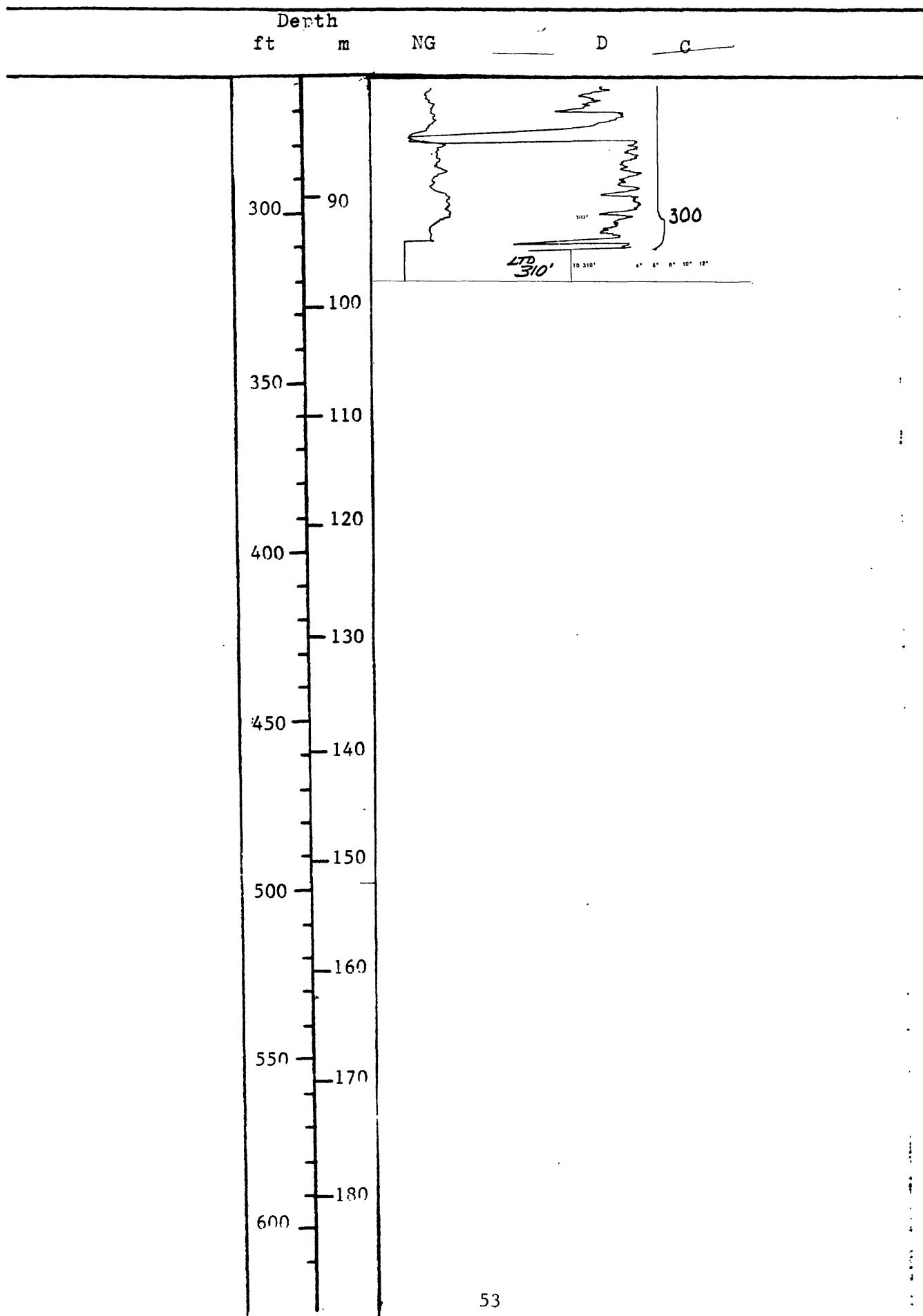
Location NW1/4NE1/4SW1/4 sec. 21, T. 7 S., R. 51 E. County Powder River

Drilled depth 315' Logged depth 310' Fluid level _____

Remarks Dry Hole



Hole no. B6 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B7 **Geologist** Frank S enger
Type log Lithologic **Elev.** 3935' **Total depth** 455'
Location NE¼NW¼ **Sec.** 13 **T.** 7 **S.R.** 51 **E.**
Nearst town Broadus **County** Powder River **State** Mont. **Quad.** Bear Skull Mt.
Drilled by: U.S. Geological Survey
Drillar(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/23/80 **Complete** 9/23/80
Non-core intervals and size hole: 0-105', 140-455', 5 1/8"
Cored intervals and size: 105.0-140.0 (3")
Remarks Begin drilling 0900 hrs. 20' casin set

LOG

From	To	Length	Description
(in feet)			
0	5	5	Alluvium, loose sand, light yellow
5	56	51	Sandstone, light brown, fine grained quartz sub-round to sub-angular with black chert, very soft, some with clay
56	62	6	Sandstone, light blue gray to medium gray to dark gray, fine to very fine grained, quartz sub-angular with black silty or clayey material, black chert
62	105	43	Siltstone, medium gray to medium brown gray with thin coal streaks, sandstone, medium brown gray, very fine grained, silty
105	129	24	Coal with + 2' parting at 107', + 1' parting at 114', + 1.5' parting at 116', + 1' parting at 120', + 1' parting at 124', + 1' parting at 126'
129	166	37	Siltstone, medium gray, sandy
166	170	4	Shale, medium gray, interbedded with shale, carbonaceous, dark brown
170	173	3	Coal with + .5' parting at 172'
173	180	7	Siltstone, dark carbonaceous
180	182	2	Coal
182	204	22	Siltstone, medium gray, shale, medium gray

LOG

From	To (in feet)	Length	Description
204	217	13	Carbonaceous shale, dark brown, sandstone, medium gray, very fine grained
217	233	16	Siltstone, medium gray, sandstone, medium gray, very fine grained
233	238	5	Coal with \pm 1' parting at 236'
238	307	69	Siltstone, medium gray to medium brown gray, sandstone, medium gray, very fine grained, silty
307	313	6	Coal
313	337	24	Siltstone, medium gray, with thin (coal?) \pm 1' streaks at 317 and 320'
337	339	2	Coal
339	356	17	Siltstone, medium gray to dark brown, carbonaceous, sandstone, medium gray
356	436	80	Sandstone, medium gray, very fine grained, siltstone, medium gray, sandy
			Total depth geophysical log 436'
			Sample log to total depth
436	440	4	Shale, medium to dark gray
440	445	5	Sandstone, medium green gray, very fine grained, very calcareous
445	450	5	Sandstone, medium green gray, very fine grained, very calcareous
450	455	5	Sandstone, medium green gray, very fine grained, very calcareous
			T.D. 455' 1245 hrs.
			Circulating until 1300 hrs.
			Steel pulled at 1319 hrs.

**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-B7 **Geologist** Frank S encer
Type log Core descri tion **Elev.** 3935' **Total depth** 455'
Location NE¼NW¼ **Sec.** 13 **T.** 7 **S. R.** 51 **E.**
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Bear Skull Mt.
Drilled by: U.S. Geological Survey
Drillar(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/23/80 **Complete** 9/23/80
Non-core intervals and size hole: 0-105', 140-455' 5 1/8"
Cored intervals and size: 105.0-140.0 (3"0
Remarks _____

LOG

From	To	Length	Description
(in feet)			
Recovered first run 105.7-120.0'			
105.7	107.4	1.7	Siltstone, medium gray
107.4	117.7	12.4	Coal, brown, woody
117.7	117.8	0.1	Carbonaceous shale
117.8	120.0	0.2	Coal, brown
Recovered second run 120.0 to 130.0			
120.0	124.8	4.8	Coal, dirty brown and ground up, core barrel released
124.8	130.0	5.2	Lost
Recovered third run 130.0 to 139.85			
130.0	131.65	1.65	Coal
131.65	139.85	8.2	Siltstone, sandy

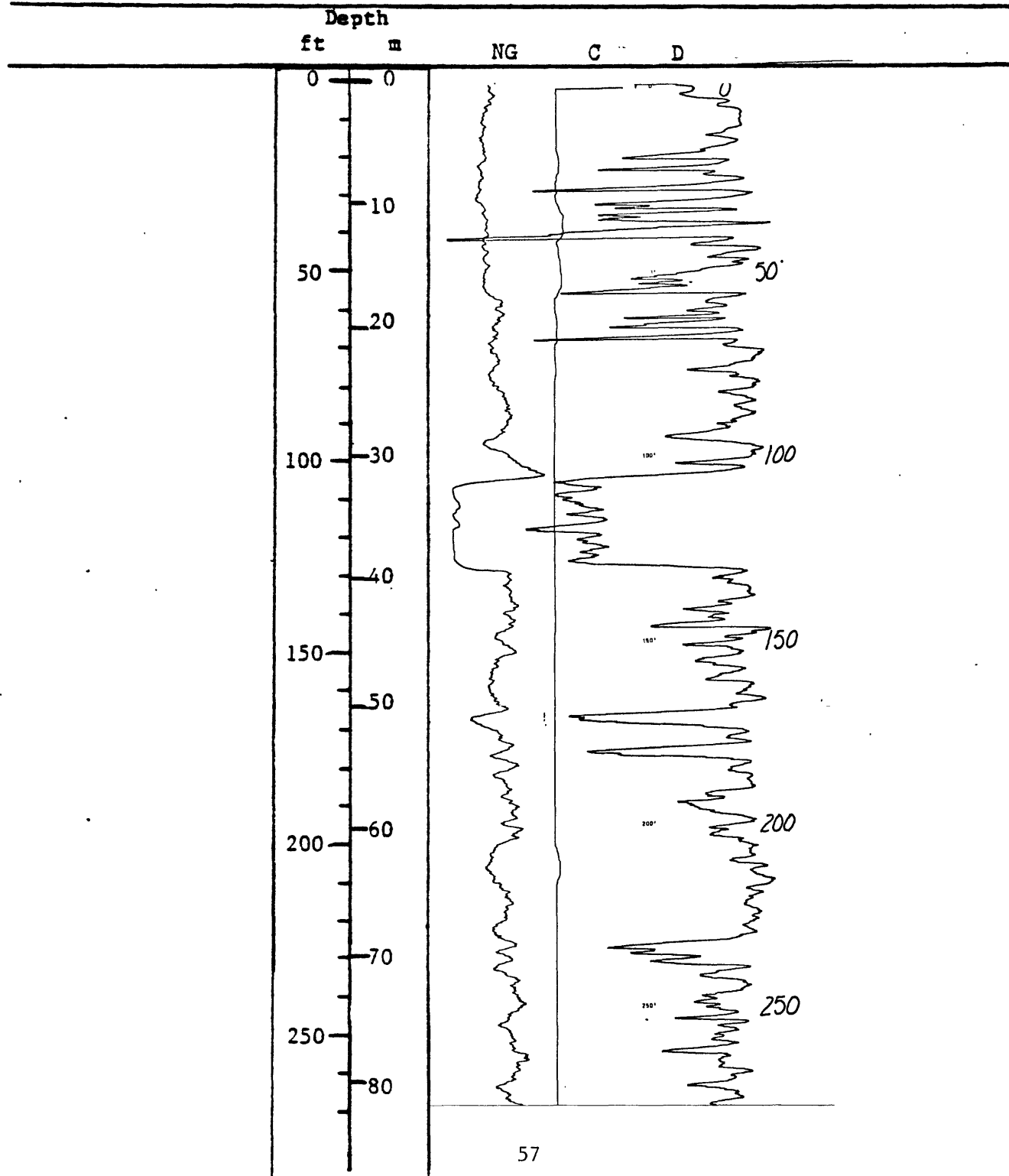
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. B7 Date logged 9/23/80 Surface elevation 3935'

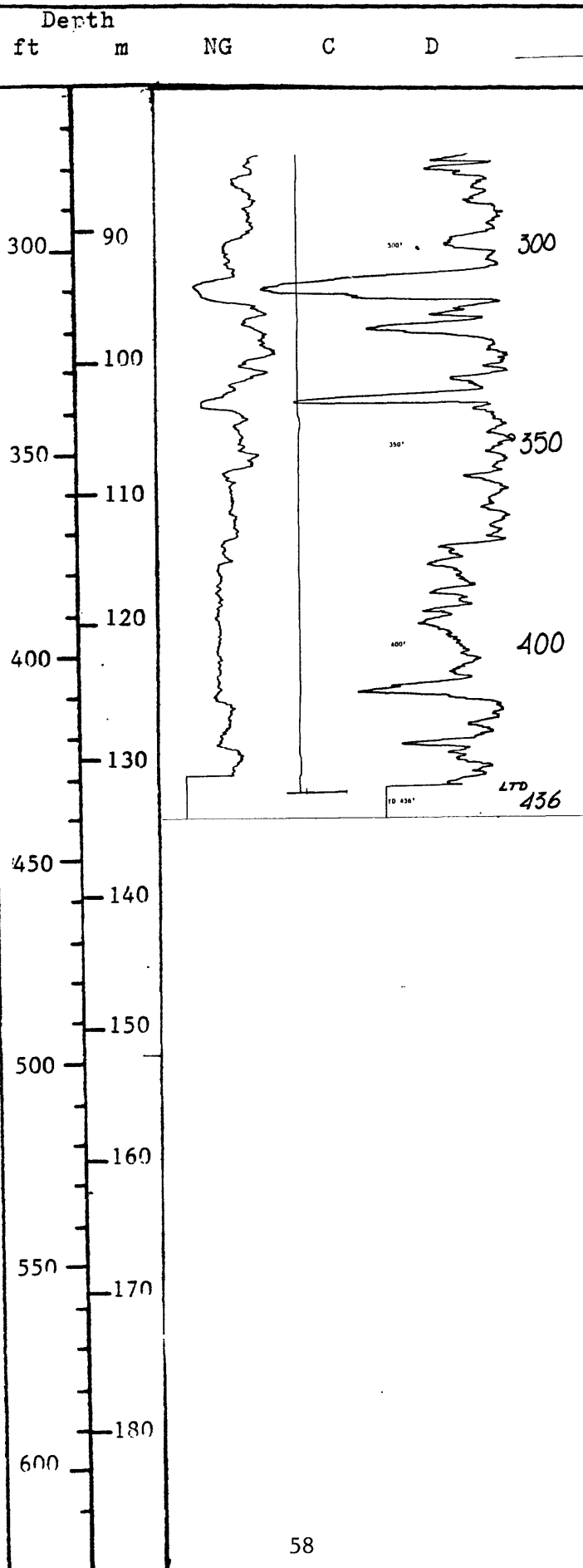
Location NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 7 S., R. 51 E. County Powder River

Drilled depth 455' Logged depth 436' Fluid level _____

Remarks Dry hole



Hole no. B7 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-C1 Geologist Frank Spencer
 Type log Lithologic Elev. 3500' Total depth 275'
 Location SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 34 T. 8 S. R. 49 E.
 Nearest town Broadus County Powder River State Mont. Quad. Three Bar Ranch
 Drilled by: U.S. Geological Survey
 Driller(s): Arthur Clark
 Drill: Gardner-Denver 17W Data start 9/26/80 Complete 9/26/80
 Non-core intervals and size hole: 0-275' 5 1 8" /
 Cored intervals and size: Drilling at 1015 hrs. Casing set at 20'
 Remarks _____

LOG

From	To	Length	Description
(in feet)			
0	38	38	Alluvium, light brown to medium brown, sandy, silty, and clayey zone with clinker
38	43	5	Shale, light brown, gypsiferous, poorly indurated
43	49	6	Sandstone, medium brown, fine to very fine grained, poorly indurated, siltstone, medium brown, sandy
49	89	40	Sandstone, dark gray, very fine grained with thin coal bed (4-6"?) at + 63'
89	96	7	Carbonaceous shale, dark brown
96	98	2	Coal (Driller call)
98	106	8	Shale, medium gray
106	128	22	Siltstone, medium gray
128	132	4	Carbonaceous shale, dark brown
132	133	1	Coal (Driller call)
133	146	13	Siltstone, dark brown to medium gray.
			Total depth geophysical log 146'
			Sample log to total depth
146	155	9	Coal (Driller call); Driller reports 15-20gpm water

