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GEOLOGIC SECTION OF BRADLEY, CALHOUN, OUACHITA,  
AND PART OF NEVADA COUNTIES, ARKANSAS<sup>1</sup>

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ABSTRACT

A series of 23 test holes has been drilled across Bradley, Calhoun, Ouachita, and part of Nevada Counties in south-central Arkansas to determine the geology of the shallow water-bearing deposits of Tertiary and Quaternary age. The correlation of the lithologic and electric logs of the test holes and available electric and drillers' logs of oil-test wells indicates that: (1) the transition zone in the upper part of the Midway group may be about 85 feet thick in Nevada and Ouachita Counties; (2) the contact between the Wilcox and Claiborne groups is about 12 miles northwest of the location shown on the geologic map of Arkansas, and the Wilcox group is probably not present at the surface anywhere in Ouachita County; (3) a structural terrace extends from near the boundary between Ouachita and Calhoun Counties into western Calhoun County; and (4) the Jackson group may extend in the subsurface as far west as Calhoun County and may be considerably thicker in Bradley County than has been previously supposed.

The deposits of Eocene age in the report area are composed mainly of sand, silt, and clay that were deposited near the shoreline of the Mississippi trough. The presence of lignite, glauconite, and marine microfossils suggests that the formations of this age were deposited under both subaerial and submarine conditions. The deposits of Quaternary age consist of coarse terrace sand and gravel and alluvium that generally is composed of finer sand, silt, and clay.

INTRODUCTION

The U.S. Geological Survey in cooperation with the Arkansas Geological and Conservation Commission is conducting a study of the ground-water resources of the State of Arkansas. As a part of this study, 23 test holes were drilled by a contractor in Bradley, Calhoun, Ouachita, and a part of Nevada

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<sup>1</sup>Publication authorized by the Director, U.S. Geological Survey.

GEOLOGIC SECTION OF COUNTIES IN ARKANSAS

Counties in south-central Arkansas in December 1958 and January 1959. The location of these counties within the State and the major structural and topographic features discussed in this report are shown in Figure 1. The primary purpose of the work was to determine the geological framework of the area and to obtain detailed information about the shallow water-bearing deposits of Tertiary and Quaternary age.

Electric logs were run on all test holes. The electric logs and the lithologic logs of the test holes and logs of three water-supply wells have been correlated with electric and drillers' logs of oil-test wells in establishing the formational boundaries. The logs of two of these water-supply wells are drillers' logs -- one of the city well at Hampton in Calhoun County, and the other of a well at the Southern Kraft Division of the International Paper Company at Camden, in Ouachita County. The third is a composite log of two test holes drilled in obtaining a water supply at Chidester in Ouachita County.

GENERAL GEOLOGY

The boundary between the Mississippi embayment part of the Coastal Plain and the Interior Highlands province (Cushing, and others, 1960) is known as the Fall Line (Fig. 1). In Arkansas this line follows a broad arc from the northeast corner to the southwest corner of the State. The rocks of tertiary age in Bradley, Calhoun, Ouachita, and Nevada Counties were deposited in the shallow Mississippi trough southeast of the Fall Line. Throughout the Tertiary period, the shoreline in the embayment fluctuated rather rapidly, providing an alternating sequence of submarine and subaerial environments of deposition. Consequently, the formations are composed of deposits ranging from fairly deep water clay and marl, through shallow-water sand, silt, and clay, to clean beach sand and lignitic back-beach silt and clay. The formations that are present in the report area are listed in Table 1.

The rocks of Tertiary age in Nevada and Ouachita Counties dip southeasterly away from the Fall Line at approximately 35 feet per mile. Near the Ouachita-Calhoun County line the dip changes to an easterly direction and decreases to about 2 feet per mile, forming a structural terrace. The terrace ends in western Calhoun County where the dip increases to about 20 feet per mile. This rate of dip remains fairly constant through the remainder of the report area; however, the direction of dip changes to the northeast in Bradley County reflecting the structural depression of the Desha basin.

