George County
Geology and Mineral Resources

CHARLES H. WILLIAMS, JR.

THEO H. DINKINS, JR.

THOMAS E. McCUTCHEON

BULLETIN 108

MISSISSIPPI GEOLOGICAL, ECONOMIC AND
TOPOGRAPHICAL SURVEY

WILLIAM HALSELL MOORE
DIRECTOR AND STATE GEOLOGIST

JACKSON, MISSISSIPPI
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LETTER OF TRANSMITTAL

Office of the Mississippi Geological, Economic and
Topographical Survey
Jackson, Mississippi

November 15, 1967

Mr. Henry N. Toler, Chairman, and
Members of the Board
Mississippi Geological, Economic and Topographical Survey

Gentlemen:

It is with pleasure that I transmit to you Bulletin 108 of the Mississippi Geological Survey, "George County Geology and Mineral Resources," by Charles H. Williams, Jr., and others.

This Bulletin was made possible by the cooperation of the George County Board of Supervisors. The Bulletin contains much data that will be of use in the development of the County's mineral resources. The excellent color map and cross sections clearly demonstrate the geological conditions at the surface and near surface in George County and should aid in understanding the relations between mineral resources and geology.

Respectfully submitted,

William H. Moore
Director and State Geologist

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GEORGE COUNTY GEOLOGY

CHARLES H. WILLIAMS, JR.

ABSTRACT

George County is located in the southeastern part of the State. Land area of the County measures 481 square miles, or 307,840 acres.

Geological units exposed at the surface are part of the Miocene series of the Tertiary system and part of the Pleistocene and Recent series of the Quaternary system. The units in ascending order are the Pascagoula formation of the Miocene series, Citronelle formation, High Terraces and Low Terrace deposits of the Pleistocene series and alluvium belonging to the Recent series. Each unit has characteristic surface features and stratigraphy.

The major structural feature in George County is the east-west trending Wiggins anticline, a relatively young feature. Another anticlinal structure is located in eastern George County. Evidence of these features is noted in drainage patterns and structural nosing on the surface map.

George County has substantial supplies of good quality ground water in aquifers within the Catahoula, Pascagoula, Hattiesburg, and Citronelle formations, and in the Alluvium and Low Terrace deposits. Surface water supplies are available from the Pascagoula and Escatawpa Rivers, and Red and Black Creeks.

Surface rocks and minerals of possible economic importance include clays and natural clay mixtures and sand and gravel. Oil, gas, and sulphur may be considered as potential resources in George County.

INTRODUCTION

This report is the culmination of a geological investigation of George County, Mississippi. Primary purpose of the investigation is to interpret the geology of the County and to appraise the known and potential resources therein. Studies of this kind involve geologic mapping to provide a foundation from which industry can extend its search for usable raw materials. The report includes chapters on surface and subsurface geology, surface-water and ground-water supplies, possible economic potential of minerals within the County, and test results of these minerals.

The first phase of the geological study consisted of a thorough review of all published and unpublished material pertinent to George County. Purpose of the review was to gain a background of regional structure and variations in geologic and topographic characteristics. This was followed by a study of stereo-paired aerial photographs, aerial mosaics, and topographic maps from which stream patterns, land forms, dip slopes, outcrops, and formation contacts were noted. Added to this were field observations of contacts and measured elevations of the contacts. Well data, core-hole data, and geophysical data were combined with the above to result in a geological interpretation of the County.

Field work began in April 1966 and the last test hole was drilled May 10, 1967. The field work consisted of a study of character, distribution, and thickness of geological units exposed at the surface. Surface samples were collected for microscopic examination. Special attention was directed toward a search for materials of possible economic importance. A total of 57 holes were cored or drilled by the Survey's Failing "1500" rig to obtain stratigraphic and structural data and to obtain subsurface samples for laboratory tests. In addition to the Survey holes, information was gathered from oil tests, water wells, oil company core holes, and holes drilled by the Water Resources Division of the United States Geological Survey.

PREVIOUS INVESTIGATIONS

The earliest geological surveying expedition in Mississippi and probably on the North American continent was in December 1699. [1] Leseur, a French geologist, was sent by that Government to examine a greenish ochre which had been noticed on the banks of the Mississippi. He brought several thousands of tons of this material to *Baluxi* from whence it was shipped to France. No further information is known. Since this first geological survey, Mississippi has been studied and mapped by many notable geologists. Although no comprehensive reports of George County have been made, certain geological aspects have been the subject of previous investigations.

Early geological reports by Wailes [2] in 1854 and Harper [3] in 1857 made mention of the orange sand and gravel deposits covering the southern part of Mississippi. These men probably traversed the area that is now George County.

Hilgard [4] in his classic report on the geology and agriculture of the State of Mississippi in 1860 wrote of the sands and gravels in southern Mississippi. He also noted the gray clays in hills near "Judge Fairley's Ferry, not far from Cross Roads P.O." [5] Hilgard assigned the clay to the Tertiary Grand Gulf formation.

Several geologists came to study the fauna associated with the clays exposed along the banks of the Pascagoula, Leaf, and Chickasawhay Rivers. Johnson [6] in 1889 suggested the name Pascagoula formation for the fossiliferous clay beds found in the area which became George County.

A report by Logan [7] on structural materials of Mississippi published in 1911 mentioned the Lucedale sands exposed in railroad cuts near the town of Lucedale. This sand was used in construction of the County Court House. Lowe [8] in 1919 mentioned a "ridge" through eastern George County. He further mentioned that "an unusual amount of variation in the magnetic declination" was present in this area. He suggested that this region of Mississippi is worthy of careful investigation by oil geologists.

In 1928, Stephenson, Logan and Waring [9] with the United States Geological Survey published a report on the ground-water resources of Mississippi. Included in this report was a summation of ground-water conditions and supplies in George County.

Undoubtedly, many private geological investigations directed toward the search for minerals have been made in George County. One such report to which the writer had access was by Henry N. Toler. [10] This report gave a good description of stratigraphy and surface structure of the County.

Brown, et al. [11] published a report in 1944 on the geology and ground-water resources of the coastal area. This report included George County and the writer found it useful in the current investigation.

In 1964 the United States Geological Survey published a report [12] on the water resources of the Pascagoula area, Mississippi. George County was included in this work and some of the information on water in the present report is drawn from this source.

DESCRIPTION OF THE AREA

LOCATION AND SIZE

George County is located in the southeastern part of the State (fig. 1). The 31°00′ latitude line serves as the northern

Figure 1.—Location of George County.

boundary of the County; the southern boundary is near the 30°44′ latitude line. The eastern boundary follows the 88°25′ longitude line and the extreme western boundary parallels the 88°53′ longitude line. The County is essentially a rectangle with a three mile by six mile indentation at the northwestern corner.

George County was formed from parts of Greene and Jackson Counties in 1910 and these Counties now bound George to the north and south. The east bounding county is Mobile, Alabama. Stone and Perry Counties are adjacent to George on the west. Land area of George County measures 481 square miles, or 307,840 acres. Maximum north-south extent of the County is just over 18 miles and maximum east-west extent is just over 28 miles. The County is comprised of Townships 1 South through 3 South and Ranges 5 West through half of 9 West. Each Township was intended to be 6 miles square and comprised of 36 sections, each 1 mile square and containing 640 acres. Townships and sections in George County meet these requirements with the exception of those sections near the Pascagoula River.

POPULATION

The 1960 census lists a population of 11,098 for George County. This is an increase over the 1950 census of 10.8 percent and is slightly less than double the 5,560 listed in 1920. Population density is 23 per square mile. Of the total population, 11.6 percent are listed as non-white. The census showed 27.4 percent residing on rural farms (defined as 10 acres or more and selling products which amounted to $50.00 or more in 1959). Lucedale, the County seat, is the only incorporated town in George County. The 1960 census shows a population of 1,977 for Lucedale. Communities shown on the general highway map are Agricola, Basin, Benndale, Bexley, Evanston, Latonia, Mauvella (Movella), Merrill, and Shipman. Other communities and small villages shown on the official County map are Donovan, Luce Farms, and Rubel. Avent, Rocky Creek, and Crossroads are noted on topographic maps.

CLIMATE

George County has a humid and semitropical climate. Climatological data for George County for a ten-year period January 1956 to January 1966 is shown on Table 1. The data was compiled from United States Weather Bureau reports. Measurements were made at the recording station at Merrill. The mean annual temperature is 65.35 degrees and seasonal ranges are from 47.7 degrees in the winter to 80.1 degrees in the summer. Figure 2 shows that George County had an average annual rainfall of 64 inches for the 25 year period 1931 through 1955. Average annual rainfall in the County since 1955 has closely followed this pattern. Annual rainfall is fairly well distributed seasonly with the greatest amount falling in the summer months. Snow is extremely rare, but a total of 13 inches was recorded during December 1963.

TABLE 1

Normal, Monthly, Seasonal, and Annual Temperature and Precipitation at Merrill, George County, Mississippi*

Month	Temperature			Precipitation		
	Average	Absolute maximum	Absolute minimum	Average	Absolute maximum	Absolute minimum
	F°	F°	F°	Inches	Inches	Inches
December	49.1	82	6	5.43	13.38	3.03
January	42.1	84	6	4.78	8.42	1.73
February	51.7	87	16	5.48	16.60	1.89
Winter	47.7	87	6	5.23	16.60	1.73
March	56.6	90	25	6.98	15.50	2.52
April	66.5	95	31	4.42	9.15	.66
May	73.7	99	39	4.76	9.01	.81
Spring	65.6	99	25	5.38	15.50	.66
June	79.8	108	43	6.46	17.43	2.14
July	81.3	102	61	7.25	12.82	4.14
August	80.7	100	54	5.68	10.61	2.56
Summer	80.1	108	43	6.46	17.43	2.14
September	76.5	100	45	7.35	17.37	.76
October	65.9	96	26	3.42	7.31	.02
November	57.2	88	18	3.55	9.48	1.05
Fall	66.5	100	45	4.77	17.37	.02
Year	65.35	108	6	65.19	------	------

* Average temperature and precipitation based on a 10 year record; compiled from available recordings in U. S. Department of Commerce, Weather Bureau, "Climatological Data," January 1956 through January 1966.

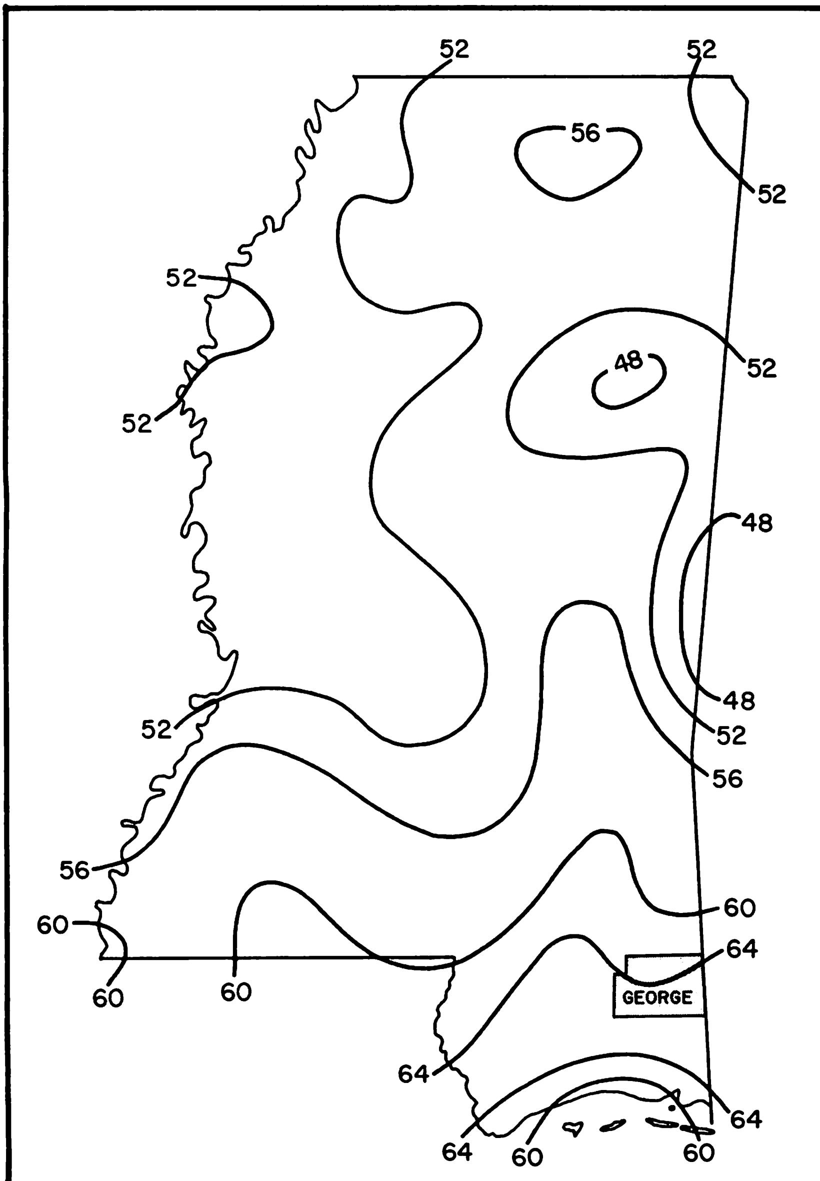


Figure 2.—Mean annual precipitation, in inches. Extracted from U. S. Weather Bureau, 1959, "Climates of the States." Based on 25 year period 1931-55.

CULTURE AND INDUSTRY

The 1960 census lists a total labor force of 3,384 for George County. Median age is 23.3 years.

George County is mainly an agricultural area. Principal sources of farm income are livestock, tung, pecan and fruit orchards, and row crops. The 1960 census shows that 30.4 percent of all land in the County is in farms.

The Mississippi Manufacturers Guide, 1965 edition, lists fifteen manufacturing establishments in George County. Fourteen are at Lucedale and one is at Benndale. The majority of the establishments are engaged in manufacture of lumber and wood products. Four establishments manufacture food and kindred products. One establishment is listed for each of the following manufacturing categories: printing and publishing, furniture and finishing, apparel products. Specific manufactured products are shuttle blocks, logs and poles, plugs for paper rolls, pine lumber, rough and finished lumber, veneer, soft drinks, livestock feed, mixed feed, fluid milk and related products, job printing and newspaper, cedar chests, beds and tables, sport shirts.

ACCESSIBILITY

A good system of Federal, State, and County highways and roads makes most of George County readily accessible. A total of 522.6 miles of roads comprise the system with 172.4 miles paved. U. S. 98 extends diagonally through the northern half of the County and passes through Lucedale. This highway is a bituminous paved surface and connects Lucedale with Mobile, Alabama, approximately 35 miles to the southeast, and Hattiesburg, Mississippi, approximately 60 miles to the northwest.

State Highway 63 is a bituminous paved surface crossing the eastern half of the County. It connects Lucedale with Pascagoula, Mississippi, approximately 40 miles to the south and extends northward to Waynesboro, Mississippi. State Highway 613 is an east parallel to State Highway 63 and connects Lucedale to Moss Point, Mississippi. Highway 57 crosses the western half of George County in a north-south direction. It passes through Benndale and extends southward to U. S. Highway 90 along the coast and northward to U. S. Highway 98. State Highway 26 connects Lucedale to Wiggins, Mississippi, approximately 36 miles to the west. Highways 613, 57 and 26 are bituminous paved surfaces.

The County maintains some 413.33 miles of roads with 73.27 miles paved. Remainder of the roads are gravel or sand surfaced and generally well graded and drained. This insures good farm-to-market access in most parts of the County. Portions of the County cannot readily be reached due to lack of bridges across major drainages.

Two rail lines traverse George County. The Gulf, Mobile and Ohio line essentially parallels U. S. Highway 98 and connects Lucedale with Mobile, Alabama, to the southeast and Laurel, Mississippi, to the northwest. The Mississippi Export Railroad line extends from Pascagoula, Mississippi to Evanston, two miles southeast of Lucedale, where it junctions with the Gulf, Mobile and Ohio line.

GEOMORPHOLOGY

DRAINAGE

George County lies within the Pascagoula River Drainage Basin, the second largest river basin in the State (fig. 3). The two largest streams in the County are the Pascagoula River and the Escatawpa River.

The Chickasawhay and Leaf Rivers join at the northern edge of George County to form the Pascagoula River which crosses George County from north to south, separating the western third of the County from the eastern two-thirds. The Pascagoula River has extensive bottom lands. The principal western tributaries within the County boundaries are Whiskey, Black, and Red Creeks. The main eastern tributary is Big Creek.

The Escatawpa River flows diagonally through the southeastern part of George County. Brushy Creek and Rocky Creek are the principal tributaries of the Escatawpa River, both entering from the west.

PHYSIOGRAPHY

Mississippi lies within the Gulf Coastal province of North America. The State is further divided into 12 distinct physiographic units (fig. 4). George County lies wholly within the Piney Woods physiographic province as defined by Priddy.[13]

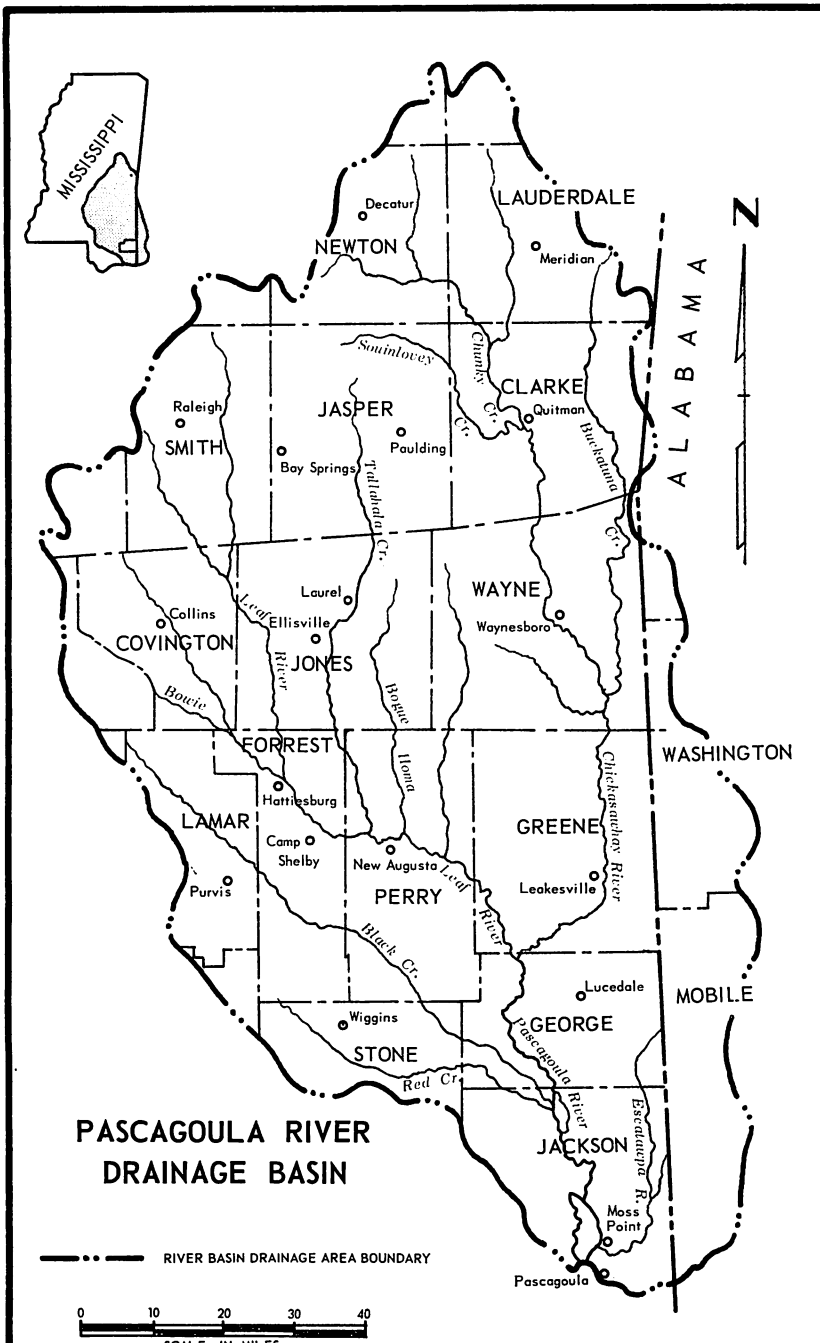


Figure 3.—Map showing major drainages and limits of the Pascagoula River drainage basin.

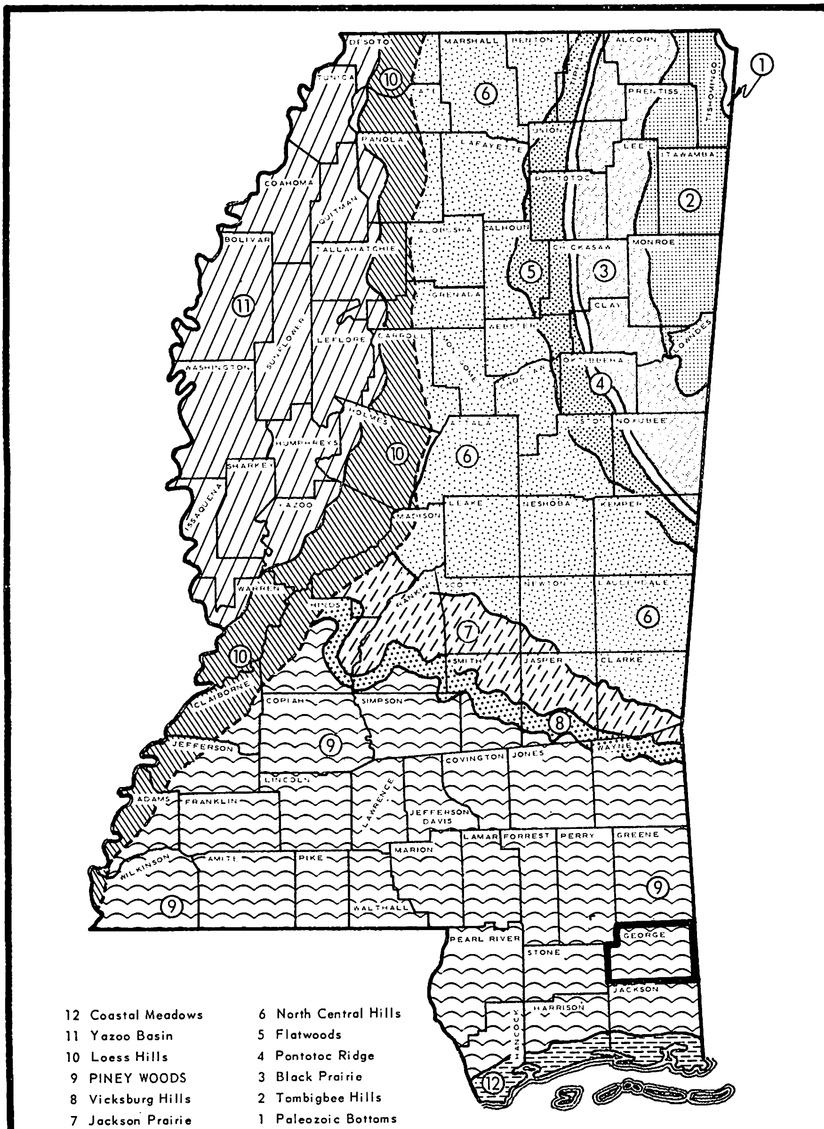


Figure 4.—Map showing physiographic provinces of Mississippi. After R. R. Priddy.

This province was previously designated Long-Leaf Pine Hills by Lowe in 1915[14] because the area was covered by long-leaf pine forests. In George County long-leaf pine was predominantly in the uplands and mixed with short-leaf pine and slash pine on the lower terraces. Most of the pine area was deforested in the early nineteen hundreds. The Piney Woods province is bordered on the north by the Vicksburg Hills and on the south by the Coastal Meadows province.

GENERAL TOPOGRAPHY

Surface mapping in George County was aided immeasurably by complete topographic map coverage. Topographic maps utilized in the County survey include the Benndale, Lucedale, Wilmer, Vestry, Vancleave, and Hurley quadrangles. The quad-

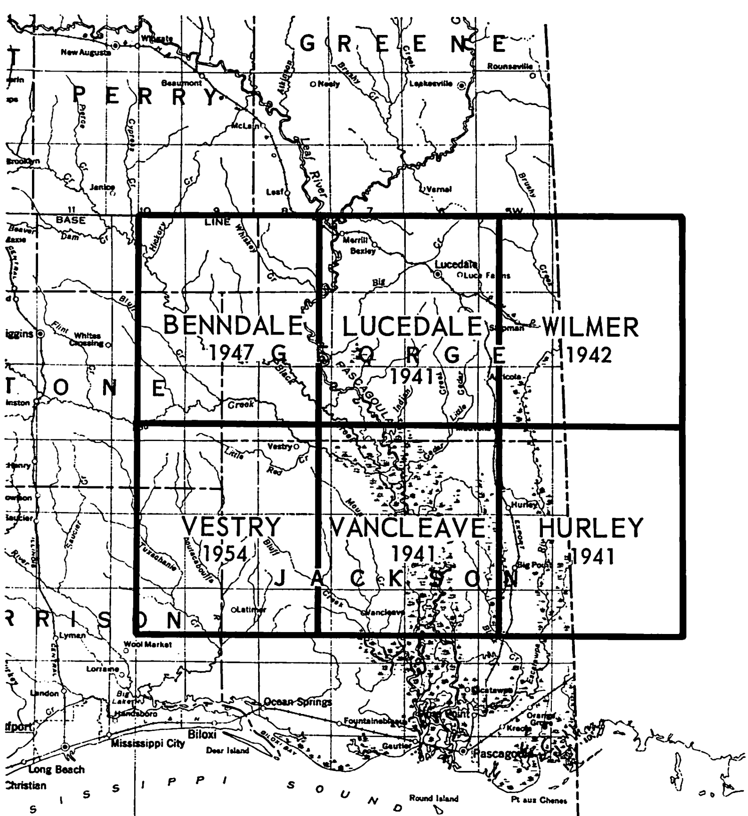


Figure 5.—Topographic map coverage of George County.

rangle coverage is shown by Figure 5. These maps were prepared under the auspices of the Federal Government and all but the Vestry quadrangle were published prior to 1950. Vestry quadrangle was published in 1954. All maps were prepared using plane table methods and aided by aerial photographs. Topography of the Vestry quadrangle was mapped with the additional aid of the Kelsh plotter. Datum on the maps is mean sea level. The availability of these maps enables the geologist to get a better picture of the overall topography of the County and to locate the position of outcrops and other physical features quickly and accurately on maps. They also enable the geologist to determine, without time consuming use of surveying equipment, the location and elevation of formation contacts, core holes, water wells, etc.

As a public service, the Mississippi Geological Survey stocks available topographic maps of Mississippi. Topographic map coverage of George County is available at the Survey office or can be ordered by mail from the Survey.

Topographic detail, or surface configuration, results from erosive processes acting on sediments exposed at the surface. The geological units exposed in George County range in age from Miocene to Recent and are shown by Figure 6. Aerial extent of these units is shown on the Geologic Map, Plate 1. Hills and highlands are formed on sediments more resistant to erosion and valleys and lowlands are formed on sediments less resistant. Topographic character of George County is chiefly determined by the more resistant, red sandy beds of the Citronelle formation which overlaps the less resistant, green and gray clays of the Pascagoula formation. The County can be subdivided into uplands and lowlands. The uplands include the Citronelle deposits and High Terraces; the lowlands include deposits of the Pascagoula formation, Low Terraces and alluvial plains.

George County topography is rolling to moderately hilly with hilly to broken land in some areas. Total relief in the County is 300 feet. Elevations rise from 20 feet above sea level along the Pascagoula River in southern George County to 320 feet above sea level near Sand Hill Church and in sec. 5, T. 1 S., R. 5 W. The larger streams have cut deep valleys with broad

ERA	SYSTEM	SERIES	STRATIGRAPHIC UNIT	THICKNESS (feet)	LITHOLOGIC CHARACTER
CENOZOIC	QUATERNARY	RECENT	Alluvium	0–50 +	Sand and gravel, Clay lenses. Weathers orange and red.
		PLEISTOCENE	Low Terrace Deposits	0–50	Clay, silt, sand and gravel. Contains abundant organic material.
			Citronelle (Includes High Terrace Deposits)	0–140	Sand and gravel, clay lenses. Contains Abundant silicified wood. Occupies higher elevations.
	TERTIARY	MIOCENE	Pascagoula	300(?)–1000 +	Clay and sand, some small gravel lenses. Clay is blue and green on fresh exposure. Fossiliferous, clam *Rangia johnsoni* is commonly associated with the formation.

Figure 6.—Generalized section of exposed strata in George County.

valley flats. Deep ravines have been cut at the heads of smaller tributaries. The cross sections on Plates 2 and 3 illustrate the geomorphology of George County. The East-West cross sections and the North-South cross sections extend across the County from boundary to boundary. They are spaced two miles apart and parallel section lines as shown by cross section index maps. Cross sections A and B on Plate 2 are diagonal sections from northeast to southwest. Vertical scale for the cross sections is 1 inch equals 200 feet and horizontal scale is 1 inch equals 2 miles. This great vertical exaggeration causes the hilltops and valleys to appear as peaks and troughs, when, naturally, the hilltops are much broader, slopes are gentler and valleys are not nearly so sharp. Study of cross sections should be made in conjunction with the Geologic Map. The horizontal scale of the cross sections is in a 1 to 1 ratio with the Geologic Map to facilitate usage.

A cuesta system is fairly well developed west of the Pascagoula River (a cuesta is a slopping plane which is terminated on one side by a steep slope). The cuestas are shown between miles 3-14 on North-South cross sections 1, 2 and 3, Plate 3. Whiskey and Black Creeks flow along the base of cuestas whose north and northeast slopes are steep compared to the south and southwest long gentle slopes. Low terraces are developed on the gentle slopes on the north sides of Black and Red Creeks. The low terraces and alluvial plains are characteristically flat and are readily recognized on the cross sections. Surface features of each stratigraphic unit are more thoroughly discussed under individual headings.

SURFACE OF CITRONELLE FORMATION

The highest uplands in George County are associated with the approximate top of the Citronelle formation. This formation is shown in red on the Geologic Map (pl. 1). At the end of Citronelle deposition, the surface was a gently sloping plane inclined southward. This is indicated by the lines designated "Citronelle Surface" on cross sections A and B, Plate 2. Erosion has since altered this surface but several mesa-like benches remain as evidence of the original Citronelle surface and the horizon still appears as an unbroken plane as demonstrated by Figure 7. The benches remain in a youthful state locally due to rain water seeping into the ground rather than removing

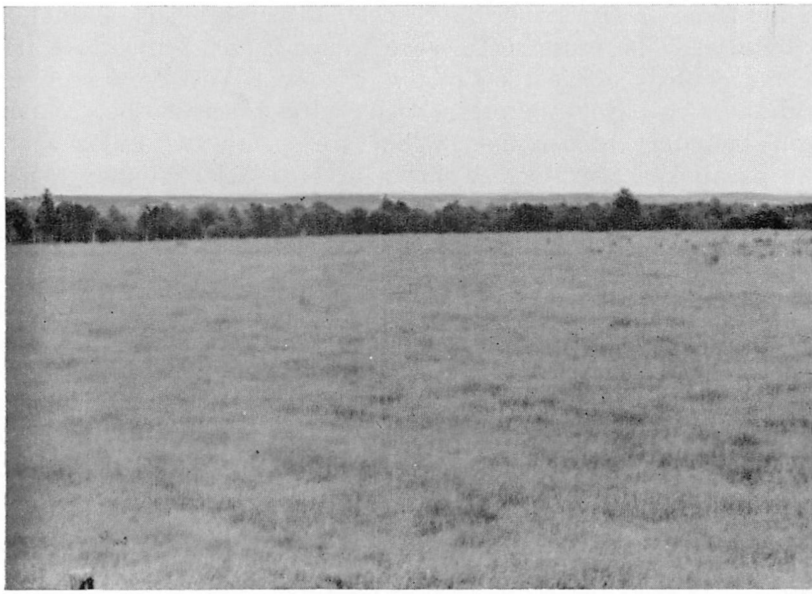


Figure 7.—Citronelle bench in foreground and view of horizon, looking east. Location is S½ sec. 17, T. 3 S., R. 5 W. June, 1966.

sediment by runoff. Elsewhere, drainage has cut through the Citronelle and into the Pascagoula formation. The term "bench" as used in this report is defined as a level or gently sloping erosion plane inclined seaward.[15]

Benches on the original Citronelle surface were noted east of the Pascagoula River in George County. Flat areas west of the Pascagoula River appear related to those described under High Terraces in this report. Some of the more prominent benches are described below:

(1) A flat area covering parts of several sections in T. 1 N., along the boundary line of Rs. 5 and 6 W. This flat slopes southward from an altitude of 310 feet above sea level to 300 feet above sea level and is shown between miles 20-22 on East-West cross section 2. It is also seen immediately southwest of Scarborough Creek on Northeast-Southwest cross section A, Plate 2 and between miles 16-18 on North-South cross section 11, Plate 3.

(2) A flat area which covers parts of several sections mostly in T. 2 S., R. 6 W. This bench slopes southward from an altitude of 280 feet above sea level in the town of Lucedale to 260 feet above sea level near Ward school. It is illustrated by East-West cross section 4 (miles 17-21), and 5 (miles 18-21) and by Northeast-Southwest cross section A, at Lucedale. North-South cross sections 9 (miles 11-13) and 10 (miles 9-12), also exhibit this bench.

(3) A flat area which covers parts of several sections centered around the Agricola Community. This bench slopes to the south from an altitude of 240 feet above sea level to 200 feet above sea level. It is shown by East-West cross sections 7 and 8 between miles 21-23 and at Agricola School on Northeast-Southwest cross section B, Plate 2 and North-South cross section 11 between miles 5-7, Plate 3. This bench is seen in the foreground of Figure 7.

Randomly distributed depressions are common on the flat surfaces of the Citronelle formation. The depressions are generally circular or elliptical. Several are shown on the aerial photograph (fig. 8). No distinct pattern of orientation was noted. They vary in size from small pockets to areas comprising many acres. The largest noted in George County covers approximately 160 acres located near Luce Farms. Brown [16] reports depressions covering areas larger than one square mile in the coastal area. A ground-level view of a small depression is shown by Figure 9. Some of the depressions retain rainwater and serve as natural reservoirs. The features are rare west of the Pascagoula River in George County. They seem to be restricted to the flats of original Citronelle surfaces and sparingly to the High Terraces.

Brown referred to the depressions as "blow-outs" and suggested they were caused by wind action. A concentration of small dunes and crescent-shaped depressions were noted one and one-half miles southwest of Agricola in the SW¼ sec. 12, T. 3 S., R. 6 W. They are oriented in a northwesterly direction and do appear to have been caused by wind action. The numerous larger depressions in the County may also be wind

Figure 8.—Aerial photograph of Citronelle or High Terrace terrain showing circular depressions. At least 12 depressions are shown. The road intersection to the northwest marks the common corner of secs. 20, 21, 28 and 29, T. 3 S., R. 6 W. Section 28 is bordered by section-line roads. March, 1942.