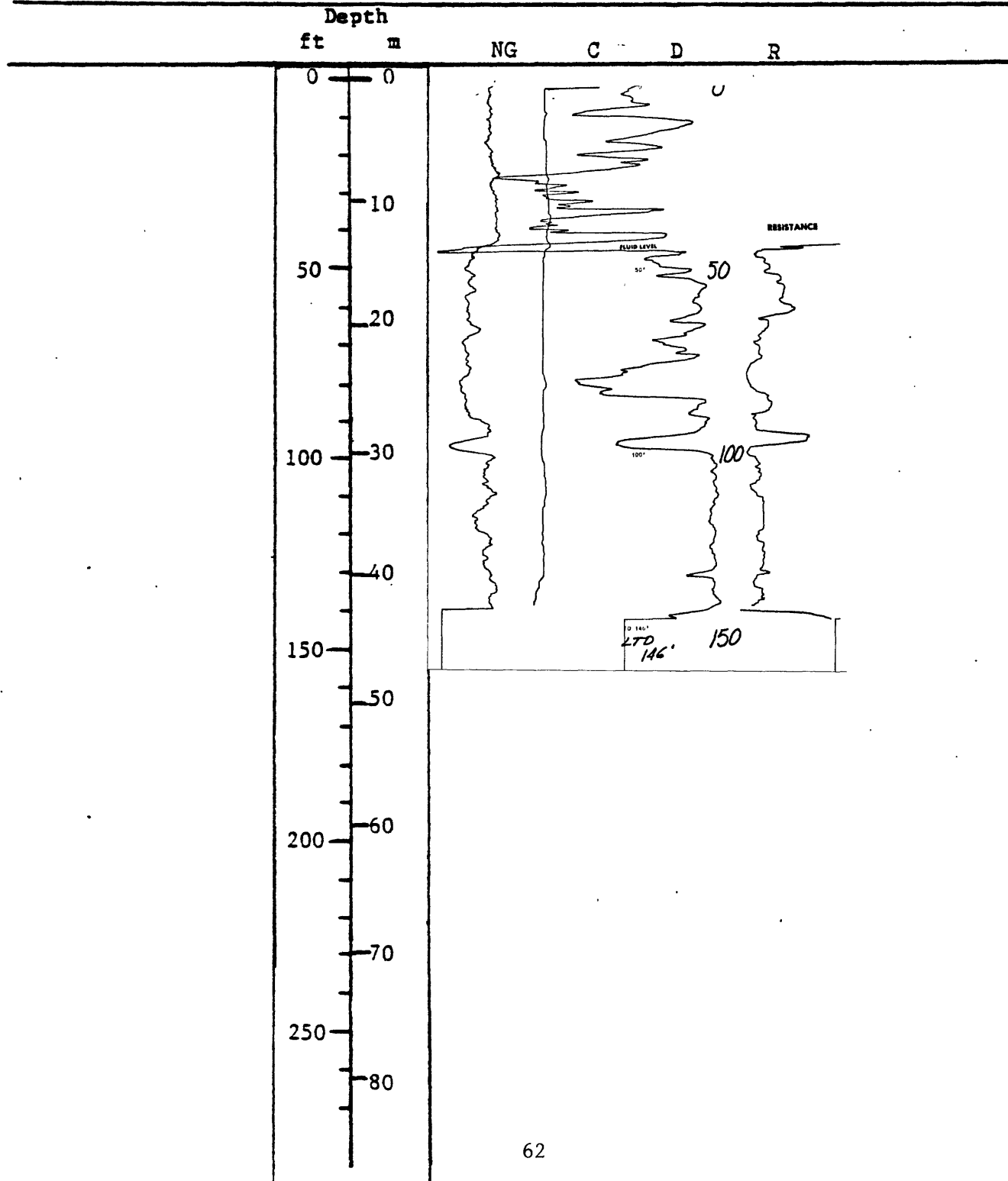
LOG			
From	To (in feet)	Length	Description
155	160	5	Sandstone, medium to dark gray, very fine grained
160	165	5	Sandstone, medium to dark gray, very fine grained
165	170	5	Sandstone, medium to dark gray, very fine grained
170	175	5	Sandstone, medium to dark gray, very fine grained
175	180	5	Sandstone, light to medium gray, very fine grained
180	185	5	Sandstone, light to medium gray, very fine grained
185	190	5	Sandstone, light to medium gray, very fine grained
190	195	5	Sandstone, light to medium gray, very fine grained
195	200	5	Sandstone, dark gray, very fine grained
200	205	5	Siltstone, light gray, calcareous, interbedded with sandstone, dark gray, very fine grained, calcareous in part
205	210	5	Sandstone, medium to dark gray, very fine grained
210	215	5	Sandstone, medium to dark gray, very fine grained
215	220	5	Sandstone, medium to dark gray, very fine grained
220	225	5	Sandstone, medium to dark gray, very fine grained
225	230	5	Sandstone, medium to dark gray, very fine grained
230	235	5	Sandstone, medium to dark gray, very fine grained
235	240	5	Sandstone, medium gray, very fine grained, silty with clinker from up hole
240	245	5	Siltstone, dark brown, sandy
245	250	5	Carbonaceous shale, dark brown, interbedded with siltstone, dark gray
250	255	5	Carbonaceous shale, dark brown, interbedded with siltstone, dark gray
255	260	5	Siltstone, medium gray, interbedded with sandstone, dark gray, very fine grained
260	265	5	Siltstone, medium gray, interbedded with carbonaceous shale, dark brown
265	270	5	Sandstone, light gray, very fine grained, calcareous

LOG

From	To (in feet)	Length	Description
270	275	5	Siltstone, medium gray, interbedded with thin sandstone, dark gray, very fine grained T.D. 275' @ 1200 hrs. Pulled steel, 1227 hrs.

U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. C1 Date logged 9/26/80 Surface elevation 3500'
Location SW1/4SW1/4 sec. 34, T. 8 S., R. 49 E. County Powder River
Drilled depth 275' Logged depth 146' Fluid level 44'
Remarks Casing set at 20'



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-C2 **Geologist** Janet Brown
Type log Lithologic **Elev.** 3674' **Total depth** 480'
Location NE $\frac{1}{4}$ **Sec.** 33 **T.** 7 S. **R.** 50E.
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Baldy Peak
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant
Drill: Portadrill 524 **Date start** 9/24/80 **Complete** 9/24/80
Non-core intervals and size hole: 0-480' 5 1/8"
Cored intervals and size: _____
Remarks _____

LOG

From	To (in feet)	Length	Description
0	21	21	Clay, yellow brown(10YR-5/4)64%, to dark yellow brown (10YR-1/2)20%, with clinker, red orange(10R-6/6)11%, sandstone, yellow brown(10YR-5/4)5%, fine grained
21	96	75	Siltstone, olive gray(5Y-4/1)50%, to light olive gray (5Y-6/1)28%, to olive black(5Y-2/1)14%, sandstone, yellow brown(10YR-5/4)4%, fine grained, carbonaceous shale, dusky brown(5YR-2/2)4% at \pm 22'
96	97	1	Coal(?)
97	103	4	Siltstone, olive gray(5Y-4/1)
103	123	20	Coal, black(N-1), silky, with \pm 3' parting at 111', \pm 1' parting at 115', \pm 3' parting at 120'
123	199	76	Sandstone, very light gray(N-8) to medium gray(N-5), fine grained, siltstone, light gray(N-7)
199	201	2	Limestone, very hard
201	314	113	Claystone, medium gray(N-5) to medium dark gray(N-4), gray black(N-2), olive gray(5YR-4/1), Sandstone, medium dark gray(N-4) to brown gray(5YR-4/1) to olive gray (5Y-4/1), fine grained
314	315	1	Coal, black(N-1)
315	350	35	Claystone, medium gray(N-5) to medium dark gray(N-4) to dark gray(N-3)

LOG			
From	To (in feet)	Length	Description
350	356	6	Coal, black(N-1), silky with $\pm .5'$ parting at 353', $\pm 1'$ parting at 354'
356	402	46	Siltstone, brown gray(5YR-4/1) to medium dark gray(N-4) Total depth geophysical log 402' Sample log to total depth
402	405	3	Siltstone, medium dark gray(N-4)
405	410	5	Siltstone, medium dark gray(N-4)
410	415	5	Siltstone, medium dark gray(N-4)
415	480	65	Poor samples-no log to total depth

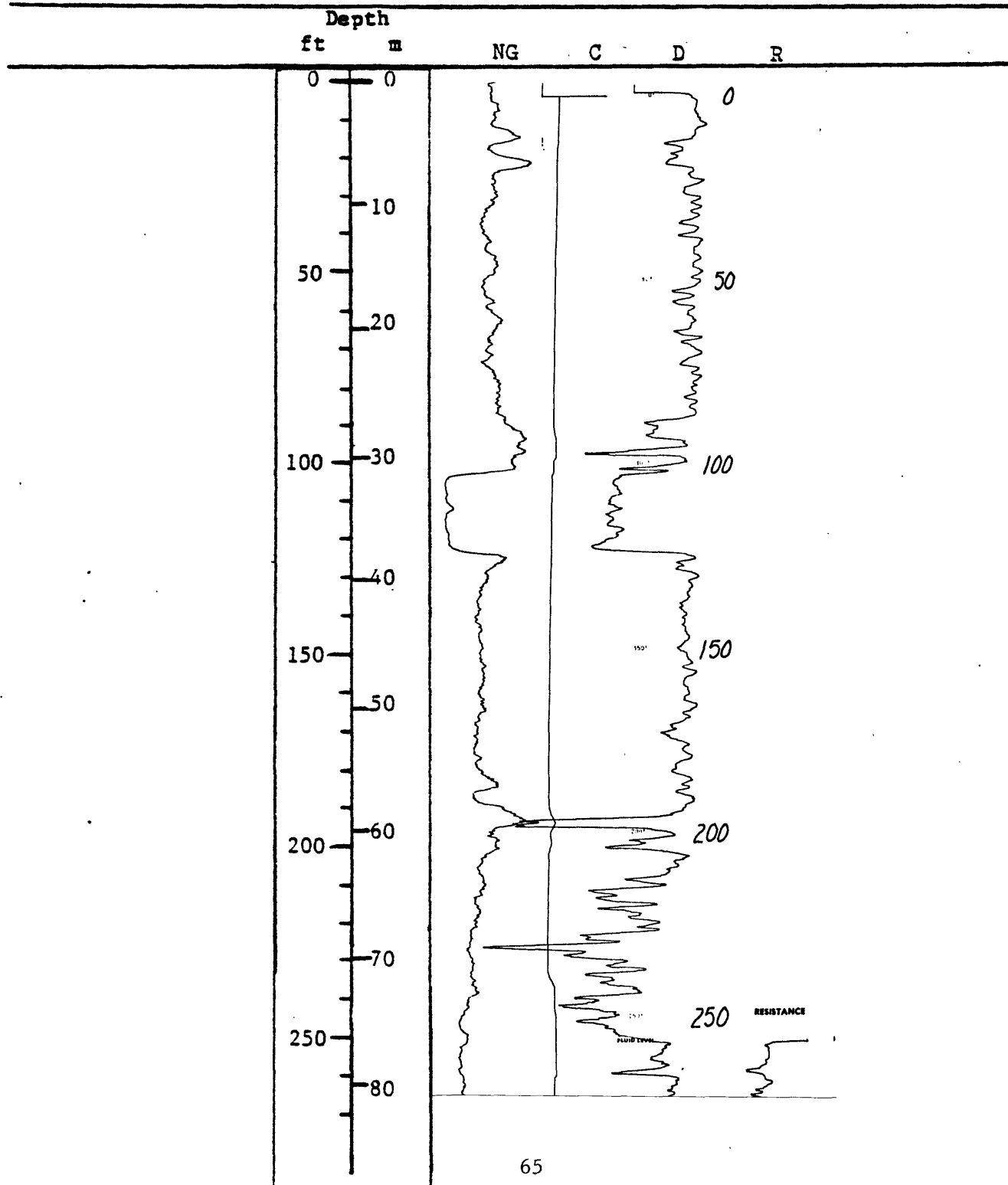
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. C2 Date logged 9/25/80 Surface elevation 3674'

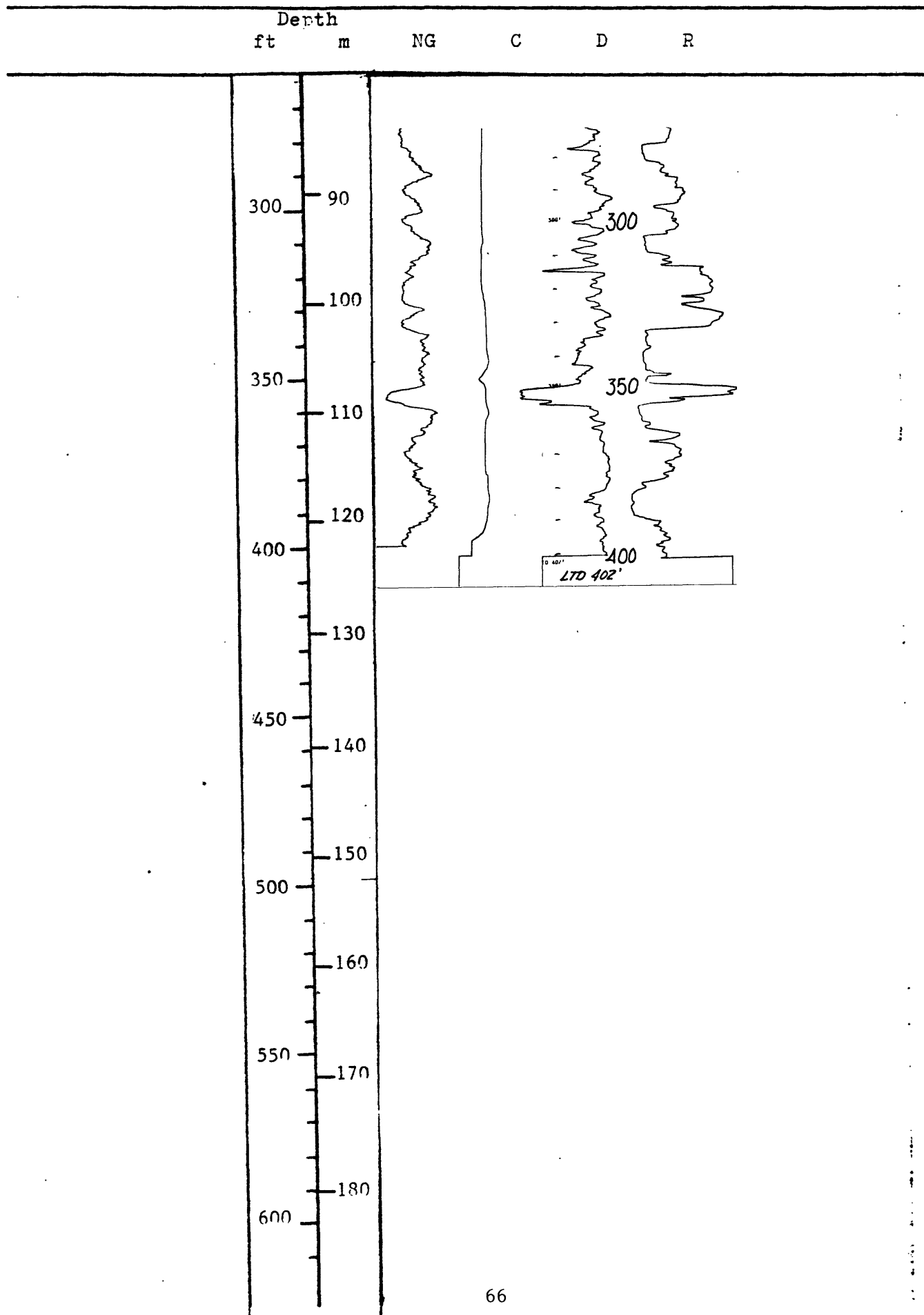
Location NE 1/4 sec. 33, T. 7 S., R. 50 E. County Powder River

Drilled depth 480' Logged depth 402' Fluid level 257'

Remarks _____



Hole no. C2 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-C3 **Geologist** M. McPhillips
Type log Lithologic **Elev.** 3510' **Total depth** 215'
Location Ctr N½S½ **Sec.** 23 **T.** 7S. **R.** 50E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Baldy Peak
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant
Drill: Portad drill 524 **Date start** 9/16/80 **Complete** 9/16/80
Non-core intervals and size hole: 0-215' 5 1/8"
Cored intervals and size: _____
Remarks Casing run; Geophysical research hole for Frank Sentfle. U.S.G.S.
Reston, Va.

LOG

From	To	Length	Description
(in feet)			
0	24	24	Alluvium, moderate yellow brown to pale yellow brown with clinker
24	111	87	Sandstone, dark yellow orange to light olive to light gray, fine to very fine grained, some claystone, medium light gray to medium blue gray, shale, brown gray carbonaceous
111	115	4	Coal, black, dull to silky with <u>±1'</u> parting at 113'
115	165	50	Sandstone, light olive gray to medium gray, fine to very fine grained, siltstone, green gray, claystone, medium blue gray to medium light gray
165	177	12	Coal, shaley zone, brown black
177	210	33	Sandstone, light olive gray to medium gray, fine to very fine grained
			Total depth geophysical log 210'
210	215	5	No sample
			T.D. 215'

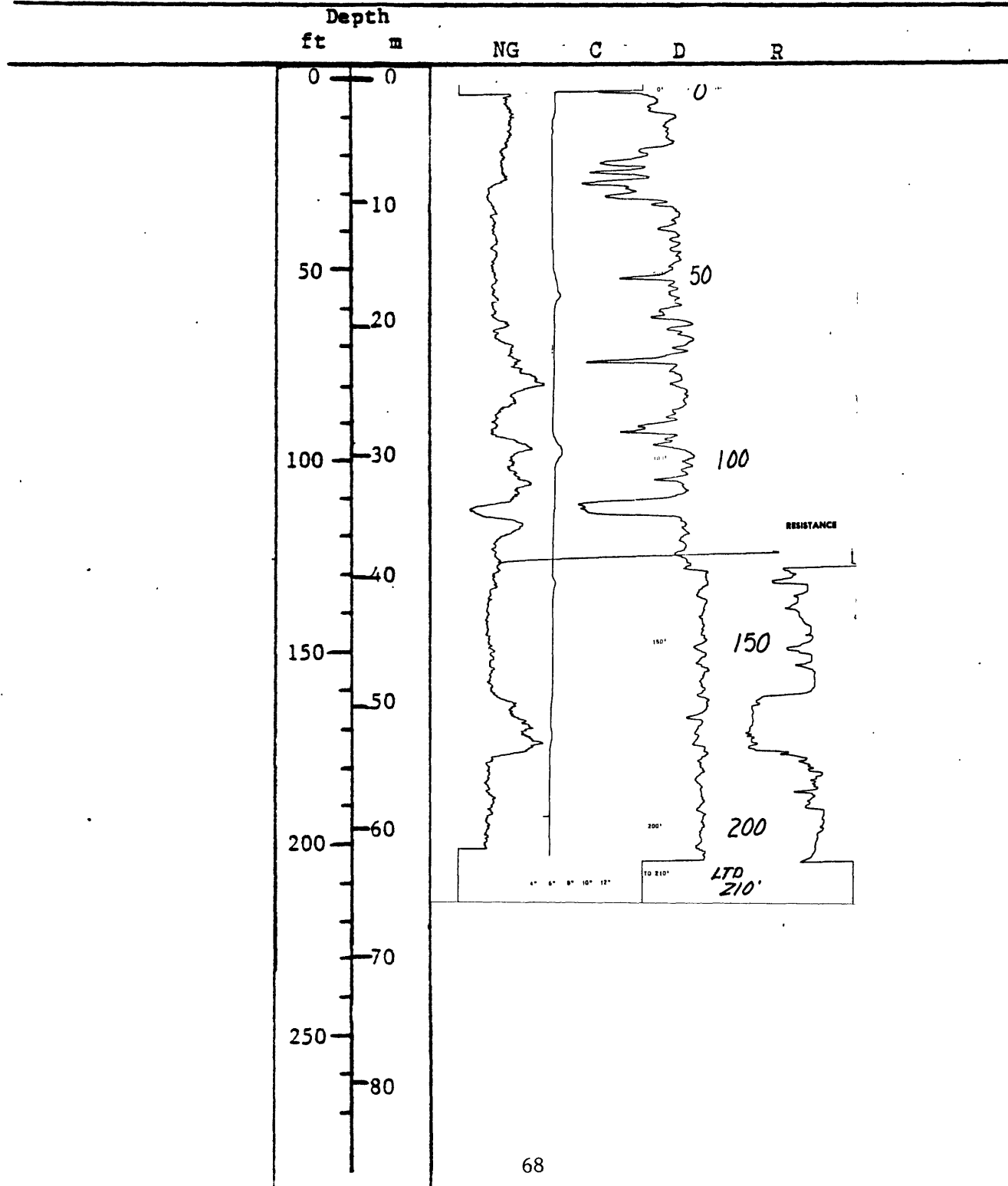
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. C3 Date logged 9/16/80 Surface elevation 3510'

