GEOLOGICAL SURVEY CIRCULAR 241

THE GROUND-WATER RESOURCES OF COLUMBIA COUNTY, ARKANSAS A RECONNAISSANCE

By D. B. Tait, R. C. Baker, and G. A. Billingsley

Prepared in cooperation with the Division of Geology, Arkansas Resources and Development Commission, and the University of Arkansas Institute of Science and Technology

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THE GROUND-WATER RESOURCES OF COLUMBIA COUNTY, ARKANSAS

A RECONNAISSANCE

ABSTRACT

Ground water is used in Columbia County, Arkansas, at an estimated rate of about 3 million gallons per day. The city of Magnolia, oil fields, and oil processing industries are the principal users of ground water.

The Sparta sand of Tertiary age, yields moderately mineralized, generally soft, sodium bicarbonate water at a rate of about 2.7 million gallons per day. The maximum optimum perennial yield from the Sparta in the county cannot be estimated, but the decline in water levels suggests that the optimum rate of pumping in the vicinity of Magnolia is about 3 million gallons per day.

Sediments of Quaternary age in the western part of the county might be developed as a source of fairly hard, moderately mineralized water.

INTRODUCTION

Purpose and Scope of Investigation

This report was prepared in cooperation with the Division of Geology, Arkansas Resources and Development Commission, and the University of Arkansas, Institute of Science and Technology. Its purpose is to present information about the occurrence of ground water and the records of water wells in Columbia County, Ark. A brief review of the geology and geography of the county, particularly as pertinent to the occurrence and use of ground water, is included, together with records of 48 wells and 7 springs, chemical analyses of 30 wells and 7 springs, and 16 logs of water wells, water test wells, oil wells and oil test wells.

The field work was done principally by D. B. Tait, geologist, under the direct supervision of R. C. Baker, district geologist, and under the general direction of A. N. Sayre, geologist in charge of the Ground Water Branch, Water Resources Division, U. S. Geological Survey.

Acknowledgments

The writers are grateful to all persons who gave information or help in the preparation of the report, particularly Lon H. Embree, Magnolia Municipal Water Works; L. B. Smith, C. Hamlin, and C. R. Carnahan, water well drillers; Ross Coe and R. H. Counter, the Carter Oil Company; L. A. Greene, Southern State College; R. P. Alger, Schlumberger Well Surveying Corporation; K. C. Gilbert, Layne-Arkansas Company; Sterling S. Lacy, Jr. and James Staggs, McAlester Fuel Company; D. K. Mackay, Arkansas Oil and Gas Commission; O. H. Hanyka, Shell Oil Company; and B. W. Montgomery, Hiwan Oil and Gas Company.

Location

Columbia County is in the southwest part of Arkansas. It is bordered on the west by LaFayette, on the north by Nevada and Ouachita, and on the east by Union Counties; on the south are Webster and Claiborne Parishes, Louisiana.

Well-Numbering System

The well-numbering system used in this report is based upon the location of the wells with respect to the federal land survey used in Arkansas. The component parts of a well number are the township number; the range number; the section number; and three lowercase letters which indicate, respectively, the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section in which the well is located. The lowercase letters are assigned in counter-clockwise order beginning with a in the northeast quarter or quarter-quarter or quarter-quarter-quarter section. Serial numbers are appended to each well located within the quarter-quarter-quarter section. This system of numbering wells according to their location is illustrated in figure 1.

GEOGRAPHY

Topography

Physiographically Columbia County is part of an area known as the Gulf Coastal Plain.

The ground surface is generally rolling, its altitude is from 200 to 400 feet above sea level. The lowest altitude is in the southeast part of the county and the highest is in the north-central part. In the vicinity of Magnolia the ground surface is about 280 to 360 feet above sea level.

The county lies in the basin of the Red River, and the divide between the Red River and the Ouachita River, a major tributary of the Red, crosses it near the center in a general southerly direction. There are no large streams, but several small streams flow southwestward and southeastward.

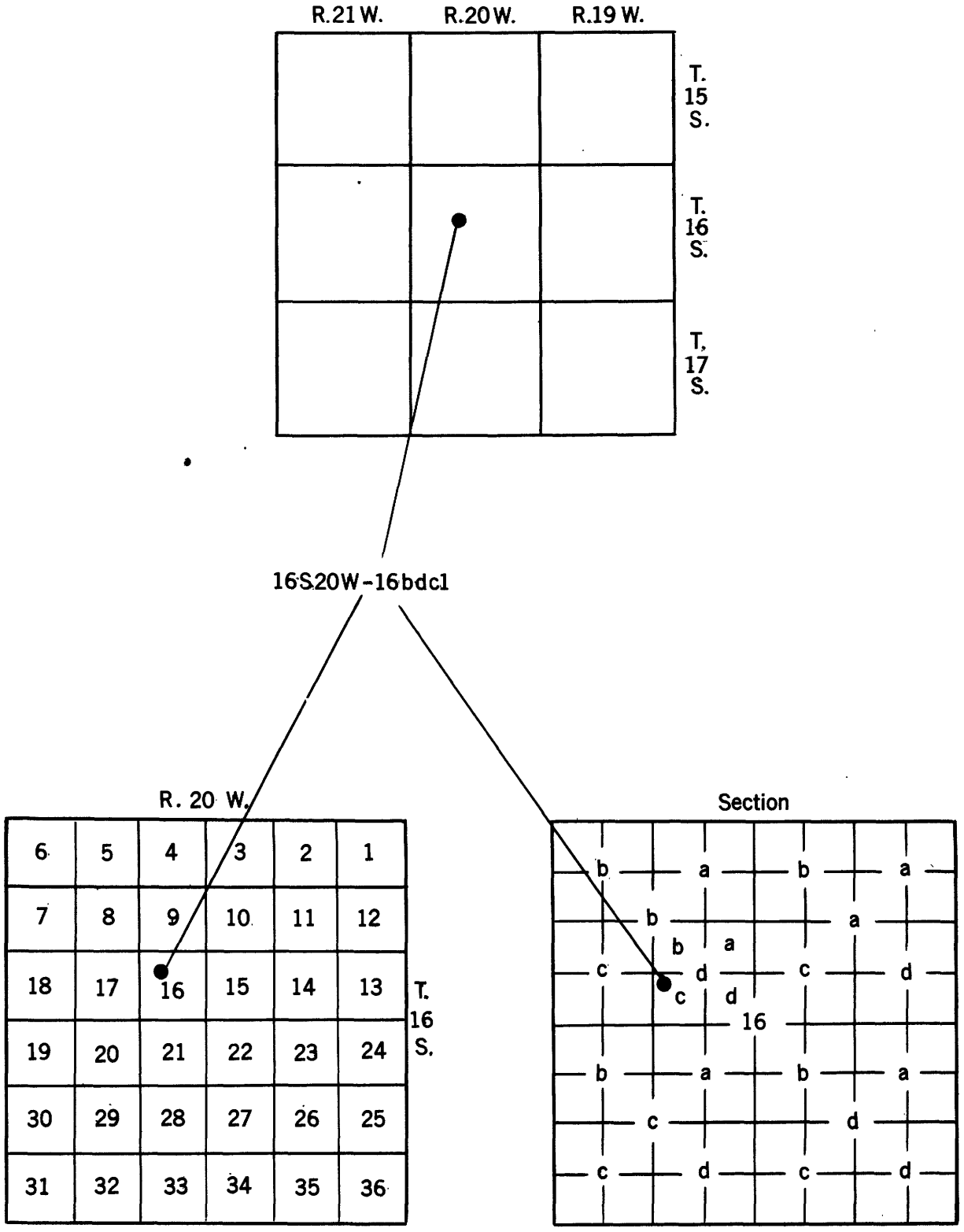

Figure 1. Sketch showing well-numbering system used in this report.