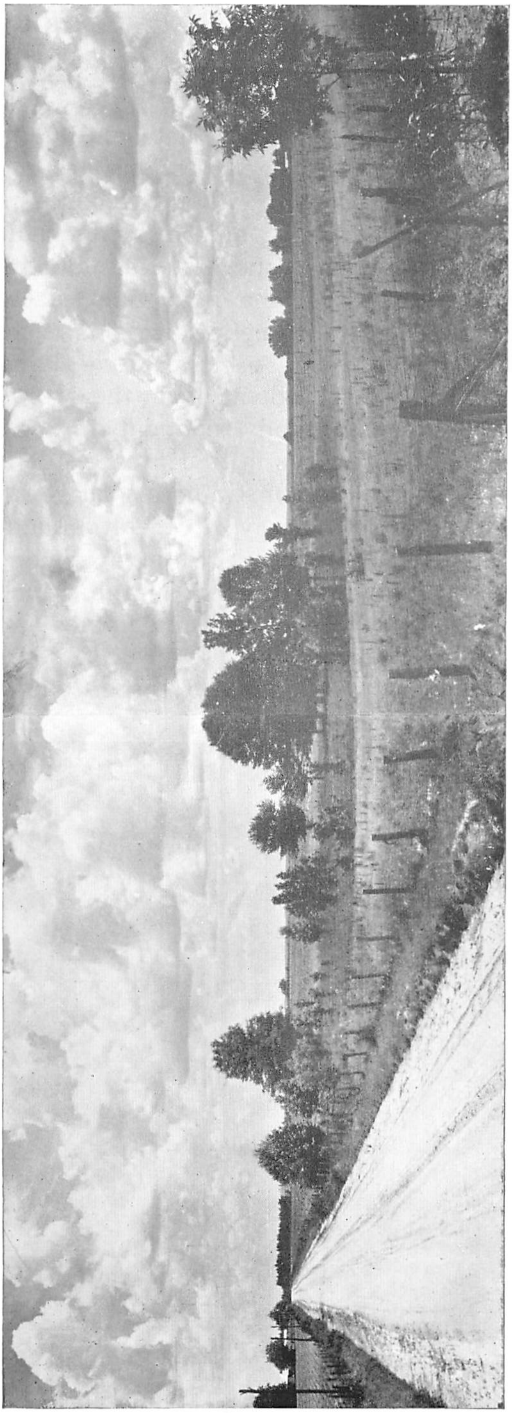


Figure 9.—Ground-level view of a partly filled depression on the surface of the Citronelle formation. Location of the depression is NE¼SW¼ sec. 32, T. 2 S., R. 5 W. View is toward the southeast. G. F. Brown photo, 1944.

originated but their size suggests that solution may have affected their growth. Solution depressions are usually due to solution of limestone, marls or other carbonate rocks but the depressions in George County are in sandy sediments which contain no (or little) calcareous material. Furthermore, presence of the depressions on the high flats places them at a position where the sandy Citronelle formation is thickest; therefore, any soluble calcareous parts of underlying Pascagoula sediments are at the greatest depth from the depressions. Smith investigated depressions in sandy sediments in South Carolina.[17] He concluded that depressions in that area result from selective leaching of iron and aluminum minerals accelerated by acids. The acids are derived from decay of vegetation and are effective solvents for iron and aluminum. Striking evidence that leaching has occurred in sandy materials of George County is seen in the layers of limonite commonly found immediately above impervious sands or beds of clay. Figure 10 is an example of solution and redeposition of iron in George County. Ferrugious

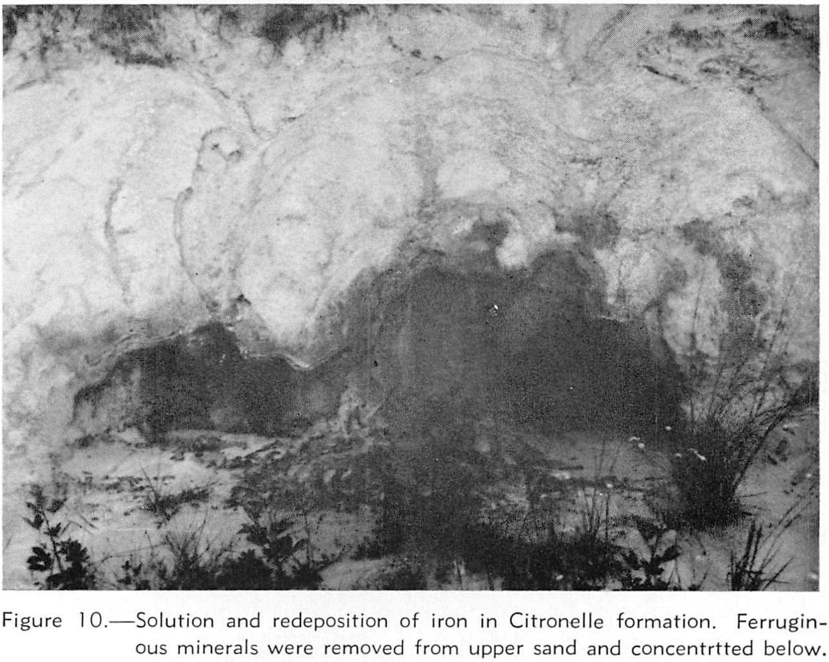


Figure 10.—Solution and redeposition of iron in Citronelle formation. Ferruginous minerals were removed from upper sand and concentrtted below. A two inch convolute limonite layer separates the sands. Location is west roadcut in NE¼ sec. 29, T. 2 S., R. 6W. June, 1966.

minerals have been removed from the upper sand (light) and concentrated below (dark) with a two inch convolute layer of limonite between.

Smith listed the following factors favoring solution development of depressions in sandy sediments of South Carolina:

(1) The porous and permeable nature of sands facilitate seepage and thereby increase the solution of rocks by groundwater.

(2) Flat land surfaces reduce rainfall run-off and therefore increases leaching.

(3) Abundant rainfall is necessary for vegetation and the formation of organic acids as well as for the solution of mineral matter.

(4) Warm, moist climate hastens plant growth and promotes decay and leaching.

These same factors are prevalent in George County. Based on the above data the author favors a solution origin for the depressions.

Another possible explanation of the depressions is that they may be due to impact of meteors. The fact that the depressions were noted only on the high flat surfaces and not on exposed surfaces of other formations would necessitate a meteorite fall sometime after Citronelle deposition but prior to erosion which exposed Miocene sediments and also prior to the later deposition of low terraces. The following observations cast doubt on a meteorite origin of the depressions. Impact rims usually associated with known meteorite craters are not present around the depressions in George County. No axial orientation of individual depressions could be determined as would be expected if a meteorite shower occurred in this area. The writer knows of no irregular magnetic measurements associated with the depressions. The lack of magnetic anomlies, however, would not preclude the possibility of a stony variety of meteors.

The possibility of additional theories as to the origin of the depressions cannot be excluded, but thus far the solution theory offers the most plausible explanation to the nature and the origin of the circular depressions in George County. Wind action probably was a contributing factor.

HIGH TERRACES

Remnants of beveled surfaces are present in George County west and south of the prominent upland benches previously described. These remnants, like the Citronelle benches, are flat surfaces of considerable size. Brown[18] recognized these areas and noted that their position was at lower elevations than the original Citronelle benches. He termed them High Terraces. The relation between the High Terraces and the Citronelle surfaces is best illustrated on Northeast-Southwest cross sections A and B, Plate 2.

Scarps associated with the High Terraces face toward the Pascagoula River. They may have been cut by the ancestral Pascagoula River when base level was at a much higher altitude or by wave action when sea level was higher. Altitudes of some High Terraces correspond with altitudes of shore lines noted along the Atlantic seaboard and in the Mississippi Embayment by Cooke.[19] No recognizable bedding features, grain sizes, color differences or lithological differences were found to distinguish High Terrace deposits from Citronelle rocks. Topographic features also appear identical, though the number of depressions on the Terraces seems to be less. The similarity between High Terrace deposits and the Citronelle formation is such that the writer found it impossible to distinguish between them except by elevation. Therefore, the High Terraces are treated in this report as geomorphic features only and are mapped with the Citronelle formation on the Geologic Map (pl. 1).

Some of the larger remnants of High Terraces are described as follows:

(1) A flat comprised of parts of several sections around the Central School and County Home area. A southward slope is apparent with an altitude of 215 feet above sea level near Central School and 200 feet above sea level one mile southeast of the County Home. This flat is shown on East-West cross section 5 between miles 14-15, at Central School on Northeast-Southwest cross section A, and on North-South cross section 8 between miles 8-9.

(2) A flat comprised of parts of several sections in the western half of T. 3 S., R. 6 W. Barton Church is centered on this flat. Altitude is 150 feet above sea level at the north end and 130 feet above sea level at the south end. It is shown by East-West cross section 9 between miles 16-19, Northeast-Southwest cross section B at Barton Church, Plate 2, and North-South cross section 9 between miles 1-5, Plate 3.

(3) The flat area on which Mauvella (Movella) Community is centered. Though this flat is small in areal extent, a southward slope is evident with an altitude of 164 feet above sea level at the north and 150 feet above sea level at the south. This flat is shown on East-West cross section 9 between miles 22-24, Plate 2.

(4) The flat area west of the Pascagoula River centered between Whiskey and Black Creeks. This flat slopes to the south from an altitude of 200 feet above sea level to 160 feet above sea level. It is shown on East-West cross sections 4 (miles 1-4) and 5 (miles 2-5), Plate 2, and North-South cross section 2 between miles 10-13, Plate 3.

TERRAIN OF PASCAGOULA FORMATION

Clays, silts, and sands of the Pascagoula formation crop out mostly along the streams and their upper valleys in George County. The Pascagoula formation is shown in green on the Geologic Map (pl. 1). Outcrops are more common west of the Pascagoula River. North of Whiskey Creek Pascagoula rocks crop out over an extensive area and form an upland with only minor areas of Citronelle cover. Pascagoula outcrops were noted as high as 190 feet above sea level in George County; those near this altitude being along the northern edge of the County.

The topography on Pascagoula outcrops is typically gently rolling. Drainage patterns have a lace-like and dendritic form (fig. 11). Much of the swampy and poorly drained areas not in the present alluvial plains or low terraces is associated with Pascagoula clay outcrops. Abundant growth of the trumpet-shaped pitcher plants flourishes where drainage is rather poor and in most instances this growth is indicative of clay soils associated with the Miocene outcrops. The cross sections show the topography related to Pascagoula outcrops (pls. 2 and 3). As previously noted, exposure of the Pascagoula formation is restricted to stream valleys except in northwestern George County where it is present as uplands. This area is shown on

Figure 11.—Aerial photography showing lace-like dendritic drainage patterns. Tappley Branch, a west flowing tributary of Big Creek is shown. The stream crosses sec. 6, T. 2 S., R. 6 W., and sec. 1, T. 2 S., R. 7 W., in the photograph. March, 1942.

the East-West cross sections 1 and 2 between miles 3-6, Plate 2, and North-South cross sections 2 and 3 between miles 14-18, Plate 3.

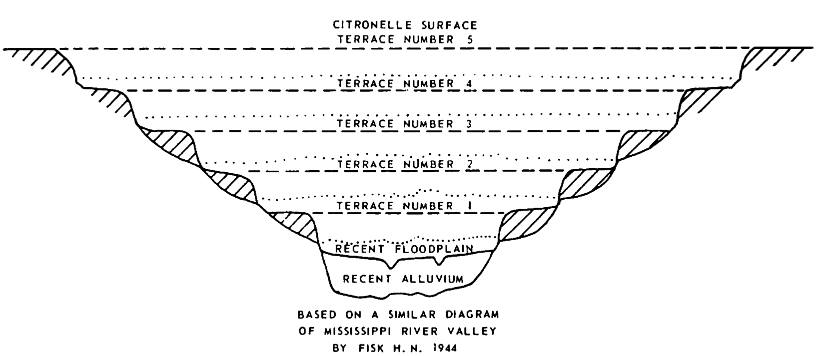
Pascagoula deposits are distinguishable from Citronelle deposits and High Terraces on aerial photos and mosaics. They have a noticeably darker gray tone than the light gray and white tones of the Citronelle and High Terraces.

LOW TERRACES

Low Terrace deposits are found adjacent to the alluvial plains of the larger streams in George County. They are fluvial deposits and their surfaces represent alluvial plains of streams which drained the area when base level was at a higher elevation. The Low Terraces are shown in hues of orange, olive, and reddish-brown on the Geologic Map (pl. 1). Position of the terraces indicates they were formed after the drainage system assumed the present general outline.

Three levels of Low Terraces are present in George County. The lowest, or First-level terrace, is situated generally 6 to 10 feet above the present alluvial plain (flood plain). It is referred to as Pamlico terrace in this report. Stratigraphically subjacent to the Pamlico terrace is a Second-level low terrace. The Third-level low terraces are the oldest and most dissected by erosion. Figure 12 is an idealized terrace profile of the

IDEALIZED TERRACE SECTION OF RIVER VALLEYS



BASED ON A SIMILAR DIAGRAM OF MISSISSIPPI RIVER VALLEY BY FISK H. N. 1944

Figure 12.—Idealized terrace profile of the large river valleys in George County. Numbers 1, 2 and 3 are the Low Terraces of this report. Terrace number 4 may be a destructive terrace rather than constructive.

larger river valleys in George County. The closest corollary to the idealized section is in southeastern George County where terraces are preserved on both sides of the Escatawpa River. This is shown on East-West cross sections 8, 9 and 10 between miles 23-27, Plate 2.

The different levels of terraces in George County are probably related to inter-glacial stages of the Pleistocene epoch. With the exception of Pamlico terraces, no attempt was made by the writer to relate the terraces to a particular inter-glacial stage. Pamlico terraces can be traced along the river valleys to the point where they coalesce with their marine equivalent, the Pamlico plain, along the Gulf Coast.

Pamlico terraces are shown in reddish-brown on the Geologic Map (pl. 1). One is found on the west side of the Escatawpa River valley at an altitude of 50 to 60 feet above sea level at the George-Jackson County line. (See East-West cross section 10 at mile 25.5, Plate 2.) It rises northward to an altitude of 100 feet above sea level near the upper part of T. 2 S., at the George-Mobile County line. Another Pamlico terrace is seen adjacent to the western limits of the Pascagoula River alluvial plain in the northern part of the County. Here the terrace occupies an altitude interval of 40 to 60 feet above sea level, shown by East-West cross sections 1, 2, and 3 between miles 6-7. On the north side of Red Creek near the George-Jackson County line, a Pamlico terrace is at an altitude of 35 to 55 feet above sea level. It is seen on East-West cross section 10 between miles 8-11 and on Northeast-Southwest cross section A, southwest end. On North-South cross sections 4 and 5, it is at mile 1 (pl. 3).

Second-level terrace deposits occupy altitude intervals several feet above the Pamlico terraces. They are shown in olive on the Geologic Map (pl. 1). One is at an altitude of 55 to 70 feet above sea level on the east side of the Escatawpa River valley at the George-Jackson County line (See East-West cross section 10 at mile 26.5, Plate 2.) It rises northward to an altitude interval of 60 to 75 feet above sea level near the Howell Bridge in sec. 2, T. 3 S., R. 5 W. Remnants of a Second-level terrace are seen on the north side of Black Creek where the terrace deposits occupy an altitude interval from 55 to 80 feet above sea level.

(See North-South cross section 2 at mile 8, Plate 3.) The terrace slopes southward to an altitude of 40 to 70 feet above sea level south of Benndale Post Office as shown on East-West cross section 8 between miles 7-8 (pl. 2) and North-South cross section 4 at mile 5 (pl. 3). A Second-level terrace on the north side of Red Creek is at an altitude of 55-80 feet above sea level as shown on East-West cross section 9 between miles 5-8 and North-South cross section 4 at mile 2.

Third-level terrace deposits are represented by remnants bordering all of the larger streams in George County. They are shown in orange on the Geologic Map (pl. 1). On the west side of the Escatawpa River valley Third-level terrace deposits occupy an altitude interval of 60 to 100 feet above sea level at the George-Jackson County line. (See East-West cross section 10 at mile 25, Plate 2.) The terrace unit rises to an interval of 70 to 115 feet above sea level near the Howell Bridge. Scattered remnants of a Third-level terrace are seen just east of the Pascagoula River in the northern part of George County where they occupy an altitude interval of 80 to 105 feet above sea level as shown on East-West cross section 1 between miles 13-15. Remnants of a Third-level terrace occupy this same altitude interval on the north sides of Black and Red Creeks as shown on North-South cross sections 1 (miles 3-4 and miles 8-9) and 3 (miles 3-4). East of the Pascagoula River at the southern end of the County this terrace ranges from 40 to 80 feet above sea level. (See Northeast-Southwest cross section B, southwest end, Plate 2.)

All of the aforementioned terraces have similar surface character and sediment composition. Henceforth in this report they will be treated as a group and referred to as the Low Terraces.

The surfaces of the Low Terraces are characteristically level, but some features are apparent. Meander scars are present on most of the terraces and can be readily observed on aerial photographs. Figure 13 is an aerial photograph covering all of secs. 22, 23, 26 and 27, and the N½ of secs. 34 and 35, T. 2 S., R. 9 W. (See Geologic Map, Plate 1, for comparison.) Parts of the Pascagoula formation, Third-level terrace, Second-level terrace, and present alluvial plain of Black Creek are shown. Contacts of the units are delineated with heavy lines. Some of the meander scars are delineated with fine lines. The meander scars remain as a record of the drainage systems which deposited the terraces. The old channels were in some cases larger than the present channels as indicated on Figure 13. Present-day

Figure 13.—Aerial photography showing meander scars on two levels of Low Terraces and Black Creek alluvial plain. The photograph covers all of secs. 22, 23, 26 and 27, and the N ½ of secs. 34 and 35, T. 2 S., R. 9 W. March, 1942.

drainage is, in some cases, still partly controlled by features on the terraces. Some tributary streams flow for considerable distances in pre-existing channels.

ALLUVIAL PLAINS

The combined alluvial plains of the larger streams in George County cover a considerable area. The alluvial plains are shown in yellow on the Geologic Map (pl. 1). The Pascagoula River has the broadest plain, measuring approximately four miles in width immediately south of Merrill and approximately four and one-half miles in width near the George-Jackson County line. The combined alluvial plains of the Chickasawhay and Leaf Rivers at the George-Green County line measure six and three-fourths miles across.

The Pascagoula River alluvial plain rises from 20 feet above sea level at the George-Jackson County line (center of East-West cross section 10, Plate 2) to 50 feet above sea level at Merrill. The plain slopes southward at an average rate of 1.66 feet per mile. The Pascagoula River has a wide loop meander pattern as would be expected on such a low gradient. Where the Pascagoula River alluvial plain crosses the central part of George County it is commonly bordered by high angle scarps of Miocene, Citronelle, and terrace deposits (East-West cross sections 4, 5, 6, 7, Plate 2).

The Escatawpa River alluvial plain averages approximately one-half mile in width throughout its traverse of George County (pl. 1). The relatively narrow width of the Escatawpa River alluvial plain is due to a steeper gradient. The plain rises from 40 feet above sea level at the George-Jackson County line to 70 feet above sea level ten miles upstream at the George-Mobile County line. The gradient is approximately 3 feet per mile and the River is flowing in a fairly straight channel. The Escatawpa River alluvial plain is bordered on the west side by Pamlico terrace deposits (East-West cross sections 5-10, Plate 2). Second-level low terrace deposits border the plain on the east as shown by East-West cross sections 8, 9, 10, Plate 2. North of the Second-level terrace the alluvial plain is bordered by a steep slope of Miocene and Citronelle deposits (East-West cross section 7, Plate 2).

The alluvial plain of Red Creek varies in width from one-half mile up to one mile (pl. 1). It rises from 30 feet above sea level at the George-Jackson County line to 50 feet above sea level at the George-Stone County line. (See East-West cross section 10, Plate 2, and North-South cross section 1, Plate 3.) The plain is bordered by Miocene and Low Terrace deposits.

Black Creek alluvial plain varies from one mile to one and one-half miles in width (pl. 1). The plain rises from 20 feet above sea level at the George-Jackson County line to 50 feet above sea level at the George-Stone County line. (See East-West cross section 10, Plate 2 and North-South cross section 2, Plate 3.) It merges with the alluvial plain of the Pascagoula River near the center of the east edge of T. 3 S., R. 8 W. Black Creek alluvial plain is bordered by low terrace deposits to the north and northwest. (See North-South cross sections 1, 2 and 4, Plate 3.) To the south it is bordered by Pascagoula and Citronelle outcrops where the sharp slopes give rise to the Wyatt Hills. (See North-South cross sections 1 and 2, Plate 3.)

The alluvial plain of Whiskey creek is less than one-half mile in width (pl. 1). Pascagoula formation outcrops are adjacent to the plain on the north. (See North-South cross sections 2 and 3, Plate 3.) A steep slope borders the south where outcrops of the Pascagoula and Citronella formations form the Whiskey Creek hills. (See North-South cross sections 2 and 3, Plate 3.)

The alluvial plains (flood plains) of George County are generally covered with trees and undergrowth but some surface features are visible. Some of the features are meander scars and narrow depressions of abandoned channels, oxbow lakes, and natural levees.

STRATIGRAPHY—SURFACE

To gain an understanding of the stratigraphy of George County, an intensive study of the outcrops was made and surface samples were microscopically examined. In addition, fifty-seven holes were cored or drilled by the Survey. (See Core Hole and Test Hole Records section.) Cores, samples, and electrical logs of these holes along with samples and electrical logs of water wells and core holes drilled by others were studied.

Exposed strata in George County ranges in age from Middle Miocene (25 million years) to Recent. (Refer to Figure 6, a generalized section of the exposed strata.) Composite thickness of the exposed section is about 900 feet. The total section is comprised of clastic sediments: gravel, sand, silt, and clay. Depositional environments represented are fluvial, flood plain, deltaic, estuarine and lagoonal, and littoral.

A general review of pertinent literature is presented to acquaint readers with the derivation of stratigraphic nomenclature as applied to sediments in George County.

TERTIARY SYSTEM—MIOCENE SERIES

PASCAGOULA FORMATION

Nomenclature. The first description of sediments now considered Pascagoula formation was by Eugene W. Hilgard in 1860 when he wrote of the green, blue, and gray clays exposed in the banks of the Leaf, Chickasawhay, and Pascagoula Rivers.[20] Hilgard recognized the age equivalency of these outcrops to Wailes' "Grand Gulf sandstones"[21] in southwestern Mississippi. That he noted the lateral gradation from sandstones to clays across southern Mississippi is evident by his statement:

> N.W. of a line drawn from Fort Adams, Wilkinson County, to Raleigh, Smith County sandstones are quite abundant in this formation — rather the prevalent material. S. E. of that line, however, I know of none, the several kinds of clay forming the exclusive material.[22]

These sediments were included in Hilgard's Grand Gulf group which he placed between the Vicksburg beds and the "Orange Sands" in the geologic column. Hilgard did not definitely specify an age but suggested that the group might logically be considered Eocene.[23]

L. C. Johnson, U. S. Geological Survey, made a study of the stratigraphic relations of the Grand Gulf in Louisiana, Mississippi, and Alabama in 1889. He established the age of the Grand Gulf as "not older than Miocene, and as certainly not Quaternary."[24] Regarding this study, McGee in 1890[25] wrote that Johnson had designated Pascagoula formation as a name for a series of deposits "carrying a moderately abundant fauna of rather recent (apparently late Neogene) aspect." The deposits were located along the Pascagoula River in southeastern

Mississippi. This is the first written mention of Pascagoula, in geologic usage.

Pascagoula, as a formation name, was assured in 1893 when Johnson's four phase subdivision of the Grand Gulf was published.[26] Below is his description of the fourth phase:

> A fourth manifests itself below Leakesville on the Chickasawhay, on the Lower Leaf River and Pascagoula — being clays of a more tenaceous quality — abounding in specks and nodules of calcareous material, and in a few places holding shells of mollusks. One locality of the last, where first discovered, is the Shell Landing below Roberts Bluff, four miles south-west of Vernal postoffice. This is the Pascagoula phase or formation.

Shell Landing is considered the type locality of the Pascagoula formation.

In 1894 W. H. Dall and Stanley-Brown[27] correlated the Pascagoula formation with Miocene age sediments based on fossils. Later in 1898 Dall listed the Pascagoula formation as Miocene age in the Eighteenth Annual Report of the U. S. Geological Survey.[28]

Following these early observations, the age of the Pascagoula formation came into question. Carlotta Maury[29] considered it to be Oligocene age in 1902. Crider[30] erroneously placed the Pascagoula formation immediately above the Vicksburg beds and below the Grand Gulf beds in 1906.

E. N. Lowe in 1915 mentioned the fossiliferous green clay outcrops of the Pascagoula formation. He noted "the fossils of these beds are oysters, *gnathodons,* and others of salt water or estuarine habits, ... (which) indicate the marine or estuarine character of the deposit."[31]

A year later Matson[32] described the Pascagoula formation as:

> A series of blue, green, and gray clays, locally calcareous, with interbedded sands and more rarely sandstones ...... This formation is locally fossiliferous and has furnished remains of marine or brackish-water invertebrates at Shell Bluff and Givhens Landing, on Chickasawhay River, Miss., and in numerous wells in the southern part of the State.

The next extensive report on the Pascagoula formation was in 1941 by A. R. Mincher.[33] This report focused on the fauna and age of the Pascagoula formation. Mincher concluded that at the type locality the formation is Middle Miocene age.

The literature contains other references to the Pascagoula formation but most agreed with those here mentioned and are not cited.

Outcrop and subsurface. The Pascagoula formation is the stratigraphic interval above the Hattiesburg formation and below the Citronelle formation in George County. It may also be overlain by terrace or alluvial deposits. Sediments of the Citronelle once completely covered the Pascagoula formation. The Pascagoula is now exposed only where the Citronelle has been eroded away. The Geologic Map (pl. 1) and the cross sections (pls. 2 and 3) show the exposed areas. Outcrops of the Pascagoula formation are generally easily recognized in George County. The green and gray colored sediments stand in contrast to red and orange colors prevalent in younger sediments.

The Pascagoula formation is comprised of terrigenous clastics with scattered lenses of fossil assemblages. Majority sediment type is silty clay. Other sediments are silt, sand, sandy clay, and some gravelly sand.

Pascagoula clays are found in various stages of oxidation. Those in a non-oxidized state are the common green, gray, and blue colored clays. Slightly oxidized clays appear as mottled or irregular marked clays and are also common on the outcrop. Mottled clays appear in shades of purple, light-red, and yellow. Pascagoula clays more completely oxidized are also abundant on the outcrop. These are deeper shades of red. Recognition of the formation in this state of oxidation is sometimes difficult because of a similar appearance to the red colored sediments of younger formations.

Weathering effects contribute criteria by which Pascagoula clays are recognized on the outcrop. Precipitation runoff carves intricate patterns in the clays leaving the surface with a characteristically hummocky appearance as shown by Figure 14. The clays also have a characteristic shrinkage pattern which causes the outcrop to appear to be composed of small tiles. This is demonstrated on Figure 15, center of the bottom half of the picture.

Silt and sand components of the Pascagoula clays are mostly quartz. Some manganiferous and limonitic specks are present

Figure 14.—Erosion patterns on Pascagoula clay. Concentration of iron gravel on surface in foreground. Location is SE¼SW¼ sec 9, T. 2 S., R. 7 W., looking west. June, 1966.

as well as some small pyrite crystals. Mica flakes are frequently observed in the outcrop and in subsurface samples. Occasionally the clay is calcareous. White earthy calcareous masses, or nodules, were noted in several cores. The nodules range up to tennis ball size.

Several samples of Pascagoula clays were analyzed by standard x-ray methods. (See Table 2.) Montmorillinite (non-complexed smectite) was determined the majority clay mineral, followed by kaolinite. Mica (or illite) was also present. Detailed chemical analyses of Pascagoula clays are shown on Table 12.

Sands are fairly abundant in the Pascagoula formation. On the outcrop they appear mostly as lenses and none can be traced more than a few hundred yards. In the subsurface some beds can be correlated over a greater area. One sand was found which can be correlated countywide and is used in this report to separate the Pascagoula from the Hattiesburg formation. (See Plate 4.)

TABLE 2

X-Ray Analyses, George County Clay Samples

Sample (Core Hole No.)	Formation	Clay Mineral Types *
AJ-1	Pascagoula fm.	(1) Montmorillonite (non-complexed smectite) (2) Kaolinite
AJ-12	Pascagoula fm.	(1) Montmorillonite (non-complexed smectite) (2) Kaolinite (3) Mica (or illite)
AJ-14X	Pascagoula fm.	(1) Montmorillonite (non-complexed smectite) (2) Kaolinite
AJ-30	Alluvium	(1) Montmorillonite (non-complexed smectite) (2) Kaolinite
AJ-35	Terrace deposit	(1) Kaolinite (2) Mica (or illite)
AJ-49	Pascagoula fm.	(1) Montmorillonite (non-complexed smectite) (2) Kaolinite

* Majority clay mineral listed first

Pascagoula sands, like the clays, have a green and gray color. On the outcrop, however, the sands frequently appear red, yellow, or orange due to limonitic and hematitic staining. Cross-bedding and laminations in the sand are commonly observed in roadcuts or river bank exposures. Most of the sands are unconsolidated and friable, though some are found in a loosely consolidated or cemented state. The cementing material is usually limonite or hematite. Normally the sand includes clay as matrix material. Sand grain sizes are very fine-grained (1/16 mm.) to very coarse-grained (2.0 mm.) with some small pebbles. The grains are mostly spheroid shaped and sub-rounded with abundant rounded grains. Some frosted quartz grains were noted. The sands usually have a fair degree of sorting.

Quartz is the main constituent of the Pascagoula sands accompanied by minor heavy mineral associations. Black chert grains are fairly common and occasionally give the sands a salt and pepper appearance. Mica flakes and pyrite crystals occur sporadically. Black and chocolate colored carbonaceous and lignitic streaks occur scattered through the sands. Carbonized wood was recovered from a Pascagoula sand in Hole AJ-20. (See Core and Test Hole Records section.) Some of the sands are slightly calcareous.

Type locality of the Pascagoula formation is Shell Landing (Shell Bluff), as previously mentioned. Specific location is described as along the bank of the Chickasawhay River, center of SE¼ sec. 28, T. 1 N., R. 7 W., Greene County, Mississippi. This is approximately one mile north of the George County line. At this location an estuarine tongue, or lens, about 20 feet thick is exposed. Mincher's[34] description of this locality is:

	Feet
Cover of sand and gravel	10±
Brown silty clay, with many internal and external molds of pelecypods, all calcareous material leached out	2
Light bluish grey sandy marl, with many *Rangia johnsoni*, and *Ostrea westi*, n. sp.	1
Light bluish grey sandy marl, with many *Rangia johnsoni* and fragments of large shells, to river level at low stage	2
Light bluish grey sandy clay, with few shell fragments, and streaks of light blue to bottom of auger hole	20

Rangia johnsoni is a fossil clam (mollusk) and is actually the basis for identifying the Pascagoula formation on the outcrop and in the subsurface. It is generally considered a guide fossil of the Pascagoula formation. In addition to *Rangia johnsoni,* Mincher described several other fossils from Pascagoula outcrops near the type locality. They are:

Pelecypoda

Ostrea westi

Ostracoda

Anomocytheridea pascagoulaensis

Anomocytheridea ovata

Perissocytheridea matsoni

Cytherura johnsoni

Microcythere moresiana

Microcythere johnsoni

Cytheromorpha pascagoulaensis

Foraminifera

Elphidium gunteri

Eponidella cushmani

Rotalia beccarii

Ammodiscus sp.

A fossil gar and a crocodile tooth have also been found in the Pascagoula formation in this area and shells are common in cuttings from wells in George County. Test Hole AJ-45 encountered a zone at 430 to 450 feet which was comprised entirely of shell fragments. (See Figure 27.) These fragments are tentatively identified as *Rangia johnsoni*. Fish vertebrae were also observed in samples from this interval.

Some excellent exposures of the Pascagoula formation are seen in road cuts in George County. Figure 15 is a road cut on State Highway 26 near Crossroads. Nearly 15 feet of olive-green Pascagoula clay overlain by 15 feet of High Terrace or Citronelle deposits is exposed. Another good exposure of Pascagoula sediments is a road cut on River Road near White Creek Bridge just north of Basin. This exposure exhibits a lens of cross-bedded Pascagoula sand. McCreas Bluff furnishes an excellent exposure in the west bank of the Pascagoula River, as shown on Figure 16. Brown[35] described this section:

	Feet	Feet
Low Terrace deposits		12
Sand, gravelly; composed of pebbles and grains of quartz, chalcedony, and chert. Some petrified logs (one palm) are near base	12	
Pascagoula formation		29
Clay, dark-gray; stained yellow from overlying sand	2	
Clay, sandy; weathers yellow; slightly bedded	3	
Clay, dark-gray; weathers by cracking	3	
Clay, sandy, light-gray; non-stained bed near base; massive	11	
Sand, massive and cross-bedded; local lenses of clay conglomerate; gray and blue-gray where unweathered, yellow where weathered. This sand is locally laminated and silty near the top of the exposure at the north end of the bluff where it is 32 feet thick	10	

Soils. The Pascagoula formation breaks down into distinctive type soils which are useful for identifying the unit in the field. Outcrop areas of Pascagoula clay show a red heavy clay which passes into mottled red, yellow, and gray clay within 30 inches. In more sandy outcrop areas a light-gray to yellowish-gray fine sandy loam develops. When dry these soils are stiff and friable but when wet they become sticky and have a high plasticity.

Contacts. Most authors have stated that the Pascagoula is separated from the underlying Hattiesburg formation as well as the overlying sediments by an unconformity. There is ample evidence leaving no doubt of the unconformity between the Pascagoula formation and overlying sediments. No mention was made, however, of where the unconformable contact between the Hattiesburg and Pascagoula could be observed. This unconformity may be based on the early concept that Hattiesburg sediments were non-marine, whereas, the Pascagoula formation was thought to be marine or, at least, brackish water

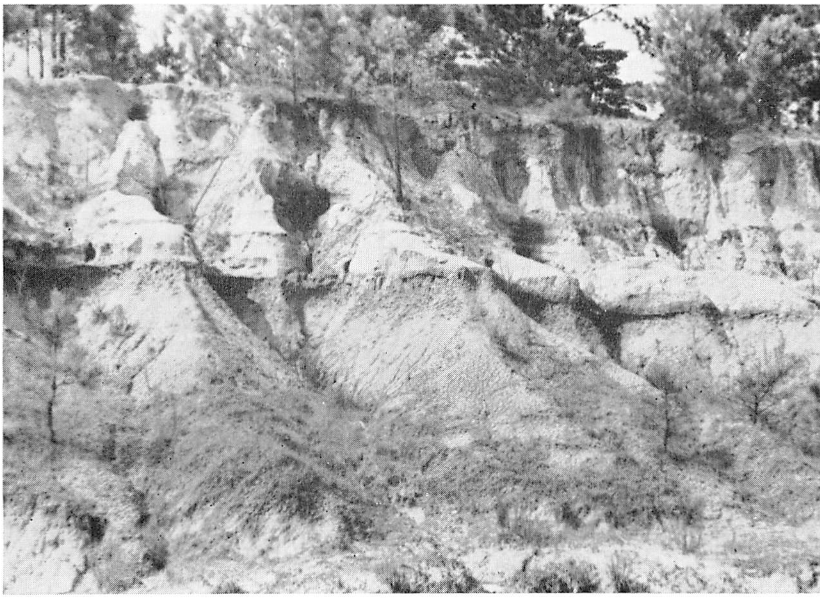


Figure 15.—Pascagoula clay overlain by nearly 15 feet of Citronelle or High Terrace sand and gravel. Elevation of contact is about 120 feet. Location is on west edge of sec. 8, T. 2 S., R. 7 W., Highway 26 near crossroads, north face of roadcut. June, 1966.

deposits. No exposure exhibiting what might be considered a contact between the Hattiesburg and Pascagoula formations could be found in George County by the writer. Foster[36] and Mincher[37] made special attempts to locate the contact in areas adjacent to George County with no success. Hattiesburg outcrops observed by the writer in Forrest, Perry, and Greene Counties have much the same appearance as Pascagoula outcrops with the exception that reddish-brown and light chocolate colors seemed to be more common in the Hattiesburg formation. Also, some lenses of sandstone were observed where none were seen in the Pascagoula. Lenses of brackish water fossils are restricted to Pascagoula outcrops.