Location CTR. N $\frac{1}{2}$ S $\frac{1}{2}$ sec. 23, T. 7 S., R. 50 E. County Powder River

Drilled depth 215' Logged depth 210' Fluid level 130'

Remarks Hole cased



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-C4 Geologist Janet Brown
 Type log Lithologic Elev. 3520' Total depth 280'
 Location SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 7 T. 7S R. 51E
 Nearest town Broadus County Powder River State Mont. Quad. Baldy Peak
 Drilled by: U.S. Geological Survey
 Driller(s): Stephen Grant
 Drill: Portadrill 524 Date start 9/24/80 Complete 9/25/80
 Non-core intervals and size hole: 0-280' 5 1/8"
 Cored intervals and size: _____
 Remarks About 80' below Cache burn

LOG

From	To	Length	Description
(in feet)			
0	18	18	Alluvium with clay, yellow gray(5Y-7/2) to moderate olive brown(5Y-7/4), sandstone, gray orange(10YR-7/4), fine grained
18	33	15	Sandstone, dark yellow orange(10YR-6/6), fine grained, claystone, moderate yellow brown(10YR-5/4), carbonaceous shale, dusky brown(5YR-2/2), clay chips, dusky yellow brown(10YR-2/2)
33	161	128	Claystone, olive gray(5Y-4/1) to dark green gray(5GY-4/1) to brown black(5YR-2/1), sandstone, dusky yellow(5Y-6/4) to light olive brown(5Y-5/6) to yellow gray(5Y-7/2) to dark yellow orange(10YR-6/6), fine grained to very fine grained, some clay chips, dark gray(5Y-4/1) at \pm 150 to 160'
161	163	2	Coal
163	207	44	Sandstone, olive gray(5Y-4/1) fine grained
207	208	1	Coal(?)
208	220	12	Sandstone, olive gray(5Y-4/1), fine grained
220	222	2	Coal, gray black(N-2)
222	244	22	Sandstone, olive gray(5Y-4/1), fine grained
244	246	2	Coal, gray black(N-2)
246	269	23	Sandstone, olive gray(5Y-4/1), fine grained Total depth geophysical log 269'

LOG

From	To (in feet)	Length	Description
Sample log to total depth			
269	270	1	Sandstone, olive gray(5Y-4/1), fine grained
270	275	5	Sandstone, olive gray(5Y-4/1), fine grained
275	280	5	Sandstone, olive gray(5Y-4/1), fine grained
T.D. 280'			

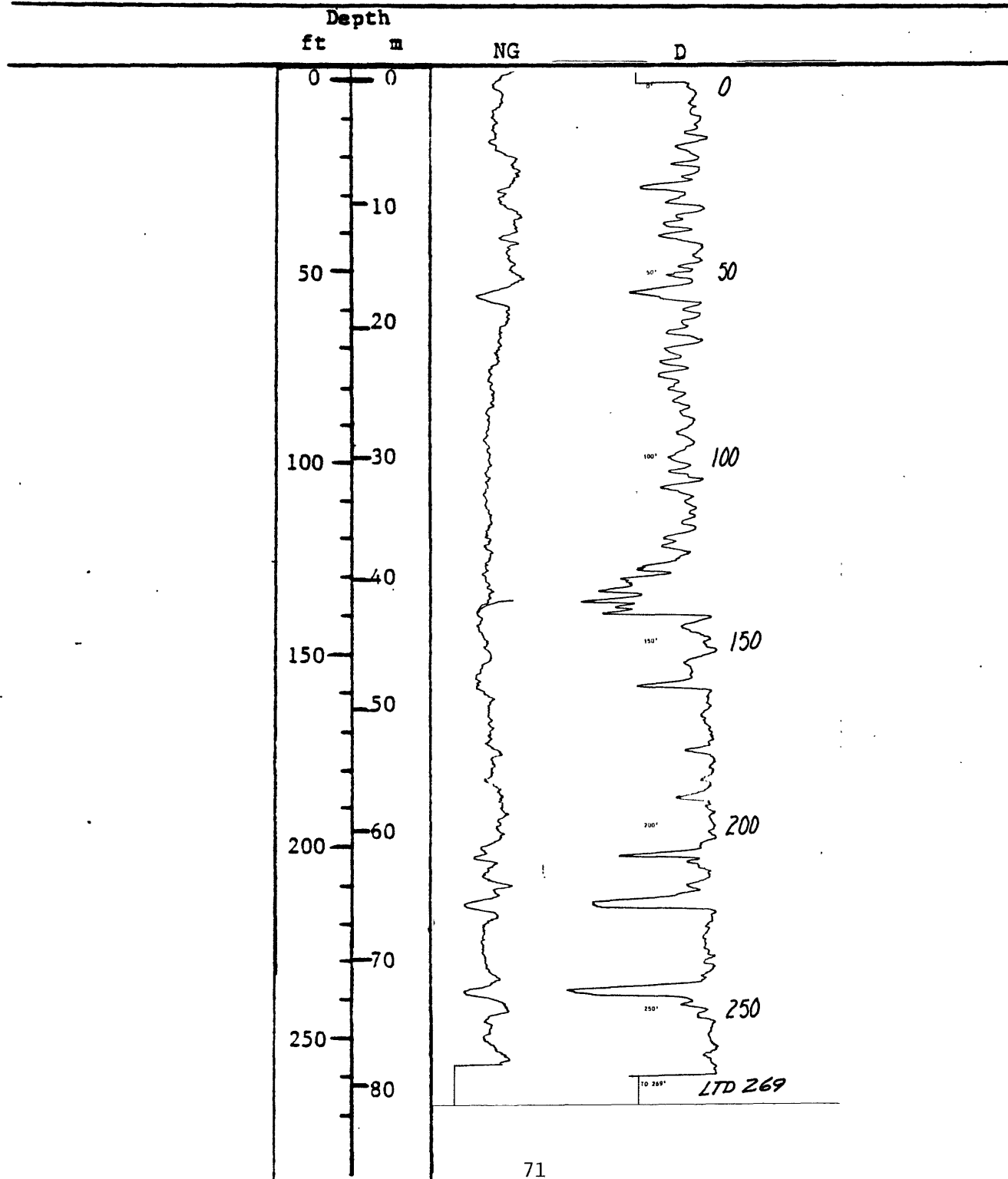
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. C4 Date logged 9/24/80 Surface elevation 3520'

Location SW/NE 1/4 sec. 7, T. 7 S., R. 51 E. County Powder River

Drilled depth 280' Logged depth 269' Fluid level _____

Remarks Dry hole



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-D1 **Geologist** Frank Spencer
Type log Lithologic **Elev.** 3320' **Total depth** 155'
Location NW¼NW¼ **Sec.** 31 **T.** 6S. **R.** 51E.
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Lonesome Peak
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/24/80 **Complete** 9/25/80
Non-core intervals and size hole: 0-155' 5 1/8"
Cored intervals and size: _____
Remarks _____

LOG

From	To (in feet)	Length	Description
0	47	47	Alluvium, sandy, silty, and clayey zone with clinker
47	55	8	Coal, blossom with carbonaceous shale, dark gray to dark brown with $\pm 3'$ parting at 50'
55	73	18	Siltstone, medium orange to medium gray, sandy, sandstone, light gray, very fine grained, silty
73	75	2	Coal (Driller call)
75	134	59	Sandstone, light gray to medium gray, fine to very fine grained, silty with carbonaceous shale interbedded $\pm 3'$ at 75', siltstone, medium gray
134	148	14	Siltstone, medium to light gray, sandy, sandstone, light gray, fine grained with pyrite balls at $\pm 136'$
			Total depth geophysical log 148'
			Sample log to depth
148	155	7	Siltstone, medium gray

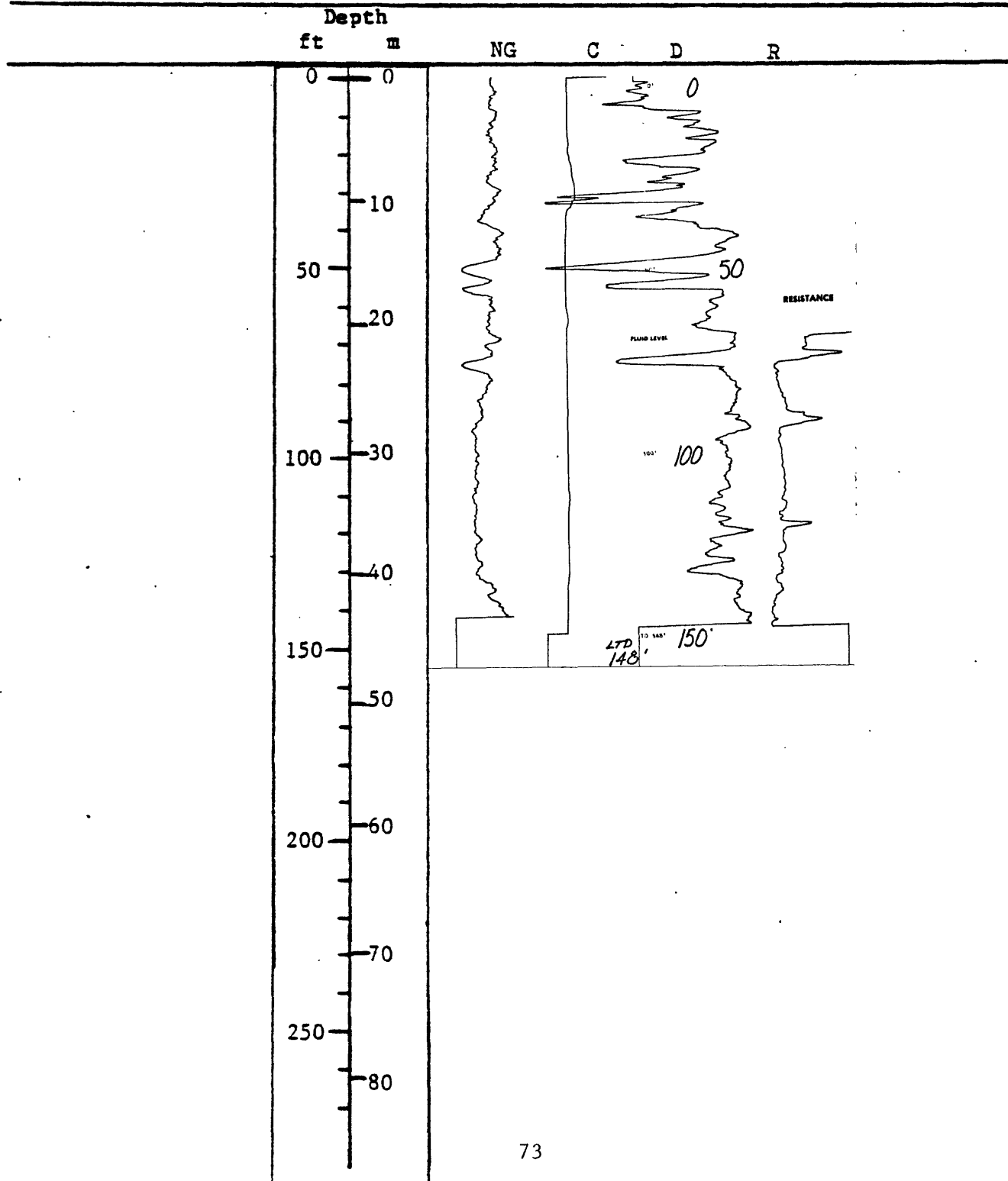
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. D1 Date logged 9/24/80 Surface elevation 3320'

Location NW4NW4 sec. 31, T. 6 S., R. 51 E. County Powder River

Drilled depth 155' Logged depth 148' Fluid level 69'

Remarks _____



**U.S. Geological Survey
Branch of Coal Resources**

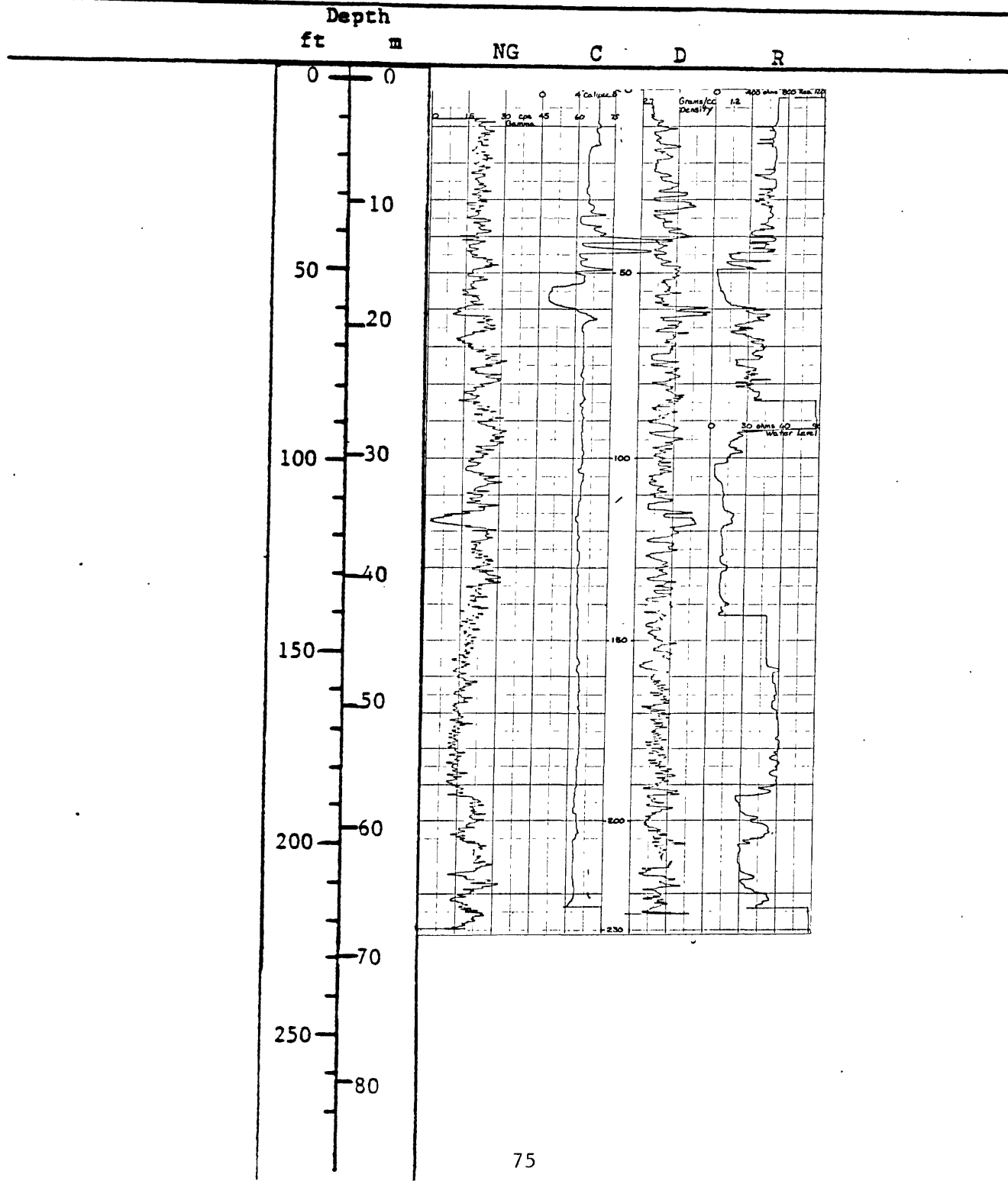
Project Moorhead-Broadus
Hole No. 80 MB-E2 **Geologist** M. McPhillips
Type log Lithologic **Elev.** 3250' **Total depth** 235'
Location SW¼NE¼ **Sec.** 3 **T.** 6S **R.** 50E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Lonesome Peak
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant
Drill: Portadrill 524 **Date start** 9/9/80 **Complete** 9/10/80
Non-core intervals and size hole: 0-235' 5 1/8"
Cored intervals and size:
Remarks Spud below Broadus coal bed +50'.

