DESCRIPTIVE, GEOLOGIC, AND BOREHOLE GEOPHYSICAL LOGS FOR 23 TEST HOLES IN SOUTH-CENTRAL NEBRASKA

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ABSTRACT

This report presents logs for 23 test holes drilled in eight counties in south-central Nebraska as part of a study of the hydrogeology of the area. Five logs are presented for each of the test holes. The first is a written description summarizing the sediments penetrated during drilling; the second is a geologic log providing a diagrammatic representation of the stratigraphic units; the remaining three show spontaneous potential, single-point resistance, and natural-gamma radiation measured in the test holes.

The test holes penetrate silts, sands, and gravels of Quaternary age, and siltstones, sandstones, and silts of the Ogallala Formation of Tertiary age. Each test hole was drilled deep enough to penetrate about 20 feet of the underlying Cretaceous-age bedrock.

INTRODUCTION

In January 1980, the Nebraska Natural Resources Commission, together with the Tri-Basin and Lower Republican Natural Resources Districts, entered into a joint agreement with the U.S. Geological Survey for a hydrogeologic study in all or part of eight counties encompassing nearly 4,000 square miles in south-central Nebraska. The objective of this study, called the "South-Central Nebraska Hydrogeology Study," is to describe the hydrogeology of the study area in sufficient detail so that the effects of potential water-resources development and management alternatives can be analyzed. An inventory of available test-hole data

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in the study area indicated the need for additional test-hole information if the objectives of the study were to be met. Accordingly, 23 new test holes were drilled in areas where test-hole information did not exist or where existing information was difficult to interpret, and appropriate logs were prepared.

Purpose and Scope

Logs of test holes have a long-term intrinsic value. Not only do they serve the immediate needs of the investigators who obtain and prepare them, but they are useful in future investigations. The purpose of this report, therefore, is to acquaint others with the existence of the original logs for the 23 new test holes and to provide summaries of those logs.

Five logs are presented for each of the test holes. The first is a written description summarizing the sediments penetrated during drilling (descriptive log). The second is a diagrammatic representation of the stratigraphic units (geologic log). The remaining three are borehole geophysical logs showing spontaneous potential, single-point resistance, and natural-gamma radiation measured in the test holes. In addition, caliper logs and (or) 64-inch long-normal logs are available for each of the test holes but are not summarized in this report. Availability of these additional logs is indicated under "Remarks" in the headings of the descriptive logs.

The locations of the 23 test holes and the boundaries of the South-Central Nebraska Hydrogeology Study are shown on figure 1. Most of the test holes align along township lines in conformance with the long-established generalized plan of test-hole drilling followed by the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey.

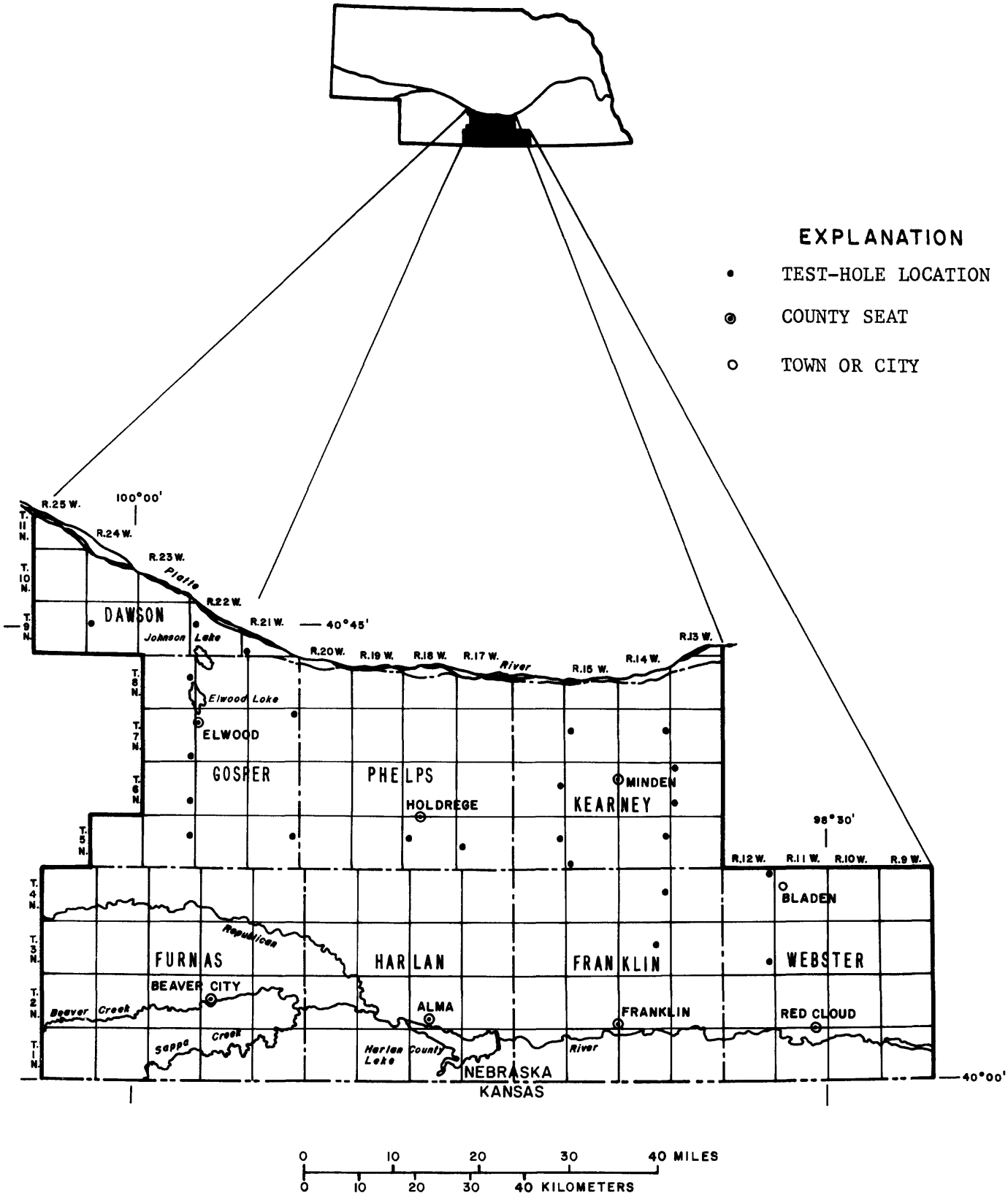

Figure 1.--Location of test holes in the South-Central Nebraska Hydrogeology Study area.

Test-Hole Numbering System

Test holes described in this report are numbered using a system based on the land subdivisions within the U.S. Bureau of Land Management's survey of Nebraska. This system is illustrated in figure 2. In the system, the numeral preceding the N (North) indicates the township, the numeral preceding the W (West) indicates the range, and the numeral preceding the terminal letters indicates the section in which the test hole is located. The terminal letters denote, in respective order, the quarter section, the quarter-quarter section, the quarter-quarter-quarter section, and the quarter-quarter-quarter-quarter section, and are assigned in counter-clockwise direction beginning with "A" in the northeast corner of each subdivision. The final number is the sequence number. In this report all test-hole numbers have a sequence number of 1. However, if there were several more test holes in any of the same 2½-acre tracts, they would have sequence numbers of 2, 3, etc. Thus, the number of the test hole in the SE¼, NE¼, SE¼, SE¼, sec. 14, T.3 N., R.14 W., would be "3N-14W-14DADD1."

For convenience during drilling, a field number is usually assigned to each test hole. In this study, such a number is in the form "1-B-81," where "1" refers to the chronological number assigned when each well is drilled, "B" refers to the particular drilling rig used, and "81" refers to the year of drilling.

Previous Work

From 1933 through 1942, numerous test holes were drilled in the Republican River basin in Nebraska by the U.S. Geological Survey, the Conservation and Survey Division of the University of Nebraska, and the Bureau of Irrigation, Water Power, and Drainage of the Nebraska Department of Roads and Irrigation. Logs of these test holes, many of which are for the study area, were published as part of a ground-water study of the Republican River basin in Nebraska (Waite and others, 1944).

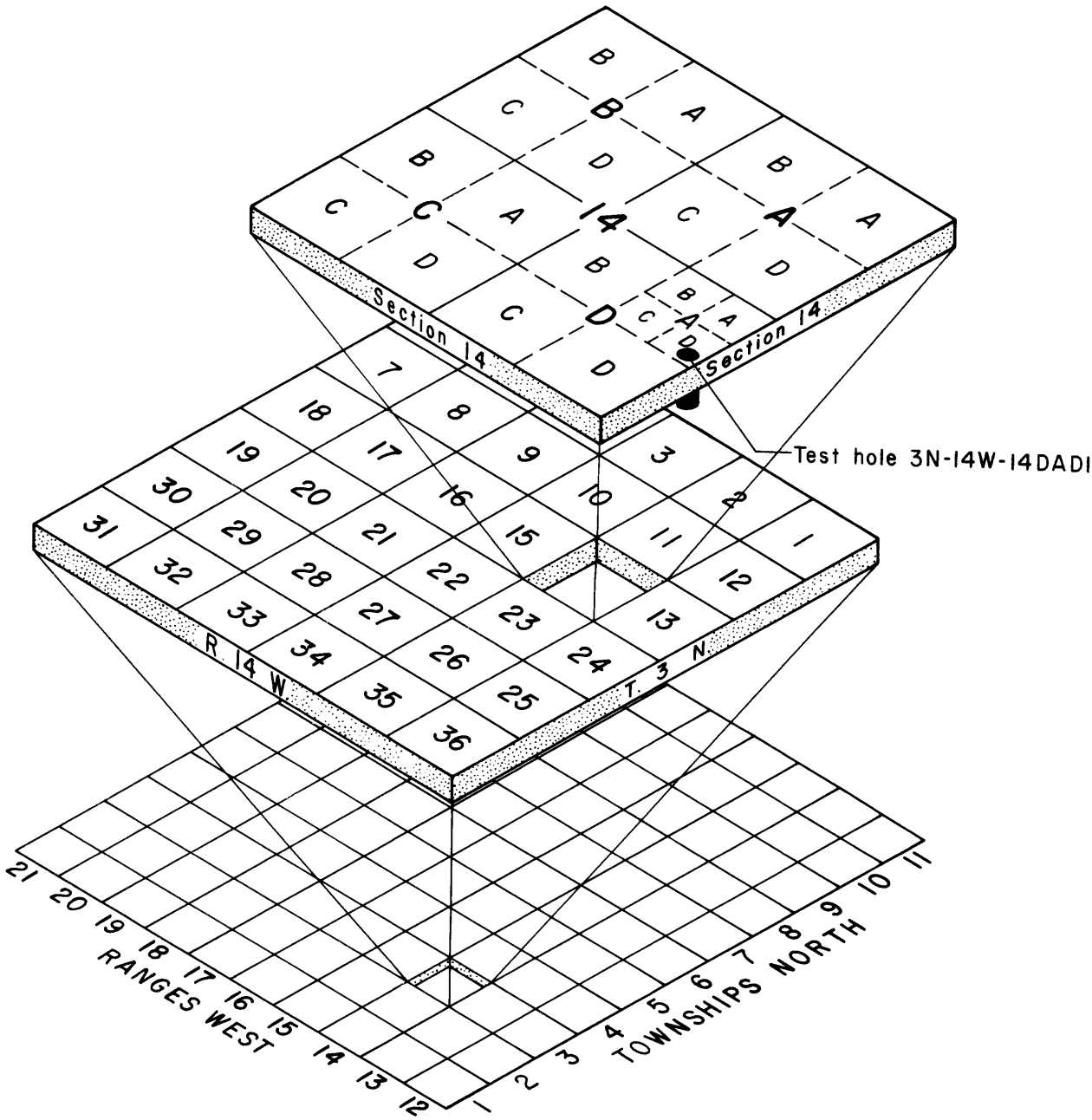

Figure 2.--System for numbering test holes.

Beginning in the 1930's, the Conservation and Survey Division and the U.S. Geological Survey were involved in a cooperative program of drilling test holes in Nebraska. The logs of those drilled through 1952 in the study area are published in county test-hole reports for Adams, Buffalo, Dawson and Custer, Franklin, Gosper, Harlan, Kearney, Phelps, and Webster Counties (Keech and Schreurs, 1953a-i).

The U.S. Bureau of Reclamation published results of a reconnaissance on the Fort Kearney Unit, and logs of several test holes in the study area are given in their report (Johnson, 1969). Finally, the U.S. Geological Survey published a ground-water report for Buffalo County in which several logs of new test holes were included (Schreurs, 1956).

Nebraska law requires registration with the Nebraska Department of Water Resources of all municipal, industrial, and irrigation wells. As part of the requirements for registration, the driller's logs must be submitted with the registration forms. The quality of these driller's logs is quite variable, but many of the logs are useful in making hydrogeologic interpretations. Approximately 6,980 registered wells were located in the study area as of December 31, 1982.

A few geophysical logs from oil and gas test wells drilled in the study area and that are adequate for determining the contact between Tertiary sediments and Cretaceous-age bedrock also are available.

Acknowledgments

Frank Smith, geologist, Conservation and Survey Division of the University of Nebraska, examined samples of drill cuttings and assisted in determining contacts between Pleistocene and Tertiary sediments and in confirming the identity of the Cretaceous bedrock formations. The managers of the Tri-Basin and Lower Republican Natural Resources Districts assisted in obtaining cooperation from local residents and county governments.

DRILLING AND LOGGING OF THE TEST HOLES

The 23 test holes for which logs are given in this report were drilled during April, May, and June 1981. The drilling was done, under contract, by the Conservation and Survey Division, University of Nebraska. The total footage drilled was 8,305, an average of 361 feet per test hole. The deepest test hole, near Johnson Lake in Gosper County, was 710 feet; the shallowest, near the town of Bladen in Webster County, was 200 feet.

All of the test holes were drilled deep enough to penetrate about 20 feet of the underlying Cretaceous bedrock. Units penetrated in drilling include: silts, sands, and gravels of Quarternary age; sandstone, siltstone, sands and silts of the Ogallala Formation of Tertiary age; and siltstones of pre-Ogallala, Tertiary age. Cretaceous bedrock units penetrated include the Pierre Shale and marls and chalks of the Niobrara Formation.

General supervision during drilling was provided by a hydrogeologist who collected, examined, sacked, and labeled samples of the cuttings and developed field descriptive logs at the drilling site. Samples of the cuttings were obtained from each unit of homogeneous material and were obtained at 5-foot intervals if the unit was more than 5 feet thick. After first evidence of reaching Cretaceous bedrock, samples were obtained at least every 5 feet for about 20 feet to assure that bedrock had been reached and to assure that adequate samples would be available for identifying the composition of the bedrock.

In developing the descriptive logs at the drilling site, descriptions of the drill cuttings were recorded along with the drilling times and drilling action. Field samples containing significant quantities of silt or clay were compared, while wet, to a Munsell soil-color chart to determine sample color. No colors were described for sands or sand and gravel units, because their color often reflects surface coatings on the grains and because individual gravel clasts often have widely varying

colors. Also, diluted hydrochloric acid was applied to representative fractions of all samples to aid in estimating the relative amount of calcareous material in the samples.

After drilling was completed, probes were lowered into the boreholes to acquire geophysical information. Spontaneous potential, single-point resistance, and natural gamma-ray logs were run for all test holes; 64-inch long-normal logs and (or) caliper logs were run on each of the test holes. Equipment used in logging was provided by the U.S. Geological Survey. Logging speeds of 25 to 35 feet per minute were used for the spontaneous-potential and resistance logs, and a speed of 20 feet per minute was used for the natural gamma-ray and caliper logs.

DISCUSSION OF DESCRIPTIVE, GEOLOGIC, AND GEOPHYSICAL LOGS

The descriptive logs in this report are based on the sample logs developed in the field. These logs were modified slightly by using the geophysical logs to locate contacts between different materials and by re-examining drill cuttings where field descriptions of texture were inadequate.

Most of the test holes were drilled along the edge of county roadways near intersections. These test holes generally penetrated 2 to 4 feet of compacted roadfill material. This material ordinarily is locally acquired topsoil and loess, and its texture is clayey silt and silty clay.

Surface elevations for each test hole were determined from U.S. Geological Survey 7½-minute quadrangle sheets. The range of error in these elevations is usually $\pm$ 5 feet or $\pm$ 10 feet, depending on whether contour intervals on tne quadrangle sheets are 10 feet or 20 feet.

The geologic logs represent the lithology at each test-hole site with graphic patterns. The patterns are explained on plate 1 at the back of the report. Numbers to the left of the geologic logs are the depths from land surface, in feet. These numbers correspond to tick marks on the geophysical logs.

The geophysical logs were reduced to publication size using a computerized digitizer. Vertical and horizontal scales were reduced by different factors, but the factors used were kept constant for the geophysical logs of all 23 test holes.

Spontaneous-potential, single-point resistance, and natural gamma-ray are the only geophysical logs presented in this report. On all of these logs, units increase in value from left to right. Units of measurements are millivolts for the spontaneous-potential logs, ohms for the resistance logs, and counts per second for the natural gamma-ray logs.

In general, spontaneous-potential and natural gamma-ray logs have lower values for coarse-grained sediments than for fine-grained sediments. However, for electrical resistance logs, the values are higher for coarse-grained sediments than for fine-grained sediments.

Occasional problems were encountered with some logs when the pen ran off the track during the logging procedure. Usually this was corrected by recentering the pen onto the track and recording how much displacement was required to do so. The pen was not reset on some graphs, however, and parts of those records were lost. Examples of log traces when such problems occurred are shown on plate 1.

The original copies of the descriptive and geophysical logs are available in the files of the Conservation and Survey Division, University of Nebraska, 113 Nebraska Hall, Lincoln, Nebr. 68588. Likewise, samples of drill cuttings are stored in the core and sample library maintained by the Conservation and Survey Division.

ARRANGEMENT OF THE LOGS

All logs for a given test hole are presented together, with the descriptive log presented first. Heading information over the descriptive log includes a precise statement of location of the test-hole site, the land-surface elevation of the site, the date drilled, and the field number of the test hole. Following the descriptive log, the geologic

and geophysical logs are presented side by side on the same page. Heading information over these logs includes depth to water from land surface, total depth drilled, and, in remarks, the availability of additional log information not being shown.

Logs for the individual test holes are presented in numerical sequence according to increasing size of the test-hole number.

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_____ 1953d, Logs of test holes - Franklin County, Nebraska: Conservation and Survey Division, University of Nebraska, and U.S. Geological Survey, 14 p.

_____ 1953e, Logs of test holes - Gosper County, Nebraska: Conservation and Survey Division, University of Nebraska, and U.S. Geological Survey, 30 p.

_____ 1953f, Logs of test holes - Harlan County, Nebraska: Conservation and Survey Division, University of Nebraska, and U.S. Geological Survey, 25 p.

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Test-hole 3N-12W-25AAAA1

Location: 8 ft. S. of N. sec. line and 26 ft. W. of E. sec. line.
Date drilled: 6-4-81.
Field number: 22-B-81.
Land surface altitude: 1,967 ft above National Geodetic Vertical Datum of 1929 (NGVD).

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	3
Clay, dark brown	3	4
Clay, silty, brown	4	6
Clay, moderately to very silty, light brown	6	28
Silt, slightly sandy, clayey	28	30
Silt, light brown	30	42
Silt, slightly sandy, light brown	42	48
Silt, moderately sandy, light grayish brown	48	64
Silt, light grayish brown	64	65
Sand, very fine to fine	65	74
Sand, medium to coarse	74	80
Sand and gravel, medium sand to medium gravel, 35 percent gravel, much very coarse sand	80	102
Silt, moderately sandy, gray	102	103
Sand and gravel, medium sand to fine gravel, 10 percent gravel, much coarse sand	103	114
Sand, medium to coarse	114	120
Sand and gravel, sand is medium to very coarse	120	150
Sand, coarse to very coarse	150	155
Sand and gravel, medium sand to fine gravel, 5 to 10 percent gravel, much medium to coarse sand	155	162
Silt, light gray	162	163

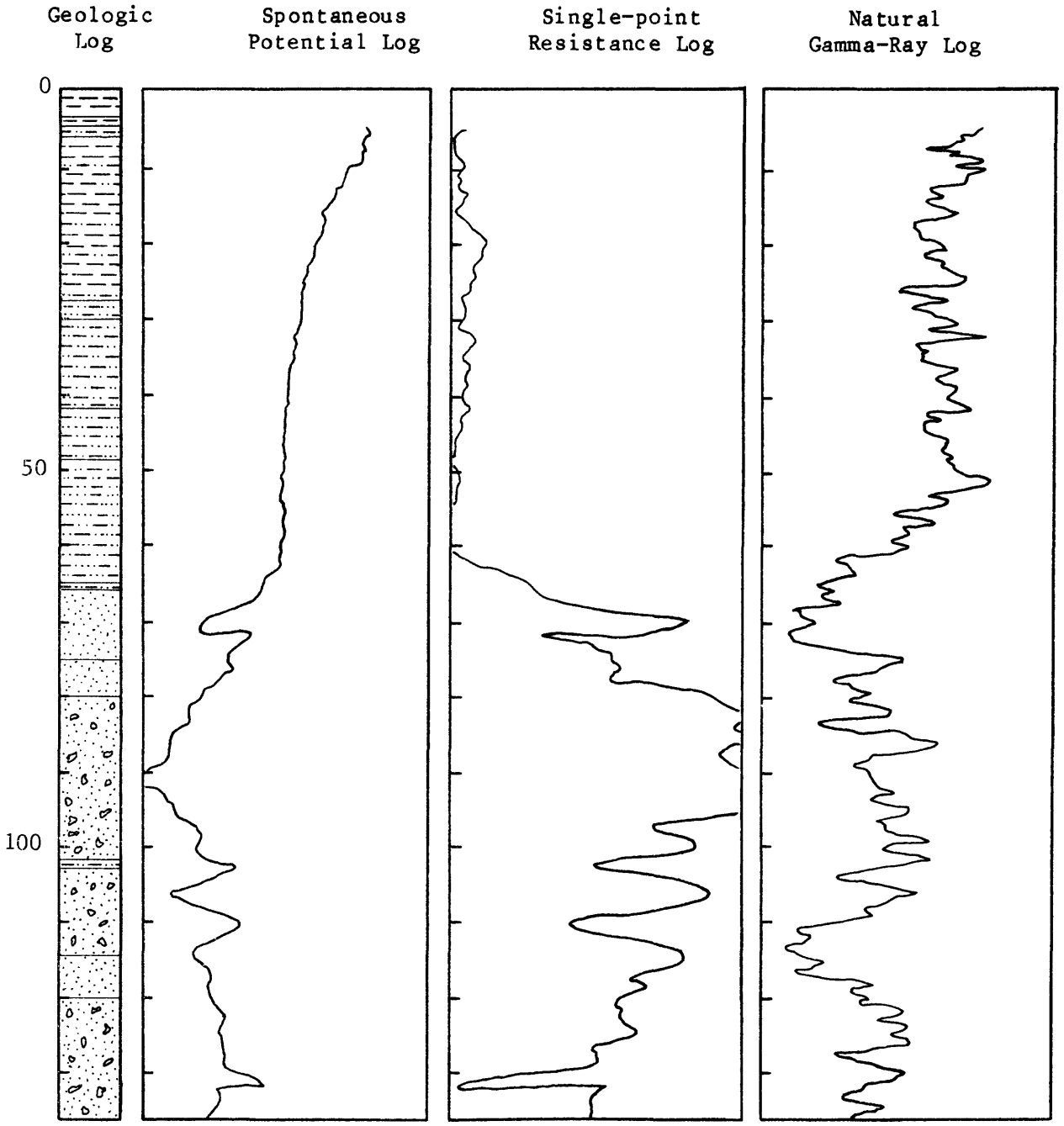
Test-hole 3N-12W-25AAAA1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand and gravel, medium sand to medium gravel, 35 percent gravel, much medium to very coarse sand	163	172
Clay, tan	172	173
Sand and gravel, medium sand to coarse gravel, 70 percent gravel, much fine gravel	173	180
Sand and gravel, fine sand to medium gravel, 10 percent gravel much medium to coarse sand	180	193
Clay, silty, grayish-brown to brown	193	200
Silt, very clayey and clay, moderately silty, brown, calcareous nodules	200	214
Silt, very clayey and clay, moderately silty, very light brown, very limy in part	214	233
Silt, moderately sandy, light brown	233	235
Sand, fine to medium	235	247
Cretaceous System, Niobrara Formation:		
Clay, very light gray	247	250
Clay, dark blueish-gray to greenish gray	250	270

Test-hole 3N-12W-25AAAA 1 (cont'd)

Depth to water: 113 feet.
Total Depth Drilled: 270 feet.
Remarks: 64 inch long normal log available.



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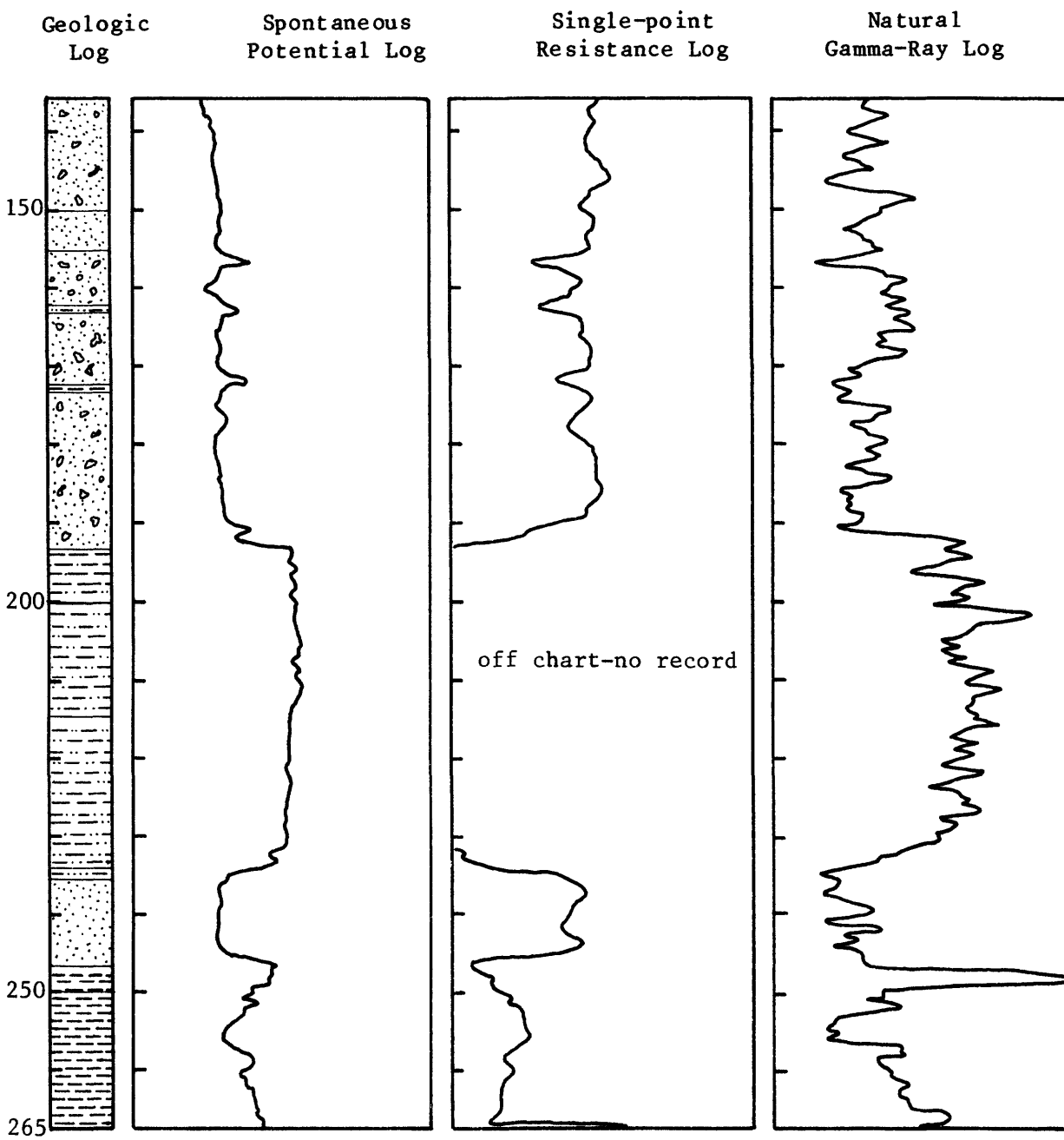


Test-hole 3N-14W-14DADD1

Location: 963 ft. S. of half sec. line and 7 ft W. of E. sec. line.
Date drilled: 5-29-81.
Field number: 21-B-81.
Land surface altitude: 2,086 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	1
Silt, slightly clayey, very dark grayish-brown	1	2
Silt, slightly clayey, light yellowish-brown	2	8
Silt, slightly sandy, very fine to fine sand, dark yellowish-brown	8	12
Silt, moderately sandy, sand is very fine to fine, yellowish-brown	12	21
Sand, very fine to fine, some medium	21	31
Silt, moderately sandy, sand is very fine, brownish-yellow to yellowish-brown	31	47
Sand, very fine to fine, very silty, brownish-yellow	47	55
Silt, slightly sandy and clayey, light yellowish-brown to brownish-yellow	55	60
Silt, slightly to moderately clayey, yellowish-brown	60	70
Silt, slightly clayey, some very fine sand, yellowish-brown	70	84
Sand, moderately silty, light yellowish-brown	84	88
Silt, very sandy, slightly clayey, light yellowish-brown	88	89
Sand, very fine to fine	89	92
Silt, very sandy, brownish-yellow	92	94
Sand, very fine to fine, moderately silty	94	95

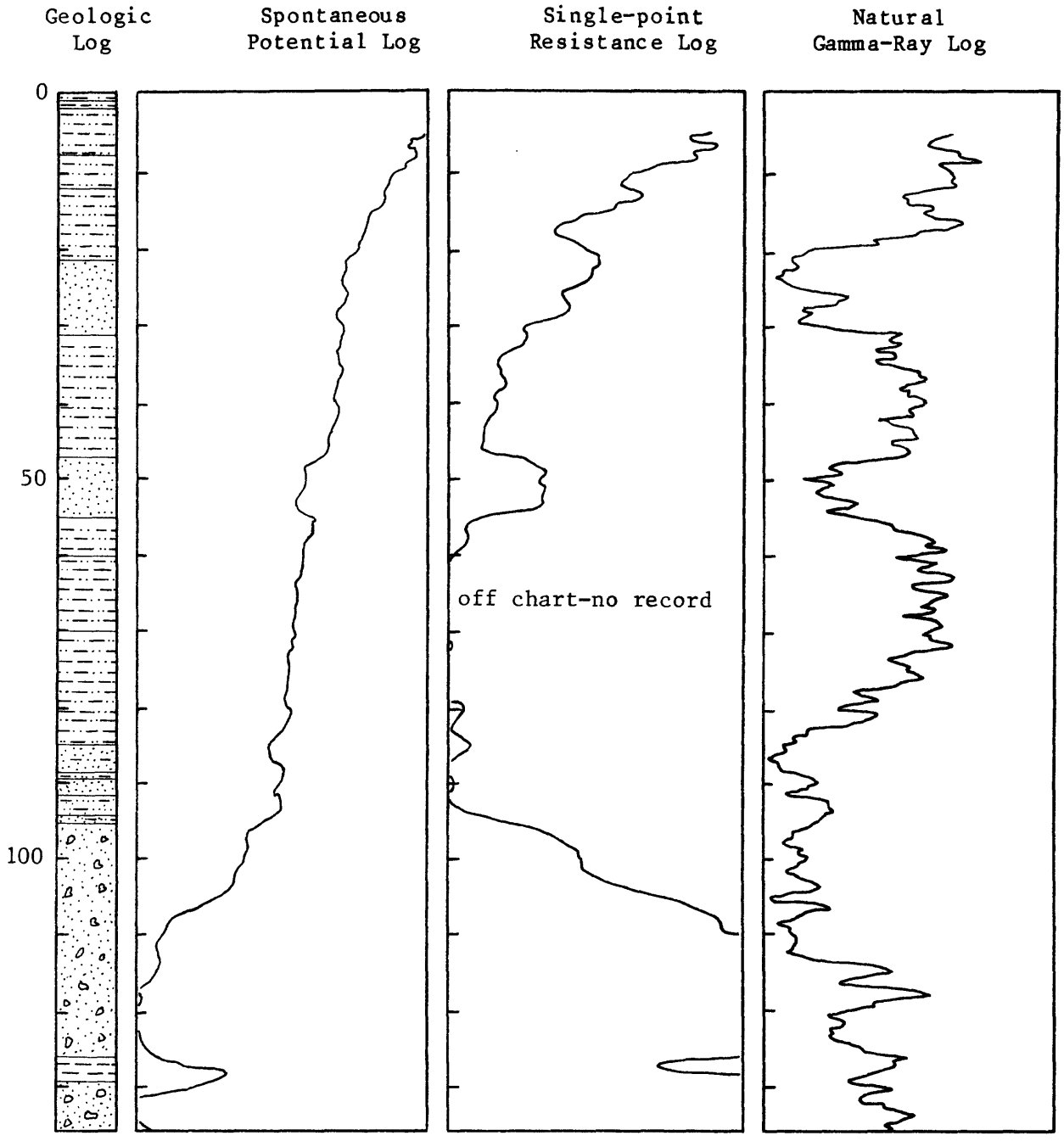
Test-hole 3N-14W-14DADD1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand and gravel, fine sand to medium gravel, much coarse sand to fine gravel----------	95 -	127
Clay, light yellowish-brown----------	127 -	129
Sand and gravel, fine sand to coarse gravel, much coarse sand to fine gravel, fragments of weathered shale from 205 to 210 feet----------	129 -	210
Cretaceous System, Pierre Formation:		
Clay, pale olive----------	210 -	211
Clay, black----------	211 -	219
Niobrara Formation:		
Clay, dark grayish-brown, moderately to very calcareous-----	219 -	230

Test-hole 3N-14W-14DADD 1 (cont'd)

Depth to water: 161 feet.
Total Depth Drilled: 230 feet.
Remarks: 64 inch long normal log available.



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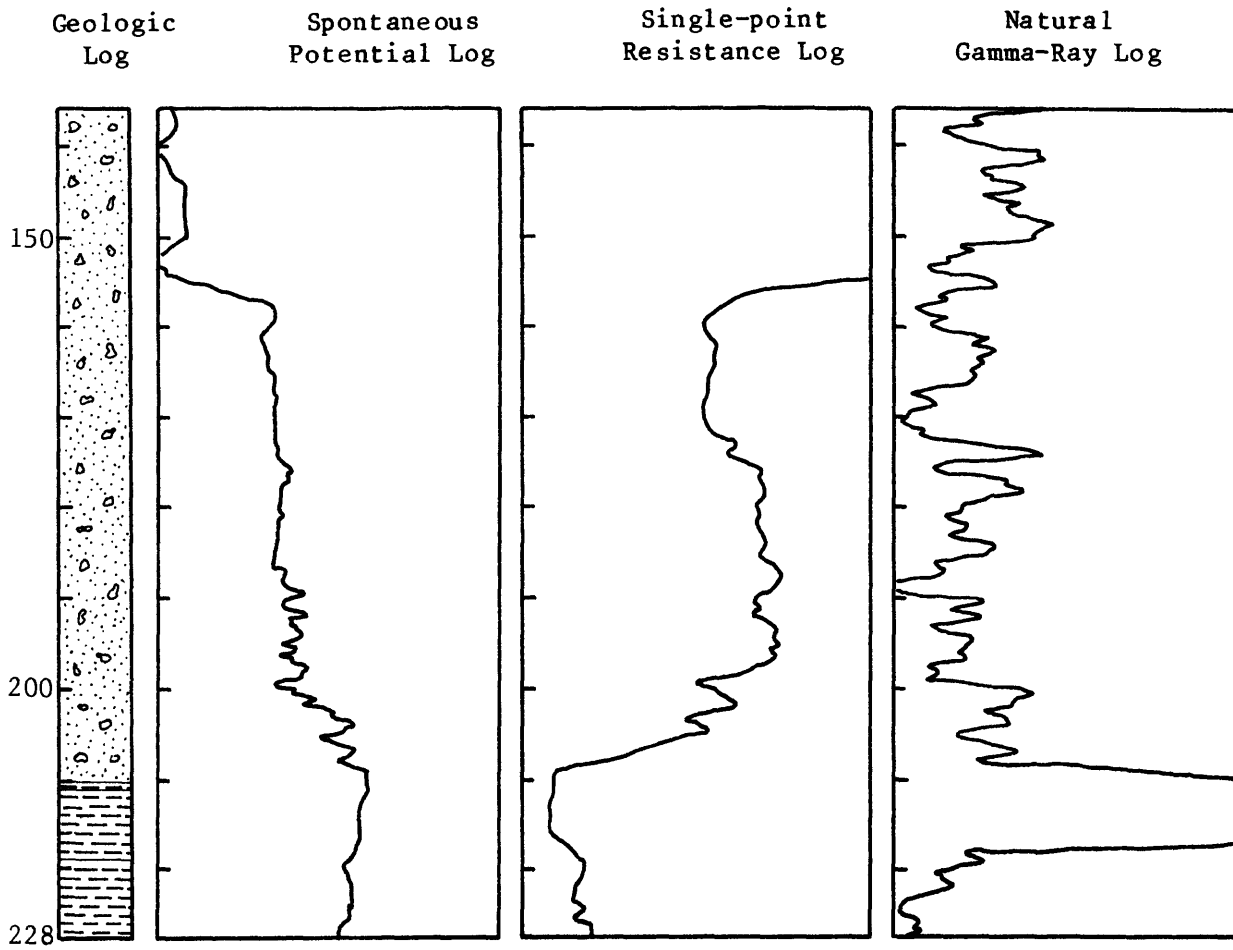


Test-hole 4N-12W-1ABAA1

Location: 551 ft. S. of N. sec. line and 8 ft. W. of E. quarter line.
Date drilled: 6-3-81.
Field number: 23-B-81.
Land surface altitude: 1,955 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	5
Clay, moderately silty, brown	5	17
Clay, moderately silty, light brown	17	31
Silt, moderately clayey, brown	31	40
Silt, slightly to very sandy, brown	40	49
Silt, clayey, brown	49	50
Silt, moderately sandy, brown	50	66
Silt, light brownish-gray	66	79
Silt, very sandy, light brown	79	81
Silt, moderately clayey, gray	81	89
Silt, moderately sandy, light gray	89	93
Sand, fine	93	105
Silt, very sandy, gray	105	110
Sand, fine to medium, silty	110	113
Silt, very sandy, gray	113	115
Sand, medium to coarse, some gravel	115	119
Silt, moderately sandy, light gray	119	120
Sand and gravel, sand is fine to very coarse	120	176

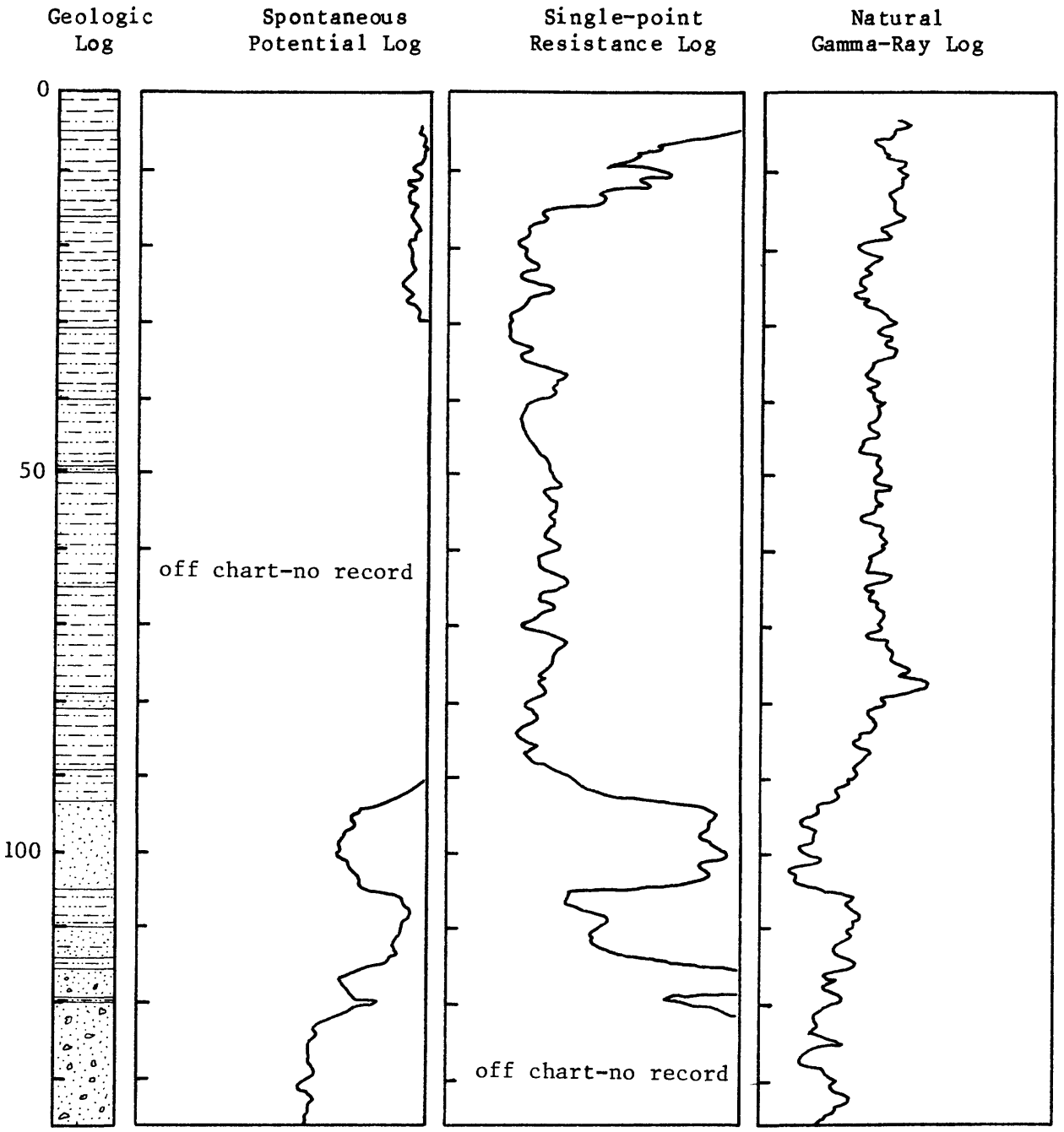
Test-hole 4N-12W-1ABAA1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Cretaceous System, Niobrara Formation:		
Clay, yellow, slightly calcareous----------	176	180
Clay, dark gray to dark olive gray----------	180	200

Test-hole 4N-12W-1ABAA 1 (cont'd)

Depth to water: 76 feet.
Total Depth Drilled: 200 feet.
Remarks: 64 inch long normal log available.