In this report the Hattiesburg/Pascagoula contact is based on a lithologic consideration. The contact is placed at the base of a gravelly sand which can be correlated over most of the County. This is demonstrated by the cross section on Plate 4. Placement at this position does not conflict with any paleon-

Figure 16.—Pascagoula clay and sand overlain by Low Terrace sand. Location is McCreas Bluff on Pascagoula River, SE corner of irregular sec. 41, T. 2 S., R. 8 W. (See text for description of measured section.) G. F. Brown photo, 1944.

tological evidence in that the interval assigned to Pascagoula includes all known subsurface occurrences of *Rangia johnsoni* in George County. This placement also agrees with Vestal's observations in Adams County where he reported that the contact was between the upper surface of a massive clay and an overlying sand.[38]

Projecting at an established rate of dip from subsurface to surface, the selected contact between the Hattiesburg and Pascagoula formations falls in southern Greene County. This is indicated on the index map on Plate 4. Detailed paleontological and heavy mineral suite studies, such as Cogen[39] conducted along the Texas and Louisiana coasts, may lead to a more precise contact placement in the future.

A pronounced unconformity occurs at the upper surface of the Pascagoula formation in George County. Pascagoula sediments are found in contact with Citronelle deposits, terrace deposits, and alluvial deposits. To the south, in Jackson County, Brown[40] identified the Graham Ferry formation overlying the Pascagoula formation.

An excellent exposure of the contact between Pascagoula clay and High Terrace or Citronelle sand and gravel is shown by Figure 15. An exposure of Pascagoula sediments in angular contact with the unconformity is exhibited on Figure 17. Figure 18 shows an irregular contact between Pascagoula clay and Citronelle sand and Figure 19 is an example of a Low Terrace

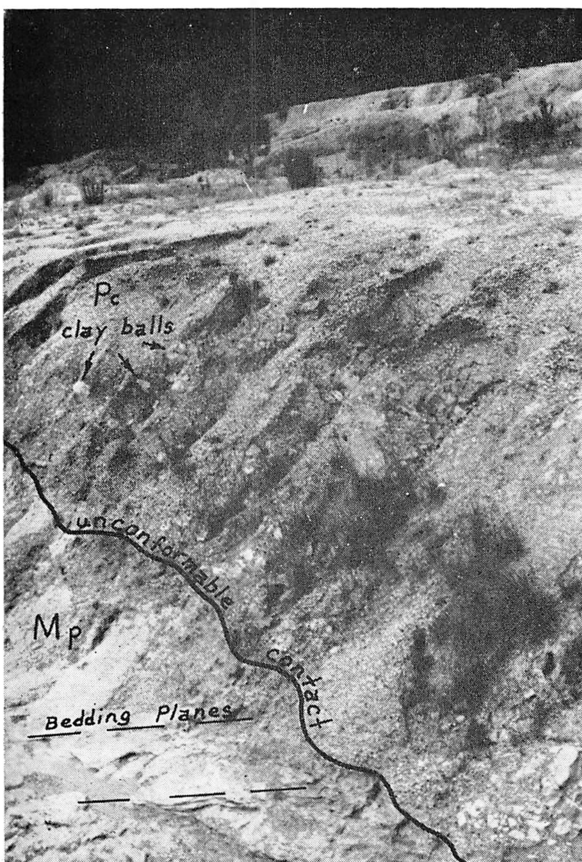


Figure 17.—Angular unconformable contact of Pascagoula and Citronelle or High Terrace sediments. Clay balls derived from underlying Pascagoula formation are included in the sand and gravel. Location is a drainage ditch in the County gravel pit, SW¼NE¼ sec. 17, T. 2 S., R. 7 W. June, 1966.

Figure 18.—Irregular contact of Pascagoula clay and Citronelle sand. Elevation of contact is 160 feet. Location is NW¼ sec. 21, T. 1 S., R. 6 W., west road cut just north of bridge on Big Creek near confluence of Beaverdam and Denny Mill Creeks. June, 1966.

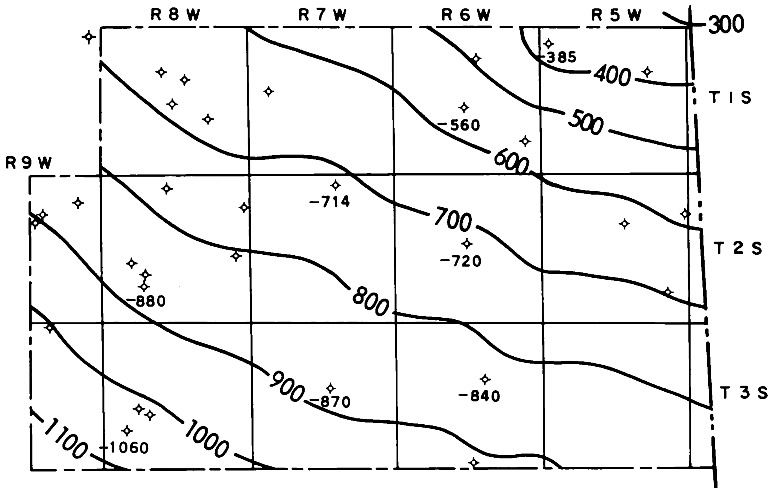
sand overlying a Pascagoula sand. A contact between Pascagoula sediments and alluvium is exposed in the east bank of the Pascagoula River, south of the Merrill Bridge. This exposure can be seen at low water stage.

Thickness and attitude. The thickness of Pascagoula sediments varies from near 300 feet in the northern part of George County to over 1000 feet in southern George County. This is illustrated by Figure 20, an isopachous map, and by the cross section on Plate 4. Variation in thickness is mostly due to post-depositional truncation of the Pascagoula formation, but some gulfward thickening is evident. Figure 21 shows that the base of the Pascagoula formation dips south-southwest at approximately 33 feet per mile. This represents a slight increase in rate of dip compared to the pre-Citronelle attitude.

Age. Paleontological evidence substantiates a Tertiary-Miocene age for the Pascagoula formation in George County. More specifically, it is Middle Miocene. Mincher[41] concluded that the Pascagoula formation, or "*Rangia johnsoni* zone," at the type locality represents a brackish phase of the marine *Arca* zone of Florida which includes marker fossils of Middle Miocene age. Results of Brown's investigation concur with a Middle Miocene age.

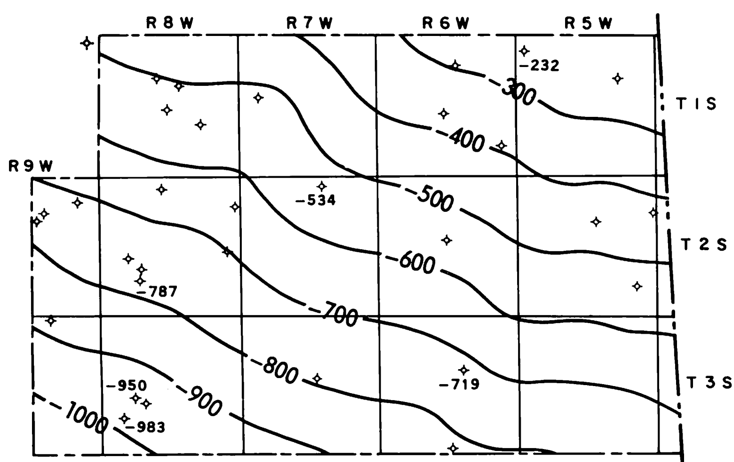
Depositional environment. Pascagoula sediments of George County are considered to have been deposited in a near-shore continental environment with estuarine conditions. The environment was much like the present Mississippi coastal area with bays, marshes, and comparable sized streams. The green and gray clays were deposited as lagoonal, marsh, or tidal flat muds. Commonly noted lignitic and carbonaceous streaks attest to these conditions as well as the occurrence of woody material found in Core Hole AJ-20. Sands and silts were contributed by rivers and distributaries and thus are lenticular. An obvious Miocene channel filled with sand is exposed in a road cut near Big Creek. The channel is shown in Figure 22. The fill material consists of cross-bedded coarse sand with

Figure 19.—Pascagoula sand overlain by a Third-level Low Terrace sand. Contact is sharp and even. Elevation of contact is about 85 feet. Location is S½NE¼ sec. 33, T. 1 S., R. 8 W., on road just west of intersection with Highway 57. July, 1966.



ISOPACHOUS MAP
PASCAGOULA FORMATION
CONTOUR INTERVAL = 100 FEET
Scale in Miles
GEOLOGY BY C. H. W.

Figure 20.—Isopachous map of Pascagoula formation.



STRUCTURE MAP
BASE OF PASCAGOULA FORMATION
CONTOUR INTERVAL = 100 FEET
Scale in Miles
GEOLOGY BY C. H. W.
CORE HOLE AND WATER WELL DATUMS NOT SHOWN

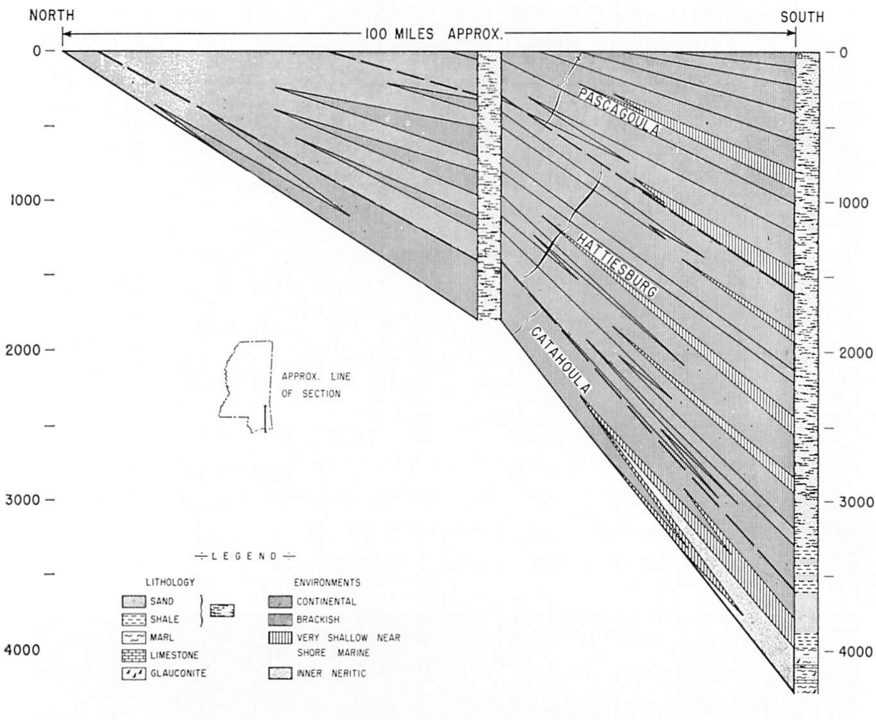
Figure 21.—Structure map, base of Pascagoula formation.

some rounded quartz and clay pebbles. Some sands may be attributed to local fluctuations of the strandline. Faunal assemblages (oyster reefs) existed where conditions favored their development and these now appear as lenses. The fauna have been identified as brackish water dwellers. Fossil gar and crocodile teeth found in the Pascagoula formation are added environmental indicators.

The entire Miocene was a time of general regression with only minor transgressions. This is demonstrated on Figure 23, a section constructed by E. H. Rainwater.[42] The line of section traverses George County. The central portion of the section depicts George County stratigraphy as an alternation of brackish and continental environments.

In contrast to the relatively low energy depositional environment in George County, large scale delta building was occurring in southern Louisiana where the Pascagoula interval includes thousands of feet of deltaic deposits.

Figure 22.—Channel within Pascagoula formation. Channel fill is coarse, cross-bedded material. Elevation is about 80 feet and location is just south of bridge across Big Creek in the center of S½ sec. 34, T. 1 S., R. 7 W. June, 1966.



SECTION OF MIOCENE SEDIMENTS IN SOUTHEASTERN MISSISSIPPI

Figure 23.—Section of Miocene sediments by E. H. Rainwater, 1962.

QUATERNARY SYSTEM—PLEISTOCENE SERIES

CITRONELLE FORMATION

Nomenclature. The deposits now considered as the Citronelle formation have been called numerous formation names in the past. The earliest name given to these sediments was "Diluvium or northern drift" by Wailes in 1854.[43] Wailes explained that the term "diluvium" was retained from an early concept of a period of violent irruption of water, the Noachian deluge. The word Diluvium is still used synonymously with Quaternary in many foreign countries.[44] The term "northern drift" was added by Wailes to signify his conformance to later views on the subject; mainly, the abandonment of the deluge hypothesis.

Three years later in 1857 Harper[45] used the name "Orange sand" in place of "Diluvium" and stated that ". . . . . hills of the orange sand, with the characteristic pebble stratum, are found here and there, even near the sea-coast."

Hilgard[46] in 1860 also used the name "orange sand." The following statement indicates that he was including Citronelle sediments as part of the Orange Sand formation:

> But the formation which gives character to the surface configuration of the State — whose presence is the rule, and whose absence the exception requiring special mention; which forms the main body of most ridges, and to a very great extent, their surface also — is that which has been very appropriately designated . . . the orange sand formation.

In the following three decades many names were applied to the sand and gravel beds of the Southeast. Some of the names were Ferruginous sand, Drift, Southern drift, Prairie Diluvium, Lagrange, stratified drift, Bluff gravel, Plateau gravel, Appomattox, Columbia, Fayette beds, and Tertiary gravel. This diversity of nomenclature and suspected isonomic discrepancies led to a conference of eminent geologists in 1891 to select a suitable name for the formation. The name Lafayette was chosen and the type locality was Lafayette County, Mississippi.

The term Lafayette formation was consistently applied for a number of years but became undesirable in 1911 when Berry[47] found that the typical deposits in Lafayette County were of Eocene age and thus not related to younger deposits as intended.

Matson[48] in 1916 proposed the name Citronelle formation for the nonmarine sediments "that occur near the seaward margin of the Gulf Coastal Plain, extending from a short distance east of the western boundary of Florida westward to Texas." Citronelle, Alabama was designated as the type locality because of excellent exposures of the formation in that vicinity. Citronelle has been the accepted formation name since this proposal though the age has been the subject of considerable conjecture.

Outcrop and subsurface. The Citronelle formation in George County is the sequence of nonmarine sediments unconformably overlying the Pascagoula formation and below the terrace deposits. It consists almost entirely of oxidized terrigenous clastics: gravel, sand, silt, and clay. It forms the upland plains and caps the interstream divides.

The Citronelle formation originally covered the surface of George County. Erosion has since removed the formation from some areas, mainly stream valleys, as demonstrated by Plates 1, 2, and 3.

The most typical and striking feature of the Citronelle formation is its red and orange color. The color is provided by oxides of iron, hematite and limonite, which are present as finely disseminated particles, probably deposited with the sediment. The base color appears in a variety of tints; crimson, purple, maroon, pink. Yellow and white is not uncommon.

Sand is the major constituent of the Citronelle formation with associated lenses and layers of gravel and clay. As a rule, gravel is present mostly in the lower part with coarse sands. The amount of gravel decreases upward through the section. Where pebbles are absent the whole formation is sand. According to some geologists an upper sand can be mapped separately from the basal graveliferous sands. These geologists contend that only the basal graveliferous sands are Citronelle. In this report the upper sands are included in the Citronelle formation.

Probably 95 percent of the sand grains are quartz, with chert and dark heavy minerals (ferromagnesians ?) comprising the rest. Grain sizes range from very fine—(1/16 mm.) to very coarse—(2.0 mm.) with abundant granules (4.0 mm.). Medium —(1/4 mm.) and coarse—(1.0 mm.) are the most common sizes. Degree of roundness is usually sub-angular and sorting is poor. Frosted quartz grains are abundant. In some places the Citronelle formation is unconsolidated and has little cementing, other places it is a hard ferruginous sandstone or conglomerate. Certainly, cementing by iron oxide is sufficient to make the formation more resistant than others which crop out in George County. The sand is usually massive and has a lack of stratification. No beds have great lateral or vertical identifying characteristics by which they may be correlated.

Gravelly sand is generally concentrated in the basal part of the Citronelle formation but can be present as scattered irregular lenses throughout the formation. Composition of the gravel is chert, quartz, and tripolitic chert. Chert is the most abundant constituent with varying percentages of quartz and tripolitic chert. The pebbles range in size from a fraction of an inch to several inches in diameter. Most exhibit a fair degree of rounding; quartz pebbles are mostly rounded. Pebble shapes vary from disk and blade shaped to spheroidal. Most of the chert pebbles are brown to light tan and buff, quartz pebbles are usually white to light gray, and tripolitic pebbles are light buff, gray, and white. Iron staining is usually present on the pebble surfaces. The chert pebbles commonly contain silica psuedomorphs of Paleozoic fossils, indicating the age and locality from which the rocks were derived. Coral and oolite structures seem most common.

Associated clays probably represent less than 10 percent of the Citronelle formation. They are usually various shades of red but pure white clay is not uncommon. The clays occur as lenses and have a limited areal extent. A detailed chemical analysis of a Citronelle clay is included in Table 12.

Ferruginous sandstone and siltstone is commonly noted on the Citronelle outcrops. It generally is in the basal part of the formation and mostly at the Citronelle/Pascagoula formation contact. This is probably due to impervious Pascagoula clay impeding the downflow of iron-rich waters causing a concentration of iron oxide. The ferruginous material is in the form of thin hard layers a few inches thick, though some thicker layers were noted. Some places it is in the form of plates were it has been broken by weathering and erosion and lies strewn about the surface. Ferruginous sandstone and siltstone nodules, or pellets, of varying size are common on the outcrop. They appear as an iron gravel on the surface. A concentration of iron gravel is noted in the foreground of Figure 14 where the iron pebbles lie on an eroded surface of Pascagoula clay.

Petrified wood is commonly associated with sediments of the Citronelle formation in George County. Small fragments are the most abundant but logs of considerable size are not uncommon. Figure 24, center foreground, shows a log two feet in length and ten inches in diameter in a graveliferous sand. Two types of wood were observed in George County. The most common type is the siliceous varieties. The other is a soft porous fibrous mass, light colored, which readily crumbles when touched. Palm wood was identified by Brown.[49]

On the outcrop large scale fluvial cross-bedding in the coarser material is commonly noted. Figure 25 shows sweeping cross-beds of gravel and coarse sand. The County gravel pit furnishes excellent exposures of giant cross-bedding.

Several localities exhibit an interesting facet of Citronelle deposition; a clay-ball conglomerate. The conglomerate consists of Pascagoula clay in a Citronelle sand matrix. It is found only in the basal part of the Citronelle formation. The clay-balls are various shapes from rounded to angular. Sizes are from less than an inch to boulders several feet in diameter. Some of the clay-balls have original laminations preserved. The clay-balls are clearly displayed in faces of the County gravel pit. Some clay-balls are labeled on Figure 17. Other localities where clay-ball conglomerates were observed by the writer are:

SE¼SW¼ sec. 9, T. 2 S., R. 7 W., State Highway 26 road cut, north bank.

SW¼SE¼ sec. 13, T. 3 S., R. 7 W., Section line road cut, north bank.

Figure 24.—Silicified log in Citronelle or High Terrace sand and gravel. Log is in center foreground. Dimensions of log is 2 feet in length and 10 inches in diameter. Location of photo is backside of Highway 26 roadcut near west edge of sec. 8, T. 2 S., R. 7 W. June, 1966.

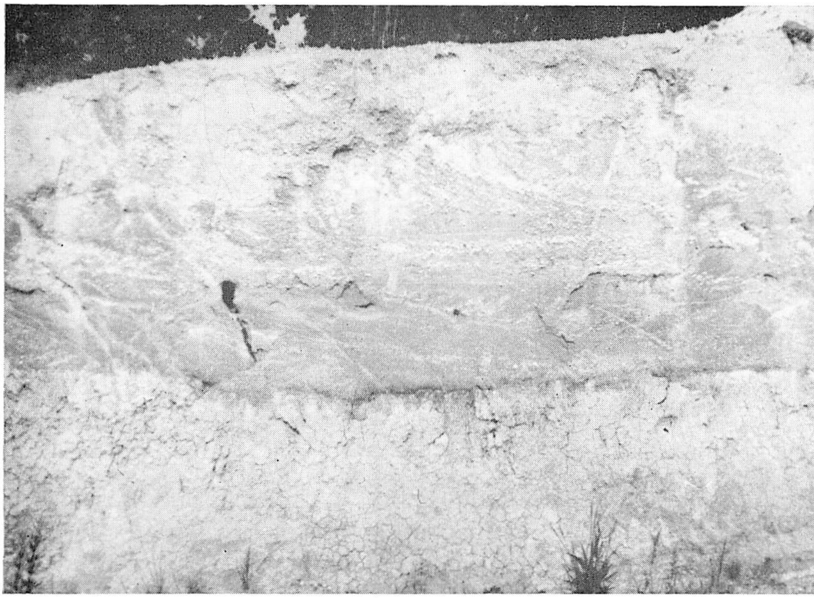


Figure 25.—Cross-bedding in Citronelle deposits overlying Pascagoula clay. Elevation of contact is about 140 feet. Location is roadcut in center of sec. 24, T. 2 S., R. 9 W. July, 1966.

Center N½ sec. 3, T. 3 S., R. 5 W., new road cut, north bank.

SW¼SE¼ sec. 10, T. 1 S., R. 7 W., road cut, west bank.

SW¼SE¼ sec. 5, T. 2 S., R. 7 W., road cut.

Center sec. 29, T. 3 S., R. 8 W., new road cut, north bank.

A gray and light gray gravelly sand is commonly found in the basal Citronelle formation at the contact with the Pascagoula formation. This sand rarely exceeds three or four feet in thickness. Lack of the characteristic red iron stain is probably due to proximity to the water table. Commonly the gray sand is wet on the outcrop. Springs are abundant at the Citronelle/Pascagoula formation contact in George County.

Soil. Soils developed on the Citronelle sediments are characterized by their dark-red or brownish-red color. They are generally loamy sands which are well drained and have a friable nature. The soils are useful criteria for identifying the formation in plowed fields, road surfaces, driveways, ant hills, uprooted trees in areas where vegetation otherwise covers typical outcrops.

Contacts. Contact between the Citronelle formation and the underlying Pascagoula formation is unconformable and usually readily discernable in George County. It should be noted that coluvium derived from the Citronelle formation extends down slope in many places, masking the true contact with the underlying Pascagoula formation. Figures 15, 17, 18, and 25 all show Citronelle sand, or gravelly sand overlying Pascagoula clay. In these examples a striking color contrast is exhibited between the deposits on both sides of the contact in addition to the lithologic contrast. Figure 26 is a rare example of Citronelle clay overlying a Pascagoula sand.

Subsurface contacts between the Citronelle and Pascagoula formations are usually apparent on electrical logs as well as lithology logs. A distinct change in resistivity is noted at the contact. This is demonstrated by Figure 27, an electrical log

Figure 26.—Citronelle clay overlying Pascagoula sand. Elevation of contact is about 135 feet. Location is roadcut just north of railroad crossing at Shipman, NW¼NW¼ sec. 15, T. 2 S., R. 5 W. June, 1966.

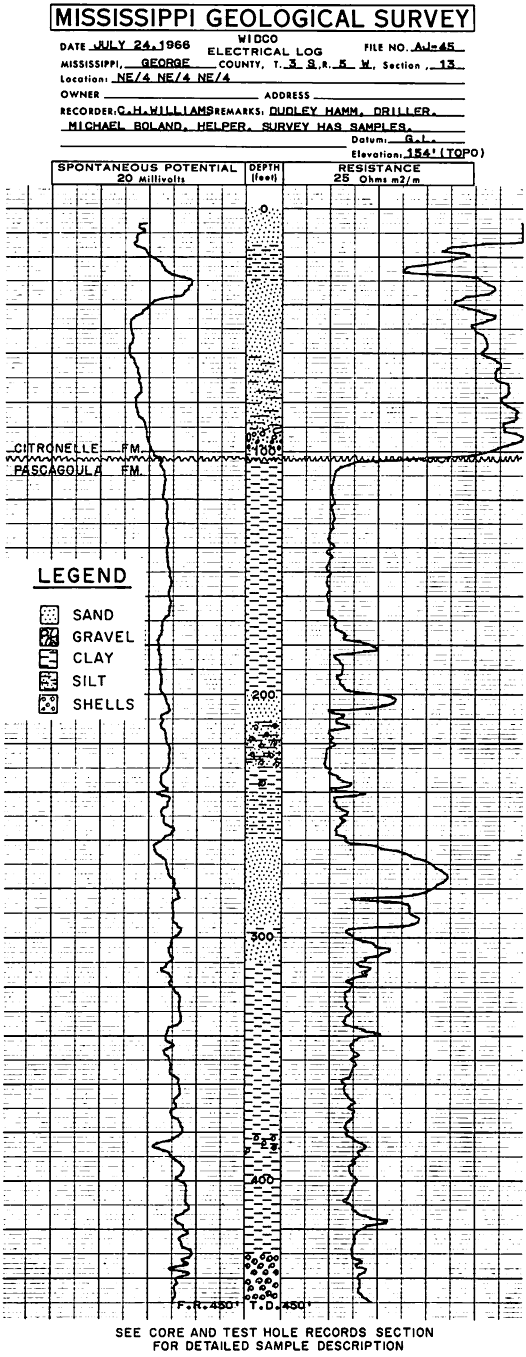


Figure 27.—Electrical log of AJ-45. Demonstrates distinct resistivity change at Citronelle/Pascagoula formation contact.

of Test Hole AJ-45. Lithology determined from sample analysis is plotted on the center column.

Contacts between the Citronelle formation and overlying terrace deposits are also unconformable but clear exposures are few in George County. A good exposure was observed in the road cut midway between Pleasant Hill Church and Indian Creek (SW¼NE¼ sec. 39, T. 3 S., R. 7 W.). Here a Low Terrace sand cuts diagonally across Citronelle sand and gravel.

Thickness and Attitude. The thickness of the Citronelle formation varies from zero where it is completely eroded to a maximum near 140 feet on the upland flats. This is best illustrated by the cross sections on Plates 2 and 3. Variations in thickness are due both to irregularities on the pre-Citronelle surface and the degree of post-Citronelle erosion.

The remnants of original Citronelle surfaces described in the Geomorphology section of this report exhibit a dip, or inclination, to the south. Restoring the original surface by using elevations of the northernmost and southernmost Citronelle benches, a dip to the south of 7.7 feet per mile was derived. Attitude of the base of the Citronelle formation is discussed in the Structure section of this report.

Age. The age of the Citronelle formation is a matter of conjecture at the present time. Arguments favoring Pliocene age as well as Pleistocene age have been presented. It is not within the scope of this report to attempt to solve the age problem and the designation of Citronelle as Pleistocene in this report is a matter of the writer's personal opinion. The following is a brief summary of arguments pertaining to the age of the Citronelle formation.

Matson [50] in 1916 referred to the Citronelle as the Pliocene Citronelle. This age designation was based on a flora study by Berry [51] presented in a companion paper. Berry said of the plant remains found in the Citronelle formation at the type locality that "It is of a very recent aspect and yet it contains a considerable number of extinct types, some of which represent genera unknown in the Pleistocene or Recent floras of North America and therefore indicate Pliocene age." [52]

Between the years 1935 and 1951, Doering,[53] Fisk,[54] Roy,[55] and Carlston[56] found evidence of an unconformity separating the plant-bearing clays described by Berry from overlying sands. These writers concluded that the Citronelle formation is therefore Pleistocene age.

In 1944 Brown[57] discovered a series of deltaic sediments above the Pascagoula formation and disconformably below the Citronelle formation in the coastal area of Mississippi. He named these sediments the Graham Ferry formation. Brown presented faunal evidence indicating that the Graham Ferry formation is transitional; i.e. it contains fossils belonging to both Pliocene time and Pleistocene time. Thus, Brown concluded that the overlying Citronelle formation is Pleistocene age.

Doering[58] in 1956 correlated the Citronelle with the Willis formation across Louisiana and Texas. He noted that Deussen's discovery of Pleistocene *Equus* teeth from Willis beds in Texas established a Pleistocene age for the equivalent Citronelle formation.

Stringfield and LaMoreaux[59] in 1957 defended Berry's Pliocene age for the Citronelle formation at the type locality. They acknowledged the presence of an unconformity between the leaf-bearing clay and overlying sands but noted that typical Citronelle sands also occurred below the subject clays therefore maintaining a Pliocene age.

The following year Doering[60] presented convincing evidence favoring a Pleistocene age for the Citronelle formation. He pointed out that a period of renewal of tectonic activity after a quiet time, followed by glacial activity is the basis for correlating the beginning of the Pleistocene epoch in Europe and in the Mid-Continent and Pacific regions of the United States. He stated that the parallelism of the geologic history of these areas with the Gulf Coast region and the relationship of deposition in the Gulf Coast region to erosion in the Mid-Continent strongly suggests that the Citronelle is a basal Pleistocene formation. Doering further commented that Berry's Pliocene age assignment is questionable because of lack of correlation with established Pliocene sediments.

The writer feels that a preponderance of data favors an early Pleistocene age for the Citronelle formation in the area of this report.

Depositional environment. The Citronelle formation is essentially a fresh-water deposit in George County. Depositional agents were probably in the form of broad shallow floods coming from the north. The large size cross-bedding indicates deposition in the form of advancing fronts of small local deltas and point bars within stream channels; probably a series of braided, laterally migrating, high velocity streams. The overall result appears to be a vertical accumulation of sediment in the form of coalescing alluvial fans and deltas. The lack of correlative units within the Citronelle formation is also indicative of deposition by ever varying currents of shallow channel streams. Some of the Citronelle clay sediments were probably paludal or lacustrine deposits. Some may be clay plugs filling abandoned channels. The previously described clay-balls resulted from scour and undercutting of the Pascagoula formation by early Citronelle streams. Occasionally the sands near the top of the Citronelle formation have a dunal appearance, suggesting dunal accumulations may have occurred in the closing stages of Citronelle deposition.

HIGH TERRACES

The High Terraces, as described in the Geomorphology section, are mapped with the Citronelle formation in this report. As previously mentioned, no recognizable bedding features, grain sizes, color differences or lithologic differences were found to distinguish High Terrace deposits from Citronelle rocks. It must be pointed out that there exists a possibility that the High Terraces are 'cut' terraces rather than 'alluvial' ones. They may be a result of planation when sea level was much higher than at present. As mentioned in the Geomorphology section, certain High Terrace elevations noted in George County are correlative with shore line elevations along the Atlantic Coast and in the Mississippi Embayment.

LOW TERRACES

Nomenclature. The nomenclature of Low Terraces used in this report is the writer's with the exception of the Pamlico terrace. The system is based on recognition of three levels of fluvial terrace deposition adjacent to the major streams in George County. The apparent relationship of the Low Terraces to the present drainage system is the basis for distinguishing the Low Terraces from the High Terraces. The three terrace units are referred to by level; First-, Second-, or Third-, depending on their elevation above the present flood plain. The First-level terrace is the lowest and youngest and the Third-level terrace is the highest and oldest of the Low Terraces. The First-level terrace is also called the Pamlico terrace, as explained in the Geomorphology section of this report. The writer feels that this system of nomenclature provides a basis for mapping age equivalent fluvial terraces. To help avoid the possibility of miscorrelating, one should recognize that the altitude and slope of a terrace depends on the position and gradient of the depositing stream. Therefore, the altitude and slope of equivalent terraces may differ just as the altitude and gradient of the present alluvial plain of the Escatawpa River differs from that of the Pascagoula River.

Outcrop and subsurface. The Low Terraces, like the Citronelle formation, are comprised of oxidized terrigenous clastics: sand, gravelly sand, silt, and clays in a downward fine to coarse sequence. The Low Terraces are described as a group because of their similar lithologies and identical depositional histories. Being fluvial deposits, much of the Low Terrace material is derived from adjacent formations and therefore may appear similar to them, especially the Citronelle. Low Terrace sediments are usually less indurated than Citronelle sediments and an experienced eye can recognize color differences. The Low Terraces are more yellow, orange, and brown in appearance when compared to the red tones of the Citronelle. The youngest terrace (Pamlico) appears mostly yellowish-gray, buff, and white. This may be due to the shorter duration of exposure to weathering and its closer association with the water table as compared to the older terraces.

Low Terrace sands are mostly quartz and they vary from very fine-grained (1/16 mm.) to very coarse-grained (2.0 mm.). The grains are mostly sub-rounded. As a rule the sands are poorly sorted. They commonly are silty and contain disseminated clay particles. In some places inclusions of gray clay (reworked Miocene?) are present. Organic material is frequently included in the terraces and siderite nodules are not uncommon.

Gravel in Low Terraces is more concentrated in some places than others. It is found in the basal parts of the deposit except where it occurs locally in irregular lenses. Figure 28 shows a terrace gravel grading upward into sand. Sizes of the pebbles range from a fraction of an inch up to several inches in diameter. Mostly the pebbles are smoothly rounded though not generally spheroid shaped. They are comprised of chert and quartz like the Citronelle gravels from which most were derived.

Figure 28.—Low Terrace gravel and sand. Location is north side of Highway 26 roadcut just west of Pascagoula River, center SW¼ sec. 22, T. 2 S., R. 8 W. July, 1966.

Clay beds are present locally in the Low Terraces. They are usually tan, pink, yellow, or red colored. An x-ray analysis of clay samples obtained from Core Hole AJ-35 showed that the major clay mineral is kaolinite. (See Table 2.) A detailed chemical analysis of these samples is included in Table 12.

Outcrops of Low Terraces tend to have considerable vegetative cover and some are under cultivation. Roadways traversing the Low Terraces have less road cuts owing to the typically level topography associated with the terraces. Outcrops of Third-level terraces are observed more frequently than others due to their higher altitudes and consequent greater amount of erosion.

Soils. Soils formed on the Low Terraces vary from yellowish-and brownish-red and yellowish-gray sandy loams to a black muck. The Third-level terraces contain the redder soils. A grayish cast is noticeable on the surface of cultivated fields and clods are fairly friable. The black muck soils are a swampy phase associated with poorly drained areas, most commonly First-level terraces.

Contacts. All formational contacts with the Low Terraces are unconformable due to the depositional nature of the Low Terraces. Figures 16 and 19 exhibit sharp contacts between Low Terrace sediments and the Pascagoula formation. Figure 29 shows a sharp contact between Low Terrace gravel and Pascagoula sand. Some exposures of contacts between Low Terraces and Pascagoula sediments clearly indicate that Miocene material was incorporated into the terraces.

One exposed contact between a Low Terrace and Citronelle rocks was described in the preceding Citronelle section. Another road cut exposure of the contact between these units was noted on the section line road at the base of sec. 4, T. 3 S., R. 5 W. Here a good color variation is exhibited; the Low Terrace is a yellow-brown color versus the red color of the Citronelle.

Contacts of Low Terraces with Recent alluvium are generally covered by vegetation because of their close association with the water table. Most exposures of these contacts are near bridge constructions.

Thickness and attitude. Thickness of individual Low Terrace deposits varies from zero at their featheredge to near 50 feet.