Along most of its length, the section shown in Figure 2 was

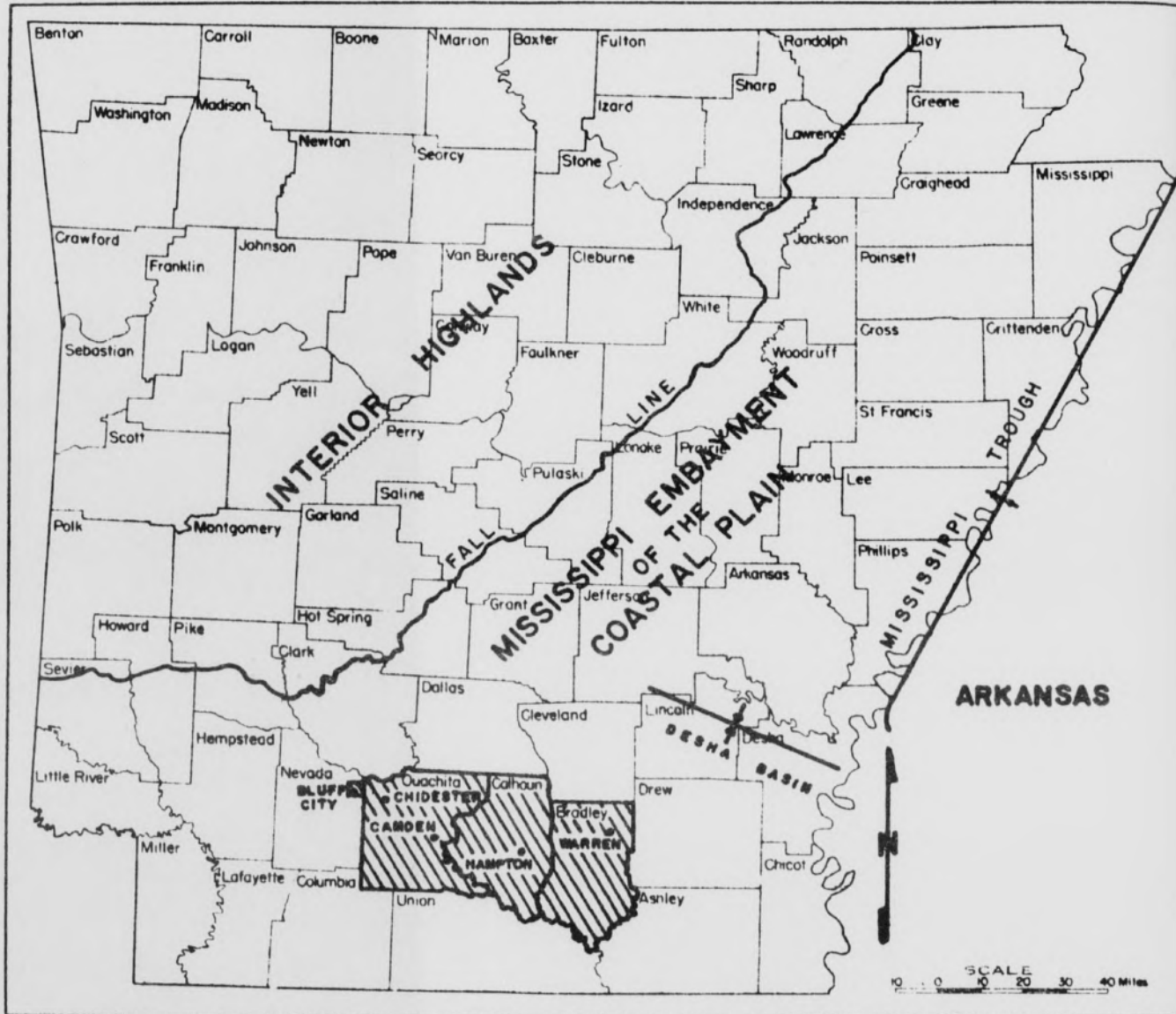


Figure 1. Map showing area and major topographic and structural features discussed in this report.

Table 1. Generalized geologic column of Bradley, Calhoun, Ouachita, and Nevada Counties, Arkansas

SYSTEM	SERIES	GROUP	SUBDIVISION
Quaternary	Recent		Alluvium
	Pleistocene		--- ? --- ? --- Terrace Deposits
Tertiary	Eocene	Jackson	
		Claiborne	Cockfield formation
			Cook Mountain formation
			Sparta sand
			Cane River formation
			Carrizo sand
	Wilcox		
	Paleocene	Midway	Porters Creek clay
			Clayton formation

drilled at right angles to the strike of the formations. The change in direction of the section line from southeast to east near Camden follows the change in direction of dip in that vicinity. Although the direction of dip changes again in eastern Bradley County, the last four test holes were drilled on the extension of the line in Calhoun and western Bradley Counties.