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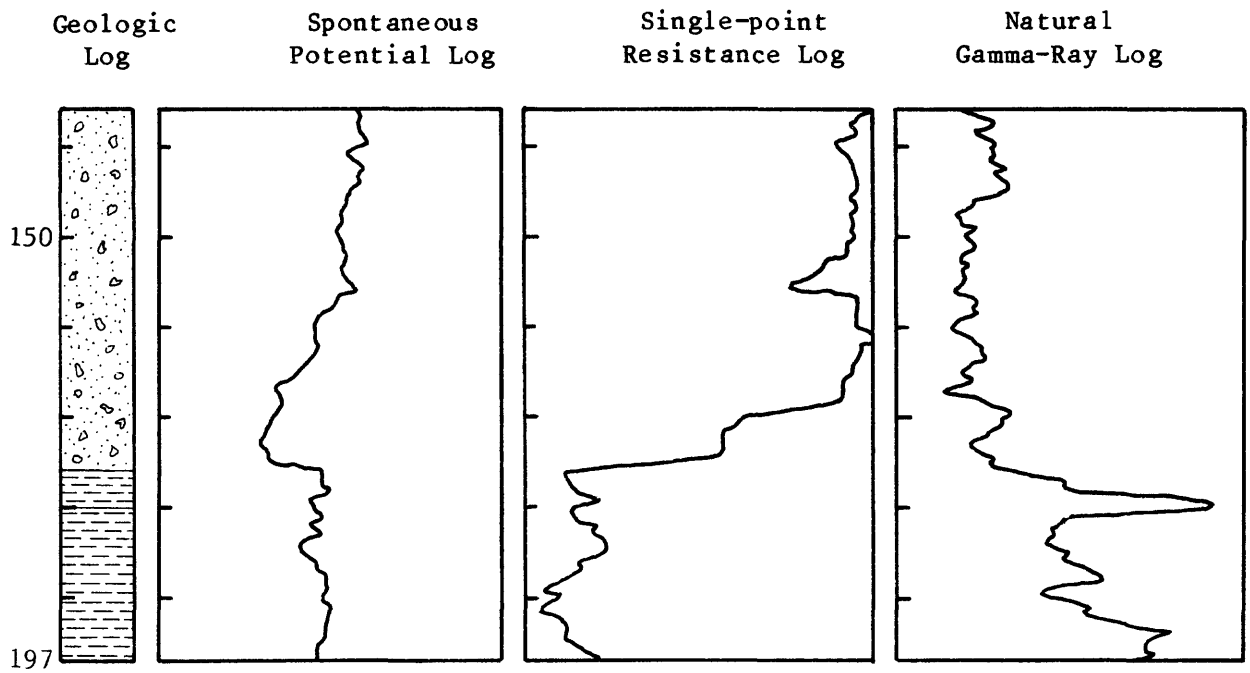


Test-hole 4N-14W-13DDDD1

Location: N. edge of an E-W county road, near intersection.
Date drilled: 5-28-81.
Field number: 20-B-81.
Land surface altitude: 2,133 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Silt, slightly to moderately clayey, very dark grayish-brown	2	3
Silt, slightly clayey, brown to light yellowish-brown	3	5
Silt, some very fine sand, light yellowish-brown	5	17
Silt, slightly to moderately sandy, very fine sand, dark brown to dark yellowish-brown	17	22
Silt, slightly to moderately sandy, yellowish-brown	22	25
Silt, slightly clayey, some very fine sand, yellowish-brown	25	55
Silt, moderately sandy 60 to 64 feet, yellowish-brown	55	64
Sand, very fine	64	70
Silt, very sandy to sand, very silty, brownish-yellow to yellowish-brown	70	81
Sand, very fine, pale brown	81	85
Silt, very sandy, very fine sand, brownish-yellow	85	100
Silt, very clayey and clay, very silty, slightly sandy from 100 to 105 feet, light yellowish-brown	100	113
Sand, very fine, light brown	113	117
Silt, moderately to very sandy, very fine sand, yellowish-brown	117	121
Sand, very fine to medium, much fine	121	123

Test-hole 4N-14W-13DDDD1 (cont'd)

Descriptive Log

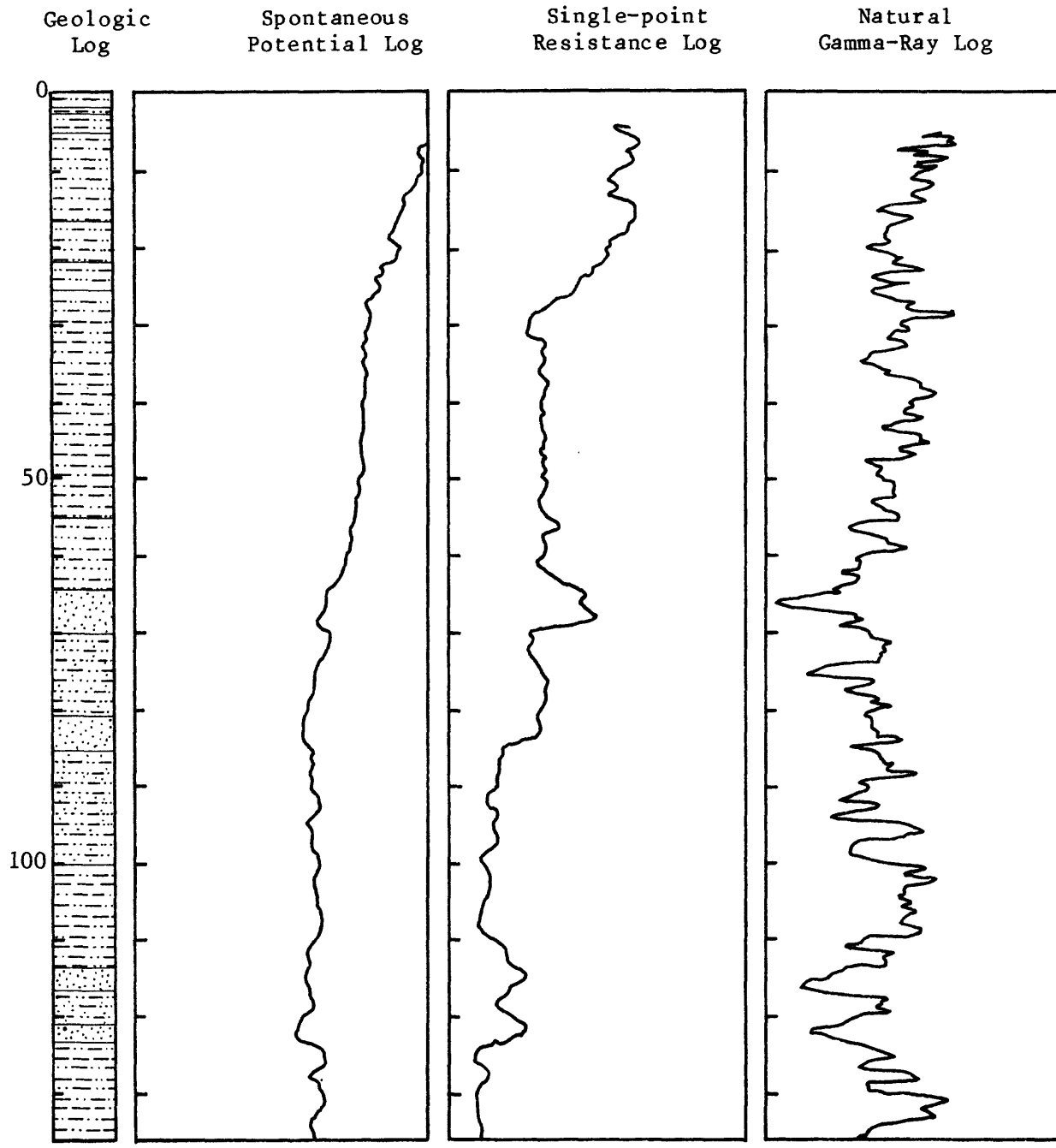
	Depth, in feet From	To
Silt, moderately to very clayey and clay, moderately silty, light yellowish-brown	123	136
Silt, slightly clayey, some very fine sand, yellowish-brown	136	141
Sand, very fine to fine, pale brown	141	142
Silt, moderately sandy and clayey, yellowish-brown	142	148
Sand, very fine to medium, much fine	148	149
Sand, very silty, pale yellowish-brown	149	150
Sand and gravel, fine sand to coarse gravel, much coarse sand to fine gravel	150	180
Sand and gravel, same as above except much fine to medium gravel	180	195
Sand and gravel, fine sand to medium gravel, much coarse to very coarse sand	195	215
Clay, silty, light yellowish-brown	215	217
Sand, fine to very coarse, some fine gravel, much medium to coarse sand	217	220
Clay, moderately silty, light yellowish-brown	220	221
Sand, medium with a silty clay layer 223 to 224 feet	221	225
Sand, fine to coarse, much medium to coarse	225	227
Silt, slightly clayey, some very fine sand, light brownish-gray	227	230
Sand and gravel, medium sand to fine gravel	230	232
Silt, moderately sandy, very fine sand, slightly clayey, light brownish-gray,	232	240
Silt, slightly clayey, light brownish-gray to gray	240	255
Silt, slightly clayey, moderately sandy, medium to coarse sand	255	261

Test-hole 4N-14W-13DDDD1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Tertiary System, Ogallala Group:		
Clay, very silty and silt, very clayey, olive gray----------	261	265
Sand and gravel, fine sand to medium gravel----------	265	271
Cretaceous System, Pierre Formation:		
Clay, light yellowish-brown----------	271	275
Clay, black----------	275	290

Depth to water: 173 feet.
Total Depth Drilled: 290 feet.
Remarks: 64 inch long normal log available.



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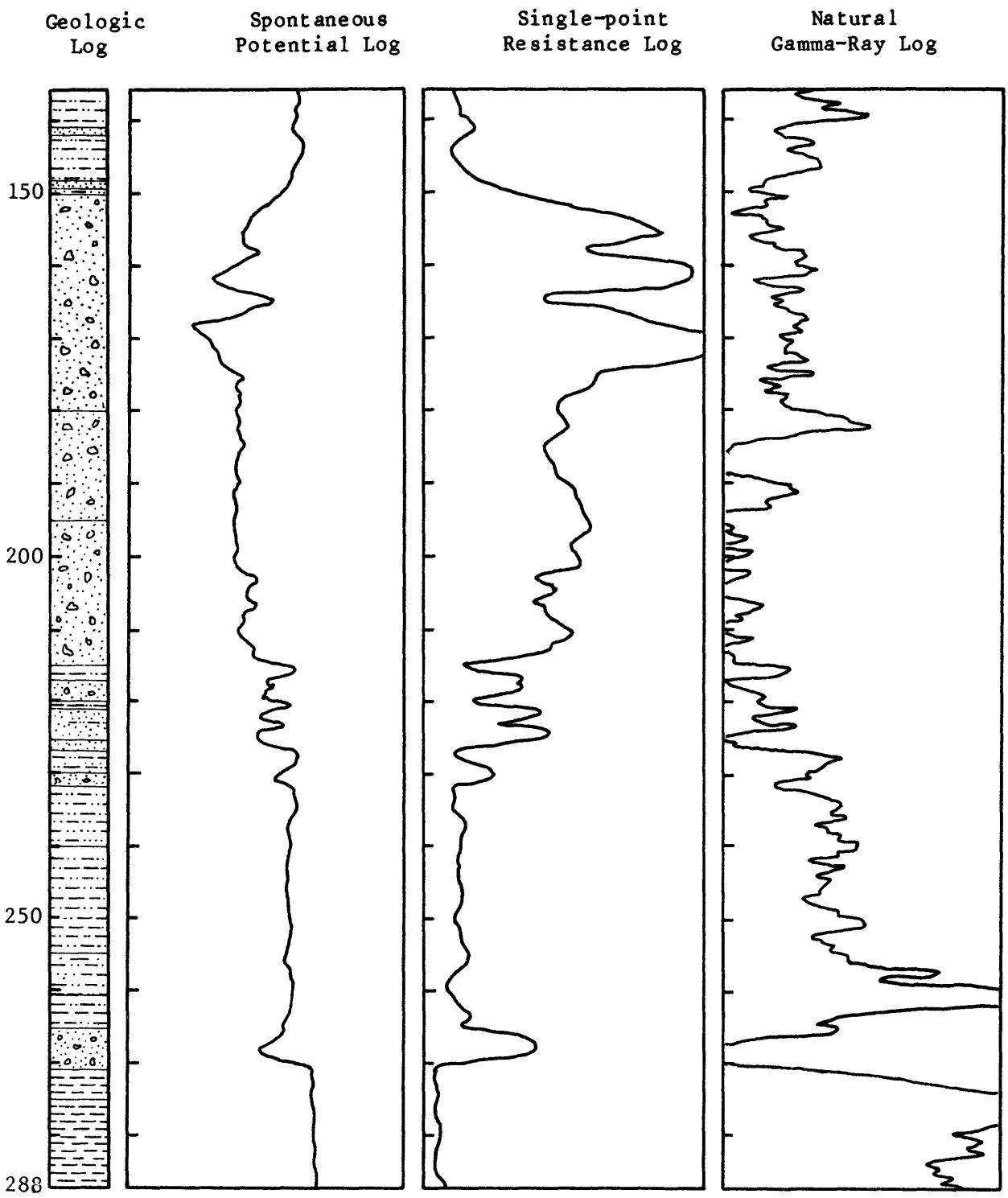


Test-hole 5N-14W-13DDDD1

Location: 8 ft. N. of S. sec. line and 336 ft. W. of E. sec. line.
Date drilled: 5-26-81.
Field number: 19-B-81.
Land surface altitude: 2,118 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Silt, slightly to very clayey, very dark gray to very dark brown	2	5
Silt, moderately clayey, brown	5	7
Silt, slightly to moderately clayey, some very fine sand, iron-staining, slightly calcareous from 10 to 17 feet, light yellowish-brown	7	17
Silt, slightly sandy, brown	17	21
Silt, slightly sandy, abundant iron-staining, yellowish-brown	21	26
Silt, very sandy, much iron-staining, light yellowish-brown-	26	30
Silt, moderately clayey and sandy, iron-staining, yellowish-brown to light yellowish-brown, slightly calcareous----	30	40
Silt, very clayey, yellowish-brown, very calcareous	40	45
Silt, very sandy, slightly clayey, few mollusk shells, yellowish-brown, slightly calcareous	45	54
Silt, moderately to very clayey, light yellowish-brown, moderately to very calcareous	54	62
Sand, fine, silty from 63 to 64 feet	62	67
Silt, moderately to very sandy, fine sand, light yellowish-brown, very calcareous	67	72
Sand, very fine to medium, much fine, very silty	72	76
Sand, very fine to medium, much fine, slightly silty	76	81

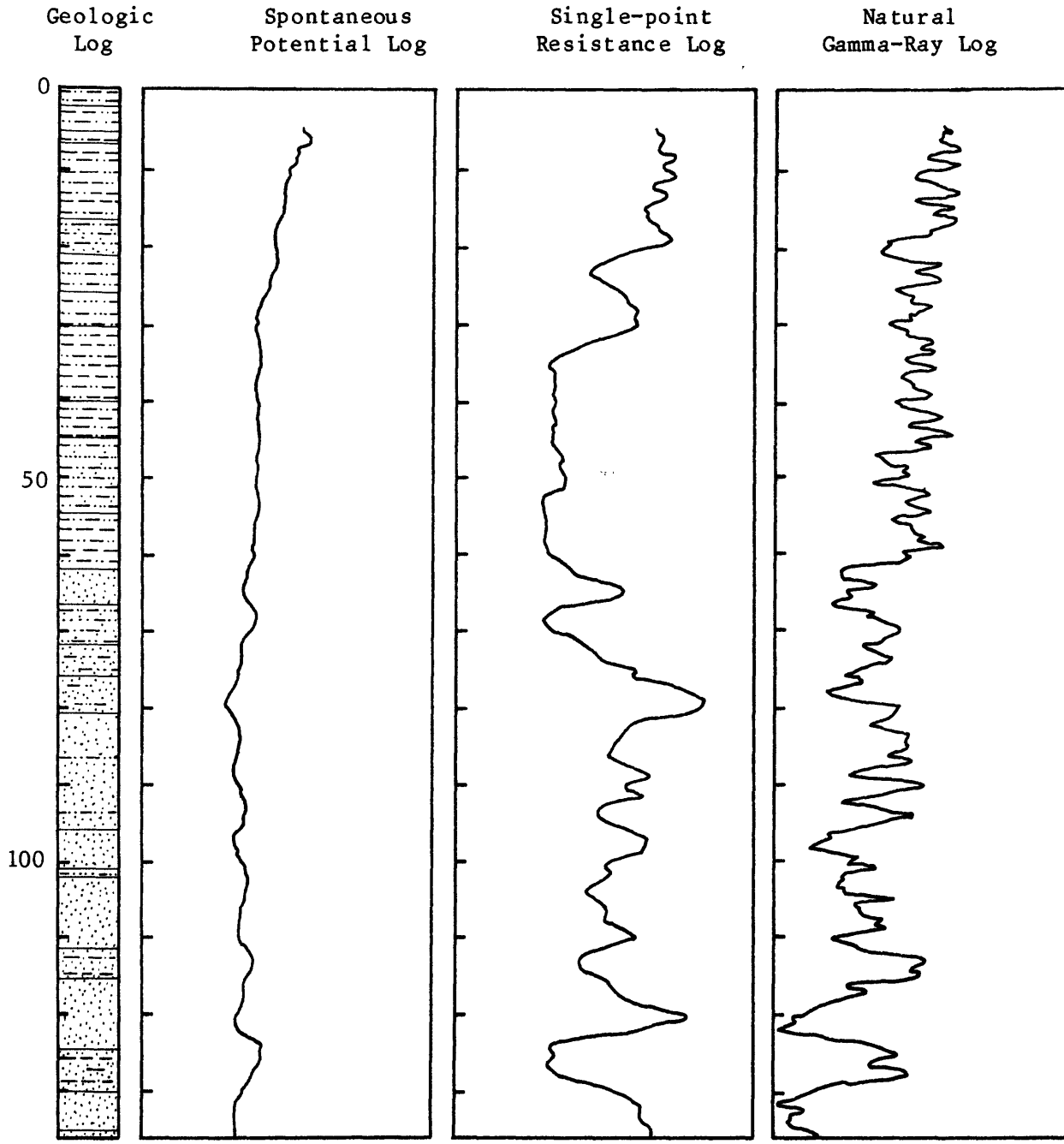
Test-hole 5N-14W-13DDDD1 (cont'd)

Descriptive Log

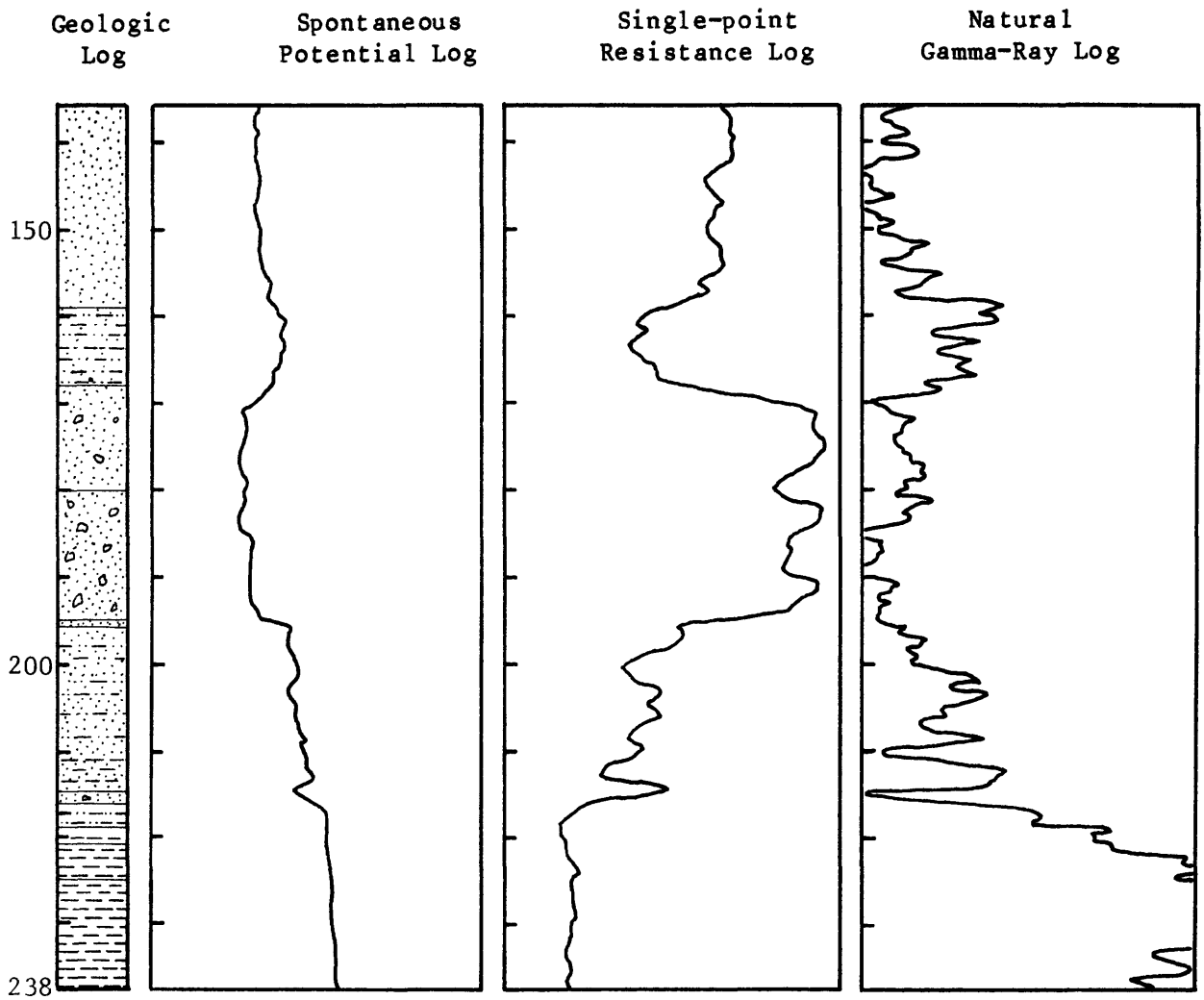
	Depth, in feet From	To
Sand, medium, interbedded with silt, light olive brown------	81	96
Sand, medium----------	96	101
Sand, very fine to fine, slightly silty, moderately well sorted----------	101	102
Sand, medium, some iron-staining, pale olive brown----------	102	112
Sand, medium, very silty and clayey----------	112	116
Sand, medium to coarse----------	116	124
Sand, medium, very clayey, light gray, some iron-staining---	124	130
Sand, medium----------	130	135
Sand, coarse, pale yellowish-brown----------	135	159
Sand, very silty and silt, very sandy and clayey, some iron-staining, pale yellowish-brown----------	159	168
Sand, medium to very coarse, some gravel clasts, pale yellowish-brown----------	168	180
Sand and gravel, some pebbles to 10 mm----------	180	195
Sand, medium to coarse, much medium----------	195	196
Sand, medium to coarse, slightly to very silty, very clayey 210 to 215 feet, light gray----------	196	214
Sand, coarse, a few gravel clasts----------	214	216
Siltstone, very clayey, pale olive----------	216	219
Cretaceous System, Pierre Formation:		
Clay, olive yellow----------	219	221
Clay, gray to olive brown----------	221	225
Clay, black----------	225	240

Test-hole 5N-14W-13DDDD 1 (cont'd)

Depth to water: 122 feet.
Total Depth Drilled: 240 feet.
Remarks: 64 inch long normal log available.



Test-hole 5N-14W-13DDDD1 (cont'd)



Test-hole 5N-15W-31CCCC1

Location: 12 ft. N. of S. sec. line and 60 ft. E. of W. sec. line.
Date drilled: 5-7-81.
Field number: 12-B-81.
Land surface altitude: 2,184 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	1.5
Silt, slightly to moderately clayey, dark brownish gray	1.5	3.5
Silt, slightly clayey, light yellowish brown	3.5	9.5
Silt, moderately sandy and clayey, very pale brown to brown, slightly calcareous	9.5	14.5
Silty, sandy, brown, slightly calcareous	14.5	15
Sand, moderately to very silty, light yellowish brown to brown	15	17
Sand, very fine to medium, much fine	17	38
Clay, moderately silty, light yellowish brown	38	41
Silt, moderately to very clayey, pale olive	41	43
Silt, moderately sandy, very fine sand	43	44
Sand, very fine to medium	44	52
Sand, very silty, few iron stains	52	54
Silt, very sandy, iron-staining	54	57
Sand, fine to coarse	57	61
Sand, very fine to medium, very silty, iron staining	61	65
Silt, very sandy, very fine to medium sand, moderately clayey	65	67
Sand, moderately silty	67	73

Test-hole 5N-15W-31CCCC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand, very fine to medium, some coarse	73	78
Silt, slightly to moderately clayey, and sandy, yellowish brown to brownish yellow	78	98
Sand, very fine to medium, some coarse	98	105
Sand, very fine to medium, moderately silty	105	114
Sand, fine to coarse, some very coarse	114	115
Sand and gravel, fine sand to fine gravel, 20 to 25 percent gravel	115	145
Sand and gravel, medium sand to very fine gravel 20 percent gravel	145	155
Sand and gravel, fine sand to medium gravel, 10 percent gravel	155	170
Sand and gravel, medium sand to medium gravel, 10 percent gravel	170	177
Tertiary System, Ogallala Group:		
Silt, moderately sandy and slightly clayey, light brownish gray	177	185
Silt, moderately clayey, pale brown	185	188
Silt, slightly to moderately clayey, some very fine sand, light yellowish brown, slightly calcareous in places	188	204
Silt, moderately clayey, brown	204	207
Silty clay and clayey silt, light brownish gray	207	221
Silt, moderately to very clayey, pale brown, slightly calcareous	221	233
Silt, slightly clayey, light brownish gray, slightly calcareous, some iron-staining, slightly sandy 250 to 255 feet	233	261
Clay, moderately silty, olive gray	261	265

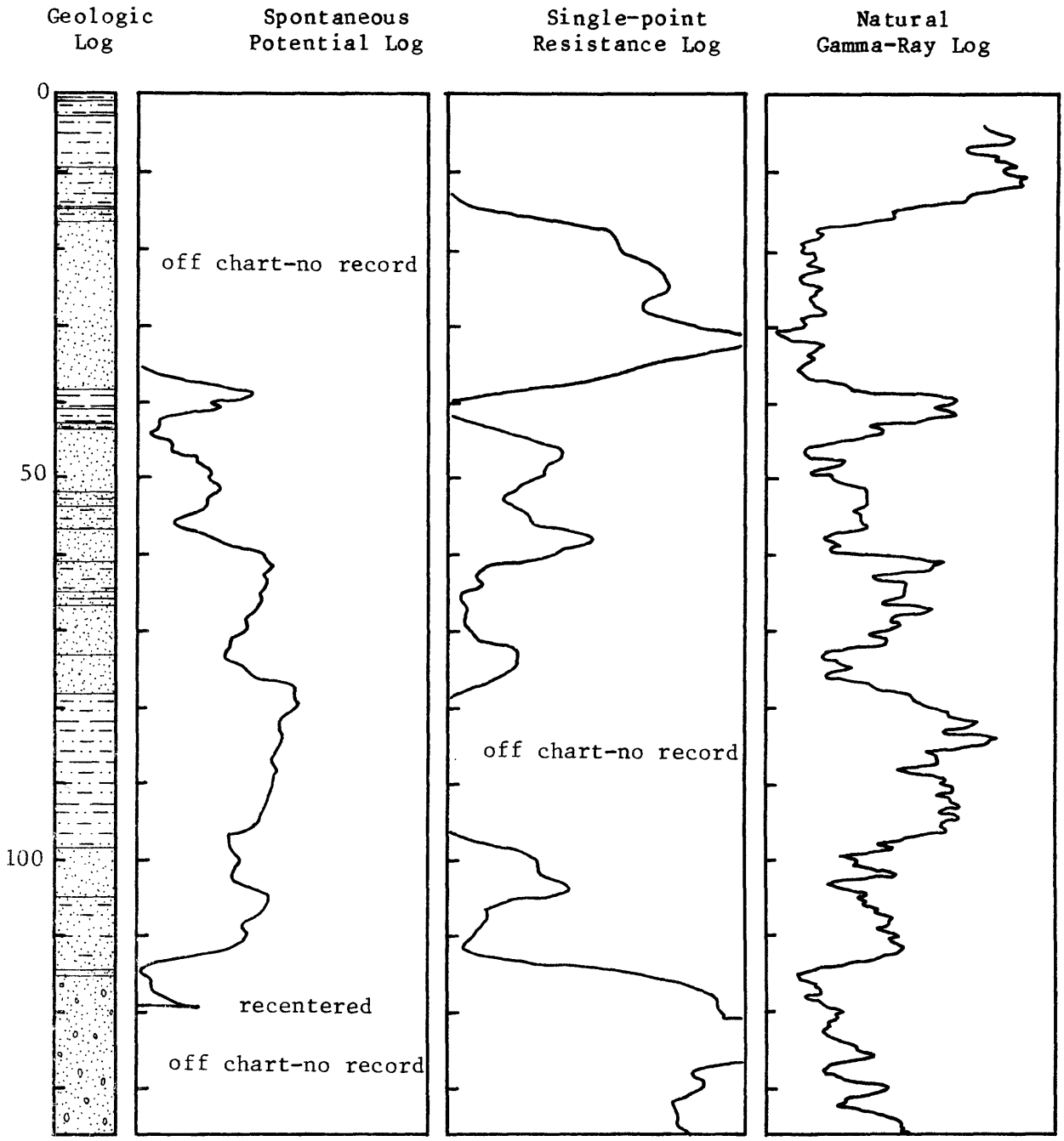
Test-hole 5N-15W-31CCCC1 (cont'd)

Descriptive Log

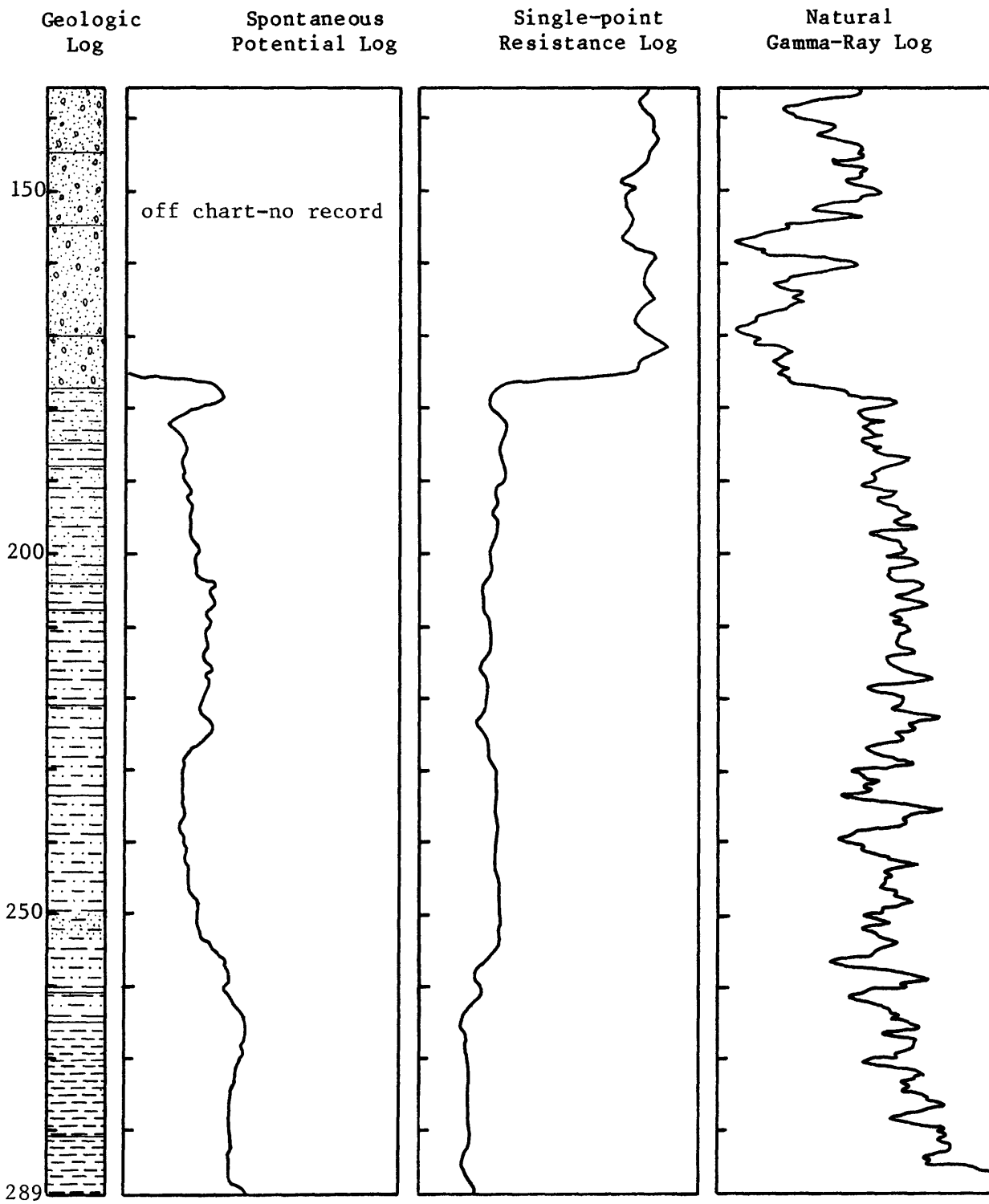
	Depth, in feet From	To
Cretaceous System, Pierre Formation:		
Shale, light olive gray, abundant iron-staining----------	265	281
Shale, medium gray----------	281	290

Test-hole 5N-15W-31CCCC 1 (cont'd)

Depth to water: 124 feet.
Total Depth Drilled: 290 feet.
Remarks: 64 inch long normal log available.