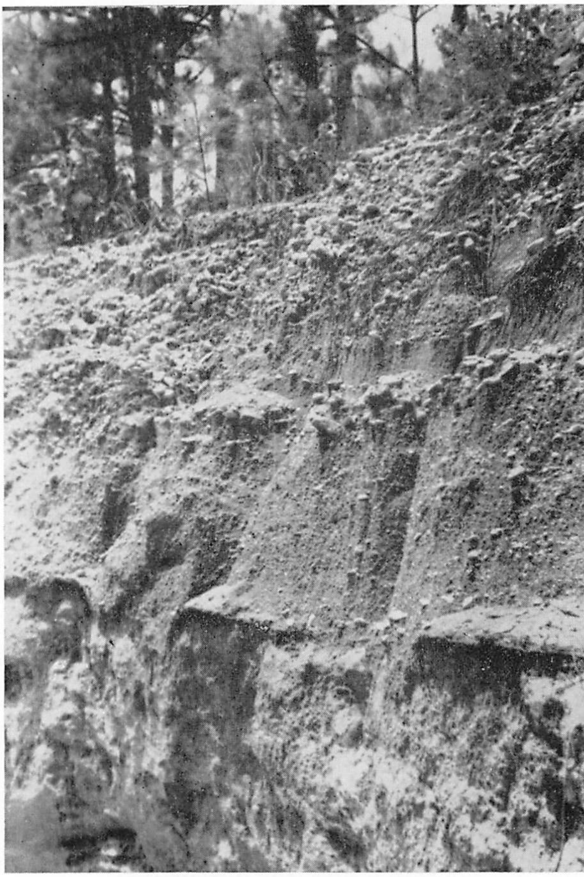


Figure 29.—Low Terrace gravel overlying Pascagoula sand. Large pebbles are present. Elevation of contact is about 80 feet and location is roadcut in NW¼ sec. 22, T. 2 S., R. 8 W. July, 1966.

This is demonstrated on Plates 2 and 3. The terraces slope toward the south at a slightly greater rate than the present flood plains. As previously explained, each river has its own slope or depositional profile. The terraces also have a gentle inclination toward the center of the present flood plains.

Age. A late Quarternary - Pleistocene age assignment for the Low Terraces is deemed adequate. The writer recognizes that all of the terraces are probably related to interglacial stages and, therefore, could be assigned to a specific time interval, but the Pamlico terrace (First-level terrace) is the only one so assigned in this report. This deposit can be correlated with the Pamlico plain on the Gulf Coast which, according to Brown, slopes gulfward from an altitude of 25 feet above sea level.[61] The presence of a sea floor plain whose shore line is at an altitude of 25 feet above sea level is the basis for designating it as Pamlico. A Pleistocene marine fauna is associated with the Pamlico interval on the Gulf Coast.[62] The remaining Low Terraces are necessarily pre-Pamlico and may be Talbot and Penholoway equivalents in keeping with coastal terrace nomenclature recognized by Cooke.[63]

Depositional environment. The environment in which the Low Terraces were deposited was similar to the present conditions in George County. Each terrace unit merged gulfward with contemporary estuarine or marine equivalents just as flood plains of the present streams merge with estuarine, beach, and near-shore deposits at the Coast. The fluvial terraces are comparable in size and have a similar volume and slope relationship to the present alluvial deposits. The Low Terrace sediments accumulated as channel sands and gravels, natural levees, back-levee and marsh muds and silts, and clay plugs.

Valley cutting occurred during glacial stages when base level was lowered due to withdrawal of oceanic water to form ice. Alluviation of the valleys occurred during interglacial stages when melt water raised the base level. Apparent epeirogenic elevation has resulted in younger terrace units being deposited at succeedingly lower positions. Arguments favoring (1) a eustatic change of sea level and (2) an isostatic adjustment compensating for subsidence in depocenters have been offered in explanation of the elevation.

QUATERNARY SYSTEM—RECENT SERIES

ALLUVIUM

Nomenclature. Alluvium is comprised of a mass of stream deposits. The term is intended to apply to unconsolidated stream deposits of a comparatively recent time.

Outcrop and subsurface. Alluvium, by definition, is comprised of clastics. In George County the alluvium includes clastics of all sizes from clay-sized particles to gravel. Bedding and grain size distribution in the alluvial deposits is irregular.

Individual sand, gravel, and clay deposits vary in thickness. The alluvial mass includes deposits of bars, abandoned stream channels, flood plains, and natural levees.

Vegetative growth generally covers the surface of alluvial plains in George County so that most exposures are along the banks of streams. The sand bars of the Pascagoula and Escatawpa Rivers are the most commonly noted alluvial deposits in the County. Samples from two Pascagoula River bars and one Escatawpa River bar were chemically analyzed. Screen analyses were also run on these samples. The analyses are shown on Table 13. Grain size percentages of these bars are illustrated by histograms on Figure 30. Microscopic examination showed the sands to be clear to white, fine- to coarse-grained, but mostly medium, sub-rounded to rounded, quartz grains.

Alluvial sands recovered from core holes range from very fine- to very coarse-grained. Some appear well sorted but most are poorly sorted and contain varying amounts of clay. Colors generally are light shades of gray, orange, yellow and pink.

Gravel is present within the alluvium as scattered lenses and several core holes encountered gravel. The pebbles are similar to those of the Citronelle and Low Terraces from which most were derived.

Back-swamp deposits are quite extensive in George County. They consist principally of interbedded thinly laminated silt, silty clay and clay. The clays are generally gray to gray-brown colored with occasional reddish mottling. They have a high organic content consisting of leaf remains, logs, twigs, roots, and other comminuted vegetal matter. Some have a fetid (hydrogen sulphide) odor. Clay samples from Core Hole AJ-30 were analyzed by x-ray. Montmorillinite is the major clay mineral. (See Table 2.) Several alluvial clay samples were chemically analyzed. The analyses are shown on Table 12.

Abandoned channels are filled with clay and mud, silt, or sand depending on the manner in which the channel they fill was cut off from the river. Those channels which were abandoned rapidly receive only fine floodwater clay and mud. Those abandoned more slowly collect sand until they choke and cause final diversion of the channel.

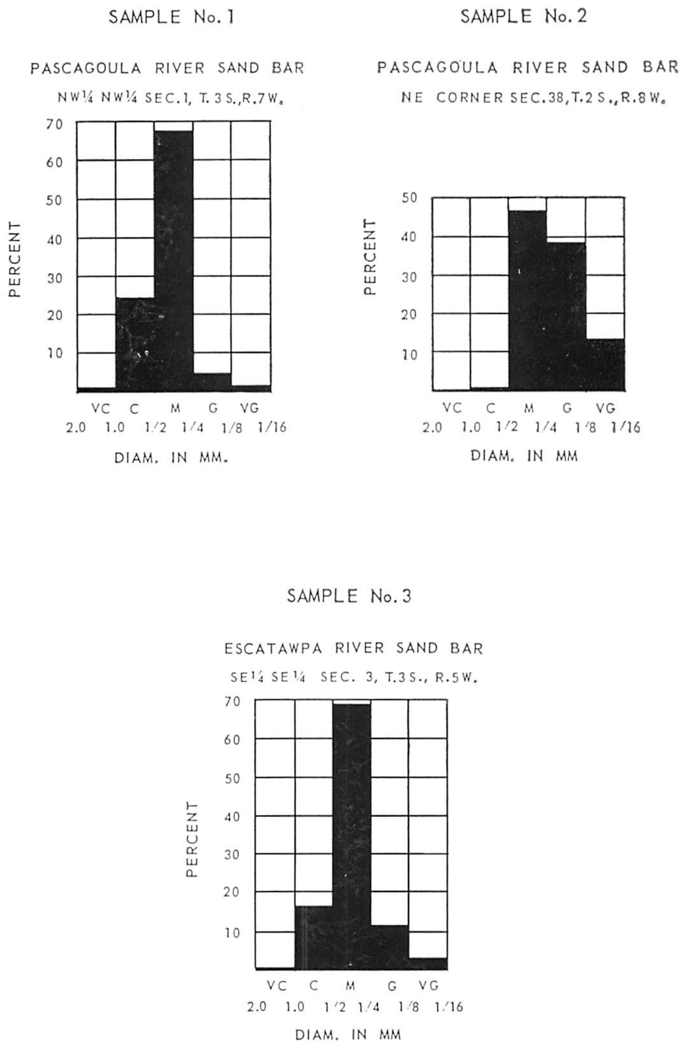


Figure 30.—Histograms of Pascagoula and Escatawpa River sands. Chemical and screen analyses of these sands listed on Table 11.

Soil. Soils developed on the alluvium are generally a brownish and grayish colored clay or silty clay loam. They become very plastic when wet but crumble fairly easily on drying.

Contacts. The alluvium is unconformably in contact with all previously described formations in George County. Vegetative cover obscures most contacts but some can be observed along the stream banks. One good exposure of the contact of alluvium and Pascagoula sediments is described in the Pascagoula section. Subsurface contacts of the alluvium and Pascagoula formation are readily apparent on electrical logs and lithology logs.

Thickness and attitude. The alluvium varies in thickness from zero to more than 50 feet in George County, as shown on Plates 2 and 3. The slope of the alluvial plain is to the south and each stream has its own gradient. As mentioned in the Geomorphology section, the Pascagoula plain slopes at an average rate of 1.66 feet per mile and the Escatawpa plain slopes at an average rate of 3 feet per mile in George County.

Age. As explained, the alluvium is the youngest deposit in George County and accretion is still in progress. Thus it is of Recent age. Some scientists prefer the term Holocene in place of Recent.

Depositional environment. The environment of deposition of alluvium is clearly displayed in George County. In brief review, the significant units are channel deposits, point bars, natural levees, and back-levee (flood plain) deposits. These units together form the alluvium which in turn merges with equivalent estuarine, beach, and near-shore deposits of the modern Gulf Coast.

STRUCTURE

GENERAL STATEMENT

Structural configuration of George County is shown on contoured maps using as datums the top of Lower Tuscaloosa, Wilcox and *Heterostegina* limestone and the base of the Pascagoula formation. These maps illustrate structure at deep, intermediate, and shallow depths. Surface structure is illustrated by a contoured map using the base of the Citronelle formation as a datum. Datums for all but the surface structure map were obtained from electrical logs of oil and gas tests drilled in George County; sample tops were used where no electrical log was available. Datums obtained from numerous core holes drilled by the Survey and major oil companies plus datums obtained from electrical logs of several water wells enhance the accuracy of the shallow maps.

A total of thirty-one oil and gas tests have been drilled in George County. Locations of the wells are shown on Figure 31. Specific data for each well is listed on Table 3.

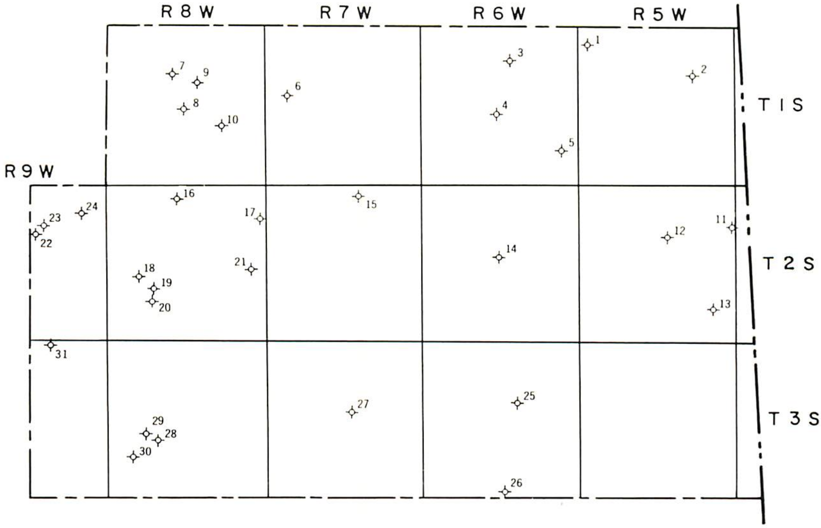


Figure 31.—Locations of oil and gas tests. Table 3 lists specific data for each well.

The Southern Natural Gas Company, Green Estate, et al. No. 1 is the deepest well in the County. It is located in northwestern George County in sec. 37, T. 1 S., R. 8 W. The well was drilled in 1955 and reached a total depth of 13,308 feet. The oldest formation penetrated is the Sligo of Comanchean Cretaceous age.

TABLE 3
Oil and Gas Tests in George County
Complete to January 1, 1967

Location					Operator and well name	Completion Date	Elevation*	Total depth	Stratigraphic unit*		Electric log*	Samples*
No.	T.	R.	Sec.						Surface	Bottom		
1	1S	5W	6	N½ SW	United Gas Public Service Co., Williams Unit 1	1935	223	6928	Pc	K—	yes	no
2	1S	5W	11	SE SW	Southern Prod. Co., et al, Hibernia Bank 1	1954	133	8307	Mp	K—	yes	yes
3	1S	6W	10	SE NW	Sinclair Oil & Gas Co. Luce Packing Co. 1	1954	253	8308	Pc	K—	yes	yes
4	1S	6W	21	SE NE	Central Oil Co., Luce Packing Co. 1	1955	235	8106	Pc	K—	yes	yes
5	1S	6W	25	NE SW SW	A. C. Glassel et al, Luce Packing Co. 1	1933	278	3137	Pc	E—	no	yes
6	1S	7W	39	900′ S&W of NE cor. 38	Central Oil Co. et al, Green 1	1959	76	11511	Qa	K—	yes	yes
7	1S	8W	9	CSW	Ryan & Anderson, Newman Lbr. Co. 1 (formerly Love, Newman Lbr. Co.)	1938	110	7038	Mp	K—	yes	yes
8	1S	8W	21	E½ NE NE	Sunnyland Contr. Co., U. S. A. 1	1955	102	9013	Mp	K—	yes	no
9	1S	8W	37	NW NW	Southern Natural Gas. Co., Green Est. et al 1	1955	68	13308	Qp	K—	yes	yes

TABLE 3—(Continued)

Location				Operator and well name	Completion Date	Elevation*	Total depth	Stratigraphic unit		Electric log*	Samples*
No.	T.	R.	Sec.					Surface	Bottom		
10	1S	8W	42 SE SE	Davis, Green 1	—	54	11522	Qa	K—	no	no
11	2S	5W	12 NE NE	LaRue et al, Mrs. Florence Boss 1	1954	103	8503	Mp	K—	yes	yes
12	2S	5W	15 NE NW	LaRue et al, K. W. Stringfellow 1	1954	149	8515	Pc	K—	yes	yes
13	2S	5W	25 SW SW	Sadler Oil Co. et al, Hibernia Bank 1	1955	71	8510	Qp	K—	yes	yes
14	2S	6W	16 SE SE	LaRue et al, Board of Supervisors 1	1954	179	8316	Pc	K—	no	yes
15	2S	7W	3 W½ SW NE	Hassie Hunt, H. C. McLain 1	1949	201	8506	Pc	K—	yes	no
16	2S	8W	3 W½ SW SW	Crow Drlg. Co. et al, B. E. Green 1	1953	97	8235	Mp	K	yes	yes
17	2S	8W	12 W½ SE	Gulf Refining Co., Pascagoula Hardwood Co. 1	1933	55	2025	Qa	—	no	yes
18	2S	8W	20 NW SW	H. H. Duck, Dantzler et al 1	1951	148	8702	Pc	K—	yes	yes
19	2S	8W	29 NW NE	Larco Drlg. Co. et al, Tillary 1	1958	139	11014	Pc	K—	yes	yes
20	2S	8W	29 NW SE	LaRue et al, A. F. Dantzler et al 1	1954	123	8638	Pc	K—	yes	yes
21	2S	8W	42 C N½	R. G. Copeland, Pascagoula Hwd. and Lbr. Co. 1	1957	56	11009	Qa	K—	yes	yes

TABLE 3—(Continued)

Location					Operator and well name	Completion Date	Elevation*	Total depth	Stratigraphic unit		Electric log*	Samples*
No.	T.	R.	Sec.						Surface	Bottom		
22	2S	9W	10	SW SW	A. R. Temple et al, A. F. Dantzler 1	1952	175	8404	Pc	K—	yes	yes
23	2S	9W	10	W½ SE	Gulf Refining Co., Dantzler Lbr. Co. et al 8	1935	145	3450	Mp	—	no	no
24	2S	9W	11	NE NE	Crow Drlg. Co. et al, A. S. Dantzler 1	1954	208	8299	Pc	K—	yes	yes
25	3S	6W	15	SW NE	Viking Oil Co., Hibernia Bank 1	1961	146	8585	Pc	K	yes	yes
26	3S	6W	34	SW SW	D. S. Hager et al, Phoenix Min. Corp. 1	1962	78	9535	Mp	K	yes	yes
27	3S	7W	15	SW SW	Gulf Refining Co., Pascagoula Hwd. & Lbr. Co. 2	1933	30	2500	Qa	—	no	yes
28	3S	8W	20	SE SE	Jett Drlg. Co. et al, Dantzler Lbr. Co. 1	1960	49	12013	Qa	K—	yes	no
29	3S	8W	20	E½ NE SW	Ohio Oil Co., Dantzler Lbr. Co. 1	1948	61	6022	Qa	K	yes	yes
30	3S	8W	30	SE NE	Ohio Oil Co., Dantzler Lbr. Co. 2	1948	82	5924	Mp	K	yes	yes
31	3S	9W	3	NE NE	D. S. Hager et al, University of Mississippi	1963	95	8533	Mp	K	yes	no

* Elevation—Derrick floor
* Electric log—Filed at Mississippi Geological Survey
* Samples—Filed at Mississippi Geological Survey
* Stratigraphic unit—Qa = Alluviam; Qp = Pamlico; Pc = Citronelle; Mp = Pascagoula; E = Eocene; K = Cretaceous

REGIONAL STRUCTURE

Major structural features of the central Gulf Coastal Plain are shown on Figure 32. Regionally, George County is situated at the southern edge of the East Mississippi Syncline (Mississippi Interior Salt Dome Basin; Perry Basin) and north of the axis of the Gulf Coast Geosyncline. The axis of the Wiggins

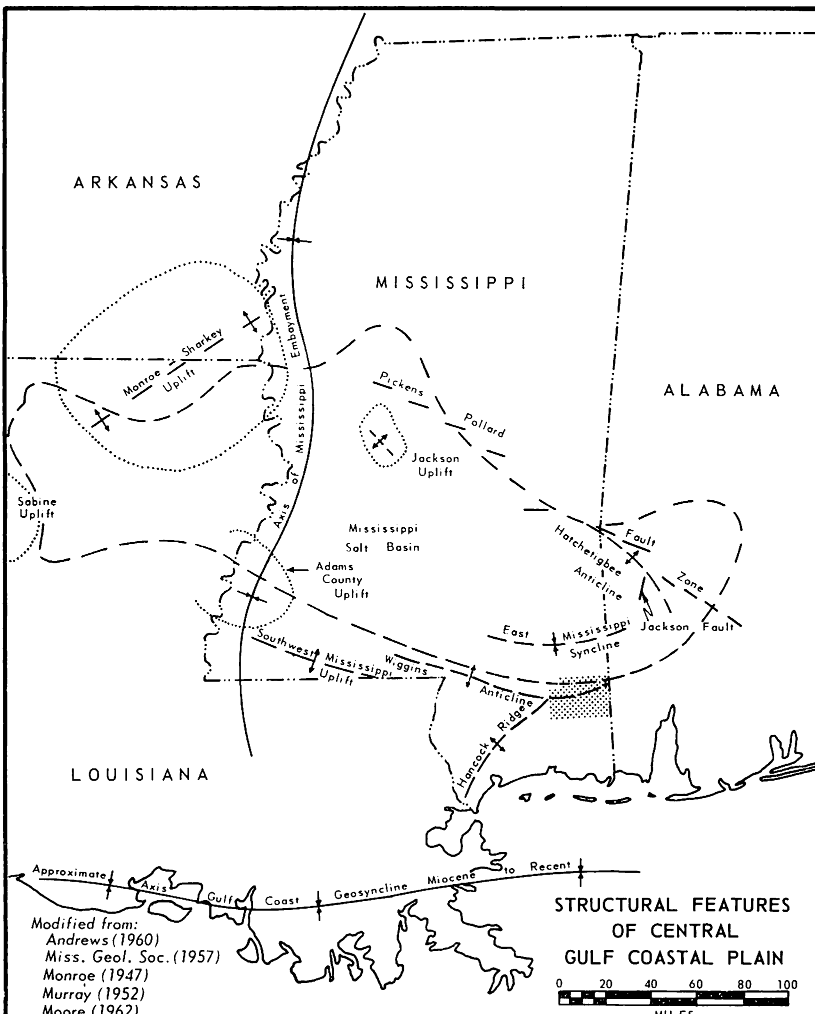


Figure 32.—Structural features of central Gulf Coastal Plain. George County is shown as stipled area.

Anticline traverses the County in a westerly direction. This feature derives its name from the town of Wiggins, Mississippi, which is situated near the anticlinal axis in Stone County.

LOCAL STRUCTURE

Several structural features in George County are shown on the accompanying maps. Structural features are described first as they appear in the subsurface, followed by a description of structural configuration based on surface mapping. Some minor structural anomalies are present but are not discussed. All of the described subsurface features are evident at the surface in George County.

SUBSURFACE

Figure 33 is a structure map on the Lower Tuscaloosa. The datum is easily correlatable on electrical logs and can be recognized in well cuttings in George County.

The Wiggins anticline is apparent on the Lower Tuscaloosa map. It plunges west-southwest across George County, entering

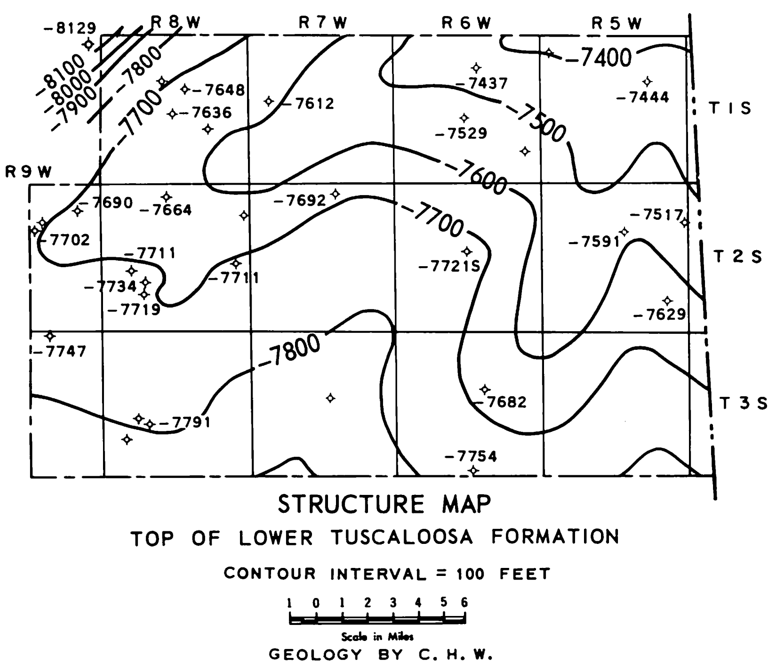


Figure 33.—Structure map, top of Lower Tuscaloosa formation.

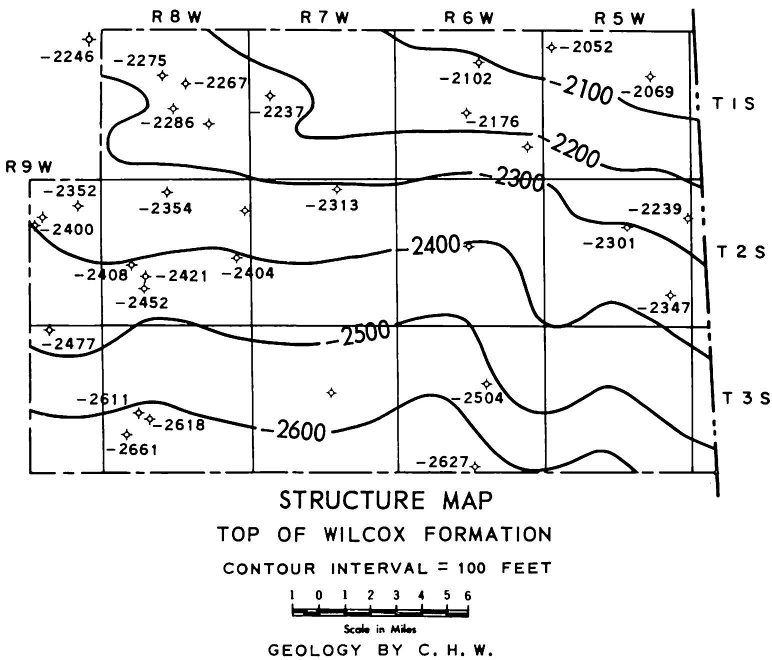


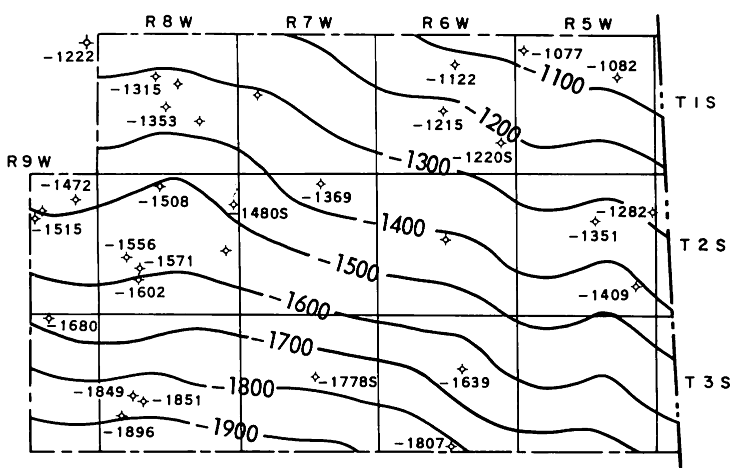
Figure 34.—Structure map, top of Wilcox formation.

at the northeast corner of the County. The feature appears as an assymetrical fold with strong dip northward into the Perry Basin. The southern flank of the Wiggins anticline exhibits a more gradual dip. The anticlinal axis is evident on the Wilcox structure map, Figure 34, but not nearly so apparent as on the deeper horizon. The axis is not evident on the *Heterostegina* map, Figure 35, but the feature is actually determining strike. Thickness of Oligocene and early Miocene sediments combined with southward tilting has the effect of masking the Wiggins anticline at this horizon.

The writer feels the necessity to further discuss the Wiggins anticline with the hope that his observations in George County may help dissolve some of the mystery generally attached to this feature. Most questions deal with the age and cause of tectonism associated with the feature. Is the Wiggins anticline due to salt or basement movement? Is it a Paleozoic or a relatively late feature? The writer's concept of the Wiggins anticline in George County is outlined below.

Prior to attaining the now pronounced anticlinal (reversal) configuration, the George County area was a generally stable area as compared to the persistently negative area to the north. That is to say, it had a cause-and-effect relationship with the Perry Basin, a Mesozoic and early Cenozoic depocenter. Whether or not a basement or Paleozoic feature was responsible for this early relationship is unknown as no wells have yet reached basement or Paleozoic rocks in this vicinity. Geophysical data does indicate an east-west lineation. The recently published Basement Map of North America[64] indicates that basement in this area is below 24,000 feet.

Figure 36 shows the development of the Wiggins anticline in the George County area by a series of schematic cross sections illustrating configuration at successive stages. During Mesozoic and Early Tertiary time the thickest accumulation of sediment was north of George County. Isopachous maps of these sediments reveal only regional thinning to the south with no indication of anticlinal structure in George County as demonstrated



STRUCTURE MAP

TOP OF HETEROSTEGINA LIMESTONE

CONTOUR INTERVAL = 100 FEET

1 0 1 2 3 4 5 6

Scale in Miles

GEOLOGY BY C. H. W.

CORE HOLE DATUMS NOT SHOWN

Figure 35.—Structure map, top of **Heterostegina** limestone.

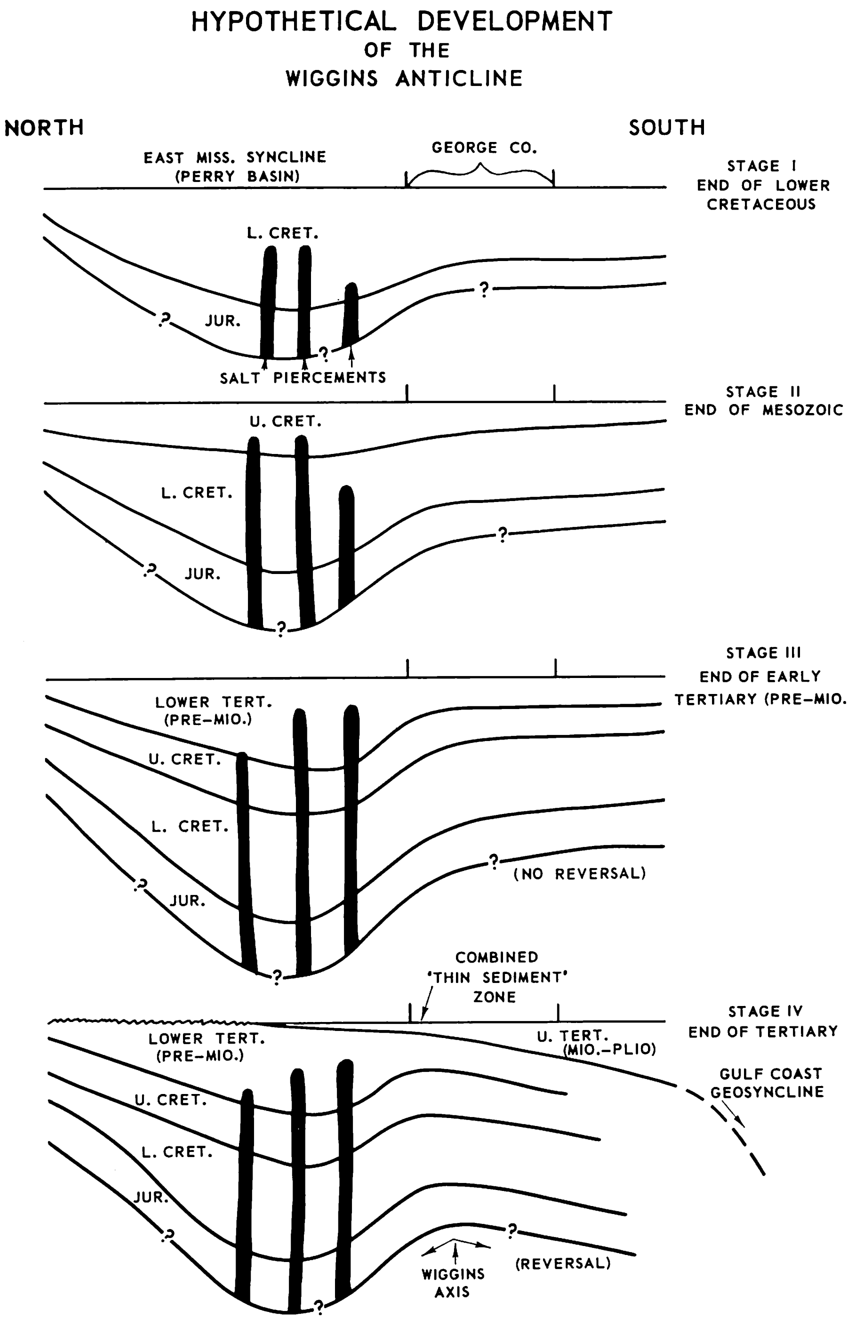


Figure 36.—Hypothetical development of the Wiggins anticline.

by Figure 36, Stages I-III. The thinning is due to decreasing supply of sediment in a southerly direction; the subsiding area to the north collecting the major portion of sediment. By Late Tertiary time the center of deposition had shifted southward beyond George County in association with the Gulf Coast Geosyncline. Subsidence and accompanying southward tilting provided a south dip to the heretofore near-horizontal beds in George County creating the south flank of the Wiggins anticline, Figure 36, Stage IV. The axis of the feature served as a hinge or fulcrum. The term 'flexure' might better apply to the Wiggins feature in that bending of sediment is implied. Isopachous maps show that Late Tertiary to Recent sediments have a normal gulfward thickening; i. e. north to south.

George County is thus situated just south of a Mesozoic and Early Tertiary depocenter and north of the thickest accumulations of sediment in Late Tertiary time. The combined 'thin sediment' zone accents the Wiggins anticline. The lack of piercement-type salt domes in this area lends support to the writer's concept; assuming that piercements occur in areas where a primary concentration of sediment overburden is available for triggering action (fig. 36).

Another anticlinal structure shown on the accompanying maps is located in eastern George County. It trends in a north-northeast—south-southwest direction and plunges to the south. This structure appears strongest on the Lower Tuscaloosa map (fig. 33) and decreases in intensity upward. The axis of this structure is coincident with a gravity minimum and may be due to deep seated salt movement. Complementing synclinal axes are present on both the east and west sides of the anticline.

SURFACE

Structural configuration based on surface mapping in George County is shown on Plate 5. Datum is the base of the Citronelle formation. A thorough study of surface stratigraphy in George County revealed no mappable beds within the outcropping formations. The only stratigraphic marker available for mapping is the contact between the Pascagoula and Citronelle formations. The writer is fully cognizant that maps contoured on unconformities are of questionable value in determining structure. Nonetheless, contours on the base of the Citronelle formation do present a relation to subsurface structure in George County.

Most of the elevations of the Pascagoula/Citronelle formation contact (map datum) were obtained from the topographic maps described in the General Topography section of this report. Accordingly a contour interval of twenty feet was used in order to minimize effects due to interpolation. Some irregularities on the unconformable Pascagoula surface were noted in George County, but the writer feels that the ample control, when plotted on a countywide basis, reduces the amount of error applicable to a sectionwide area, and that the overall interpretation is a reasonable indication of true structure.

Surface evidence of the Wiggins anticline exists in the form of westward nosing as shown on Plate 5, and in the anomalous course of the Pascagoula River. The axis of the feature is traced west-southwest across the County from the northeast corner. Low relief culminations are indicated along the axis. The Pascagoula River alluvial plain is bowed to the west in George County closely following the plunge of the Wiggins anticline. (Refer to Figure 3 for regional drainage patterns.)

The cross sections on Plates 2 and 3 show structure in addition to illustrating stratigraphic and geomorphologic details. The surface structure datum is plainly demonstrated by the red-green contrast. North-South cross sections 6-12 (pl. 3) show reversal over the Wiggins anticline. Cross section 13 shows south dip from the crest of the feature. The fact that reversal is shown on both the surface structure map and the North-South cross sections and is not indicated on shallow subsurface maps (Top of *Heterostegina,* Figure 35 and Base of Pascagoula, Figure 21) is probably due to the combined effect of a smaller contour interval, gravitational slide, and pre-Citronelle depositional topography. Contour interval on the shallow subsurface maps is 100 feet as compared to a 20 foot interval on the surface map. The smaller contour interval shows more detail. The steepening of dip indicated by crowding of contours adjacent to and in the direction of the major river valleys suggests that gravitational sliding may have occurred. Certainly the Pascagoula clay surface would act as a lubricant. This possibility is not hard to imagine when studying the cross sections. Pre-

Citronelle topography may have been conformable to subsurface structure. Erosion of the Pascagoula surface may have left topographic highs along the axis of the Wiggins anticline and thus contours on the base of Citronelle datum reflect this situation.

Other conditions possibly reflecting to some degree the Wiggins structure are the narrowing of the Pascagoula River alluvial plain where it crosses the axis, less meander loops in the River at this position, and deflection of the River against the west bank. Also the Low Terraces west of the River and along the axial trend appear more dissected by erosion. This may indicate some late upward movement of the Wiggins feature.

It should be mentioned that all of the above cited indications of structure may be due to the Wiggins anticline only in an indirect relation. The possibility exists that the surface indications may be reflecting a post-Oligocene undaform edge condition which developed coincidently with the axis of the Wiggins anticline.

The anticlinal feature shown on subsurface maps in eastern George County is also reflected on the surface structure map. The axis of this feature on the surface appears slightly west of the subsurface axis. The reason for the divergence of axes is believed to be partly due to a combination of pre-Citronelle topography and gravitational sliding toward the Escatawpa valley. East-West cross sections 5-8 (pl. 2) show reversal over this feature. Cross section B also shows reversal over the anticlinal axis. The topographic ridge associated with this structure has long been recognized by geologists and George County residents. It is referred to locally as the Lucedale Ridge. In 1923 E. N. Lowe in the Ninth Biennial Report of the Mississippi Geological Survey [65] wrote the following:

> Extending through eastern George County in a generally northeast direction from the lowlands skirting the Gulf, is a notable ridge, or region of uplands from 285 to 325 feet above sea level. This ridge is "remarkably straight and regular as compared with other watershed ridges in the coastal region, occasionally widening and flattening to a plateau of several square miles."