#### Midway Group

The Midway group of Paleocene age underlies most of the Mississippi embayment and crops out in Arkansas near the

Fall Line. In the area discussed in this report, the deposits vary in thickness from approximately 400 feet near the Fall Line to about 600 feet in Bradley County.

In Bradley, Calhoun, and Ouachita Counties, as in most of the Coastal Plain part of Arkansas, the Porters Creek clay of the Midway group generally is considered the fresh-water "basement," and once this formation is reached, further drilling in search of potable water usually is unprofitable.

In most of the previous geological work in Arkansas, the base of the first "sand kick" above the typical Porters Creek clay has been used as the formation top to facilitate making electric-log correlations. A sandy transition zone has been recognized above the clay, and it has been included in the Midway group by some authors, but placed in the Wilcox group by others. Correlation of electric logs in the vicinity indicates that the top of the typical Porters Creek clay, or the base of the transition zone, is about 35 feet below the total depth reached in test hole 1. A weathered zone of light-gray to white clay was encountered at a depth of 151 feet in test hole 1. This clay was underlain by a dark-gray to black clay, and it is thought that the top of this light-colored interval may mark the top of the transition zone and be the contact between the Midway group and the overlying Wilcox group. Because the test hole was stopped short of total penetration of the transition zone, which is about 85 feet thick at this location, the common electric-log pick of the top of the Porters Creek clay is shown on the accompanying section, and the transition zone is included in the Wilcox group. The determination of the proper placement of this zone must await the collection of more paleontological data.

#### Wilcox Group

In south-central Arkansas the Wilcox group of early Eocene age is not divided into formations as it is in the bauxite-producing area in Pulaski and Saline Counties. Such division might be possible in the area after detailed study of the group, but it is not attempted here. Deposits of the Wilcox group are conformable on those of the underlying Midway group, but an unconformity exists between the Wilcox group and the overlying Claiborne group (Stearns, 1957, p. 1092). The Wilcox group crops out in Nevada County and around the edge of the Mississippi embayment except in those areas where it is overlain by younger deposits. It is approximately 210 feet thick in the area of this report if the top of the light-gray to white clay in test hole 1 is the basal contact. Considering the base

of the group to be the conventional electric-log pick, as is shown on the cross section, the group is about 290 feet thick.

The drill cuttings from the test holes indicate that the Wilcox group in Nevada and Ouachita Counties consists of swamp or back-beach lignitic clays and lignite, shallow-marine sands and clays, and fairly deep water glauconitic clays. The back-beach clays are dark gray to dark brown in color and contain much lignite. The shallow-marine clays generally are light gray to gray, and the deeper water glauconitic clays are green in color. The sands of the group are mostly very fine to fine in grain size and gray or brown in color. The strand line evidently moved rapidly over these counties during Wilcox time, because there is no indication of any widespread beach-sand deposits in the area comparable to the "1,400-foot" sand of the Wilcox group, familiar to well drillers in northeastern Arkansas.

The contact between the Wilcox and Claiborne groups crops out near Bluff City in Nevada County and has a general north-east-southwest trend. The geologic map of Arkansas shows this contact about midway between Chidester and Camden in Ouachita County. The interpretation based on this geologic section indicates that the Wilcox group has a much smaller outcrop area than is shown on the State geologic map. It probably does not appear at the surface anywhere in Ouachita County.

#### Claiborne Group

In south-central Arkansas the Claiborne group of middle Eocene age includes five formations. From oldest to youngest they are the Carrizo sand, the Cane River formation, the Sparta sand, the Cook Mountain formation, and the Cockfield formation. All of the formations in this group, whether deposited under subaerial or submarine conditions or both, are composed of near-shore deposits.

Carrizo sand. -- The Carrizo Sand is approximately 70 feet thick in Nevada and Ouachita Counties where it was penetrated by test hole 2 and well C. Correlation of electric logs of oil-test wells indicates that the formation thickens to about 150 feet farther downdip in Bradley County.

The formation consists mainly of gray and brown very fine to medium sand, and it is probably a transgressive beach deposit; however, some shallow-water clay was encountered in test hole 2 and some lignite in well C.