Test-hole 5N-15W-31CCCC1 (cont'd)



Test-hole 5N-16W-13DDDD1

Location: 10 ft. N. of S. sec. line and 196 ft. W. of E. sec. line.
Date drilled: 5-12-81.
Field number: 13-B-81.
Land surface altitude: 2,184 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	3
Silt, very dark grayish brown	3	8
Clay, slightly silty, yellowish brown	8	26
Sand, very fine to medium	26	35
Sand and gravel, medium sand to fine gravel	35	40
Clay, moderately silty, dark yellowish brown	40	42
Sand, moderately silty and clayey, dark yellowish brown	42	44
Silt, very sandy, very fine sand, yellowish brown	44	50
Silt, yellowish brown	50	55
Sand, very fine, moderately silty, yellowish brown to brownish yellow	55	60
Sand and gravel, medium sand to fine gravel	60	64
Silt, slightly sandy, light yellowish brown	64	66
Sand and gravel, medium sand to fine gravel	66	90
Silt, moderately sandy, light yellowish brown to yellowish brown	90	109
Sand and gravel, fine sand to medium gravel, poorly sorted, a few thin silt layers	109	148
Silt, slightly sandy, light yellowish brown	148	150
Sand and gravel, medium sand to medium gravel, slightly silty	150	164

Test-hole 5N-16W-13DDDD1 (cont'd)

Descriptive Log

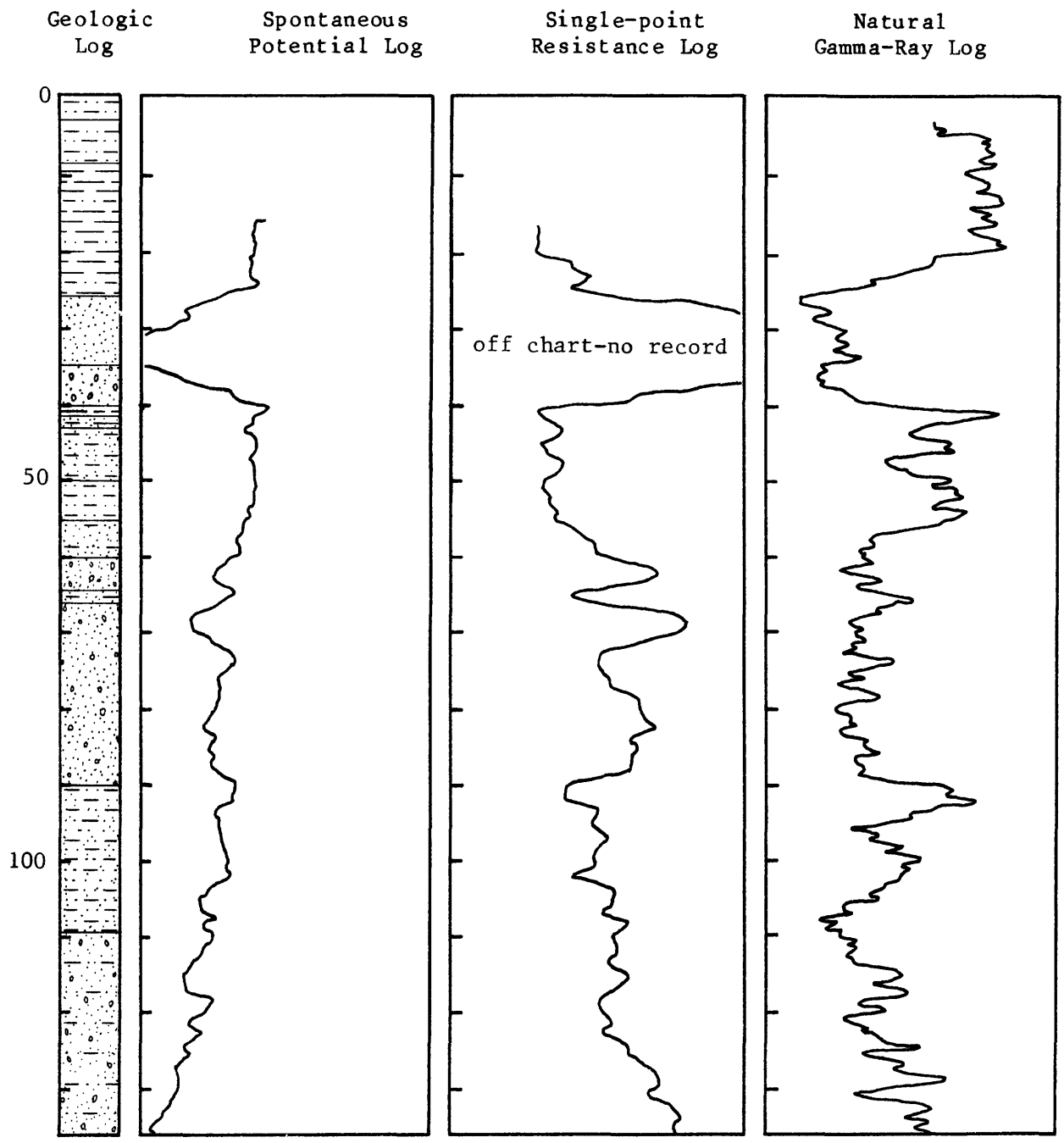
	Depth, in feet From	To
Silt layer	164	165
Sand, medium and fine gravel, poorly sorted	165	175
Clay, moderately silty, brown	175	182
Clay, moderately sandy, yellow	182	185
Clay, yellowish brown	185	200
Clay, slightly silty and sandy, brownish yellow to light yellowish brown	200	228
Tertiary System, Ogallala Group:		
Sand, very fine, very silty, light yellowish brown	228	235
Sand, very fine	235	238
Silt, moderately clayey and sandy, sand is very fine to fine, pale yellow to yellow	238	245
Sand, fine, moderately silty, light gray	245	250
Silt, very clayey, pale yellow	250	258
Silt, slightly clayey, sandy in part, pale yellow to pale olive	258	270
Silt, slightly sandy, very fine sand, moderately calcareous, pale olive	270	274
Sand, very fine to fine, some medium, olive color, slightly calcareous	274	290
Silt, slightly sandy, pale olive	290	300
Sand, very fine to fine, pale olive	300	303
Silt, moderately sandy, pale olive to yellow olive	303	304

Test-hole 5N-16W-13DDDD1 (cont'd)

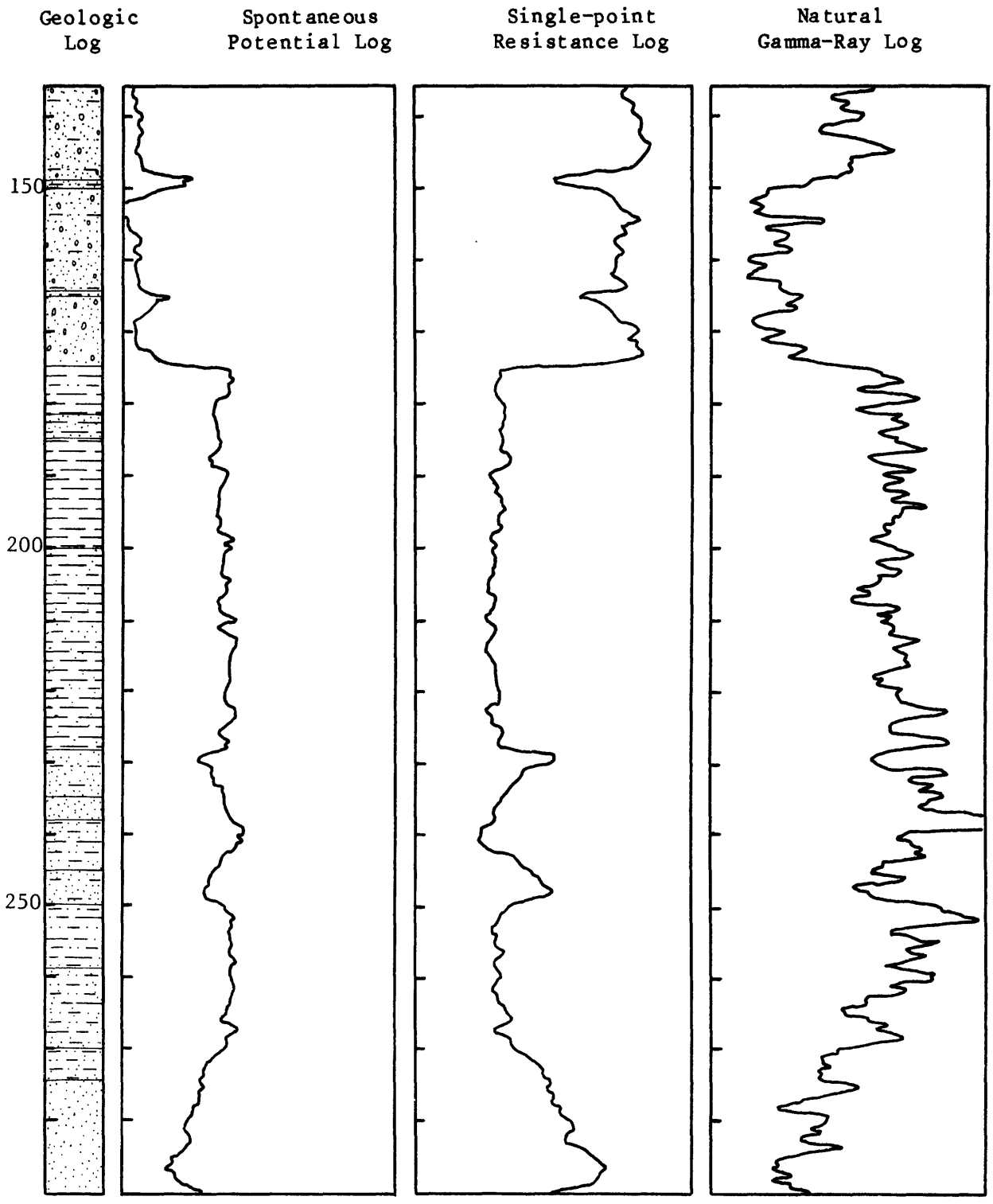
Descriptive Log

	Depth, in feet From	To
Cretaceous System, Pierre Formation:		
Clay, yellowish gray, moderately calcareous----------	304 -	307
Clay, olive gray, moderately to very calcareous----------	307 -	330

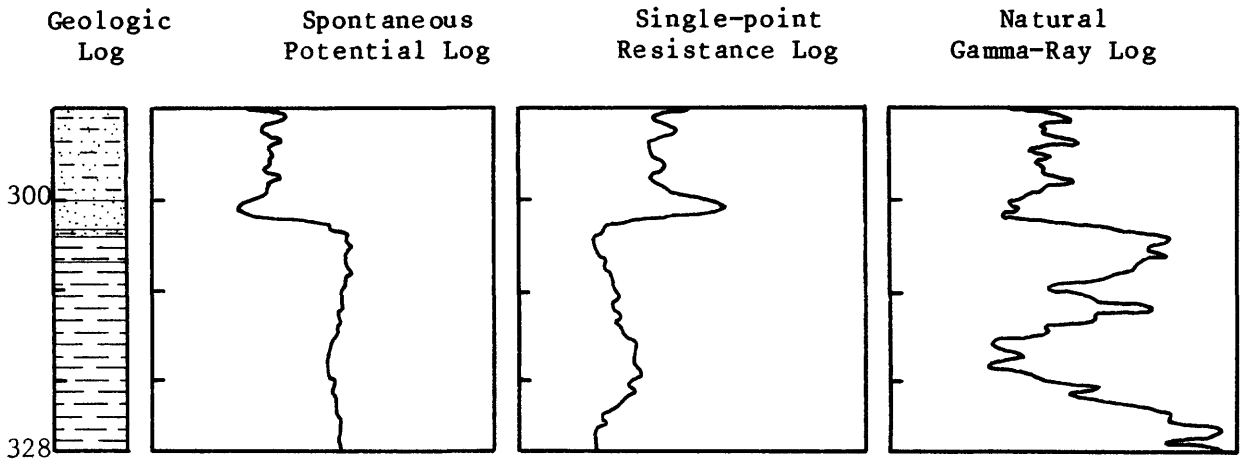
Depth to water: 73 feet.
Total Depth Drilled: 330 feet.
Remarks: 64 inch long normal log available.



Test-hole 5N-16W-13DDDD1 (cont'd)



Test-hole 5N-16W-13DDDD1 (cont'd)



Test-hole 5N-17W-19AAAA1

Location: 147 ft. S. of N. sec. line and 9 ft. W. of E. sec. line.
Date drilled: 5-6-81.
Field number: 11-B-81.
Land surface altitude: 2,253 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	3
Clay, silty, dark grayish brown	3	4
Clay, very silty, brown to grayish brown	4	5
Silt, moderately clayey, dark grayish brown	5	8
Silt, slightly to moderately clayey, brown to dark brown	8	15
Silt, very clayey, and clay, very silty, dark grayish brown	15	16
Silt, moderately to very clayey, some limonitic rootlets, light olive gray to pale olive	16	20
Silt, slightly to very clayey, some iron-staining, light brownish gray	20	40
Silt, moderately to very sandy, very fine to fine sand, brown	40	47
Silt, moderately to very clayey, slightly sandy, pale brown	47	51
Sand, very fine to fine	51	56
Sand, very fine to fine, moderately to very silty	56	62
Sand, very fine to coarse, some very coarse	62	72
Silt, very sandy, sand is very fine to fine, light brownish gray	72	73
Sand, very fine to medium, some coarse	73	84
Silt, very sandy, very fine to medium sand, some iron-staining	84	85

Test-hole 5N-17W-19AAAA1 (cont'd)

Descriptive Log

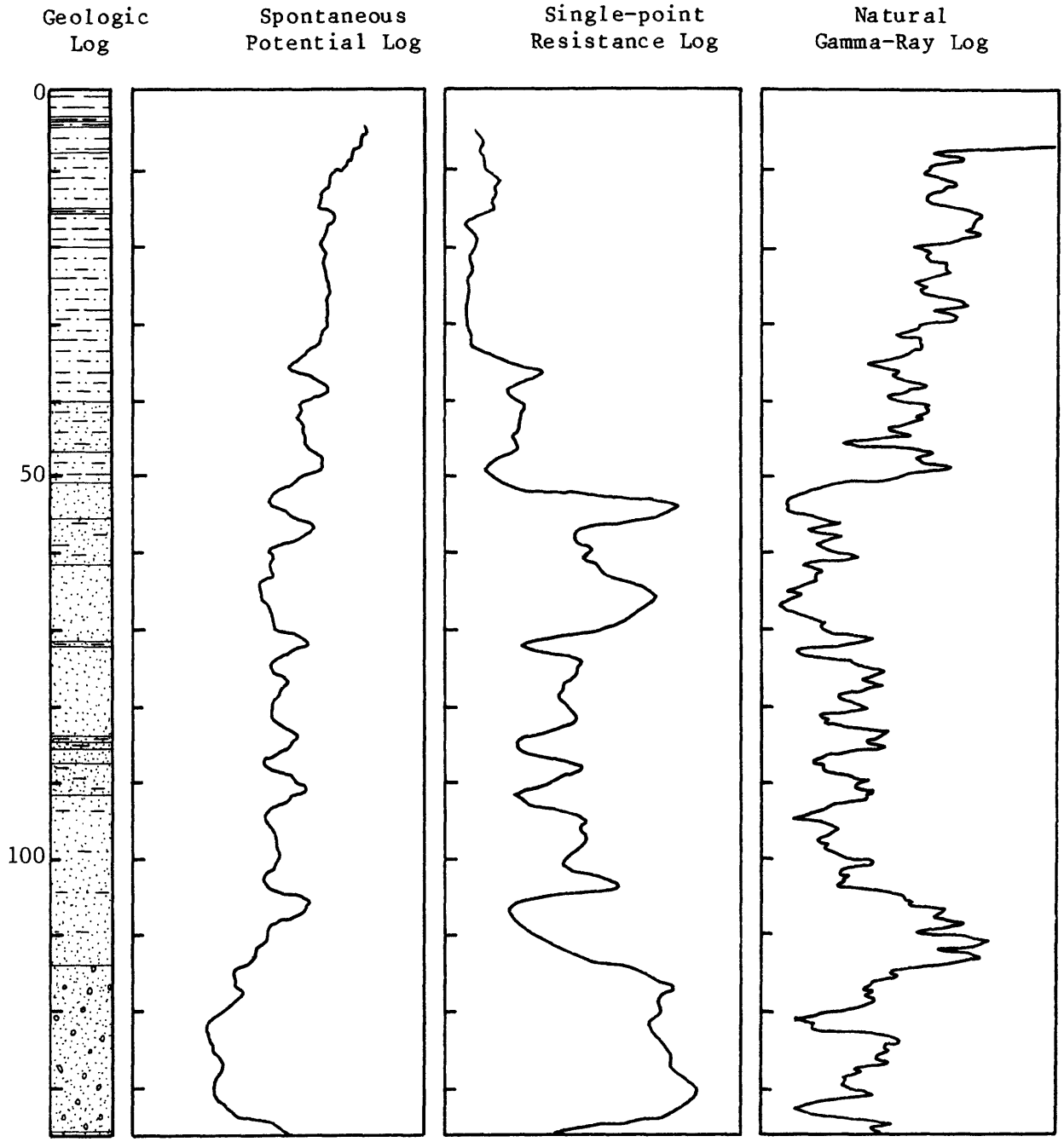
	Depth, in feet From	To
Sand, very fine to medium, slightly to moderately silty-----	85 -	86
Sand, very fine to medium----------	86 -	88
Sand, very fine to medium, moderately silty----------	88 -	92
Sand, very fine to coarse, a few silt layers----------	92 -	114
Sand and gravel, fine sand to coarse gravel, 50 percent gravel----------	114 -	135
Tertiary System, Ogallala Group:		
Sandstone, sand is very fine to fine----------	135 -	136
Silt, very sandy, very fine to medium sand, moderately clayey, light olive gray to white, very calcareous-----	136 -	140
Sand, very fine to medium, slightly silty----------	140 -	146
Sand, very fine to medium, slightly silty, clayey and marly, calcareous----------	146 -	157
Clay, moderately silty and sandy, very fine sand, white, very calcareous----------	157 -	165
Sand and gravel, fine sand to medium gravel, 70 percent gravel----------	165 -	181
Sand, moderately silty and marly, sand is very fine to medium, sandstone 181.5 to 182 feet----------	181 -	183
Sand, very fine to medium, some coarse, coarser 204 to 207 feet----------	183 -	208
Silt, moderately sandy and clayey, light gray, slightly to moderately calcareous----------	208 -	212
Limestone----------	212 -	213
Silt, very clayey, moderately sandy, sand is very fine to fine, light gray----------	213 -	214
Limestone----------	214 -	215

Test-hole 5N-17W-19AAAA1 (cont'd)

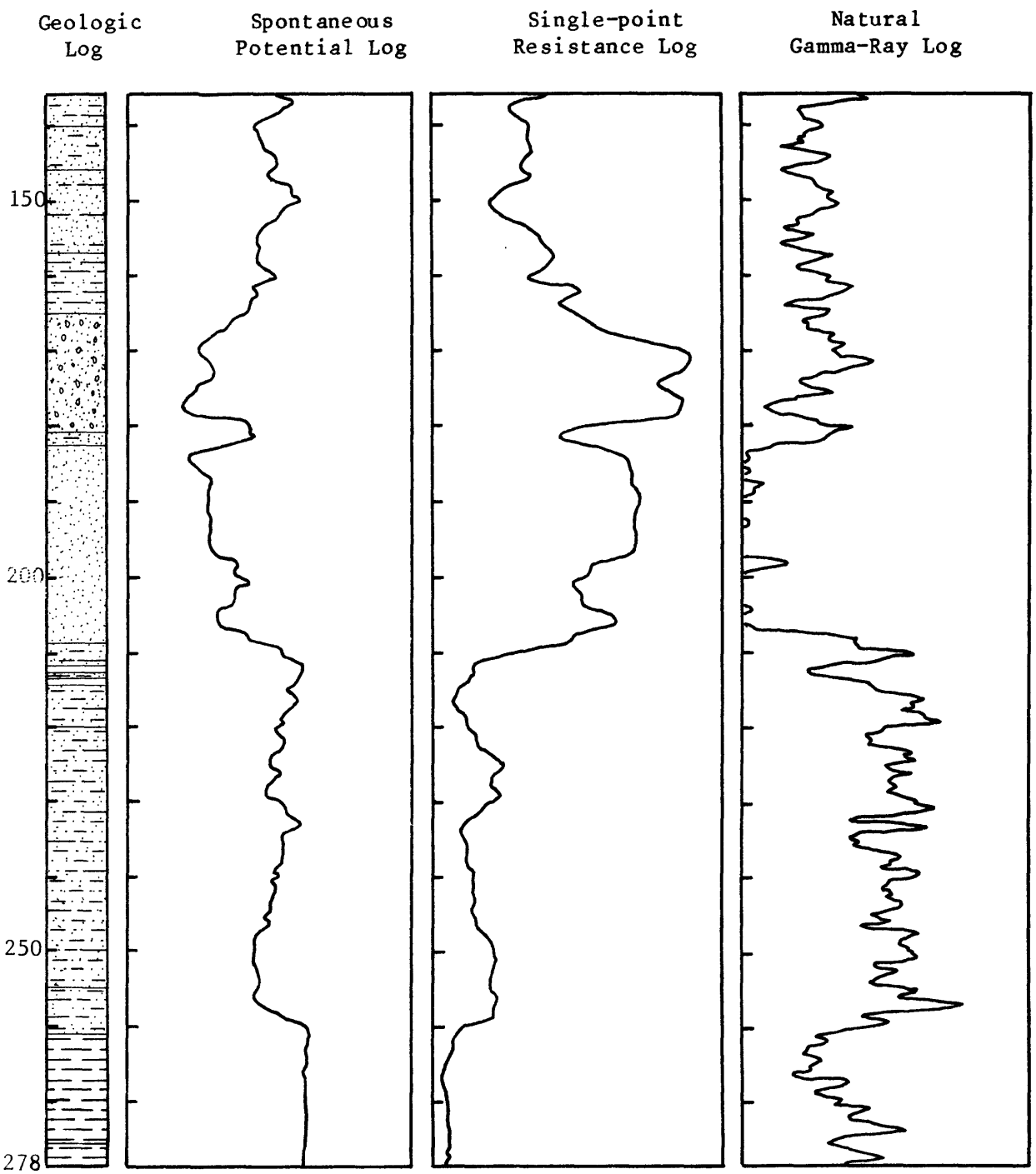
Descriptive Log

	Depth, in feet From	To
Silt, moderately to very clayey, slightly sandy, light gray	215	220
Silt, slightly to moderately clayey, slightly sandy, light gray	220	255
Silt, moderately sandy, slightly clayey, lithic gravel from 260-261, light gray	255	261
Cretaceous System, Pierre Formation:		
Clay, pale yellow, slightly to moderately calcareous, medium to dark gray from 269 to 275 feet	261	275

Depth to water: 108 feet.
Total Depth Drilled: 275 feet.
Remarks: 64 inch long normal log available.



Test-hole 5N-17W-19AAAA1 (cont'd)



Test-hole 5N-18W-18CCCB1

Location: 744 ft. S. of 1/4 sec. line and 11 ft. E. of W. sec. line.
Date drilled: 5-4-81.
Field number: 10-B-81.
Land surface altitude: 2,322 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Silt, slightly to moderately clayey, dark to very dark grayish brown	2	3
Silt, moderately clayey, dark brown to brown	3	6
Silt, slightly clayey, dark grayish-brown	6	7
Silt, slightly to moderately clayey, some iron-staining, light yellowish brown, slightly calcareous	7	29
Silt, slightly clayey, brownish yellow to yellowish-brown, slightly calcareous	29	34
Silt, slightly clayey, some very fine sand, dark brown to dark yellowish-brown	34	39
Silt, moderately clayey, slightly sandy, some iron-staining, yellowish-brown	39	46
Silt, moderately sandy, moderately clayey, yellowish brown	46	50
Silt, slightly to moderately clayey, slightly to moderately sandy, very sandy 74-80, brown to light yellowish-brown	50	80
Sand, very fine to fine, slightly silty	80	83
Silt, moderately sandy, very fine to find sand, light yellowish-brown	83	85
Sand, very fine to medium	85	92
Silt, very sandy, very fine to fine sand	92	98
Sand, very fine to medium, some coarse	98	115

Test-hole 5N-18W-18CCCB1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Silt, very sandy, very fine to fine sand, slightly clayey, yellowish brown	115	121
Sand, very fine to medium, some coarse	121	155
Silt, slightly clayey and sandy, brownish-yellow	155	156
Sand, very fine to medium, trace of coarse	156	160
Silt, slightly to moderately clayey, slightly sandy, very fine sand, yellowish brown	160	165
Silt, slightly clayey, moderately to very sandy, very fine to medium sand, yellowish-brown to light yellowish-brown	165	180
Sand, very fine to medium, very silty	180	188
Silt, very sandy, very fine to fine sand, light yellowish-brown	188	193
Sand, very fine to very coarse, trace fine gravel, poorly sorted	193	200
Sand and gravel, coarse sand to medium gravel, 60 percent gravel	200	230
Silt, slightly clayey and sandy, very fine sand, light yellowish-brown	230	231
Sand and gravel, medium sand to medium gravel, much coarse sand to fine gravel	231	259
Silt, moderately to very sandy, very fine sand, yellowish-brown	259	263
Tertiary System, Ogallala Group:		
Silt, marly, very pale-brown	263	266
Silt, moderately clayey, slightly sandy, very fine sand, very pale brown, in part moderately calcareous	266	273

Test-hole 5N-18W-18CCCB1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand, very silty, pale yellow----------	273	275
Marl, very sandy, pale yellow----------	275	277
Sand, very fine to fine, marly----------	278	281
Silt, slightly to moderately clayey, very sandy, olive------	281	285
Sand, very fine to medium, much fine----------	285	288
Clay, slightly silty and sandy, pale olive----------	288	289
Sand, slightly silty, very fine to find sand, some sandstone, few rootlets----------	289	305
Silt, slightly to moderately clayey, moderately sandy, very fine to fine sand, olive, very slightly calcareous-----	305	311
Silt, slightly to moderately clayey, slightly sandy, very fine sand, dark brown, very slightly calcareous--------	311	313
Sand, very fine to fine, moderately silty, light olive gray-	313	315
Silt, very sandy, very fine to medium sand, light brownish-gray----------	315	319
Sand, moderately to very silty, very calcareous----------	318	322
Sand, very fine to medium, trace of coarse, a few rootlets and limy nodules----------	322	328
Silt, very sandy, very fine to fine, slightly clayey, light gray, moderately calcareous----------	328	332
Sand, very fine to coarse, much fine to medium, rootlets, in part slightly silty----------	332	359
Silt, slightly to moderately clayey, slightly sandy, very fine sand, light gray to light brownish gray----------	359	370
Sand, very fine to coarse, rootlets----------	370	372
Silt, moderately sandy, very fine to fine sand, slightly clayey, brown----------	372	378

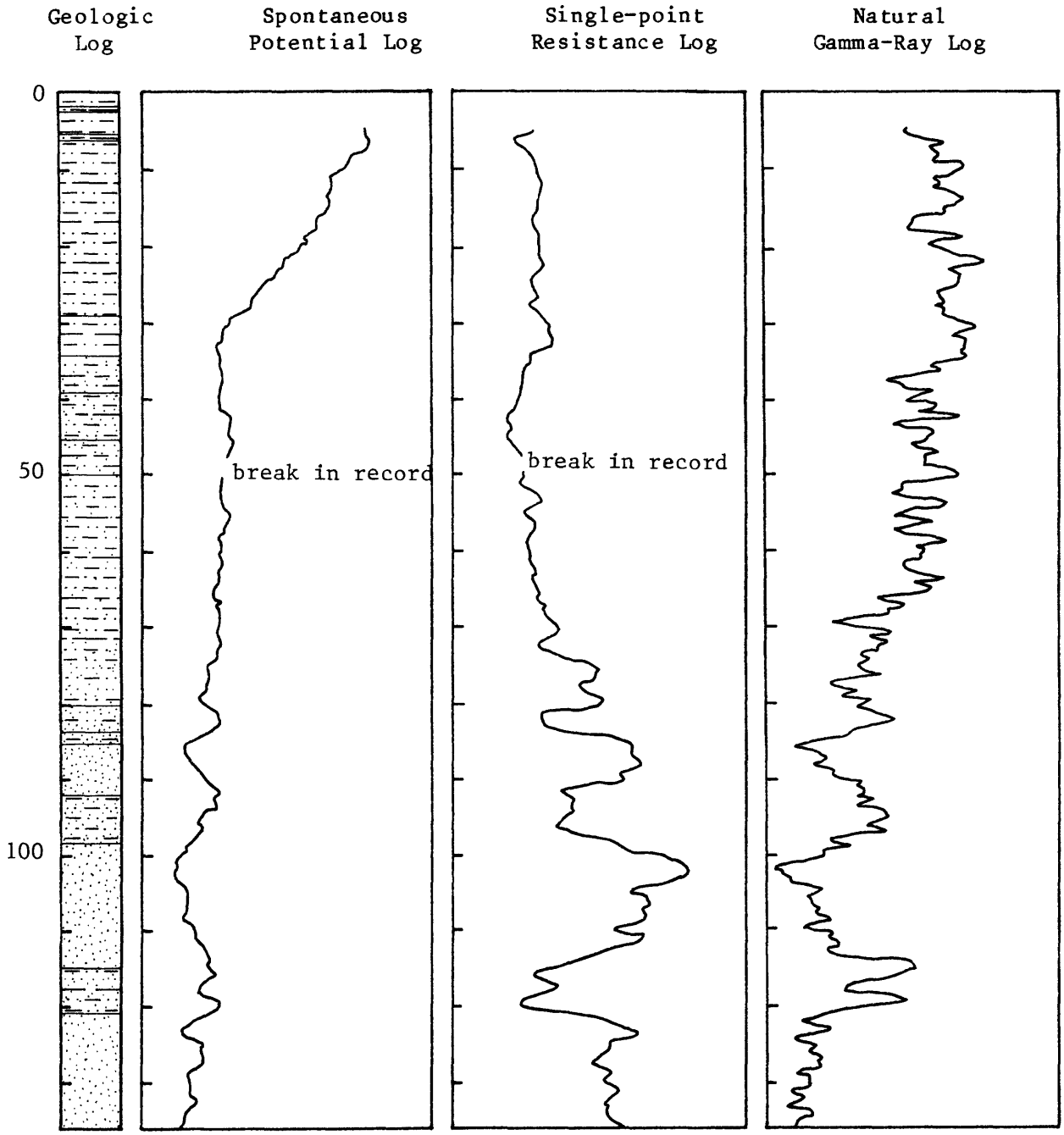
Test-hole 5N-18W-18CCCB1 (cont'd)

Descriptive Log

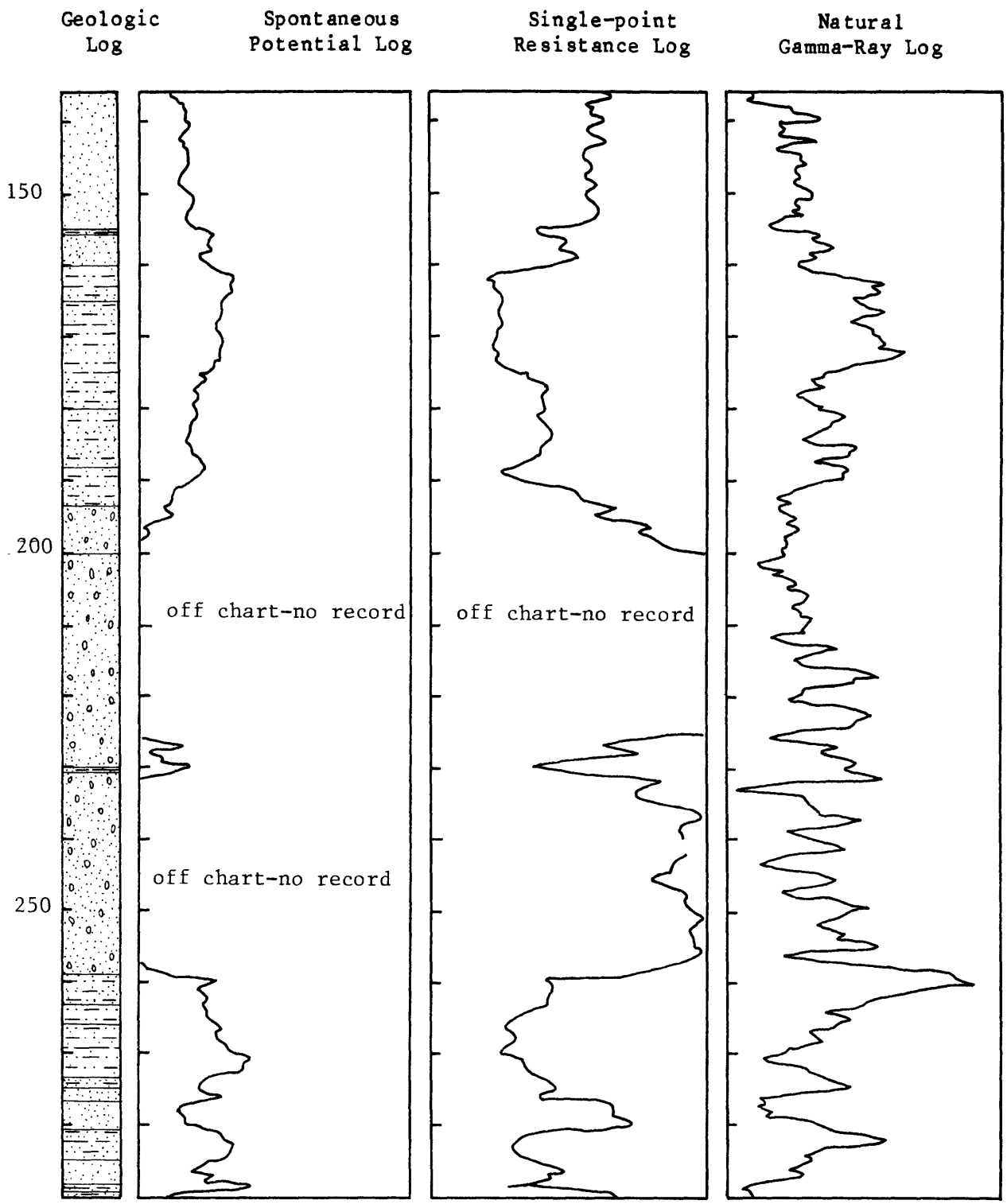
	Depth, in feet From	To
Sand, slightly gravelly, fine sand to fine gravel, 5 percent gravel, rootlets	378	413
Silt, slightly to moderately clayey, yellowish brown to light brownish-gray	413	419
Sand, slightly gravelly, fine sand to fine gravel, 3 to 5 percent gravel, clay lens from 442 to 443 feet	419	451
Clay, moderately silty, olive	451	453
Sand, slightly gravelly, fine sand to fine gravel, 5 percent gravel, much medium to coarse sand	453	475
Claystone, siliceous, olive	475	476
Gravel, lithic, claystone and yellow calcareous rock fragments	476	478
Cretaceous System, Pierre Formation:		
Shale, gray, slightly calcareous	478	480
Shale, dark gray, slightly calcareous	480	500

Test-hole 5N-18W-18CBCB1 (cont'd)

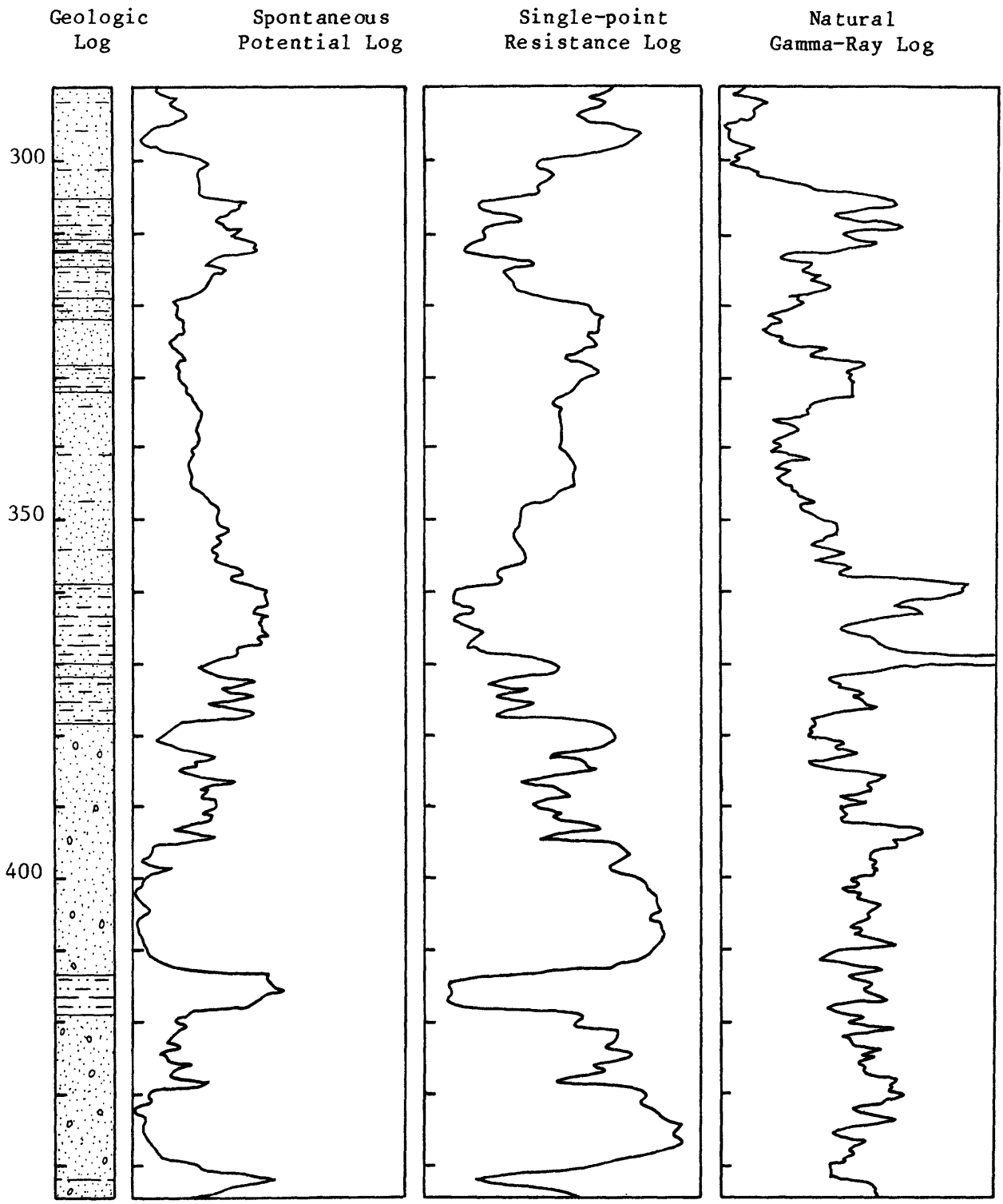
Depth to water: 152 feet.
Total Depth Drilled: 500 feet.
Remarks: 64 inch long normal log available.



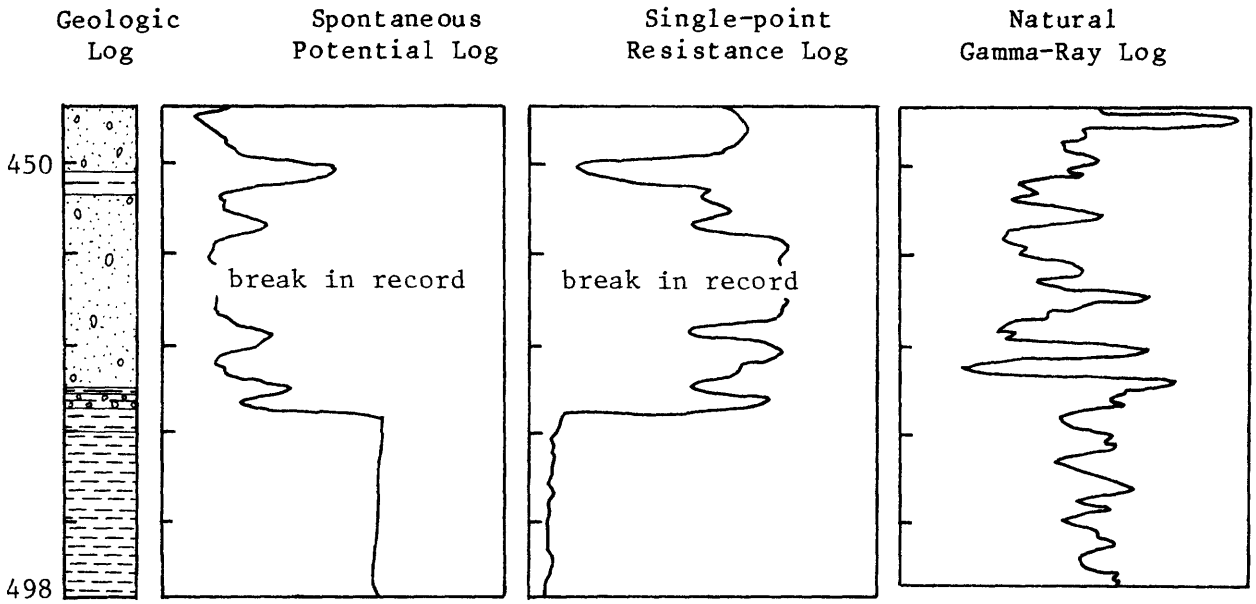
Test-hole 5N-18W-18CBCB1 (cont'd)



Test-hole 5N-18W-18CBCB1 (cont'd)



Test-hole 5N-18W-18CBCB1 (cont'd)



Test-hole 5N-21W-13DDA1

Location: 1,006 ft. N. of S. sec. line and 12.5 ft. W. of E. sec. line.
Date drilled: 4-23-81.
Field number: 6-B-81.
Land surface altitude: 2,350 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	3
Silt, clayey with some very fine sand, yellowish brown, slightly calcareous	3	25
Silt, moderately to very clayey, brown to dark brown	25	35
Silt, very clayey, slightly sandy, very fine sand, yellowish brown	35	44
Silt, very clayey, slightly sandy, very fine sand, dark yellowish brown, slightly calcareous	44	46
Silt, very sandy, very fine sand, slightly clayey, yellowish brown to light yellowish brown, slightly to moderately calcareous	46	64
Sand, very fine to fine, very silty	64	68
Silt, moderately sandy and clayey, yellowish brown	68	74
Silt, moderately clayey, light yellowish brown to yellowish brown, very calcareous	74	90
Silt, slightly clayey and sandy, light yellowish brown, very calcareous	90	103
Silt, very clayey, very pale brown to light yellowish brown, very calcareous	103	105
Silt, very clayey, moderately sandy, very pale brown, very calcareous	105	113
Sand, fine to coarse, much medium, brown	113	120

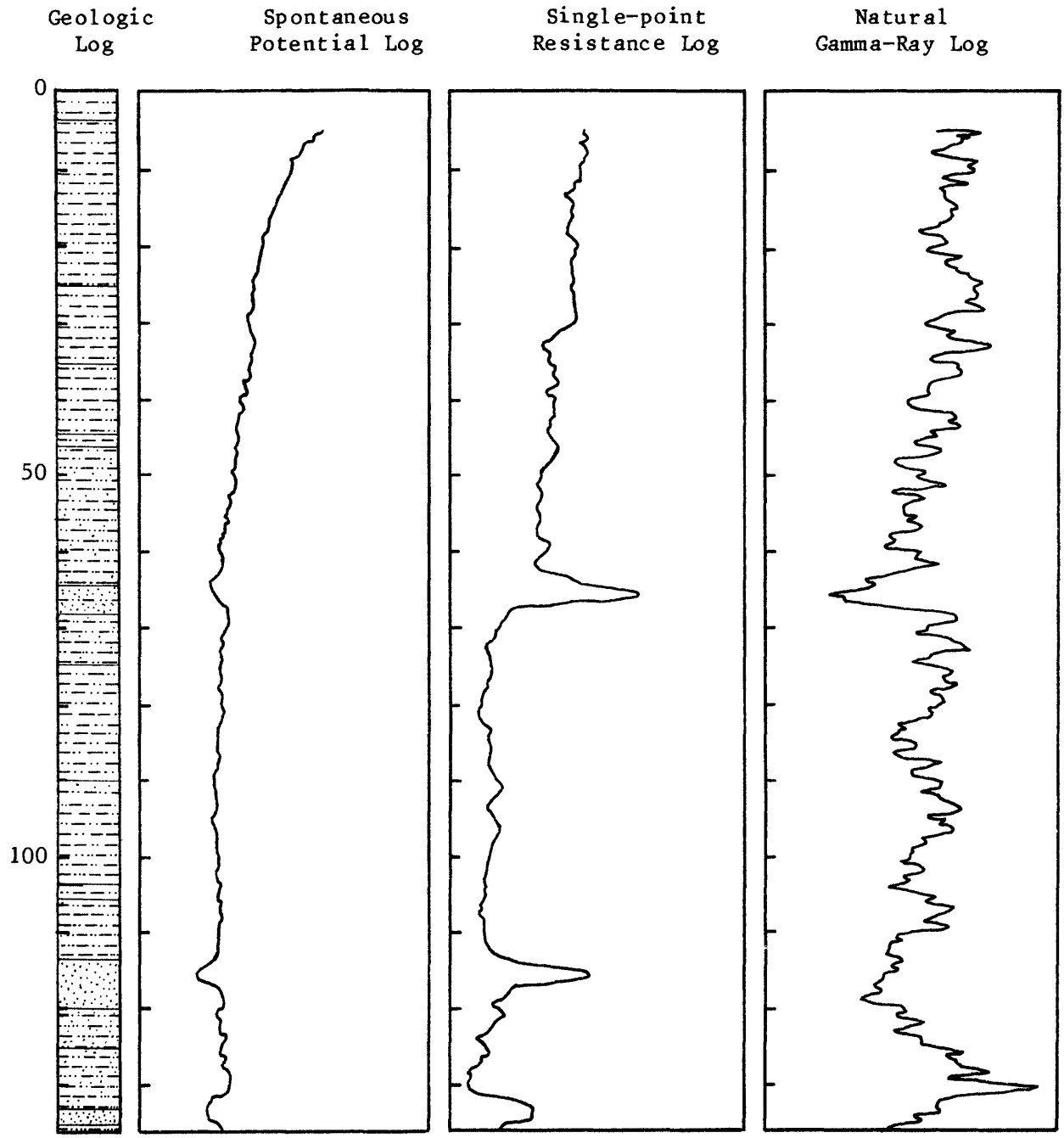
Test-hole 5N-21W-13DDA1 (cont'd)

Descriptive Log

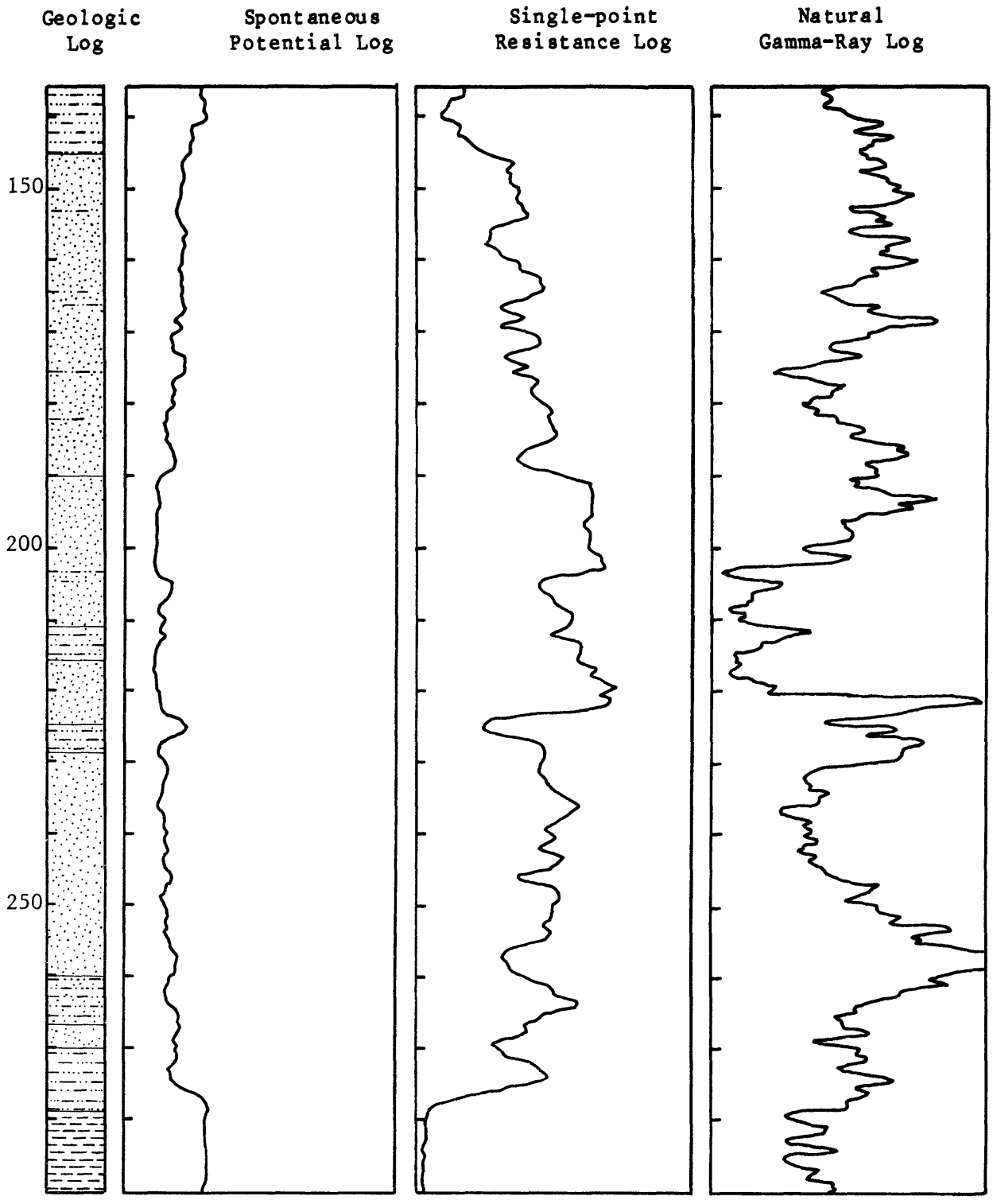
	Depth, in feet From	To
Silt and siltstone, very sandy, very fine to fine sand, very pale brown	120	125
Silt, slightly clayey and sandy, light brown	125	133
Sand, fine to medium	133	135
Tertiary System, Ogallala Group:		
Silt, very sandy, fine sand, light yellowish-brown	135	145
Sandstone, very fine to fine, trace coarse, a few light brownish-gray silt lenses, calcareous 175 to 185 feet	145	190
Sand, very fine to medium, much fine, silty 204 to 208 feet	190	211
Silt, white, with some limy sandstone	211	215
Sand, very fine to coarse, much fine, light brown	215	224
Silt and sand, very fine to medium sand, silt is pale yellow to pale olive	224	228
Sandstone, very fine to fine, very pale brown to pale olive, slightly calcareous	228	260
Silt, very sandy, very fine to fine sand, pale yellow, very calcareous	260	267
Sandstone, very fine to fine, pale olive, moderately calcareous	267	270
Silt, very sandy, very fine to fine sand, pale yellow to pale olive, very calcareous	270	279
Cretaceous System, Pierre Formation:		
Clay, pale yellow to yellow, very calcareous	279	300

Test-hole 5N-21W-13DDA 1 (cont'd)

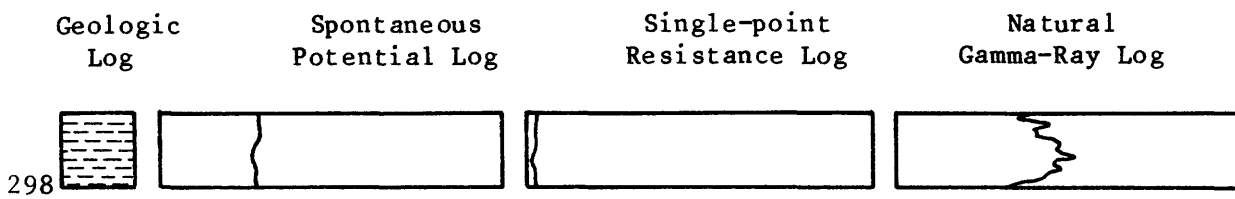
Depth to water: 90 feet.
Total Depth Drilled: 300 feet.
Remarks: Caliper log, 64 inch long normal log available.