Lowe also cited subsurface evidence in the form of drillers' logs that the ridge "may be a broad anticline, or possibly a faulted uplift."

The position of the Escatawpa valley appears to be dictated by structure in that the valley is coincident with the subsurface synclinal axis east of the southward plunging anticlinal feature.

WATER RESOURCES

GENERAL STATEMENT

A chapter on water resources is included because of an ever-increasing demand for information concerning water supplies and because George County should have water facts at hand for both local interests and future industries. The general availability and character of ground-water and surface water supplies in George County is discussed in this chapter. Basically, matters concerning water involve the science of geology, e. g. occurrence, availability, and quality.

RELATION TO USE

The importance of having an adequate and suitable supply of fresh water cannot be exaggerated. Quality of available water helps determine its present and potential use—e. g. drinking, irrigation, recreational, industrial. The United States Public Health Service standards for drinking water are shown on Table 4. Industrial water quality requirements vary as to use.

TABLE 4

U. S. Public Health Service, drinking-water standards, 1962

Chemical constituent	Recommended limit (ppm)	Maximum allowable (ppm)
Alkyl benzene sulfonate (ABS)	0.5	—
Arsenic (As)	.01	0.05
Chloride (Cl)	250	—
Copper (Cu)	1.0	—
Fluoride (F)	[1].8-1.7	[1]1.6-3.4
Iron (Fe)	.3	—
Lead (Pb)	—	.05
Manganese (Mn)	.05	—
Nitrate (NO_3)	45	—
Sulfate (SO_4)	250	—
Dissolved solids	500	—

[1] Varies inversely with mean annual temperature.

Table 5 shows general industry tolerances. The source and significance of common mineral constituents and physical properties of water are outlined below.

Silica (SiO_2).—Silica, dissolved from practically all rocks, does not affect use of water for domestic purposes. It affects industrial use of water because it contributes to formation of boiler scale and helps cement other scale-forming substances which may cause damage in a short time. Well water generally contains more silica than surface water.

Iron (Fe).—Iron is dissolved from practically all rocks and soils, and nearly all natural water contains some iron. Water having a low pH tends to be corrosive and may dissolve iron in objectionable quantities from pipes. Iron precipitates on exposure of water to air, forming an insoluble hydrated oxide which causes reddish-brown stains on fixtures and on clothing washed in iron-bearing water. In large amounts iron imparts a taste and makes water unsuitable for manufacture of food, paper, ice, and other products used in food processing. Iron may cause trouble by supporting growth of bacteria, which clog screens and gravel packing around wells. Iron can be removed by aeration, sedimentation, and filtration; by precipitation during removal of hardness; or by ion exchange.

Calcium (Ca) and magnesium (Mg).—Calcium and magnesium are dissolved mostly from limestone, dolomite, calcareous sand, and gypsum, by water containing carbon dioxide. Calcium and magnesium are the principal cause of hardness of water and contribute to the formation of scale in boilers, hot-water heaters, and pipes and to the objectionable curd in the presence of soap. These mineral constituents and hardness greatly affect the value of waters for public and industrial uses.

Sodium (Na) and potassium (K).—Compounds of sodium and potassium are abundant in nature and highly soluble in water. Some ground water that contains moderate amounts of dissolved material and is hard may, in passing through rock formations, undergo base exchange and become soft at greater depths. Water containing more than 50 ppm of the two combined may cause foaming in boilers; usually not objectionable in drinking water until the quantity is sufficient to affect the taste.

Bicarbonate (HCO_3) and carbonate (CO_3).—Bicarbonate and carbonate in natural water result from the action of carbon-dioxide-bearing water on rock materials, principally limestone and dolomite. Carbonate is present in only a few natural waters. Bicarbonate is of little significance in public supplies except in large amounts, where taste is affected or where the alkalinity affects the corrosiveness of the water. Large amounts of sodium bicarbonate cause foaming in boilers.

Sulfate (SO_4).—Sulfate is dissolved mostly from soils and beds of shale and gypsum, but some results from the oxidation of sulfides of iron. In combination with calcium and magnesium sulfate contributes to formation of hard scale and affects the use of water for industrial uses.

Chloride (Cl).—Chloride is in nearly all water in varying amounts. It is dissolved from soils and rocks over or through which the water passes. The chlorides of calcium, magnesium, sodium, and potassium are readily soluble. Drainage from sewage, salt springs, and oil fields and other industrial wastes may add large amounts of chloride to streams and groundwater reservoirs. Small quantities of chloride have little affect on the use of water. Sodium chloride imparts a salty taste which may be detectable when the chloride exceeds 100 ppm, although in some waters 500 ppm may not be noticeable.

Fluoride (F).—In nature fluoride occurs in fluorspar, cryolite, and some other minerals. Most natural water contains a little fluoride. Fluoride in larger amounts may cause mottling of children's teeth. However, water having about 1 ppm of fluoride may substantially reduce tooth decay in children who have used the water during calcification of their teeth. Fluoride content may be of little importance in industrial use of water.

Nitrate (NO_3).—Nitrate in water represents the final oxidation product of organic nitrogen compounds. Its presence may indicate pollution, and in high concentration it may be an indicator of sewage or other organic matter. In amounts less than 5 ppm nitrate has no effect on the value of water for ordinary uses. A National Research Council report concludes that water having a nitrate content in excess of 44 ppm should be regarded as unsafe for infant feeding. It may be a contributing factor to nitrate cyanosis ("blue-baby disease") in such unusual amounts.

Dissolved solids.—The dissolved-solids content represents the total quantity of dissolved mineral constituents, and includes any organic matter present and some water of crystallization. The amount and character of the solids depend on the solubility and type of rocks with which the water has been in contact. The taste of the water often is affected by the amount of dissolved solids.

Color.—Color refers to the appearance of water that is free of suspended matter. It results almost entirely from extraction of coloring matter from decaying organic materials such as roots and leaves in bodies of surface water or in the ground. Natural color of 10 units or less usually goes unnoticed and even in larger amounts is harmless in drinking water. Color is objectionable in the use of water for many industrial purposes, however, it may be removed from water by coagulation, sedimentation, and filtration.

Hydrogen-ion concentration (pH).—The hydrogen-ion concentration of water, expressed as the pH, is a measure of the relative acidity or alkalinity. A pH of 7.0 indicates a neutral water. Values progressively lower than 7.0 denote increasing acidity, and those above 7.0 denote increasing alkalinity. The pH indicates the activity of the water toward metal; as pH increases the corrosiveness normally decreases, although excessively alkaline water may be corrosive to some metal surfaces. The pH values of public supplies have an important bearing on the utility of the water for many industrial purposes.

Specific conductance (micromhos at 25°C).—Specific conductance is a measure of the ability of a water to conduct an electric current, and it furnishes a rough measure of the mineral content of the water. It gives no indication of the relative quantities of the different constituents in solution. It is useful in making comparisons of the estimated total mineral content of different waters, and of following changes in such content of water in a stream.

Temperature.—The temperature shown is in degrees Fahrenheit and represents the temperature of the water at the time of sampling. Most measurements are made at the well head after sufficient water has been withdrawn to represent the approximate temperature in the formation. Ground water in a given locality is generally of constant temperature, varying very little during the year. The average temperature of water at depths of a few tens of feet generally is about the same as the mean annual air temperature. It increases with depth at the rate of about 1° for each 50 to 100 feet.

Hardness.—In the development of a water supply hardness is one of the most important single factors to be considered. It is caused principally by the calcium and magnesium in solution and is generally reported as the amount of calcium carbonate equivalent to the calcium and magnesium. Carbonate hardness, as shown in the analyses, refers to hardness caused by the calcium and magnesium equivalent to the bicarbonate and is called "temporary" hardness, as it can be removed by boiling the water. "Permanent" or noncarbonate hardness is caused by the combination of calcium and magnesium with sulfate, chloride, and nitrate. Scale caused by carbonate hardness usually is porous and easily removed, but that caused by noncarbonate hardness is hard and difficult to remove. Hardness is usually recognized in water by the increased quantity of soap required to make a permanent lather. As hardness increases, soap consumption rises sharply, and an objectionable curd is formed.

Water having a hardness of less than 60 ppm, expressed as $CaCO_3$, is generally recognized as soft and suitable for ordinary use. Water having a hardness of 60 to 120 ppm is considered moderately hard, but still usable without softening except for certain industrial applications and for laundering. Water having a hardness of more than 120 ppm is considered hard.

TABLE 5

Water quality tolerances for industrial applications

[American Water Works Association (1950, p. 67, table 3-4). Remarks: A, no corrosiveness; B, no slime formation; C, conformance to Federal drinking-water standards; D, Al_2O_3 less than 8 ppm, SiO_2 less than 25 ppm, Cu less than 5 ppm. Chemical constituents in parts per million]

Industrial use	Turbidity	Color	Fe	Mn	Fe+Mn	Hardness	Alkalinity	pH	Total solids	Remarks
Air conditioning[1]	----	----	0.5	0.5	0.5	----	----	----	----	A, B
Baking	10	10	.2	.2	.2	(2)	----	----	----	C
Boiler feed:										
0-150 psi	20	80	----	----	----	75	----	8.0+	3,000-1,000	
150-250 psi	10	40	----	----	----	40	----	8.5+	2,500-500	
250 psi and up	5	5	----	----	----	8	----	9.0+	1,500-100	
Canning:										
Legumes	10	----	.2	.2	.2	25-75	----	----	----	C
General	10	----	.2	.2	.2	----	----	----	----	C
Carbonated beverages[3]	2	10	.2	.2	.3	250	50	----	850	C
Confectionery	----	----	.2	.2	.2	----	----	(4)	100	
Cooling[5]	50	----	.5	.5	.5	50	----	----	----	A, B
Ice (raw water)[6]	1-5	5	.2	.2	.2	----	30-50	----	300	C
Laundering	----	----	.2	.2	.2	50	----	----	----	
Plastics, clear, uncolored	2	2	.02	.02	.02	----	----	----	200	
Paper and pulp:[7]										
Ground wood	50	20	1.0	.5	.0	180	----	----	----	A
Kraft pulp	25	15	.2	.1	.2	100	----	----	300	
Soda and sulfite	15	10	.1	.05	.1	100	----	----	200	
Light paper, HL-grade	5	5	.1	.05	.1	50	----	----	200	B

TABLE 5—(Continued)

Industrial use	Turbidity	Color	Fe	Mn	Fe+Mn	Hardness	Alkalinity	pH	Total solids	Remarks
Rayon (viscose) pulp:										
Production	5	5	.05	.03	.05	8	50	----	100	D
Manufacture	.3	----	.0	.0	.0	55	----	7.8-8.3	----	
Tanning[8]	20	10-100	.2	.2	.2	50-135	135	8.0	----	
Textiles:										
General[9]	5	20	.25	.25	----	20	----	----	----	
Dyeing	5	5-20	.25	.25	.25	20	----	----	----	
Wood scouring[10]	----	70	1.0	1.0	1.0	20	----	----	----	
Cotton bandage	5	5	.2	.2	.2	20	----	----	----	

[1] Waters having algae and hydrogen sulfide odors are most unsuitable for air conditioning.

[2] Some hardness desirable.

[3] Clear, ordorless, sterile water for syrup and carbonation. Water consistent in character. Most high-quality filtered municipal water not satisfactory for beverages.

[4] Hard candy requires pH of 7.0 or greater, for low value favors inversion of sucrose and causes sticky product.

[5] Control of corrosion is necessary as is also control of organisms, such as sulfur and iron bacteria, which tend to form slimes.

[6] Calcium bicarbonate is particularly troublesome. Magnesium bicarbonate tends to greenish color. Carbon dioxide assists to prevent cracking. Sulfates and chlorides of Ca, Mg, Na should each be less than 300 ppm (white butts).

[7] Uniformity of composition and temperature desirable. Iron objectionable because cellulose absorbs iron from dilute solutions. Manganese very objectionable; clogs pipelines and is oxidized by chlorine to permanganates, which cause reddish color.

[8] Excessive iron, manganese, or turbidity creates spots and discoloration in tanning of hides and leather goods.

[9] Constant composition; residual alumina less than 0.5 ppm.

[10] Calcium, magnesium, iron, manganese, suspended matter, and soluble organic matter may be objectionable.

GROUND WATER

GENERAL HYDROLOGY

In George County ground water is contained in aquifers of Miocene to Recent age. The term ground water is defined as fresh water (containing less than 1000 parts per million of dissolved salts). The major rock units which contain aquifers are the Catahoula, Hattiesburg, Pascagoula, Citronelle, Terraces, and Alluvium. The cross section on Plate 4 illustrates the position of some of the aquifers.

The term aquifer is defined as a unit which is porous enough to contain water and permeable enough to allow movement of the water. All of the fresh-water aquifers in George County are unconsolidated sands.

Recharge area for George County aquifers extends from the southern end of George County northward through Greene and Wayne Counties, Mississippi, and the western parts of Mobile and Washington Counties, Alabama. This area receives an annual rainfall of 60 inches as shown by Figure 2. That part of the water which does not escape by surface run-off, evaporation, and transpiration enters permeable outcropping units in the recharge areas and moves in the direction of dip through George County. Artesian head, or hydrostatic pressure, is imparted to the water as it moves down the gradient in aquifers and becomes confined between impermeable beds. Sufficient head is usually present to force the water many feet above the sands when they are penetrated by wells. Wells in which this condition is present are called artesian wells. If sufficient pressure is present to force water above the land surface then the wells will flow.

A study of ground water utilizes information available in the form of existing wells. In George County data has been collected on nearly 200 wells drilled between the years 1900 and 1966. Information gathered by the writer was added to well data previously published by the Mississippi Board of Water Commissioners.[66] Figure 37 is a map showing the locations of wells for which information is given. The well numbering system used is that already established for the County. Each complete township comprises one grid; partial townships are included with an adjoining township. The grid areas are designated alphabetically beginning with A in the upper left township

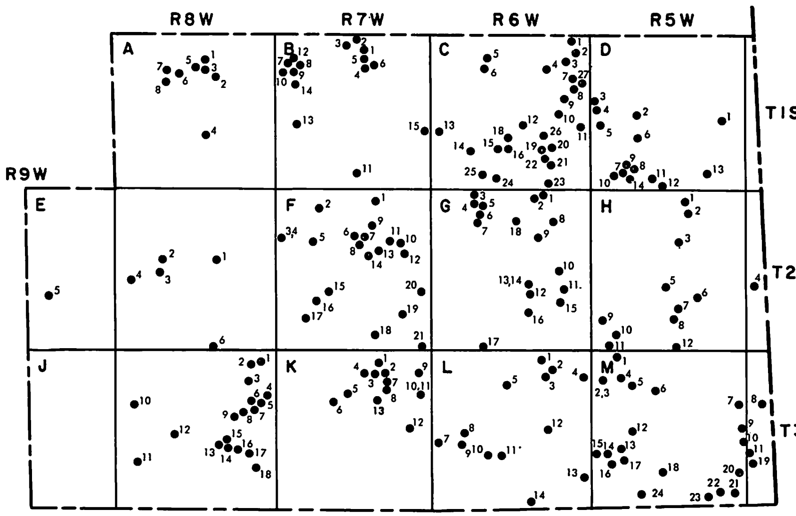
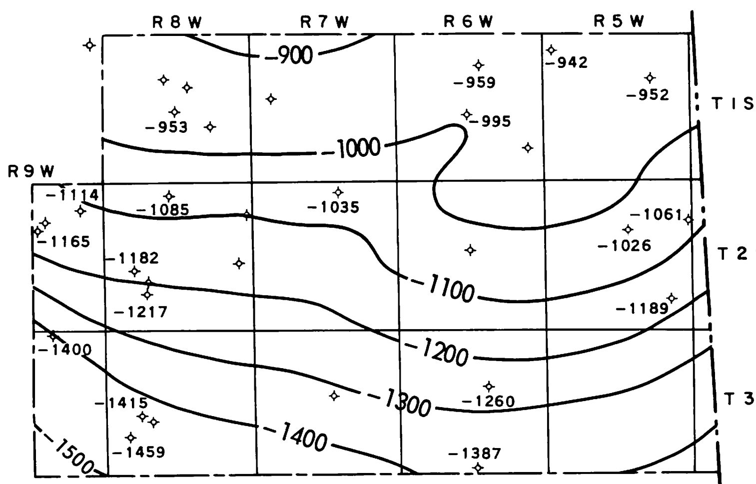


Figure 37.—Locations of water wells. Specific data for wells is listed on Table 6.



BASE OF FRESH WATER
AS DETERMINED FROM ELECTRICAL LOGS
CONTOUR INTERVAL = 100 FEET

1 0 1 2 3 4 5 6
Scale in Miles

GEOLOGY BY C. H. W.

Figure 38.—Map showing base of fresh water as determined from electrical logs.

and progressing to the right and downward in the normal reading order. The letter I is not used, thereby avoiding confusion with the numerical 1. Wells in each grid are numbered consecutively; e. g. — A 1, A 2, A 3, etc. Numbers on the map correspond with numbers in the tables. Table 6 consists of pertinent well data including geologic information, well construction, and water use. Table 7 lists chemical analyses of water from selected wells.

Electrical logs of wells are used to determine depth, thickness, and quality of untapped aquifers. For simplicity, an electrical log is a chart which shows horizontal reactions of an induced electrical current for every vertical foot of depth. Electrical logs of oil tests in George County (fig. 31 and tab. 3) were utilized in determining fresh-water information at depth. Figure 38 is a contour map showing configuration and approximate base of fresh water in the County. Fresh water may be obtained to a depth of near -1500 feet in the southwestern part of the County.

Table 8 gives pertinent information of fresh-water aquifers within the Pascagoula, Hattiesburg, and Catahoula formations as determined from electrical logs on oil tests. The rating assigned to each aquifer is an indication of its porosity and permeability, thickness, and estimated water quality (dissolved solids). Those aquifers ranked 'excellent' show excellent log character in addition to being relatively thick and homogeneous. Note that the aquifers listed on Table 8 are not the only aquifers present but are the ones thick enough to yield large quantities. Aquifers may be present above the depth where electrical measurements start.

CATAHOULA FORMATION

The oldest and deepest ground-water aquifers underlying George County are in the upper part of the Catahoula formation. Wells 900 to 1500 feet deep would be required to reach these sands. Recharge area for Catahoula aquifers is in Wayne and northeastern Greene Counties, Mississippi, and northern Washington County, Alabama, as shown by the map on Plate 4. No wells are currently producing water from Catahoula aquifers in George County.

HATTIESBURG FORMATION

The Hattiesburg formation contains several aquifers of considerable thickness capable of yielding large supplies of fresh water in George County. The water supply for the town of Lucedale is obtained from wells completed in sands in the Hattiesburg formation. The 1000 foot deep city wells, C 15 and C 17 (tab. 6) yield up to 500 gallons per minute. A chemical analysis of water from well C 15 is included in Table 7. The water is a sodium-bicarbonate type which contains moderate dissolved solids and has a pH of 7.

Two recently installed community water system wells, C 26 and C 27 (tab. 6), are also completed in Hattiesburg aquifers. Both wells are about 1000 feet deep and yield up to 200 gallons per minute. Comparison of electrical logs of wells in George County (tab. 8) indicates that the Hattiesburg formation contains other aquifers capable of similar or larger yields. Recharge area for Hattiesburg aquifers is mostly in Greene County, Mississippi, as shown by the map on Plate 4. Flowing wells could probably be obtained from Hattiesburg aquifers with wells located in the stream bottoms or other low lying areas. Hattiesburg reservoirs contain a large supply of water for future demands in the County.

PASCAGOULA FORMATION

Numerous aquifers in the Pascagoula formation underlying George County are capable of high yields. A large number of wells are completed in Pascagoula aquifers. This is due to the sands occuring at relatively shallow depths (tab. 6 and 8). Pascagoula reservoirs contain a soft, sodium-bicarbonate type water as shown by chemical analyses (tab. 7).

Many wells completed in Pascagoula formation aquifers are flowing wells. Figure 39 is a map delineating the area where flowing wells may be obtained from Pascagoula aquifers. Wells in this area flow because of hydrostatic pressure and low topography. Figure 40 shows a flowing well completed in a Pascagoula aquifer in George County. The well was drilled in 1939 and is located near the bridge over White Creek in T. 3 S., R. 7 W. (K 2, tab. 6). Depth of the well is 93 feet. When completed the well flowed at a rate of 120 gpm and the static

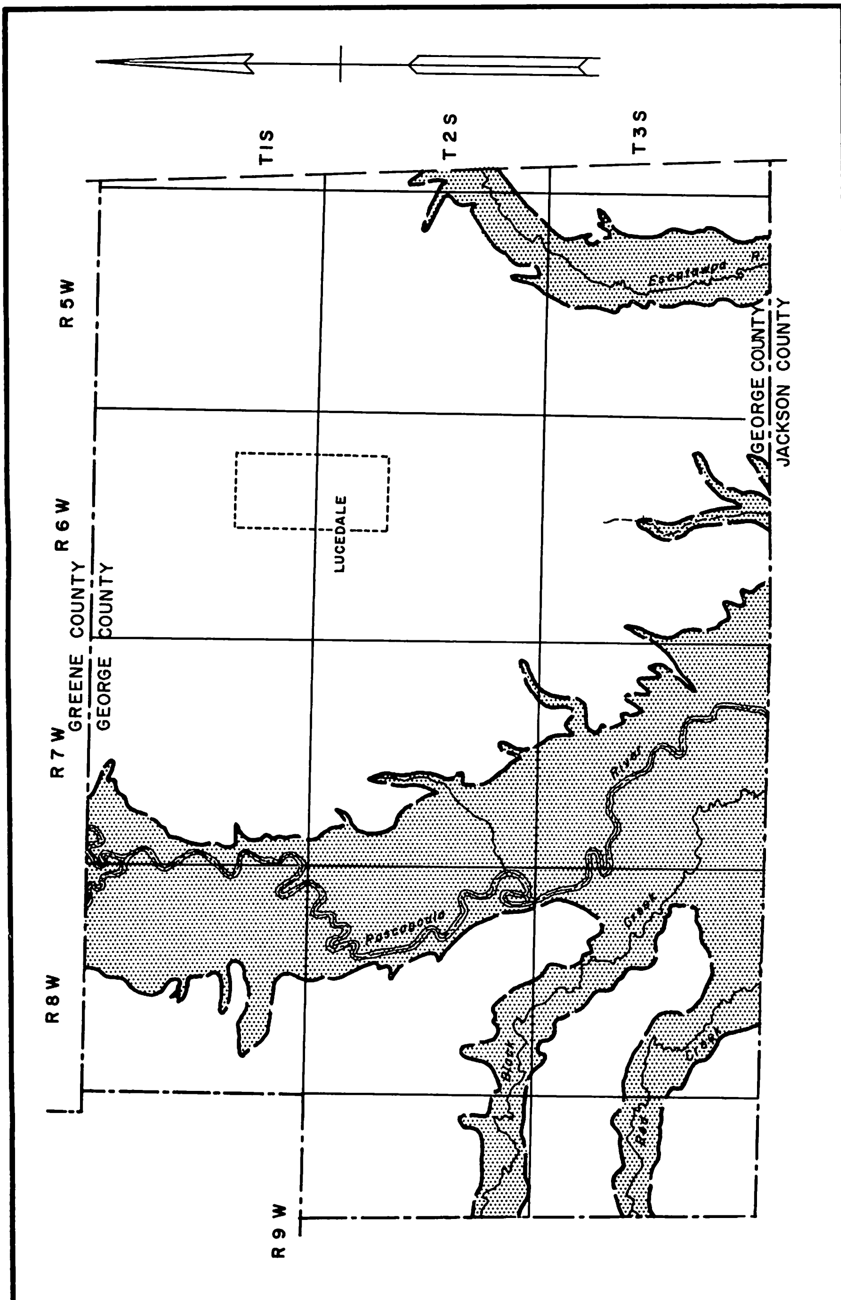


Figure 39.—Map showing areas of flowing artesian wells (stipled).

Figure 40.—A flowing well located just north of White Creek bridge in the northwest corner of irregular sec. 16, T. 3 S., R. 7 W. This well is designated K2 on Table 6. June, 1966.

water level was 26 feet above the land surface. Chemical analysis of water from this well is shown on Table 7.

Pascagoula formation outcrops, shown on the Geologic Map (pl. 1) are areas of recharge for ground water. Where the Pascagoula formation is covered by younger deposits, recharge water passes through these units before reaching Pascagoula sands or underlying reservoirs.

Electrical log study indicates that many aquifers capable of yielding large volumes of water are present in the Pascagoula formation throughout George County. Several thick aquifers are shown on the cross section on Plate 4.

CITRONELLE FORMATION

The Citronelle formation is an important unit in the hydrology of George County. The High Terraces are included with the Citronelle in this discussion. The belt of maximum rainfall (fig. 2) coincides with the broad areal extent of Citronelle outcrops and the porous and permeable nature of the unit allows a large volume of rain water to percolate into the formation. The large volumes of water in this formation sustains the base flow of streams draining the area.

The basal few feet of the Citronelle formation is perennially saturated (water table conditions). This is due to the underlying impervious clays of the Pascagoula formation stopping further downward movement of the water. Springs discharging water are commonly associated with this contact. Until 1950 the municipal water supply for Lucedale was obtained from protected springs located at the base of the Citronelle formation, less than a mile north of the Post Office (C 16, tab. 6). The spring yielded an estimated 60-70 gpm. A chemical analysis of water from this spring is shown on Table 7. Most of the small farm and domestic wells in George County derive water from the Citronelle formation (tab. 6).

ALLUVIUM AND LOW TERRACE DEPOSITS

Alluvium and Low Terrace deposits contain an abundant supply of fresh water in George County. Generally the lower parts of these deposits are sand and gravel and the water is under water table conditions. The water contained in these units has a low dissolved solids content but may be acidic causing a reaction with metal.

APPLICATION OF GROUND-WATER DATA

Anyone interested in developing a water supply at a particular location in George County will find the maps, cross sections, tables, and text useful. These items include sufficient data to analyze the water supply possibilities at selected sites. The depths and aquifer thickness may be estimated from Tables 6 and 8. Figure 38 may be used to estimate depth to the base of fresh water. Altitude of the land surface at well sites may be determined from topographic maps (fig. 5), bench marks, or surveys. Some bench marks and elevation stations are noted on the Geologic Map (pl. 1). Quality of the water may be estimated from data on Table 7.

TABLE 6

Records of Water Wells in George County, Mississippi

Well number: See text for explanation of well numbering system.

Altitudes: b, barometric, s, survey, t, topographic map.

Water-bearing unit: Qa, alluvium; Qt, terrace deposits; Tc, Citronelle Formation; Tp, Pascagoula Formation; Th, Hattiesburg Formation.

Water levels: Reported depths are given in feet; measured depths are given to tenths of feet.

Method of lift: B, bucket; C, cylinder; H, hydraulic ram; J, jet; S, suction; Su, submersible; T, turbine.

Use of water: A, abandoned; D, domestic; I, industrial; Ir, irrigation; O, observation; P, public supply; R, recreation; S, stock; T, test hole; U, unused.

Yield: f, flow; p, pump.

Remarks: a, chemical analysis; e, electric log; 1, driller's log.

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
A 1	R. M. Coward	— — Avent	1911	50 t	335	Tp	3x1½	—	+15	8/19/41	—	D	6 (f 1941)	a., Flowing, 1961; casing rusted. Temp. water 71°F.
2	Solomon Box	—	1920	55 t	23	Qt	1½	—	20	1941	S	D	—	a., Temp. wtr. 68°F.
3	W. P. Green	—	1933	60 t	18	Qt	—	—	—	—	S	D	—	
4	Douglas Dixon	—	1951	60 t	16	Qt	1½	13	2	1959	S	D	—	

	5	Mrs. Forest Fairly	—	1939	120 t	48	Tp	1½	45	31	1959	C	D	—	
	6	F. F. Fairly	—	1924	140 t	40	Tp	2	37	31	8/ ?/59	J	D	—	
	7	Salem Cons. School	—	1929	170 t	60	Tp	2	—	40	1959	J	U	—	
	8	Larry Cooley	—	—	170 t	58	Tp	2	55	40	1959	J	D	—	
B	1	B. L. Walters	Fowler Butane	1954	90 t	525	Th	2	513	+13.0	4/20/59	S	D,R	10 (f 1959)	a
	2	Horace McKniss	—	—	65 t	—	—	4x2	—	+12	4/20/59	—	D	5 (f 1959)	
	3	C. W. Hobby	— — Stevens	1946	65 t	185	Tp	4x2	—	+	1959	S	D	small	a
	4	L. J. Stringfellow	— — Reeves	1958	100 t	63	Tp	1½	60	30	1958	J	D	—	
	5	E. G. Stringfellow	—	—	90 t	38	Qt?	2	35	15.0	6/16/59	—	U	—	
	6	Holmes Church	—	—	120 t	24	Tp	1½	—	16.2	8/23/60	—	U	—	
	7	A. W. Byrd	Fowler Butane	1953	50 t	400	Tp	4x2	—	+	1959	—	D,R	30 (f 1959)	Aquifers at 200 & 400′.
	8	Church	—	—	50 t	15	Qa	1½	—	8.4	8/17/60	—	U	—	
	9	A. B. Hobby	— — Dunum	—	61 b	260	Tp	—	—	+ 6	8/19/41	—	D	1 (f 1941)	a
	10	C. H. Guy	—	1953	50 t	400	Tp	2	—	+34	6/16/59	—	R	20 (f 1959)	
	11	W. J. Mizell	—	—	150 t	36	Tp	2	33	24	1960	J	D	—	
	12	J. C. Dorsett	Lee Dunum	1910	64—	260	Tp	2	—	+ 3	8/19/41	—	D	1 (f 1941)	a., Temp. water 68½°F.
	13	Mrs. A. K. Givens	Will Reeves	1940	—	72	Tp	2	—	60	8/20/41	—	D,S	—	Temp. wtr. 68°F.
	14	Big Creek Lbr. Co.	—	—	50—	80	Tp	2	—	—	—	—	A	—	a
	15	Bexely Community	J. Braden	1966	185 t	600	Tp	6	540	90	1/ -/67	Su,T	P	300	a, e, Community wtr. system
C	1	L. B. Welford	—	1940	300 t	80	Tc	2	75	60	1940	J	D,S	—	
	2	W. R. Eubanks	—	1944	300 t	57	Tc	3	52	46.2	11/14/60	C	S	—	
	3	H. F. Estridge	— — Davis	1944	305 t	73	Tc	2	68	65	1957	J	D,S	—	

TABLE 6—(Continued)

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
4	J. M. Eubanks	do	—	292 t	65	Tc	2	60	45	1960	C	D	—	
5	James Reeves	—	1946	290 t	61	Tc	2	—	40	1946	J	D	—	
6	Alton Eubanks	—	1946	303 t	300	Tp	2	—	42	1946	C	U	—	
7	T. L. Crenshaw	— — Davis	1959	300 t	65	Tc	2	60	40	1959	J	D	—	
8	Church of Christ	— — Deerman	1957	300 t	76	Tc	2	71	50	1957	J	D,S	—	
9	J. L. Averett	—	1950	290 t	80	Tc	2	75	50	1958	C	D	—	
10	Lee Havard	— — Holland	1958	280 t	80	Tc	2	75	55	1958	J	S	—	
11	E. C. Rogers	Jim Pierce	1960	270 t	74	Tc	3x2	70	60	8/10/60	J	S	—	
12	Pal Fryflogal	— — Deerman	1959	230 t	80	Tc	4	—	30	1959	—	U	—	
13	—	—	—	150 t	16	Tp	1½	—	10.7	8/23/60	—	U	—	
C14	R. G. Corley	—	1939	248 b	85	Tc?	—	—	67	1939	C	D,S	—	
15	Town of Lucedale	Layne Central Co.	1950	224 b	1,012	Th	10	982	99	10/12/58	T	P	548 (p 1950)	a
16	do	—	1919	190 t	20	Tc	—	—	0	1959	S	U	50+ (f 1959)	a, Springs.
17	do	Layne Central Co.	1959	221 b	1,008	Th	10	958	110.4	5/16/60	T	P	—	e, 1
18	Ollie Jones	—	1950	259 t	76	Tc?	2x1½	72	21	1950	J	D	5 (p 1950)	
19	John Monroe	— — Bailey	1959	280 t	65	Tc	2	60	60	1959	J	D,S	—	
20	Antioch Church	— — Davis	1957	270 t	70	Tc	2	65	40	1957	J	D,S	—	

21	Holder & Luce	do	1941	272 t	32	Tc	1½	—	5	1941	S	D	—	a
22	Chester Gough	—	—	272 t	28	Tc	1½	—	15	1960	J	D,S	—	
23	International Paper Co.	—	1960	282 t	110	Tp	—	100	65	7/60	J	D	—	
24	Mary Graphenread	—	1921	260 t	20	Tc	—	—	12.4	8/21/41	B	D	—	a
25	Earnes Stevens	—	1948	265 t	61	Tc	2	57	44	1948	J	D	—	
26	Multi Mart System	J. Braden	1966	289 t	980	Th	8x6	952	190	1/67	Su,T	P	195	a, e, Community system, T.D. 1003′
27	Rocky Creek Comm.	J. Braden	1966	302 t	1,060	Th	6x4	1,020	230	1/67	Su,T	P	200	a, e, Community system, T.D. 1087′
D 1	—	—	—	170 t	20	Tp	1	—	16.1	8/14/41	S	U	—	
2	Lloyd Eubanks	— — Davis	1960	270 t	86	Tc	2	81	66	9/ /60	C	D,S	—	
3	L. D. Hatcher	—	1954	308 t	35	Tc	2	32	27	1954	J	D,S	—	
4	Rocky Creek School	— — Pringle	1946	285 t	120	Tc?	5	99	—	—	T	P	—	
5	—	—	—	292 t	63	Tc	2	—	58.8	11/16/60	—	U	—	
6	Fred Boone	Jim Pierce	1960	230 t	47	Tc	2	43	30	8/12/60	J	D	—	
7	Hwy. 98 Truck Stop	— — Deerman	1956	281 t	120	Tp	2	115	70	1956	J	D	—	
8	Burton Moffett	—	1937	280 t	20	Tc	1½	15	15	1960	J	D	—	
9	Q. D. Merritt	Hattiesburg Butane	1960	280 t	35	Tc	2	25	8	10/ 7/60	J	D	—	
10	Fred Brewer	Jim Pierce	1960	275 t	105	Tp	2	101	70	8/24/60	C	D,S	—	
11	Shelby Barrow	—	—	—	60	Tc	—	50	50	1941	C	D	—	
12	Harold Stringfellow	Jim Pierce	1960	210 t	52	Tc	2	48	32	8/15/60	J	D,S	—	

TABLE 6—(Continued)

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
13	State of Mississippi	—	1940?	—	—	Tc	—	—	+	—	—	—	Small	a., Uncased drilled well ebbs & flows
14	Rocky Creek Comm.	J. Braden	1966	270 t	630	Tp	8x6	560	190	1/ ?/67	Su,T	P	325	e, Com- wtr. system
E 1	Mrs. Baker	—	1957	50 t	208	Tp	2	—	+ 4	11/17/60	S	D	2 (f 1960)	
2	W. A. Easterling	Fowler Butane	1955	170 t	400	Tp	2	—	100	1955	C	D,S	—	
3	E. A. Stokely	—	—	158 b	48	Tc	—	—	40	1941	B	D	—	
4	M. E. Cooper	— — Holland	1927	146 t	22	Tc	1½	—	—	—	S	D	—	Temp. wtr. 69°F.
5	W. F. Hunt	—	1956	103 t	35	Qt	1½	32	—	—	J	D	—	
6	M. S. King	— — Reeves	—	92 b	17	Qt	—	—	9.0	8/15/41	B	D	—	
F 1	Central Fire Tower	Fowler Butane	1951	200 t	660	Tp	2	—	80	1956	J	D	—	
2	M. H. Allman	Paul Kinch	1915	150 t	203	Tp	3	—	63	1926	C	D	—	