LOG

From	To	Length	Description
(in feet)			
0	59	59	Soil, light yellow brown to light brown to medium brown, sandy, very fine to fine grained, sub-round, calcareous, Iron Oxide stained at +35', clayey zones, some clinker
59	62	3	Coal, black, silky, hard with +1' parting at 60', trace shell fragments, some siltstone, light olive gray, some claystone, medium gray
62	114	52	Claystone, medium light gray to medium blue gray to medium gray, coal, brown black, shaley, some clinker, shale, carbonaceous, brownish black to black
114	119	5	Coal, black, silky, with +1' parting at 115'
119	230	111	Claystone, medium gray, sandy, silty zone with coal(?) stringers
			Total depth geophysical log 230'
			Sample log to total depth
230	235	5	Very poor sample
			T.D. 235'

U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E2 Date logged 9/10/80 Surface elevation 3250'
Location SW1/4NE1/4 sec. 3, T. 6 S., R. 50 E. County Powder River
Drilled depth 235' Logged depth 230' Fluid level 92'
Remarks Spud below Broadus coal bed + 50'



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-E3 Geologist M. McPhillips
 Type log Lithologic Elev. 3720' Total depth 690'
 Location NW¼NE¼ Sec. 15 T. 6S R. 49E
 Nearest town Broadus County Powder River State Mont. Quad. Yarger Butte
 Drilled by: U.S. Geological Survey
 Driller(s): Stephen Grant
 Drill: Portadrill 524 Date start 9/11/80 Complete 9/11/80
 Non-core intervals and size hole: 0-690' 5 1/8"
 Corred intervals and size:
 Remarks Above abandoned mine (surface) in Pawnee Coal

LOG

From	To	Length	Description
(in feet)			
0	5	5	Alluvium, yellow gray
5	42	37	Sand, white to very light gray to yellow gray to very light olive gray to light gray to medium light gray, very fine to fine grained, sub-round, abdt quartz, some Iron Oxide stained, shale, gray
42	61	19	Coal, brown black, flaky, weathered, with $\pm 5'$ parting at 45', $\pm 4'$ parting at 53'
61	126	65	Sandstone, light gray, very fine grained with shaley, sandy, and silty zone, some carbonaceous material
126	133	7	Coal, black with resin with $\pm 1'$ parting at 127', $\pm 2'$ parting at 129'
133	203	70	Shale, light to medium light gray to yellow gray to brown gray to olive black with shell fragments, sandstone, light to medium light gray, very fine grained, silty, with some carbonaceous material
203	238	35	Shale, light gray to medium dark gray, some carbonaceous material, sandstone, pale yellow brown to brown gray, very fine grained, siltstone, light gray with coaly material
238	239	1	Coal, thin bed $\pm 1'$
239	263	24	Sandstone, medium light gray to medium gray, fine to very fine grained, clayey, shale, medium light to medium dark gray with carbonaceous material at $\pm 257'$

LOG

From	To (in feet)	Length	Description
263	273	10	Coal, black, very dry (powdery) with $\pm 2'$ parting at 264'
273	297	24	Coaly, shaley, sandy zone, carbonaceous material, thin coal at $\pm 2'$ at 283', thin coal $\pm 1'$ at 296'
297	382	85	Poor samples, sandy (fine to very fine grained), with claystone, medium light gray to medium olive gray, siltstone, medium light gray to medium gray
382	392	10	Coal, black, dull, some gypsum with $\pm 2'$ parting at 385'
392	449	57	Claystone, medium to medium light gray, siltstone, light olive gray to medium gray, very hard
449	452	3	Coal, black, silky, hard with $\pm .5'$ parting at 451'
452	553	101	Claystone, medium light to medium gray to light olive gray, silty, with some carbonaceous material, shale, medium light to medium gray, siltstone, light olive to olive gray, thin coal at $\pm 500'$
553	612	59	No samples, driller reports sand
612	618	6	Coal, black, dull, hard with $\pm 3'$ parting at 614'
618	634	16	Small and poor sample, claystone, medium light gray, coal, black, dull, hard, and shale, brown black, carbonaceous, siltstone, light olive gray
634	642	8	Coal, black, silky, hard with $\pm 2'$ parting at 638'
642	663	21	Claystone, medium light gray to medium gray
663	673	10	Coal, thin bed $\pm 1'$ at 663' and claystone, medium light to medium gray, trace siltstone, light olive gray to medium gray
			Total depth geophysical log 673'
			Sample log to total depth
673	690	17	Poor samples, much coal from caving and washing out

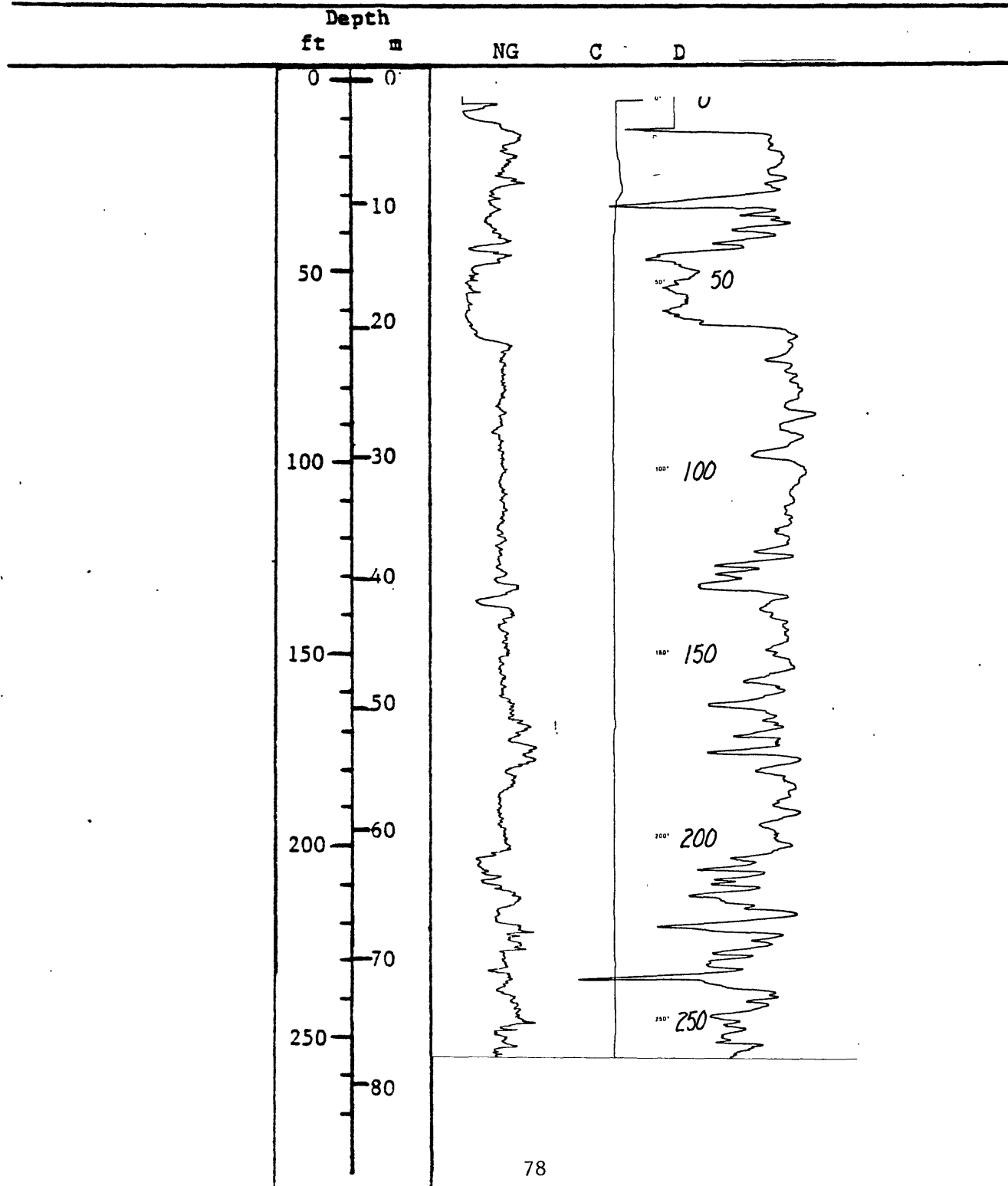
U.S. Geological Survey
Geophysical log. 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E3 Date logged 9/11/80 Surface elevation 3720'

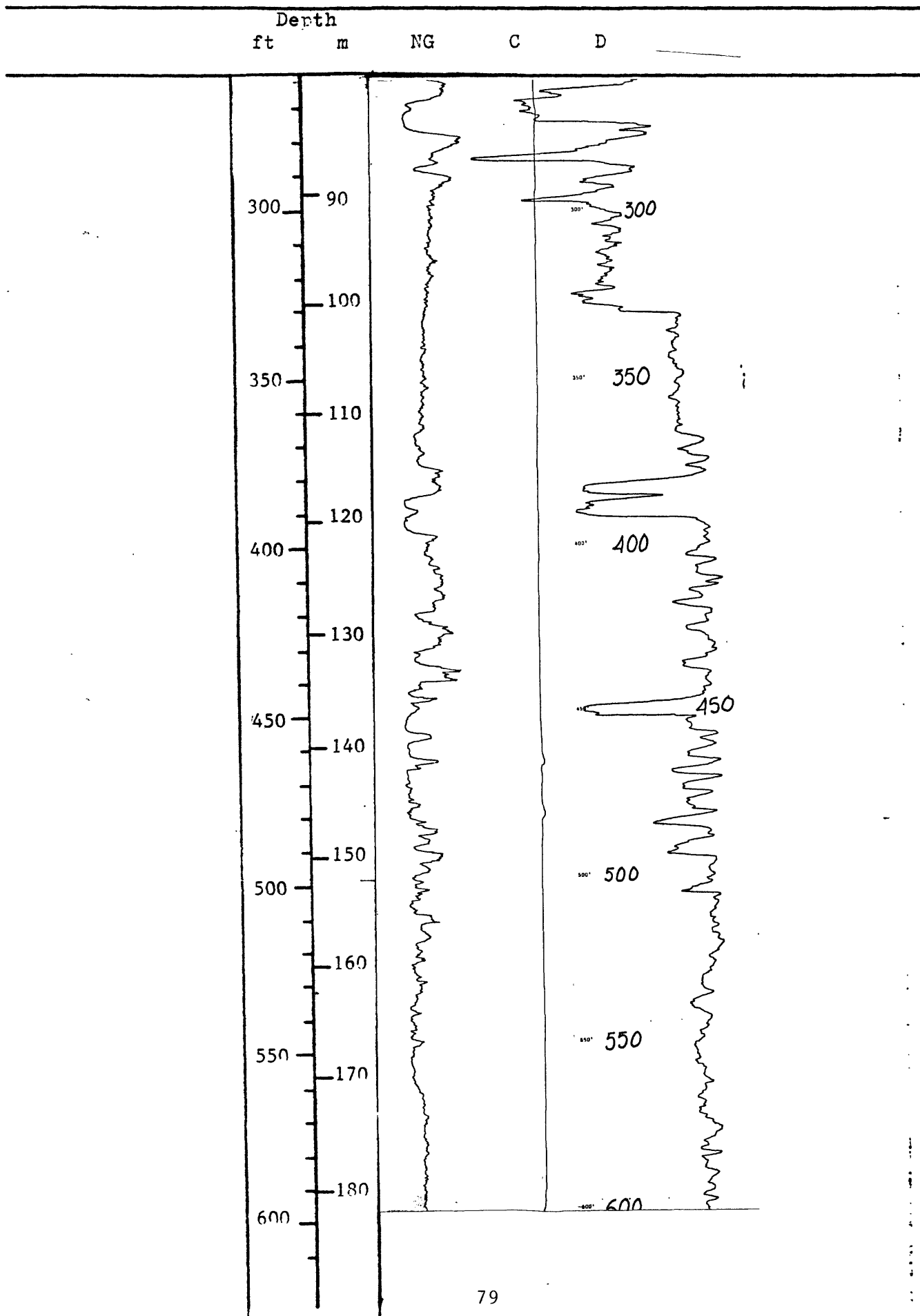
Location NW1/4NE1/4 sec. 15, T. 6 S., R. 49 E. County Powder River

Drilled depth 690' Logged depth 673' Fluid level _____

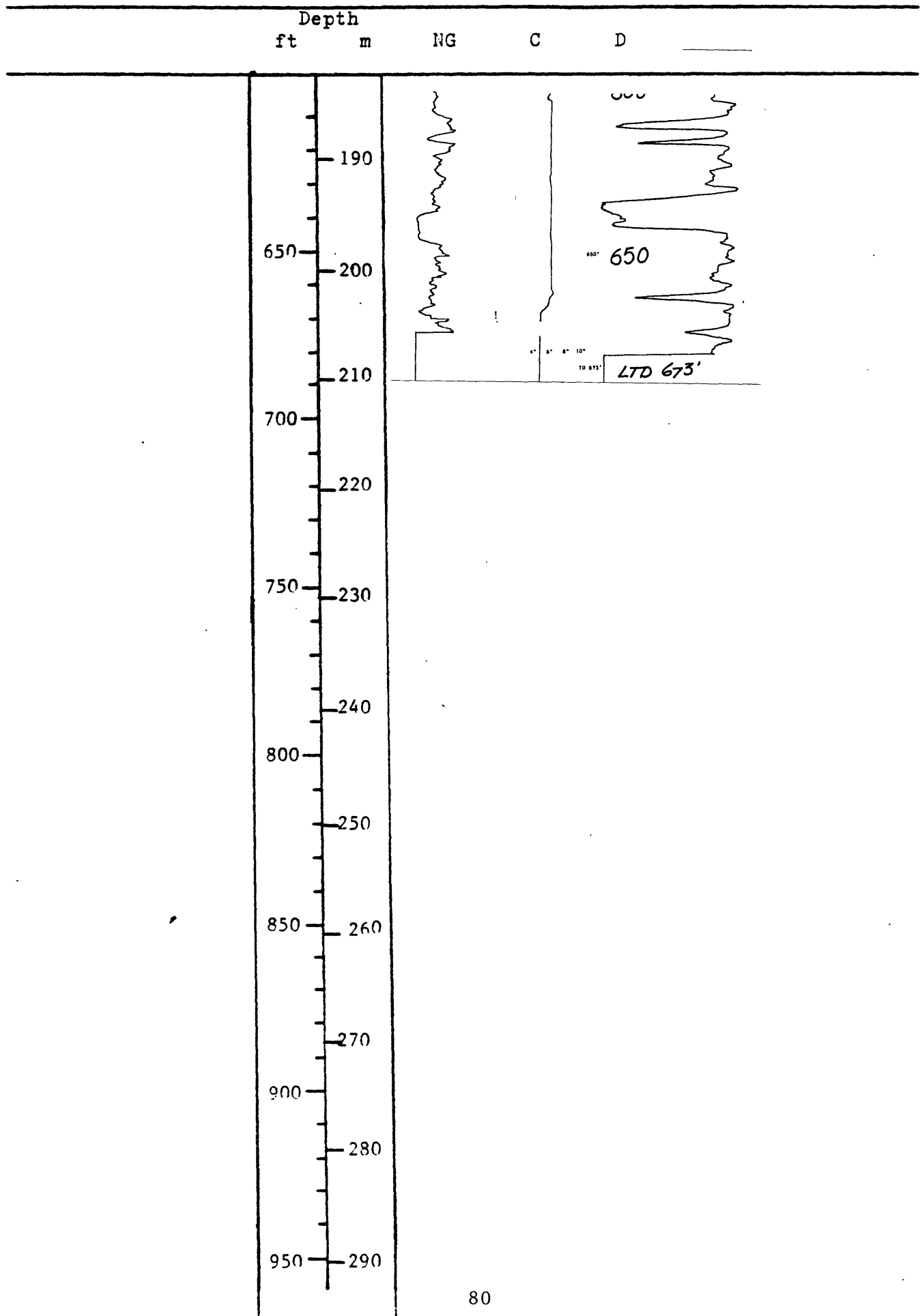
Remarks Above abandoned mine (surface) in Pawnee coal



Hole no. E3 (continued)



Hole no. E3 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E4 **Geologist** Frank S. Sencer
Type log Lithologic **Elev.** 3380' **Total depth** 575'
Location NE $\frac{1}{4}$ SW $\frac{1}{4}$ **Sec.** 24 **T.** 6S **R.** 49E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Yarger Butte
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Data start** 9/11/80 **Complete** 9/12/80
Non-core intervals and size hole: 0-575' 5 1/8"
Cored intervals and size: _____
Remarks _____

LOG

From	To	Length	Description
(in feet)			
0	11	11	Alluvium, light yellow, sandy clay
11	47	36	Shale, red to red brown, clinkered, siltstone, red brown to salmon pink, sandstone, salmon red to red orange, very fine grained, clinkered
47	80	33	Sandstone, light yellow brown, very fine to fine grained, siltstone, medium gray, shale, red brown, clinkered
80	87	7	Carbonaceous shale zone with coal spars
87	148	61	Siltstone, medium gray, sandstone, light gray to medium gray, very fine grained with carbonaceous shale, dark brown
148	153	5	Coal, with $\pm 1'$ parting at 151'
153	196	43	Sandstone, medium gray, very fine grained, siltstone, light to medium gray, some carbonaceous shale, dark brown
196	200	4	Coal, very weathered like coal bloom or flower with $\pm .5'$ parting at 197'
200	221	21	Carbonaceous shale, dark brown, siltstone, medium gray
221	226	5	Coaly zone
226	307	81	Sandstone, medium gray, very fine grained, siltstone, light gray to medium to dark gray, sandy, shale, carbonaceous, dark brown

LOG

From	To (in feet)	Length	Description
307	308	1	Coal(?)
308	327	19	Siltstone, medium gray
327	332	5	Coal with $\pm .5'$ parting at 330'
332	393	61	Siltstone, medium gray, sandstone, light gray to medium gray, very fine grained, shale, carbonaceous, dark brown
393	395	2	Coal(?)
395	457	62	Siltstone, medium gray, sandy, silty, shaley, sandstone, medium gray, very fine grained, shale, carbonaceous, dark brown
457	467	10	Coal(?), brown, interbedded with carbonaceous shale, dark brown
467	562	95	Siltstone, medium to dark brown to medium gray, carbonaceous, sandstone, medium to light gray, very fine grained, silty, carbonaceous shale, dark brown
			Total depth geophysical log 562'
			Sample log to total depth
562	570	8	Sandstone, medium to dark brown gray
570	575	5	Siltstone, dark brown gray
			T.D. 575'