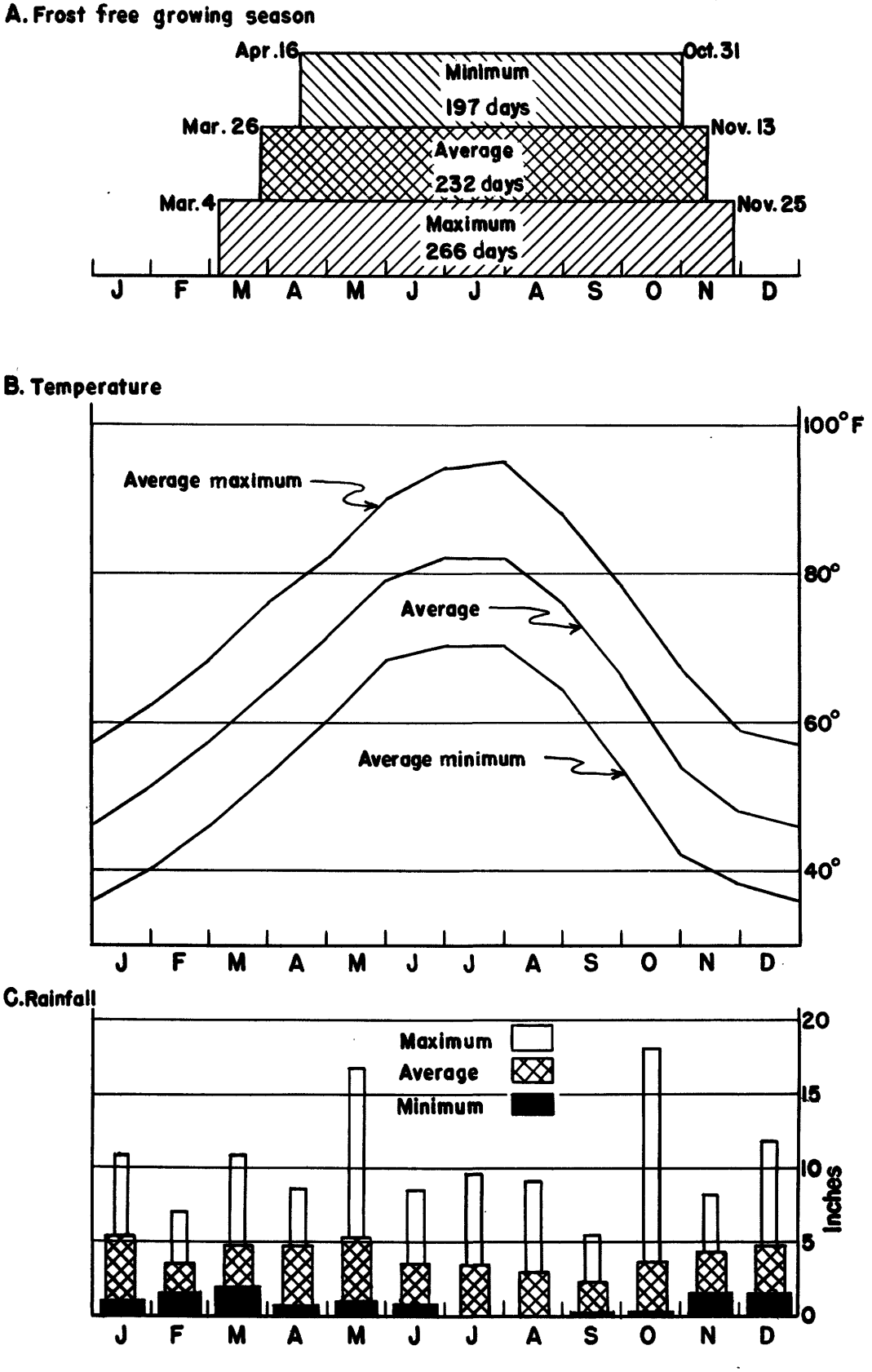

Figure 2. Selected climatological data for Magnolia, Ark., 1919-1950.

Climate

Information concerning the growing season, temperature, and rainfall at the city of Magnolia is shown on figure 2. In general the summers are hot and the winters mild; the average annual temperature is 65.4°F. Rainfall is plentiful for most needs, the largest amounts falling in the winter and spring months. The average annual rainfall at Magnolia is 48.48 inches; the maximum for any year, 69.15 inches, occurred in 1919, and the minimum, 30.23 inches, in 1936.

Development

The population of Columbia County has increased from about 20,000 to 30,000 people in the last 60 years. This is shown on table 1, which gives the population of the county and of the five largest municipalities from 1881 to 1950 inclusive. Magnolia, the largest municipality and the county seat, is near the geographic center of the county (fig. 3).

Most of the population live on farms or are employed in agriculture. The sandy loam soils, usually well drained, are suitable for most crops.

The largest industries are associated with oil and its processing. They serve the principal oil fields--Magnolia, Atlanta, Village, Dorchest-Macedonia, and parts of the Stephens and Buckner fields--and constitute the principal users of ground water in the county. Lumbering is also an important industry of long standing, and there are numerous smaller industries, most of which are located in the vicinity of Magnolia.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

General features

The floor or basement of the Gulf Coastal Plain is made up of hard, folded, and faulted Paleozoic rocks. In Columbia County these rocks occur at a depth of more than a mile below land surface, and their nearest exposure is at the edge of the mountainous area about 50 miles to the north.

The Paleozoic rocks in Columbia County are overlain by Mesozoic sedimentary rocks, which range in thickness from 5,000 to 10,000 feet. They are important sources of oil and gas, but the water contained in them is highly mineralized.

Table 1.--Population of Columbia County and selected municipalities by decades, 1881-1950, inclusive

Decade ending	Indicated municipalities					Columbia County
	Taylor	Emerson	McNeil	Waldo	Magnolia	
1890----------	...	...	...	...	1,486	19,893
1900----------	...	...	...	...	1,614	22,077
1910----------	...	...	482	597	2,045	23,820
1920----------	275	357	448	704	2,158	27,670
1930----------	263	373	460	942	3,008	27,320
1940----------	335	501	694	1,240	4,326	29,822
1950----------	...	523	597	1,491	6,918	28,770

The Mesozoic sedimentary rocks are overlain by the poorly consolidated deposits of the Tertiary system, which are the most important freshwater-bearing strata in the county.

Structure

With respect to the ground-water resources in Columbia County, the most important structural features are the regional dip of the Tertiary formations, which is to the south or southeast at about 10 to 30 feet per mile, and the faulting of the Tertiary formations. Figure 3 is a structure map of Columbia County contoured on the contact of the Cane River formation and the overlying Sparta sand, both of the Claiborne group. The Sparta sand is the most important ground-water-producing formation in the county and dips in a generally southeasterly direction at about 20 feet per mile.

The Sparta sand crops out (fig. 4) as a northeast-trending band of an average width of about 8 miles, in the northern part of Columbia, the southern part of Nevada, the northwestern part of Lafayette, and the southwestern part of Ouachita counties. Ground water in the Sparta sand is recharged in the outcrop area by precipitation and surface water and, conditions permitting, the water can move downdip to the areas of pumping. There are minor folds superimposed on the regional dip. So far as is known these minor folds do not have an appreciable effect on the occurrence and quantity of fresh water.

The zone of faulting north of Columbia County, shown on figure 4, may intercept the ground water in the Sparta sand moving from the area of recharge into Columbia County. The displacement on these faults differs locally, ranging from only a few feet to as much as 200 feet. Where permeable beds in the Sparta are displaced and are in fault

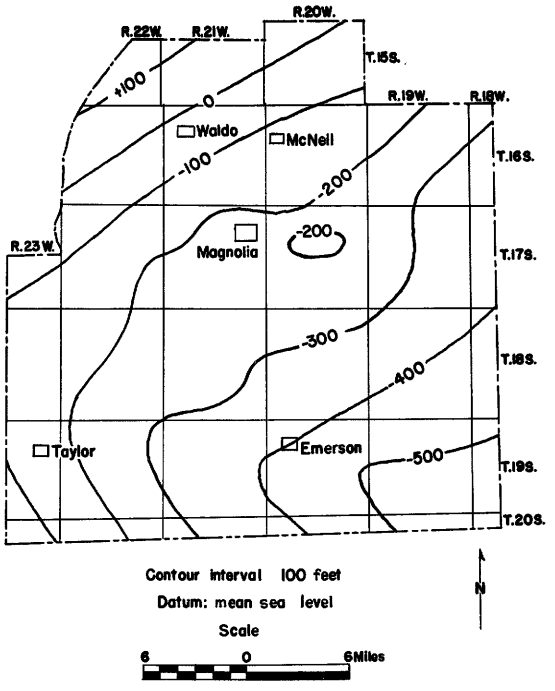

Figure 3. Structure contours on the contact of the Cane River formation and Sparta sand, Columbia County, Ark.

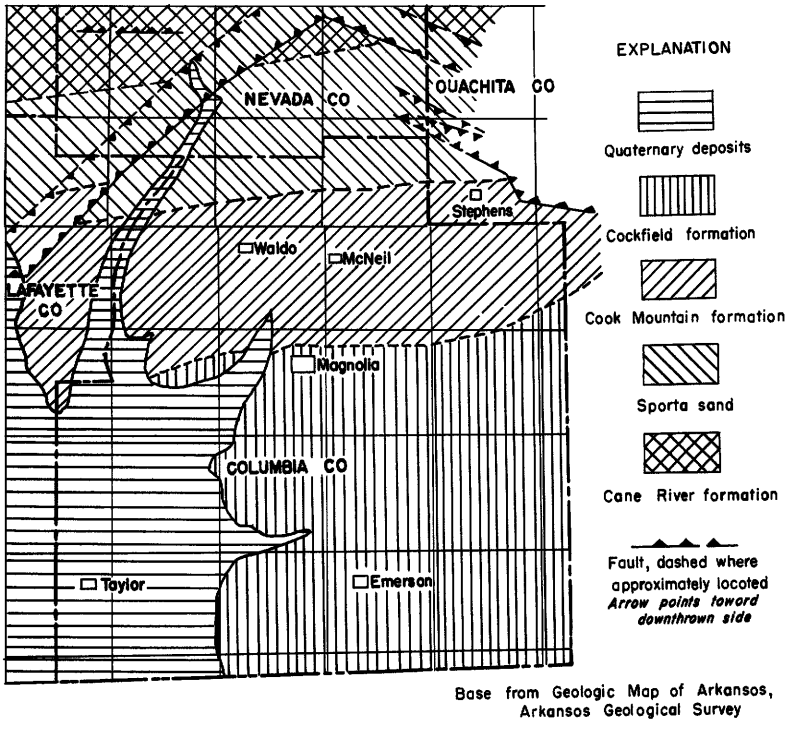

Figure 4. Geologic map of Columbia County and vicinity.

Table 2.--Generalized geologic column of Tertiary and Quaternary formations, Columbia County, Ark.

	Era and system	Series	Group and formation	Thickness (feet)	Character of materials
Cenozoic	Quaternary.		Terrace deposits and alluvium.	0-80	Varicolored silt and clay; discontinuous beds of coarse sand and gravel at base.
			Unconformity.		
	Tertiary.	Eocene.	Claiborne: Cockfield.	0-100	Grayish sand, varicolored lignitic shale, and occasional thin beds of lignite.
			Claiborne: Cook Mountain.	0-280	Brown and greenish lignitic shale and silty shale; sparsely fossiliferous, gray glauconitic shale and sand in lower part.
			Claiborne: Sparta sand.	250-400	Upper part predominantly brown and greenish lignitic silty shale, occasional thin sand and lignite beds; lower part predominantly medium-grained sand in beds as much as 100 feet thick, occasional thin greenish shale and lignite beds.
			Claiborne: Local unconformity		
			Claiborne: Cane River.	330-370	Brown lignitic shale, abundantly glauconitic and fossiliferous in upper part; interbedded with sparsely glauconitic and fossiliferous sand and brown shale in middle and lower part; basal sand in northern part of county.
			Unconformity		
			Wilcox.	200-400+	In northern part of county, gray to greenish silt and silty shale, and thin-bedded lignite with thin greenish sand, white shale, calcareous sandstone and "ironstone"; in southern part, light to dark brown shale and silty shale, lignite, and thin sand beds, with abundant calcareous sandstone and "ironstone."
		Paleocene.	Midway.	440-530	Blue, slightly silty, micaceous shale, sparsely fossiliferous; blue to brownish limy shale, glauconitic and fossiliferous at base.
			Unconformity		
Mesozoic	Cretaceous.	Gulf.	Maverro: Arkadelphia marl.		

contact with impermeable beds, the capacity of the formation to transmit water from the outcrop into Columbia County is reduced. No faults have been recognized in the Tertiary formations in the county.