Cane River formation. -- The Cane River formation is about 125 feet thick in the vicinity of test hole 3; and, based on

electric log correlations, it thickens down dip to about 400 feet in Bradley County. It probably was deposited under much the same environmental conditions as prevailed during deposition of the Wilcox group. During Cane River time, however, the strand line was perhaps a little more stable as most of the formation consists of shallow-water dark-gray to dark-brown silts and silty clays. Some fluctuation of the strand line did occur as is evidenced by (1) the presence of some lignite and lignitic clay, which probably indicates back-beach deposition; (2) the presence of some clean sand, which is probably a remnant of the beach itself; and (3) the presence of some glauconite in test hole 4, which may indicate relatively deeper water deposition.

Sparta sand. -- The Sparta sand is approximately 280 feet thick at its outcrop near test hole 6, but it thins to about 200 feet across the structural terrace near the Ouachita-Calhoun County line. Correlation of electric logs of oil-test wells indicates that east of the terrace the formation thickens again to about 260 feet in central Calhoun County and to about 500 feet in Bradley County.

The formation consists mainly of gray very fine to medium sands and brown and gray sandy clays. A layer of medium to very coarse sand was encountered at or near the base of the formation in well C and test holes 4 and 5. The formation probably was deposited as a beach sand by a transgressive sea, but the shallow-water clay and back-beach lignitic clay and lignite found in Ouachita and Calhoun Counties indicate that the shoreline fluctuated somewhat in that area.

Cook Mountain formation. -- Except for that area where it has been subjected to erosion, the Cook Mountain formation maintains a rather uniform thickness of about 140 feet in the section shown in this report. In most of the Mississippi embayment the formation consists of fairly deep water marine clays, but in this area the near-shore shallow-water dark-gray to dark-brown silty clays are prevalent. The formation contains some silt, sand, and lignitic clay that probably was deposited in a back-beach environment.

Cockfield formation. -- The Cockfield formation maintains an average thickness of about 250 feet in Bradley and Calhoun Counties. Like most of the formations of Eocene age, it appears to have been deposited during a time of rapid shoreline fluctuations, because it is composed of both back-beach and shallow-water deposits. It consists mainly of gray and brown very fine to fine sand and silt, and dark-gray, dark-brown, and green lignitic silty clay. Some of the sand lenses are nearly free of silt and are probably beach deposits; but most



of the formation apparently was deposited under subaerial conditions inasmuch as most of the sand, silt, and clay of the formation is lignitic and lignite commonly is present as thin interbeds. Some of the sand contains small amounts of glauconite which probably was concentrated along the beaches by wave action.

### Jackson Group

The interpretation shown on Figure 2 indicates that the Jackson group is about 295 feet thick in Bradley County and is present beneath a cover of terrace and alluvial deposits of Quaternary age as far west as the eastern part of Calhoun County. This thickness and extent of the Jackson group is considerably greater than that proposed by Wilbert (1953, p. 64) and is suggested for the reasons discussed in the following paragraphs.

The Jackson group consists mainly of gray, brown, and green silty clay and some lignite and was deposited primarily under marine conditions. Its contact with the predominantly continental sands of the underlying Cockfield formation is placed at a definite break in lithology as shown on Figure 2. This position of the contact, determined by the interpretation of lithologic logs, correlates well with a projection of the contact indicated by the characteristic "kick" at the change in lithology on electric logs of oil-test wells east of Bradley County. Unfortunately, this "kick" is not on all electric logs in the area of study, because surface casing has been set through the Cockfield-Jackson contact zone in most oil tests in Bradley and Calhoun Counties.

The interpretation shown on Figure 2 is also suggested by a zone of globigerina that occurs in several test holes between 20 and 30 feet above the contact shown. The presence of these marine microfossils indicates that the base of the Jackson group probably is not significantly higher than it is shown on Figure 2.

Further paleontological data are necessary to substantiate the placing of the Cockfield-Jackson contact at the suggested break in lithology near the zone of marine microfossils. Until these data are available, the position of the contact at the horizon shown on Figure 2 must be considered tentative.

### Terrace Deposits

Most of the hills in the report area are capped with terrace deposits of Quaternary age. The deposits average 35 to 40 feet in thickness and mainly consist of poorly sorted sand,

some clay, and gravel.

This investigation indicates that there are at least three distinct terraces. The oldest terrace, and the one highest in elevation, is found at an altitude of approximately 300 feet, capping the hills in western Ouachita County and in at least that part of northeastern Nevada County where the first two test holes were drilled. The next terrace caps hills approximately 250 feet in altitude from central Ouachita County to eastern Bradley County. The youngest terrace, and the lowest in elevation, is found at altitudes of approximately 200 feet from central Ouachita County to eastern Bradley County, but its principal development is in Calhoun County. Gravel has been mined from each of the terraces, but the lowest terrace has been most extensively exploited.