3	Pascagoula Hardwood Co.	—	1934	50	t	31	Qa	2	26	15	1959	J	D	—	SWL 1940, -6.
4	do	—	—	50	t	249	Tp	2	—	+	1959	—	U	2 (f 1960)	
5	L. A. Cochran	— — Mizell	1949	157	t	75	Tp	1½	—	50	1950	C	D	—	
6	T. T. Bennett	— — Reeves	1941	190	t	100	Tp	2	95	60	12/ /58	C	D	—	
7	A. E. Becklin	J. R. Colville	1959	190	t	74	Tc	2x1¼	64	55	4/24/59	J	D,S	—	e, T.D. 245′
8	A. F. Holcomb	Jim Pierce	1958	190	t	63	Tc	4x2	57	38	3/ /58	C	D	—	
9	Alfred Baxter	— — Deerman	1957	200	t	108	Tp	2	103	—	—	J	D	—	
10	C. E. Rouse	—	1930	205	t	40	Tc	2	35	15	1959	J	D	—	
11	do	Fowler Butane	1950	212	t	85	Tp?	2	80	—	—	C	D	—	
12	—	—	—	211	t	25	Tc	1½	—	17.9	8/17/60	—	U	—	
13	Lyman Childress	—	—	212	t	48	Tc	2	43	42	1959	J	D	—	
14	Lloyd Childress	—	1931	200	t	63	Tc	2x1¼	58	20	1931	J	D	—	a
15	Carl Griffin	— — Davis	1940	54	t	190	Tp	2	—	+12.1	8/21/41	—	D	2 (1941)	a, Temp. wtr. 69°F.
16	—	—	—	45	t	17	Qa	1½	14	8.4	8/16/60	—	U	—	
17	Dave Davis	— — Holland	1939	38	t	153	Tp	1½	—	+ 4.9	8/21/41	—	D	0.2 (f 1941)	a, Temp. wtr. 69°F.
18	Archie Fairley	—	1949	145	t	70	Tp	2	65	55	1949	J	D	—	
19	J. K. Fairley	—	—	160	t	65	Tp?	2	60	45	1959	J	D	—	
20	J. S. Dixon	—	1956	205	t	60	Tc	2	56	40	1956	J	D,S	—	
21	Otto Davis	Jim Pierce	1957	150	t	63	Tp	2	58	38	1957	J	U	—	
G 1	Mississippi Export RR	Abb Vice	1915	250	t	90	Tp	2	—	12	1941	C	U	—	
2	S. G. Perry	— — Reeves	1941	270	t	55	Tc	2	50	42	1941	J	D	—	
3	J. C. McDonald	—	1918	270	t	42	Tc	2x1¼	37	28	1959	J	D	—	
4	William Holland	Fowler Butane	1956	270	t	140	Tp	2x1½	130	90	1956	J	D	—	

TABLE 6—(Continued)

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
5	W. R. Williamson	Jim Pierce	1957	263 t	65	Tc	2	60	53	1957	J	D,S	—	
6	Singing River Power Association	L. L. Garland	1960	270 t	343	Tp	4	—	93.45	8/15/60	Su	D,I	—	
7	W. P. Cunningham	—	1947	269 t	82	Tc	2	77	66	1947	C	—	—	
8	Troy Rucker	—	—	255 t	35	Tc	1½	30	20	1959	J	D	—	
9	Ellis Easley	—	—	262 t	32	Tc	18	—	30	8/14/41	B	D	—	
10	Henry Pitts	—	—	255 t	75	Tc	2	72	65	1947	J	D,S	—	
11	International Paper Co.	—	1960	255 t	90	Tc	2	80	60	7/ /60	J	D	—	
12	H. C. Walker	Jim Pierce	1920	240 t	70	Tc	2	67	60	1959	J	D	—	
13	V. E. Howell	do	1956	250 t	83	Tc	3	73	50	1960	J	Ir	20 (p 1960)	
14	do	do	1958	250 t	107	Tc?	3	97	50	1960	J	Ir	20 (p 1960)	
15	L. E. Sheppard	do	—	251 t	98	Tc?	2	—	50	1960	C	D,S	—	
16	S. A. Moore	do	1958	241 t	64	Tc	2	54	—	—	J	D,S	—	
17	Curtis Hudson	do	1956	173 t	52	Tp	2	48	32	1956	C	D	—	

	18	Multi Mart System	J. Braden	1966	270 t	660	Tp	6x4	630	190	1/ ?/67	Su,T	P	85	e, Community wtr. sys. T.D. 777′
H	1	J. V. Cooley	—	1926	275 t	60	Tc	2	—	25	1941	C	D	—	
	2	Allen Havard	—	1939	200 t	39	Tc	—	35	23	1959	J	D,S	—	
	3	C. C. Newbill	—	1947	160 t	32	Tc?	2	28	3	1959	J	D,S	—	
	4	Kirkland Naval Stores	— — Davis	1939	83 t	145	Tp	—	—	+ 4	8/23/41	H	D,S	1.5 (f 1941) 1 (f 1960)	a, Original SWL+10′, Temp. wtr. 70°F.
	5	H. L. Ward	Jim Pierce	1958	170 t	60	Tp?	—	—	—	—	J	D,S	—	
	6	V. M. West	—	—	153 b	24	Tc	2	—	18.90	8/29/60	—	U	—	
	7	Hudie Pitts	Jim Pierce	1959	160 t	120	Tp	2	—	75	1959	J	D,S	—	
	8	Martha Lee	—	1944	140 t	145	Tp	2	—	70	1944	C	D,S	—	
	9	W. E. Powell	Jim Pierce	—	240 t	85	Tc	2	82	—	—	C	D,S	—	
	10	—	—	—	240 t	25	Tc	1½	—	18.6	7/21/60	—	U	—	
	11	Ruri-Mar Ranch	— — Williams	1955	232 t	300	Tp	—	—	—	—	—	T	—	
	12	J. E. Davis	—	1949	125 t	23	Tc	2	20	7	1949	J	D,S	—	
J	1	C. A. Murrah	— — Maxie	1938	37 t	151	Tp	3	—	+ 8	8/16/60	S	D,S	—	
	2	W. W. Wilkerson	Fowler Butane	1954	80 t	476	Tp	2	—	1.5	1954	J	D,S	—	a
	3	C. A. Wilkerson	do	1955	70 t	340	Tp	2	332	+18	1955	J	D,S	—	
	4	— — Crump	Sutter Well Works	1941	38 b	104	Tp	2	—	+11	8/13/41	—	D	6 (f 1941)	a, Temp. wtr. 67°F.?
	5	W. J. Green	Paul Kinch	1914	39 t	93	Tp	2	—	+10.6	8/11/41	—	D	25 (f 1941)	a, Temp. wtr. 69°F.

TABLE 6—(Continued)

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
6	Crump & Green	Sutter Well Works	1941	49 b	145	Tp	2	—	+ 4.5	8/13/41	—	—	15 (f 1941)	a, Temp. wtr. 63°F.
7	Black Creek Lumber Co.	do	1940	57 b	140	Tp	2	—	3.5	8/13/41	S	I	30 (p 1941)	a, Temp. wtr. 69°F.
8	R. J. Green	—	1955	50 t	167	Tp	2	—	+ 8.1	10/ 3/60	—	D	—	
9	E. H. Green	—	1955	60 t	170	Tp	2	—	10	1955	J	D	—	
10	Winston Maple	—	1900	110 t	43	Tp	1½	40	21	1960	J	D,S	—	
11	Newton Naval Stores	— — Holland	1935	85 t	300	Tp	2	—	—	—	—	U	—	
12	George Maple	H. L. Garland	1958	80 t	400	Tp	2	—	+ 4	7/21/58	—	D	—	
13	W. J. Easterling	— — Reeves	—	80 t	40	Tp?	2	37	20	1957	J	D	—	
14	Broome School	—	1952	84 t	150	Tp	2	—	—	—	J	D	—	
15	do	Paul Kinch	—	84 t	120	Tp	4	—	—	—	S	P	—	a
16	— — McGoof	— — Williams	—	89 b	18	Qt?	—	—	14	8/13/41	B	D	—	
17	Everett Cain	— — Holland	1936	66 b	185	Tp	2	—	17	1936	S	D	—	a
18	Bertha Moore	Fowler Butane	1954	56 t	425	Tp	2	—	+18	1954	—	D	—	

K 1	Ralph Fairley	Jim Pierce	1959	160 t	40	Tc	2x1¼	—	—	—	J	D	—	
2	State of Mississippi	Humble Oil Co.	1939	55 s	93	Tp	4	—	+26	8/20/41	—	U	120 (f 1941)	a, Temp. wtr. 69°F.
3	—	—	—	48 t	11	Tp?	1½	—	8.7	8/16/60	S	D	—	
4	J. K. Hinton	Jim Pierce	1958	45 s	115	Tp	2½	—	+10	4/22/59	S	D	6 (f 1959)	
5	Pascagoula Hardwood Co.	—	—	42 s	95	Tp	2	—	7.4	8/21/41	—	D	30 (f 1941)	Temp. wtr. 69°F.
6	W. C. Young	Jim Pierce	—	20 t	88	Tp	4	—	+12.6	4/22/59	S	D	40 (f 1959)	
7	G. V. Bond	— — Helvenston	1870	130 t	25	Tc	—	—	19.5	8/21/41	—	U	—	
8	L. M. Smith	—	—	140 t	25	Tc	36	—	20.7	8/15/60	—	U	—	
9	— — Scott	Jim Pierce	1956	160 t	64	Tc	2	58	44	1956	J	D	—	
10	Basin School	—	—	158 t	58	Tc	2	—	35.4	10/26/60	—	U	—	
11	do	Jim Pierce	1960	158 t	48	Tc	2	44	36	10/21/60	J	P	—	One of 2 wells in use.
12	Henry Wallsmith	—	1941	80 t	32	Tp	—	—	24.0	8/21/41	B	U	—	
13	W. H. Allbritton	—	1961	140 t	840	Tp	—	—	—	—	—	—	—	
L 1	Parker Lookout Tower	—	1935	210 t	264	Tp	2	259	50	1960	—	U	—	
2	Fred Parker	Jim Pierce	1955	200 t	113	Tp	2	109	52	1955	J	D,S	—	
3	Quentin Parker	Fowler Butane	1953	180 t	315	Tp	3x2	304	80	1953	J	D,S	—	
4	Ford Churchwell	Jim Pierce	1958	200 t	43	Tc	2	39	27	1958	J	D,S	—	
5	L. C. Johnson	—	1950	160 t	115	Tc	2	—	42	1950	J	D	—	
6	N. H. Grant	—	—	70 t	17	Tp	1½	—	11.0	8/16/60	—	U	—	
7	W. H. Holcomb	—	1947	60 t	32	Tp	1½	—	16	8/15/60	J	D	—	
8	J. Eckford	—	1960	140 t	55	Tp?	2	52	37	7/ /60	C	D	—	
9	Naomi Anderson	—	—	130 t	46	Tp	8	—	33.2	8/15/60	B	D	—	

TABLE 6—(Continued)

Well No.	Owner	Driller	Year drilled	Altitude of land-surface datum (ft.)	Depth of well (ft.)	Water-bearing unit	Diameter (in.)	Depth to top of screen (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Method of lift	Use of water	Yield (gpm)	Remarks
10	M. L. Pope	—	—	126 t	75	Tp	2	70	42	1959	J	D	—	
11	J. W. Donalson	Jim Pierce	—	126 t	70	Tp	2	65	45	1960	C	D,S	—	
12	U. S. Geological Survey	USGS	1960	140 t	25	Tc	—	—	—	—	—	T	—	
13	E. E. Emerson	—	—	110 t	16	Tc	1½	14	14.3	8/ 8/60	S	D	—	
14	Rolly Emerson	I. W. Smith	1954	67 b	200	Tp	2	—	+20	6/12/59	S	D	10 (f 1959)	
M 1	U. S. Geological Survey	— — Colville	1960	236 t	819	—	—	—	—	—	—	T	—	e, 1
2	Buchanan Co.	Abb Vice	1940	218 t	75	Tc	—	—	55	—	C	D,S	—	a
3	M. C. Hamilton	—	—	218 t	65	Tc	2	60	30	—	J	D,S	—	
4	Grover Purvis	Jim Pierce	1946	200 t	80	Tc?	2	—	45	1950	J	D,S	—	
5	— — Campbell	— — Colville	1960	200 t	101	Tp	1½	91	48.5	5/ 3/60	—	D	—	
6	Carroll Corley	—	—	100 b	18	Tp	1½	—	11.1	8/29/60	S	D,S	—	
7	Leo Crawley	—	1939	145 t	40	Tc?	2	36	—	—	J	D,S	—	
8	L. C. Dossett	—	1944	190 t	60	Tc	4	56	50	1944	J	D	—	
9	R. S. Roe	—	1949	140 t	104	Tp	2	99	—	—	J	D	—	
10	Mattie Roe	—	1900	170 t	30	Tc	2	26	16	1948	J	D	—	

11	Curtis Tanner	— — Dossett	1919	168 t	105	Tp	2	100	50	—	C	D	—
12	—	—	—	170 t	36	Tc	2	—	32.2	8/ 8/60	—	U	—
13	A. D. Tilley	—	—	160 t	60	Tc?	2	55	25	1959	J	D,S	—
14	L. J. Jones	—	1947	160 t	21	Tc	1½	—	12	1952	J	D,S	—
15	—	—	—	130 t	11	Tc	1½	—	5.3	8/ 8/60	S	S	—
16	—	—	—	164 t	22	Tc	1½	—	16.8	8/ 4/60	—	U	—
17	Raymond Tanner	—	—	162 t	31	Tc	—	—	22.0	8/14/41	B	D	—
18	—	—	—	70 t	32	Tp	1½	—	11.6	8/ 8/60	—	U	—
19	W. A. Radcliff	—	1949	168 t	130	Tp	2	—	50	1949	J	D	—
20	Ralph Kile	Jim Pierce	1948	160 t	75	Tc?	2	70	55	1948	C	D	—
21	Gomer Estis	do	1952	140 t	100	Tp	2	95	50	—	J	D	—
22	J. P. Griffin	do	1949	120 t	75	Tp	2	71	40	1949	J	D,S	—
23	James Griffin	—	1939	65 t	35	Tp	1½	30	15	—	S	D	—
24	—	—	1960	150 t	30	Tc	1½	—	21.5	7/22/60	S	D	—

TABLE 7

Analyses of Water From Wells in George County (Parts Per Million)

Well No.	Water bearing unit	Depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$	pH	Color
A1	Tp	335	8-24-41	71	—	—	—	—	—	—	245	39	2	63	1.2	—	—	12	—	—
A2	Qt	23	8-28-41	68	—	—	—	—	—	—	10	0	1	5	0	0	—	15	—	—
B1	Tp	525	4-20-59	72	5.1	0.08	1.4	0.1	105	1.3	226	16	6.4	7.0	.3	1.0	281	4	8.7	25
B3	Tp	185	4-20-59	68	7.7	.33	1.6	.6	66	1.3	144	0	2.2	21	.4	.6	221	6	7.4	15
B9	Tp	260	8-28-41	—	—	—	—	—	—	—	241	16	1	67	.9	—	—	15	—	—
B12	Tp	260	5- -15	68.5	16	0	5.2	2.4	130	—	229	12	12	69	—	0	—	23	—	—
B14	Tp	80	7- -14	—	16	2.0	3.4	1.1	6.9	—	18	0	.8	6.5	—	0	—	13	—	—
B15	Tp	600	6-14-66	—	—	—	—	—	—	—	—	—	—	83	—	—	—	10	8.9	45
C15	Th	1012	12-16-58	—	8.9	.10	.8	.1	56	2.0	114	0	8.4	18	.1	.2	186	2	6.9	7
C16	Tc	20	8- 7-19	—	13	.05	.6	.6	18	—	17	13	1.9	4.5	—	—	58	4	—	—
C21	Tc	32	8-28-41	—	—	—	—	—	—	—	18	0	1	4	0	6.5	—	30	—	—
C24	Tc	20	8-28-41	—	—	—	—	—	—	—	2	0	1	10	0	13	—	23	—	—
C26	Th	976	6- 1-66	—	—	0.2	—	—	—	—	—	—	—	8	—	—	—	3	7.9	15
C27	Th	1060	8-25-66	—	—	0.2	—	—	—	—	—	—	—	9	—	—	—	0	7.8	
D13	Tp	—	8-28-41	70	—	—	—	—	—	—	16	0	10	2	.1	0	—	18	—	—
F14	Tc	63	4-22-59	69	2.3	.46	1.2	.4	2.2	.2	5	0	.8	3.5	.0	.6	26	4	5.4	1
F15	Tp	190	8-28-41	69	—	—	—	—	—	—	216	40	5	14	.7	—	—	18	—	—
F17	Tp	153	8-28-41	70	—	—	—	—	—	—	280	14	1	67	1.3	0	—	27	—	—

TABLE 7—(Continued)

Well No.	Water bearing unit	Depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$	pH	Color
H4	Tp	145	8-28-41	—	—	—	—	—	—	—		7	2	.2	0	—	—	12	—	—
J2	Tp	476	?-59	67	—	—	2.5	.9	—	—	—	—	—	15	—	—	—	10	—	—
J4	Tp	104	8-28-41	67	—	—	—	—	—	—	137	24	7	5	.5	0	—	21	—	—
J5	Tp	93	8-28-41	69	—	—	—	—	—	—	140	21	9	4	.7	0	—	18	—	—
J6	Tp	145	8-28-41	69	—	—	—	—	—	—	172	18	8	4	.6	0	—	12	—	—
J7	Tp	140	8-28-41	69	—	—	—	—	—	—	132	10	10	4	.5	0	—	14	—	—
J15	Tp	120?	8-28-41	—	—	—	—	—	—	—	136	11	9	5	.6	1.2	—	21	—	—
J17	Tp	185	8-28-41	—	—	—	—	—	—	—	132	21	12	3	.4	—	—	14	—	—
K2	Tp	93	4-22-59	69	18	.45	7.2	1.5	16	2.5	64	0	6.2	3.2	.0	.3	112	24	7.6	2
K2	Tp	93	8-28-41	69	—	—	—	—	—	—	66	—	4	3	.2	0	—	36	—	—
M2	Tc?	75	8-28-41	—	—	—	—	—	—	—	27	0	1	3	0	2.7	—	34	—	—

Analysts: U.S.G.S.; Miss. State Chem. Lab.; U. of Miss.; Miss. State Bd. of Health.

TABLE 8

Fresh-water aquifers of George County

Data from electric logs of oil tests

Well	Location			Elevation**	Top of log	Aquifer interval	Thickness		Forma-	Approximate base of
No.*	Twn.	Rge.	Sec.	(feet)	(feet)	(feet)	(feet)	Grade	tion***	fresh-water (feet)
1	1S	5W	6	223	254	254(+) - 275	21+	good	Mp	1165 (-942)
						404- 415	11	good	Mp	
						440- 455	15	good	Mp	
						555- 566	11	fair	Mh	
						730- 805	75	fair	Mh	
						870- 945	75	excellent	Mh	
						1005-1055	50	excellent	Mc	
2	1S	5W	11	133	899	970- 996	26	good	Mc	1085 (-952)
						1035-1043	8	fair	Mc	
3	1S	6W	10	253	1087	1087(+)-1116	29+	good	Mc	1212 (-959)
						1162-1210	48	poor -poss. brackish	Mc	
4	1S	6W	21	235	797	800(+) - 835	35+	fair	Mh	1230 (-995)
						895- 935	40	fair	Mh	
						950- 979	29	good	Mh	
						1016-1142	136	excellent	Mh	
5	1S	6W	25	—	no log					
6	1S	7W	39	76	1408 (in salt water)					

7	1S	8W	9	110	1378 (in salt water)					
8	1S	8W	21	102	958	958(+)-1055	97+	excellent	Mh	1055 (-953)
9	1S	8W	37	68	2496 (in salt water)					
10	1S	8W	42	—	no log					
11	2S	5W	12	103	844	908-1020	112	excellent	Mh	1164 (-1061)
						1052-1084	32	good	Mc	
						1139-1152	13	good	Mc	
12	2S	5W	15	149	854	994-1016	22	good	Mh	1175 (-1026)
						1105-1160	55	good	Mh	
13	2S	5W	25	71	605	869- 893	24	fair	Mh	1260 (-1189)
						994-1080	86	excellent	Mh	
						1107-1144	37	fair	Mc	
14	2S	6W	16	—	no log					
15	2S	7W	3	201	100	670- 732	62	good	Mp	1236 (-1035)
						918- 973	65	good	Mh	
						985-1020	35	good	Mh	
						1045-1085	40	good	Mh	
						1090-1142	52	good	Mh	
						1170-1236	66	good	Mh	
16	2S	8W	3	97	845	1062-1185	123	excellent	Mh	1185 (-1085)
17	2S	8W	12	—	no log					

TABLE 8—(Continued)

Well No.*	Location Twn.	Rge.	Sec.	Elevation** (feet)	Top of log (feet)	Aquifer interval (feet)	Thickness (feet)	Grade	Formation***	Approximate base of fresh-water (feet)
18	2S	8W	20	148	986	997-1018	21	fair	Mh	1330 (-1182)
						1264-1320	56	good	Mh	
19	2S	8W	29	139	1449 (in salt water)					
20	2S	8W	29	123	823	823(+)- 910	87+	excellent	Mp	1340 (-1217)
						1050-1085	35	fair	Mh	
						1245-1340	95	excellent	Mh	
21	2S	8W	42	56	1676 (in salt water)					
22	2S	9W	10	175	943	1144-1173	29	good	Mh	1340 (-1165)
						1253-1330	77	good	Mh	
23	2S	9W	10	—	no log					
24	2S	9W	11	208	848	933-1026	93	excellent	Mh	1322 (-1114)
						1132-1322	190	excellent	Mh	
25	3S	6W	15	146	824	824(+)- 855	39+	good	Mp	1406 (-1260)
						980-1035	55	good	Mh	
						1325-1406	81	fair-poor	Mh	
26	3S	6W	34	78	1071	1184-1197	13	fair	Mh	1465 (-1387)
						1372-1465	93	excellent	Mh	

27	3S	7W	15	—	no log					
28	3S	8W	20	49	1720 (in salt water)					
29	3S	8W	20	61	25	100- 240	140	good	Mp	1476 (-1415)
						318- 392	74	good	Mp	
						411- 456	45	good	Mp	
						718- 818	100	fair	Mp	
						912-1010	98	excellent	Mp	
						1156-1190	34	good	Mh	
						1386-1473	87	excellent	Mh	
30	3S	8W	30	82	80	184- 227	43	fair	Mp	1543 (-1459)
						333- 500	167	good	Mp	
						1000-1067	67	excellent	Mp	
						1207-1270	63	good	Mh	
						1420-1542	122	excellent	Mh	
31	3S	9W	3	95	1094	1285-1300	15	fair	Mh	1495 (-1400)
						1340-1400	60	good	Mh	
						1430-1442	12	fair	Mc	
						1453-1485	32	fair	Mc	

* refer to Table 3.
** Derrick floor elev.
***Mp = Pascagoula fm.; Mh = Hattiesburg fm.; Mc = Catahoula fm.

SURFACE WATER

George County is located within the southern portion of the Pascagoula River drainage basin (fig. 3). Hydrologic data has been gathered by the United States Geological Survey at various stations throughout the basin. Several stations are located on streams in or near George County and these stations record data which is pertinent to the County. An abundant supply of good quality surface water is available in the County as interpreted from this data. Table 9 shows streamflow data for area streams. Chemical analyses of water from streams in George County are listed on Table 10.

Additional supplies of surface water may be available to George County in the future in the form of surface reservoirs. Engineering studies are currently developed on a proposal to dam the Escatawpa River near Harleston, creating a large reservoir.

ECONOMIC GEOLOGY

Economic considerations are of utmost importance in geological investigations of a county. One of the chief purposes of the George County investigation was to locate and report mineral resources of known or probable economic value. During field mapping the idea of possible utilization of rocks examined was foremost in mind. Of the 57 holes cored or drilled in the course of this investigation more than two-thirds were located specifically for the purpose of obtaining samples for various testing procedures. The preceding sections on Geomorphology, Stratigraphy, and Structure add to the overall understanding of mineral resources of George County.

CLAYS AND NATURAL CLAY MIXTURES

Millions of tons of clays and clay-like materials are present in George County. Various tests performed on samples of George County clays conclusively show that some of the clays could become an important mineral resource.

The term 'clay' commonly covers a wide range of chemical and physical compositions. Grim [67] in his text on clay mineralogy defines clay as "a rock term and also a particle-size term in the mechanical analysis of sedimentary rocks, soils, etc. As a rock term it is difficult to define precisely, because of the wide variety

TABLE 9
Streamflow Data

Stream	Station location	Drainage area (sq. mi.)	Records available	Average drainage	Extremes Max.	Date	Min.	Date
Pascagoula River	Merrill SW¼, sec.18, T.1S., R.7W	6600	October 1930 to September 1965	35 years; 9,529 cfs* (6200 mgd)	178,000 cfs (115,700 mgd)	2/27/61	696 cfs (425 mgd)	11/ 3/36
Red Creek	Vestry SW¼, sec.34, T.1S., R.8W.	416	July 1958 to September 1965	7 years; 851 cfs (553 mgd)	21,500 cfs (13,900 mgd)	12/12/61	88 cfs (57 mgd)	10/22/63
Escatawpa River	Wilmer NW¼, sec.19, T.2S., R.4W.	506	August 1945 to September 1965	20 years; 979 cfs (637 mgd)	30,000 cfs (19,500 mgd)	6/ 2/59	37 cfs (24 mgd)	9/2-4/54

* cfs = *cubic foot per second* is the rate of discharge of a stream whose channel is 1 square foot in cross-sectioned area and whose average velocity is 1 foot per second.

mgd = *million gallons per day.*

Data compiled from records published in *Water Resources Data for Mississippi,* 1965.

TABLE 10

Chemical analyses, in parts per million, of water from streams in George County, Mississippi

Stream	Location	Length of Record	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Copper (Cu)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Dissolved solids: Residue at 180°C	Dissolved solids: Calculated from determined constituents	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: non-carbonate	Specific conductance (micromhos at 25° C)	pH	Color
			TIME-WEIGHTED AVERAGES																					
Pascagoula River	Near Benndale at bridge on Highway 26	Aug. '58 to Sept. '60	8944	3.8	0.14	0.00	0.01	5.9	1.05	18	1.35	18	4.4	29	0.1	1.3	tr.	100	73	18	5	137	6.7	29
Black Creek	Near Benndale SW¼, sec. 14, T. 3 S, R. 8 W.	Feb. '58 to Jan. '61	1252	4.5	0.10	0.12	0.00	1.3	0.7	2.7	0.5	7	1.5	3.5	0.1	0.7	—	37	19	6	1	27	5.9	36
Red Creek	Near Vestry SW¼, sec. 34, T. 3 S., R. 8 W.	Feb. '58 to Jan. '61	750	4.6	0.75	0.03	0.03	1.9	0.9	7.3	0.6	5	1.7	13	0.2	0.7	—	54	34	9	4	59	5.7	36
Big Creek	Near Crossroads SW¼, sec. 9, T. 2 S., R. 7 W.	Aug. '58 to Jan. '61	56.5	3.8	0.15	0.01	0.02	1.1	0.6	2.5	0.3	5	0.9	3.5	0.1	0.8	—	28	16	5	.5	25	5.8	19
Escatawpa River	Near Hurley NE¼, sec. 12, T. 5 S., R. 5 W.	Jul. '58 to Dec. '60	625	3.1	0.05	0.01	0.00	1.1	0.5	2.7	0.3	5	1.4	3.5	0.1	0.5	—	30	16	5	.6	25	5.9	26

Data compiled from records published in *U. S. Geol. Survey Water Supply Paper 1763* of materials that have been called clays. In general the term clay implies a natural earth, fine-grained material which develops a plasticity when mixed with a limited amount of water. By plasticity is meant the property of the moistened material to be deformed under the application of pressure, with the deformed shape being retained when the deforming pressure is removed. Chemical analysis of clays shows them to be essentially silica, alumina and water, frequently with appreciable quantities of iron, alkalies and alkaline earths ...... As a particle size term, the clay fraction is that size fraction composed of the smallest particles. The maximum size of particles in the clay size grade is defined differently in different disciplines. In geology the tendency has been to follow the Wentworth scale and to define the clay grade as material finer than about 4 microns."

Some of the George County samples selected for testing do not meet all the requirements for a clay in that they may contain varying amounts of silt-sized and sand-sized particles. They do however exhibit clay properties. Moore [68] referred to these types as 'natural clay mixtures.' That term is appropriate for certain George County examples.

Exposures of clays and natural clay mixtures in George County were studied and the lithologic character, accessibility, and overburden conditions were noted. Additional information was obtained from cores and cuttings of the Survey holes. Locations of the Survey holes are shown by Figure 41 and also on the Geologic Map (pl. 1).

Samples from 19 holes were submitted for testing. Requirements for selection of test samples were that a minimum of 8 vertical feet of quality clay be present in an accessible area with little or no overburden. Clay samples for testing were obtained by core methods. Figure 42 shows coring operations at Hole AJ-10; clay sample (center of photograph) is being extruded from 2 foot core barrel. Figure 43 shows 32 feet of clay obtained by continuous core operations at Hole AJ-18. Of the submitted samples, 14 were from Pascagoula formation clays, 4 were from alluvium deposits, and 1 was from a Low Terrace deposit. Some data was available on clay from the Citronelle formation.

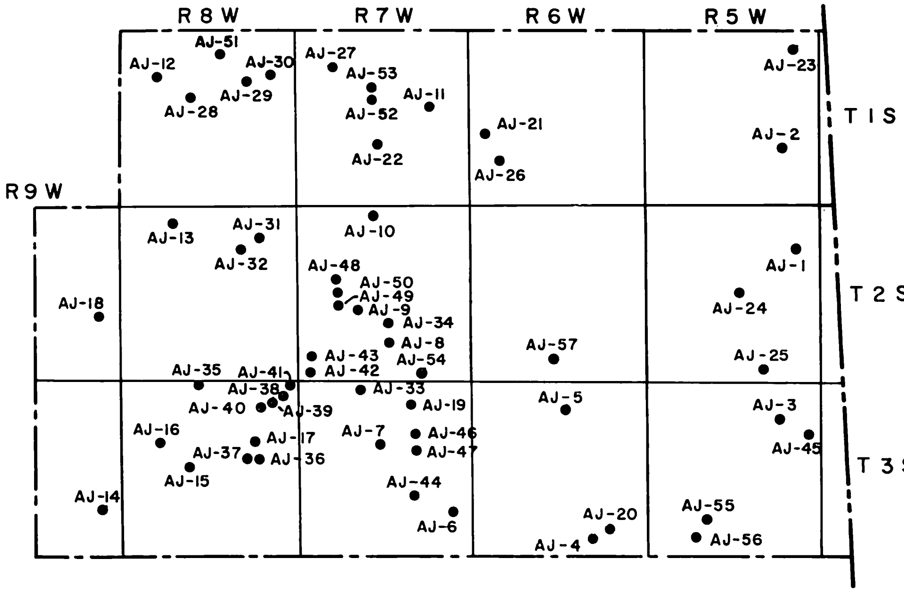


Figure 41.—Locations of core and test holes drilled by the Mississippi Geological Survey.

Ceramic tests were performed at the Georgia Institute of Technology in the School of Ceramics laboratories. Testing was conducted by Thomas E. McCutcheon, Ceramic Engineer. Examination and descriptions of residues from screen analysis was by Theo H. Dinkins, Mississippi Geological Survey stratigrapher. Shilstone Testing Laboratory of New Orleans, Louisiana, made chemical analyses of the samples. X-ray analyses were provided on certain clay samples by Steve Whatley. Details of ceramic tests procedures and results are included in the section titled George County Clay Tests. Screen analyses results are listed on Table 13. Chemical analyses are shown graphically by Figure 44 and in detail on Table 12. X-ray analyses are shown on Table 2.

PASCAGOULA CLAY

Outcrops of Pascagoula clays are common in George County. The major portion of the green colored area on the Geologic Map (pl. 1) represents surface exposures of Pascagoula clay or natural clay mixtures. The 14 holes from which Pascagoula samples were tested are located so as to offer representation to practically every part of the County.

Ceramic tests performed on Pascagoula clays from George County determined that they might be utilized for a variety of products. Good color ranges and firing properties make them suitable for manufacture of brick and tile. The clays may also be utilized in the heavy clay products field. Good bonding properties present possibilities of use in the manufacture of abrasive wheels and shapes and to increase strength of foundry sand. Tests showed that the Pascagoula clays have possibilities for use as a lubricant and suspending agent in drilling operations (drilling mud). The clay could probably be used as an absorbent

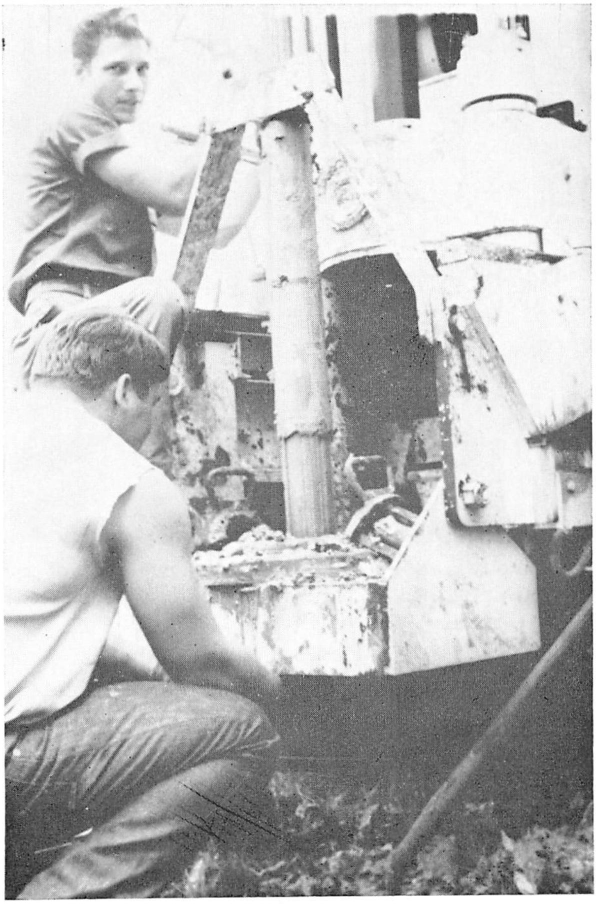


Figure 42.—Coring operations at AJ-10. A Pascagoula clay sample is shown at center of photograph being extruded from 2 foot core barrel. Driller is Dudley Hamm and helper is Mike Boland. June, 1966.