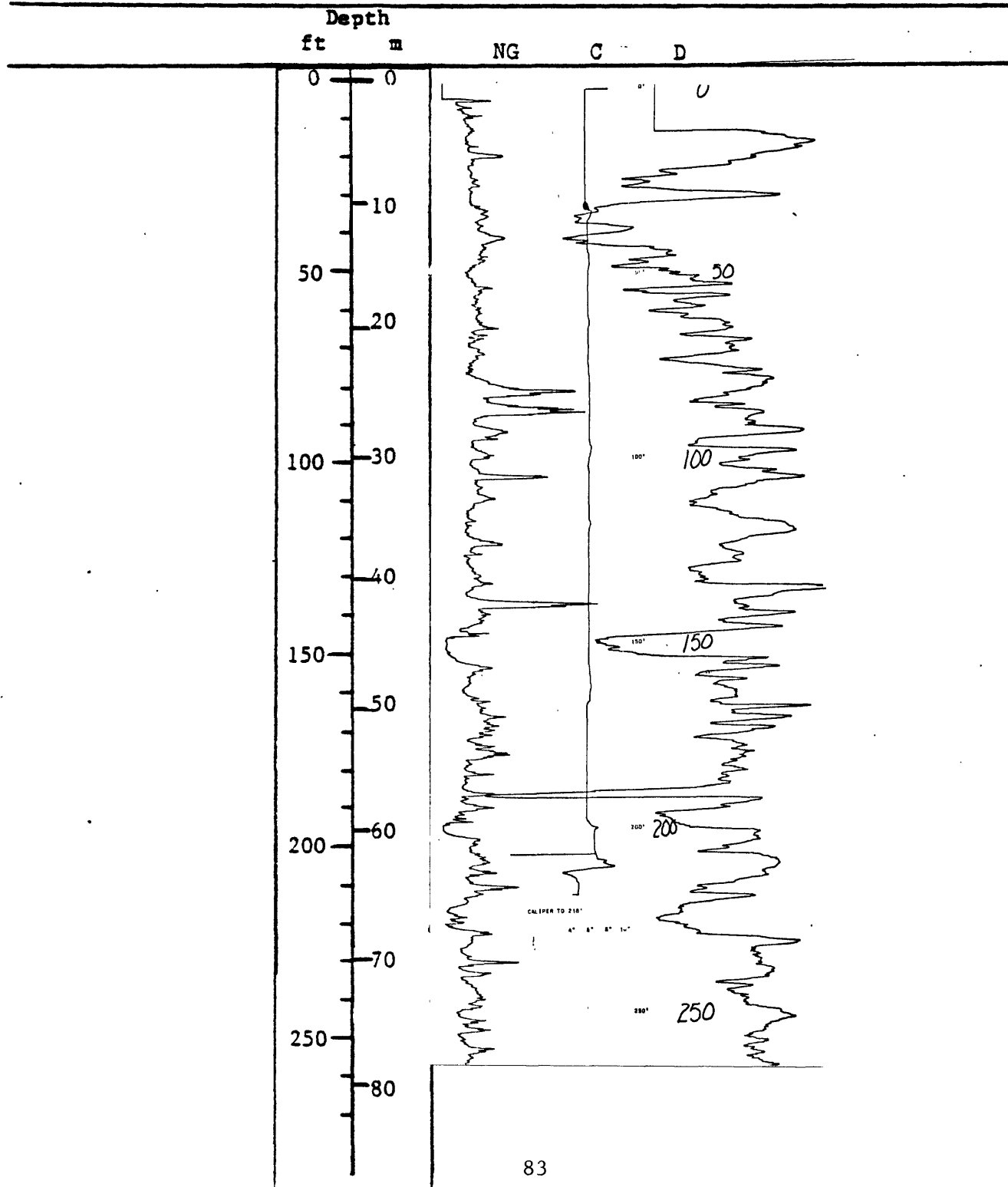
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E4 Date logged 9/12/80 Surface elevation 3380'

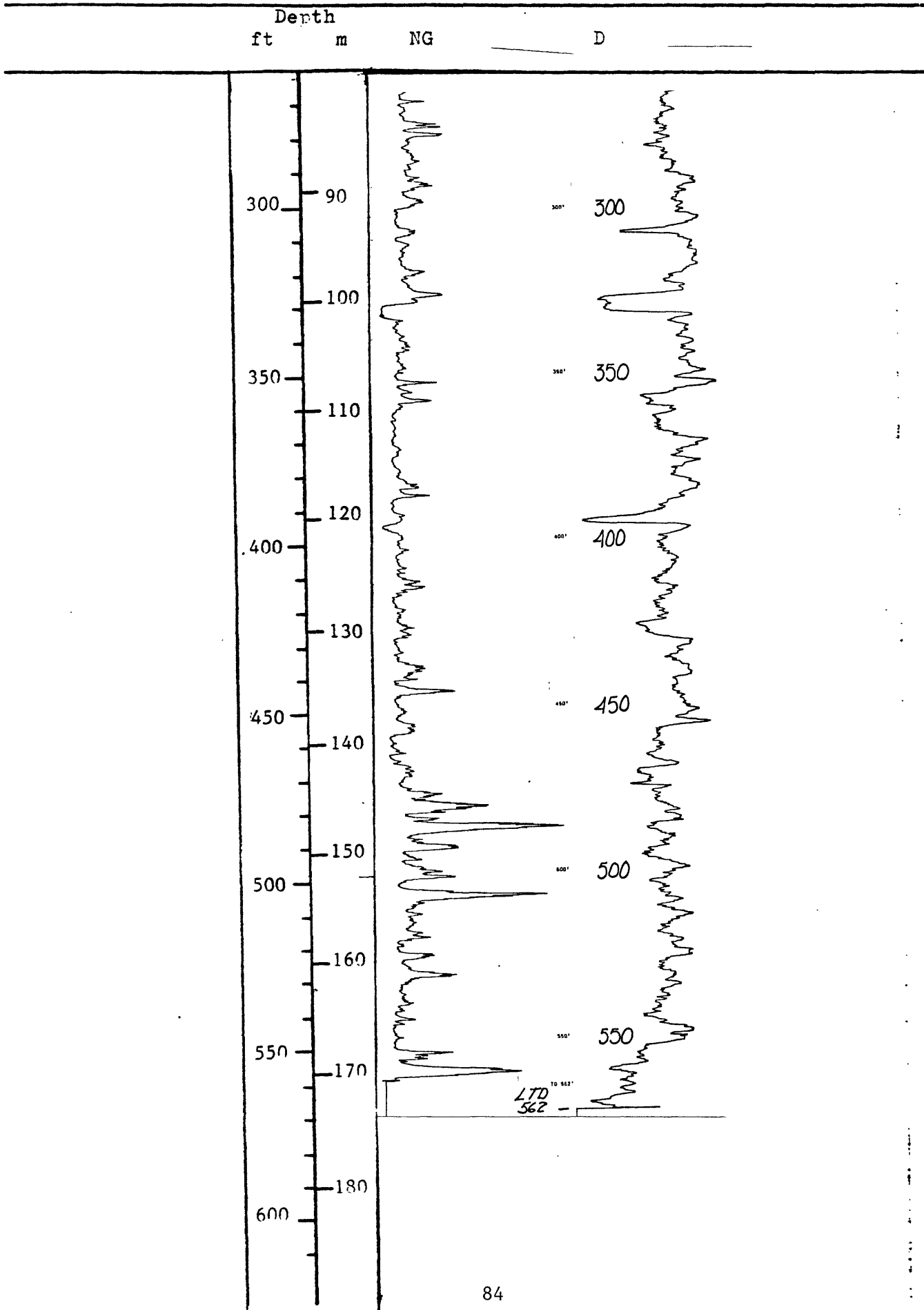
Location NE1/4SW1/4 sec. 24, T. 6 S., R. 49 E. County Powder River

Drilled depth 575' Logged depth 562' Fluid level _____

Remarks _____



Hole no. E4 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E5 **Geologist** Frank Spencer
Type log Lithologic **Elev.** 3615' **Total depth** 575'
Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ **Sec.** 25 **T.** 6S **R.** 48E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Hodson Flats
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/12/80 **Complete** 9/12/80
Non-core intervals and size hole: 0-575' 5 1/8"
Cored intervals and size: None
Remarks Casin set, 20' at 1340 hrs.

LOG

From	To	Length	Description
(in feet)			
0	10	10	Alluvium, sandy, silty with clay, light yellow brown to medium brown
10	19	9	Siltstone, medium brown, weathered
19	35	16	Sandstone, light to medium gray, very fine grained to fine grained, soft and loose
35	53	18	Coal
53	105	52	Sandstone, light to medium gray, very fine grained, siltstone, light to medium gray, sandy
105	109	4	Carbonaceous shale and siltstone, dark brown
109	117	8	Coal with <u>+3'</u> parting at 110'
117	119	2	Carbonaceous shale and siltstone, dark brown
119	157	38	Siltstone, medium to dark gray, sandstone, light to medium gray, fine to very fine grained, some carbonaceous shale at <u>+ 155'</u>
157	161	4	Shale, carbonaceous, dark brown
161	182	21	Sandstone, medium gray, very fine grained, silty, carbonaceous shale, dark brown at <u>+ 178'</u>
182	183	1	Coal(?)

LOG

From	To (in feet)	Length	Description
183	191	8	Shale, carbonaceous, dark brown, shale, medium gray, sandy
191	195	4	Coal with $\pm .5'$ parting at 192'
195	230	35	Sandstone, medium gray to light brown gray to dark brown gray, fine to very fine grained, siltstone, light brown gray to medium gray, sandy, shale, carbonaceous at $\pm 228'$
230	232	2	Coal(?)
232	240	8	Shale, carbonaceous, dark brown, sandstone, medium to dark brown gray, very fine grained
240	246	6	Coal with $\pm 1'$ parting at 242'
246	298	52	Sandstone, medium brown gray, to light brown gray to light to medium gray, silty, some calcareous, siltstone, medium brown gray, sandy
298	299	1	Coal(?), driller call
299	407	108	Siltstone, medium to light gray, sandy, sandstone, light to medium gray, very fine grained
407	418	11	Coal with $\pm 2'$ parting at 411'
418	456	38	Siltstone, light to medium gray to medium olive gray, sandstone, medium gray, very fine grained, silty
456	462	6	Coal
462	533	71	Sandstone, light to medium gray, very fine grained, Siltstone, medium gray
533	536	3	Coal with $\pm .5'$ parting at 535'
536	562	26	Siltstone, medium gray interbedded with carbonaceous shale, sandy, sandstone, medium gray, very fine grained
			Total depth geophysical log 562'
			Sample log to total depth
562	565	3	Siltstone, light greenish gray
565	570	5	Siltstone, light greenish gray, very fine grained, silty
570	575	5	Siltstone, light greenish gray

T.D. 575' 1630 hrs. Out of hole 1715 hrs.

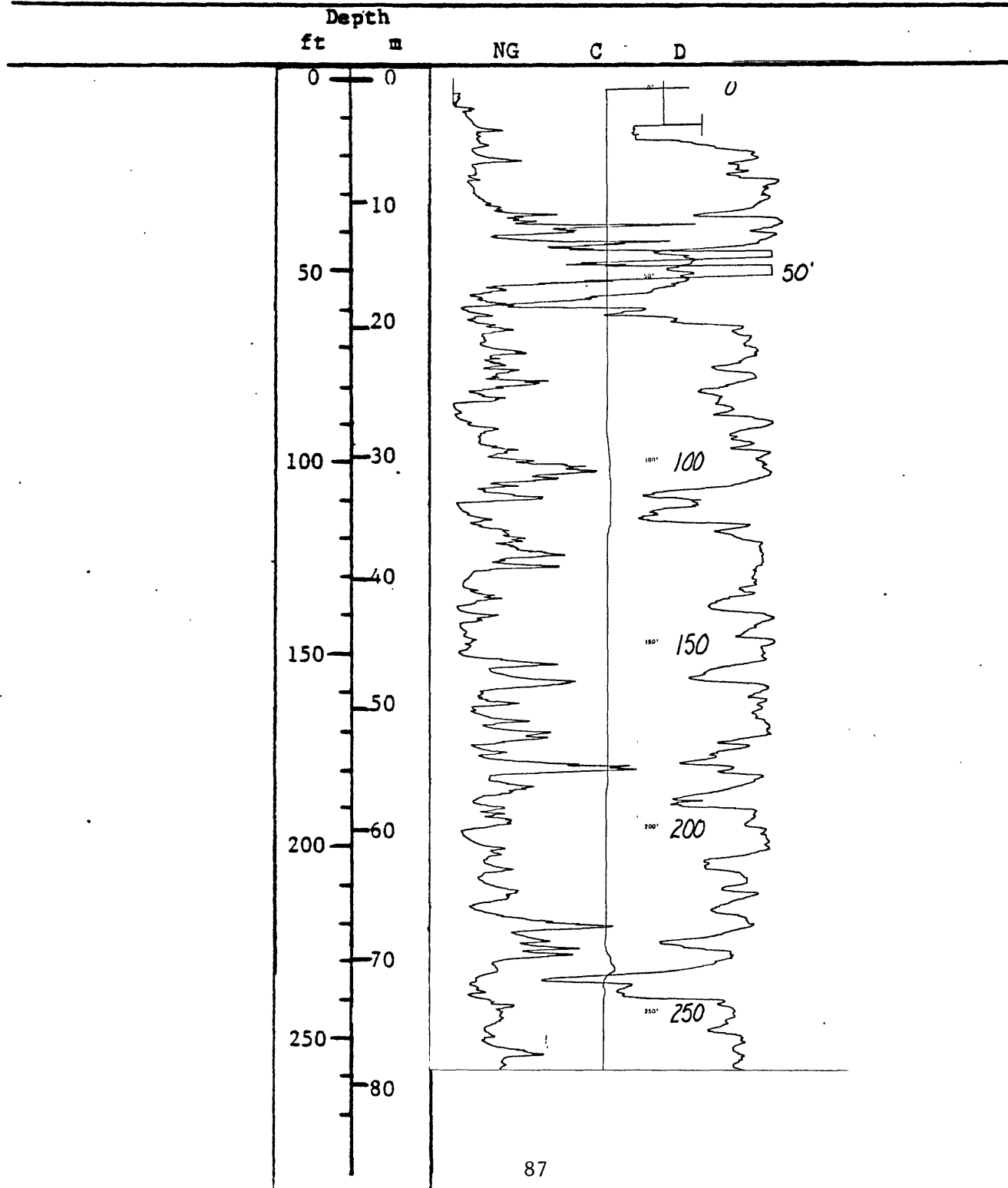
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E5 Date logged 9/12/80 Surface elevation 3615'

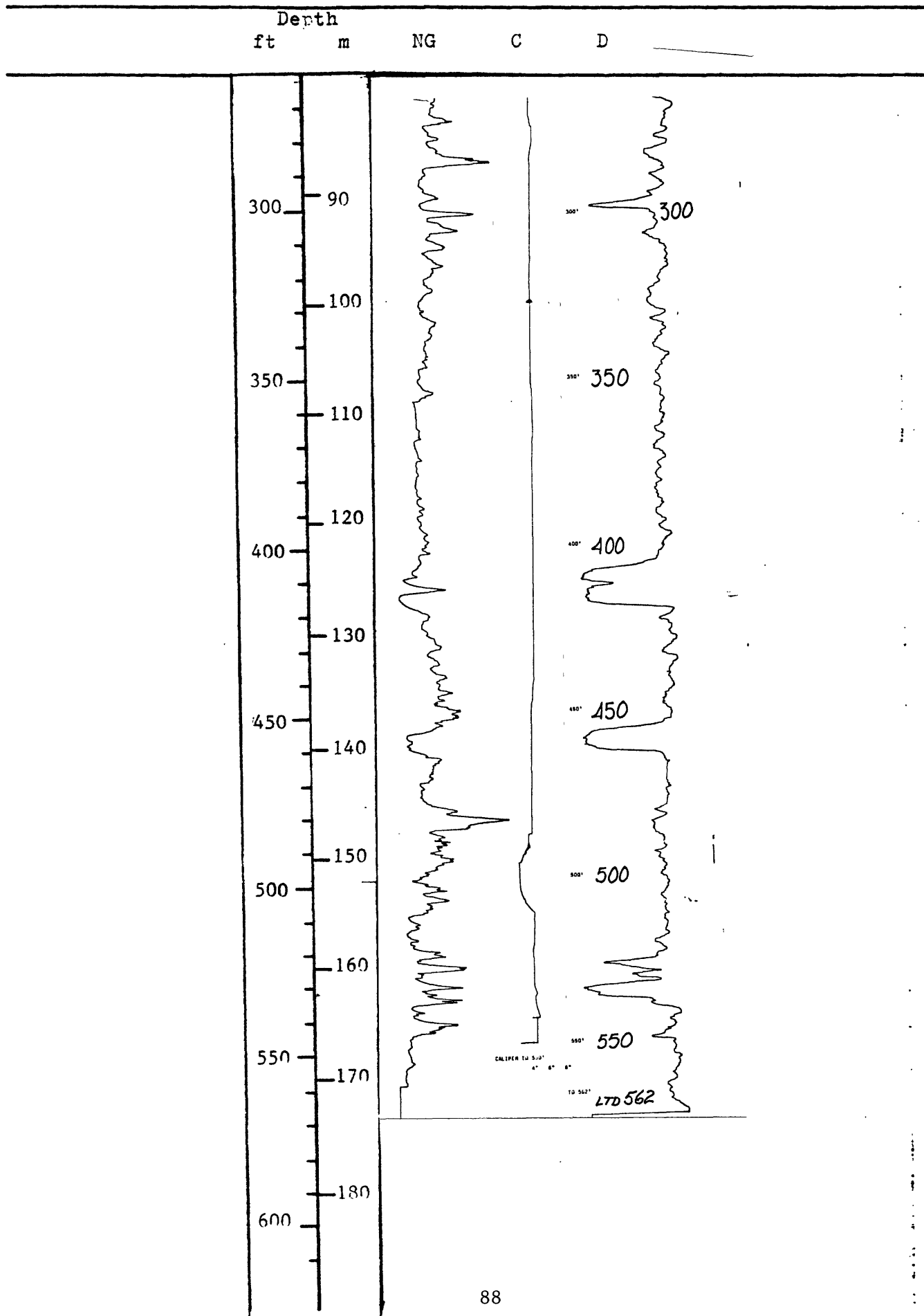
Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 6 S., R. 48 E. County Powder River