Tertiary system

The deposits of the Tertiary system crop out in most of Columbia County, except in the southwestern part, where they are covered by younger deposits of the Quaternary system. The Tertiary deposits are about 1,300 feet thick in the northern part of the county and about 2,000 feet thick in the southern part. In northern Louisiana the Tertiary sediments have been subdivided into formations that can be recognized over fairly large areas. These formations have also been recognized in southern Arkansas. Stratigraphic breaks can be determined by a study of samples of drill cuttings; however, driller's logs and electric logs do not provide sufficient detailed information to permit positive identification of contents between certain of the formations of Tertiary age. Locally, therefore, some of the formational contacts must be inferred, though their position is believed to be fairly accurate.

A generalized geologic column of the Tertiary and Quaternary formations in Columbia County is given in table 2, and plate 1 shows the stratigraphic relationship on the basis of electric-log correlations.

Paleocene series

Midway formation

The Midway formation ranges in thickness from 440 feet in the northern part of the county to 530 feet in the southern part. It is composed largely of bluish, silty, micaceous shale which is sparsely fossiliferous. The basal part of the formation consists of dark blue to brown limy shale which is glauconitic and fossiliferous.

The Midway formation is quite impermeable and does not yield water to wells in the county. It prevents the upward movement of highly mineralized water from the underlying Mesozoic sedimentary rocks into the Tertiary deposits and also the downward movement of fresh water from the overlying deposits.

Eocene series

Wilcox formation

The Wilcox formation overlies the Midway formation. It ranges from about 200 to slightly over 400 feet in thickness. In the northern part of the county the Wilcox is composed dominantly of greenish silt and silty shale, white clay, thin beds of greenish sand, and lignite. In the southern part it is composed dominantly of light to dark brown shale, silty shale, thin sand beds and lignite. Numerous thin beds of calcareous sandstone and "ironstone" are scattered throughout the formation. In few localities the beds of sand in the Wilcox exceed 10 feet in thickness.

Claiborne group

Cane River formation.--The Cane River formation of the Claiborne group overlies the Wilcox formation. In Columbia County the formation is about 370 feet thick in the north but thins to about 330 feet in the south. In the southern part of the county it consists mainly of dark brown shale and silty shale with occasional thin beds of sand. The upper part of the formation is abundantly glauconitic and is fossiliferous. The lower part of the formation is sparsely glauconitic and sparsely fossiliferous. The Cane River strata become more sandy to the north, and at the outcrop area, about 5 miles north of the county line, they consist dominantly of sand. Locally in the northern and northwestern part of the county some of the sand beds attain a thickness of about 40 feet. The sand is generally medium- to fine-grained.

In the northern part of the county a moderately thick sand bed lies between Cane River strata above and the Wilcox formation below. This sand bed, as shown on the geologic section, plate 1, has been included in the Cane River formation, although it may be a part of the Wilcox formation.

Several wells yield water from the Cane River formation in northeastern Columbia County. The wells generally have small capacity.

Information about wells tapping the Cane River and other formations is given in table 3 (p. 8-9), and chemical analyses of the ground water of Columbia County are given in table 4, (p. 10-11). Locations of wells are shown on figure 5.

The chemical analyses indicate that the water is soft and moderately high in mineral content, sodium bicarbonate being predominant. The mineral concentration of water from the Cane River formation increases with depth.

The Cane River formation will not yield large amounts of water to wells; wells of small capacity, however, can be developed in the northern third and along the western edge of the county.

Sparta sand.--The Sparta sand in the county ranges in thickness from 250 feet in the north to 400 feet thick in the south. The lower part of the formation, ranging from 150 to more than 200 feet in thickness, consists largely of lenses of medium- to fine-grained sand interbedded with gray lignitic clay and lignite. The sand beds range from 20 to more than 100 feet in thickness, with an average of about 60 feet. They are lenticular and the proportion of sand to silt and clay varies from place to place (see logs of wells, p. 15-23). The lower part of the formation yields most of the water produced from the Sparta sand.

TABLE 3.--RECORD OF WELLS AND SPRINGS

See text for description of well-numbering system. Water level: R, reported; P, pumping. Use: PS, public supply; I, industrial; D, domestic; N, not used.

Well number or spring number	Owner or name	Date drilled	Total depth of well (feet)	Diameter (inches)	Depth to bottom of screen (feet)	Land surface altitude (approx. feet above sea level)	Water level (feet below land surface)	Date of measurement	Yield or capacity (gpm)	Use	Remarks
				Cane River formation							
15S20W-12ccc1	Crow & O'Ferrall	1948	390	7	390	242	20R	1948	50	I	
15S20W-13bbb1	Sohio Oil Co	1948	408	7	376	230	20	1948	300	PS	
				Sparta Sand							
15S19W-19dba1	Arkansas Fuel Oil Co	1950	286	8	270	...	125P	1950	60	I	
16S20W-16bdc1	Boy Scouts of America	1946	422	4	322	...	...	...	...	N	Electric log on file.
16S20W-16bdc2	----------do----------	1948	630	4	508	...	180R	1948	5	PS	Do.
16S20W-17bbc1	McNeil Mfg. Co	1936	310	5	310	...	196	1950	10	I	
16S20W-18dbd1	M. H. Hollman	1950	476	6-4	476	...	194R	1950	50	D	
16S21W-16bdb1	Town of Waldo	1940	900	8	364	...	182	1949	131	PS	Log given in this report.
16S21W-16bdb2	----------do----------	1936	250	8	250	...	45R	1946	40	PS	Driller's log on file.
16S21W-25adb1	Mr. Overstreet	1944	402	3-1 1/2	402	...	171	1944	10	D	Do.
17S19W-15abd1	Shell Oil Co	1947	516	8-4 1/2	504	324.5	...	...	90	I	
17S19W-15bdc1	Carter Oil Co	1938	584	12-8	584	312	217	1950	150	PS	Log given in this report.
17S19W-18cdb1	----------do----------	1946	470	10-6	470	253	131R	1946	50	I	Driller's log on file.
17S19W-30abb1	----------do----------	1945	501	10-6	501	244	174R	1945	50	I	Do.
17S20W-15abb1	----------do----------	1946	442	10-6	442	352	290P	1950	120	I	Do.
17S20W-22cdc1	----------do----------	1945	470	10-6	470	294	224P	1950	135	I	Do.
17S20W-23bab1	Shell Oil Co	1943	562	12-8	562	...	....	....	100	N	Do.
17S20W-23bab2	----------do----------	1943	588	12-8	568	...	205P	1943	100	I	Log given in this report.
17S20W-23bab3	Lion Oil Co	1941	445	12	445	...	218R	1941	100	I	Driller's log on file.
17S20W-23bcd1	Shell Oil Co	1948	546	12-8	546	...	252R	1948	250	I	Do.
17S20W-27abb1	Mid-Valley Pipe Line Co	1950	408	4-2 1/2	408	...	221R	1950	10	D	

17S21W-1bbd1	Magnolia A. & M----------	1943	425	12	425	323	186R	1943	150	PS	Driller's log on file.
17S21W-1bca1	----------do----------	1931	453	12	453	348	179R	1931	115	PS	Log given in this report.
17S21W-1bca2	----------do----------	....	430	4	...	348	255	1950	...	..	
17S21W-11dcb1	Town of Magnolia----------	1944	440	12	410	288	220	1950	440	PS	Driller's log on file.
17S21W-11ddb1	----------do----------	1928	433	8	433	311	147R	1928	320	PS	Do.
17S21W-11ddb2	----------do----------	1937	440	8	440	303	148R	1937	380	PS	Do.
17S21W-12aaa1	----------do----------	1950	460	12-8	436	353	278R	1950	460	PS	Electric log on file.
17S21W-23add1	Partee Lumber Co----------	1948	425	4	425	...	160R	1948	30	PS	
17S21W-23ddd1	----------do----------	1940	425	9	425	...	160R	1940	60	I	
17S21W-24bad1	W. F. Downs----------	1950	516	7	516	...	215	1950	50	I	
18S19W-17bdd1	Hiwan Oil & Gas Co----------	1948	577	10	386	...	195	1950	200	I	Driller's log on file.
18S21W-4ddd1	Mathieson Chemical Co-------	1945	502	8-4 1/2	502	...	216P	1950	300	I	Do.
18S21W-9aaa1	Arkansas-Louisiana Co-------	....	535	12-8	535	...	...	....	225	I	
18S21W-9aaa2	----------do----------	....	485	13-8	485	...	...	....	318	I	
18S21W-19dac1	Magnolia High School-------	1948	513	7-3	489	...	175	1950	10	PS	Electric log on file.
19S20W-8daa2	Town of Emerson----------	1950	451	8-4	436	320	201	1950	140	PS	Driller's log on file.
19S20W-16bac1	Foster-Grayson Lbr. Co------	1948	430	7	430	315	...	....	10	PS	
19S23W-10aab1	Mrs. D. B. Waggoner---------	1943	400	6	400	...	30R	1943	...	N	
19S23W-11dab1	C. Wellborn----------	1949	230	2	230	....	42R	1949	5	D	Driller's log on file.
19S23W-11cda1	Mrs. A. P. Stuart----------	....	...	2	....	...	...	....	5	D	
	Cook Mountain formation										
16S20W-16dba1S	Boy Scouts of America-------	....	...	...	...	...	...	....	1-2	N	
16S20W-16dba2S	----------do----------	....	...	...	...	...	...	...	1-2	N	
16S20W-16dba3S	----------do----------	....	...	...	...	...	...	...	1-2	N	
16S20W-16dba4S	----------do----------	....	...	...	...	...	...	...	1-2	N	
16S20W-16dba5S	----------do----------	....	...	...	...	...	...	...	1-2	N	
16S20W-16dba6S	----------do----------	....	...	...	...	...	...	...	1-2	N	
17S20W-36cab1	Tidewater-Seaboard Oil Co---	1944	238	7	222	...	...	...	20	PS	Electric log on file.
18S19W-17bdd2	Hiwan Oil & Gas Co----------	1947	324	8	303	...	75P	1947	20	I	Log given in this report.
19S19W-1dba1	State Forestry Comm---------	1949	280	4	280	....	130R	1949	10	D	
19S20W-8daa1	Emerson Pub. School---------	1946	314	3	290	320	80R	1946	5	PS	Driller's log on file.
19S23W-11cad1	D. C. Hughes----------	1949	110	2	110	...	42R	1949	5	D	Log given in this report.
	Cockfield formation										
16S20W-35abb1S	Boy Scouts of America-------	....	...	...	...	...	...	....	1-2	N	
19S21W-17ccc1	Mrs. J. C. Walker----------	1946	85	4	85	...	...	....	5	D	
	Quaternary deposits										
19S23W-13ccb1	W. R. Stuart----------	1950	60	3	60	....	17R	1950	6	D	Log given in this report.