Test-hole 5N-21W-13DDA1 (cont'd)



Test-hole 5N-21W-13DDA1 (cont'd)



Test-hole 5N-23W-13AAB1

Location: 625 ft. S. of N. sec. line and 8 ft. E. of quarter sec. line.
Date drilled: 4-22-81.
Field number: 5-B-81.
Land surface altitude: 2,346 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Topsoil, silt, slightly calcareous, very dark gray	2	4
Silt, slightly sandy, very fine sand, pale brown, slightly calcareous	4	30
Silt, slightly sandy, very fine sand, dark grayish brown to brown	30	37
Silt, moderately clayey, light yellowish brown	37	45
Silt, very sandy, medium to coarse sand, slightly clayey 45 to 50 feet, light yellowish brown	45	53
Sand, very fine to coarse, much fine to medium, very silty from 68 to 71 feet, light gray to very pale brown	53	75
Silt, very sandy, fine to medium sand, very pale brown	75	82
Tertiary System, Ogallala Group:		
Sand and sandstone, very fine to coarse, much fine to medium, a few rootlets, brown	82	109
Silt, very sandy, very fine to fine sand, light gray to pale brown	109	115
Sandstone, very fine to medium, much medium, brown	115	121
Silt, very sandy, very fine to medium sand, much fine, pale brown	121	127
Silt, moderately to very sandy, very fine to fine sand, slightly limy in part, pale yellow to pale olive	127	144

Test-hole 5N-23W-13AAB1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sandstone and sand, fine to medium, pale brown----------	144	151
Silt, moderately to very sandy, fine to coarse sand, very pale brown----------	151	160
Sandstone and sand, fine to coarse, much fine to medium, silty and limy from 165 to 170 feet----------	160	171
Silt, moderately sandy, very fine to fine, very calcareous, very pale brown----------	171	174
Silt, moderately sandy, very fine to fine sand, pale yellow-	174	178
Silt, moderately sandy, very fine to fine sand, slightly clayey from 179 to 180 feet, pale brown to very pale brown----------	178	185
Sandstone, very fine to fine, slightly silty, brown---------	185	188
Silt, slightly to moderately sandy, very fine to fine sand, slightly clayey, very pale brown to light yellowish-brown----------	188	198
Silt and siltstone, moderately sandy, very fine sand, very pale-brown, moderately calcareous----------	198	209
Silt and siltstone, pale yellow----------	209	217
Silt, moderately clayey, very pale-brown----------	217	220
Clay, very silty, very pale-brown, slightly calcareous------	220	225
Silt, moderately clayey, very pale brown, slightly to moderately calcareous----------	225	230
Clay, slightly silty, very pale brown to yellow, slightly to moderately calcareous, fragments of hard yellow limy rock from 245 to 246 feet----------	230	246
Silt, very clayey and sandy, sand is very fine to medium, yellow----------	246	249
Sand, fine to very coarse, coarsens slightly with depth, tubular rootlets, yellow lithic fragments, silty 255 to 258 feet----------	249	261

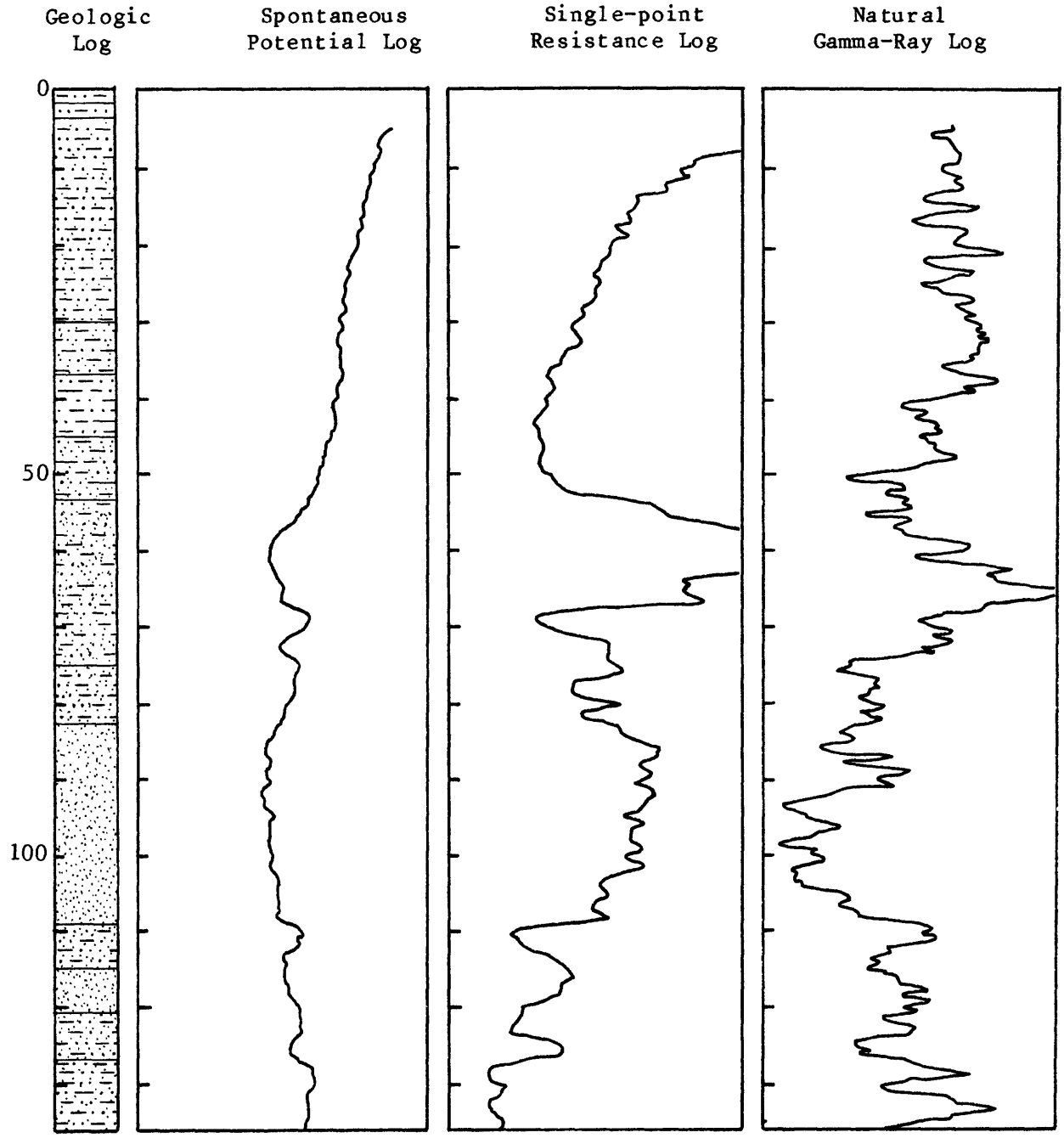
Test-hole 5N-23W-13AAB1 (cont'd)

Descriptive Log

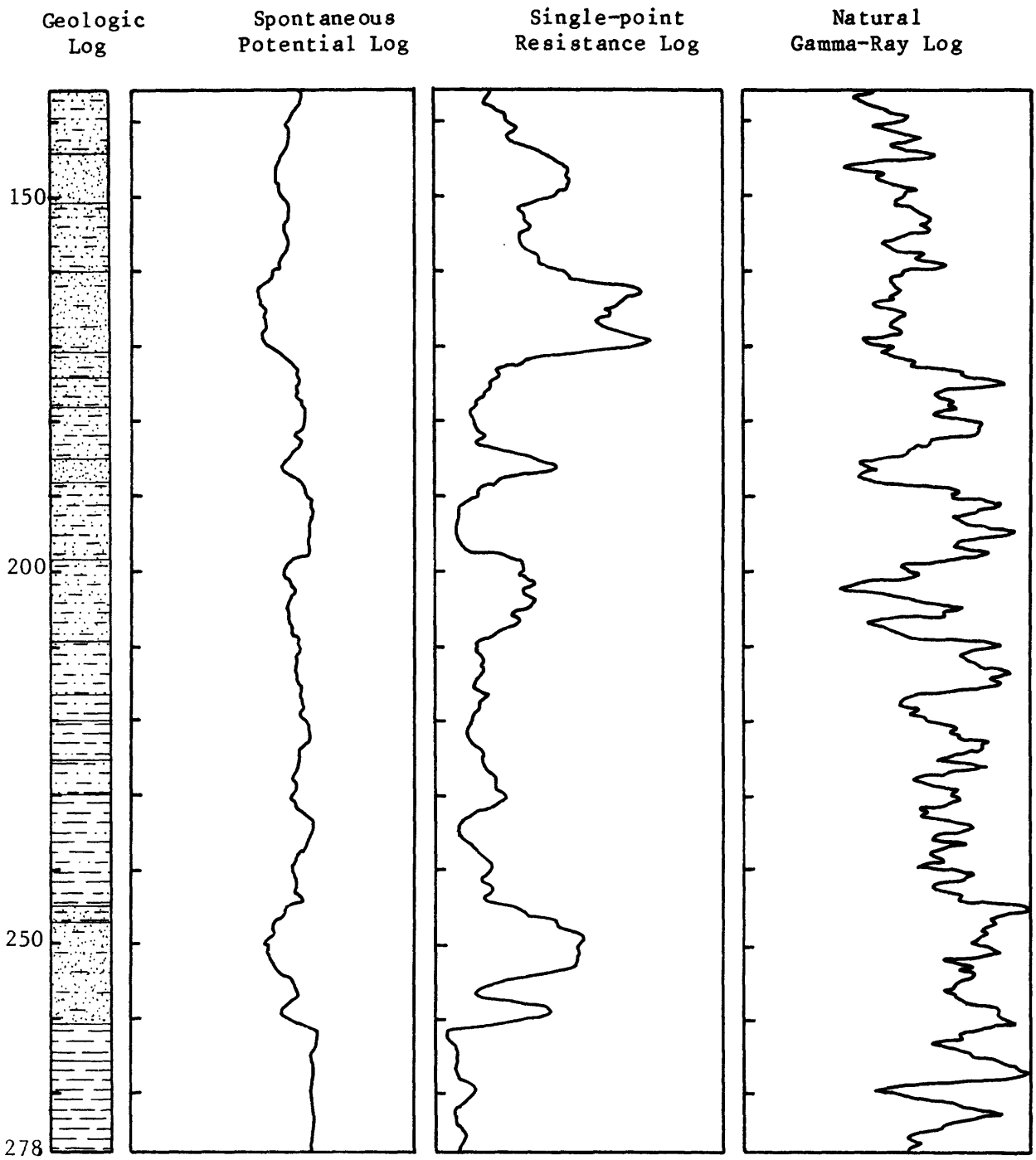
	Depth, in feet From	To
Cretaceous System, Pierre Formation:		
Clay, yellow to light gray----------	261 -	266
Clay, dark gray----------	266 -	280

Test-hole 5N-23W-13AAB1 (cont'd)

Depth to water: 83 feet.
Total Depth Drilled: 280 feet.
Remarks: Caliper log available.



Test-hole 5N-23W-13AAB1 (cont'd)



Test-hole 6N-13W-6BBCC1

Location: 122 ft. S. of quarter-section line and 4 ft. E. of W. sec. line.
Date drilled: 5-20-81.
Field number: 17-B-81.
Land surface altitude: 2,091 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	1
Silt, slightly clayey, dark grayish brown	1	2
Silt, slightly clayey, pale brown	2	17
Silt, moderately clayey, slightly sandy, dark to very dark grayish-brown	17	25
Sand, very fine to fine, slightly clayey, light yellowish-brown	25	30
Sand, very fine to medium, slightly silty from 30 to 35 feet, yellowish-brown to light yellowish-brown	30	45
Sand, very fine to coarse, yellowish-brown	45	52
Silt, moderately sandy and clayey, yellowish-brown	52	57
Sand, medium to coarse, yellowish-brown	57	65
Sand, very fine to medium, slightly silty, yellowish-brown	65	80
Sand and gravel, very fine sand to fine gravel, very slightly silty in part	80	85
Sand, very fine to fine, slightly silty	85	87
Silt, moderately clayey, slightly sandy, very fine to fine sand, yellowish-brown	87	94
Sand and gravel, fine to very coarse sand and fine gravel	94	148
Silt, slightly sandy and clayey, sand is very fine, yellowish-brown	148	151

Test-hole 6N-13W-6BBCC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand and gravel, fine sand to fine gravel	151	190
Clay, moderately sandy, light olive-brown	190	192
Silt, moderately sandy, very fine sand, slightly clayey yellowish-brown	192	197
Silt, moderately sandy, very fine sand, slightly clayey, brown	197	198
Sand, very fine to medium, brown	198	200
Silt, moderately clayey, light brownish-gray	200	205
Silt, moderately sandy, very fine sand, grayish-brown, slightly to moderately calcareous	205	220
Sand, very fine to coarse, slightly silty, yellowish-brown	220	238
Silt, moderately clayey and sandy, very fine sand, light brownish-gray, moderately calcareous 246-250	238	255
Tertiary System, Ogallala Group:		
Clay, moderately silty, slightly sandy, olive gray, moderately calcareous	255	280
Silt, moderately clayey, olive gray, slightly calcareous	280	290
Silt, slightly clayey and sandy, very fine sand, olive gray, slightly calcareous	290	295
Sand, very fine, moderately silty, slightly calcareous	295	305
Silt, moderately sandy and clayey, very fine sand, dark gray, slightly calcareous	305	310
Sand, very fine to coarse, much fine to medium, interbedded with silt, moderately clayey, dark gray to olive gray, slightly calcareous	310	332
Sand, very fine to very coarse; gravel, fine, gray, slightly calcareous	332	346

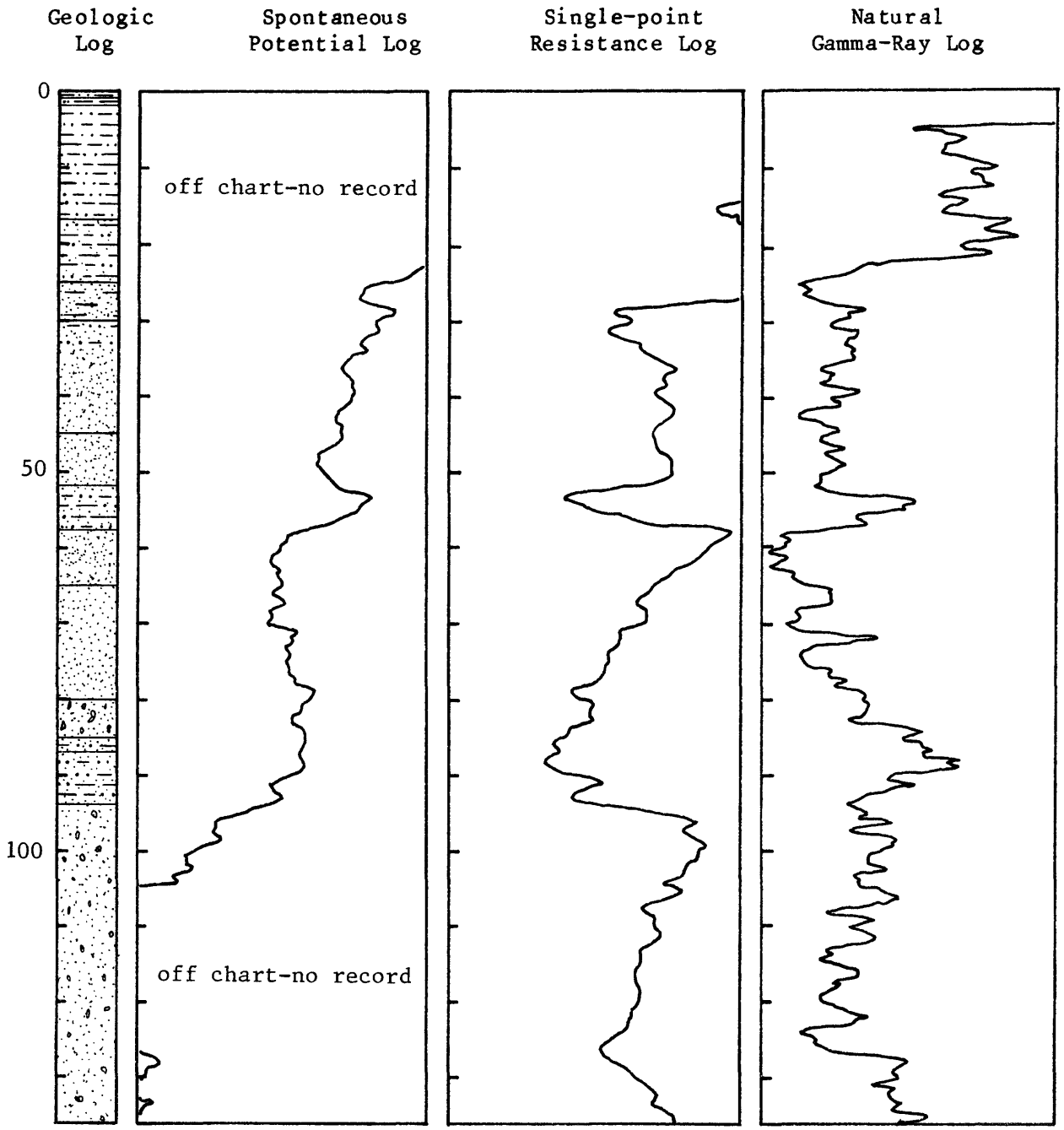
Test-hole 6N-13W-6BBCC1 (cont'd)

Descriptive Log

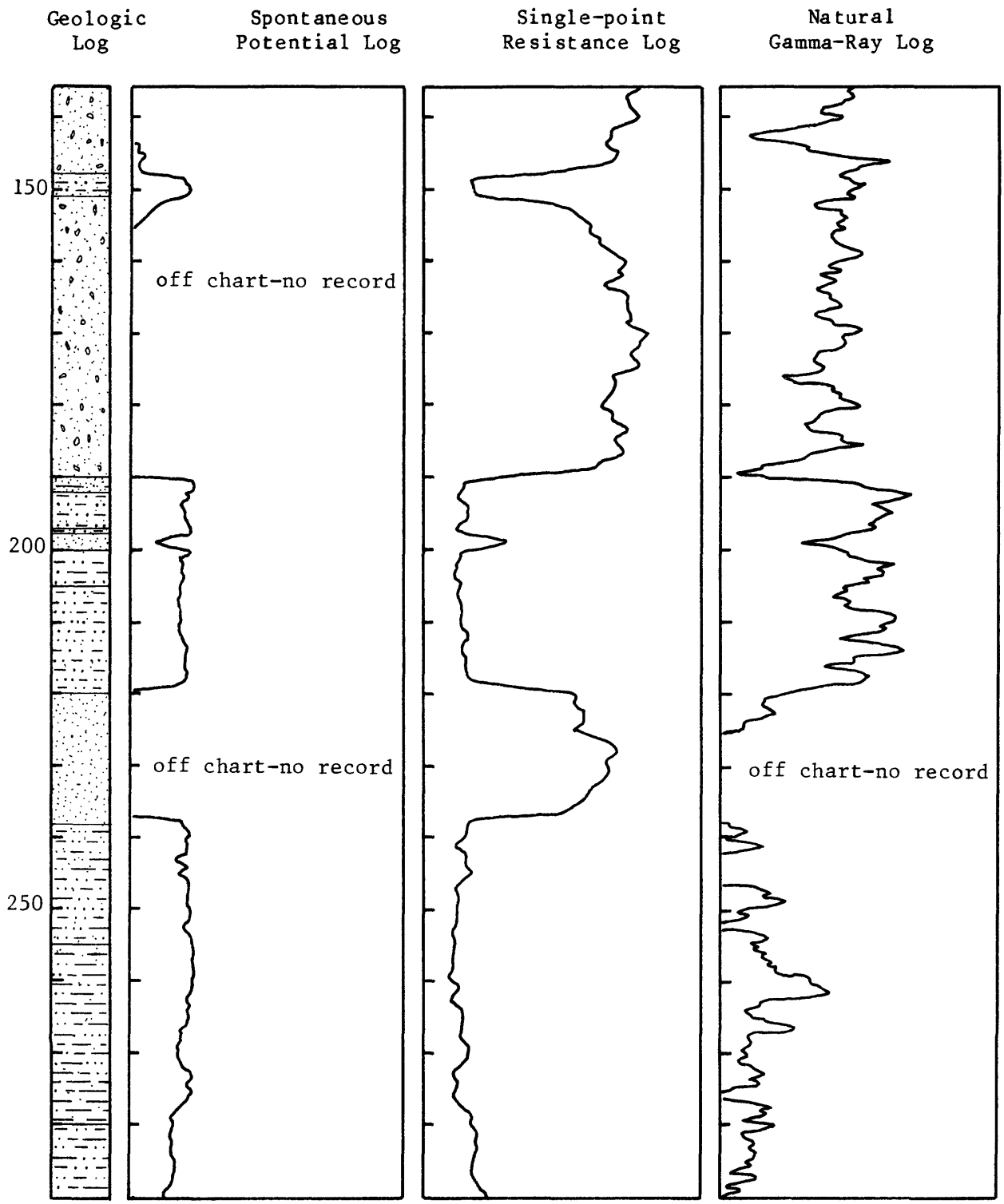
	Depth, in feet From	To
Cretaceous System, Pierre Formation:		
Shale, clayey, dark grayish-black----------	346 -	360

Test-hole 6N-13W-6BBCC 1 (cont'd)

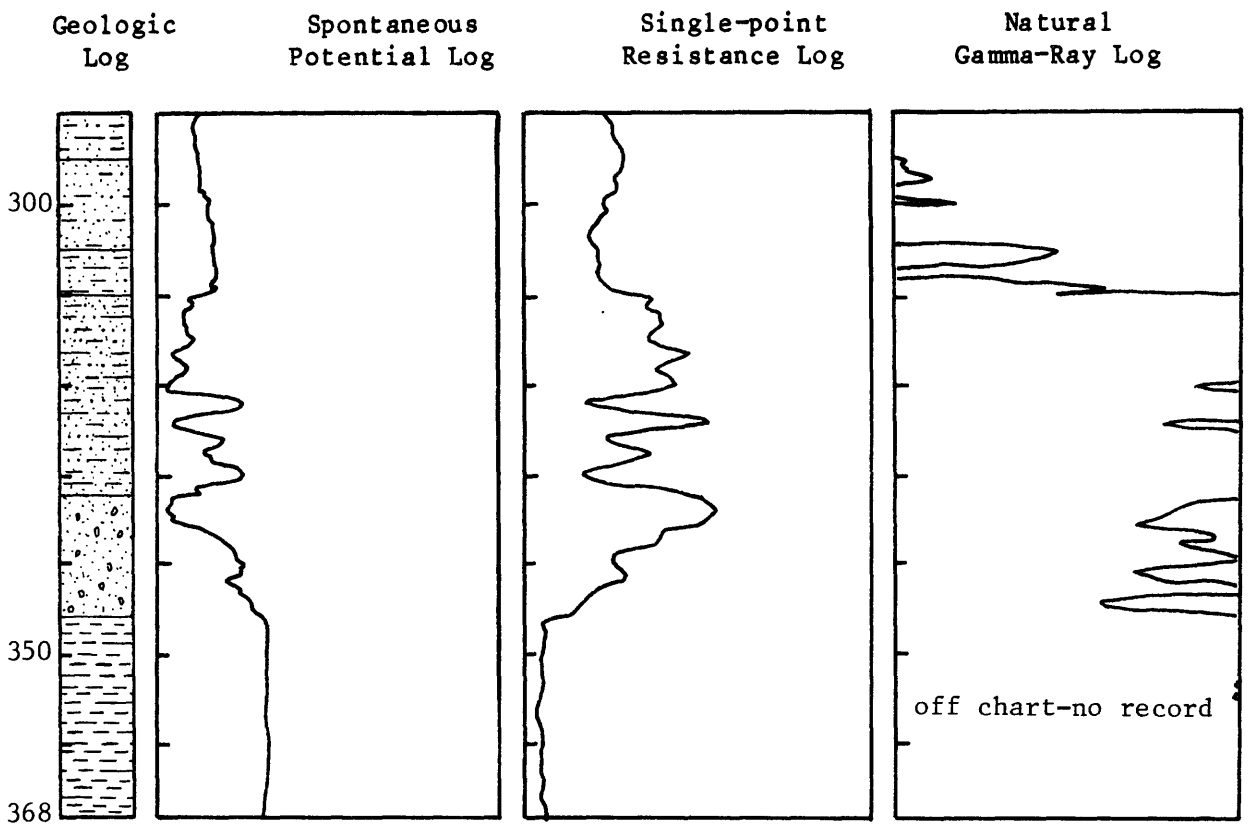
Depth to water: 54 feet.
Total Depth Drilled: 360 feet.
Remarks: 64 inch long normal log available.



Test-hole 6N-13W-6BBCC1 (cont'd)



Test-hole 6N-13W-6BBCC1 (cont'd)



Test-hole 6N-13W-30BBBB1

Location: 127 ft. S. of N. sec. line and 6 ft. E. of W. sec. line.
Date drilled: 5-21-81.
Field number: 18-B-81.
Land surface altitude: 2,116 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Silt, moderately clayey, very dark grayish-brown	2	3
Silt, some iron-staining, yellowish-brown to dark yellowish-brown, slightly calcareous 3-10	3	16
Sand, very fine, very silty, dark yellowish-brown	16	18
Sand, very fine to coarse, slightly silty, dark brown to dark yellowish-brown	18	38
Silt, moderately sandy, very fine sand, yellowish-brown, slightly calcareous	38	40
Sand, very fine to medium, moderately silty, dark yellowish-brown	40	44
Silt, moderately sandy, very fine sand, slightly clayey, yellowish-brown	44	50
Silt, very clayey, moderately sandy, yellowish-brown	50	55
Silt, slightly clayey, brown to yellowish-brown	55	60
Sand, very fine to medium, moderately silty, pale brown	60	73
Silt, slightly clayey, some very fine sand, a few iron stains, yellowish-brown to pale brown	73	80
Silt, moderately sandy, very fine to fine sand, slightly clayey 85 to 95 feet, yellowish-brown	80	95
Sand, very fine to fine, moderately silty, yellowish-brown	95	97
Silt, slightly sandy, very clayey, iron-staining, yellowish-brown	97	106

Test-hole 6N-13W-30BBBB1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Silt, very sandy, yellowish-brown	106	110
Silt, moderately sandy and clayey, very fine sand, yellowish-brown	110	120
Sand, very fine to medium, moderately silty, yellowish-brown	120	124
Silt, moderately clayey, slightly sandy, brown	124	127
Sand, very fine to coarse, pale brown	127	130
Silt, moderately clayey, slightly sandy, brown	130	134
Sand, very fine to medium, pale brown	134	145
Sand, very fine to very coarse, pale brown, silt lenses at 149 feet and 154 feet	145	155
Sand and gravel, very fine sand to fine gravel	155	173
Silt, moderately sandy, very fine sand, moderately to very clayey, olive to olive brown	173	180
Sand and gravel, very fine sand to fine gravel, very silty and clayey, moderately calcareous	180	185
Sand, very fine, moderately silty, yellowish-brown, slightly calcareous	185	207
Silt, moderately sandy, very fine sand, very clayey, yellowish-brown, moderately calcareous	207	218
Sandstone, very fine sand, brown, slightly calcareous	218	219
Silt, moderately sandy, very fine sand, slightly clayey, yellowish-brown	219	225
Sand, very fine, slightly silty, yellowish-brown	225	228
Sand, very fine to very coarse, slightly silty, pale brown, slightly calcareous	228	230

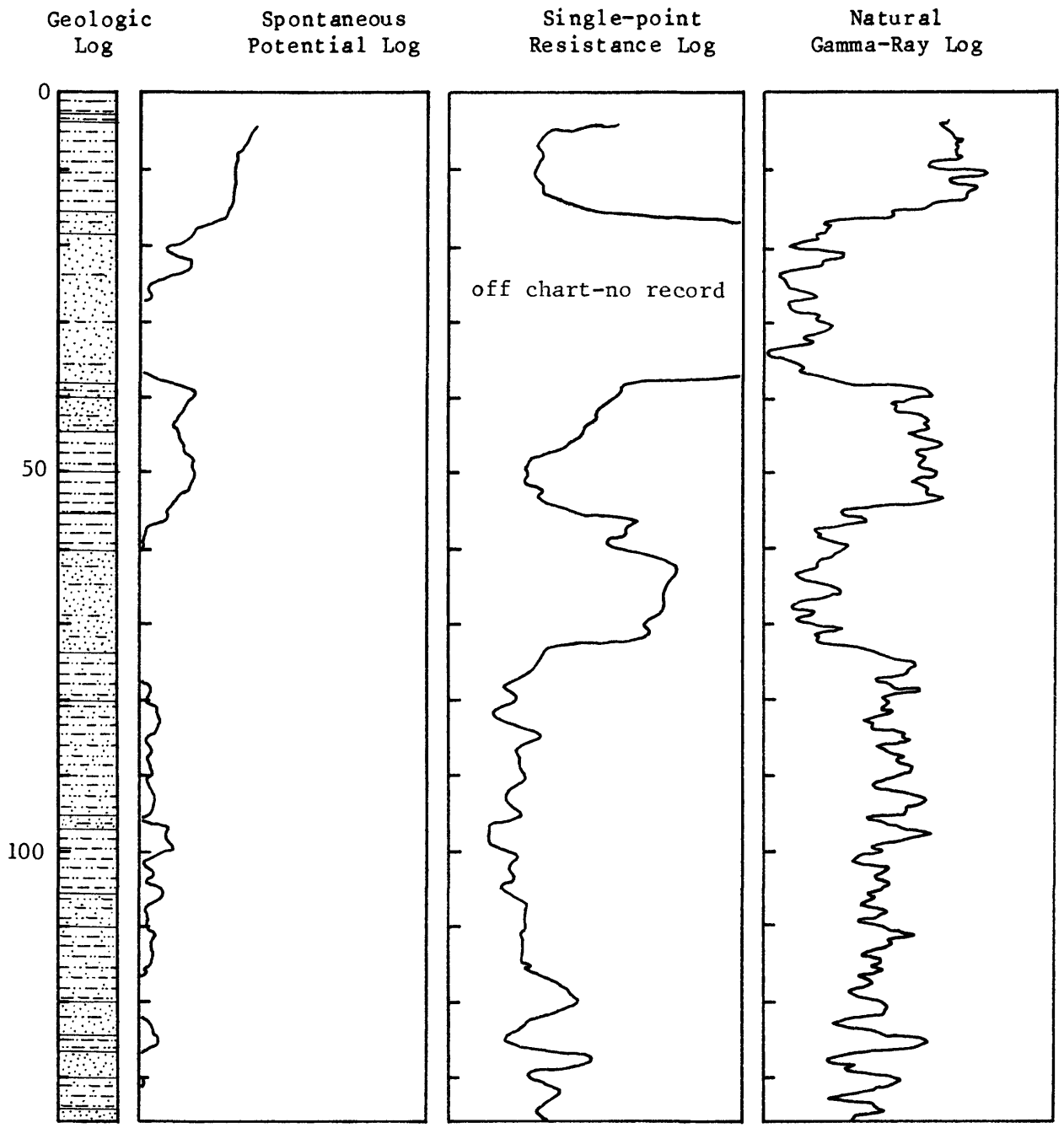
Test-hole 6N-13W-30BBBB1 (cont'd)

Descriptive Log

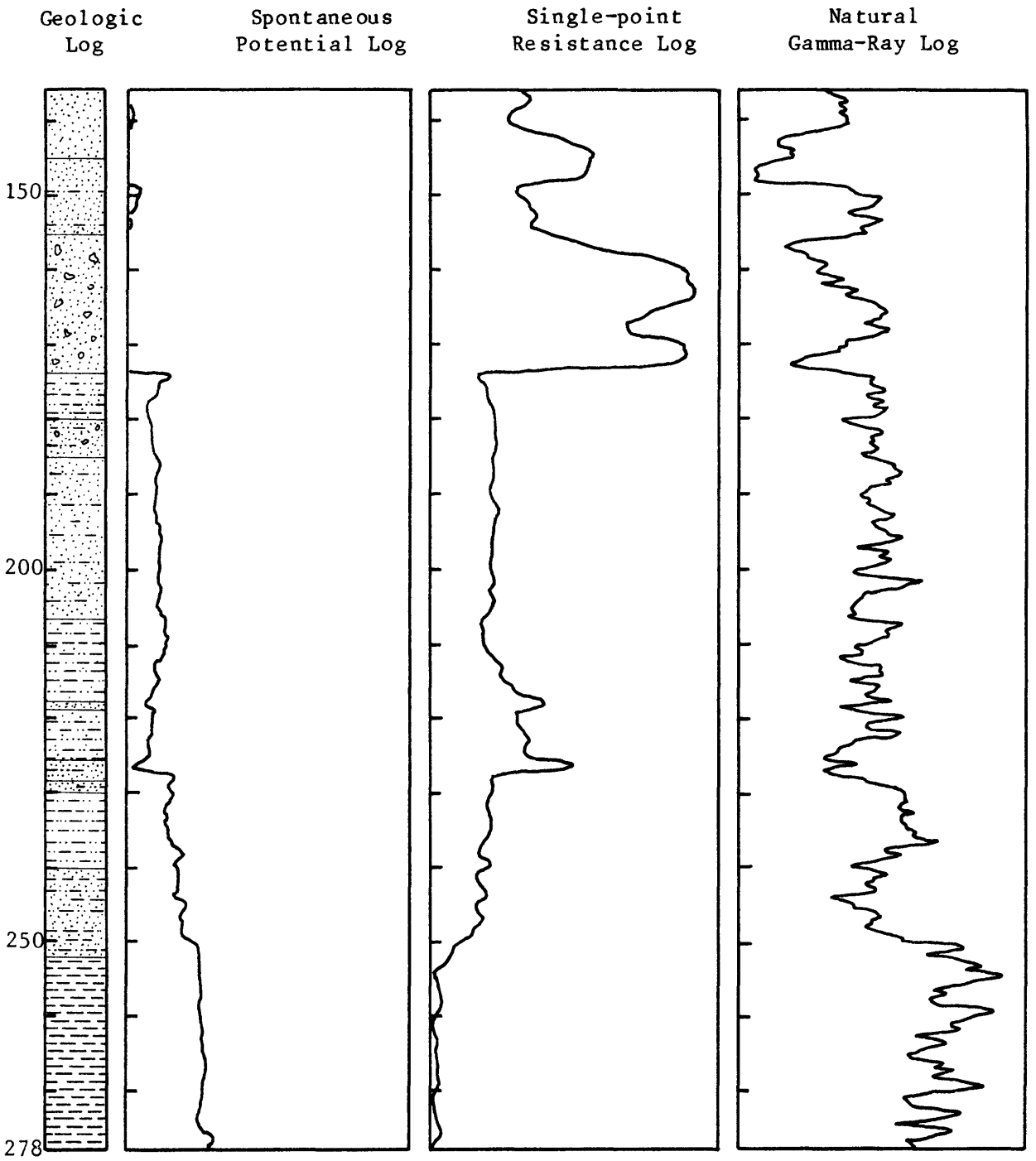
	Depth, in feet From	To
Silt, moderately sandy, very fine sand, moderately clayey, moderately calcareous----------	230 -	240
Sand, very silty and clayey, light yellowish-brown, slightly calcareous----------	240 -	252
Cretaceous System, Pierre Formation:		
Clay, very dark gray----------	252 -	280

Test-hole 6N-13W-30BBBB 1 (cont'd)

Depth to water: 76 feet.
Total Depth Drilled: 280 feet.
Remarks: 64 inch long normal log available.