Drilled depth 575' Logged depth 562' Fluid level _____

Remarks Casing set, 20'



Hole no. E5 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E6 **Geologist** Frank S encer
Type log Lithologic **Elev.** 3356' **Total depth** 515'
Location SE $\frac{1}{4}$ SW $\frac{1}{4}$ **Sac.** 3 **T.** 7S **R.** 49E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Huckins School
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/10/80 **Complete** 9/10/80
Non-core intervals and size hole: 0-515' 5 1/8"
Cored intervals and size: None
Remarks _____

LOG

From	To	Length	Description
(in feet)			
0	12	12	Alluvium, loose sand, Iron stained
12	17	5	Sandstone, light orange yellow, fine grained, Iron Oxide stained
17	22	5	Shale, carbonaceous, dark brown, siltstone, carbonaceous, dark brown
22	66	44	Sandstone, light yellow gray, very fine grained with thin lenses
66	69	3	Coal
69	104	35	Sandstone, light gray green to medium gray to light to medium green, very fine grained, silty, calcareous, siltstone, medium gray, sandy
104	107	3	Coal with <u>+1'</u> parting at 105'
107	122	15	Sandstone, medium gray, very fine grained, silty, (water)
122	126	4	Coal (?)
126	199	73	Sandstone, medium to dark gray, fine to very fine grained, some pyrite, siltstone, medium gray
199	241	42	Siltstone, light to medium dark gray, sandy, inter-bedded with shale, carbonaceous, dark greenish gray to dark brown

LOG

From	To (in feet)	Length	Description
241	245	4	Coal (drillers call)
245	276	31	Siltstone, medium gray, sandy, shale, carbonaceous, dark brown at <u>+246'</u>
276	277	1	Coal(?)
277	373	96	Sandstone, light to medium to dark gray, fine to very fine grained, some calcareous, siltstone, medium to dark gray, shale, medium to dark gray, some carbonaceous
373	374	1	Coal(?)
374	392	18	Sandstone, medium gray, very fine grained, siltstone, medium gray
392	396	4	Coal with <u>+1'</u> parting at 394'
396	410	14	Shale, carbonaceous, dark brown, siltstone, medium to dark gray, sandy
410	412	2	Coal(?)
412	426	14	Shale, carbonaceous, dark brown interbedded with siltstone, medium to dark gray
426	427	1	Coal
427	455	28	Siltstone, medium gray interbedded with carbonaceous shale, dark brown, siltstone, medium gray
455	456	1	Coal(?)
456	486	30	Siltstone, light to medium gray, sandstone, medium gray, very fine grained, silty, some carbonaceous shale
486	488	2	Coal(?)
488	502	14	Siltstone, light to medium gray
			Total depth geophysical log 502'
			Sample log to total depth
502	505	3	Sandstone, light to medium gray, very fine grained
505	510	5	Sandstone, light to medium gray, very fine grained
510	515	5	Sandstone, light to medium gray, very fine grained
			T.D. 515' 1100 hrs. logging at 1130 hrs.

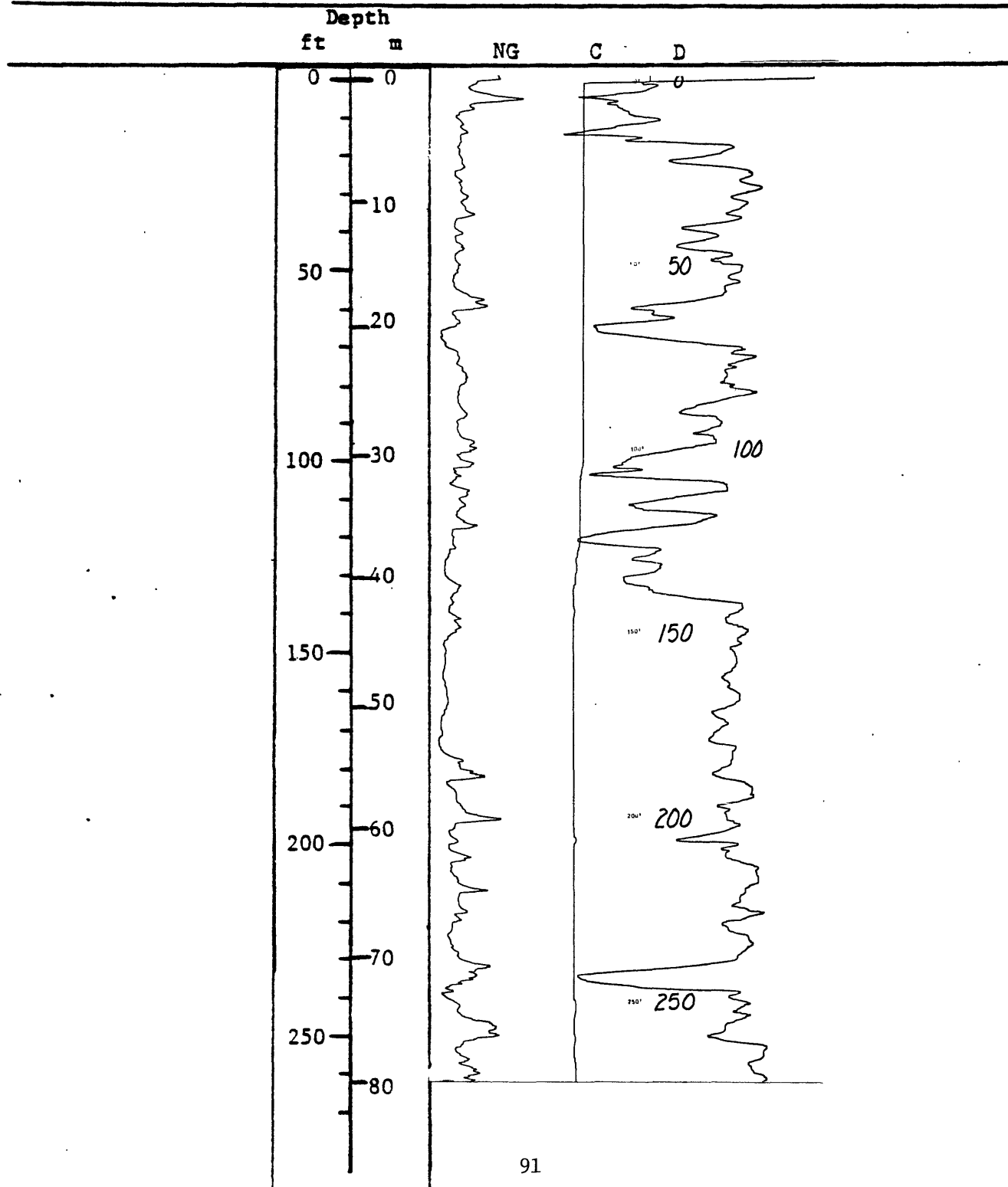
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

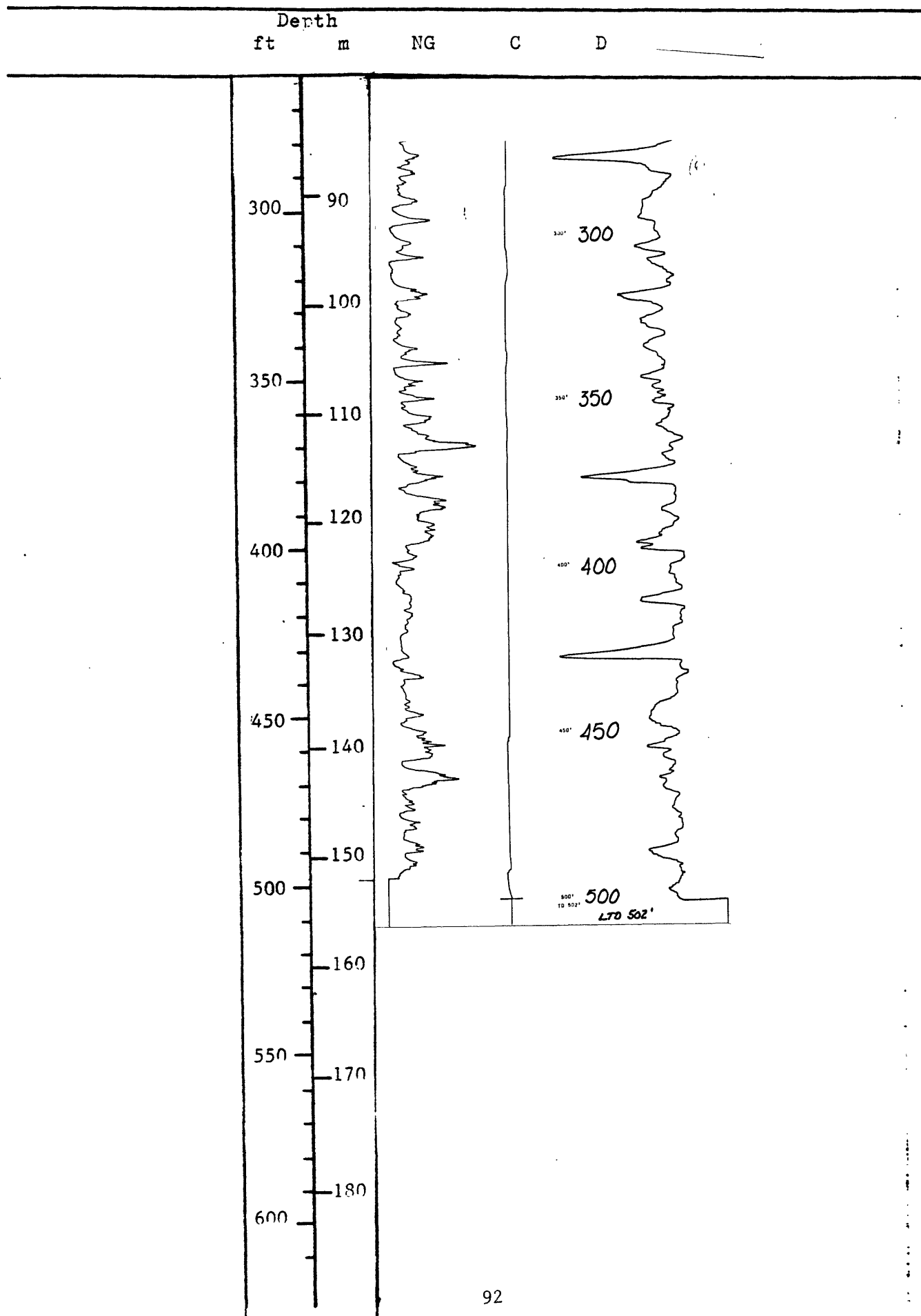
Hole no. E6 Date logged 9/11/80 Surface elevation 3356'

Location SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 7 S., R. 50 E. County Powder River

Drilled depth 515' Logged depth 502' Fluid level _____

Remarks _____



Hole no. E6 (continued)

**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
 Hole No. 80 MB-E7 Geologist M. McPhiblis
 Type log Lithologic Elev. 3490' Total depth 655'
 Location NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 35 T. 7S R. 48E
 Nearest town Broadus County Powder River State Mont. Quad. Bloom Creek
 Drilled by: U.S. Geological Survey
 Driller(s): Stephen Grant
 Drill: Portadrill 524 Date start 9/13/80 Complete 9/14/80
 Non-core intervals and size hole: 0-25.8, 60-120', 137.5-655', 5 1/8"
 Corred intervals and size: 3.0" Core
 Remarks _____

LOG

From	To	Length	Description
(in feet)			
0	25.8	25.8	No Sample
25.8	60.0	34.2	See core description
60.0	120	60	No sample
120	137.5	17.5	See core description
137.5	195	57.5	No sample described
195	235	40	Shale, medium to medium dark gray
235	238	3	Coal, black, silky, hard
238	267	29	Claystone, medium light gray, siltstone, light olive gray, hard, shale, carbonaceous, medium light gray
267	336	69	Sandstone, olive gray, very fine grained, siltstone, light olive to olive gray, claystone, medium light gray
Total depth geophysical log 336'			
Sample log to total depth			
336	340	4	Small sample, sandy, light gray, sub-round to sub-angular, with coal, black, dull to silky, hard, abdt pyrite nodules (micro) and some shale, carbonaceous brown black
340	345	5	

LOG

From	To (in feet)	Length	Description
340	345	5	Small sample, sandstone, light gray, siltstone, light olive gray, hard, and sandstone, medium light gray, very fine grained, thin carbonaceous streaks
345	350	5	Sandstone, light gray, medium grained, sub-round to sub-angular, quartz abdt, some coal in sample
350	355	5	Sandstone, light gray, medium grained, sub-round to sub-angular, quartz abdt, claystone, medium blue gray, some coal chips
355	360	5	Coal, black, dull to silky with interbedded shale, brown black, carbonaceous
360	365	5	Coal, black, shiny, with interbedded shale, carbonaceous, brown black
365	370	5	Sandstone, medium light gray, very fine grained, 40%, claystone, medium gray, 40%, coal and carbonaceous shale, 15%, sandstone, light olive gray, very fine grained, thin carbonaceous streaks, 5%
370	375	5	Claystone, light gray to olive gray, some coaly material
375	380	5	Sandstone, very light gray to medium light gray, medium grained, sub-round to sub-angular, quartz abdt, well sorted
380	385	5	Sandstone, very light gray to medium light gray, medium grained, sub-round to sub-angular, quartz abdt, well sorted
385	390	5	Claystone, medium light gray, 30%, siltstone, light olive gray, hard, 30%, sandstone, 30%, small coal chips 10%
390	395	5	Claystone, medium light gray, 10%, siltstone, light olive gray, hard, 10%, sandstone, 70%, small coal chips 10%
395	400	5	Claystone, medium light gray, 10%, siltstone, light olive gray, hard, 10%, sandstone, 70%, small coal chips 10%
400	405	5	Sandstone, 95%, coal chips 5%
405	410	5	Claystone, light gray, 10%, sandstone, 40%, small coal chips 50%
410	415	5	Sandstone, 90%, coal chips 10%

LOG			
From	To (in feet)	Length	Description
415	420	5	Sandstone
420	425	5	Sandstone
425	430	5	Sandstone, 90%, coal chips 10%
430	435	5	Sandstone
435	440	5	Sandstone
440	470	30	Sandstone, <u>Note</u> : this same sandstone dominates the samples to T.D. (655'). From this point, I only note where it appears there is a coal bed or a different bed.
470	475	5	Claystone, dark gray, carbonaceous, claystone, light gray, trace carbonaceous material and shale, black, carbonaceous, in sample with sandstone
475	480	5	Sample slightly clayey
480	485	5	Coal, black, silky, and claystone, light gray, trace carbonaceous, and sandstone
485	530	45	Sandstone
530	535	5	Coal, brown black, bony and sandstone
535	550	15	Sandstone
550	555	5	Shale, medium dark gray to brown black, carbonaceous
555	565	10	Sandstone
565	570	5	Shale, brown black, carbonaceous, clayey
570	655	85	Sandstone
			T.D. 655'

**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E7 **Geologist** M. McPhillips
Type log Core description **Elev.** 3490' **Total depth** 655'
Location NE $\frac{1}{4}$ SE $\frac{1}{4}$ **Sec.** 35 **T.** 7S **R.** 48E
Nearest town Broadus **County** Powder River **State** Mont **Quad.** Bloom Creek
Drilled by: U.S. Geological Survey
Driller(s): Stephen Grant
Drill: Portadrill 524 **Date start** 9/13/80 **Complete** 9/14/80
Non-core intervals and size hole: 0-25.8', 60-120', 137.5-655', 5 1/8"
Cored intervals and size: 3.0" Core
Remarks

LOG

From	To	Length	Description
(in feet)			
25.8	27.0	1.2	Shale, medium dark gray, thin carbonaceous streaks with interbedded sandstone, medium light gray, very fine grained, silty with thin coal streaks
27.0	30.0	3.0	Coal, black, silky, hard, abdt pyrite nodules (micro)
30.0	42.6	12.6	Coal, black, dull to silky, very abdt pyrite (nodules and bands)
42.6	56.6	14.0	Coal, black, dull to silky banded, abdt pyrite nodules (micro), abdt gypsum rosettes
56.6	57.2	0.6	Coal, black, dull to silky banded, abdt pyrite nodules (micro), abdt gypsum rosettes
57.2	60.0	2.8	Siltstone, medium light gray
120.0	122.3	2.3	Siltstone, medium gray to medium dark gray, thin carbonaceous streaks
122.3	126.4	4.1	Claystone, medium light gray to medium gray
126.4	133.0	6.6	Coal, black, dull with silky bands to silky with dull bands, shiny at 127.1 to 127.3, abdt gypsum rosettes from 127.1 to 133.0, abdt micro pyrite nodules from 127.1 to 133.0, bony near bottom, resin
133.0	136.3	3.3	Coal, black, silky with dull bands, abdt micro pyrite nodules and gypsum rosettes

LOG

From	To (in feet)	Length	Description
136.3	137.5	1.2	Siltstone, medium gray, sandy, with thin carbonaceous streaks