TABLE 4.--CHEMICAL ANALYSES
(parts per million)

Well number or Spring number	Depth to bottom of screen (feet)	Specific conductance at 25°C (Micromhos)	Temperature (°F)	pH	Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	
																		Total	Noncarbonate
Cane River formation																			
15S20W-12cccl	390	522	69	8.3	...	0.62	...	....	...	...	..	262	1.0	40	...	1.7	...	40	0
15S20W-13bbbl	376	497	68	7.7	11	.12	0.5	10	2.8	106	4.8	273	.7	34	0.1	.3	304	36	0
Sparta sand																			
16S20W-16bdc2	508	344	71	7.9	11	.55	.8	5.3	1.3	79	5.6	210	12	5.5	.1	1.8	226	19	0
16S20W-17bbcl	310	264	68	7.6	12	.22	3.1	15	2.6	43	3.2	162	9.1	3.8	.0	1.4	173	48	0
16S21W-16bdbl	364	925	..	8.6	10	.04	3.0	2.7	.1	237	2.6	553	.5	47	1.0	3.2	586	8	0
16S21W-16bdb2	250	215	..	8.0	58	5.2	1.4	21	1.7	21	5.0	117	8.2	4.5	.0	.2	180	59	0
17S19W-15bdcl	584	421	72	8.0	11	.10	.2	3.2	1.0	102	3.3	265	.7	11	.3	1.7	265	12	0
17S19W-18cdbl	470	785	..	8.1	11	.10	.8	4.5	1.3	196	6.6	454	1.4	40	.9	.9	487	16	0
17S19W-30abbl	501	358	72	8.4	12	.10	.4	2.2	.4	88	4.3	222	2.6	8.0	.3	.6	231	7	0
17S20W-15abbl	442	460	72	8.2	11	.14	.6	7.5	1.9	109	5.3	290	4.4	7.8	.5	2.4	293	26	0
17S20W-22cdcl	470	348	72	8.0	11	.09	1.4	1.8	.4	86	7.8	219	.7	6.5	.3	1.8	226	6	0
17S20W-23bcdl	546	382	74	8.1	12	.05	2.4	2.8	.9	92	3.5	234	1.5	11	.2	1.1	243	11	0
17S21W-1btdl	425	343	71	8.2	9.7	.10	.5	3.8	.8	80	7.4	192	15	6.5	.0	2.7	222	13	0
17S21W-1bcal	453	342	70	8.1	12	.32	1.4	6.8	.5	74	4.1	197	13	7.5	.1	1.9	218	19	0
17S21W-11dcbl	410	338	..	8.5	10	.02	.8	8.8	1.6	69	4.5	192	18	5.0	.0	.2	215	29	0
17S21W-12aaal	436	359	71	8.3	12	.26	1.6	5.6	.8	86	1.9	218	8.9	6.0	.1	.2	230	17	0
17S21W-23ddd1	425	327	68	8.4	12	.09	.9	6.5	1.2	74	5.0	204	7.5	6.0	.1	2.2	215	21	0
17S21W-24badl	516	417	72	8.4	..	1.1	...	...	...	...	...	240	17	8.0	...	2.7	...	10	0
18S19W-17bddl	386	352	71	8.1	11	.06	2.4	3.6	1.1	78	3.4	180	18	11	.1	1.4	219	14	0
18S21W-9aaal	535	219	71	7.8	14	.94	1.3	3.3	.8	49	1.5	132	2.7	4.5	.1	.7	144	12	0
18S21W-19dacl	489	295	68	8.3	11	1.9	2.4	2.6	.8	69	2.4	194	1.6	6.5	.2	1.0	211	10	0
18S20W-16bacl	430	374	70	7.7	15	1.4	1.5	18	3.1	60	5.3	192	11	18	.0	2.6	230	58	0
19S23W-11dabl	230	232	68	7.3	15	.32	3.2	19	5.5	23	2.4	140	3.5	4.5	.1	1.2	145	70	0
19S23W-11cdal	...	182	68	7.5	16	2.5	1.9	7.7	2.7	29	2.0	108	2.6	4.8	.0	.9	122	30	0

Cook Mountain formation

16S20W-16dba1 S	...	126	..	6.1	..	0.90	...	...	...	..	...	36	5.0	16	...	0.4	...	34	4
16S20W-16dba2 S	...	110	..	7.4	..	.61	...	...	...	..	...	47	4.0	8.8	...	.3	...	30	0
16S20W-16dba3 S	...	133	..	6.5	..	3.7	....	....	...	..	...	41	4.0	34	...	.4	...	36	2
16S20W-16dba4 S	...	106	..	6.7	..	.91	...	...	...	..	...	44	4.0	10	...	.4	...	34	0
16S20W-16dba5 S	...	145	..	5.6	..	.71	....	...	...	..	...	22	5.0	28	...	.5	...	38	20
16S20W-16dba6 S	...	170	..	6.5	..	.45	...	...	...	..	...	44	5.0	27	...	.6	...	56	20
17S20W-36cab1	222	300	68	7.7	15	.25	.6	14	2.7	55	2.2	193	6.7	4.0	.1	1.2	197	46	0
19S19W-1dba1	280	429	71	8.3	..	.12	...	...	...	..	...	210	23	21	...	2.5	...	57	0
19S20W-8daa1	290	426	70	7.0	..	11	...	...	...	..	...	156	8.0	48	...	.1	...	118	0
19S23W-11cad1	110	640	68	7.5	16	.35	3.4	56	24	60	3.8	350	25	33	.0	1.5	395	238	0

Cockfield formation

16S20W-35abb1 S	...	91.1	64	6.3	53	.10	.4	5.5	1.3	9.5	1.2	31	4.6	8.5	.0	.3	100	19	0
19S21W-17ccc1	85	70.8	68	6.1	42	6.4	.7	2.8	1.4	7.4	1.6	20	3.8	7.0	.1	.6	82	13	0