The various terraces have not been differentiated on the section. It should be possible to make a distinction between them after geologic mapping is completed and adequate elevation control is established.

#### Alluvium

Alluvium of Quaternary age covers a large part of southern Bradley and Calhoun Counties and fills most of the stream valleys in the report area. It averages 35 to 40 feet in thickness and mainly consists of sandy clay, poorly sorted sand, and gravel derived from the older terrace deposits. The alluvium is generally somewhat finer in overall grain size than the terrace deposits.

The contact between the alluvium and the terrace deposits can be only approximated on the section at this time. Some of the alluvium may be of Pleistocene age.

#### LITHOLOGIC LOGS

Lithologic logs of test holes 1 and 23 drilled for the accompanying section, the composite log of the city supply well at Chidester, and driller's logs of the city well at Hampton and a well at the Southern Kraft Division of the International Paper Company at Camden are given in Table 2. The stratigraphic designations shown on the driller's logs are the author's interpretation and are based on electric logs of nearby oil-test wells and the test holes drilled under contract for the U. S. Geological Survey.

Table 2. Lithologic Logs

Test hole 1

Location: Nevada County, SW1/4 NW1/4 SE1/4, sec. 27,  
 T. 11 S., R. 20 W.  
 Drilled by: H. E. Cutter and Dad Drilling Co.  
 Log by: U. S. Geological Survey  
 Surface altitude: 204 feet

	Thickness (feet)	Depth (feet)
Quaternary		
Alluvium		
Gravel, granules and pebbles	1	1
Sand, fine to medium, clayey, brown	4	5
Sand, very fine, clayey, variegated red, brown, orange, and gray; contains some very coarse sand, granules, and gray clay	10	15
Sand, very fine, silty and clayey, gray	5	20
Sand, very fine to medium, brown	5	25
Sand, very fine to medium, light-gray to white; contains some clay	5	30
Sand, very fine to very coarse, brown	4	34
Gravel, granules and pebbles, black; contains some wood fragments	2	36
Tertiary-Eocene		
Wilcox group		
Clay, dark-gray to dark-brown	13	49
Lignite	1	50
Clay, dark-gray to dark-brown; con- tains interbedded lignite	10	60
Clay, light-gray	5	65
Clay, silty, green to bluish-green, glauconitic	5	70
Clay, silty and sandy in part, light- gray to gray; contains some glau- conite and lignite	45	115

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Table 2. Lithologic logs (continued)

## Test hole 1 (continued)

	Thickness (feet)	Depth (feet)
Sand, very fine to fine, clayey, gray	10	125
Clay, silty, gray, lignitic in part	12	137
Clay, silty, brown to gray-brown; interval from 150-151 feet ap- pears weathered	14	151
Clay, light-gray to white	11	162
Clay, dark-gray, almost black; con- tains some interbedded light-gray to white clay, hard streaks of ce- mented sand at 183 feet, 193 feet, and 196 feet	38	200

## Well C

Location: Ouachita County, NE 1/4 NE 1/4 NE 1/4, Sec. 14,  
T. 12 S., R. 19 W.

Owner: Town of Chidester, Ark.

Drilled by: [Log from the surface to 178 feet is modified  
from a driller's log supplied by the Carlross Well  
Supply Co. Log from 178 feet to total depth is  
from a test hole drilled by the Childers Drilling  
Co. and logged by the U. S. Geological Sur-  
vey.]

Surface altitude: 286 feet

	Thickness (feet)	Depth (feet)
Tertiary-Eocene		
Sparta sand		
Sand, reddish-brown	8	8
Sand, brown; contains streaks of red clay	12	20

Table 2. Lithologic logs (continued)

Well C (continued)

	Thickness (feet)	Depth (feet)
Sand, white to light-tan	10	30
Sand; contains streaks of soft white clay	21	51
Sand, light-brown to tan, water bearing	47	98
Sand, hard-packed, water-bearing; contains 5 feet of coarse sand	20	118
Cane River formation		
Clay, hard	7	125
Clay, sandy, soft	4	129
Clay, black, very hard [lignite]	12	141
Sand, streaks	4	145
Sand; contains streaks of clay	10	155
Clay, black, very hard [lignite]	22	177
Rock, hard	1	178
Clay, and lignite, dark-brown	63	241
Sand, medium, light-gray	13	254
Sand, medium, clayey, brown; contains lignite	12	266
Shale, brown	13	279
Carrizo sand		
Sand, fine to medium, gray; contains blue to almost black clay	26	305
Sand, very fine to medium, brown; contains streaks of shale, clay, and some gravel	24	329
Sandstone, fine-grained, brown	2	331
Sand, fine to medium, gray; contains streaks of brown siltstone and some lignite	22	353
Wilcox group		
Lignite	13	366