End of Core Description

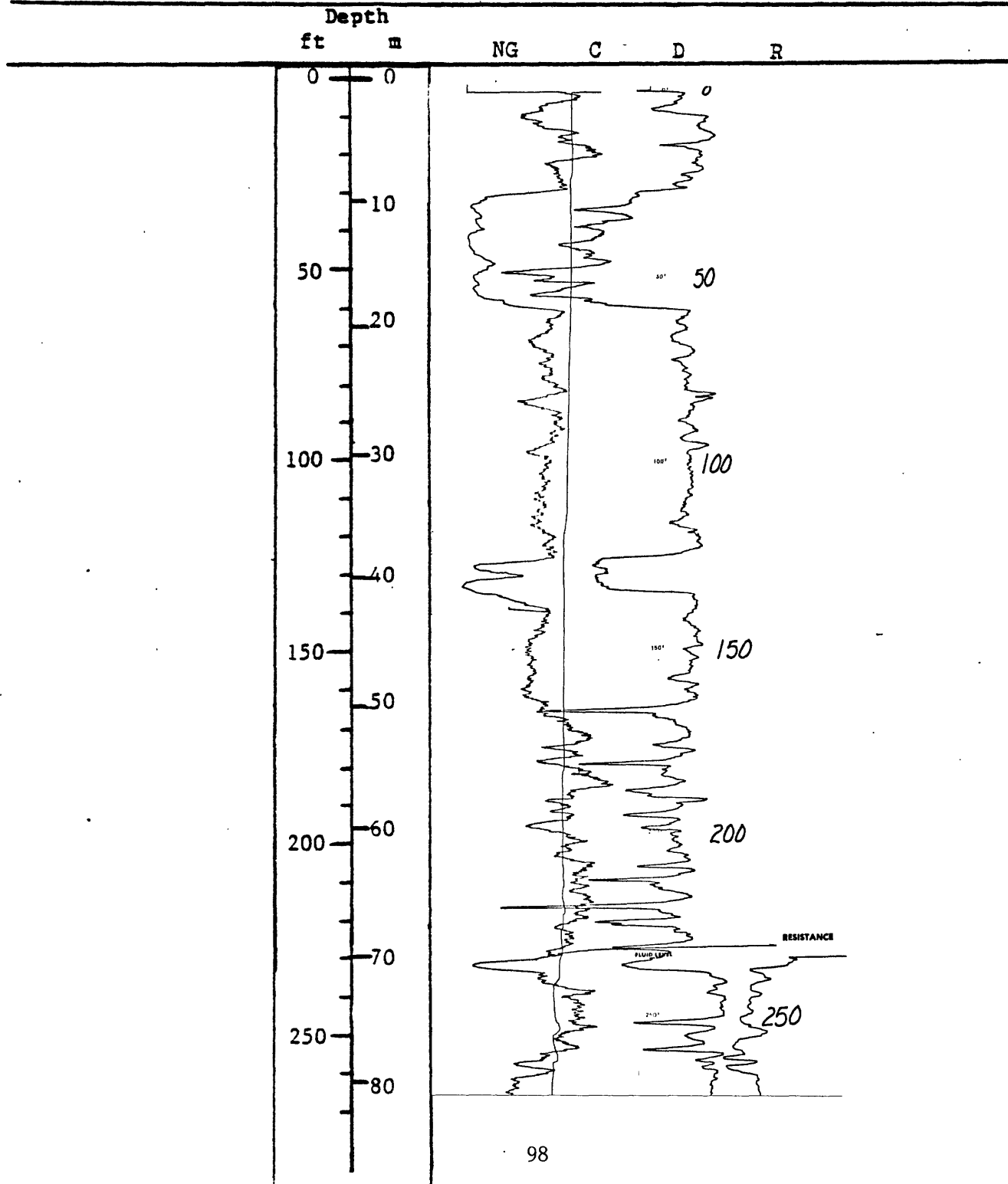
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E7 Date logged 9/14/80 Surface elevation 3490'

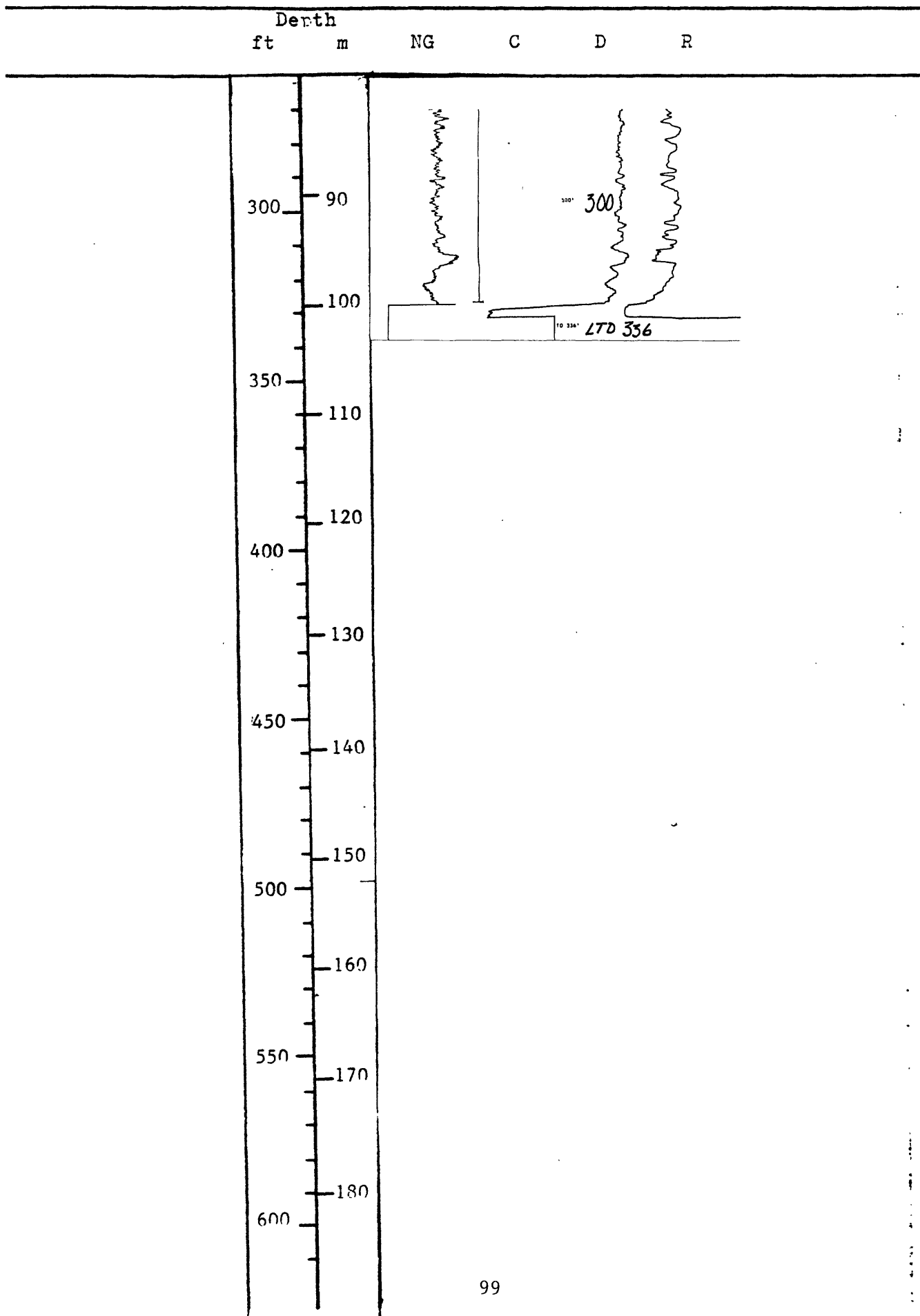
Location N¹4SE¹4 sec. 35, T. 7 S., R. 48 E. County Powder River

Drilled depth 655' Logged depth 336' Fluid level 234'

Remarks _____



Hole no. E7 (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E8 **Geologist** M. McPhillips
Type log Lithologic **Elev.** 3340 **Total depth** 95'
Location SE $\frac{1}{4}$ SW $\frac{1}{4}$ **Sec.** 15 **T.** 8S **R.** 48E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Bloom Creek
Drilled by: U S. Geological Survey
Driller(s): Stephen Grant
Drill: Portadrill 524 **Date start** 9/12/80 **Complete** 9/12/80
Non-core intervals and size hole: 0-95' 5 1/8"
Cored intervals and size: _____
Remarks Abandoned and moved to 80 MB-E8a- excessive alluvium and clinker
No geophysical log run

LOG

From	To	Length	Description
(in feet)			
0	5	5	Soil, dark yellow brown
5	10	5	Soil, gray orange, some clinker
10	15	5	Soil with sand, fine to medium grained
15	20	5	Soil with sand, fine to course grained
20	25	5	Sand (soil), dark yellow brown, fine to medium grained, sub-round, with 10% clinker, mod red brown to mod red orange
25	30	5	Alluvium, pale yellow brown, mostly sand, fine to very course grained
30	35	5	Alluvium, pale yellow brown, mostly sand, fine to very course grained, sub-round, with abdt clinker, angular
35	40	5	Sandstone, mod yellow brown, fine to very fine grained, clayey, with some clinker
40	45	5	Sandstone, mod yellow brown, fine to very fine grained, clayey, with some clinker
45	50	5	Sandstone, mod yellow brown, fine to very fine grained, clayey, with some clinker

LOG

From	To (in feet)	Length	Description
50	55	5	Sandstone, mod yellow brown, fine to very fine grained, clayey, with some clinker
55	60	5	Sandstone, dark yellow brown, fine to very fine grained, clayey, with some clinker
60	65	5	Sandstone
65	95	30	No sample described
			Problems with clinker- Arthur Clark later drilled hole above clinker
			See 80 MB-E8a

**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E8a **Geologist** Frank Spencer
Type log Lithologic **Elev.** 3480' **Total depth** 695'
Location SW $\frac{1}{4}$ SE $\frac{1}{4}$ **Sec.** 16 **T.** 8S **R.** 48E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Bloom Creek
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/12/80 **Complete** 9/13/80
Non-core intervals and size hole: 0-695' 5 1/8"
Cored intervals and size: _____
Remarks Surface casing 30'

LOG

From	To	Length	Description
(in feet)			
0	19	19	Alluvium, sand, light yellow to off white, fine grained with clinker, dark brown, carbonaceous at \pm 17'
19	59	40	Sandstone, light yellow to light yellow gray to light to medium gray, fine to very fine grained with some clay
59	75	16	Coal with \pm 2' parting at 61', \pm 3' parting at 65', \pm .5' parting at 71', \pm 1' parting at 73'
75	83	8	Shale, carbonaceous, dark brown, siltstone, medium to light gray
83	91	8	Coal with \pm 3' parting at 84'
91	175	84	Sandstone, medium to dark green gray, fine to very fine grained, siltstone, medium to dark gray, sandy, calcareous
175	179	4	Coal, shaly (probably carbonaceous, shale, from cuttings)
179	183	4	Shale, carbonaceous
183	188	5	Coal, dirty, shaly, carbonaceous with \pm .5' parting at 186'
188	238	50	Siltstone, medium to dark gray, shale, dark gray to dark brown, silty, carbonaceous, sandstone, medium to dark gray, very fine grained
238	242	4	Coal

LOG

From	To (in feet)	Length	Description
242	252	10	Shale, carbonaceous, dark brown, siltstone, dark brown with some carbonaceous material
252	257	5	Coal with <u>+1'</u> parting at 254'
257	378	122	Sandstone, dark brown to light to medium to dark gray to medium brown gray, fine to very fine grained, interbedded with shale, carbonaceous, dark brown, siltstone, light to medium gray, sandstone, light gray, very fine grained, calcareous lenses
378	380	2	Coal
380	447	67	Siltstone, dark brown to light to medium gray interbedded with shale carbonaceous, dark brown, sandstone, light to medium gray to medium brown gray, very fine grained
447	450	3	Coal (driller call)
450	464	14	Siltstone, medium to dark brown, carbonaceous, shale, carbonaceous
464	465	1	Coal (drillers call)
465	568	103	Sandstone, light to medium gray, very fine grained, siltstone, light to medium gray, shale carbonaceous, dark brown, @ <u>+</u> 565'
568	569	1	Coal(?)
569	619	50	Siltstone, light to medium gray, sandstone, light to medium gray, very fine grained, shale, carbonaceous with siltstone, dark brown, interbedded at <u>+</u> 617'
619	627	8	Coal, dirty, shaley with <u>+2'</u> parting at 623'
627	662	35	Siltstone, light to dark brown to light gray, carbonaceous, sandstone, medium gray, very fine grained, some carbonaceous shale, dark brown at <u>+</u> 627'
662	667	5	Coal with <u>+.5'</u> parting at 663'
667	684	17	Siltstone, light gray
			Total depth geophysical log 684'
			Sample log to total depth
684	685	1	Sandstone, light gray, very fine grained
685	690	5	Sandstone, light gray, very fine grained

LOG

From	To (in feet)	Length	Description
690	695	5	Sandstone, light gray, very fine grained T.D. 695'

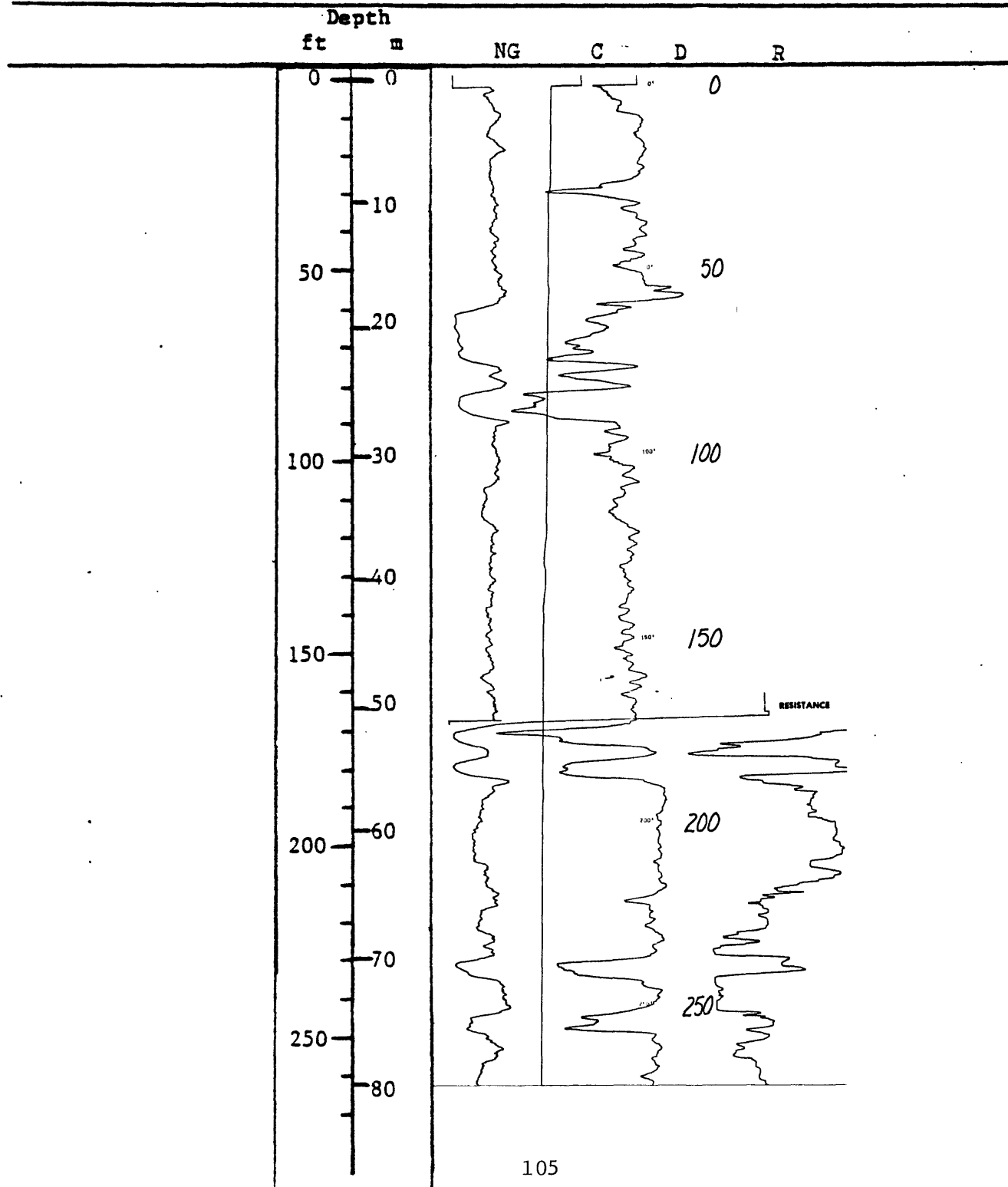
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E8a Date logged 9/13/80 Surface elevation 3480'