Test-hole 6N-13W-30BBBB1 (cont'd)



Test-hole 6N-16W-13DDDD1

Location: 10 ft. N. of S. sec. line and 190 ft. W. of E. sec. line.
Date drilled: 5-13-81.
Field number: 14-B-81.
Land surface altitude: 2,210 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	10
Clay, moderately to very silty, limonitic stains and calcareous nodules, olive	10	19
Silt, olive	19	25
Silt, moderately sandy, fine to medium sand, olive	25	29
Sand, fine to medium, a few organic fragments	29	55
Sand, fine, organic fragments, olive color	55	65
Sand, fine, well sorted	65	74
Silt, very sandy, brownish yellow	74	78
Clay, slightly silty, brownish yellow	78	85
Sand, fine, some medium from 85 to 90 feet, pale olive to yellowish brown	85	99
Clay, moderately sandy and silty, light yellowish-brown to yellowish brown	99	105
Sand, fine to medium, silty 106 to 107 feet	105	113
Silt, moderately sandy, yellowish brown	113	122
Sand and gravel, medium sand to fine gravel	122	129
Silt, moderately clayey, olive gray	129	133
Sand and gravel, medium sand to fine gravel, slightly silty in places	133	149

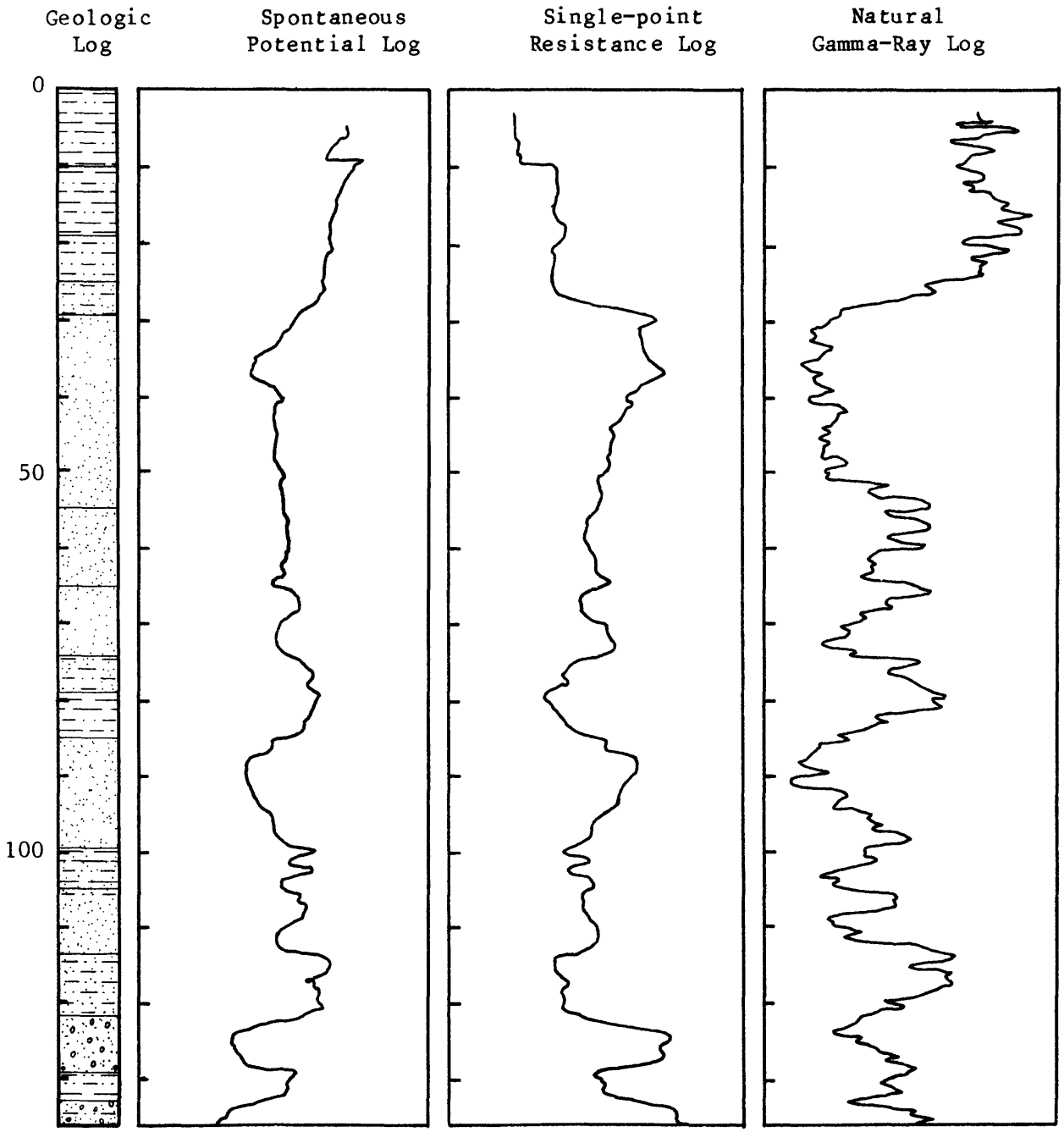
Test-hole 6N-16W-13DDDD1 (cont'd)

Descriptive Log

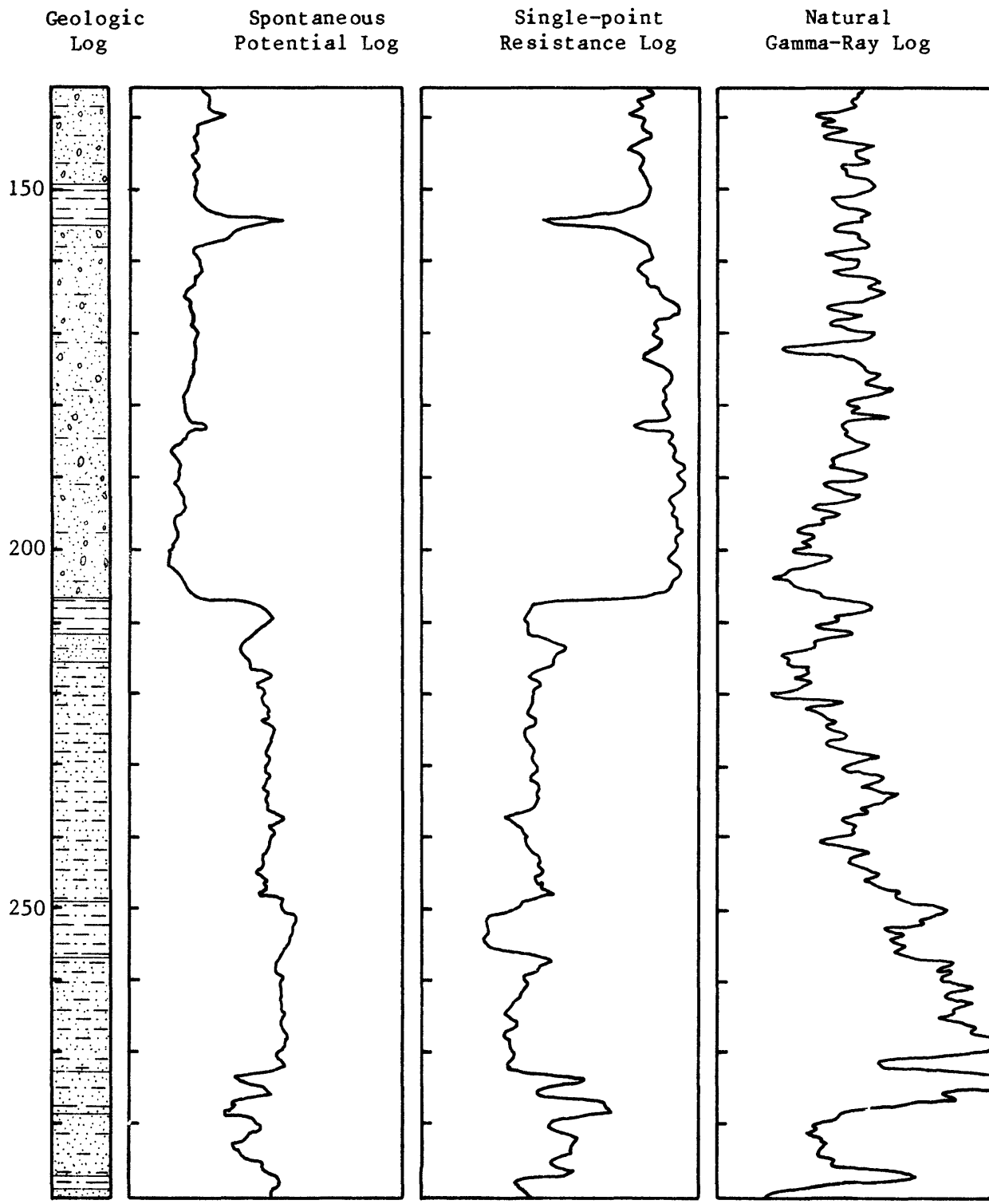
	Depth, in feet From	To
Clay, silty, pale olive	149	155
Sand and gravel, poorly sorted, a few silt layers	155	207
Clay, light gray	207	212
Tertiary System, Ogallala Group:		
Sand, fine, moderately silty, slightly consolidated, pale olive	212	216
Silt, moderately sandy, fine sand, a few shell fragments, pale yellow to pale olive	216	249
Silt, moderately clayey, light yellowish brown	249	257
Silt, moderately sandy, light yellowish brown	257	273
Sand, silty, contains clayballs, light yellowish-brown	273	278
Sandstone, very fine to fine, some interbedded silt, moderately to very calcareous	278	287
Silt, clayey, pale yellow	287	289
Sand, very fine to medium, much fine, in part loosely cemented, contains calcareous fragments	289	315
Sand and silt interbedded, pale yellow silt, very fine sand	315	337
Silt, very sandy, pale olive	337	338
Gravel, fine to medium, some green siltstone	338	341
Cretaceous System, Pierre Formation:		
Clay, gray, slightly calcareous	341	342
Clay, olive gray	342	360

Test-hole 6N-16W-13DDDD 1 (cont'd)

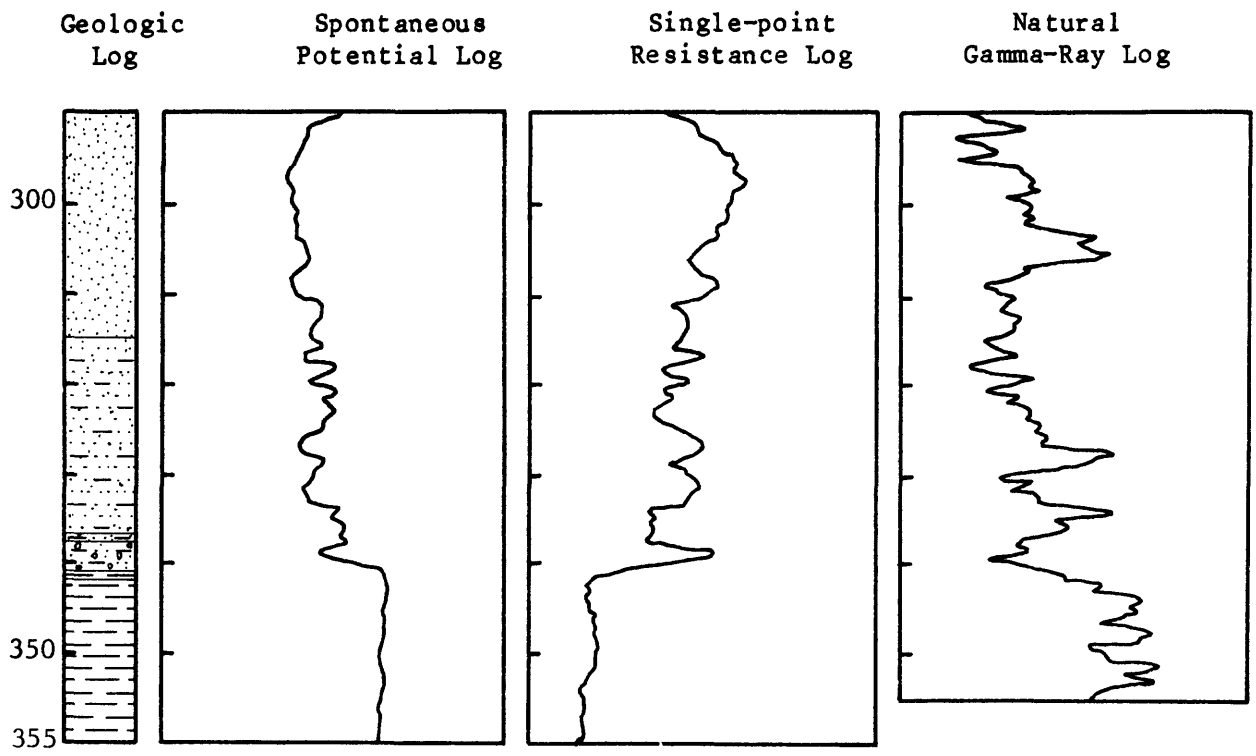
Depth to water: 31 feet.
Total Depth Drilled: 360 feet.
Remarks: 64 inch long normal log available.



Test-hole 6N-16W-13DDDD1 (cont'd)



Test-hole 6N-16W-13DDDD1 (cont'd)



Test-hole 6N-23W-25AAAA1

Location: 295 ft. S. of N. sec. line and 7 ft. W. of E. sec. line.
Date drilled: 4-27-81.
Field number: 7-B-81.
Land surface altitude: 2,410 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill and topsoil	0	2
Silt, slightly clayey, some very fine sand, light light yellowish brown to brown, slightly calcareous	2	34
Silt, moderately clayey, some very fine sand, dark brown to yellowish brown	34	36
Silt, moderately sandy, very fine to fine sand, moderately calcareous, light yellowish brown to very pale brown	36	46
Siltstone, moderately sandy, very fine to fine, very pale brown, very calcareous	46	48
Silt, very sandy, very fine to fine sand, light brown	48	55
Sand, fine to medium, slightly silty	55	60
Silt, very sandy, very fine to medium sand, much fine to medium, light brown to reddish yellow calcareous in part	60	74
Silt and siltstone, moderately sandy, fine to medium sand, light brown, slightly calcareous	74	80
Silt, moderately sandy, fine to medium sand, light brown	80	82
Silt, very sandy, fine sand, light brown to very pale brown, moderately calcareous	82	89
Sand, fine to coarse, much medium, some limy siltstone and limestone fragments, light brown	89	97
Silt, very sandy, very fine sand, light brown	97	110
Sand, very fine	110	114

Test-hole 6N-23W-25AAAA1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Silt, very sandy, brown, slightly calcareous	114	115
Sand, very silty, pinkish gray, very calcareous	115	120
Tertiary System, Ogallala Group:		
Sandstone and siltstone interbedded, pale to very pale brown, very calcareous	120	133
Silt and siltstone interbedded, silt is very sandy, very fine sand, light brown to very pale-brown, very calcareous	133	146
Sandstone and sand, very fine to medium sand, a few rootlets, light yellowish brown, slightly calcareous	146	177
Silt, very sandy, sand is very fine to very coarse, very pale-brown	177	190
Sand, very fine to very coarse, a few rootlets, light yellowish-brown	190	205
Sand, medium to very coarse, a few rootlets, light yellowish-brown	205	220
Silt, very sandy, light yellowish-brown	220	237
Sandstone, very fine to fine, light yellowish-brown, slightly calcareous	237	247
Silt, moderately to very sandy, very pale-brown, very calcareous, less sandy from 247 to 249 feet	247	253
Sandstone and sand, very fine to fine, pale brown, very calcareous	253	258
Sandstone, and silt interbedded, sandstone is very fine, silt is very sandy, very pale brown, very calcareous	258	265
Silt, very sandy, sand is fine to medium, very pale-brown, very calcareous	265	268

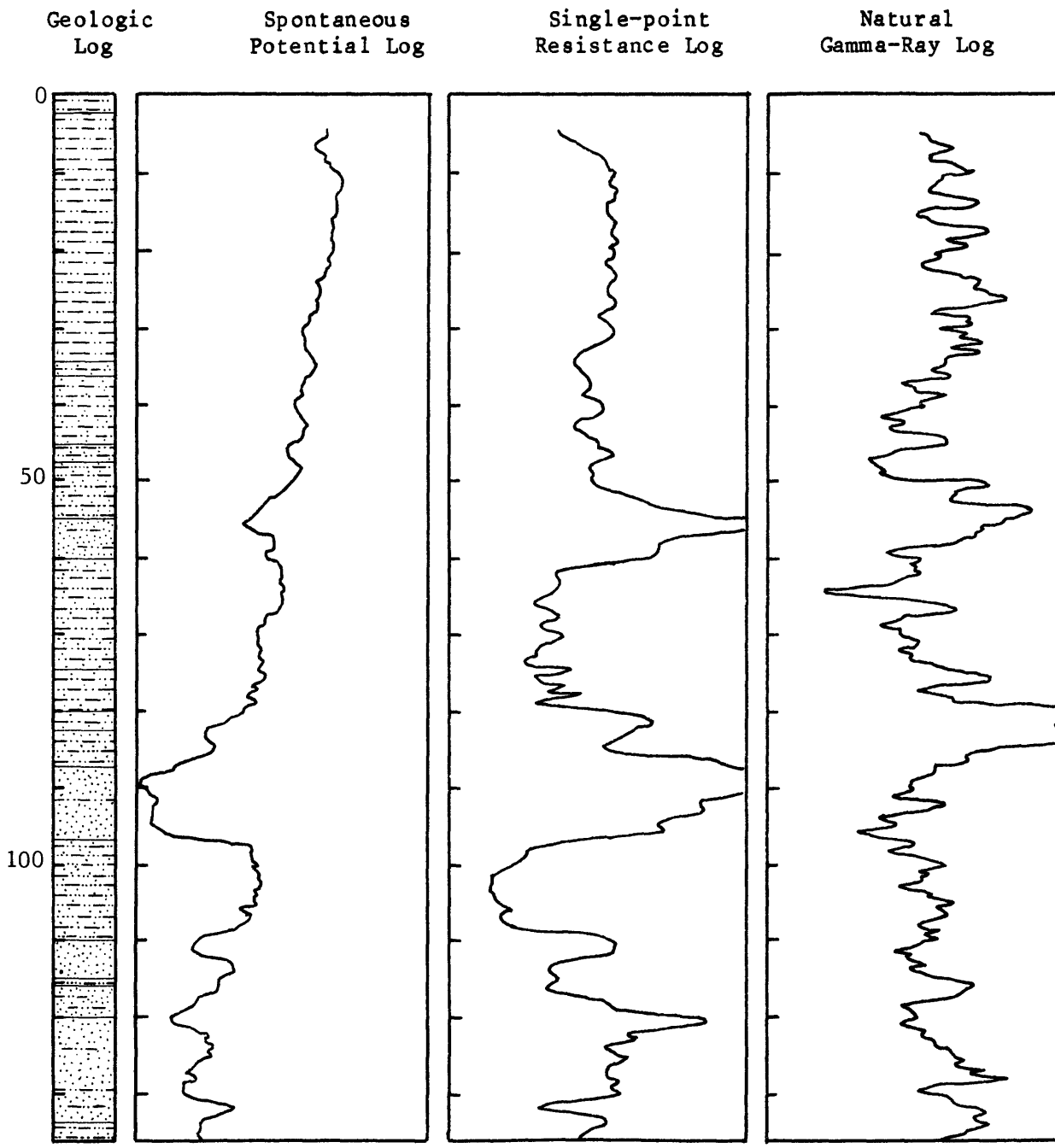
Test-hole 6N-23W-25AAAA1 (cont'd)

Descriptive Log

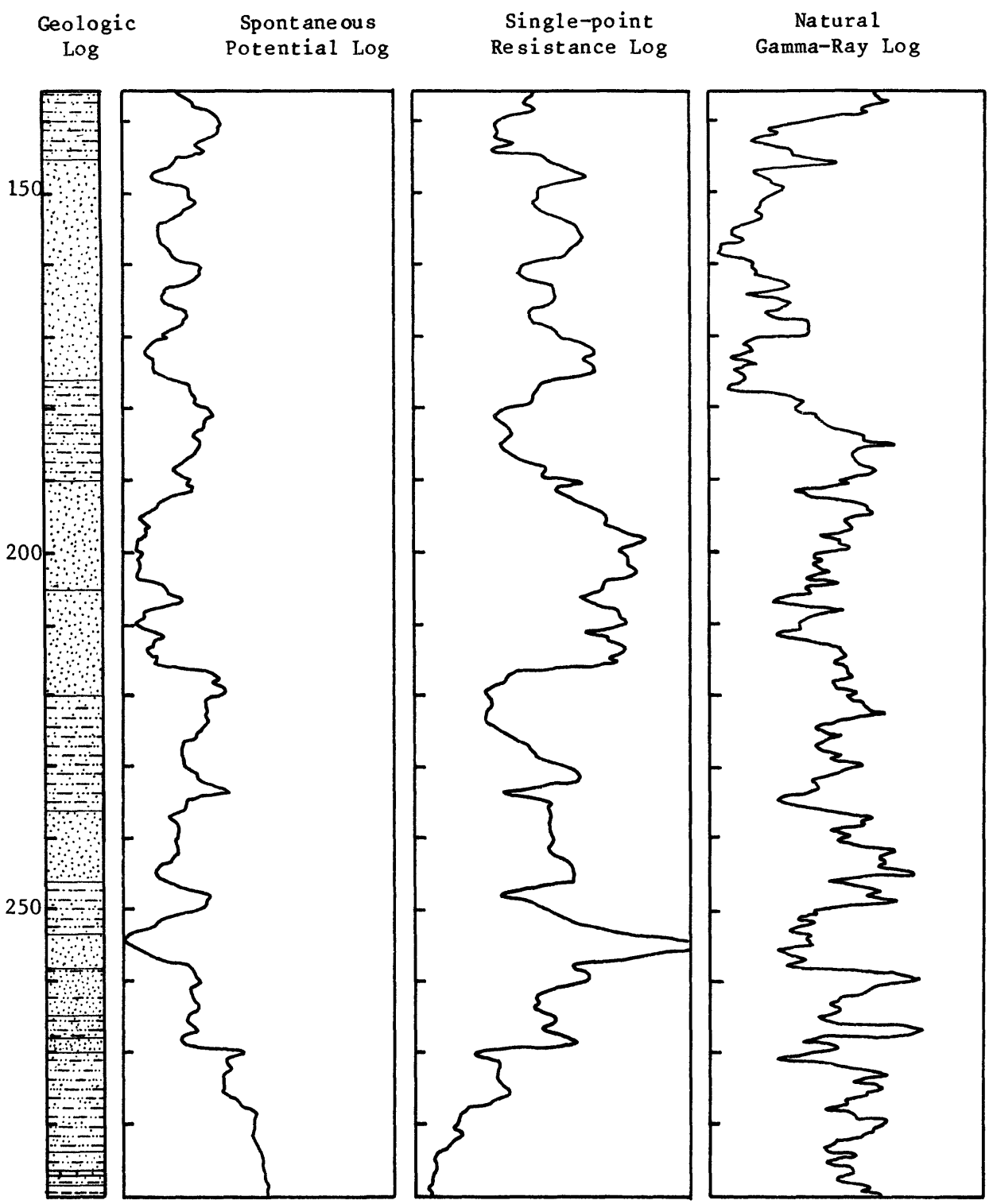
	Depth, in feet From	To
Sand, fine to coarse, pale brown	268	270
Silt, very sandy, very pale brown, very calcareous 279 to 283 feet	270	283
Limestone and sandy silt, interbedded, very pale brown, very calcareous	283	288
Cretaceous System, Pierre Formation:		
Clay, very pale brown	288	290
Clay, light yellowish-brown, moderately calcareous	290	295
Clay, light yellowish-brown	295	310

Test-hole 6N-23W-25AAAA1 (cont'd)

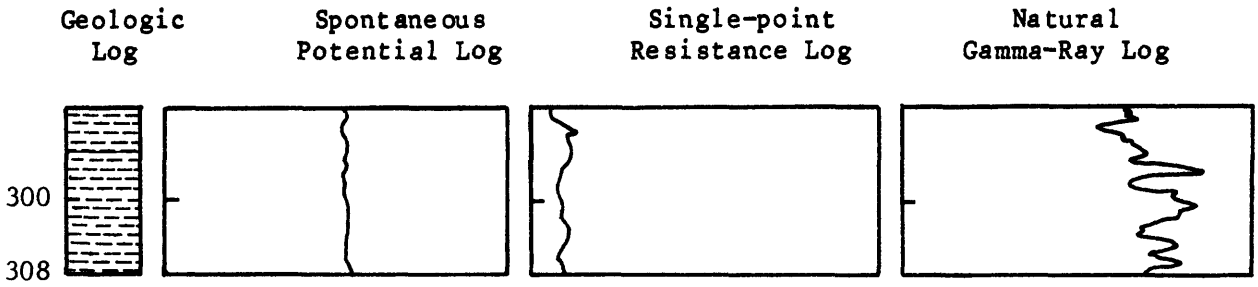
Depth to water: 96 feet.
Total Depth Drilled: 310 feet.
Remarks: Caliper log, 64 inch long normal log available.



Test-hole 6N-23W-25AAAA1 (cont'd)



Test-hole 6N-23W-25AAAA1 (cont'd)



Test-hole 7N-14W-13DDDC1

Location: 8 ft. N. of S. sec. line and 714 ft. W. of E. sec. line.
Date drilled: 5-19-81.
Field number: 13-B-81.
Land surface altitude: 2,100 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	2
Sand, very fine, very silty and clayey, dark grayish-brown to brown	2	4
Silt, moderately clayey, iron-staining, yellowish brown to brown	4	29
Silt, moderately to very clayey, moderately sandy, grayish brown to dark grayish brown	29	34
Sand, very fine to fine, slightly silty and clayey, very pale brown to yellowish-brown, clay lenses at 60, 63, and 73 feet	34	80
Sand, fine to medium, some coarse, yellowish brown, clay layer from 92 to 93 feet	80	95
Sand and gravel, very fine sand to coarse gravel	95	110
Sand and gravel, very fine sand to coarse gravel coarser than above, clay layer from 135 to 136 feet	110	192
Clay, brown	192	193
Sand and gravel, very fine sand to coarse gravel	193	197
Sand, very fine, very clayey, grayish brown	197	202
Sand, fine to medium, grayish brown	202	205
Sand, coarse, grayish brown	205	220

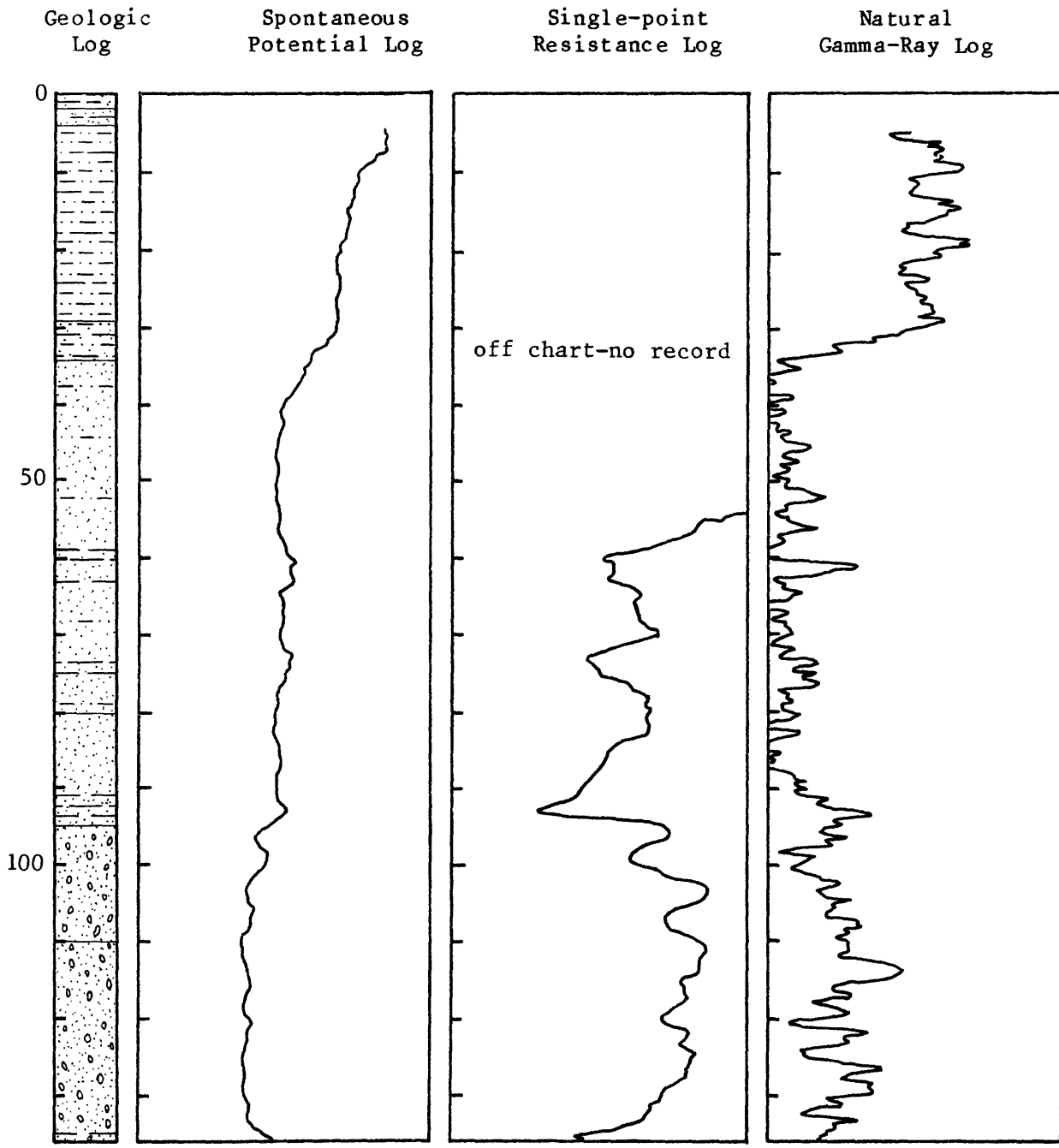
Test-hole 7N-14W-13DDDC1 (cont'd)

Descriptive Log

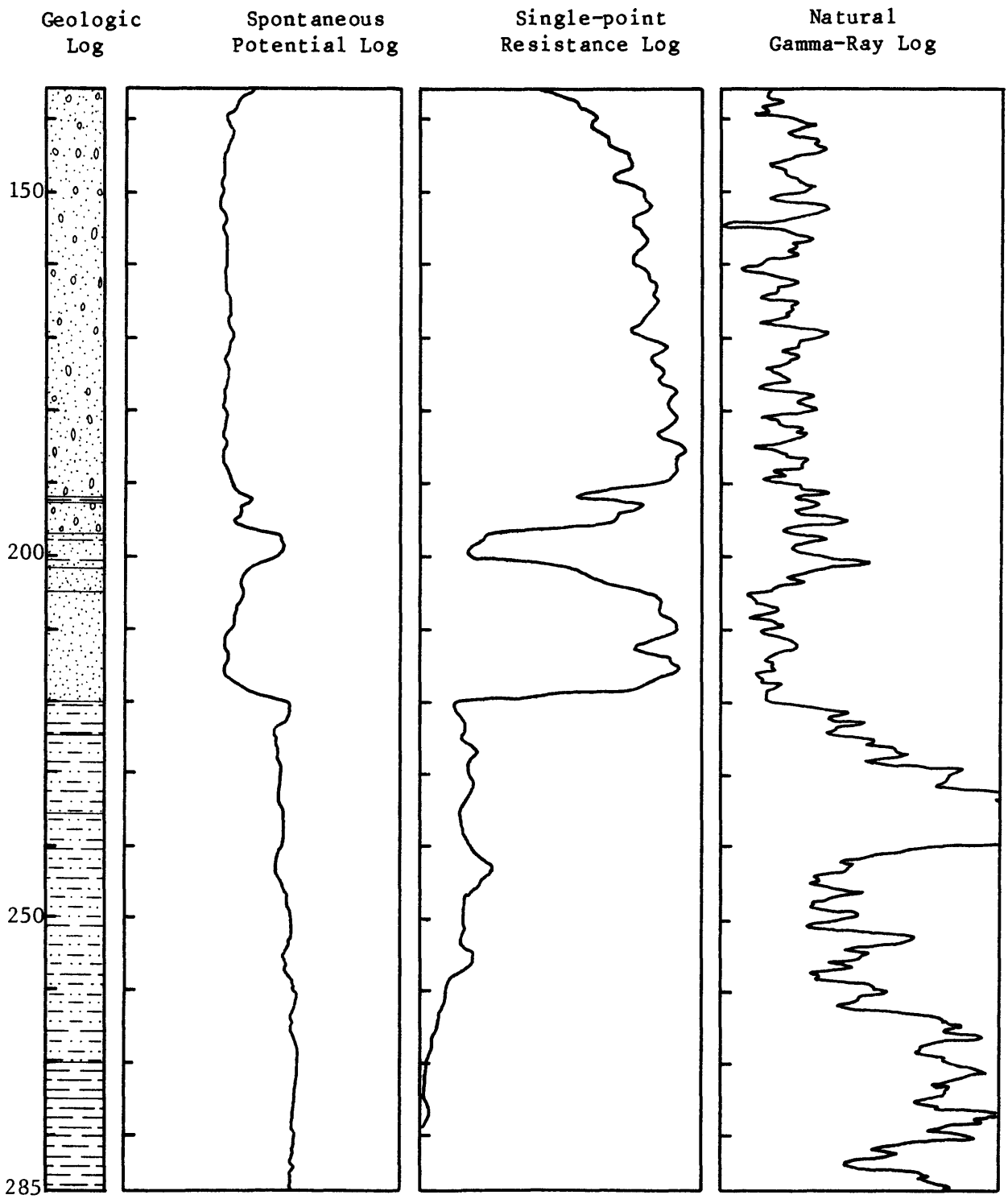
	Depth, in feet From	To
Tertiary System, Ogallala Group:		
Clay, moderately silty, olive	220	225
Silt, slightly silty and clayey, pale olive to olive, moderately calcareous	225	236
Silt, moderately clayey, slightly sandy, very fine sand, olive gray, slightly to moderately calcareous	236	270
Cretaceous System, Pierre Formation:		
Clay, olive	270	275
Clay, very dark gray, thin bentonite layer at 280 feet	275	290

Test-hole 7N-14W-13DDDC 1 (cont'd)

Depth to water: 45 feet.
Total Depth Drilled: 290 feet.
Remarks: 64 inch long normal log available.



Test-hole 7N-14W-13DDDC1 (cont'd)



Test-hole 7N-15W-18CCC1

Location: 232 ft. N. of S. sec. line and approximately 10 ft. E. of W. sec. line.
Date drilled: 5-14-81.
Field number: 15-B-81.
Land surface altitude: 2,175 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, moderately clayey, very dark grayish-brown----------	0 -	2
Silt, slightly clayey and sandy, very fine sand, light yellowish-brown----------	2 -	15
Silt, moderately clayey, dark to very dark grayish-brown----	15 -	21
Sand, very fine to medium, much very fine to fine, slightly silty in part----------	21 -	48
Silt, moderately sandy, slightly to moderately clayey, yellowish-brown to brownish-yellow----------	48 -	54
Sand, fine to coarse, some fine gravel----------	54 -	60
Gravel, fine to medium, slightly silty from 79 to 85 feet---	60 -	85
Sand, fine----------	85 -	87
Gravel, fine to medium, several clay lenses 115 to 120 feet-	87 -	136
Clay, moderately silty, light olive-gray to olive gray------	136 -	146
Gravel, contains some dark clasts----------	146 -	154
Clay, moderately silty, olive, moderately calcareous--------	154 -	160
Silt, moderately clayey, slightly sandy, moderately to very calcareous, olive gray----------	160 -	168
Silt, moderately clayey, some sand and gravel, yellowish brown to light yellowish-brown, moderately calcareous, a few greenish clay layers----------	168 -	180
Silt, slightly clayey, yellowish-brown, moderately calcareous----------	180 -	192

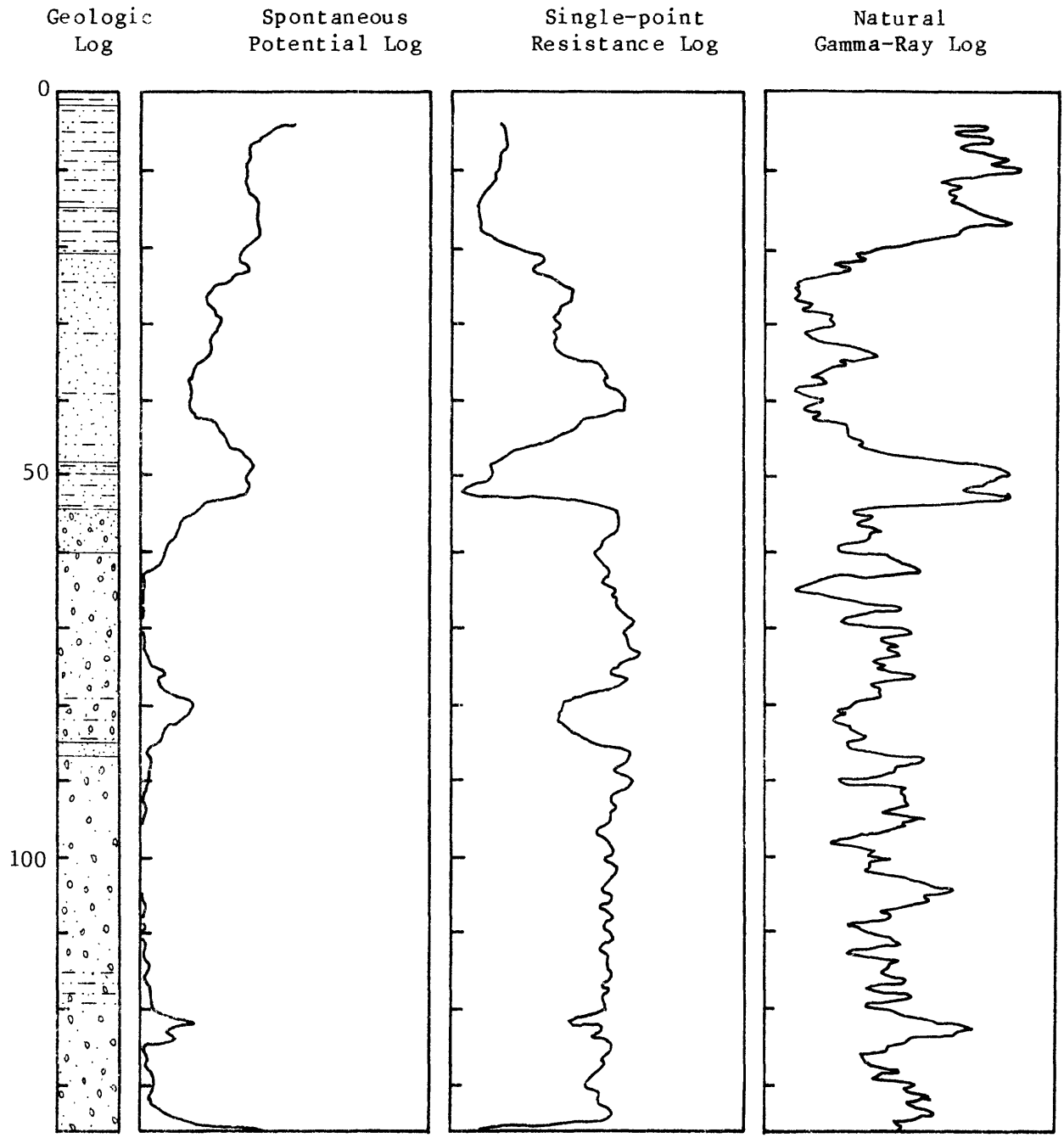
Test-hole 7N-15W-18CCC1 (cont'd)

Descriptive Log

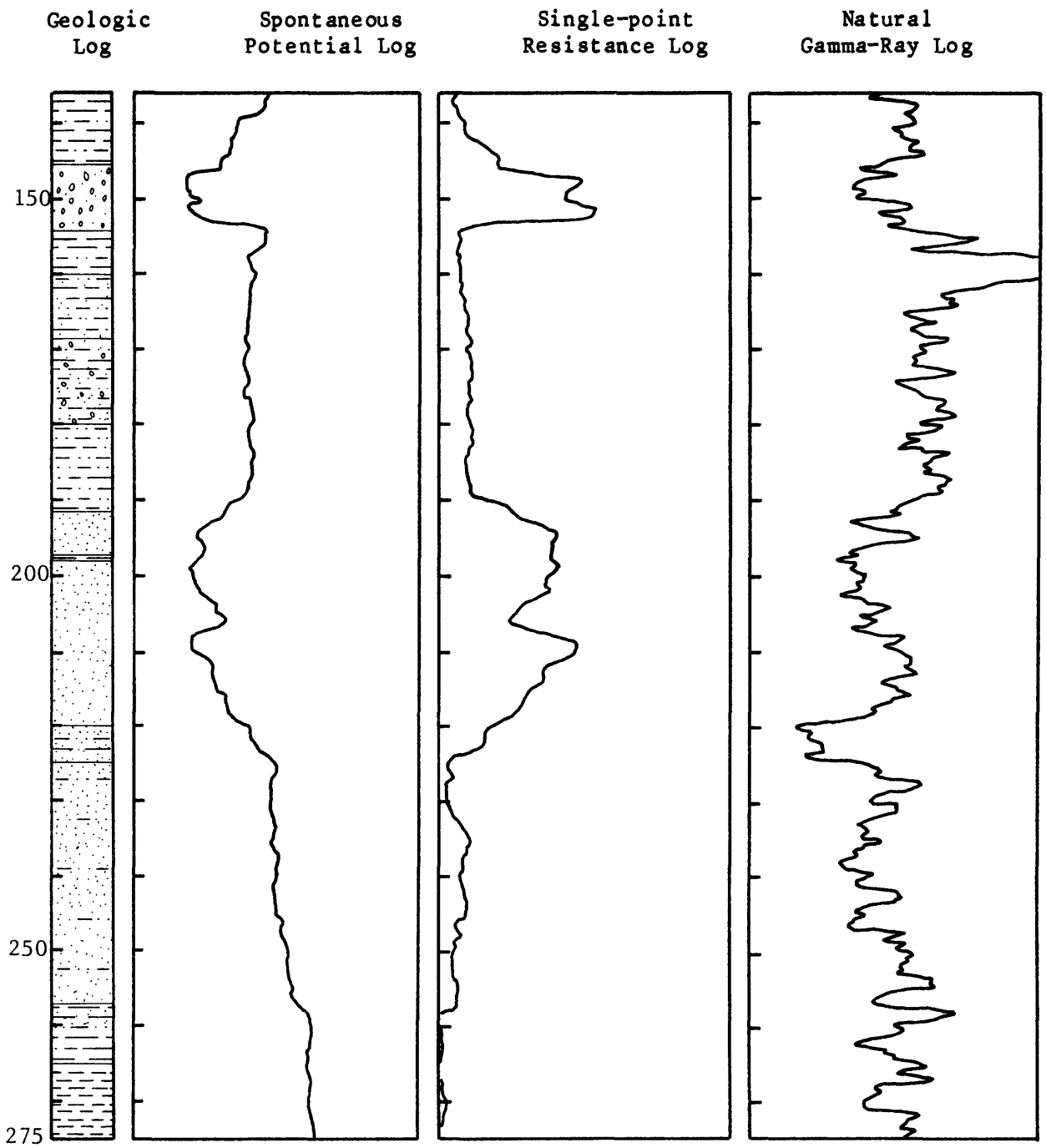
	Depth, in feet From	To
Tertiary System, Ogallala Group:		
Sand, very fine to fine, lightly cemented, slightly silty, very calcareous----------	192	197
Clay, white, very calcareous----------	197	198
Sandstone, very fine to fine, lime cemented, olive white, very calcareous----------	198	220
Sand, very fine, moderately silty, clayey zones, lightly cemented, light yellowish-brown, moderately calcareous-	220	225
Sand, moderately to very silty, pale yellow, slightly to moderately calcareous 245 to 257 feet----------	225	257
Clay, moderately silty, slightly sandy 257 to 260 feet, light gray to pale olive, very calcareous----------	257	265
Cretaceous System, Pierre Formation:		
Shale, weathered yellow 265 to 267 feet, dark gray to olive gray, moderately to very calcareous----------	265	280

Test-hole 7N-15W-18CCC 1 (cont'd)

Depth to water: 20 feet.
Total Depth Drilled: 280 feet.
Remarks: 64 inch long normal log available.