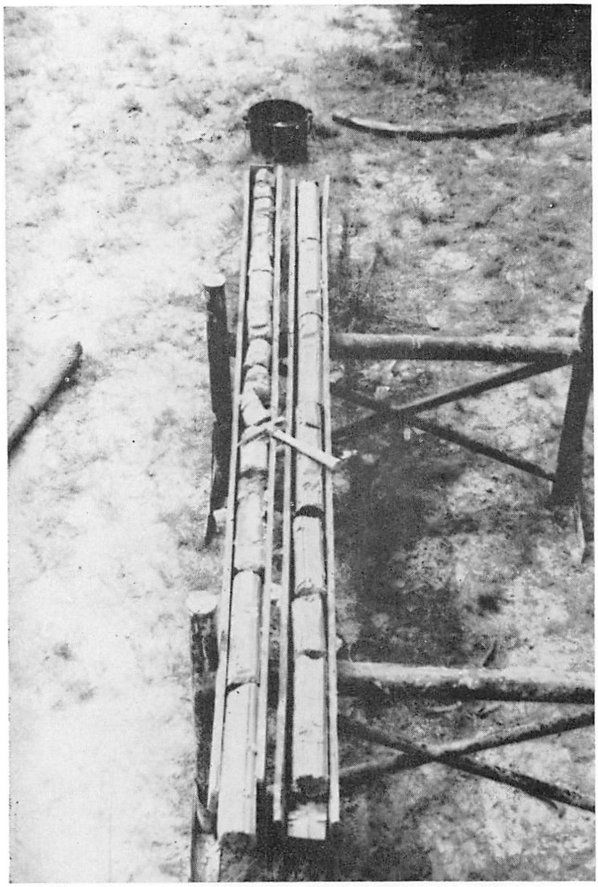


Figure 43.—Continuous core from AJ-18. Thirty-two feet of core recovery is shown. Detailed sample description is in core and test hole records section. June, 1966.

in soil treatment and conditioning. The tests indicate that with some beneficiation George County Pascagoula clays could compete with bentonite, a very useful montmorillonite type of clay.

ALLUVIAL AND TERRACE CLAY

Alluvial and Terrace clays and natural clay mixtures are found in the areas so designated on the Geologic Map (pl. 1). Outcrops of clays in these deposits are rarer than Pascagoula clay outcrops due to vegetative cover but the nature of these deposits in George County insures that large quantities of clay are present. Samples for testing were acquired by random coring in the outcrop area.

The Alluvial and Terrace clays and natural clay mixtures from George County produced beautiful pastel shades of light red and buff when burned. They have good plastic, drying, and firing properties in addition to the favorable burning colors. These properties are desirable in the manufacture of face brick, structural tile, conduit, drain tile, and fireproofing material.

CITRONELLE CLAY

Clay and natural clay mixtures occur in lenses in the Citronelle formation. Exposures of clay lenses may be observed in areas shown in red on the Geologic Map.

Citronelle clay from George County is presently being utilized as a pottery and stoneware clay. Requirements of clay used in this manner are that they have good plastic properties, high strength and low shrinkage. The well-known Shearwater Pottery, Ocean Springs, Mississippi, is made from Citronelle clay mined at Lucedale. A chemical analysis of clay from this locality is included in Table 12.

SAND AND GRAVEL

Sand and gravel deposits in George County are present at three distinct levels; high level (Citronelle formation and High Terraces), intermediate level (Low Terraces), and low level (alluvium). Gravel is generally concentrated in the basal portions of the deposits mentioned above though it may also occur in lenses within the formations. Pebbles in all of the graveliferous units are comprised of chert, quartz, and tripolitic chert in that order. The pebbles range in size but most are less than 1 inch in diameter. The gravel deposits are mixed with varying amounts of sand and clay. Size and thickness of the gravel deposits may vary widely.

Gravel deposits in the Citronelle formation generally have considerable overburden. Where the Citronelle formation is more than 100 feet in thickness, gravel concentrations in the basal 30 feet have little or no economic value. This situation eliminates commercial operations in much of the George County area. On the other hand, gravel concentrations in the basal 30 feet of a unit 40 to 50 feet thick become economically significant. This situation is present in High Terrace areas of George

County and is, in fact, the situation at the County gravel pit. (See cross sections on Plates 2 and 3). In these areas the overburden is substantially less regardless of whether the High Terraces result from destructive or constructive conditions. Gravel deposits are present with negligable amounts of overburden in the vicinity of Holes AJ-9 and AJ-34. (See Core and Test Hole Records section).

Gravel concentrations in Low Terrace deposits were noted in Core Holes AJ-13, 15, 17, and 51. Surface exposures of gravel were noted in the Low Terrace in sec. 22, T. 2 S., R. 8 W. (See Figures 28 and 29). Gravel in similar Low Terrace deposits in Perry County have been mined extensively for some time.

Core Holes AJ-30, 31, 36, and 37 recovered gravel concentrations from alluvial deposits. Gravel deposits in alluvium and in Low Terrace deposits are generally associated with water table conditions and require the use of pumps to recover gravel. This condition provides a washed-gravel product used as heavy aggregate in constructional industries.

Sand deposits are plentiful in George County. Sand is available in various stages of purity from very clayey sand to free grains. Sand for topping material and other construction uses can be obtained from the Citronelle formation, Low Terrace deposits, and alluvium.

Samples from two Pascagoula River sand bars and one Escatawpa River sand bar were tested to determine their quality for possible industrial use. A chemical analysis and a screen analysis was made on each sample. Results of these tests are shown on Table 11. The sands are high-silica types and are relatively free of impurities. The analyses indicate that the sands could be utilized for manufacture of some grades of glass as well as some other products requiring high-silica sand.

TABLE 11

Chemical and Screen Analysis of Sand

Sample No. 1

Pascagoula River sand bar—location NW¼,NW¼, sec. 1, T. 3 S., R. 7 W., George County

Heavy Minerals	0.090%
Silica, as SiO_2	99.56 %
Iron, as Fe_2O_3	0.046%

TABLE 11—(Continued)

SCREEN ANALYSIS	PER CENT RETAINED
16 m	0.2
20 m	2.0
30 m	22.5
40 m	52.0
50 m	16.7
70 m	5.3
100 m	0.9
140 m	0.3
Pan	0.1

- - - - - - - -

Sample No. 2

Pascagoula River sand bar—location NE corner of irregular sec. 38, T. 2 S., R. 8 W.

Heavy Minerals 0.075%
Silica, as SiO_2 .... 98.78 %
Iron, as Fe_2O_3 .... 0.129%

SCREEN ANALYSIS	PER CENT RETAINED
16 m	None
20 m	None
30 m	0.4
40 m	6.9
50 m	40.3
70 m	38.7
100 m	8.4
140 m	1.0
Pan	4.3

- - - - - - - -

Sample No. 3

Escatawpa River sand bar—location SE¼, SE¼, sec. 3, T. 3 S., R. 5W.

Heavy Minerals 0.282%
Silica, as SiO_2 .... 99.74 %
Iron, as Fe_2O_3 .... 0.039%

SCREEN ANALYSIS	PER CENT RETAINED
16 m	0.5
20 m	1.7
30 m	14.4
40 m	39.6
50 m	29.2
70 m	11.7
100 m	2.1
140 m	0.4
Pan	0.4

OIL, GAS, SULPHUR

Production of oil and gas is established in three counties which border George County to the west, north and east. They are Perry and Greene Counties, Mississippi, and Mobile County, Alabama. George County has no oil and gas production at the present but various oil and gas showings have been reported in George County test wells. The subsurface contains many feet of sediment of reservoir quality. A detailed description of subsurface stratigraphy is included in this report.

Hydrogen sulphide gas has been encountered in deep wells near George County. In the discovery well of Black Creek Field located in Perry County less than 5 miles west of George County, Phillips Petroleum Company tested a deep zone capable of yielding 47 long tons of sulphur per day in addition to natural gas.

The writer believes that future drilling will lead to the discovery of hydrocarbon and sulphur reservoirs in George County. Geophysical crews are currently operating in George County seeking potential entrapment conditions.

SALINE WATER

Saline water in reservoirs below the fresh-water zone may be considered a possible resource. Much chemical manufacturing begins with brine water. Certain marketable elements are extracted from oil field brines in other areas. Economists predict that salt consumption will quadruple within the next 35 years and with the increased demand it is possible some additional uses for saline water may be made. Improvement of desalination techniques imply a definite potential for saline water supplies; possible by-products may have a value.

SUMMARY

George County does not have great deposits of metallic ores which are universally so romanticized, but it does have mineral resources which may play an important part in the future expanding economy of the County. Value of clay produced in Mississippi in 1965 was almost $6,000,000 and sand and gravel was valued at about $9,000,000 according to the Bureau of Mines.[69]

George County is favorably situated near potential market areas and water supplies are substantial. (See Water Resources section). The data assembled in this report should be of use to parties interested in potential development and exploitation of George County resources.

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to the George County Board of Supervisors for their assistance and support in the various phases of this investigation. Acknowledgment is due also to the Water Resources Division of the United States Geological Survey for certain water well logs.

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CORE HOLE AND TEST HOLE RECORDS

All holes cored or drilled by the Mississippi Geological Survey in the geological and mineral resources investigation of George County are designated numerically in order of completion. The letters AJ preceding the hole numbers are code letters designating George County in the Survey's County Sample Index System. All material secured and tested in the George County investigation is permanently filed at the Survey.

Locations of the holes cored or drilled by the Survey are shown on Figure 41 and on the Geologic Map (p. 1). Specific locations are included under individual hole descriptions. The purpose for coring or drilling each hole is also included.

Descriptions of cores and cuttings from the holes follows:

HOLE AJ-1

Location: SE.¼, NW.¼, SW.¼, Sec.12, T.2S., R.5W. In Highway 98 right-of-way, southwest side, approximately 200 feet northwest of secondary road intersection.

Elevation: 125 feet (topographic map) Date: June 14, 1966

Purpose: AJ-1 spudded approximately 5 feet below Citronelle formation/Pascagoula formation contact. Cored 43 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
2	2	Soil, gray-brown, sandy, silty, clayey.
2	4	Sand, fine- to medium-grained, abundant coarse grains, sub-angular to sub-rounded, abundant rounded grains, clayey, yellow color due to limonite stained clay particles.
2	6	Clay, light-gray, common red and yellow staining due to limonite and hematite, silty, sandy; grains range from fine to coarse and sub-rounded to rounded, some frosted.
2	8	Silt, light-gray, clayey, purple, maroon and yellow staining common.
2	10	Clay, light-gray, common red and orange staining, silty, rare mica flakes.
14	24	Silt, light-gray, some yellow staining diminishing downward, clayey, rare mica flakes.
4	28	Silt, pale olive-green, clayey, thin streaks of sand, very fine-grained.
6	34	Silt, pale olive-green, clayey, some yellow staining.
2	36	Silt, light olive-green, clayey, sandy, very fine-grained, rare mica flakes.
7	43	Silt, as above, becoming increasingly sandy
		Total depth: 43 feet

HOLE AJ-2

Location: NE.¼, NE.¼, SE.¼, Sec.23, T.1S., R.5W. Approximately 20 feet from road on northwest side.

Elevation: 140 feet (topographic map) Date: June 14, 1966

Purpose: AJ-2 spudded approximately 25 feet below Citronelle formation/Pascagoula formation contact. Cored 32 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
6	6	Soil and silt, yellow, very sandy with grains ranging up to coarse.
2	8	Clay, light-gray with pale olive-green tint, common yellow staining, silty.
4	12	Clay, as above, with streaks of clayey silt.
2	14	Silt, light-gray, clayey.
11	25	Clay, light olive-green, silty.
2	27	Clay, olive-green, silty, with fine-grained sand.
2	29	Sand, gray, fine-grained, sub-angular to sub-rounded, clayey.
3	32	Sand, light-gray, fine- to medium-grained, sub-rounded, silty, water-bearing.
		Total depth: 32 feet

HOLE AJ-3

Location: SW.¼, SE.¼, NE.¼, Sec.11, T.3S., R.5W. Approximately 20 feet from road, northwest side, in woods.

Elevation: 85 feet (topographic map) Date: June 14, 1966

Purpose: AJ-3 spudded in Third-level low terrace deposits. Cored to obtain stratigraphic information.

Thickness	Depth	Description
		Third-level low terrace
18	18	Sand, ranges from fine- to coarse-grained, mostly sub-rounded, poorly sorted, slightly clayey, pink, red, and yellow color due to clay particles. Abundant quartz granules and pebbles
		Total depth: 18 feet in wet sand.

HOLE AJ-4

Location: NE.¼, NW.¼, SW.¼, Sec.35, T.3S., R.6W. Approximately 300 feet from road, west side, in woods.

Elevation: 75 feet (topographic map) Date: June 15, 1966

Purpose: AJ-4 spudded approximately 15 feet below Citronelle formation/Pascagoula formation contact. Attempted to core to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
8	8	Sand, fine-grained, abundant very fine, medium and coarse grains, clayey, light-yellow color due to staining of clay particles.
		Total depth: 8 feet in water. (See AJ-20 nearby cored section)

HOLE AJ-5

Location: NE.¼, SW.¼, SE.¼, Sec.3, T.3S., R.6W. Approximately 30 feet from road, southeast side, in woods.

Elevation: 140 feet (topographic map) Date: June 15, 1966

Purpose: AJ-5 spudded approximately 10 feet below Citronelle formation/Pascagoula formation contact. Cored 42 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
4	4	Silt, light-gray, sandy, clayey, common red, orange, and yellow staining due to color of clay particles.
2	6	Silt, as above, with thin streaks of light-gray, very fine-grained sand.
2	8	Silt, mostly yellow stained, sandy and clayey with some silty clay.

14	22	Clay, light-gray, silty with streaks of light-gray silt, clayey and sandy.
5	27	Silt, light olive-green, very clayey, contains small pyrite nodules.
9	36	Silt, light olive-green, clayey, streaks of very fine-grained, silty sand.
2	38	Sand, light-gray, very fine-grained, silty, trace of carbonaceous material.
4	42	Sand, gray, very fine-grained, laminated with black carbonaceous material.
		Total depth: 42 feet

HOLE AJ-6

Location: Approximately 600 feet east and 1800 feet north of the southwest corner, Sec.24, T.3S., R.7W. Approximately 10 feet from road in ditch on northeast side, just northwest of Indian Creek.

Elevation: 55 feet (topographic map) Date: June 16, 1966

Purpose: AJ-6 spudded approximately 10 feet above Third-level low terrace/Pascagoula formation contact. Attempted to core into Pascagoula formation to obtain clay for testing.

Thickness	Depth	Description
		Third-level low terrace
8	8	Sand, medium-grained, abundant fine and coarse grains, abundant small quartz granules, sub-rounded, poorly sorted, slightly clayey, orange-red color due to stained clay particles.
		Total depth: 8 feet, too wet for further core recovery.

HOLE AJ-7

Location: NW.¼, NW.¼, SW.¼, Sec.15, T.3S., R.7W. Approximately 200 feet from road, southeast side, in cleared area.

Elevation: 34 feet (hand level from bench mark) Date: June 16, 1966

Purpose: AJ-7 spudded in the Pascagoula River alluvial plain. Cored for stratigraphic information and to obtain clay for testing.

Thickness	Depth	Description
		Alluvium
12	12	Sand, light-gray to pale-yellow, medium- to coarse-grained, sub-rounded to rounded, abundant small quartz granules, some streaks of clayey silt.
		Total depth: 12 feet, too wet for further core recovery.

HOLE AJ-8

Location: NW.¼, SE.¼, SE.¼, Sec.21, T.2S., R.7W. Approximately 10 feet from road, north side.

Elevation: 125 feet (topographic map) Date: June 21, 1966

Purpose: AJ-8 spudded approximately 5 feet below Citronelle formation/Pascagoula formation contact. Cored 42 feet for stratigraphic information and to obtain clay for testing.

Thickness	Depth	Description
		Pascagoula formation
4	4	Sand, light-gray, very fine-grained, silty, slightly clayey, yellow color common due to staining.
15	19	Clay, light-gray with pale olive-green tint, sandy and silty, streaks of sand, as above.
6	25	Clay, pale olive-green, sandy and silty with streaks of light-gray sand.

2	27	Silt, light olive-green, very clayey, contains some white, chalky, calcareous nodules.
1	28	Silt, as above, with abundant white, chalky, calcareous masses and nodules.
7	35	Silt, light olive-green, sandy, very clayey, few white, chalky, calcareous nodules, traces of mica flakes.
7	42	Clay, light olive-green, silty, slightly calcareous, few white, chalky, calcareous nodules.
		Total depth: 42 feet

HOLE AJ-9

Location: NW.¼, NW.¼, SW.¼, Sec.16, T.2S., R.7W. Approximately 20 feet east of wire fence along common line of section 15 and 16.

Elevation: 135 feet (topographic map) Date: June 21, 1966

Purpose: AJ-9 spudded in Citronelle formation. Drilled 70 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
10	10	Sand, fine- to coarse-grained, poorly sorted, silty, slightly clayey, red color due to staining, abundant small quartz granules, angular to rounded, some small, white, chert pebbles.
20	30	Sand and gravel, sand, as above, gravel is comprised of quartz and chert pebbles and abundant tripolitic chert pebbles, size ranges up to 20 mm. long axis.
10	40	Sand and gravel, as above, with abundant yellow silty clay (possibly clay balls).
		Pascagoula formation
30	70	Clay, light olive-green, silty, with some sand, gray, very fine-grained.
		Total depth: 70 feet

HOLE AJ-10

Location: NW.¼, NW.¼, NE.¼, Sec.3, T.2S., R.7W. Approximately 300 feet northeast of road junction, next to tree line.

Elevation: 160 feet (hand level) Date: June 22, 1966

Purpose: AJ-10 spudded approximately 20 feet below Citronelle formation/Pascagoula formation contact. Cored 42 feet to obtain clay for testing.

Thickness	Depth	Description
		Pascagoula formation
5	5	Sand, light-gray, fine-grained, sub-rounded, well sorted, common pink, orange and yellow color due to staining, very slightly clayey.
11	16	Clay, light-gray with pale olive-green tint, silty, slightly sandy.
7	23	Silt, light-gray, very clayey.
4	27	Silt, light-gray, very clayey, sandy, common yellow and orange color due to staining, contains abundant black, carbonaceous material and some white, chalky, calcareous material.
8	35	Silt, pale olive-green, clayey and sandy, some white, chalky, calcareous nodules, trace of mica flakes.
7	42	Clay, light olive-green, silty, streaks of very fine-grained, clayey, sand, some yellow staining, trace of mica flakes.
		Total depth: 42 feet

HOLE AJ-11

Location: SE.¼, NW.¼, SE.¼, Sec.14, T.1S., R.7W. In U. S. Highway 98 right-of-way, southwest side, up hill from railroad bridge.

Elevation: 165 feet (topographic map) Date: June 22, 1966

Purpose: AJ-11 spudded approximately 25 feet above Citronelle formation/Pascagoula formation contact. Cored 32 feet to obtain clay for testing.

Thickness	Depth	Description
		Citronelle formation
7	7	Sand, fine- to medium-grained, sub-angular, poorly sorted, slightly clayey, red and orange color due to stained clay particles.
7	14	Sand, very fine- to fine-grained, very clayey, red, pink, orange and yellow color due to stained clay particles.
8	22	Sand, very fine- to fine-grained, clayey, pink color due to stained clay particles.
10	32	Silt, sandy, clayey, pink color due to staining, streaks of pink clay, silty.
		Total depth: 32 feet

HOLE AJ-12

Location: SW.¼, NE.¼, SW.¼, Sec.8, T.1S., R.8W. Approximately 10 feet east of road, 300 feet south of junction.

Elevation: 175 feet (topographic map) Date: June 23, 1966

Purpose: AJ-12 spudded just below Citronelle formation/Pascagoula formation contact. Cored 42 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
2	2	Clay and silt, light-gray, common red and orange staining.
15	17	Silt, light-gray and pale-yellow, very clayey, slightly sandy.
5	22	Sand, very fine-grained, light-gray, silty and clayey with streaks of light-gray and yellow clay.
4	26	Clay, light-gray and pale-yellow, silty, calcareous, with streaks of very fine-grained, gray, sand.
2	28	Clay, as above, with white, chalky, calcareous nodules.
8	36	Clay, olive-green, with abundant white, chalky, calcareous, nodules.
6	42	Sand, pale olive-green, very fine-grained, silty and clayey, trace of mica flakes.
		Total depth: 42 feet

HOLE AJ-13

Location: Approximately 1400 feet east and 200 feet north of the southwest corner of irregular Sec.4, T.2S., R.8W. In east right-of-way of State Highway 57.

Elevation: 100 feet (topographic map) Date: June 23, 1966

Purpose: AJ-13 spudded in a Third-level low terrace. Cored 32 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Third-level low terrace
13	13	Sand and gravel, fine- to coarse-grained, silty and clayey, yellow and orange color due to stained clay particles, abundant small rounded quartz granules and small quartz pebbles up to ¼" long axis.

		Pascagoula formation
2	15	Clay, light-gray, slightly silty.
2	17	Silt, very clayey, yellow-orange color due to staining, slightly sandy.
3	20	Sand, light-gray, fine-grained, sub-rounded, well sorted.
2	22	Sand, very fine- to fine-grained, clayey, yellow color due to stained clay particles, abundant chocolate and black carbonaceous streaks.
10	32	Clay, light olive-green, silty.
		Total depth: 32 feet

HOLE AJ-14

Location: NW.¼, SW.¼, NE.¼, Sec.25, T.3S., R.9W. In logging trail.

Elevation: 90 feet (topographic map) Date: June 27, 1966

Purpose: AJ-14 spudded at Citronelle formation/Pascagoula formation contact. Cored 42 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
2	2	Clay, light olive-green, with pink, red and yellow staining, slightly silty.
14	16	Clay, light olive-green, streaks of yellow stained clay, silty.
1	17	Clay, olive-green, abundant very fine sized limonite and manganese particles.
4	21	Clay, light olive-green with black manganiferous material.
5	26	Clay, olive-green, silty.
1	27	Clay, as above, with some red streaks.
14	41	Clay, pale olive-green, silty, slightly sandy.
1	42	Clay, as above, with red streaks.
		Total depth: 42 feet

HOLE AJ-15

Location: NE.¼, NW.¼, NE.¼, Sec.21, T.3S., R.8W. Approximately 200 feet from road, northeast side, in woods.

Elevation: 85 feet (topographic map) Date: June 28, 1966

Purpose: AJ-15 spudded in Third-level low terrace. Cored 12 feet for stratigraphic information.

Thickness	Depth	Description
		Third-level low terrace
12	12	Sand, mostly medium-grained, with abundant fine to coarse grains and small quartz granules, sub-rounded, poorly sorted, common red and orange staining, gravelly, with small quartz pebbles, up to ¼".
		Total depth: 12 feet, sand too wet for further core recovery.

HOLE AJ-16

Location: SW.¼, NE.¼, NW.¼, Sec.17, T.3S., R.8W. Approximately 20 feet from logging trail, west side, in woods.

Elevation: 90 feet (topographic map) Date: June 28, 1966

Purpose: AJ-16 spudded at Citronelle formation/Pascagoula formation contact. Cored 32 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
5	5	Clay, light-gray, with pale greenish tint, red staining, silty.
5	10	Sand, light-gray, very fine-grained, silty and clayey.
12	22	Clay, light-gray, silty and sandy, traces of mica flakes.

2	24	Silt, olive-green, sandy and clayey.
8	32	Silt, as above, with sandy streaks.
		Total depth: 32 feet

HOLE AJ-17

Location: Approximately 900 feet south and 500 feet west of the northeast corner of irregular Sec.14, T.3S., R.8W. In State Highway 57 right-of-way, west side.

Elevation: 65 feet (topographic map) Date: June 28, 1966

Purpose: AJ-17 spudded in Second-level low terrace. Cored 10 feet to wet sand, then drilled to 30 feet for stratigraphic information.

Thickness	Depth	Description
		Second-level low terrace
5	5	Sand, fine-grained, silty, clayey, light-gray, yellow and pink color due to stained clay particles.
5	10	Sand, fine- to medium-grained, sub-rounded, well sorted, white, clay matrix.
10	20	Sand, fine- to coarse-grained, sub-rounded to rounded, light-yellow, abundant small quartz granules, trace of green clay.
10	30	Sand, as above, white, gravelly, with abundant small quartz and chert pebbles, up to ¼", some sandy, yellow, clay masses (clay balls?).
		Total depth: 30 feet

HOLE AJ-18

Location: NW.¼, NW.¼, SE.¼, Sec.24, T.2S., R.9W. Approximately 20 feet from road, west side.

Elevation: 125 feet (topographic map) Date: June 29, 1966

Purpose: AJ-18 spudded just below Citronelle formation/Pascagoula formation contact. Cored 32 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
1	1	Soil and red, sandy, clay.
7	8	Clay and silt, light-gray, purple and red.
3	11	Silt, light-gray, clayey and sandy.
8	19	Sand, light-gray, very fine-grained, well sorted, contains dark-brown manganiferous material with bottom 3 inches mostly manganiferous material.
3	22	Silt, light-gray, very clayey, streaks yellow staining.
5	27	Clay, olive-green with some red streaks, silty.
2	29	Clay, olive-green, sandy streaks, very fine-grained, trace mica flakes.
3	32	Clay, as above, with abundant white, chalky, calcareous nodules.
		Total depth: 32 feet

HOLE AJ-19

Location: NE.¼, NE.¼, SE.¼, Sec.3, T.3S., R.7W. Approximately 200 feet from road, west side, in woods.

Elevation: 85 feet (topographic map) Date: June 29, 1966

Purpose: AJ-19 spudded approximately 20 feet below Citronelle formation/Pascagoula formation contact. Cored 32 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
1	1	Soil and sandy clay.
9	10	Clay, pale olive-green, sandy.

3	13	Clay, pale olive-green, very sandy.
4	17	Sand, light-gray, fine-grained, sub-rounded, well sorted, clay matrix.
9	26	Clay, pale olive-green, slightly sandy, streaks of yellow staining.
5	31	Clay, olive-green, slightly silty.
1	32	Sand, very fine-grained, clayey.
		Total depth: 32 feet

HOLE AJ-20

Location: SW.¼, SE.¼, NE.¼, Sec.35, T.3S., R.6W. Approximately 20 feet from road, northeast side.

Elevation: 80 feet (topographic map) Date: June 29, 1966

Purpose: AJ-20 spudded approximately 10 feet below Citronelle formation/Pascagoula formation contact. Cored 22 feet for stratigraphic information.

Thickness	Depth	Description
		Pascagoula formation
5	5	Clay, light-gray, red and yellow staining, silty and sandy, trace of mica flakes.
1	6	Sand, very fine- to medium-grained, sub-rounded, poorly sorted, clayey, red, yellow and orange color due to stained clay particles, gravelly, with small, red and light-gray clay pebbles comprising gravel.
2	8	Sand, light-gray, very fine-grained, well sorted, streaks of red and yellow staining, clayey.
7	15	Sand, light-gray, fine-grained, sub-rounded, well sorted, slightly clayey, some red color due to stained sand particles.
1	16	Sand, as above, but stained black and dark-gray by carbonaceous material.
1	17	Lignitic clay and woody material.
5	22	Sand, as above, with abundant pieces of carbonized wood.
		Total depth: 22 feet

HOLE AJ-21

Location: NW.¼, SE.¼, SE.¼, Sec.19, T.1S., R.6W. Approximately 100 feet south of railroad tracks on lumber mill property.

Elevation: 145 feet (hand level from bench mark) Date: June 30, 1966

Purpose: AJ-21 spudded in Big Creek alluvium. Cored 21 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
10	10	Sand, medium-grained, sub-rounded, well sorted, pink color due to stained clay particles.
7	17	Sand, fine- to coarse-grained, sub-rounded, poorly sorted, light-gray, common pink, red, orange and yellow color due to stained clay particles, very clayey.
1	18	Sand, coarse-grained, abundant medium and very coarse grains, sub-rounded to rounded, orange color due to stained clay particles, streaks of ferruginous, clayey sand.
3	21	Sand, medium-grained, sub-rounded, well sorted, light-gray, some yellow staining, slightly clayey.
		Total depth: 21 feet, too wet to recover more core.

HOLE AJ-22

Location: SE.¼, SE.¼, SE.¼, Sec.21, T.1S., R.7W. Approximately 10 feet from road, northwest side, in woods.

Elevation: 170 feet (topographic map) Date: June 30, 1966

Purpose: AJ-22 spudded approximately 10 feet below Citronelle formation/Pascagoula formation contact. Cored 18 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
14	14	Sand, very fine- to fine-grained, sub-rounded, very clayey, light-gray with some red staining.
4	18	Sand, very fine-grained, light-gray with pale olive-green tint, some yellow streaks, very clayey, some manganiferous material.
		Total depth: 18 feet

HOLE AJ-23

Location: NW.¼, NW.¼, SW.¼, Sec.1, T.1S., R.5W. Approximately 20 feet northwest of road junction, in woods.

Elevation: 180 feet (topographic map) Date: July 6, 1966

Purpose: AJ-23 spudded just below the Citronelle formation/Pascagoula formation contact. Cored 32 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
10	10	Silt, light-gray, some red stained streaks, very clayey, sandy.
5	15	Sand, light-gray, very fine-grained, clayey and silty.
6	21	Clay, pale olive-green, some yellow staining, silty, streaks of light-gray, very fine-grained sand.
2	23	Clay, as above, with concentration of manganiferous material.
5	28	Clay, light olive-green.
2	30	Clay, as above, silty, yellow-orange staining, abundant ferruginous clay nodules.
2	32	Sand, very fine-grained, light-gray, yellow staining, clayey.
		Total depth: 32 feet

HOLE AJ-24

Location: SW.¼, NE.¼, SE.¼, Sec.16, T.2S., R.5W. In center of logging trail in woods.

Elevation: 135 feet (topographic map) Date: July 18, 1966

Purpose: AJ-24 spudded near Citronelle formation/Pascagoula formation contact. Cored 22 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
8	8	Clay, pale olive-green, red staining common, sandy.
10	18	Sand, fine-grained, sub-rounded, light-gray, common yellow staining, clayey, scattered carbonaceous material.
4	22	Sand, fine-grained, sub-rounded, well sorted, light-gray, slightly clayey, scattered carbonaceous material.
		Total depth: 22 feet

HOLE AJ-25

Location: NW.¼, NE.¼, SE.¼, Sec.34, T.2S., R.5W. Approximately 20 feet southeast of road junction.

Elevation: 100 feet (topographic map) Date: July 19, 1966

Purpose: AJ-25 spudded near Citronelle formation/Pascagoula formation contact. Cored 32 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Pascagoula formation
10	10	Sand, mostly very fine- to fine-grained, sub-rounded, abundant coarse grains, light-gray, clayey, some red staining.

12	22	Silt, light-gray, very clayey, streaks of very fine-grained sand.
10	32	Clay, olive-green, sandy.
		Total depth: 32 feet

HOLE AJ-26

Location: SW.¼, NW.¼, NW.¼, Sec.29, T.1S., R.6W. In U. S. Highway 98 right-of-way, southwest side.

Elevation: 170 feet (topographic map) Date: July 19,1966

Purpose: AJ-26 spudded just above Citronelle formation/Pascagoula formation contact. Cored 32 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
14	14	Sand, fine- to coarse-grained, sub-angular, clayey, red, orange and yellow color due to stained clay particles, abundant small quartz pebbles, some clay pebbles.
		Pascagoula formation
8	22	Sand, very fine-grained, well sorted, light-gray, clayey, yellow color due to stained clay particles.
10	32	Clayey sand and sandy clay, yellow stained, very fine-grained.
		Total depth: 32 feet

HOLE AJ-27

Location: SW.¼, NW.¼, NE.¼, Sec.37, T.1S., R.7W. In logging trail, in woods.

Elevation: 65 feet (topographic map) Date: July 19, 1966

Purpose: AJ-27 spudded in Pascagoula River alluvial plain. Cored 13 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
6	6	Sand, fine- to coarse-grained, sub-angular to sub-rounded, poorly sorted, clayey, stained yellow-orange.
7	13	Sand, fine- to medium-grained, sub-rounded, abundant coarse grains, poorly sorted, some organic material, water sand.
		Total depth: 13 feet, too wet for further core recovery.

HOLE AJ-28

Location: NW.¼, NW.¼, NE.¼, Sec.16, T.1S., R.8W. Approximately 40 feet from logging trail, west side.

Elevation: 110 feet (topographic map) Date: July 20, 1966

Purpose: AJ-28 was drilled 470 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
10	10	Sand, mostly medium-grained, abundant fine grains, sub-angular, red stained.
		Pascagoula formation
10	20	Clay, light-gray, red and yellow stained, very sandy.
20	40	Clay, light-gray and pale olive-green, sandy streaks of light-gray sand, fine-grained, some medium grains.
10	50	Clay, slightly sandy, light olive-green with abundant red.
10	60	Clay, light olive-green, stained red, yellow and orange, with streaks of very fine- to fine-grained sand.
10	70	Sand, light-gray, very fine-grained, abundant medium grains, sub-rounded, clayey, red and yellow staining common.
5	75	Sand, light-gray, very fine-grained, very clayey.

35	110	Sand, light-gray to white, medium-grained, sub-rounded with abundant rounded grains, well sorted, trace black chert grains.
30	140	Sand, medium- to coarse-grained, sub-rounded to rounded, with abundant very coarse, rounded, quartz and chert grains.
30	170	Sand, mostly medium-grained, some fine, coarse and very coarse grains, sub-rounded to rounded.
10	180	Sand, as above, with increase in black and gray chert grains.
10	190	Sand, medium-grained, sub-rounded to rounded, well sorted, clear with abundant black chert grains (salt and pepper).
25	215	Sand, medium-grained, sub-rounded to rounded, clear, well sorted, abundant very coarse grains, trace of black chert grains, some small quartz and chert pebbles.
5	220	Sand, as above, gravelly, with quartz, chert and some clay pebbles.
40	260	Clay, light olive-green, slightly sandy.
10	270	Clay, light olive-green, with abundant lignitic material.
15	285	Sand, very fine-grained, abundant medium and coarse grains, sub-rounded to rounded, abundant lignitic material, very clayey, some clay and quartz pebbles.
15	300	Clay, light olive-green, slightly sandy, with streaks of sand, as above.
120	420	Silt and clay, light olive-green, streaks of gray, pink and yellow.
35	455	Clay, light olive-green and light-gray, slightly silty and sandy.
15	470	Sand, mostly medium-grained, abundant fine and coarse grains, sub-rounded, poorly sorted.
		Total depth: 470 feet

HOLE AJ-29

Location: Approximately 1400 feet east and 1200 feet north of the southwest corner of irregular Sec.11, T.1S., R.8W., on logging trail in swamp.

Elevation: 45 feet (topographic map) Date: August 3, 1966

Purpose: AJ-29 spudded in Pascagoula River alluvial plain. Cored 10 feet in attempt to recover alluvial clay sample for testing.

Thickness	Depth	Description
		Alluvium
2	2	Clay, brown, with some red staining, contains scattered organic material.
8	10	Sand, fine- to medium-grained, sub-rounded, white, water sand.
		Total depth: 10 feet, too wet to recover core.

HOLE AJ-30

Location: Approximately 3500 feet east and 1600 feet north of southwest corner of irregular Sec.11, T.1S., R.8W. On logging trail in swamp.

Elevation: 45 feet (topographic map) Date: August 4, 1966

Purpose: AJ-30 spudded on Pascagoula River alluvial plain. Cored 26 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
19	19	Silt, gray-brown, very clayey, sandy, scattered organic material.
7	26	Gravel, sandy, small quartz and chert pebbles, up to 10 mm.
		Total depth: 26 feet, too wet to recover further cores.

HOLE AJ-31

Location: Approximately 2000 feet west and 800 feet south of the northeast corner of irregular Sec.11, T.2S., R.8W. On logging trail in swamp.

Elevation: 35 feet (topographic map) Date: August 8, 1966

Purpose: AJ-31 spudded on Pascagoula River alluvial plain. Cored 17 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
1	1	Sandy soil and gravel.
16	17	Gravel and sand, pebbles up to 20 mm., quartz and chert, sand is medium- to very coarse-grained, sub-rounded to rounded.
		Total depth: 17 feet, too wet for further core recovery.

HOLE AJ-32

Location: Approximately 400 feet north and 200 feet east of southwest corner of irregular Sec.11, T.2S., R.8W. In woods, northeast of bridge on State Highway 26.