Quaternary deposits

19S23W-13ccb1	60	669	68	7.2	18	.38	3.4	59	29	47	3.3	328	4.4	60	.0	.6	387	266	0

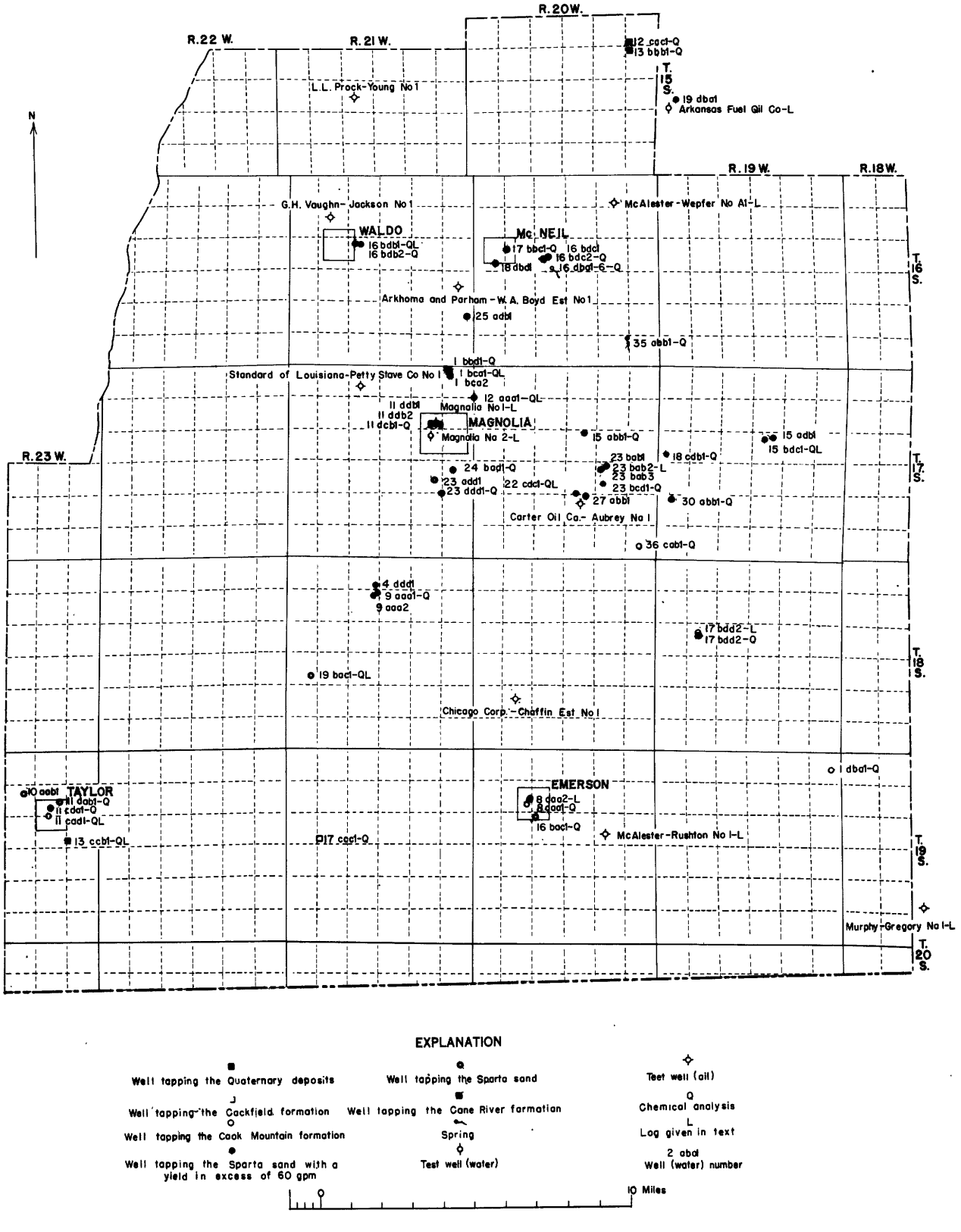

Figure 5. Well locations, Columbia County.

The upper part of the Sparta sand is composed largely of gray and brown lignitic silt and clay, interbedded with lignite and layers of fine sand. The proportion of sand to silt and clay is larger in the southern part of the county than in the northern part.

The outcrop area of the Sparta sand forms a northeast-trending band, about 8 miles wide, along the northern edge of the county. The approximate outcrop area is shown on figure 4. The formation dips generally southeast at about 20 feet per mile (fig. 3).

The Sparta sand yields most of the fresh water withdrawn through wells in Columbia County. Records show 35 wells tapping the lower part of the Sparta sand and 4 low-yielding wells, located in the southern part of the county, tapping the upper strata of the Sparta. Information about these wells is given in table 3. Information about water wells, pumping rates, and fluctuations of water levels in Columbia County before 1940 is very incomplete. The maximum average daily rate of pumping prior to 1940 is estimated to have been less than 0.5 million gallons. The effect of this early pumping is probably of little consequence at present. The pumping rate in 1941 is estimated to have been about 0.6 million gallons per day and this rate has increased to about 2.7 million gallons per day in 1950. The estimated daily rate of pumping by years is shown on figure 6.

Water withdrawn in the vicinity of Magnolia is used principally for municipal supply. East and south for a few miles withdrawals are used principally in oil fields or the oil processing industries. The Sparta sand is also an important aquifer in the areas to the east in Union County, Ark., and to the south in Webster Parish, La.

Chemical analyses (table 4) were made of samples collected from 22 wells yielding water from the Sparta sand. These samples were moderately mineralized, with dissolved solids ranging from 122 to 586 parts per million, but usually less than 250 parts per million. With the exception of 4 wells the water was extremely soft. Hardness ranged from 6 to 70 parts per million. In general the water seems to decrease in hardness as depth from which the water is withdrawn increases. Except for water from well 16S21W-1bdb2, in the town of Waldo, which contains 58 parts per million silica, the silica ranged from 9.7 to 16 parts per million. Seventeen samples contained 0.02 to 1.0 parts per million of iron, 3 contained 1.0 to 1.9 parts per million, and 2 contained more than 2.0 parts per million. The aquifer produced a sodium bicarbonate water which is low in chloride, ranging from 3.8 to 47 parts per million, but mostly below 12 parts per million. From Magnolia southeast to well 18S19W-17bdd1, Hiwan Oil and Gas Co., the sulfate exceeded the chloride; whereas in other water from the Sparta, the chloride exceeded the sulfate.

Water in the Sparta sand occurs under artesian conditions. In the vicinity of Magnolia the top of the water-bearing deposits in the Sparta are at an altitude of about 35 feet below sea level. The static level in 1928 was about 165 feet above sea level, but by 1950 it had declined to about 85 feet. Figure 6 shows the altitude of the static water level in selected wells at different times from 1928 to 1950. All measurements of water levels before 1949 are reported.

The yields of wells tapping the Sparta range from 5 to 460 gallons per minute. The specific capacities of the wells in the vicinity of Magnolia are about 5 to 10 gallons per minute per foot of drawdown and the average drawdowns in the wells are estimated to be about 35 feet. With the static levels at an altitude of about 85 feet, in 1950, the pumping levels were about 50 feet above sea level.

The results of test drilling and the differences in yields of industrial wells where large yields are sought show that the Sparta sand differs considerably from place to place. Also pumping tests indicate appreciable differences in the coefficients of transmissibility and storage in the Sparta from place to place.

An estimate of the maximum sustained yield from the Sparta sand in Columbia County cannot be made because such factors as the differences in permeability and thickness of the sand beds, the size and nature of the outcrop area, and the capacity of the formation to transmit water from the intake area to places of pumping are not sufficiently well known.

When water is withdrawn from an aquifer the area of pumping influence expands gradually toward the boundaries of the aquifer. The lowering of water levels caused by pumping may be partially counteracted by an increase in the amount of water recharged into the aquifer at the outcrop area or by a decrease in the amount of water naturally discharged from the sand beds. Such conditions would tend to decrease the lowering of the water levels caused by pumping. If the increased recharge, plus the decreased natural discharge, equals the rate of pumping, the water levels cease to decline.

On the other hand the lowering of water levels may reach more or less impermeable boundaries of the aquifer. This would have an adverse effect by tending to accelerate the rate of decline of the water level.

It is not known if the cone of depression in the Sparta sand, caused by pumping in Columbia County, has reached the outcrop area. There is a suggestion that the rate of de-

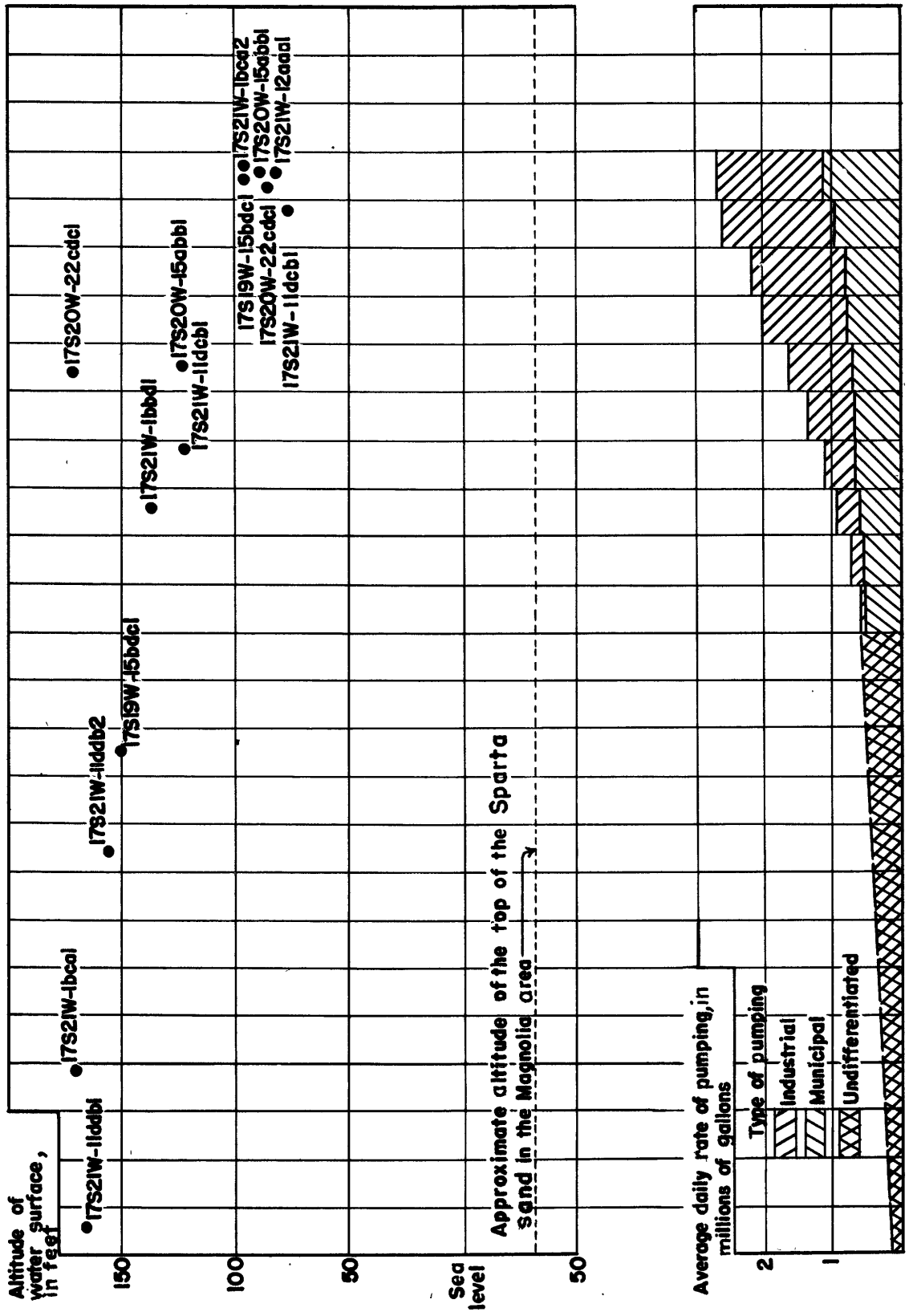

Figure 6. Altitudes of the static water surface in selected wells and the estimated daily rate of pumping from the Sparta sand in Columbia County, 1928-1950.

cline of the water level may be declining. However, the range in yields in wells and the results of test drilling show that the Sparta sand differs considerably from place to place and this, with the results of pumping tests, suggests that impermeable boundary conditions may exist in the formation in Columbia County.