Test-hole 7N-15W-18CCC1 (cont'd)



Test-hole 7N-21W-1DDDD1

Location: 6 ft. N. of S. sec. line and 146 ft. W. of E. sec. line.
Date drilled: 4-30-81.
Field number: 9-B-81.
Land surface altitude: 2,492 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill and topsoil	0 -	3
Silt, slightly clayey, some iron-staining 30 to 35 feet, light yellowish-brown to light olive-brown, slightly to moderately calcareous	3 -	35
Silt, slightly clayey, some iron-staining, pale brown to light yellowish-brown	35 -	42
Silt, slightly clayey, dark brown to brown	42 -	45
Silt, slightly to very sandy, very fine to fine sand, dark brown to very dark grayish-brown	45 -	50
Silt, slightly sandy, light yellowish-brown	50 -	60
Silt, very sandy, very fine sand, slightly clayey 76 to 80 feet, yellowish-brown	60 -	83
Silt, moderately clayey, light yellowish-brown to yellowish-brown	83 -	88
Silt, moderately sandy, very fine to fine sand, light yellowish-brown	88 -	90
Sand, very fine to fine, pale brown	90 -	99
Silt, slightly to moderately sandy, yellowish-brown	99 -	128
Sand, very fine to fine	128 -	129
Silt, very sandy, very fine to fine sand	129 -	140
Sand, very fine to fine	140 -	143

Test-hole 7N-21W-1DDDD1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Silt, moderately sandy and clayey, very fine to fine sand, yellowish-brown	143	145
Sand, very fine to fine	145	148
Clay, very silty, yellowish-brown	148	158
Sand, very fine to fine, yellowish-brown	158	160
Silt, slightly sandy, very fine to medium sand, yellowish-brown	160	164
Sand, very fine to fine	164	171
Silt, moderately sandy, yellowish-brown	171	172
Sand, very fine to fine, some medium 185 to 190 feet	172	190
Gravel, fine to medium, some very coarse sand, silty 196 to 198 feet	190	200
Sand and gravel, medium sand to fine gravel	200	207
Silt, very sandy, slightly clayey, very pale-brown to light brownish-gray	207	217
Tertiary System, Ogallala Group:		
Sandstone, very fine to fine, moderately silty, very pale brown, moderately to very calcareous	217	222
Silt and limestone	222	225
Silt and sand, very pale-brown	225	227
Sandstone, very fine to fine, pale-brown	227	233
Silt, moderately sandy, clayey from 239 to 240 feet and 234 to 236 feet, pale-brown to pale-olive	233	240
Silt, moderately sandy, light gray	240	258
Sand, very fine to fine	258	260
Silt, moderately clayey, very pale-brown, moderately calcareous	260	263

Test-hole 7N-21W-1DDDD1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand, very fine to fine	263	265
Silt, moderately clayey, white, very calcareous	265	270
Silt, moderately sandy, slightly clayey in part, very pale-brown, slightly to very calcareous 280 to 284 feet	270	284
Sand and sandstone, very fine to fine, pale-brown	284	290
Silt, very sandy, very fine sand, very pale-brown, slightly calcareous	290	295
Sandstone, very fine to fine and sand, very fine to fine white rootlets, very calcareous	295	298
Silt, moderately sandy, very fine to fine sand, very pale-brown, slightly to very calcareous, very clayey 300 to 304 feet	298	315
Sandstone, very fine to fine, a few rootlets, very pale-brown, slightly to moderately calcareous	315	327
Silt, very sandy, pale-brown	327	329
Silt and sandstone interbedded, sandstone is very fine to fine, silt is moderately sandy, yellowish-brown	329	341
Silt, moderately sandy, very fine to fine sand, pale-brown	341	350
Clay, very silty, light yellowish-brown to pale-yellow	350	353
Silt, very sandy, very fine to fine sand, pale-olive	353	361
Sand, very fine to fine, very silty, light yellowish-brown	361	375
Silt, moderately sandy, olive	375	382
Sand, very fine to fine, some medium to coarse, very silty	382	391
Silt, very sandy, very fine to fine sand, pale-olive	391	398
Limestone and limy silt, white, very calcareous	398	399
Silt, moderately to very sandy, very fine to fine sand, white	399	408

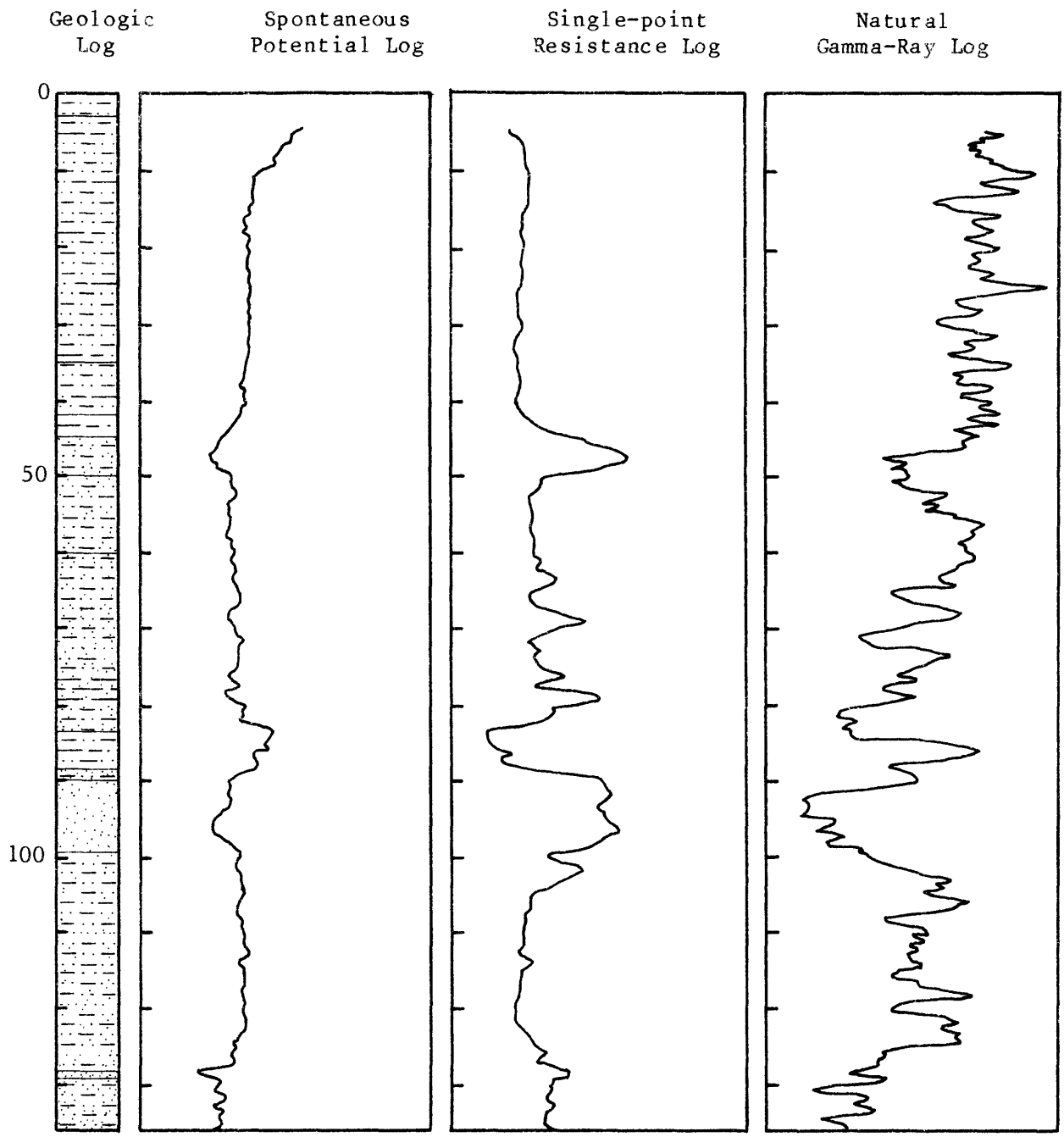
Test-hole 7N-21W-1DDDD1 (cont'd)

Descriptive Log

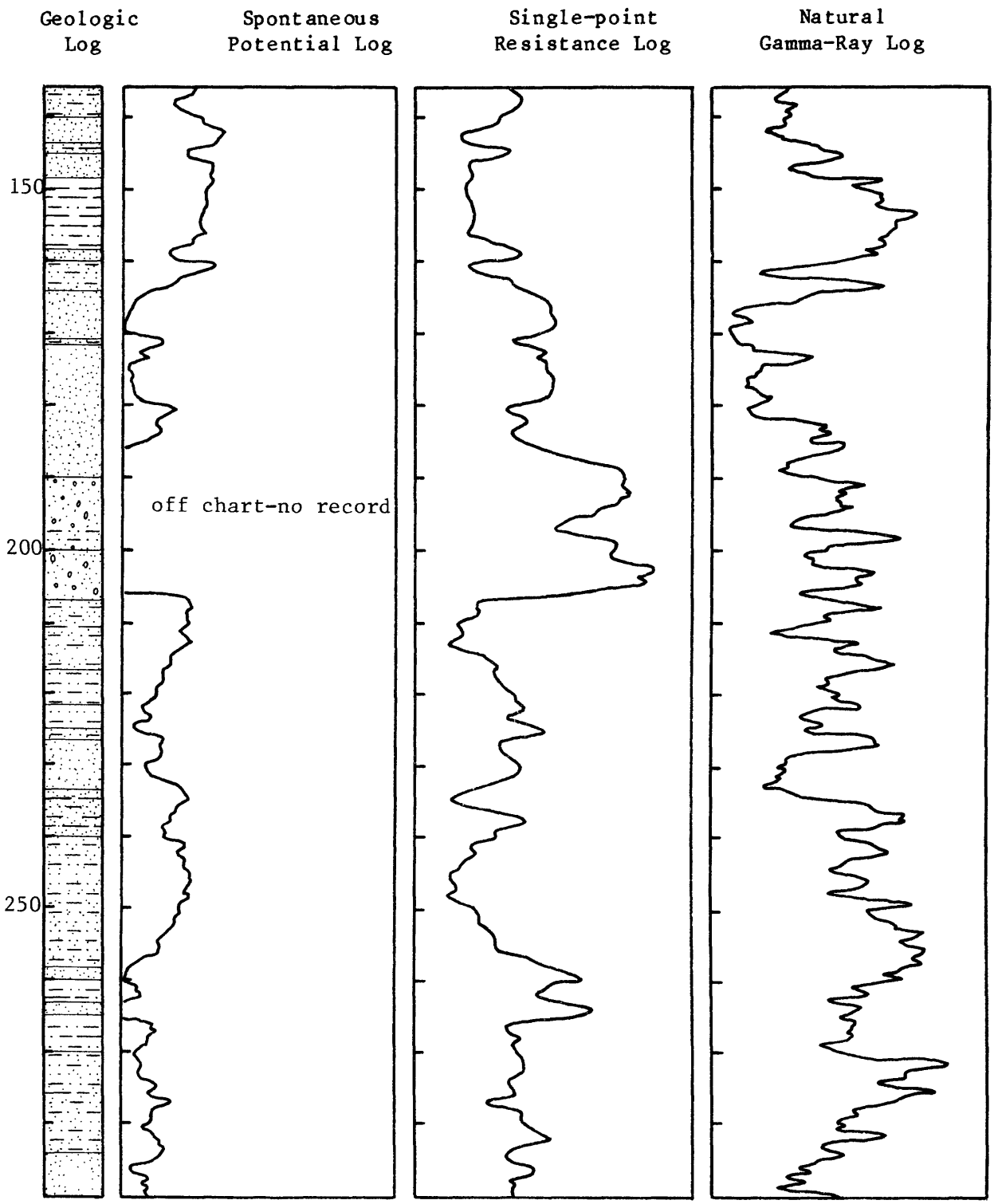
	Depth, in feet From	To
Limestone, pale-brown, very calcareous----------	408	409
Silt, moderately clayey, slightly sandy, very fine to medium sand, white to light gray, moderately calcareous	409	414
Sand, fine to coarse, much medium----------	414	416
Silt, moderately sandy, fine sand, light gray, very calcareous----------	416	420
Sand, very silty, and silt, very sandy, pale-olive to olive-	420	426
Silt, slightly clayey, slightly to very sandy, very fine sand, very pale-brown to yellowish-brown, slightly to very calcareous from 436 to 454 feet----------	426	454
Silt, moderately clayey, slightly sandy, very fine sand, pale to very pale brown, moderately calcareous---------	454	456
Silt, very sandy, very fine sand, very pale-brown----------	456	461
Clay, very silty, and silt, very pale-brown, very calcareous	461	469
Silt, slightly to moderately sandy, some limy clay lenses, pale to very pale-brown, slightly to very calcareous---	469	480
Clay, slightly silty, very pale-brown, moderately calcareous	480	485
Silt, moderately sandy, very fine sand, slightly clayey from 485 to 490 feet and 495 to 500 feet, pale to very pale-brown----------	485	508
Sand, fine to very coarse, trace of fine gravel, much medium sand, a few orange-yellow rock fragments, silty from 512 to 514 feet----------	508	528
Cretaceous System Pierre Formation:		
Clay, yellow, slightly calcareous----------	528	530
Clay, pale yellow to yellowish-gray, slightly to moderately calcareous----------	530	550

Test-hole 7N-21W-1DDDD1 (cont'd)

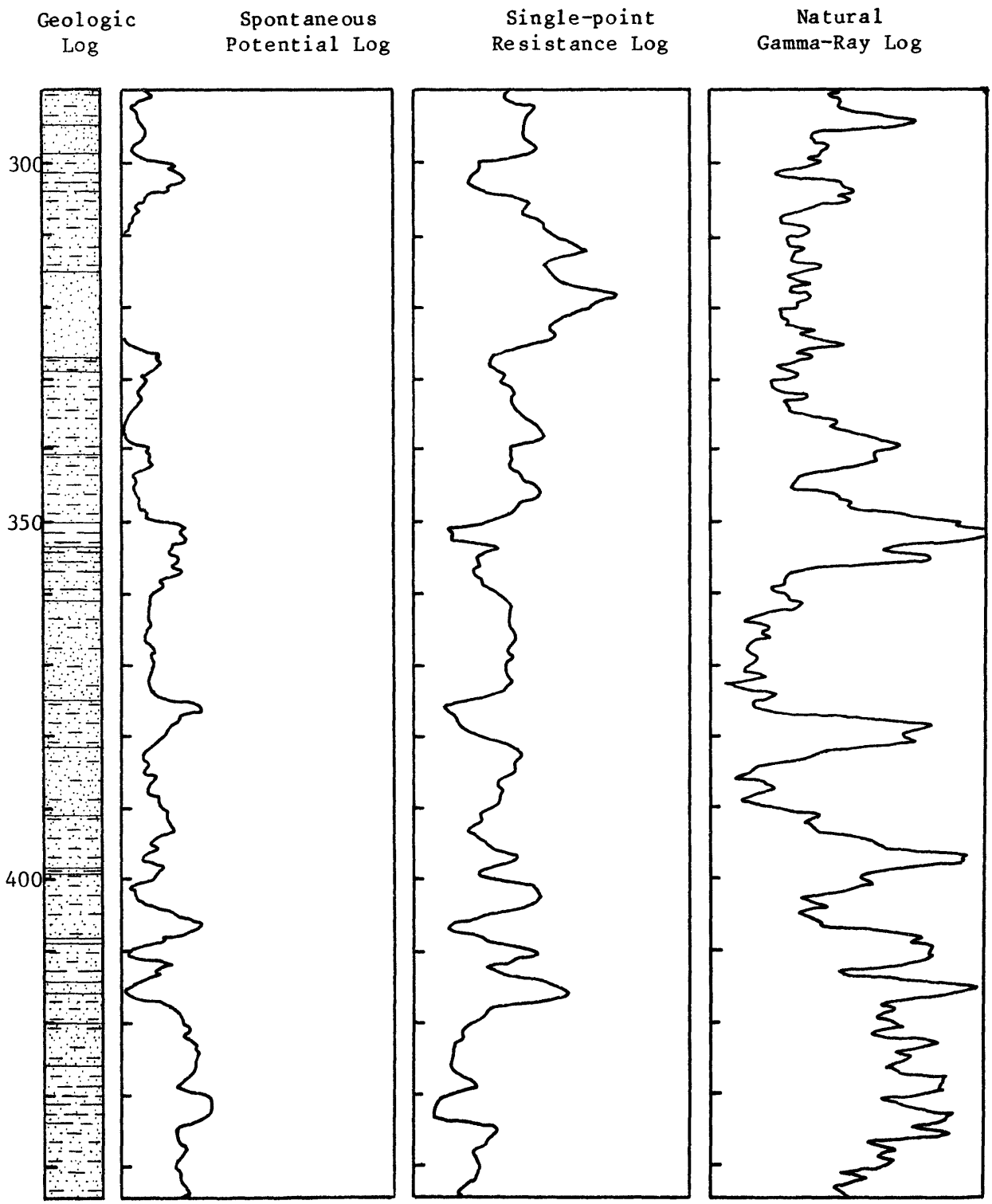
Depth to water: 115 feet.
Total Depth Drilled: 550 feet.
Remarks: Caliper log, 64 inch long normal log available.



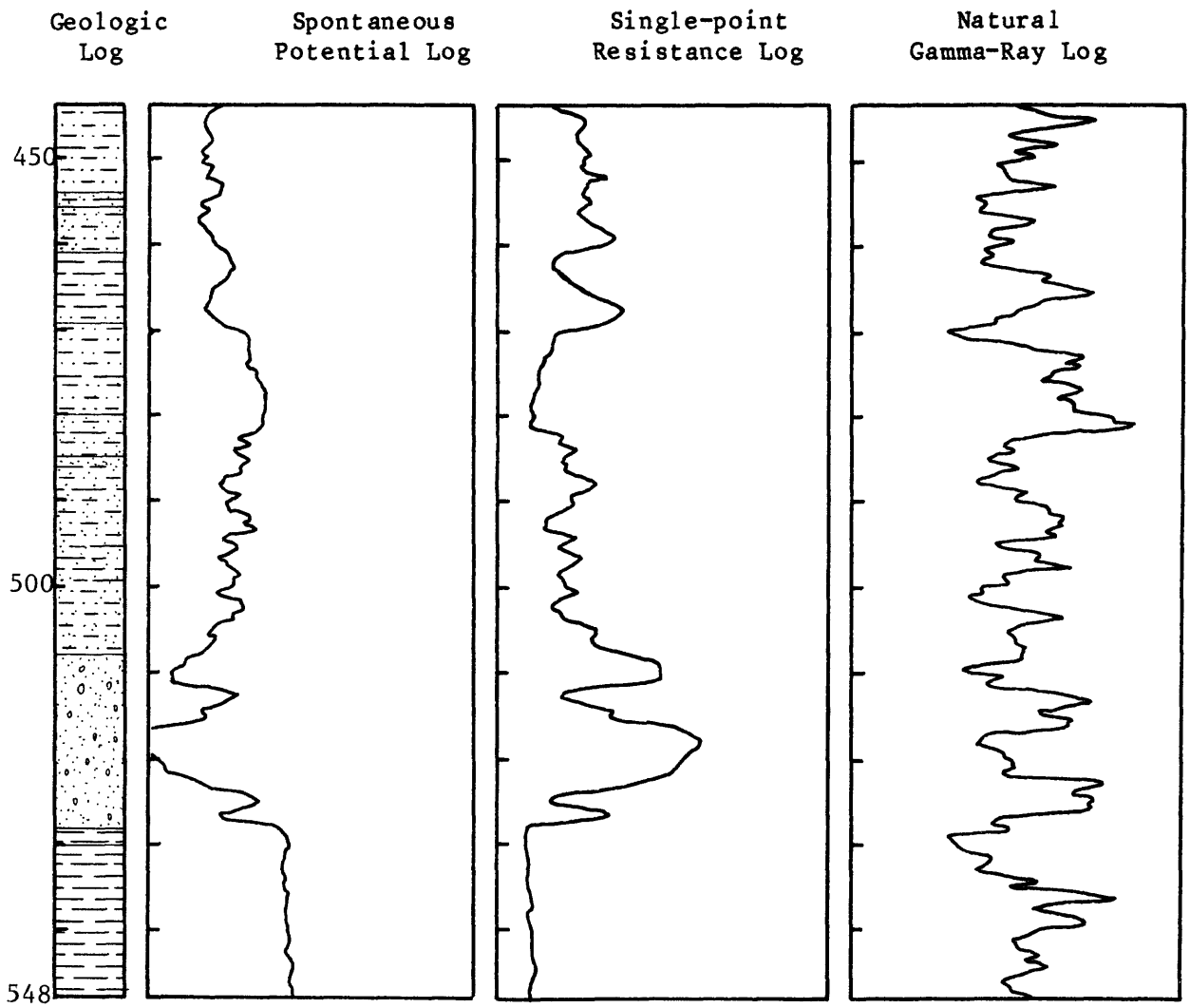
Test-hole 7N-21W-1DDDD1 (cont'd)



Test-hole 7N-21W-1DDDD1 (cont'd)



Test-hole 7N-21W-1DDDD1 (cont'd)



Test-hole 7N-23W-36AAAA1

Location: 46 ft. S. of N. sec. line and 9 ft. W. of E. sec. line.
Date drilled: 4-21-81.
Field number: 4-B-81.
Land surface altitude: 2,555 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill and topsoil	0 -	4
Silt, moderately clayey, light brownish-gray to pale brown, slightly calcareous, a few thin white shell fragments from 30 to 37 feet	4 -	37
Silt, slightly to moderately clayey, dark brown to dark grayish-brown	37 -	47
Silt, slightly clayey, very pale brown to pale brown	47 -	50
Silt, slightly clayey, moderately calcareous, some very fine sand from 55 to 57, feet pale brown to brown	50 -	71
Silt, slightly sandy and slightly clayey, sand is very fine, pale brown, moderately calcareous	71 -	95
Silt, slightly clayey in part, very fine sand, pale brown to brown, slightly calcareous	95 -	141
Silt, slightly clayey, slightly to moderately sandy, very fine sand, light yellowish-brown to pale brown, slightly to very calcareous	141 -	175
Silt, slightly clayey, very pale brown, very calcareous	175 -	180
Sand, very fine to very coarse	180 -	188
Silt, very sandy, yellowish brown, very calcareous	188 -	190
Sand, very fine to medium, much medium, pale brown	190 -	192
Silt, very sandy, limy and clayey from 199 to 202 feet, pale brown, very calcareous in part	192 -	202
Sand, very fine to very coarse, much medium to coarse	202 -	210

Test-hole 7N-23W-36AAAA1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Tertiary System, Ogallala Group:		
Sandstone, very fine to fine, very silty, lime cemented, very pale brown to white	210	212
Sand, very fine to very coarse, much medium to coarse	212	215
Silt, moderately to very sandy, very fine to very coarse sand, limy lenses, light brownish-gray to light olive-gray, slightly to moderately calcareous	215	245
Silt and sandstone interbedded, very fine to fine sand, silt is reddish-brown	245	250
Sand and sandstone, sandstone is very fine to medium and slightly silty, sand is very fine to very coarse, much fine to medium, pale brownish color, a few rootlets	250	270
Sand, very fine to medium, much fine to medium, slightly limy 280 to 285 feet, a few rootlets, pale brown	270	295
Sand, very fine to medium, much very fine to fine	295	302
Silt, slightly to moderately clayey, slightly sandy, very pale brown to brown	302	308
Sand, very fine to fine, slightly silty, a few rootlets, pale brown	308	314
Sand and sandstone, very fine to fine, slightly silty, moderately calcareous	314	321
Silt, moderately sandy, very fine sand, pale brown, moderately calcareous	321	325
Sand and sandstone, very fine, slightly silty, silt is pale yellow	325	340
Silt, moderately sandy, very fine to fine, pale olive	340	350
Silt, slightly clayey, light gray, very calcareous	350	355

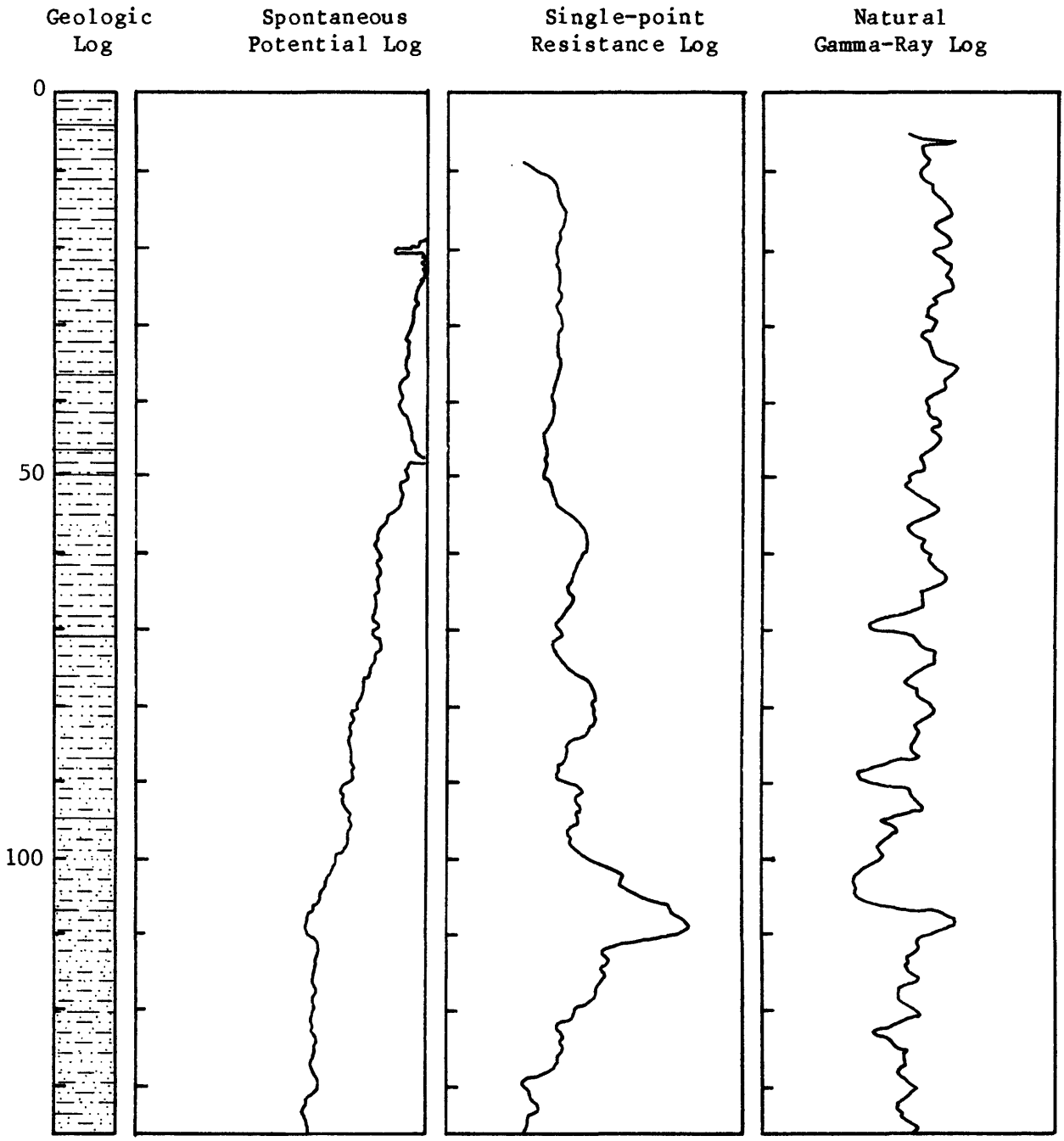
Test-hole 7N-23W-36AAAA1 (cont'd)

Descriptive Log

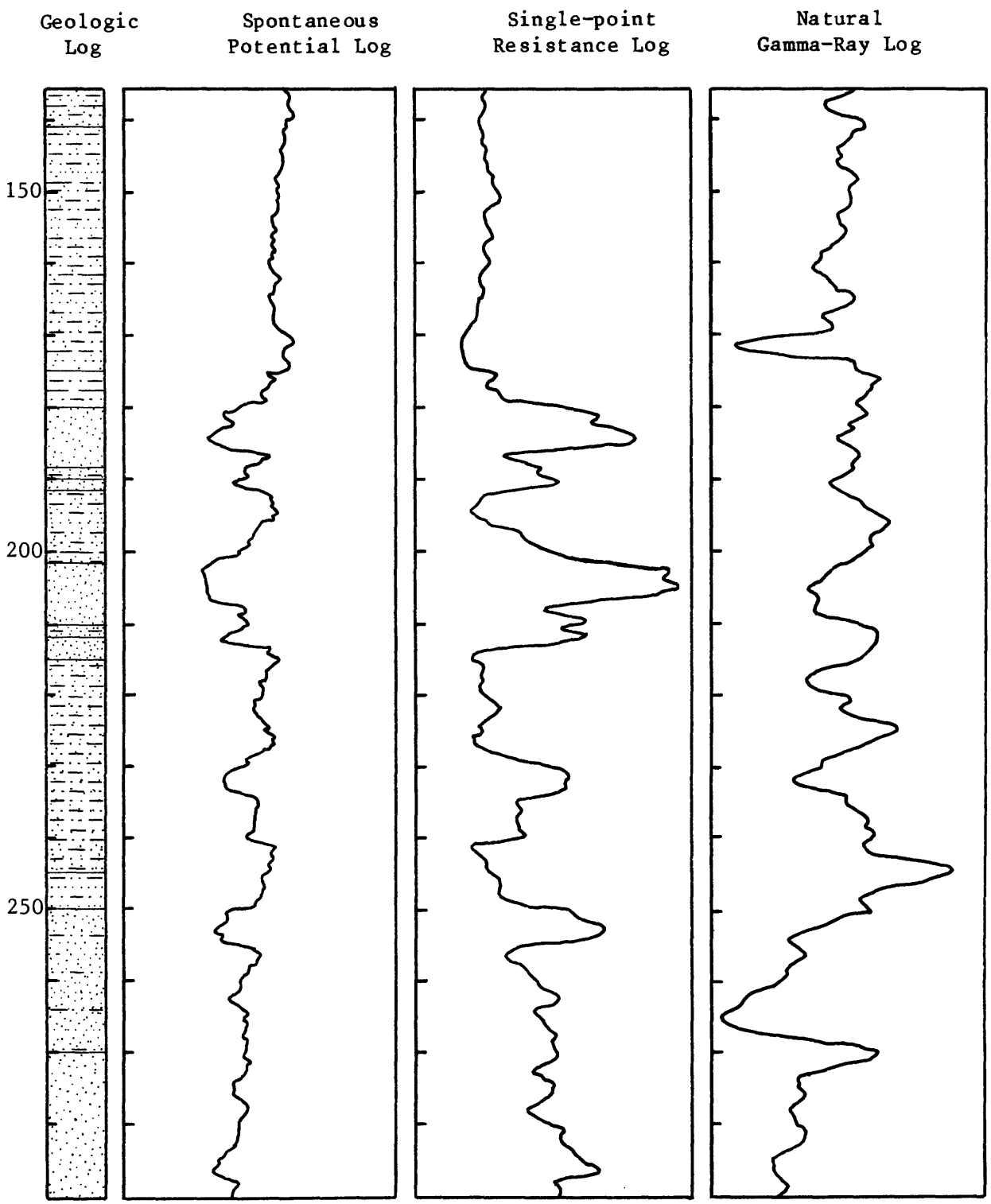
	Depth, in feet From	To
Sandstone and sandy silt, very fine to fine sand, pale olive, moderately calcareous	355	360
Silt, moderately to very sandy, very fine to fine sand, pale yellow, very calcareous	360	368
Sand, very fine to fine, brown	368	395
Silt, slightly sandy and clayey, very fine sand, pale yellow to very pale olive	395	405
Sand, very fine to very coarse, trace fine gravel, much medium to coarse sand, grades coarser with depth, olive green silt layer from 419 to 420 feet	405	450
Silt, very sandy, pale yellow	450	453
Sand, very fine to very coarse, trace of fine gravel	453	465
Silt, moderately clayey, white, very calcareous	465	468
Sand, very fine to very coarse, a trace of fine gravel	468	477
Cretaceous System, Pierre Formation:		
Clay, very calcareous, white to pale yellow	477	490
Clay, dark gray, very calcareous	490	500

Test-hole 7N-23W-36AAAA1 (cont'd)

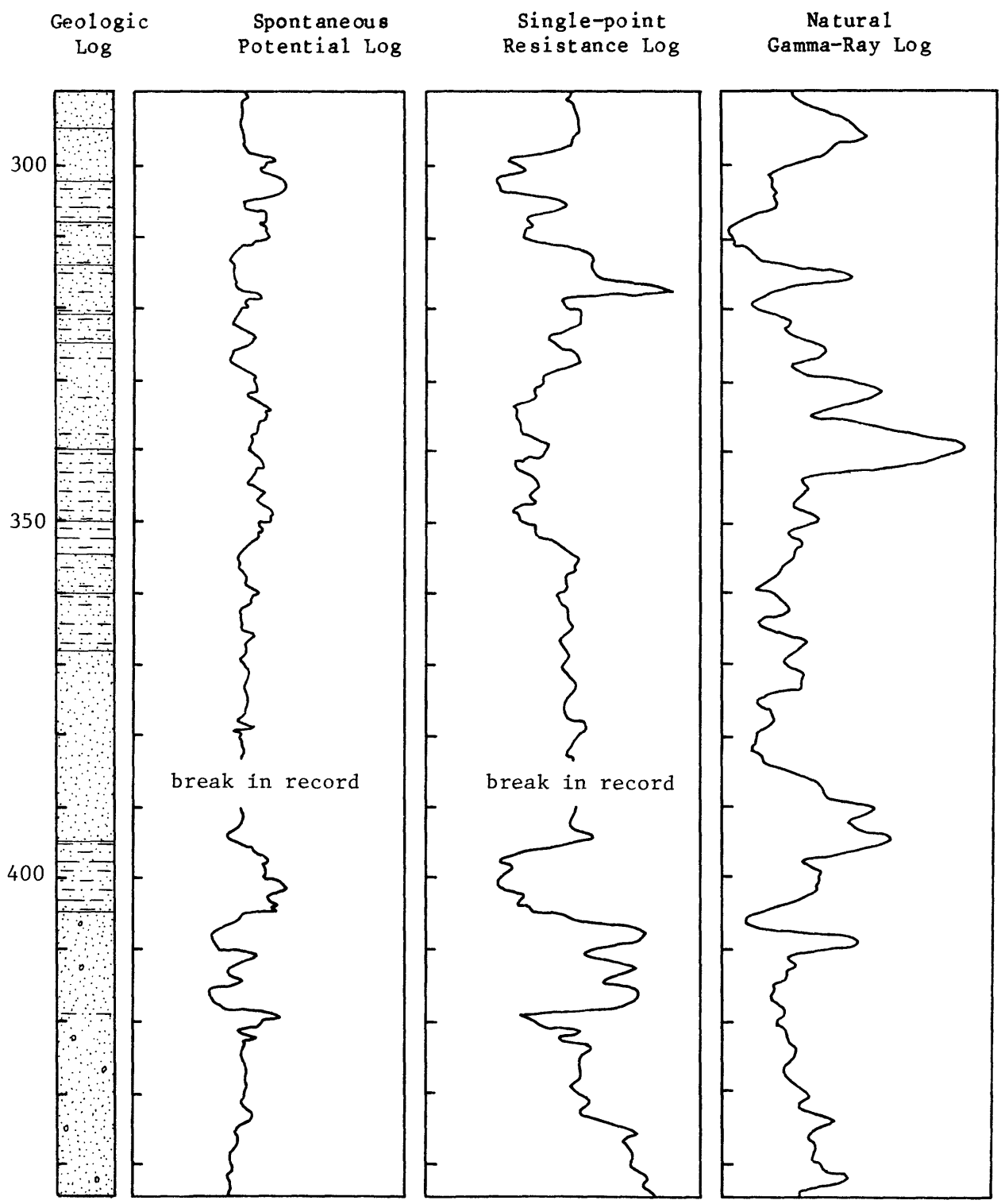
Depth to water: 168 feet.
Total Depth Drilled: 500 feet.
Remarks: Caliper log available.