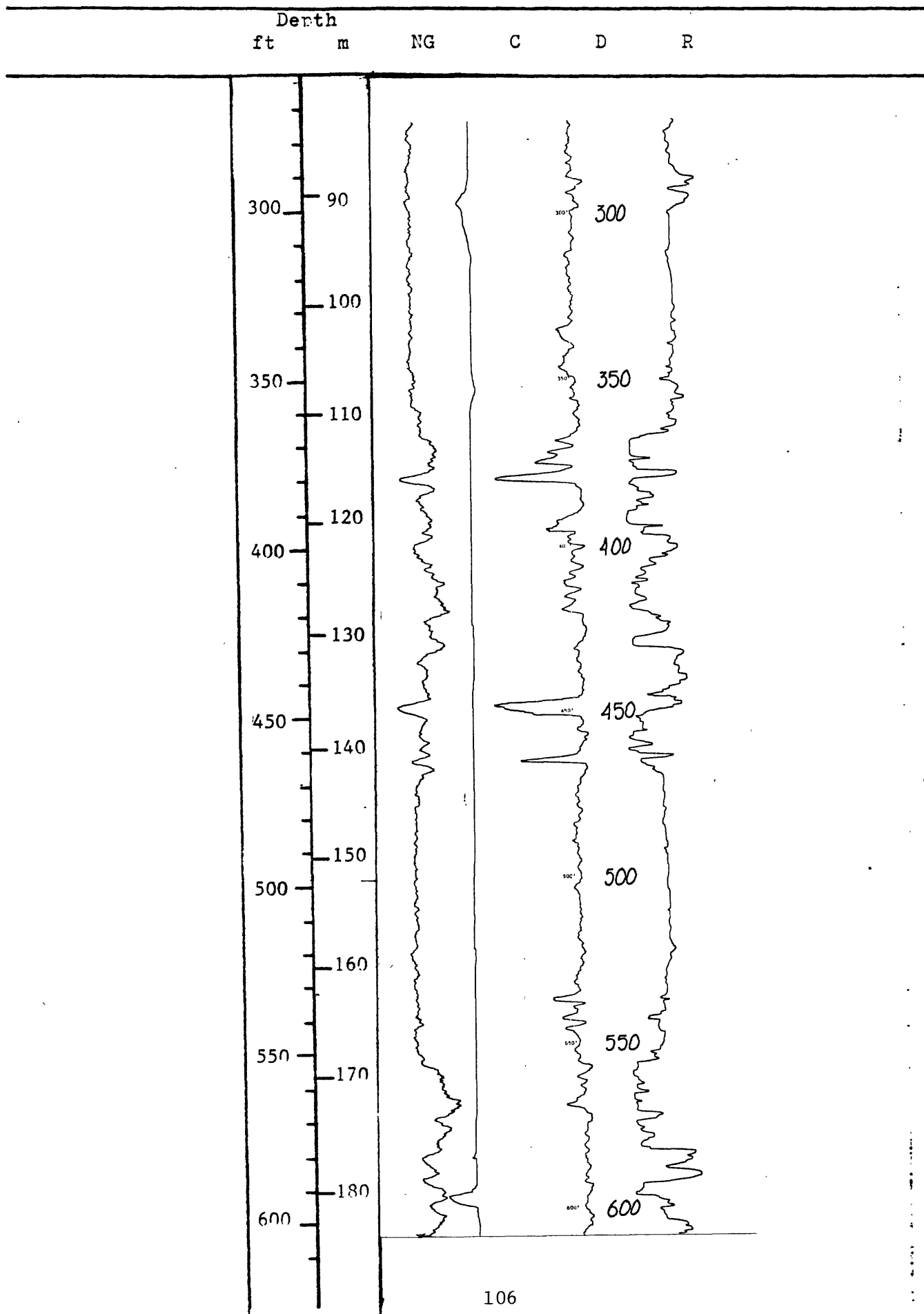
Location SW1/4SE1/4 sec. 16, T. 8 S., R. 48 E. County Powder River

Drilled depth 695' Logged depth 684' Fluid level 170'

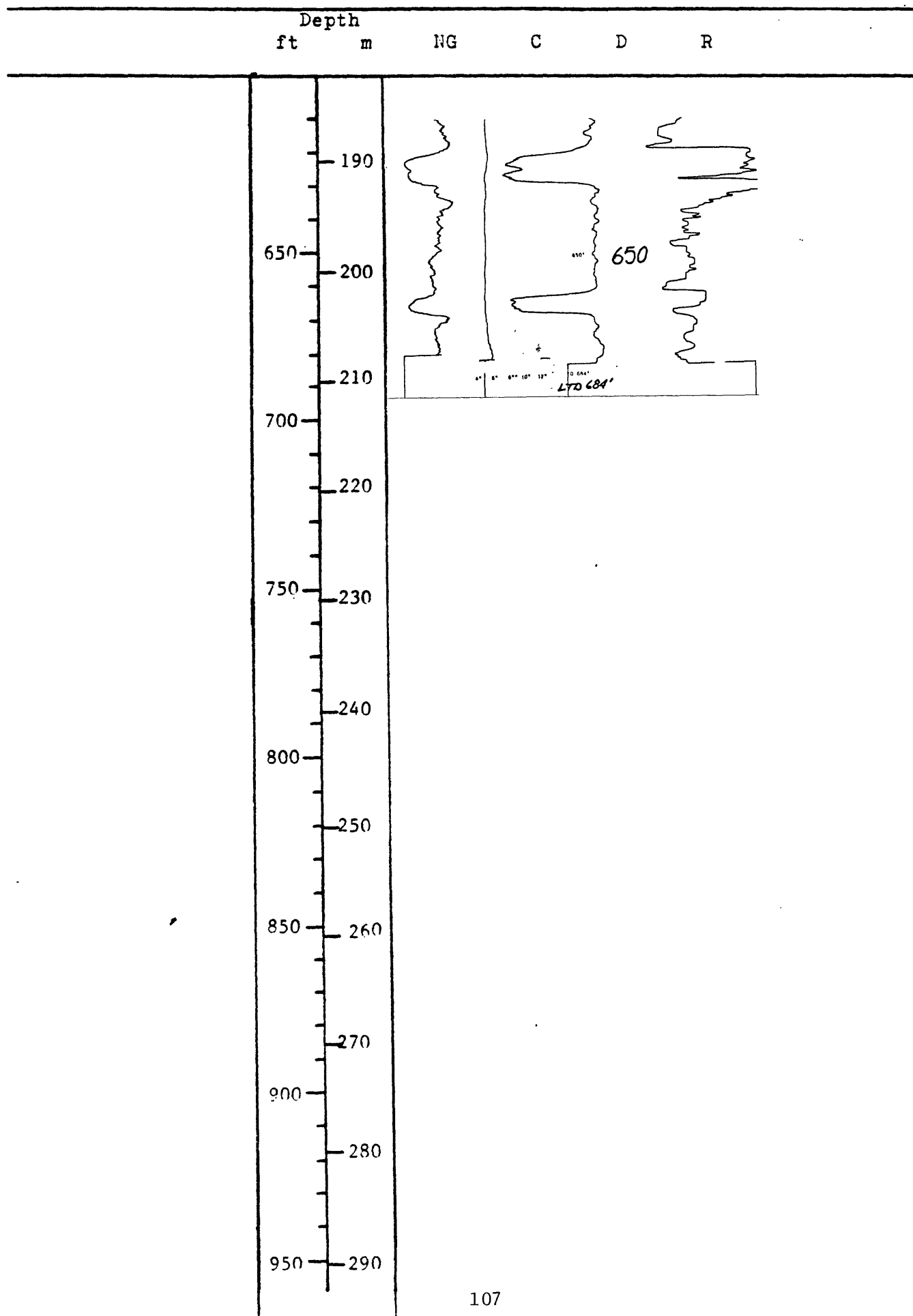
Remarks Surface casing 30'



Hole no. E8a (continued)



Hole no. E8a (continued)



**U.S. Geological Survey
Branch of Coal Resources**

Project Moorhead-Broadus
Hole No. 80 MB-E9 **Geologist** Frank S encer
Type log Lithologic **Elev.** 3470' **Total depth** 735'
Location SW¼NE¼ **Sec.** 32 **T.** 8S **R.** 48E
Nearest town Broadus **County** Powder River **State** Mont. **Quad.** Moorhead
Drilled by: U.S. Geological Survey
Driller(s): Arthur Clark
Drill: Gardner-Denver 17W **Date start** 9/12/80 **Complete** 9/13/80
Non-core intervals and size hole: 0-735' 5 1/8"
Cored intervals and size: None
Remarks Casing set at 1421 hrs. 20' surface casin Cemented 1½ hrs

LOG

From	To	Length	Description
(in feet)			
0	4	4	Siltstone, medium olive gray, weathered
4	10	6	Shale, olive gray
10	23	13	Siltstone, light olive brown to light to medium gray, weathered, slightly sandy
23	85	62	Sandstone, light yellow gray to light yellow to yellow brown, fine to very fine grained, quartz, angular, sub-round to sub-angular, siltstone, dark brown interbedded with sandstone
85	91	6	Shale, carbonaceous, dark brown
91	115	24	Sandstone, light gray, very fine grained, siltstone, light gray
115	140	25	Shale, carbonaceous, dark brown, with coal(?), brown, shaley, <u>+1'</u> at 123'
140	161	21	Siltstone, medium to dark gray to light brown gray with carbonaceous shale interbedded at <u>+ 141'</u> , sandstone, medium gray, silty
161	164	3	Coal (driller call)
164	206	42	Sandstone, medium brown to medium gray, very fine grained, siltstone, medium gray, shale, medium gray to dark brown, carbonaceous at <u>+ 200'</u>

LOG

From	To (in feet)	Length	Description
206	212	6	Coal with $\pm .5'$ parting at 211'
212	216	4	Shale, carbonaceous, dark brown
216	221	5	Coal, with $\pm .5'$ parting at 219'
221	265	44	Sandstone, medium brown gray, very fine grained, siltstone, medium gray to medium dark brown
265	269	4	Coal with $\pm .5'$ parting at 266'
269	278	9	Shale, carbonaceous, dark brown interbedded with sandstone, medium gray, very fine grained
278	280	2	Coal (driller call)
280	370	90	Sandstone, medium to light gray, very fine grained, to fine grained, siltstone, medium to light gray, shale, medium to dark gray, carbonaceous
370	380	10	Coal interbedded with siltstone and shale, carbonaceous
380	411	31	Siltstone, dark gray brown to dark brown interbedded with shale, carbonaceous, and sandstone
411	417	6	Coal with $\pm 2'$ parting at 413'
417	470	53	Siltstone, medium gray to dark gray to medium brown to dark brown, carbonaceous at $\pm 419'$, sandstone, medium gray, very fine grained
470	472	2	Coal
472	493	21	Siltstone, medium gray to dark brown, shale, carbonaceous, dark brown
493	494	1	Coal (driller call)
494	593	99	Sandstone, medium to light gray, very fine grained, siltstone, medium to light gray
593	597	4	Siltstone interbedded with shale, carbonaceous
597	646	49	Siltstone, medium to light to dark gray
646	652	6	Siltstone, light gray interbedded with shale, carbonaceous, dark brown
652	661	9	Coal with $\pm .5'$ parting at 655', $\pm 1'$ parting at 657', $\pm 1'$ parting at 659'

LOG

From	To (in feet)	Length	Description
661	692	31	Siltstone, medium to light gray, sandstone, medium brown gray, very fine grained, shale, carbonaceous, dark brown
692	695	3	Coal
695	714	19	Siltstone, dark brown gray interbedded with shale, carbonaceous and coal cuttings
			Total depth geophysical log 714'
			Sample log to total depth
714	720	6	Siltstone, dark brown gray interbedded with shale, carbonaceous
720	725	5	No sample, assumed siltstone
725	730	5	Siltstone, light gray (10% coal cutting)
730	735	5	No sample, assumed siltstone
			T.D. 735' at 1855 hrs.
			Cleaning and washing until pulling

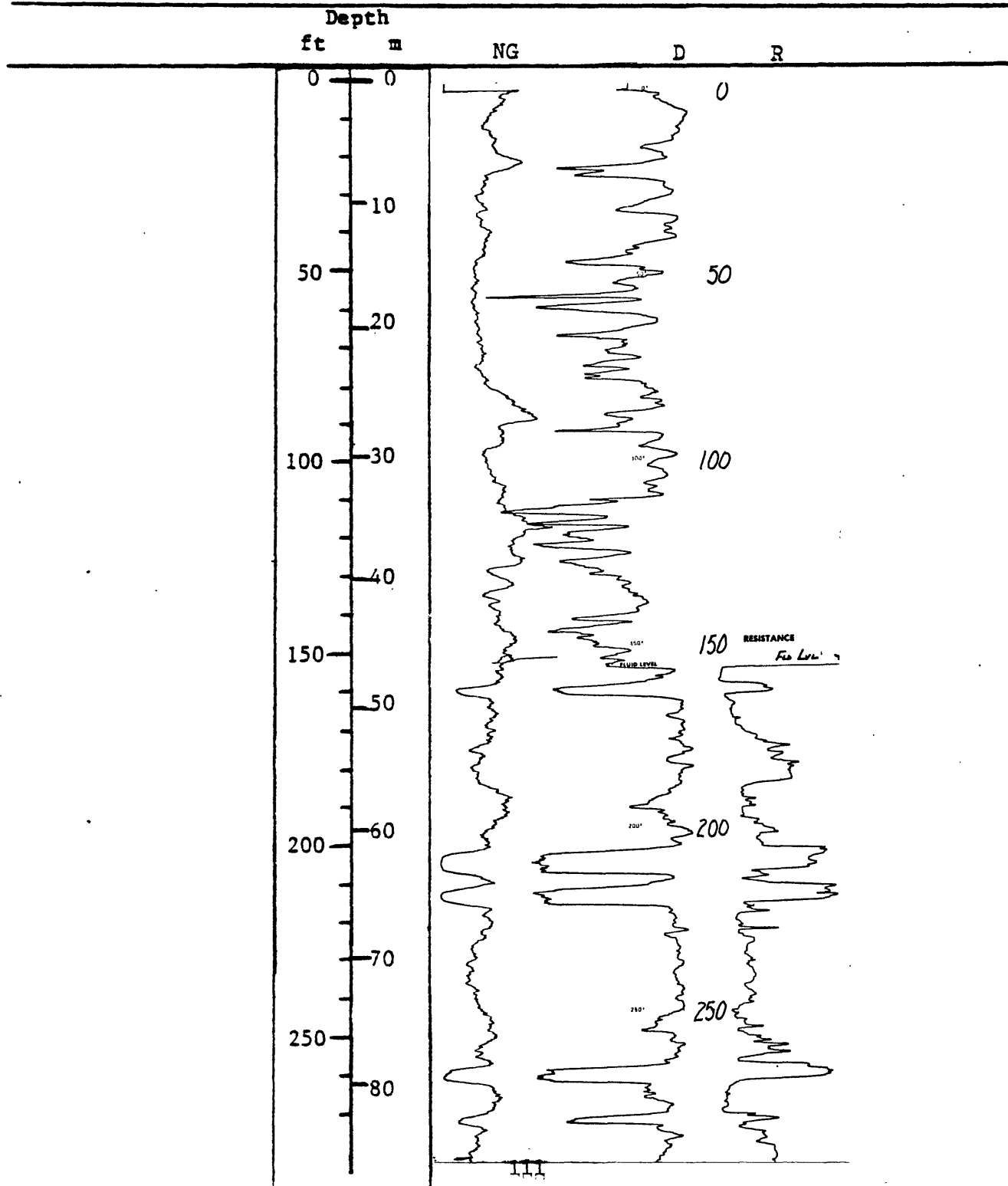
U.S. Geological Survey
Geophysical log, 1980 Drilling
Moorhead-Broadus Area, Montana

Hole no. E9 Date logged 9/13/80 Surface elevation 3470'

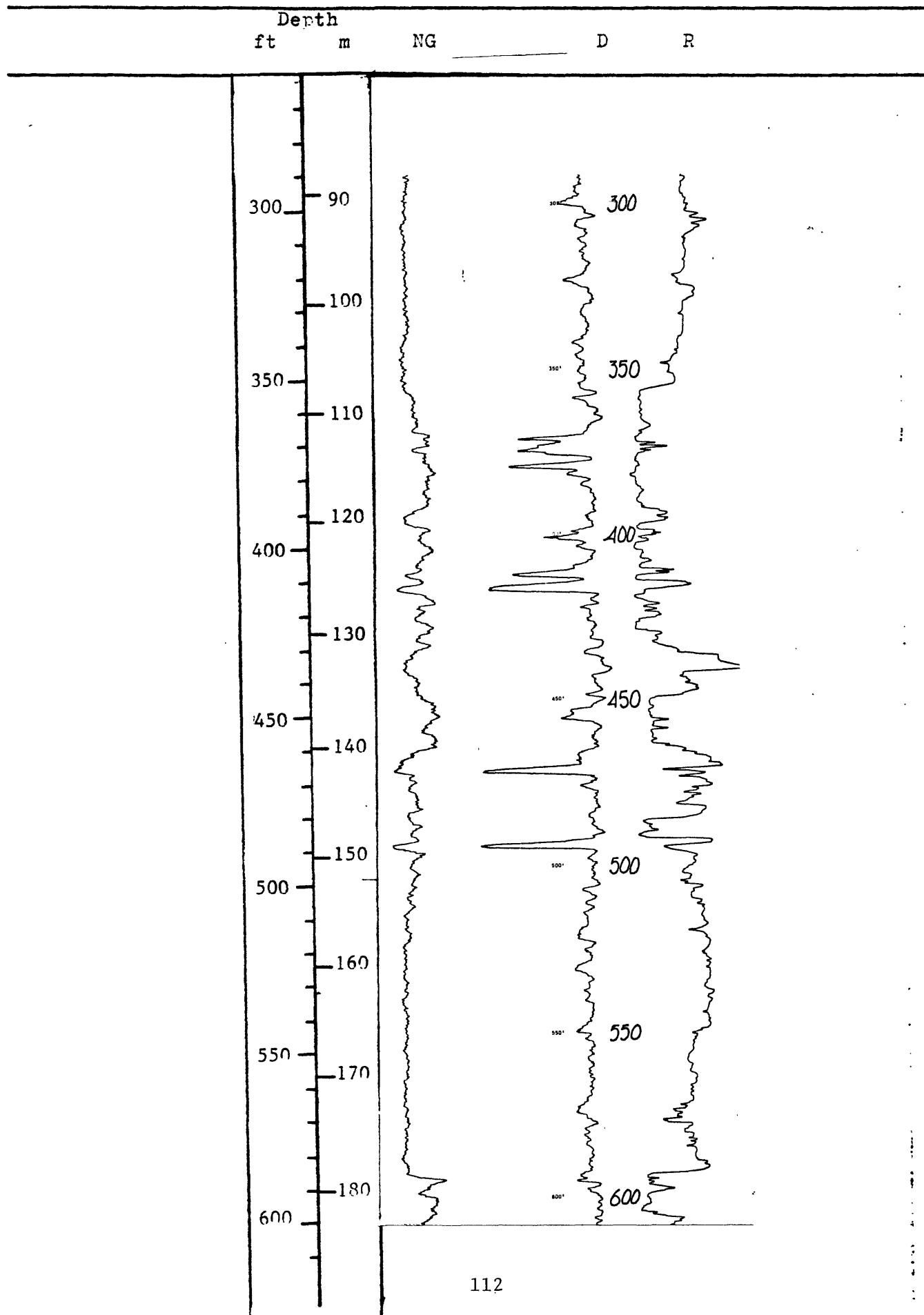
Location SW1/4NE1/4 sec. 32, T. 8 S., R. 48 E. County Powder River

Drilled depth 735' Logged depth 714' Fluid level 152'

Remarks Surface casing 20'



Hole no. E9 (continued)



Hole no. E9 (continued)