Some details of the rate of pumping and the changes in water levels in the Sparta sand in the county give a rough indication of the relationship between present conditions and the optimum maximum rate of pumping. Ordinarily it is not desirable for the water level to be drawn below the top of an artesian aquifer as this dewaters the aquifer and reduces the saturated thickness. A reduction in saturated thickness of an aquifer tends towards a reduction in yields to wells in the area. In the vicinity of Magnolia the static water levels have declined from 165 feet above sea level, in 1928, to an altitude of about 85 feet, in 1950, and the pumping levels in the wells are estimated to be about 85 feet above the top of the water-bearing beds. Some additional decline in water levels is likely if the present rate of pumping is sustained, even if the rate is not increased. The decline of 80 feet in water level was caused by pumping at a rate that increased from less than 250,000 gallons per day, in 1928, to 2.7 million gallons per day, in 1950. Thus the static water level has declined about 30 feet for each multiple of one million gallons per day in pumping. This suggests that a daily withdrawal of 3 million gallons per day may be about the optimum maximum rate of pumping from the Sparta sand in the vicinity of Magnolia.

Cook Mountain formation.--The Cook Mountain formation ranges in thickness from a feather edge to about 280 feet in Columbia County. It crops out in a band across the northern part of the county and is overlain by the Cockfield formation and Quaternary deposits in the southern part of the county.

The Cook Mountain is composed of layers of gray to greenish shale, silt, and lignitic silty shale, with a few beds of fine- to coarse-grained sand. The sand beds generally occur in the lower and middle part of the formation and they rarely exceed 30 feet in thickness. The basal part of the formation consists largely of gray to brown micaceous silty shale which is sparsely glauconitic and contains a few fossils.

The contact between the Cook Mountain formation and the underlying Sparta sand is difficult to identify on electric well logs or drillers' logs of wells. The contact, where recognized, was placed at the base of the fossiliferous and glauconitic shale but forms the lower part of the Cook Mountain formation. The contact between the Cook Mountain and the overlying Cockfield formation has tentatively been placed at the top of oolitic "rock" which ranges from a few inches to several feet in thickness and has been recognized at several outcrop areas and in well samples in Columbia County and vicinity.

The Cook Mountain formation is relatively impermeable and where it overlies the Sparta sand it tends to prevent the movement of water from the surface or from other overlying permeable deposits into the Sparta sand. This prevents recharge from reaching the Sparta sand except at its outcrop area.

Several domestic wells yield water from the Cook Mountain formation in Columbia County, and information concerning five of the wells and 6 springs is given in table 3. Most of the domestic wells tap the thin sand beds in the lower and middle part of the formation. No industrial or municipal wells are known to tap the Cook Mountain in the county and there is no indication that the formation is a potential source of ground water for wells of large capacity.

Chemical analyses were made of 10 Cook Mountain samples collected from 6 springs and 4 wells. The analyses indicate that the water was variable in composition: it ranged from 30 to 238 parts per million in hardness and from 5.6 to 8.3 in pH value. Eight samples contained 0.12 to 0.91 parts of iron per million; the remaining two contained 3.7 and 11 parts per million.

Cockfield formation.--The Cockfield formation crops out in the southeastern third of Columbia County. It has a maximum thickness of about 100 feet in the southern part of the county. The Cockfield is composed of interbedded sand and clay with occasional thin beds of lignite. The sand beds in the formation usually are thin and lenticular; individual beds seldom exceed 20 feet in thickness. The sand is dominantly medium grained.

A large number of domestic wells tap this formation throughout the southern half of the county. The wells tap sand beds throughout the formation, usually the one nearest to the surface that will furnish sufficient water for the requirements. No industrial or municipal wells tap the Cockfield formation and it is doubted that any large supplies could be obtained from it.

Samples of water were collected from one spring and one well tapping the Cockfield (table 4). Except for the iron, the analyses of the water are comparable. The water is exceptionally soft and contains a moderate amount of dissolved mineral matter. The water is characterized by relatively high silica content.

Quaternary system

The sediments of the Quaternary system consist of flood plain and terrace deposits located largely in the western part of the county. Maximum thickness may be as much as 80 feet but the average thickness is considerably less. The deposits usually have coarse sand or gravel in the basal part, and in some places the bed of coarse material has an average thickness of 5 to 10 feet. The upper and generally the thicker part of the Quaternary deposits consists of varicolored silt and clay.

Quaternary deposits yield water to wells over most of eastern Arkansas. These deposits are the largest source of ground water in Arkansas. A few domestic wells tap Quaternary deposits in Columbia County and wells of large capacity might be developed; however, this cannot be proved on the basis of available information.

One sample of water was collected from the Quaternary deposits for this report. The water was hard and contained a moderate amount of dissolved solids.

LOGS OF WELLS, WITH TENTATIVE CORRELATIONS

Driller's log; test well (water)

Owner: Arkansas Fuel Co.
Location: Sec. 19, T. 15 S., R. 19 W.; in Oachita County, about 3/4 mile E. of Columbia County line.
Source: Layne Arkansas Co.

	Thickness (feet)	Depth (feet)
Eocene, Cook Mountain formation:		
Top soil	2	2
Red and yellow clay	14	16
Fine red sand	4	20
Blue sand	10	30
Blue sandy clay	9	39
Eocene, Sparta sand:		
Boulder	1	40
Fine muddy sand	8	48
Fine blue sand	22	70
Sandy shale	56	126
Medium sand	6	132
Shale	13	145
Fine sand and lignite	34	179
Fine muddy sand	13	192
Fine sand	22	214
Fine muddy sand	18	232
Fine sand	13	245
Eocene, Cane River formation:		
Shale	23	268
Boulder	1	269
Shale	2	271
Rock	2	273
Shale	2	275
Eocene, Cane River formation (continued):		
Boulder	1	276
Shale	7	283
Hard brown fine sand	24	307
Boulder	6	313
Hard shale and gumbo	36	349
Boulder	1	350
Shale	2	352
Boulder	2	354
Hard shale	35	389
Boulder	1	390
Shale	2	392
Boulder	2	394
Medium dark sand	12	406
Hard sandy shale	38	444
Fine muddy sand	15	459
Sandy shale	13	472
Sticky shale	11	483
Sandy shale	22	505
Muddy sand	14	519
Boulder	1	520
Eocene, Wilcox formation:		
Tough gumbo and shale	37	557

Sample log; test well (oil) McAlester Fuel Co. - J. G. Wepfer no. A1

Owner: McAlester Fuel Co.
Location: 100 ft. south of center, SW¼SE¼ sec. 2, T. 16 S., R. 20 W.
Altitude (feet above sea level): 235.
Source: Samples collected and logged by the U. S. Geological Survey.

	Thickness (feet)	Depth (feet)
No samples	151	151
Eocene (Claiborne group, Sparta sand):		
Shale, light gray, silty and lignitic	19	170
Silt, light gray; lignite	63	233
Sand, gray, fine, silty, micaceous	30	263
Sand, gray, fine, silty, very micaceous; lignite	61	324
Sand, brown to gray, fine, silty, micaceous, slightly lignitic	20	344
Sand, fine to coarse; lignite	20	364
Sand, coarse, poorly sorted, angular; lignite	10	374
Eocene (Claiborne group, Cane River formation):		
Shale, purplish-brown, silty, micaceous and slightly glauconitic	31	405
Shale, purplish-brown to gray, very silty and micaceous	30	435
Shale, similar to above, glauconitic and fossiliferous	10	445
Shale; chocolate-brown, very sandy and silty, very micaceous; trace of glauconite	31	476
Shale, brown to purple, very micaceous, silty and sandy	21	497
Shale, as above, with lignite in upper ten feet	51	548
Sandstone, hard, calcareous and glauconitic; shale, as above	10	558
Shale, brown, very sandy and silty	10	568
Shale and sandy shale, purplish-brown, very micaceous and silty	31	599

Sample log; test well (oil), McAlester Fuel Co. - J. G. Wepfer no. A1--Continued

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cane River formation)--Continued		
Shale, sandy, silty, dark-brown, micaceous and slightly glauconitic	20	619
Shale, purplish-brown, silty, very micaceous	11	630
Sand, brown, silty, very micaceous	10	640
Sand, brown, angular, well-sorted with chips of brown micaceous shale	10	650
Shale, brown, silty, very micaceous	20	670
Eocene (Wilcox formation):		
Shale, white to light brown, sandy; lignitic sand	20	690
Shale, white to light gray, silty; lignite	70	760
Shale, gray, silty; lignite; trace of calcareous sandstone between 801-811	61	821
Shale, medium gray, silty, sandy; lignite	51	872

Driller's log; water well 16S21W-16bdb1

Owner: Town of Waldo.
Location: NW¼ sec. 16, T. 16 S., R. 21 W.
Source: Arkansas Resources and Development Commission.