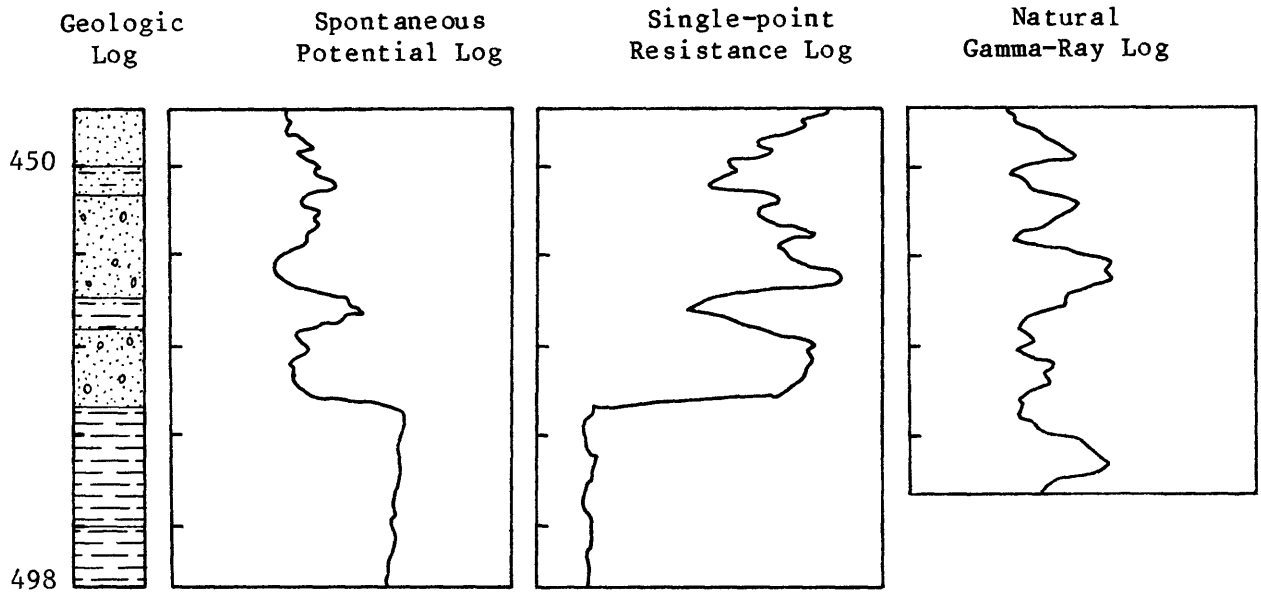
Test-hole 7N-23W-36AAAA1 (cont'd)



Test-hole 7N-23W-36AAAA1 (cont'd)



Test-hole 7N-23W-36AAAA1 (cont'd)



Test-hole 8N-23W-13DDC1

Location: 8 ft. N. of S. sec. line and 1,090 ft. W. of E. sec. line.
Date drilled: 4-16-81.
Field number: 3-B-81.
Land surface altitude: 2,644 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	1
Topsoil, silt, slightly clayey, grayish brown	1	3
Silt, slightly clayey, light brownish gray	3	4
Silt, slightly clayey, pale brown	4	20
Silt, slightly clayey, pale brown, some ironstaining	20	30
Silt, slightly clayey, pale brown	30	56
Silt, slightly clayey, dark grayish-brown	56	62
Silt, slightly clayey, pale brown to light yellowish-brown, slightly calcareous	62	80
Silt, slightly clayey, light yellowish-brown to yellowish brown	80	90
Silt, slightly clayey, light yellowish-brown, slightly calcareous	90	115
Silt, moderately, clayey, light yellowish-brown	115	128
Silt, slightly clayey and sandy, very fine sand, light yellowish brown to yellowish-brown, in part slightly calcareous	128	160
Sand, very fine to fine, moderately to very silty	160	168
Silt, moderately sandy, very fine to fine sand	168	175
Silt, slightly sandy, pale brown to yellowish brown, slightly calcareous from 190 to 200 feet	175	200

Test-hole 8N-23W-13DDC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand, very fine to fine	200	220
Sand, very fine to fine, slightly silty	220	225
Silt, moderately sandy, very fine to fine sand, pale brown, slightly calcareous, very sandy from 235 to 240 feet	225	240
Sand, very fine to fine, moderately to very silty	240	248
Silt, moderately to very sandy, pale brown to brown	248	260
Sand and gravel, very fine sand to fine gravel, much coarse to very coarse sand	260	305
Sand and gravel, coarse sand to medium gravel, much very coarse sand to fine gravel, 60 percent gravel, from 305 to 307 feet and 310 to 312 feet	305	313
Silt, moderately sandy, grayish brown to yellowish-brown	313	320
Sand and sandstone, very fine to coarse, much fine to medium, slightly calcareous	320	333
Silt, moderately sandy, fine to medium sand, pale brown, moderately calcareous	333	338.3
Sand, fine to medium, silty and clayey	338.3	340
Sand, fine to coarse, much medium	340	350
Sand and gravel, fine sand to fine gravel, much medium to coarse sand, some limy nodules from 361 to 365 feet, silt lens from 354 to 356 feet	350	365
Sand, very fine to coarse, much fine to medium, silty from 365 to 369 feet and 374 to 376 feet	365	379
Sand and silt, very fine to coarse, much fine to medium	379	383
Silt, slightly to very sandy, pale brown	383	390

Test-hole 8N-23W-13DDC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Tertiary System, Ogallala Group:		
Siltstone and sandstone, very fine to medium, some coarse, silty	390	398
Silt	398	400
Sandstone and sand, very fine to fine, slightly calcareous, a few hard limy concretions	400	406
Silt, moderately to slightly sandy, slightly clayey, very pale brown to yellowish brown	406	410
Sand and sandstone, very fine to medium, coarsens with depth, a few limy fragments	410	419
Silt, moderately sandy, fine to medium sand, very pale brown, very calcareous	419	424
Sand, very fine to coarse, much fine to medium	424	428
Silt, some fine to medium sand, very calcareous	428	429
Sand, fine to medium	429	430
Sandstone and sand, very fine to medium, much fine to medium	430	441
Silt, moderately to very sandy, fine to medium sand, moderately calcareous, pale to very pale brown	441	450
Sand, very fine to medium, much fine	450	475
Silt, moderately sandy, pale yellow, very calcareous	475	480
Sand, very fine to fine, slighty silty, pale olive to pale yellow	480	490
Sand, very fine to fine, pale yellow silt layer 507.5 to 508 feet	490	513
Sand with interbedded silt, very fine to medium sand, pale olive to pale yellow, some pale brown	513	540

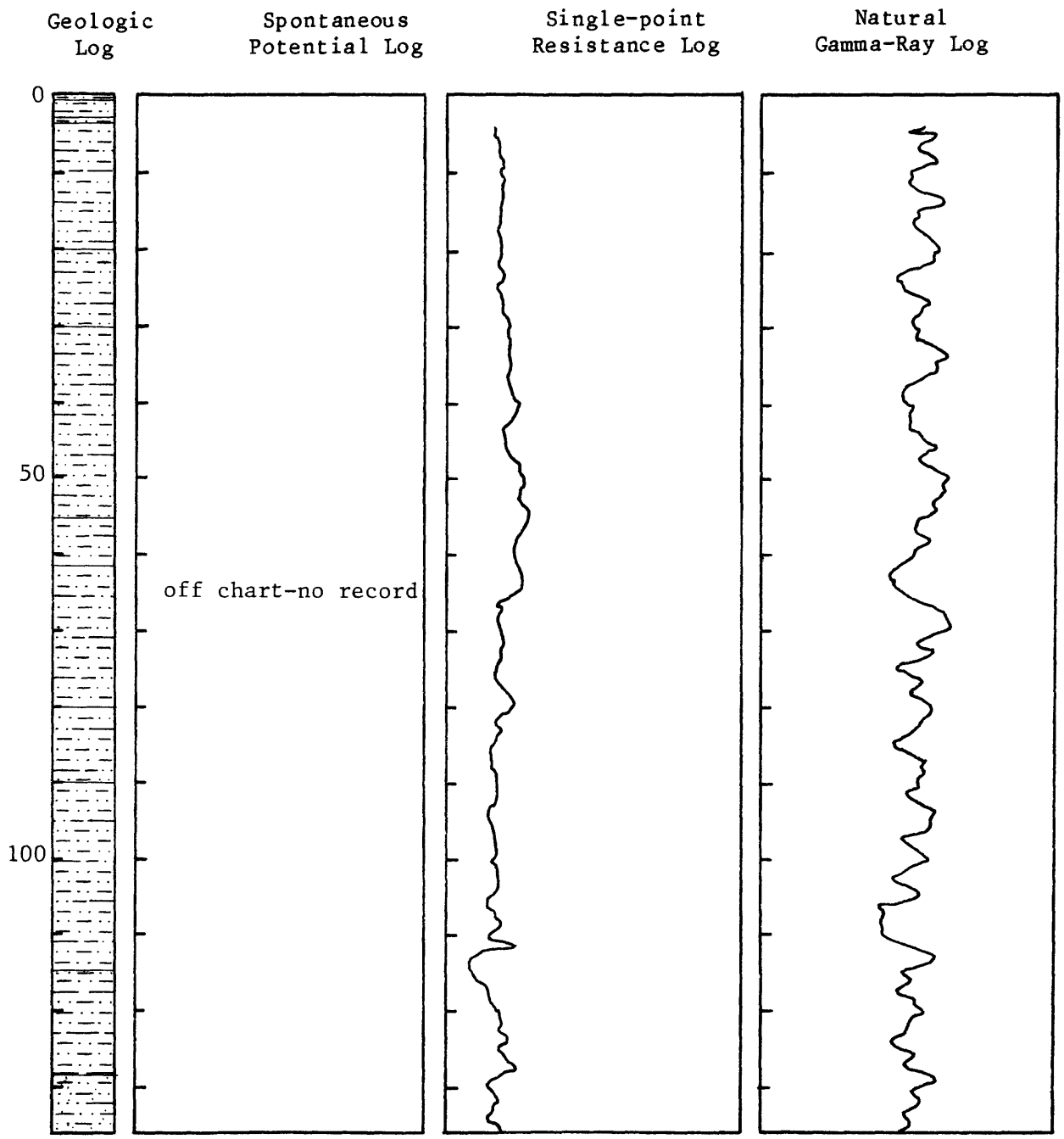
Test-hole 8N-23W-13DDC1 (cont'd)

Descriptive Log

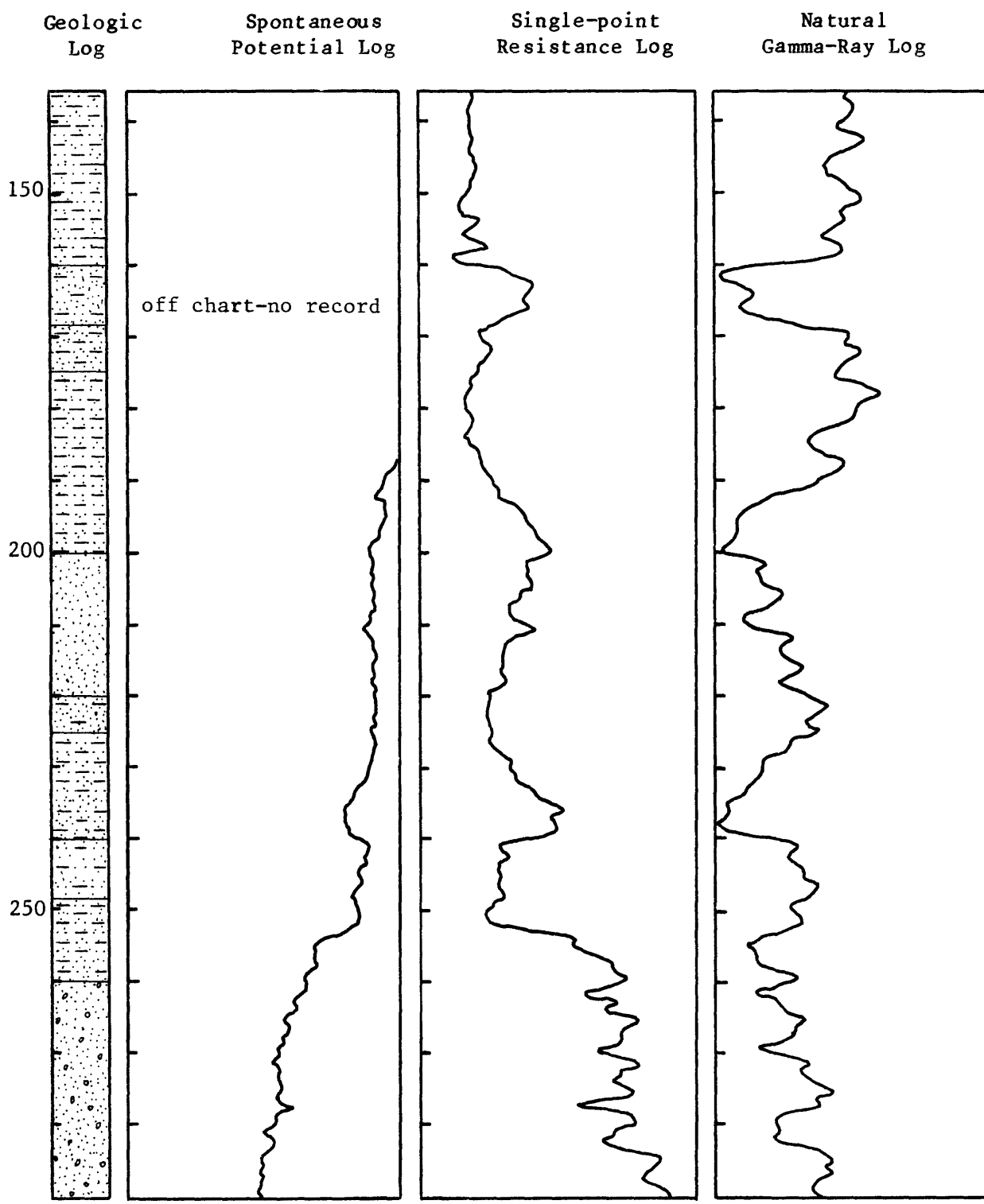
	Depth, in feet From	To
Silt, moderately to very sandy, very fine to fine sand, moderately calcareous, pale olive to pale brown, clayey from 545 to 547 feet	540	555
Sand, very fine to medium, some coarse 575 to 580 feet, slightly silty 555 to 560 feet, pale olive	555	580
Silt, slightly to moderately sandy, fine to medium sand, very sandy 605 to 613 feet, very calcareous, white to pale yellow and very pale brown	580	615
Silt, moderately limy, a few chunks of reddish-yellow chalk	615	620
Sand, very fine to medium, moderately calcareous	620	625
Silt, clayey, slightly sandy	625	631
Sand, fine to coarse, much medium sand, pale olive, silty and limy from 641 to 646 feet	631	655
Siltstone, olive	655	656
Sand, fine to coarse, much medium, moderately silty, very calcareous	656	660
Sand, fine to coarse, much medium, a few white limy fragments below 671 feet	660	673
Silt, white, calcareous	673	675
Sand, fine to coarse, much medium, few gravel grains, limy fragements, slightly calcareous	675	688
Cretaceous Pierre Formation:		
Clay, brownish black to greenish black	688	710

Test-hole 8N-23W-13DDC 1 (cont'd)

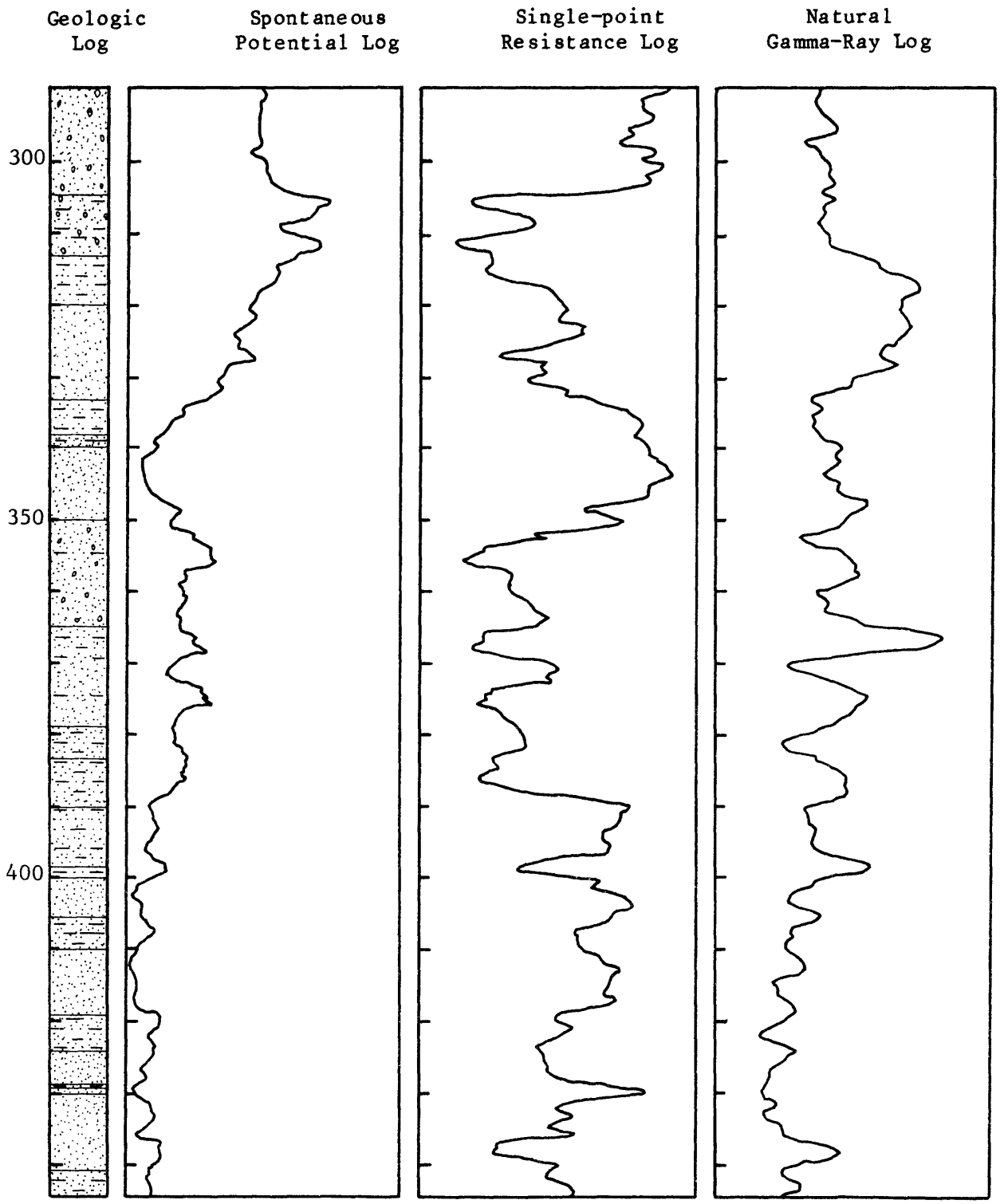
Depth to water: 134 feet.
Total Depth Drilled: 710 feet.
Remarks: Caliper log available.



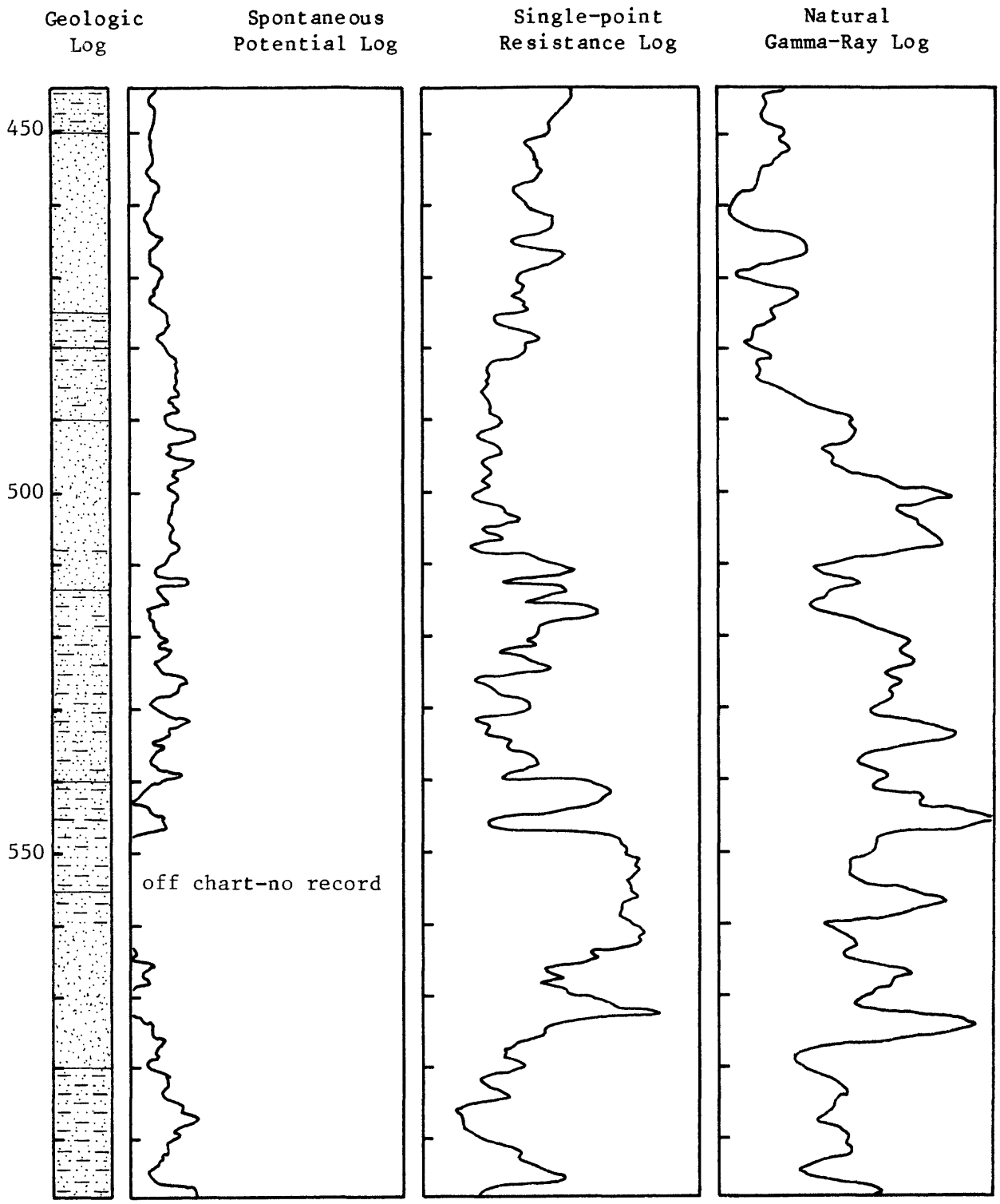
Test-hole 8N-23W-13DDC1 (cont'd)



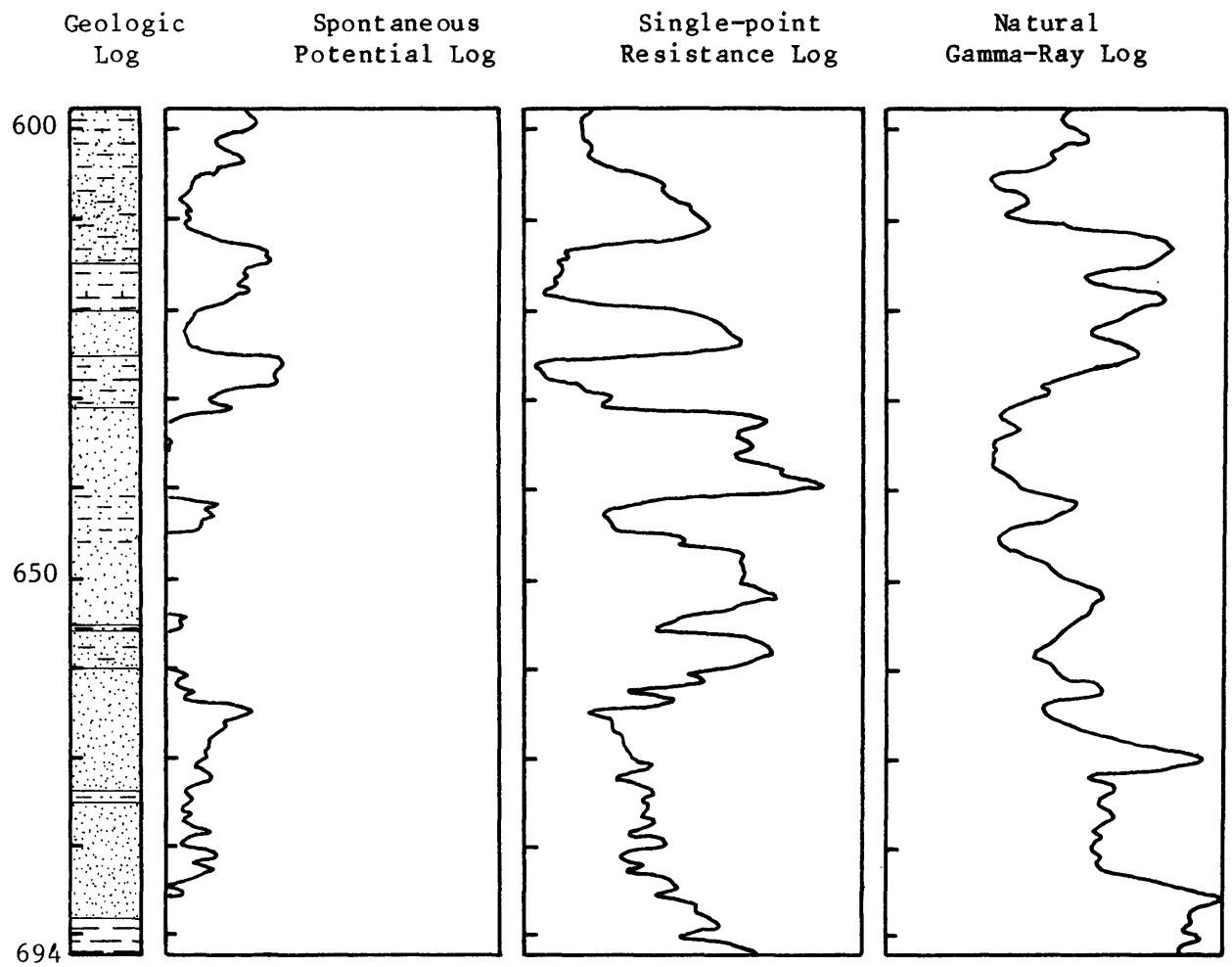
Test-hole 8N-23W-13DDC1 (cont'd)



Test-hole 8N-23W-13DDC1 (cont'd)



Test-hole 8N-23W-13DDC1 (cont'd)



Test-hole 9N-21W-31BBBB1

Location: 150 ft. S. of N. sec. line and 9 ft. E. of W. sec. line.
Date drilled: 4-15-81.
Field number: 2-B-81.
Land surface altitude: 2,408 feet above NGVD

Descriptive Log

	Depth, in feet From		To
Quaternary System, undifferentiated:			
Roadfill	0	-	1
Silt, slightly clay, dark brown to black	1	-	4
Silt, slightly clayey, light brownish gray	4	-	21
Sand and gravel, coarse sand to fine gravel, some medium gravel clasts and some medium sand	21	-	40
Sand, very coarse with some coarse sand and fine gravel, yellowish color	40	-	45
Sand and gravel, medium sand to coarse gravel, much fine to medium gravel, 70 percent gravel	45	-	54
Silt, moderately sandy, yellowish brown	54	-	59
Silt, slightly sandy, light brown to yellowish brown slightly calcareous in part	59	-	66
Silt, moderately sandy, brown	66	-	68
Silt and siltstone, a few rootlets, very pale brown	68	-	70
Sand, very fine to very coarse, some fine gravel, much coarse sand	70	-	83
Silt, yellowish brown to very pale brown	83	-	85
Tertiary System, Ogallala Group:			
Sandstone, very fine to fine, silty, lime cemented	85	-	90
Silt, slightly sandy, pale yellow	90	-	92

Test-hole 9N-21W-31BBBB1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand and sandstone, very fine to fine	92	95
Siltstone, very sandy, very fine to fine, lime cemented	95	100
Sandstone, very fine to fine, loosely cemented, rootlets, silty from 100 to 114 feet	100	118.5
Siltstone and claystone, very pale brown, calcareous	118.5	119.5
Silt, yellowish brown	119.5	120
Sand, moderately silty, limy in part	120	125
Silt, slightly to moderately sandy, slightly clayey, calcareous in part	125	130
Sandstone, very fine to fine, olive, rootlets and hackberry seeds	130	175
Sandstone, very fine to fine, moderately silty, pale brown to light olive gray, lime cemented, pale brown to light olive gray	175	184.3
Silt, very sandy	184.3	184.5
Sandstone, very fine to fine, silty 205 to 209 feet, very pale brown to pale brown, a few hackberry seeds	184.5	209
Sandstone, very fine to fine, slightly silty, pale olive to olive, rootlets	209	215
Sandstone, very fine to fine, pale brown	215	225
Sandstone, very fine to fine sand, light olive-gray to olive gray, rootlets	225	247.8
Silt, moderately sandy, light olive-gray	247.8	257.8
Sand, very fine to fine, some coarse, slightly silty, light olive gray	257.8	266.5
Silt, pale yellow	266.5	270
Sand, very fine to medium, much fine	270	280

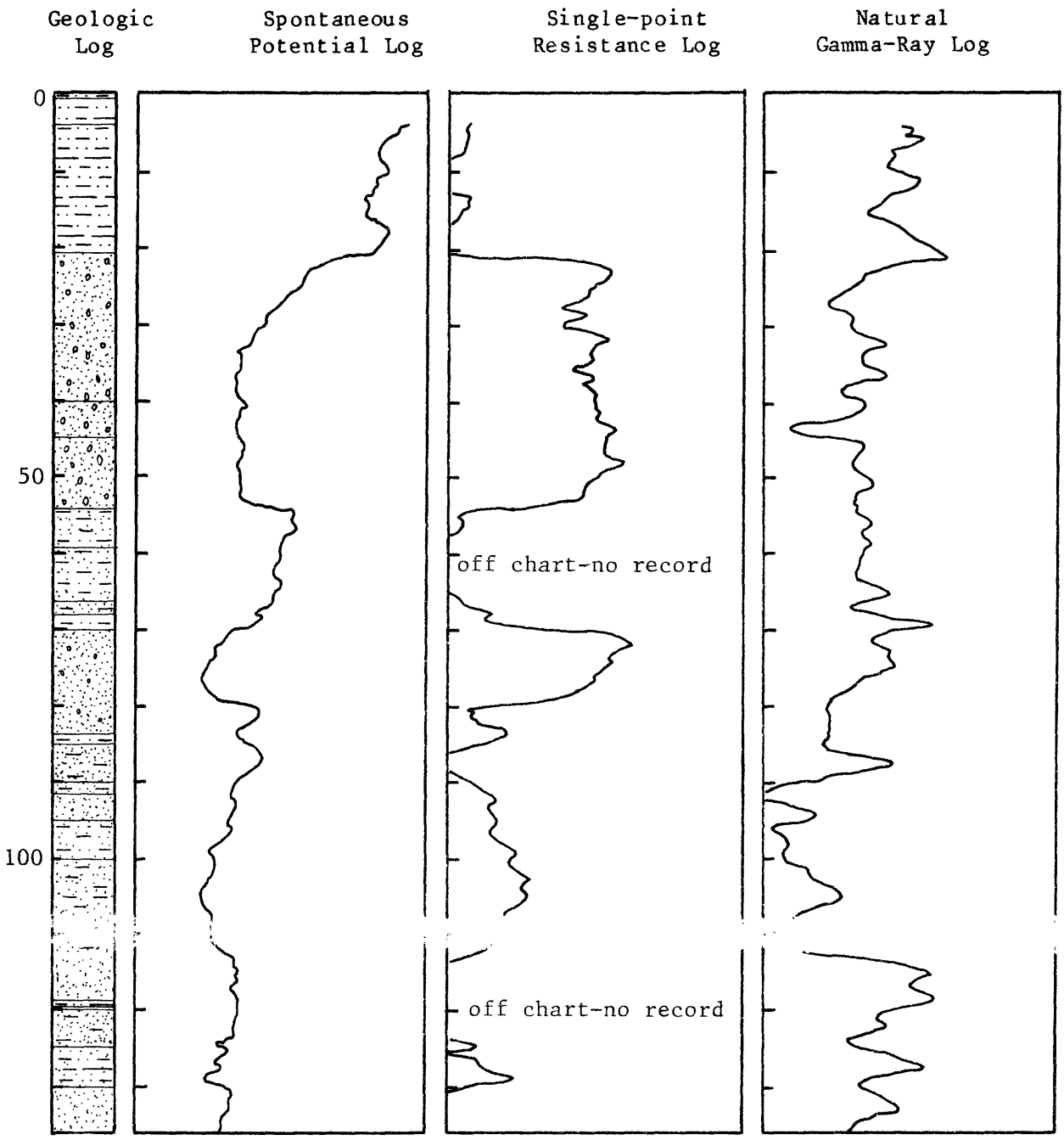
Test-hole 9N-21W-31BBBB1 (cont'd)

Descriptive Log

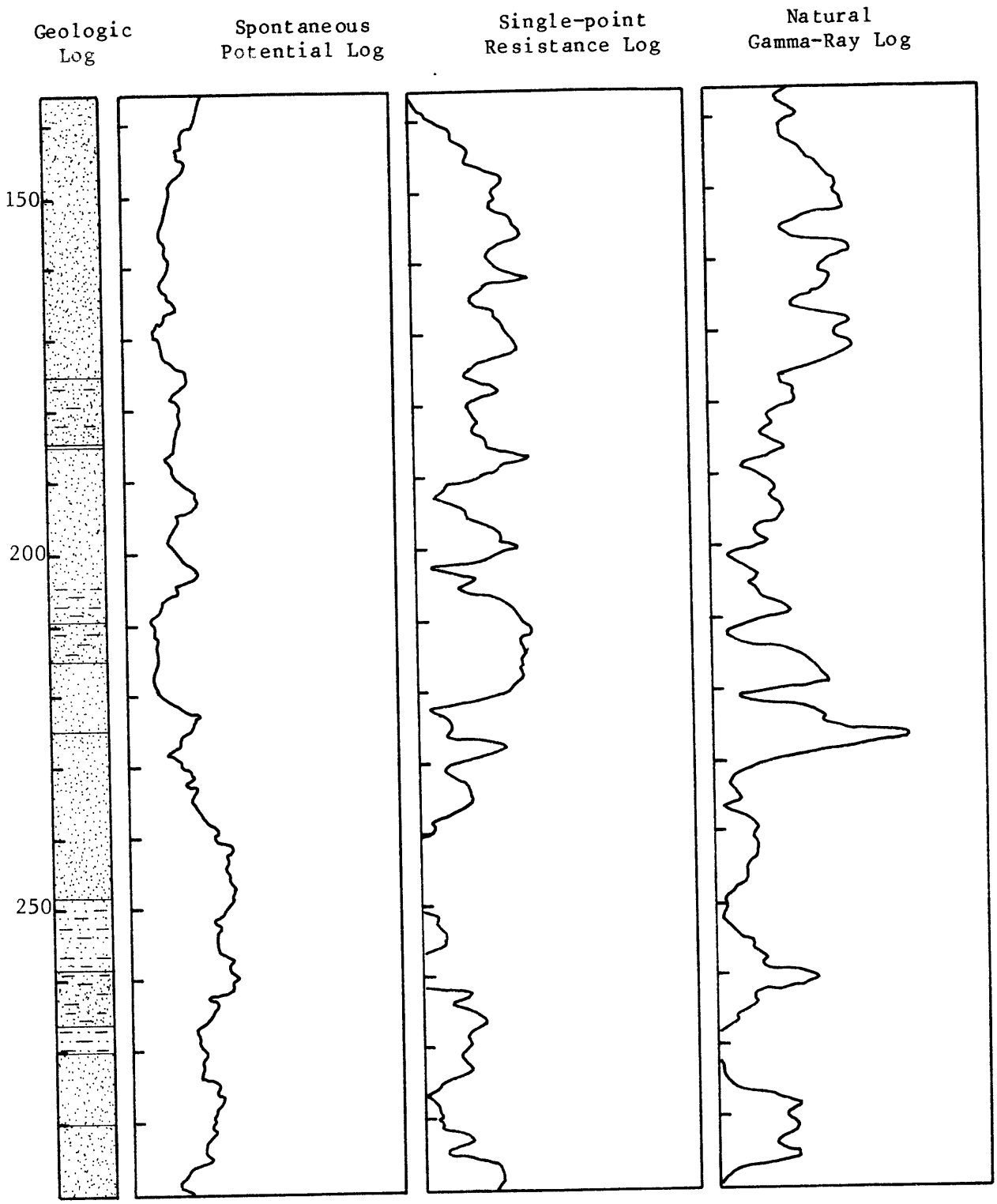
	Depth, in feet From	To
Sandstone, very fine to fine with some coarse grains	280	300
Sand, fine to coarse, much fine to medium, some olive silt 310 to 320 feet	300	320
Silt, moderately sandy, very fine sand, pale olive	320	321
Sand, fine to medium, slightly coarser below 328 feet	321	330
Sandstone, fine, some medium to coarse grains, slightly calcareous	330	331
Sand, fine to coarse, much medium, pale olive	331	335.5
Silt and sand, calcareous	335.5	340
Sandstone, very fine to fine, calcareous	340	345
Silt, clayey with some very fine to fine sand, pale yellow, calcareous	345	350
Silt, slightly sandy, very fine to fine sand, pale olive to pale yellow, very sandy from 360 to 362 feet	350	364
Sand, slightly silty, lithic limestone fragments, pale yellow	364	365
Sandstone, very fine to fine, pale yellow	365	369
Sand, very fine to fine, slightly silty, calcareous, pale yellow	369	375
Sandstone, very fine to fine, slightly silty, calcareous, pale yellow	375	380
Silt, moderately sandy, very fine to fine sand, pale yellow, calcareous	380	396
Cretaceous System, Niobrara Formation:		
Clay, silty, very calcareous	396	397
Chalk, yellow, very calcareous, many yellow ironstone fragments	397	410

Test-hole 9N-21W-31BBBB 1 (cont'd)

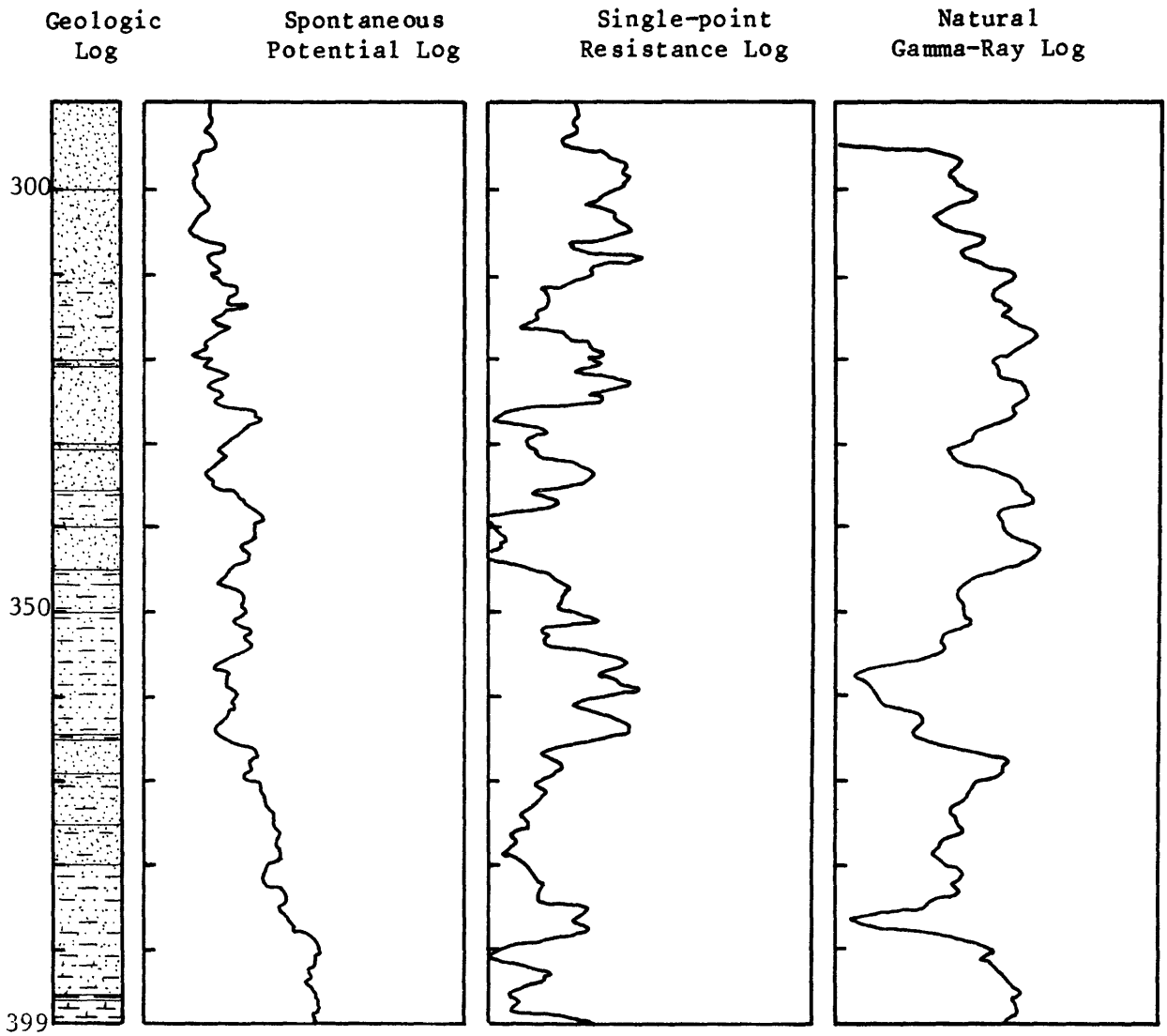
Depth to water: 9 feet.
Total Depth Drilled: 460 feet.
Remarks: Caliper log available.