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Table 2. Lithologic logs (continued)

## Well C (continued)

	Thickness (feet)	Depth (feet)
Clay, sandy, gray; lignite streak at 374 feet	28	394
Siltstone, brown	2	396
Clay, sandy, gray	19	415

## Well SK

Location: Ouachita County, NW1/4 NW1/4 NE1/4, sec. 2,  
T. 14 S., R. 17 W.  
Owner: Southern Kraft Division, International Paper Co.  
Drilled by: Layne-Arkansas Co.  
Log by: Layne-Arkansas Co.  
Surface elevation: 120 feet.

	Thickness (feet)	Depth (feet)
Quaternary		
Alluvium		
Clay	14	14
Sand	8	22
Sandy gumbo	10	32
Sand and gumbo	28	60
Tertiary-Eocene		
Cook Mountain formation		
Sandy clay	20	80

**Table 2. Lithologic logs (continued)**

**Well SK (continued)**

	Thickness (feet)	Depth (feet)
<b>Sparta sand</b>		
Sandy clay	37	117
Sand	58	175
Sandy clay	47	222
Sand	53	275
<b>Cane River formation</b>		
Soft gumbo	35	310
Rock	1	311
Gumbo, thin rock	1	312
Gumbo	5	317
Sandy shale	1	318
Shale and boulders	42	360
Sandy clay	15	375

**Well H**

Location: Calhoun County, NE 1/4 NE 1/4 NE 1/4, sec. 6,  
 T. 14 S., R. 13 W.  
 Owner: City of Hampton, Ark.  
 Drilled by: Layne-Arkansas Co.  
 Log by: Layne-Arkansas Co.  
 Surface altitude: 203 feet

	Thickness (feet)	Depth (feet)
<b>Quaternary</b>		
<b>Terrace deposits</b>		
Soil	12	12
Gravel	23	35

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Table 2. Lithologic logs (continued)

Well H (continued)

	Thickness (feet)	Depth (feet)
<b>Tertiary-Eocene</b>		
<b>Cockfield formation</b>		
Clay	30	65
Soft rock	2	67
Gumbo and sandy shale	78	145
Fine sand	4	149
Sand and shale	6	155
Fine sand	5	160
Sandy shale	20	180
Fine sand	4	184
Gumbo	16	200
Shale	20	220
Gumbo	25	245
Gumbo and 3-inch rock	5	250
Rock	1	251
<b>Cook Mountain formation</b>		
Gumbo	3	254
Soft rock	1	255
Gummy shale	61	316
Hard gumbo	10	326
Shale and sand	6	332
Sandy clay	42	374
Gumbo	23	397
<b>Sparta sand</b>		
Fine-packed sand	19	416
Gumbo	13	429
Fine gray water sand	21.5	450.5
Sandy shale	20.5	471



Table 2. Lithologic logs (continued)

Test Hole 23

Location: Bradley County, SW 1/4 NE 1/4 NE 1/4, sec. 4, T. 14 S., R. 9 W.  
 Drilled by: H. E. Cutter and Dad Drilling Co.  
 Log by: U. S. Geological Survey  
 Surface altitude: 178 feet

	Thickness (feet)	Depth (feet)
Tertiary-Eocene		
Jackson group		
Clay, silty and sandy, brown, red, and gray	10	10
Clay, silty, gray, buff, and brown, micaceous in part; contains some interbedded dark-brown silt	20	30
Clay, greenish-gray, lignitic; contains interbedded silt, some weathered streaks	5	35
Clay, silty, dark-gray, lignitic; contains interbedded silt and very fine sand	20	55
Clay, silty, dark-gray, greenish-gray, and dark-brown, lignitic; contains interbedded silt and lignite, hard streaks at 64 and 80 feet	25	80
Clay, green, lignitic, and lignitic dark-brown and greenish gray silty clay; contains interbedded lignite, silt, and very fine sand	160	240
Cockfield formation		
Sand, very fine to fine, and silt, gray; contains some interbedded clay and lignite	70	310

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