	Thickness (feet)	Depth (feet)
Eocene (Cook Mountain formation):		
Soil	1	1
Blue sandy clay	35	36
Boulder	1	37
Brown sticky shale	20	57
Sandy shale	30	87
Hard shale	10	97
Eocene (Sparta sand):		
Sandy shale	33	130
Loose sand	3	133
Sandy shale	36	169
Hard shale	9	178
Rock	1	179
Hard shale	18	197
Fine muddy sand	16	213
Hard shale	37	250
Very fine sand	29	279
Hard shale	21	300
Fine dirty sand	15	315
Hard shale	31	346
Very fine salt and pepper sand	18	364
Hard shale	66	430
Rock	1	431
Eocene (Cane River formation) Continued		
Hard shale	70	501
Sandy shale	31	532
Hard brown sand	34	566
Sandy shale	17	583
Brown dirty sand	20	603
Sandy shale	43	646
Brown dirty sand	25	671
Hard shale	3	674
Hard soapstone	13	687
Rock	1	688
Sandy shale	66	754
Rock	1	755
Sandy shale	4	759
Boulder	1	760
Sandy shale	30	790
Eocene (Wilcox formation):		
Hard shale	12	802
Sandy shale	78	880
Hard soapstone	7	887
Sandy shale	3	890
Rock	2	892
Sandy shale	4	896
Hard soapstone	4	900

Driller's log; water well 17S20W-22cdc1

Owner: Carter Oil Co.
Location: SW¼ sec. 22, T. 17 S., R. 20 W.
Altitude (feet above sea level): 294.
Source: Layne Arkansas Co.

	Thickness (feet)	Depth (feet)
Quaternary:		
Top soil	4	4
Eocene (Cook Mountain formation):		
Clay	49	53
Fine sand	5	58
Shale and boulder	5	63
Eocene (Cook Mountain formation):-- Continued		
Sandy shale	37	100
Shale and boulder	53	153
Sandy shale	135	288

Driller's log; water well 17S20W-22cdc1--Continued

	Thickness (feet)	Depth (feet)
Eocene (Sparta sand):		
Sand	12	300
Sandy shale	55	355
Eocene (Sparta sand):--Continued		
Sand with streaks of shale	65	420
Sand	50	470

Driller's log; water well 17S20W-23bab2

Owner: Shell Oil Co.
Location: NW¼ sec. 23, T. 17 S., R. 20 W.
Source: Shell Oil Co.

	Thickness (feet)	Depth (feet)
Eocene (Cockfield formation):		
Surface	24	24
Sand	9	33
Eocene (Cook Mountain formation):		
Clay	70	103
Sand	14	117
Shale and boulder	76	193
Sand	21	214
Shale	120	334
Eocene (Sparta sand):		
Sand	12	346
Shale	33	379
Sand	62	441
Shale	77	518
Sand	50	568
Eocene (Cane River formation):		
Shale and boulder	20	588

Driller's log; water well 17S21W-1bca1

Owner: Magnolia A & M. College
Location: NW¼ sec. 1, T. 17 S., R. 21 W.
Altitude (feet above sea level): 348.
Source: Arkansas Resources and Development Commission.

	Thickness (feet)	Depth (feet)
Eocene (Cockfield formation):		
Sandy clay	50	50
Eocene (Cook Mountain formation):		
Sandy shale	115	165
Pack sand	10	175
Sandy shale	9	184
Boulder	6	190
Gumbo	35	225
Sandy shale	11	236
Rock	1	237
Sandy shale	20	257
Rock	4	261
Gumbo	3	264
Rock	1	265
Gumbo	10	275
Eocene (Cook Mountain formation):		
Rock	1	276
Eocene (Sparta sand):		
Shale and gumbo	27	303
Rock	1	304
Sandy gumbo	21	325
Muddy sand	15	340
Fresh water (black) sand	18	358
Gumbo	13	371
Muddy sand	14	385
Sandy shale	20	405
Fresh water sand (fine sand)	49	454

Driller's log; Magnolia test well (water) no. 1

Owner: Town of Magnolia.
Location: Sec. 11, T. 17 S., R. 21 W.
Altitude (feet above sea level): 310
Source: Magnolia Municipal Water System.

	Thickness (feet)	Depth (feet)
Eocene (Cockfield formation):		
Surface clay	20	20
Sandy shale	70	90
Eocene (Cook Mountain formation):		
Shale	67	157
Rock	1	158
Hard shale	58	216
Rock	1	217
Shale	11	228
Rock	1	229
Shale	4	233
Rock	1	234
Shale	8	242
Eocene (Sparta sand):		
Sandy shale	8	250
Fine sandy shale	30	280
Hard sandy shale	25	305
Sandy shale	45	350
Fine sandy shale	15	365
Sandy shale	25	390
Good sandy	80	470
Lignite	5	475
Shale and lignite	8	483
Sand	7	490
Hard shale	36	526
Eocene (Cane River formation)		
Hard rock	3	529
Hard shale	6	535
Hard rock	1	536
Glauconite and lignite	2	538
Rock	1	539
Sand and glauconite	6	545
Sandy glauconite	15	560
Sandy shale	40	600
Shale and shell	14	614
Rock	1	615
Shale	5	620
Rock	1	621
Shale	2	623
Rock	1	624
Shale	8	632
Rock	1	633
Shale and boulder	27	660
Rock	1	661
Glauconite and shale	14	675
Rock	1	676
Sandy shale	19	695
Shale and lignite	20	715
Glauconite and shale	93	808

Sample log; Magnolia test well no. 1-(continued)

Owner: Town of Magnolia.
Source: Samples collected and logged by the U. S. Geological Survey with permission of the Holliday Well Co.

	Thickness (feet)	Depth (feet)
No samples	200	200
Eocene (Claiborne group, Cook Mountain formation):		
Shale, gray to brown, silty, micaceous, glauconitic; glauconitic "ironstone," sand, medium to fine, angular to rounded	55	255
Eocene (Claiborne group, Sparta formation):		
Shale, brown to gray, silty, lignitic, micaceous; sand, white, medium to fine, angular to subangular, lignite	55	310
Sand, brownish, medium, subangular; trace of gray and brown silty lignitic shale	80	390
Sand, white, medium, subangular, micaceous; lot of dark mineral grains	80	470
Sand, white, medium to fine, sub-angular; shale, gray, silty, lignitic, micaceous; lignite, pyrite	35	505
Eocene (Claiborne group, Cane River formation):		
Shale, dark gray to dark brown, silty, lignitic, and micaceous. Sand medium to fine. Sand beds vary from a few inches up to 5 feet in thickness. Glauconitic and fossiliferous. "Ironstone".	165	670

Sample log; water well 17S21W-12aaal.

Owner: Town of Magnolia.
Location: NE¼ sec. 12, T. 17 S., R. 21 W.
Altitude (feet above sea level): 354.
Source: Samples collected and logged by the U. S. Geological Survey with permission of the Holliday Well Co.

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cockfield formation):		
Clay, varicolored	18	18
Sand, yellow to orange, medium to fine, angular, micaceous	12	30
Shale, gray to brown, lignitic, silty, micaceous	12	42
Shale, gray, lignitic, silty, micaceous	6	48
Eocene (Claiborne group, Cook Mountain formation):		
"Rock," greenish-brown oolites in greenish brown matrix; phosphatic	2	50
Shale, brown, lignitic	5	55
Lignite	1	56
Shale, brown, lignitic	24	80
Sand, brown to bluish, micaceous, medium to fine	5	85
Shale, greenish to brown; lignitic; sand, white, medium to fine	10	95
Sand, bluish, fine, micaceous, grading downward into greenish fine sand	13	108
Shale, greenish to brown, sandy	47	155
Sand, blue, fine, micaceous; shale, gray, sandy	9	164
Sand, white, medium to fine, angular; shale, gray, silty; trace glauconite	19	183
Shale, grayish, silty, micaceous; sand, medium to fine; trace glauconite	94	277
Eocene (Claiborne group, Sparta sand):		
Shale, gray, lignitic, micaceous; sand, white, medium to fine	33	310
Sand, white, medium, angular; grading downward into poorly sorted coarse to medium sand. Gray, lignitic shale between 340-346	122	432
Lignite	3	435
Shale, gray, silty; sand, medium to fine	27	462

Sample log; Magnolia test well (water) no. 2

Owner: Town of Magnolia.
Location: Sec. 14, T. 17 S., R. 21 W.
Source: Samples collected and logged by the U. S. Geological Survey with permission of the Holliday Well Co.

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cockfield formation):		
Sand, yellow, medium to fine, angular, micaceous	10	10
Shale, gray to brown, lignitic, micaceous, silty	15	25
Eocene (Claiborne group, Cook Mountain formation):		
"Rock," greenish brown oolites in greenish brown matrix; phosphatic	2	27
Shale, green and brown, silty, lignitic; sand, coarse to fine, angular	18	45
Shale, greenish to brown, lignitic, silty, micaceous; sand, medium to fine, angular	100	145
Sand, white, medium to fine, angular; shale, gray, lignitic, micaceous, silty, glauconitic	26	171
Sand, fine, angular; lignite and pyrite	9	180
Shale, greenish to brown, silty, micaceous, glauconitic; trace of "ironstone"	70	250
Eocene (Claiborne group, Sparta sand):		
Shale, gray and brown, lignitic, silty, micaceous; sand, fine to medium, angular; lignite	106	356
Sand, medium to fine, micaceous; shale, gray to brown, silty, lignitic	78	434
Sand, medium to fine, angular; lignite	76	510
Eocene (Claiborne group, Cane River formation):		
Shale, dark gray to dark brown, micaceous, lignitic and silty. Sand, medium to fine. Sand beds vary from a few inches up to about 12 feet in thickness. Glauconitic and fossiliferous. "Ironstone"	206	716

Driller's log; water well 18S19W-17bdd2

Owner: Hiwan Oil & Gas Co.
Location: NW¼ sec. 17, T. 18 S., R. 19 W.
Source: L. B. Smith.

	Thickness (feet)	Depth (feet)
Eocene (Cockfield formation):		
Clay	12	12
Clay and gumbo	49	61
Sand	6	67
Eocene (Cook Mountain formation):		
Rock	1	68
Clay	29	97
Shale	16	113
Rock	1	114
Eocene (Cook Mountain formation):--Continued		
Shale	68	182
Sand	18	200
Shale	38	238
Sand	41	279
Hard sand	4	283
Sand	20	303
Shale	21	324

Driller's log; water well 18S21W-19bacl

Owner: Magnolia High School.
Location: SE¼ sec. 19, T. 18 S., R. 21 W.
Source: L. B. Smith.