Test-hole 9N-21W-13BBBB1 (cont'd)



Test-hole 9N-21W-13BBBB1 (cont'd)



Test-hole 9N-22W-18BCC1

Location: 395 ft. N. of 1/2 sec. line and 9 ft. E. of W. sec. line.
Date drilled: 4-14-81.
Field number: 1-B-81.
Land surface altitude: 2,472 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Roadfill	0	3
Sand, very fine to very coarse, slightly silty	3	9
Silt, with some interbedded sand, yellowish-brown	9	20
Sand, very fine to medium, some coarse to very coarse	20	30
Silt, moderately sandy; sand, very fine to fine, pale olive-	30	34
Sand, fine to medium with a trace of coarse; silty	34	35
Silt, moderately clayey with ironstone fragments, gray	35	37
Sand, very fine to medium, much fine	37	44
Sand and gravel, medium sand to medium gravel, much fine sand	44	55
Sand and gravel, very coarse sand to coarse gravel, much fine gravel	55	67
Tertiary System, Ogallala Group:		
Silty clay and clayey silt, light gray to white, calcareous-	67	78
Sand, very fine to medium, contains some coarse sand, few bone fragments	78	81
Clay, silty, white to light gray, calcareous	81	83
Sand, very fine to coarse, much fine	83	85
Silt, clayey, pale yellow, calcareous	85	88

Test-hole 9N-22W-18BCC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sand, medium to coarse, some fine	88	90
Silt, clayey, pale yellow, calcareous	90	94
Sand, very fine to coarse, much medium	94	95
Silt, moderately sandy, sand is very fine to medium, pale olive	95	98
Sand, very fine to fine, lime cemented	98	100
Silt and sand interbedded, sand is very fine to medium, silt is pale olive	100	105
Silt, brown to brownish gray, slightly calcareous, a few rootlets	105	114
Sandstone, very fine to medium, some coarse, lightly cemented, rootlets, brownish color, slightly calcareous	114	122
Clay, silty, yellow to yellowish brown, in part calcareous	122	126
Sand and sandstone, very fine to medium, sandstone has an olive color, iron staining and rootlets; clay lens from 137 to 138 feet	126	141
Silt and siltstone, yellowish brown, some white calcareous clay	141	145
Silt, pale reddish brown, moderately calcareous	145	147
Sand and sandstone, very fine to fine sand, in part silty, olive brown	147	154
Sand and sandstone, fine to medium, pale olive; clay layer from 154 to 155 feet	154	158
Silt, clayey, light grayish brown to pale olive	158	160
Sandstone and sand, very fine to fine, white rootlets	160	175
Siltstone and silt, light olive brown to light olive gray, a few thin white calcareous clay layers, some very fine sand	175	205

Test-hole 9N-22W-18BCC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Sandstone, very fine to fine sand with some interbedded silt	205	212
Sand, very fine to very coarse, much fine sand, gradually coarsens with depth	212	226
Siltstone, calcareous with some fine sand, hard layers 244.5 to 244.7 feet and 252 to 253 feet	226	255
Silt and sandstone, interbedded, silt is sandy and sandstone is silty, calcareous	255	260
Silt, clayey, some very fine sand, very calcareous	260	261
Sand, very fine, slightly to moderately silty, calcareous	261	265
Silt, moderately sandy, slightly clayey, pale olive-gray, slightly calcareous	265	270
Siltstone and silt, very sandy, very fine sand, light brownish-gray	270	286
Sand, very fine to fine, very silty from 286 to 294 feet, pale olive	286	300
Siltstone, moderately to very sandy, very fine to fine sand, light gray to pale yellow	300	307
Silt and clay, some very fine sand, white	307	308
Sandstone, very fine to medium, poorly consolidated, light brownish-gray to light olive-gray	308	320
Siltstone, moderately sandy, very fine to fine sand, light brownish-gray to light olive-yellow	320	332
Sand, very fine to fine, moderately silty, light olive	332	340
Sand, very fine to medium slightly silty, contains a few white silicious rootlets; clay layers from 343 to 344 feet and 350 to 352 feet	340	355
Siltstone, some very fine to medium sand, rootlets, calcareous silty clay from 366.5 to 366.9 feet	355	370
Sand and sandstone, very fine to fine, moderately silty, pale yellow to light olive	370	380

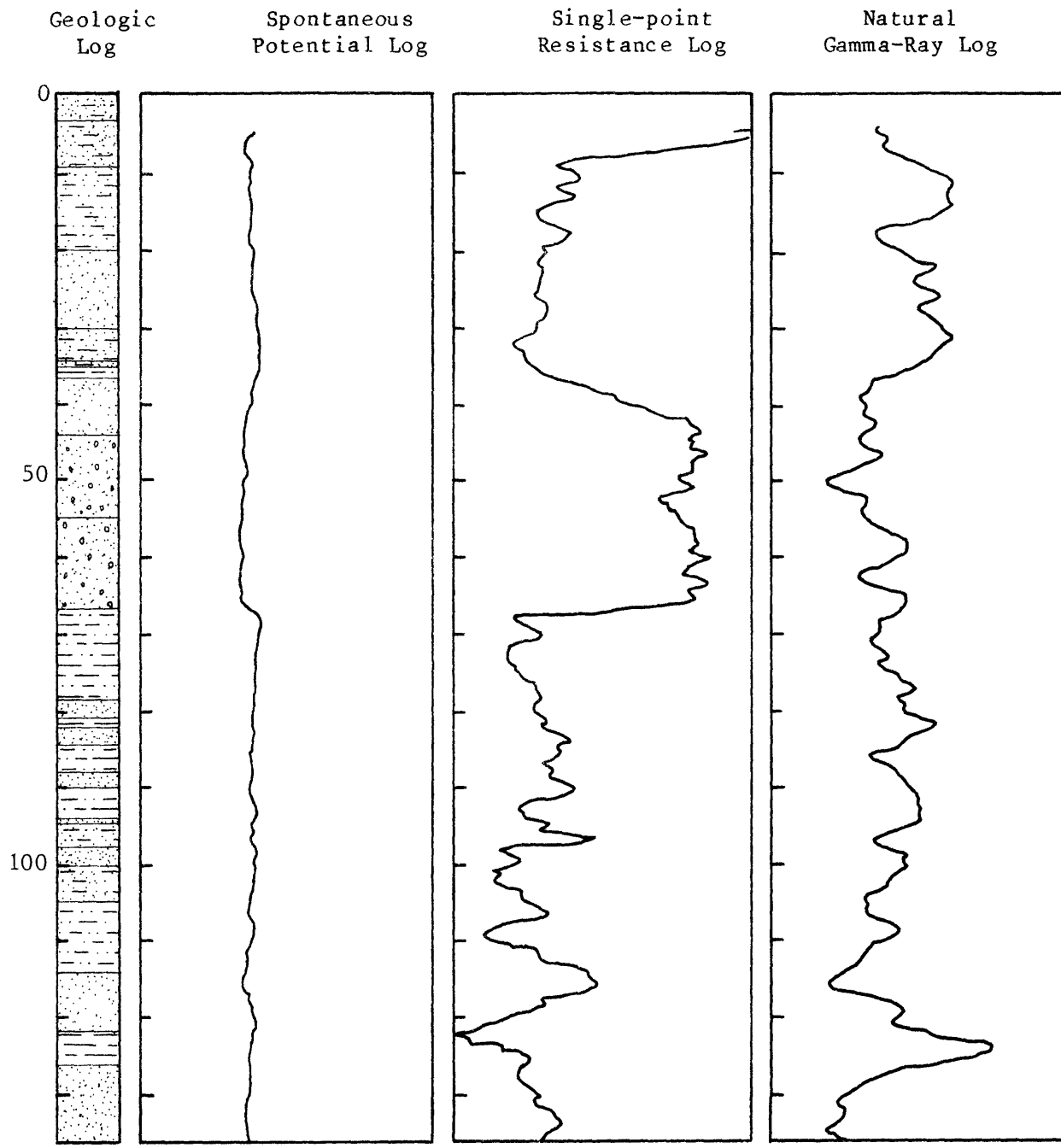
Test-hole 9N-22W-18BCC1 (cont'd)

Descriptive Log

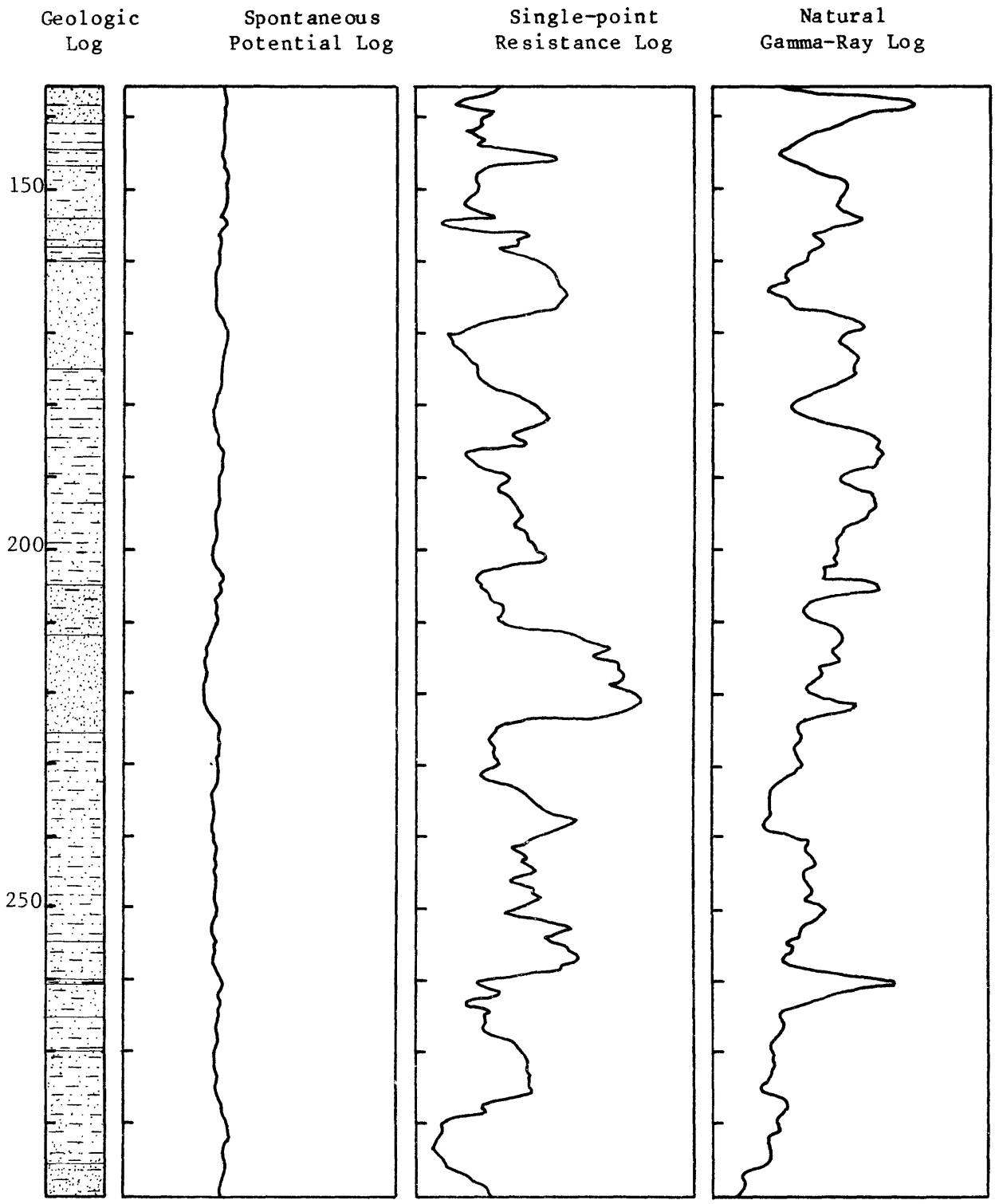
	Depth, in feet From	To
Siltstone, slightly sandy, medium to coarse sand, some calcareous silt	380	386
Silt, moderately clayey, sandy and calcareous, light gray	386	392
Sand, very fine to fine	392	398
Silt, moderately sandy, very fine to fine, light olive	398	401
Sand, very fine to medium, much medium, slightly cemented	401	410
Silty sand and sandy silt, interbedded, pale yellow, calcareous	410	418
Siltstone and silt, some medium to coarse sand, calcareous	418	428
Sandstone and siltstone, green, calcareous in part	428	431
Siltstone, and silty sand interbedded, light olive to green, a few yellowish chalk fragments and black lithic fragments, some medium to coarse sand	431	440
Silt, very clayey, very calcareous	440	442
Cretaceous System, Niobrara Formation:		
Chalk, pale yellow to white, very calcareous	442	460

Test-hole 9N-22W-18BCC 1 (cont'd)

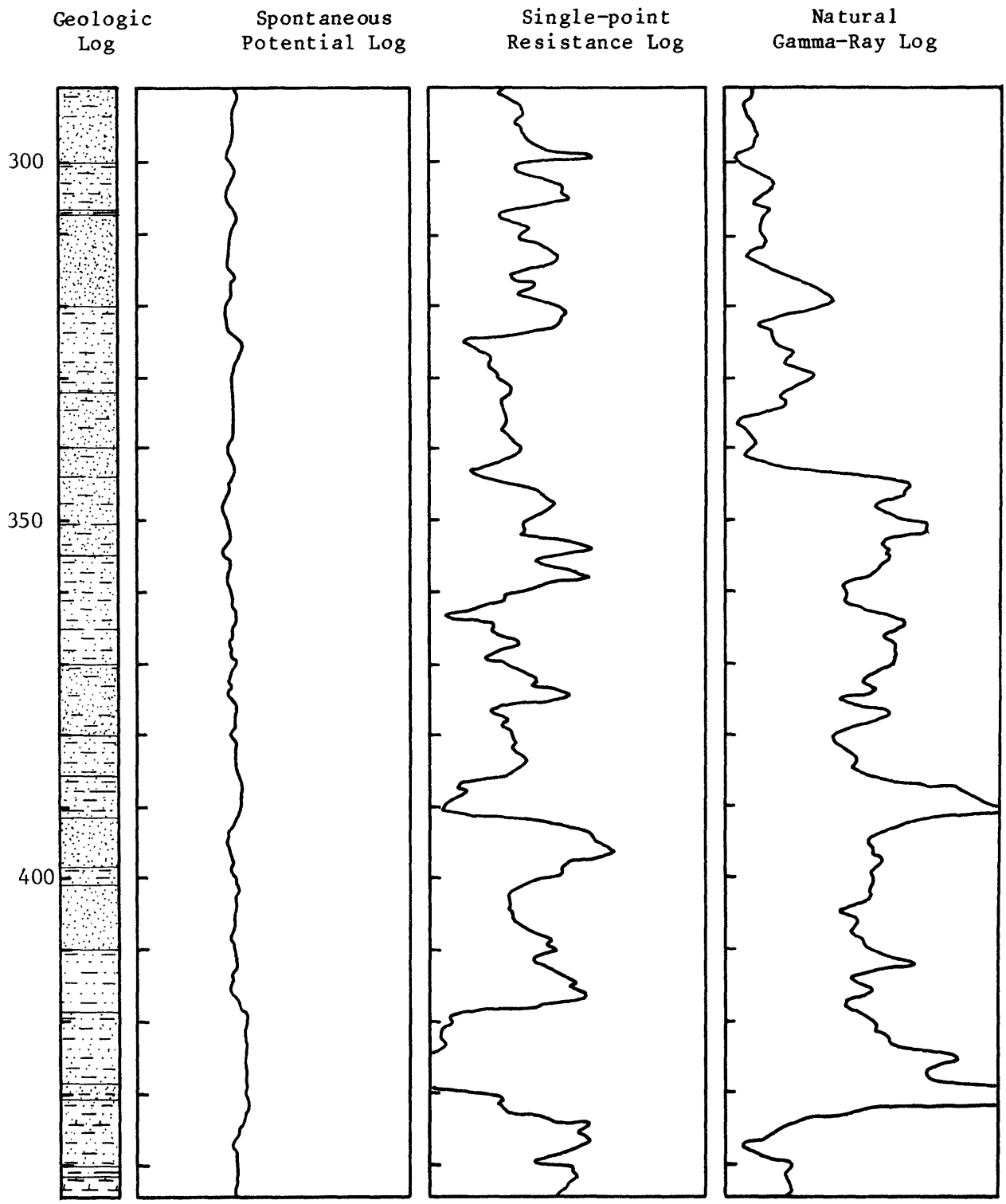
Depth to water: 14 feet.
Total Depth Drilled: 460 feet.
Remarks: Caliper log available.



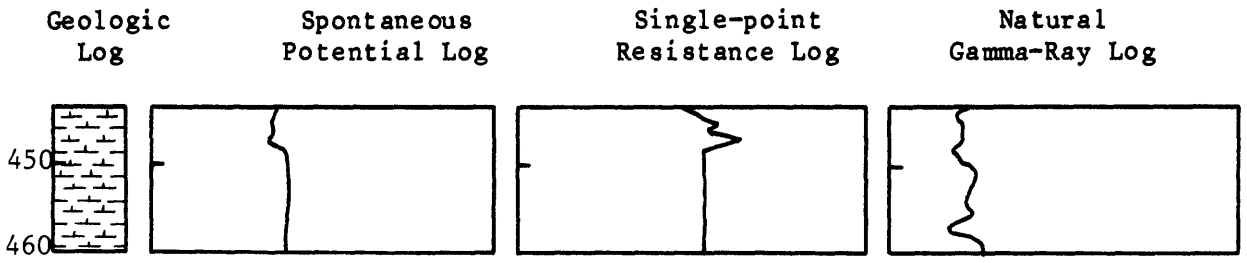
Test-hole 9N-22W-18BCC1 (cont'd)



Test-hole 9N-22W-18BCC1 (cont'd)



Test-hole 9N-22W-18BCC1 (cont'd)



Test-hole 9N-24W-18AACC1

Location: 60 ft. N. and 19 ft. W. of large tree in stream gully.
Date drilled: 4-29-81.
Field number: 8-B-81.
Land surface altitude: 2,676 feet above NGVD

Descriptive Log

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Topsoil, dark grayish brown	0	2
Silt, slightly clayey and sandy, sand is very fine, light yellowish brown to brown, slightly calcareous	2	25
Silt, slightly sandy, sand is very fine, light yellowish brown, moderately calcareous	25	37
Silt, moderately clayey, slightly sandy, very fine sand, light yellowish brown, moderately to very calcareous	37	46
Silt, moderately sandy, very fine sand, slightly clayey, yellowish brown, moderately to very calcareous	46	55
Silt, slightly clayey, moderately sandy 69 to 70 feet, light yellowish-brown to brownish-yellow, slightly to very calcareous	55	80
Silt, slightly to moderately clayey, slightly sandy, very fine sand, yellowish brown to light yellow, slightly to moderately calcareous	80	95
Silt, slightly clayey, moderately calcareous, light yellowish brown	95	105
Silt, slightly to moderately sandy, sand is very fine, light yellowish brown, very calcareous 114 to 125 feet	105	125
Silt, slightly sandy, very fine sand, moderately calcareous in part very calcareous, yellowish brown	125	145
Silt, moderately clayey, yellowish brown, moderately calcareous	145	163
Clay, moderately silty, pale brown to yellowish brown, moderately to very calcareous	163	172

Test-hole 9N-24W-18AACC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Silt, moderately clayey, brown, moderately calcareous-------	172 -	175
Sand, fine to very coarse, trace fine gravel, pale brown----	175 -	180
Silt, slightly sandy, very fine sand, light yellowish brown, very calcareous----------	180 -	190
Sand, very fine to very coarse, silt layer from 196 to 198 feet----------	190 -	203
Silt, moderately sandy, very fine sand, yellowish brown, slightly calcareous----------	203 -	211
Sand, fine to medium; very silty 212 to 215 feet----------	211 -	220
Sand, very fine to very coarse, much fine to medium---------	220 -	230
Silt, very sandy, very fine to fine sand, very calcareous light gray to very pale brown----------	230 -	247
Silt, slightly sandy and clayey, calcareous in part---------	247 -	250
Tertiary System, Ogallala Group:		
Sand and sandstone interbedded with silt, sand is very fine to fine, pale brown to pale olice, slightly calcareous----------	250 -	272
Sandstone, very fine to fine, pale brown, some interbedded silt----------	272 -	285
Sandstone, very fine to fine, some medium and coarse, pale brown----------	285 -	287
Silt, moderately clayey, sandy 290 to 292 feet, white to pale olive, moderately calcareous----------	287 -	292
Sand, very fine to fine, a few rootlets----------	292 -	299
Silt and sandstone interbedded, sand grains very fine to fine, silt is pale yellow, very calcareous----------	299 -	309

Test-hole 9N-24W-18AACC1 (cont'd)

Descriptive Log

	Depth, in feet From	To
Clay, very silty, and silt, very clayey, some claystone, yellowish-brown to light yellowish-brown, slightly to very calcareous	309	318
Silt, slightly clayey with some claystone, light yellowish-brown	318	327
Silt, very sandy, fine to medium sand, light yellowish-brown, slightly calcareous	327	333
Sand, fine to medium, very silty, light yellowish-brown, moderately calcareous	333	341
Silt, very sandy, fine to medium sand, very pale-brown, moderately calcareous	341	350
Sand, fine to medium, some coarse, slightly silty, light yellowish-brown, moderately calcareous	350	370
Sand, fine to medium, moderately silty, slightly calcareous-	370	381
Sand, fine to medium	381	390
Sand, fine to medium, moderately silty, less silty 399 to 403 feet	390	403
Silt, moderately sandy, light gray, very calcareous	403	405
Sand, very fine to fine, slightly silty, some sandy silt, pale olive, slightly calcareous	405	428
Siltstone and sandy siltstone, white, very calcareous	428	429
Sandstone, very fine to fine, pale brown	429	435
Sand and sandstone, very fine to fine, a few pale olive silt lenses	435	500
Silt, moderately sandy	500	502
Sand, very fine to fine	502	504
Silt, moderately clayey, some very fine to fine sand, white, very calcareous	504	510

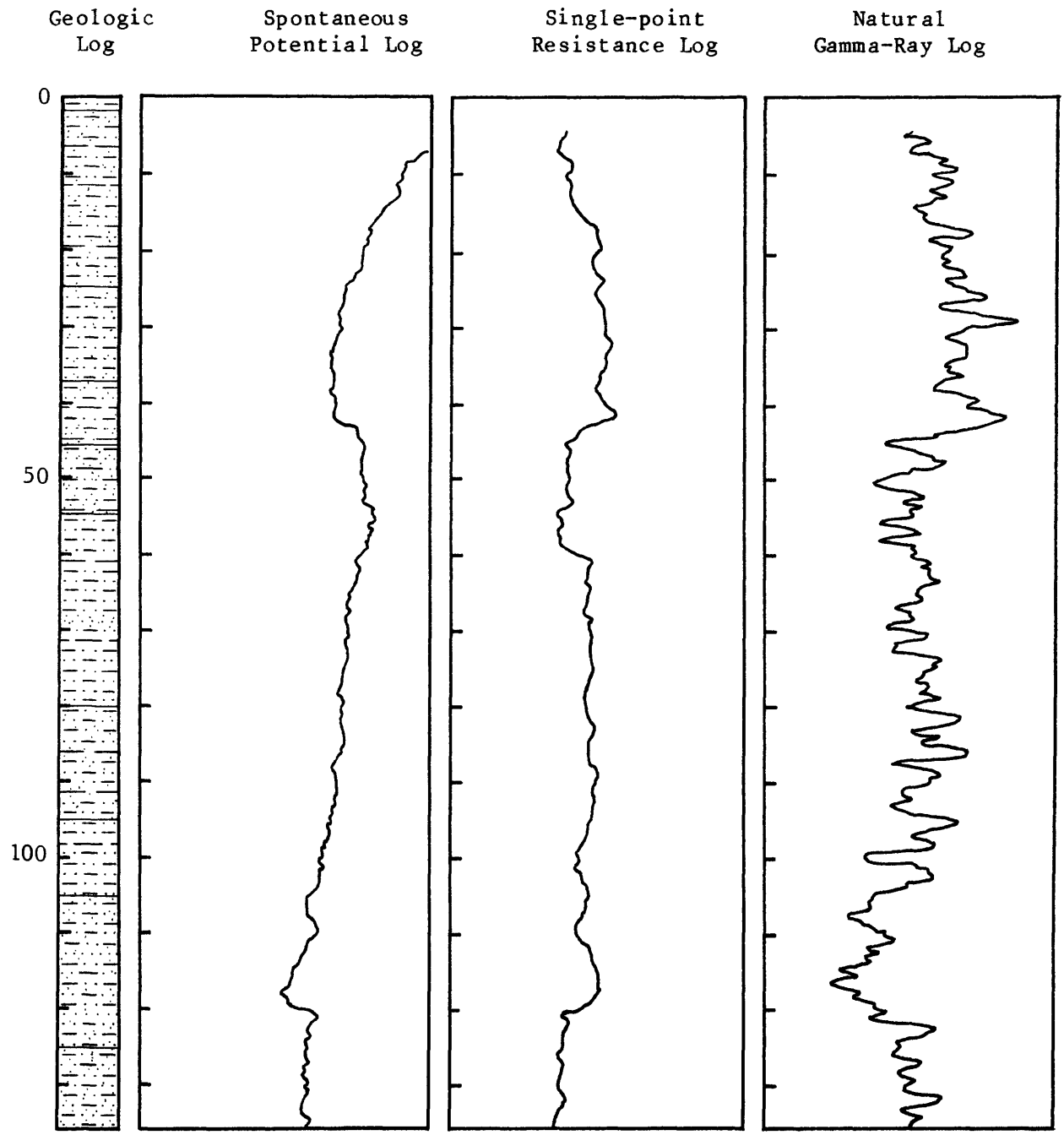
Test-hole 9N-24W-18AACC1 (cont'd)

Descriptive Log

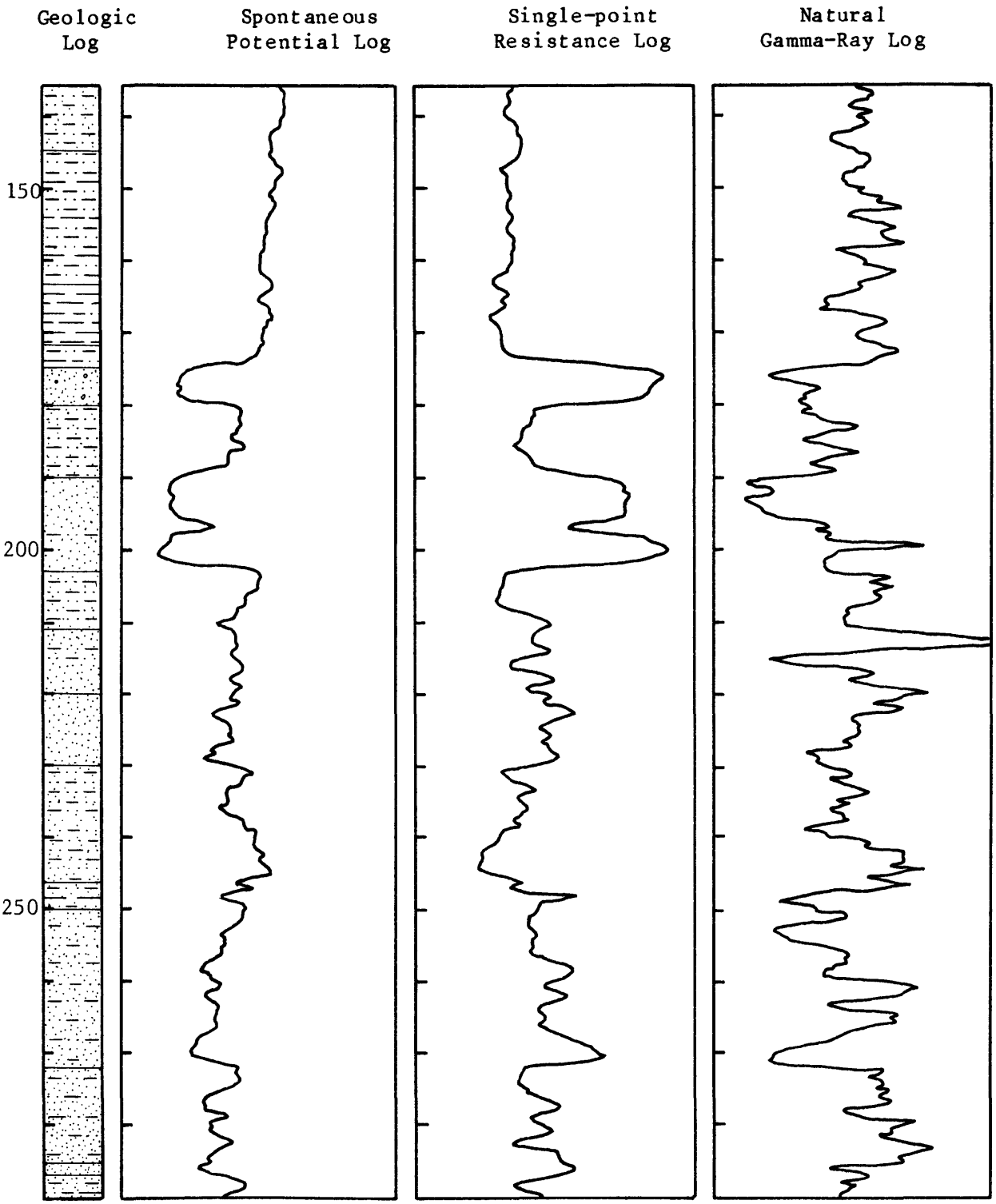
	Depth, in feet From	To
Silt and siltstone, moderately sandy, medium sand, light gray, very calcareous	510	520
Sand, fine to medium, moderately silty, slightly calcareous	520	528
Sand, fine to very coarse, much medium	528	537
Silt, very sandy, very fine to fine sand, pale olive to light gray, slightly to very calcareous	537	562
Clay, silty, some very fine sand, light olive-gray, moderately to very calcareous	562	568
Cretaceous System, Niobrara Formation:		
Clay, pale yellow to reddish yellow	568	590

Test-hole 9N-24W-18AACC 1 (cont'd)

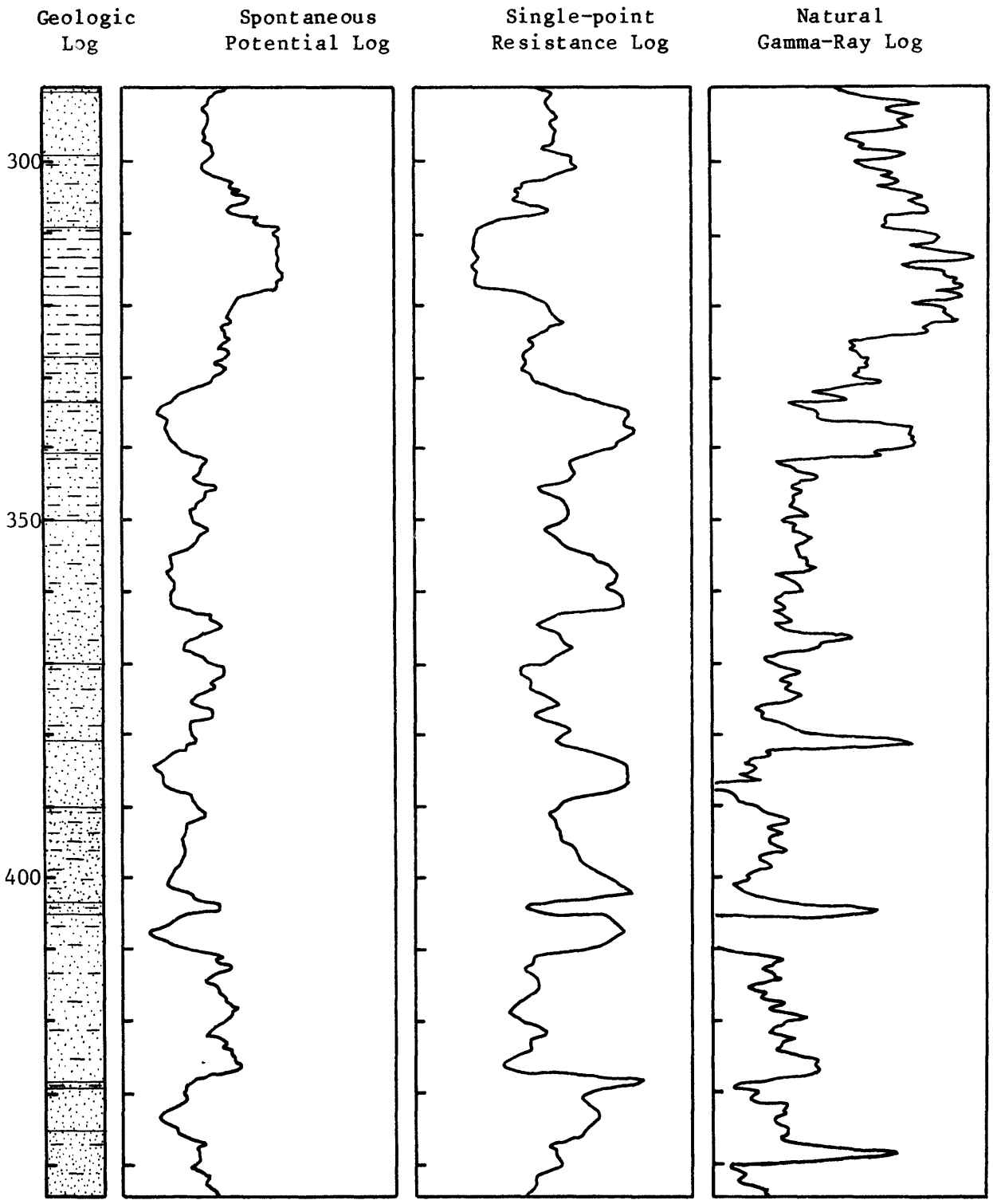
Depth to water: 94 feet.
Total Depth Drilled: 590 feet.
Remarks: Caliper log, 64 inch long normal log available.



Test-hole 9N-24W-18AACC1 (cont'd)



Test-hole 9N-24W-18AACC1 (cont'd)



Test-hole 9N-24W-18AACC1 (cont'd)

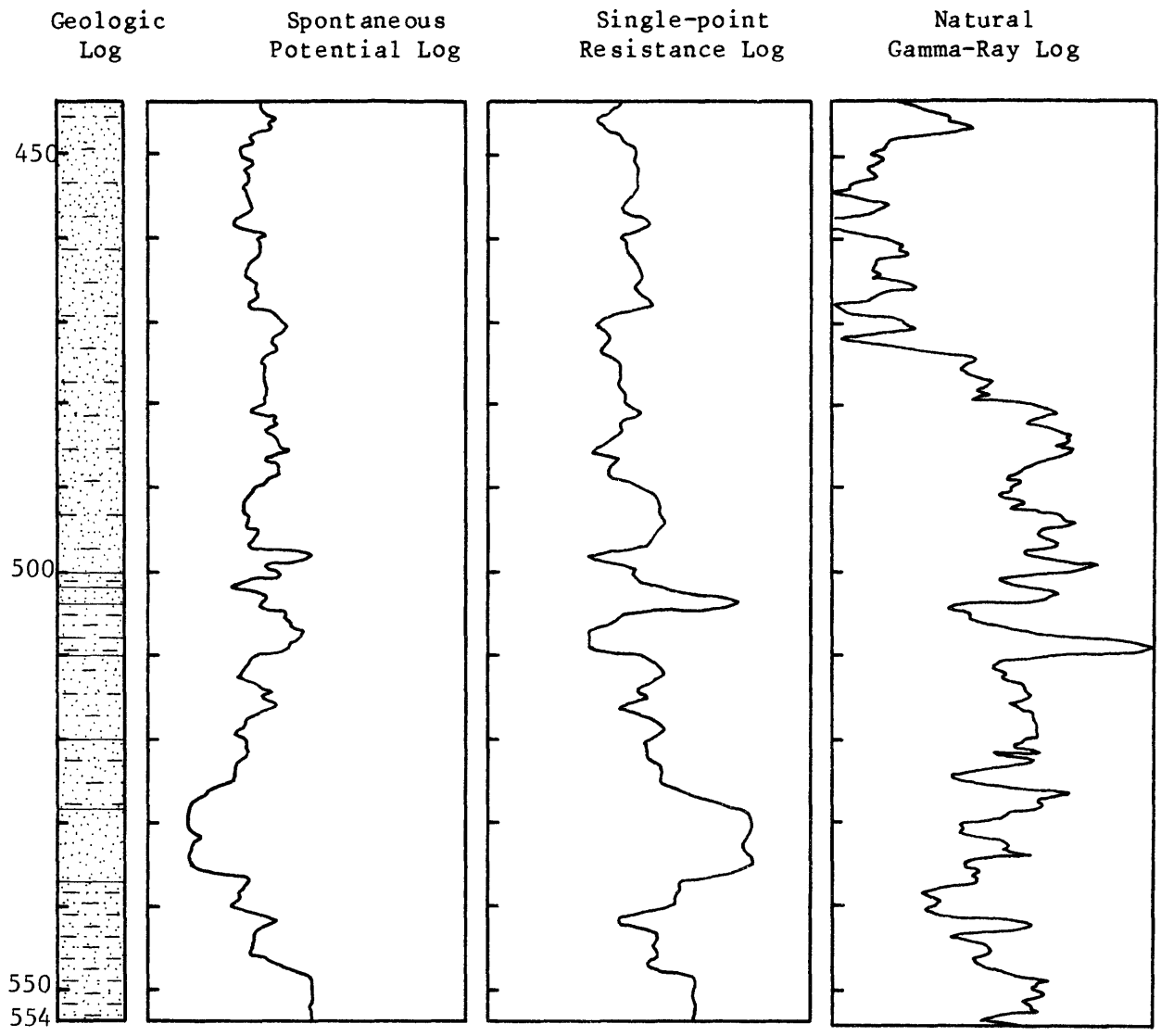
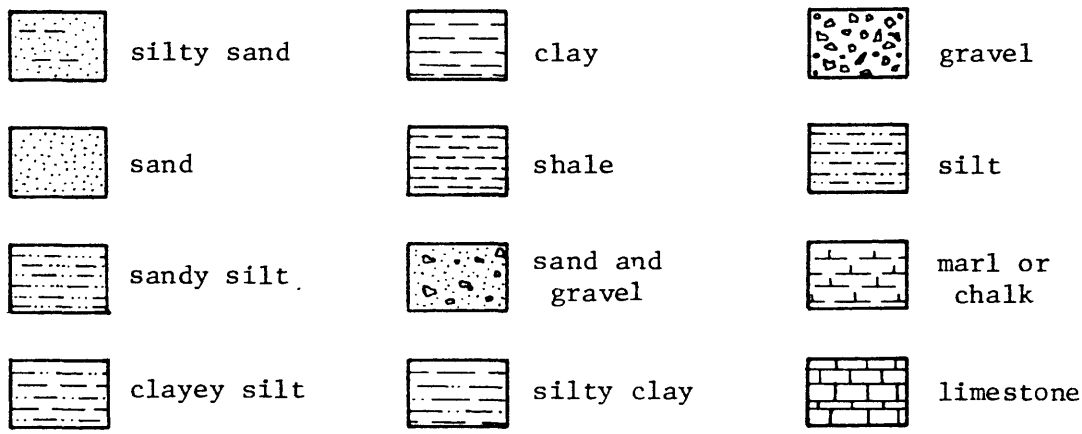
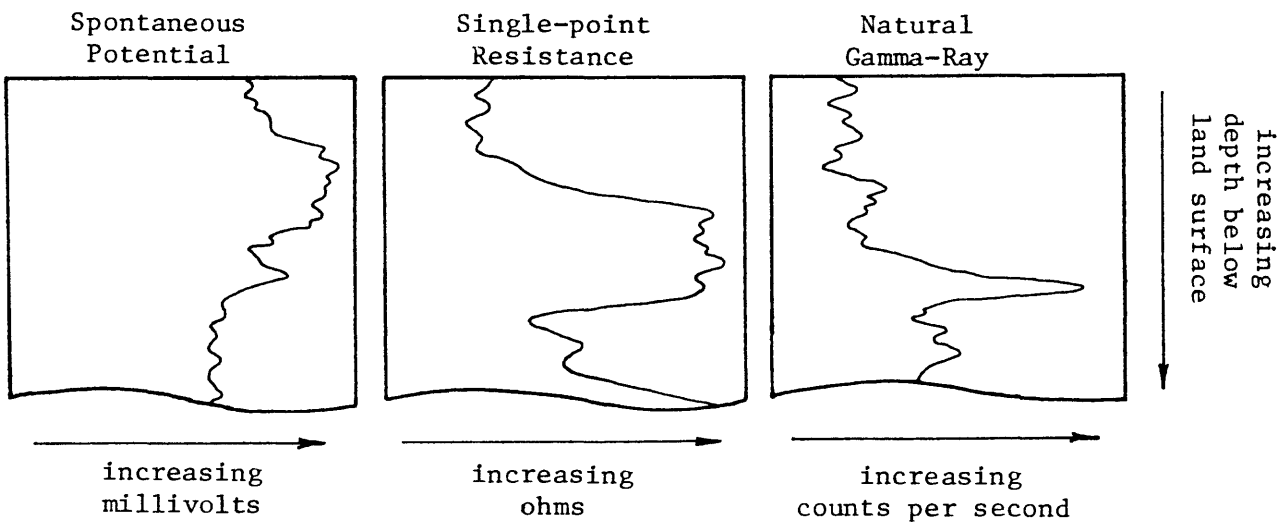


PLATE 1 - EXPLANATION OF SYMBOLS, UNITS OF MEASUREMENT, AND GAPS IN RECORDS

Symbols for geologic logs



Units of measurement for geophysical logs



Explanation of Gaps in Recorder Traces