	Thickness (feet)	Depth (feet)
Eocene (Cockfield formation):		
Sand and clay	37	37
Clay	10	47
Sand	10	57
Eocene (Cook Mountain formation):		
Shale	56	113
Rock	1	114
Shale	65	179
Shale	30	209
Rock	1	210
Sand and shale	7	217
Rock and gumbo	85	302
Eocene (Cook Mountain formation):--continued		
Gumbo	12	314
Eocene (Sparta sand):		
Sand, shale and gumbo	45	359
Sand and shale	48	407
Sand	18	425
Shale	10	435
Sand	26	461
Shale	8	469
Sand	25	494
"Gumbo"	9	503
Shale	10	513

Sample log; oil well C. H. Murphy - Gregory no. 1

Owner: C. H. Murphy Oil Co.
Location: Cen. of SE¼ SW¼, sec. 28, T. 19 S., R. 18 W., in Union County, near Columbia County line.
Altitude (feet above sea level): 209.
Source: Samples collected and logged by the U. S. Geological Survey with permission of the C. H. Murphy Oil Co.

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cockfield formation):		
Sand, buff, medium to fine, angular to subangular, clear, frosted; trace of lignite	65	65
Eocene (Claiborne group, Cook Mountain formation):		
Shale, brown, silty, lignitic; trace of glauconite and glauconitic "ironstone"	25	90

Sample log; oil well C. H. Murphy - Gregory no. 1--continued

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cook Mountain formation):--Continued		
Shale, gray to medium brown, silty, lignitic, micaceous; "ironstone" and glauconitic "ironstone"	110	200
Shale, sandy, gray, calcareous; fossil fragments	60	260
Shale, brown to gray, sandy, silty, micaceous, lignitic	20	280
Shale, dark-brown to gray, micaceous, sandy, silty, fossil fragments	30	310
Sand, gray to brown, medium to fine, micaceous, fossiliferous	50	360
Shale, light to dark gray, sandy	20	380
Eocene (Claiborne group, Sparta sand):		
Sandy silt, gray to brown, lignitic, very micaceous	50	430
Sand, fine, dark brown; brown lignitic shale, micaceous shale	10	440
Sand, fine light brown, brown lignitic shale; lignite	20	460
Shale, sandy and silty, gray to brown, lignitic, micaceous; lignite	40	500
Sand, gray, fine, angular to subangular	10	510
Sand, gray midium, angular to subangular	70	580
Shale, gray, silty; lignite	20	600
Sand, medium to fine, subangular to subrounded	30	630
Sand, silty, fine; gray-brown lignitic shales, lignite	40	670
Shale, gray, silty; lignite	20	690
Shale, silty, gray to brown, micaceous	20	710
Shale, dark brown, micaceous; trace of glauconite at 740-750	40	750
Silt, sandy, gray; lignite	10	760
Shale, brown, silty and sandy; trace of glauconite	20	780
Eocene (Claiborne group, Cane River formation):		
Shale, brown, sandy and silty	40	820
Shale, brown, hard; trace of glauconite	10	830
Shale, brown, silty, fossiliferous, glauconitic, calcareous	60	890
Shale, dark brown to black	30	920
Shale, gray, silty and sandy, glauconitic and fossiliferous	20	940
Shale, gray, very silty and sandy	10	950
Shale, gray, silty, glauconitic and fossiliferous; "ironstone"	10	960
Shale, gray to black, very silty and sandy, glauconitic and fossiliferous	20	980
Shale, gray to black, very silty and sandy	40	1,020
Shale, gray, micaceous, silty; fine sand	20	1,040
Shale, gray, silty, sandy, very fossiliferous	20	1,060
Shale, gray, silty; fragments of "ironstone"	30	1,090
Shale, gray, sandy and silty	20	1,110
Sand, gray, medium to fine, clear and frosted, micaceous	5	1,115
Sand, gray, coarse to fine, subangular to rounded, clear and frosted	15	1,130
Eocene (Wilcox formation):		
Shale, gray to brown, silty, sandy, micaceous; lignite	15	1,145

Sample log; water well 19S20W-8daa2

Owner: Town of Emerson.
Location: SE¼ sec. 8, T. 19 S., R. 20 W.
Altitude (feet above sea level): 320.
Source: Samples collected and logged by the U. S. Geological Survey with the permission of C. R. Carnahan.

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cockfield formation):		
No samples	10	10
Sand, medium to coarse, angular; clay, gray to brown, lignitic	15	25
No samples	35	60
Lignite	2	62
No samples	28	90
Eocene (Claiborne group, Cook Mountain formation):		
No samples	40	130
Silt, gray to brown, lignitic, micaceous; lignite	40	170
Sand, coarse, angular, many very dark mineral grains	5	175

Sample log; water well 19S20W-8dsa2--Continued

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cook Mountain formation):--Continued.		
Silt, gray, micaceous, lignitic	3	178
Silt, gray to brown, lignitic, micaceous; sand, medium to coarse, angular	32	210
Glauconitic, "ironstone"	1	211
Shale, greenish to brownish, sandy, glauconitic, micaceous	19	230
Glauconitic "ironstone"	1	231
Shale, medium to dark brown, sandy, micaceous, glauconitic	22	253
Glauconitic "ironstone"	1	254
Shale, medium to dark brown, sandy and silty, micaceous, glauconitic	53	307
Shale, dark brown, sandy, micaceous, glauconitic	38	345
Eocene (Claiborne group, Sparta sand):		
Shale, gray to brown, silty, lignitic, micaceous; lignite	53	398
Sand, white, fine grading to coarse at the base, angular; many mineral grains	40	438
Shale, gray to light brown, silty, lignitic, micaceous; sand, white, medium to coarse, angular	13	451

Sample log; test well (oil) McAlester Fuel Co. - W. A. Rushton no. A1

Owner: McAlester Fuel Company.
Location: 1,958.7 feet from W/L - 1,947.3 feet from S/L sec. 14, T. 19 S., R. 20 W.
Altitude (feet above sea level): 355.
Source: Samples collected and logged by the U. S. Geological Survey with permission of the McAlester Fuel Co.

	Thickness (feet)	Depth (feet)
Eocene (Claiborne group, Cockfield, Cook Mountain, and Sparta formations):		
No samples	650	650
Eocene (Claiborne group, Sparta sand):		
Shale, light to dark gray, silty, lignitic; sand, white, medium to coarse, angular; lignite	50	700
Shale, dark brown, lignitic, silty; lignite	10	710
Shale, light gray brown, silty, lignitic, micaceous; sand, medium to fine, angular	40	750
Sand, very coarse to fine, angular to rounded; shale, same as above; lignite between 780-790'	50	800
Eocene (Claiborne group, Cane River formation):		
Shale, dark gray brown, silty, micaceous; lignitic, glauconitic. Very glauconitic and abundant "ironstone" between 830-870'; fossiliferous-	70	870
Shale, light gray brown, silty, micaceous, trace of "ironstone" and glauconite; fossiliferous	10	880
Shale, light to dark brown, silty, micaceous; "ironstone", glauconitic and fossiliferous	60	940
Shale, dark brown and light gray, silty, micaceous; sand, medium, angular; glauconite and fossils	20	960
Shale, light gray, silty, micaceous; glauconitic	10	970
Shale, various shades of brown, silty, micaceous; "ironstone", glauconite and fossils; sand, medium, angular, between 980-990'; 1020-1050	80	1,050
Shale, gray brown to dark brown; lignitic, silty, micaceous; glauconite and fossils; "ironstone"	40	1,090
Shale, very dark brown, lignitic, micaceous, glauconitic and fossiliferous; sand, medium, angular	60	1,150
Eocene (Wilcox formation):		
Lignite; shale, light gray and dark brown, lignitic, silty	10	1,160
Shale, medium to dark brown, lignitic, silty; white shale; pyrite	10	1,170
Lignite, shale as above	10	1,180
Shale, medium to dark brown, lignitic, micaceous, pyrite, abundant calcareous sandstone	40	1,220
Lignite, shale as above	10	1,230

Sample log; test well (oil) McAlester Fuel Co. - W. A. Rushton no. A1--Continued

	Thickness (feet)	Depth (feet)
Eocene (Wilcox formation)--Continued		
Shale, medium to dark brown, silty, lignitic; calcareous sandstone	30	1,260
Lignite, shale as above	10	1,270
Shale, medium to dark gray brown, silty, lignitic; trace of calcareous sandstone and "ironstone"	50	1,320
Lignite, shale as above	10	1,330
Shale, medium to dark gray brown, silty, lignitic; abundant calcareous sandstone between 1340-1350 and 1390-1410	80	1,410
Lignite, shale as above	10	1,420
Shale, medium to dark gray brown, silty, lignitic; calcareous sandstone	20	1,440
Lignite; shale as above	10	1,450
Shale, light to medium gray brown, silty, lignitic; abundant calcareous sandstone between 1490-1520	90	1,540
Shale, dark brown, very silty, lignitic. Brown, fine, silty sand	10	1,550
Paleocene (Midway formation):		
Shale, bluish, silty, micaceous	100	1,650

Driller's log; water well 19S23W-11cad1

Owner: D. C. Hughes.
Location: SW¼ sec. 11, T. 19 S., R. 23 W.
Altitude (feet above sea level): 250.
Source: C. Hamlin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Quaternary:			Eocene (Cook Mountain formation):		
Red "gumbo"	25	25	Fine sand	40	110
Blue "gumbo"	45	70			

Driller's log; water well 19S23W-13ccb1

Owner: W. R. Stuart.
Location SW¼ sec. 13, T. 19 S., R. 23 W.
Altitude (feet above sea level): 250.
Source: C. Hamlin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Quaternary:			Quaternary--Continued		
White clay	19	19	Blue clay	14	50
Coarse water sand	3	22	Coarse blue sand	10	60
White clay	14	36			

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