Elevation: 35 feet (topographic map) Date: August 9, 1966

Purpose: AJ-32 spudded on Pascagoula River alluvial plain. Cored 14 feet for stratigraphic information and attempted to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
5	5	Clay, brown, sandy, very silty, scattered organic material.
6	11	Clay, gray-brown, some red staining, very sandy, grains range from fine to coarse, sub-rounded to rounded.
3	14	Sand, mostly medium-grained, abundant fine and coarse grains, white, water sand.
		Total depth: 14 feet, too wet for further core recovery.

HOLE AJ-33

Location: NE.¼, NW.¼, NE.¼, Sec.5, T.3S., R.7W. Just inside fenced pasture.

Elevation: 35 feet (topographic map) Date: August 9, 1966

Purpose: AJ-33 spudded on Pascagoula River alluvial plain. Cored 18 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
4	4	Sandy and clayey soil.
8	12	Sand, medium- to coarse-grained, sub-rounded, abundant very coarse grains, slightly gravelly with small quartz and chert pebbles (5 mm.).
6	18	Sand, as above, with increase in pebbles.
		Total depth: 18 feet, too wet for further core recovery.

HOLE AJ-34

Location: SE.¼, SW.¼, SE.¼, Sec.16, T.2S., R.7W. Just off trail, in woods.

Elevation: 140 feet (topographic map) Date: August 9, 1966

Purpose: AJ-34 spudded in Citronelle formation. Cored 22 feet to determine thickness of gravel in area.

Thickness	Depth	Description
		Citronelle formation
3	3	Sand, fine- to coarse-grained, sub-angular, poorly sorted, silty, slightly clayey, red color due to staining, abundant small quartz granules, angular to rounded, some small white chert pebbles.

6	9	Sand and gravel, sand, as above, gravel is comprised of chert and quartz pebbles with abundant white tripolitic chert pebbles, size ranges up to 25 mm. long axis.
8	17	Sand and gravel, as above, very clayey, clay is light-gray, yellow stained, and silty, possible clay balls.
2	19	Same as above with increase in clay.
		Pascagoula formation
3	22	Sand, very fine-grained, light-gray, sub-rounded, well-sorted, very clayey.
		Total depth: 22 feet

HOLE AJ-35

Location: NE.¼, NW.¼, NW.¼, Sec.3, T.3S., R.8W. Just off of trail, in woods.

Elevation: 100 feet (topographic map) Date: August 16, 1966

Purpose: AJ-35 spudded on Third-level low terrace deposits. Cored 22 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Third-level low terrace
2	2	Sandy soil and sand, very fine- to coarse-grained, sub-rounded, brown.
12	14	Sand, mostly very fine-grained, abundant fine to medium grains, sub-rounded, very clayey, purple, red, yellow staining.
8	22	Silt, purple and red stained, very clayey, sandy.
		Total depth: 22 feet

HOLE AJ-36

Location: Approximately 2500 feet east and 1500 feet north of the southwest corner of irregular Sec.14, T.3S., R.8W. In center of trail east of pond.

Elevation: 35 feet (topographic map) Date: August 16, 1966

Purpose: AJ-36 spudded on Black Creek alluvial plain. Cored 12 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
1	1	Sand, fine- to very coarse-grained, sub-rounded to rounded, poorly sorted, some small chert pebbles.
13	14	Sand and gravel, sand, as above, gravel comprised of quartz, chert and tripolitic chert pebbles, ranging up to 15 mm. long axis.
		Total depth: 14 feet

HOLE AJ-37

Location: Approximately 1900 feet east and 1300 feet north of the southwest corner of irregular Sec.14, T.3S., R.8W. In right-of-way, State Highway 57, west side.

Elevation: 35 feet (topographic map) Date: August 17, 1966

Purpose: AJ-37 spudded in the Black Creek alluvial plain. Cored 16 feet for stratigraphic information.

Thickness	Depth	Description
		Alluvium
1	1	Sand, fine- to very coarse-grained, sub-rounded to rounded, poorly sorted, some small quartz and chert pebbles.
15	16	Sand and gravel, sand, as above, gravel comprised of quartz, chert and tripolitic chert pebbles, ranging up to 20 mm. long axis.
		Total depth: 16 feet

HOLE AJ-38

Location: SE.¼, NW.¼, NE.¼, Sec.1, T.3S., R.8W. On transmission line right-of-way, in swamp.

Elevation: 32 feet (topographic map) Date: August 18, 1966

Purpose: AJ-38 spudded on Pascagoula River alluvial plain. Cored 15 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
1	1	Soil and clay, dark-brown and gray, sandy.
9	10	Silt, brown and gray-brown, very clayey.
1	11	Sand, very fine- to fine-grained, gray and tan, sub-rounded, clayey.
2	13	Silt, tan to light-gray, very clayey, trace mica flakes.
2	15	Sand, fine-grained, sub-rounded, clayey, tan to light-gray, water sand.
		Total depth: 15 feet, too wet for further core recovery.

HOLE AJ-39

Location: NE.¼, SE.¼, NW.¼, Sec.1, T.3S., R.8W. Approximately 1200 feet southwest of AJ-38, down right-of-way.

Elevation: 35 feet (topographic map) Date: August 18, 1966

Purpose: AJ-39 spudded on Pascagoula River alluvial plain. Cored 20 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
15	15	Silt, brown, tan and gray-brown, very clayey, some organic staining.
5	20	Sand, very fine- to fine-grained, abundant medium grains, sub-rounded, poorly sorted, clayey, water sand.
		Total depth: 20 feet, too wet for further core recovery.

HOLE AJ-40

Location: NW.¼, SE.¼, NW.¼, Sec.1, T.3S., R.8W. Approximately 400 feet southwest of AJ-39, down right-of-way.

Elevation: 35 feet (topographic map) Date: August 18, 1966

Purpose: AJ-40 spudded on Pascagoula River alluvial plain. Cored 14 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
3	3	Silt, brown, gray-brown, very clayey.
11	14	Sand, very fine- to fine-grained, abundant medium grains, sub-rounded, poorly sorted, clayey.
		Total depth: 14 feet

HOLE AJ-41

Location: NE.¼, NW.¼, NE.¼, Sec.1, T.3S., R.8W. Approximately 600 feet northeast of AJ-38, up right-of-way.

Elevation: 35 feet (topographic map) Date: August 18, 1966

Purpose: AJ-41 spudded on Pascagoula River alluvial plain. Cored 14 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
5	5	Silt, yellow and brown, very sandy, clayey.
9	14	Silt, tan, very clayey.
		Total depth: 14 feet

HOLE AJ-42

Location: Approximately 2300 feet north and 1000 feet east of the southwest corner of irregular Sec.42, T.2S., R.7W. On transmission line right-of-way, in swamp.

Elevation: 35 feet (topographic map) Date: August 23, 1966

Purpose: AJ-42 spudded on Pascagoula River alluvial plain. Cored 14 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
1	1	Soil, silty and clayey, brown.
11	12	Clay, tan, brown and gray-brown, silty, sandy.
2	14	Sand, medium-grained, sub-rounded, well sorted, water sand.
		Total depth: 14 feet, too wet for further core recovery.

HOLE AJ-43

Location: Approximately 700 feet east and 400 feet south of the northwest corner of irregular Sec.42, T.2S., R.7W. On trail, in swamp.

Elevation: 35 feet (topographic map) Date: August 23, 1966

Purpose: AJ-43 spudded on Pascagoula River alluvial plain. Cored 12 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
6	6	Clay, gray-brown, red staining, sandy.
4	10	Silt, gray-brown and tan, clayey, sandy.
2	12	Sand, gray, very fine- to fine-grained, clayey, water sand, H_2S odor.
		Total depth: 12 feet, too wet for further core recovery.

HOLE AJ-44

Location: Approximately 1500 feet north and 1000 feet west of the southeast corner of irregular Sec.17, T.3S., R.7W. On trail, in swamp.

Elevation: 25 feet (topographic map) Date: August 23, 1966

Purpose: AJ-44 spudded on Pascagoula River alluvial plain. Cored 15 feet for stratigraphic information and to obtain clay samples for testing.

Thickness	Depth	Description
		Alluvium
6	6	Clay, dark-brown and gray-brown, gravelly, with quartz and chert pebbles ranging up to 15 mm. long axis.
8	14	Clay, gray-brown, sandy, scattered organic material.
1	15	Sand, coarse-grained, sub-rounded, abundant very coarse grains and small quartz pebbles, clayey, water sand.
		Total depth: 15 feet

HOLE AJ-45

Location: NE.¼, NE.¼, NE.¼, Sec.13, T.3S., R.5W. Approximately 50 feet from abandoned school house, east side.

Elevation: 154 feet (topographic map) Date: August 24, 1966

Purpose: AJ-45 spudded in Citronelle formation. Drilled 450 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
15	15	Sand, fine- to medium-grained, abundant coarse grains, poorly sorted, sub-angular, abundant small quartz pebbles, clayey, red color due to stained clay particles.

15	30	Clay, white and pale-pink, sandy.
30	60	Sand, as above, white to clear.
30	90	Sand, mostly medium-grained, abundant coarse and very coarse grains, mostly sub-angular, slightly clayey, white to clear.
10	100	Gravel, comprised of quartz and chert pebbles, ranging up to 15 mm. long axis.
		Pascagoula formation
100	200	Clay, light olive-green, silty, slightly sandy, some calcareous streaks.
10	210	Sand, very fine-grained, sub-rounded, well sorted, clayey, light olive-green.
20	230	Silt, light olive-green, clayey, sandy streaks, abundant shell fragments (*Rangia johnsoni*).
10	240	Clay, light olive-green, some gray streaks, silty and sandy, trace shell fragments.
20	260	Sand, very fine- to fine-grained, sub-rounded, abundant coarse grains, very clayey.
35	295	Sand, medium- to coarse-grained, abundant very coarse grains, sub-rounded, poorly sorted, clear to white, abundant black chert grains, some pyrite.
5	300	Clay, light olive-green, slightly sandy.
10	310	Sand, very fine-grained, light olive-green, silty and clayey, trace mica flakes.
70	380	Clay, light olive-green, slightly sandy, streaks of very fine-grained, clayey sand.
10	390	Clay, light olive-green and gray, sandy and silty, abundant shell fragments (*Rangia johnsoni*), fish vertebra, some pyrite.
40	430	Clay, light olive-green, slightly sandy.
20	450	Sample is mostly shell fragments (*Rangia johnsoni*).
		Total depth: 450 feet

HOLE AJ-46

Location: Approximately 3800 feet north and 600 feet west of southeast corner of irregular Sec.10, T.3S., R.7W. On flat area near west slope.

Elevation: 135 feet (topographic map) Date: September 7, 1966

Purpose: AJ-46 spudded on Citronelle formation. Cored 17 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
9	9	Sand, fine- to medium-grained, sub-angular to sub-rounded, some coarse grains, clayey, red color due to stained clay particles.
8	17	Sand, as above, with some very coarse grains.
		Total depth: 17 feet

HOLE AJ-47

Location: Approximately 2400 feet north and 500 feet west of the southwest corner of irregular Sec.10, T.3N., R.7W. On trail down slope from flat area.

Elevation: 120 feet (topographic map) Date: September 7, 1966

Purpose: AJ-47 spudded on Citronelle formation near Pascagoula formation contact. Cored 15 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
3	3	Sand, medium- to coarse-grained, sub-angular with abundant rounded grains, yellow-orange staining.

3	6	Sand, as above, with abundant small quartz granules, red staining.
8	14	Sand, as above, light-gray to clear, with some red staining, water sand.
		Total depth: 14 feet, too wet for further core recovery.

HOLE AJ-48

Location: SW.¼, NE.¼, Sec.17, T.2S., R.7W. West of County gravel pit.

Elevation: 115 feet (topographic map) Date: September 8, 1966

Purpose: AJ-48 spudded on Citronelle formation. Cored for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
17	17	Gravel and sand, sand is fine- to very coarse-grained, sub-angular to sub-rounded, poorly sorted, stained red, slightly clayey, gravel is comprised of quartz, chert and tripolitic chert, ranging up to 20 mm. long axis.
		Total depth: 17 feet

HOLE AJ-49

Location: SW.¼, NE.¼, Sec.17, T.2S., R.7W. Approximately 600 feet north, northwest of AJ-48.

Elevation: 105 feet (topographic map) Date: September 8, 1966

Purpose: AJ-49 spudded on Citronelle formation. Cored for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
5	5	Sand, medium- to coarse-grained, abundant fine grains, sub-angular to sub-rounded, gray.
		Pascagoula formation
10	15	Clay, gray, silty.
		Total depth: 15 feet

HOLE AJ-50

Location: SW.¼, NE.¼, Sec.17, T.2S., R.7W. Approximately 500 feet north, northeast of AJ-49.

Elevation: 115 feet (topographic map) Date: September 8, 1966

Purpose: AJ-50 spudded on Citronelle formation. Cored for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
10	10	Sand, gravelly, fine- to coarse-grained, abundant very coarse grains and small quartz and chert pebbles.
4	14	Sand, as above, water sand.
		Total depth: 14 feet, too wet for further recovery.

HOLE AJ-51

Location: Approximately 2400 feet east and 900 feet south of the northwest corner of irregular Sec.3, T.1S., R.8W. On trail in woods, northeast of abandoned gravel pit.

Elevation: 55 feet (topographic map) Date: May 9, 1967

Purpose: AJ-51 spudded on Pamlico terrace (First-level low terrace). Cored 12 feet for stratigraphic information.

Thickness	Depth	Description
		Pamlico terrace
3	3	Sandy soil

9	12	Sand and gravel, sand, fine- to coarse-grained, poorly sorted, sub-rounded to rounded, white, gravel is comprised of quartz and chert pebbles, ranging up to 30 mm. long axis.
		Total depth: 12 feet

HOLE AJ-52

Location: SW.¼, SE.¼, NE.¼, Sec.16, T.1S., R.7W. Just off logging trail.

Elevation: 145 feet (topographic map) Date: May 10, 1967

Purpose: AJ-52 spudded near Citronelle formation/Pascagoula formation contact. Cored 14 feet for stratigraphic information.

Thickness	Depth	Description
		Pascagoula formation
2	2	Clayey soil, brown.
12	14	Clay, red and light-gray, silty, with streaks of yellow, clayey sand.
		Total depth: 14 feet

HOLE AJ-53

Location: NW.¼, SE.¼, NE.¼, Sec.16, T.1S., R.7W. In center of logging trail.

Elevation: 180 feet (topographic map) Date: May 10, 1967

Purpose: AJ-53 spudded on Citronelle formation. Cored 12 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
2	2	Sandy soil, reddish-brown.
10	12	Sand, medium- to coarse-grained, sub-angular, poorly sorted, slightly clayey, red staining, scattered small quartz pebbles.
		Total depth: 12 feet

HOLE AJ-54

Location: Approximately 1500 feet west and 2100 feet north of the southeast corner of irregular Sec.43, T.2S., R.7W. In center of gravel pit.

Elevation: 135 feet (topographic map) Date: May 10, 1967

Purpose: AJ-54 spudded on Citronelle formation. Cored 9 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
9	9	Sand and gravel, sand, fine- to coarse-grained, sub-angular, poorly sorted, silty, abundant quartz granules, red stained, gravel is quartz and chert pebbles, size ranges up to 25 mm. long axis.
		Total depth: 9 feet

HOLE AJ-55

Location: SE.¼, NW.¼, NE.¼, Sec.33, T.3S., R.5W. In open field.

Elevation: 185 feet (topographic map) Date: May 10, 1967

Purpose: AJ-55 spudded on Third-level low terrace deposits. Cored 16 feet for stratigraphic information.

Thickness	Depth	Description
		Third-level low terrace
2	2	Sandy soil, brown.
12	14	Sand, very fine- to fine-grained, abundant medium and coarse grains, sub-rounded, very clayey, red, yellow and purple staining.
2	16	Sand, gray, medium-grained, water bearing.
		Total depth: 16 feet

HOLE AJ-56

Location: SW.¼, NW.¼, NE.¼, Sec.33, T.3S., R.5W. Along fence line.

Elevation: 185 feet (topographic map) Date: May 10, 1967

Purpose: AJ-56 spudded on Third-level low terrace deposits. Cored 16 feet for stratigraphic information.

Thickness	Depth	Description
		Third-level low terrace
2	2	Sandy soil, brown.
12	14	Sand, very fine- to fine-grained, abundant medium and coarse grains, sub-rounded, very clayey, red, yellow and purple staining.
2	16	Sand, gray, medium-grained, water bearing.
		Total depth: 16 feet

HOLE AJ-57

Location: NE.¼, NW.¼, NW.¼, Sec.34, T.2S., R.6W. At edge of cleared area, near logging trail.

Elevation: 225 feet (topographic map) Date: May 10, 1967

Purpose: AJ-57 spudded in Citronelle formation. Cored 12 feet for stratigraphic information.

Thickness	Depth	Description
		Citronelle formation
2	2	Sandy soil, red and brown.
10	12	Sand, fine- to medium-grained, sub-angular, poorly sorted, red stained, clayey.
		Total depth: 12 feet

GEORGE COUNTY CLAY TESTS

THOMAS E. McCUTCHEON

ABSTRACT

The clays of George County offer development opportunities in the field of heavy clay products in both the plastic and dry press processes of manufacture. Their use as bond clay in various ceramic products is apparent. Other uses as in foundry application, mineral, vegetable, and naval stores purification and drilling mud are significant. Beneficiation of the Pascagoula clays would likely result in a product to compete with or replace bentonite.

INTRODUCTION

The George County clays submitted for testing and evaluation consist of fourteen samples from the Pascagoula formation, four samples from alluvial deposits, and one sample from a terrace deposit. The core hole samples representing 350 feet of strata were tested at the Georgia Institute of Technology in the School of Ceramics laboratories. The samples were designated the same number as the core holes from which they were recovered. The initial test work was done under standard conditions and procedures. These methods are designed to show the most pertinent characteristics. Often a clay may have unfavorable properties when considered for a particular use. However, the same properties may be very desirable when the clay is considered for a different use. Special tests were made on some of the clays to better determine their special characteristics and uses.

Other than ceramic testing, conventional and special chemical analyses and screen analyses were made as well as x-ray analyses on certain clays. The locations from which the samples were taken, the description of the various strata, and the stratigraphic position of the samples tested are given in the section on Core Hole and Test Hole Records.

CERAMIC TEST PROCEDURE

The clays were dried, ground and screened through 14 mesh wire screens. A five pound cut of each sample was forwarded to the Survey for use in obtaining chemical and x-ray analyses. A twenty pound sample of each clay was mulled with water to a plastic mass. The plastic clays were extruded into 1″x1″x6″ bars. The bars were air dried for several days and then oven dried, after which they were burned in a gas kiln to several temperatures. Test data was obtained from the plastic, dry and fired bars as is noted in the tables under the headings "Physical Properties in the Unburned State" and "Pyrophysical Properties." Chemical analyses, screen analyses and x-ray analyses are shown in tables so designated. Special test data and comments are given in the text.

COMMENTS

All of the nineteen samples are very plastic and have excellent extrusion properties. All tend to laminate, particularly the Pascagoula clays. The alluvial clays have the least tendency to laminate when extruded.

The Pascagoula clays have rather high water of plasticity values, high drying shrinkage, and unusually high dry strength. As usual with this type of clay, on drying, cracks are developed because of the fineness of grain size which prevents moisture from the interior of the test bars from migrating to its surface for evaporation as fast as the surface is dried. This causes a differential shrinkage between the interior and exterior of the clay mass and conduces cracking and warpage. X-ray analysis of some of the Pascagoula clays indicate that the principal clay mineral is montmorillonite. This mineral is also the principal clay mineral in western and southern bentonites, a clay widely used as a bond in foundry sand, a filtering and purifying agent for use with vegetable and mineral oils, and as drilling mud. Special tests were conducted to determine the feasibility of concentrating the active clay substance.

Since the Pascagoula clays have very desirable burned colors and good firing properties for use in many heavy clay products, special tests were made to counteract the high shrinkage, warpage, laminations, and cracking of the clays when used in their natural state. This was done by partially burning or calcining a portion of the formulated raw materials. The results are presented under the heading of "Special Tests." Other tests were conducted using the clay concentrate as a bond and plastic agent in relatively non-plastic ceramic ware bodies.

The alluvial clays are more naturally suited for use in the manufacture of heavy clay products than the Pascagoula clays. They have less shrinkage on drying and firing, less tendency to warp. They have a good firing range. Other than their porosity and absorption values, which are too high, and the fired strengths, which are too low for tile, the alluvium would be acceptable in a mild climate for many clay products. Chemical analysis of the alluvium compared to that of the Pascagoula clays, and especially sample AJ-49, show a higher silica content and a lower alumina content, indicating that the alluvium contains less clay substance than those from the Pascagoula formation. The high silica content of the alluvium accounts for their high absorption and porosity values and low fired strengths. This condition is the result of excess silica or quartz not in chemical combination with the basic clay minerals. Uncombined silica (quartz, SiO_2) will expand and contract during the heating and cooling cycles to which clay products are normally subjected. The expansion of silica breaks the ceramic bond of the clay body on heating and leaves void space within the clay body on cooling. A blend using the alluvium as the basic raw material combined with clay (AJ-49) would likely produce a good heavy clay products body. The clay, AJ-49, containing approximately twice the clay substance as the alluvium would likely reduce absorption and increase burned strength of the alluvium. Sample AJ-49 contains more alumina and less silica than any of the other Pascagoula or alluvial clays. Although its iron content is fairly high, the clay burns to light colors of cream and buff. The clay is very plastic, has higher water of plasticity and drying shrinkage values than any of the other clays. Its dry and burned strength as reported is low because of drying cracks and does not represent the potential of the clay.

The sample of terrace clay, AJ-35, is very much like the alluvium.

Screen analyses indicate that all of the clays are relatively free from excess minerals such as sand. Most of the sand and other accessory minerals are of fine grain, passing 100 mesh screen and caught on 250 mesh screen (sample AJ-42, alluvium, excepted). Sample AJ-14 when screened through 325 mesh (not reported in tables) passed 93.65 percent. In another unreported test, the residue (total) after wet blunging, decanting, washing and further decanting, was a fine non-plastic powder, probably silica.

SPECIAL TESTS

HEAVY CLAY PRODUCTS

In order to reduce shrinkage, cracking, and warpage of the Pascagoula clays, several bar samples from each test hole were calcined to 750°F. The purpose of this was to reduce the inherent plasticity of the natural clays. The calcined bars which were a blend of all the Pascagoula clays tested were crushed and screened through 14 mesh. This material was blended with 50 percent raw clay (AJ-14) and the batch was made plastic with water, mulled and extruded into test bars. Data was obtained in the plastic, dry and fired states as heretofore described. The test bars were fired to cone 4 (2167°F). For identification, the test bars were marked B-14. The following data was obtained:

Plastic and Dry Properties	Sample B-14 Blend	Typical Pascagoula
Water of plasticity wet basis	17.50%	20.70%
Water of plasticity dry basis	21.10%	26.00%
Linear drying shrinkage	6.00%	6.10%
Strength—Modulus of rupture in lb/sq/in.	848	713
Extrusion	Good	Good
Warpage	Slight	Yes
Cracking	Slight	Yes
Cone 4 Firing		
Linear shrinkage, total	9.50%	9.58%
Absorption	5.71%	5.00%
Strength—Modulus of rupture in lb/sq/in.	2010*	2800**
Color	Red	Red Range
Cracking	Slight	Yes

* Average values
** Highest average values

Most of the undersirable plastic and drying properties of the Pascagoula clays were eliminated by blending with 50 percent calcined clay. Further improvements would likely be made by increasing the calcined clay to 70 percent-75 percent.

BENEFICIATION OF PASCAGOULA CLAYS

The Pascagoula clays have as their principal clay mineral, montmorillonite and as a lesser clay mineral, kaolinite. (See x-ray analysis.) They also contain a little sand and some very fine silica. (See chemical analysis sample AJ-14 and AJ-14X.) The Pascagoula clays have the predominant characteristics of bentonite. Bentonite, as known in the trade, is derived from the weathering of volcanic ash or lava. Besides the many uses of Pascagoula clays in their natural state, additional uses could be obtained by removing the sand and fine silica contained in the clays.

To remove sand, fine silica and other minor accessory minerals from the Pascagoula clays and to obtain the extract or purely fine clay substance, 4,000 gram samples of eleven Pascagoula clays were wet with 8,000 grams of water containing a small amount of sodium silicate. The water and clay mixtures were subjected to high speed blunging for 15 minutes. The resulting solutions were allowed to settle in plastic containers for 24, 36, and 48 hours. The water and clay in suspension was decanted off, evaporated, dried and weighed. The extract, or fine clay portion of all the clays, was combined, ground and screened for further tests.

The following data shows the percentage of recoverable fine clay in beneficiation from laboratory tests. In commercial processes the recovery of acceptable refined clay would likely be in the 80 percent range.

DECANTED PASCAGOULA CLAYS

Sample	Time in Hours	Percent Recovered
AJ-1	36	23.9
AJ-8	36	30.5
AJ-10	48	14.5
AJ-12	48	16.6
AJ-13	48	7.8
AJ-14	36	33.2
AJ-16	24	41.5
AJ-18	24	45.4
AJ-19	24	46.8
AJ-23	24	44.0
AJ-25	48	10.5

The above data is for time studies and in no way reflects on the quality of the particular samples.

A comparison between the sample AJ-14 and its beneficiated equivalent, AJ-14X is shown as follows:

	Chemical Analyses* Sample AJ-14	Chemical Analyses* Sample AJ-14X	Percentage Loss and Gain
SiO_2	71.97%	55.25%	—16.54
Al_2O_3	16.58%	23.58%	+ 7.00
Fe_2O_3	4.93%	8.32%	+ 3.39
CaO	0.00%	0.89%	+ 0.80
MgO	1.19%	2.20%	+ 1.01
Na_2O	0.24%	0.49%	+ 0.25
K_2O	1.06%	0.86%	— 0.20
SO_3	0.03%	0.00%	— 0.03
P_2O_5	0.13%	0.14%	+ 0.01
Loss Ignt.	4.05%	8.27%	+ 4.22
	100.00%	100.00%	

* Shilstone Testing Laboratory

It is to be noted that the loss of silica (SiO_2) and the gain of alumina (Al_2O_3) in the decanted portion of the clay could represent excess silica in the clay not as a part of the clay mineral montmorillonite or kaolinite. The noticeable increase in iron (Fe_2O_3) in the decanted clay portion is likely an integral part of the complex mineral montmorillonite where alumina is replaced by iron and sometimes magnesia in the process of weathering.

BONDING TESTS

The standard bonding test for a clay is to mix it with 50 percent non-plastic flint (ground silica, SiO_2). This was done with other proportions, 15 percent bond clay and 30 percent bond clay. The mixtures were mulled with water and extruded and tested as heretofore described. The results of this test are given in the following table:

Composition			
Flint (SiO_2)	50%	70%	85%
Pascagoula extract	50%	30%	15%
Bar Mark	CAJ-50	CAJ-30	CAJ-15
Plastic Dry Data			
Water of plasticity wet basis	22.10	23.30	16.00%
Water of plasticity dry basis	28.30	29.80	19.00%
Linear drying shrinkage	9.00	8.50	2.00%
Strength — Modulus of rupture lb/sq/in	475**	1165	945
Extrusion	Good	Good	Poor

Firing Data Cone 4

Total linear shrinkage	10.00	9.00	2.50
Absorption	20.20	13.70	13.90
Strength — Modulus of rupture lb/sq/in	2390	3020	2175

** Slight cracks on drying

The bonding strength of the Pascagoula clay extract is unusually high. The mixture containing 30 percent bond clay is best. There was some cracking in test bars containing 50 percent bond clay. The mixture containing only 15 percent bond clay has excellent dry and fired values but was difficult to extrude.

POSSIBILITIES FOR UTILIZATION

PASCAGOULA CLAYS

The Pascagoula clays having a good color range and good firing properties could be manufactured into brick and tile by the plastic process provided a major portion of the clay is calcined. The clay in its natural state could be used for these products by using the semi-dry press method of forming the ware. Usually the plastic method of manufacture is preferred because of the varieties of textures and shapes that can be easily produced. The clays could be used as a bonding and plastic agent with semi- to non-plastic clays such as the loess to produce excellent ware in the heavy clay products field.

The clays have good possibilities for use as a bond in foundry sand, and as a bond in the manufacture of abrasive wheels and shapes, and as a lubricant and suspending agent in drilling operations. The clays could be made more proficient by a beneficiation process removing excess sand and silica. There would probably be a good market for these beneficiated clays. The clays were not tested for use as filter and decolorizer in the process of purifying mineral and vegetable oils and turpentine and rosin. This should be investigated. The supply of bentonite which is used for these purposes and in drilling mud and foundry operations is limited. A new source of this clay could be developed from the Pascagoula.

THE ALLUVIAL AND TERRACE CLAYS

The clays burn to beautiful pastel shades of light red and buff. They have good plastic, drying and firing properties and could be made into face brick, structural tile, conduit, drain tile, and fireproofing. They have excess dry strength and a little too much shrinkage and too much absorption to be ideal, but this could be remedied by calcining a part of the clay and adding to it a portion of natural Pascagoula clay. Clay AJ-49 would likely assist in producing light buff colors. Clays AJ-5, 13, 16, and 23 could be used for light red and pink colors and clays AJ-2, 8, 10, 12, 14, 18, 19, 23 and 25 would assist in producing ware in the red range.

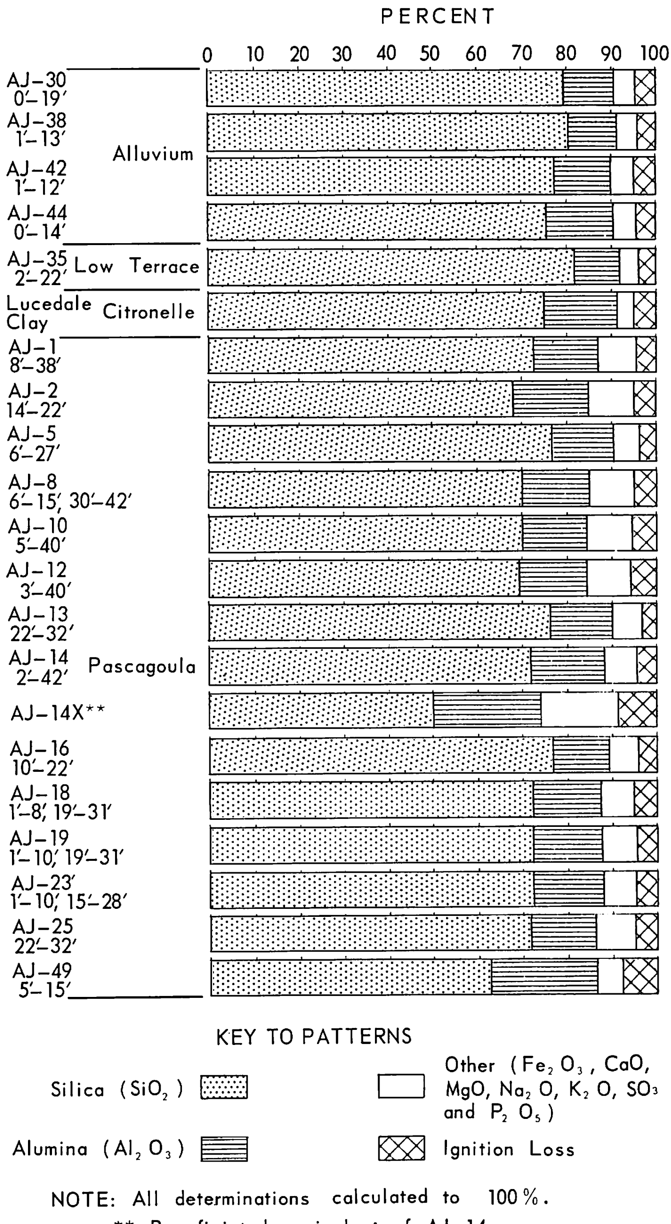

Figure 44.—Plotted chemical analyses of clays. Detailed analyses are listed in Table 12.

TABLE 12

Chemical Analyses of Clays, George County, Mississippi
Shilstone Testing Laboratory, Analyst

Sample No.*	Geologic Unit	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	P_2O_5	Loss on Ignition
Lucedale Clay	Citronelle	75.73	15.62	2.64	0	0.53	0.06	0.57	0	0.08	4.77
AJ-1 (8′-38′)	Pascagoula	73.03	13.94	5.74	0.61	1.37	0.19	0.85	0	0.13	4.14
AJ-2 (14′-22′)	Pascagoula	68.13	16.69	6.09	0.30	2.32	0.19	1.40	0	0.20	4.68
AJ-5 (6′-27′)	Pascagoula	76.90	13.35	3.95	0	1.08	0.16	0.88	0	0.12	3.56
AJ-8 (6′-15′—30′-42′)	Pascagoula	69.78	15.24	4.74	1.73	1.41	0.43	1.41	0.02	0.17	5.07
AJ-10 (5′-40′)	Pascagoula	70.26	14.34	4.82	2.50	1.38	0.37	1.11	0	0.15	5.07
AJ-12 (3′-40′)	Pascagoula	69.29	15.17	4.56	2.10	1.77	0.35	1.13	0	0.16	5.47
AJ-13 (22′-32′)	Pascagoula	76.26	13.71	4.14	0.36	1.05	0.31	0.90	0	0.13	3.14
AJ-14 (2′-42′)	Pascagoula	71.79	16.58	4.93	0	1.19	0.24	1.06	0.03	0.13	4.05
AJ-14X**	Pascagoula	55.25	23.58	8.32	0.89	2.20	0.49	0.86	0	0.14	8.27
AJ-16 (10′-22′)	Pascagoula	76.86	12.83	4.16	0	1.09	0.35	0.92	0.01	0.08	3.70
AJ-18 (1′-8′—19′-31′)	Pascagoula	72.50	15.06	4.92	0	1.46	0.32	0.99	0	0.14	4.61
AJ-19 (1′-10′—19′-31′)	Pascagoula	72.43	15.33	4.76	0.61	1.43	0.21	0.83	0	0.12	4.28
AJ-23 (1′-10′—15′-28′)	Pascagoula	72.60	15.81	4.36	0.21	1.58	0.14	0.88	0	0.12	4.30
AJ-25 (22′-32′)	Pascagoula	71.95	14.86	5.50	0.57	1.43	0.34	0.86	0	0.11	4.38
AJ-30 (0′-19′)	Alluvium	79.49	11.87	3.15	0	0.53	0.26	0.69	0	0.12	3.89
AJ-35 (2′-22′)	Low Terrace	82.00	11.28	2.27	0	0.51	0.04	0.42	0	0.08	3.40
AJ-38 (1′-13′)	Alluvium	80.44	10.72	3.35	0	0.64	0.20	0.67	0	0.12	3.86
AJ-42 (1′-12′)	Alluvium	77.65	12.47	4.30	0	0.74	0.16	0.49	0	0.10	4.09
AJ-44 (0′-14′)	Alluvium	75.92	14.34	3.83	0	0.70	0.20	0.61	0	0.10	4.30
AJ-49 (5′-15′)	Pascagoula	62.86	23.68	4.68	0	1.19	0.05	0.17	0	0.09	7.28

* Corresponds to core hole number
**Beneficiated equivalent of AJ-14

Percent, calculated to 100.00% total

TABLE 13

SCREEN ANALYSIS

TEST HOLE AJ-1, 8 TO 38 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	Nil	Quartz (A) clay nodules (C) limonitic and pale grayish-white; silt nodules (S) limonitic; pyrite (S)
100	0.1	Quartz (A) clay nodules (C) limonitic, pale grayish-white in part; silt nodules (S) limonitic, pyrite (S) siderite nodules (S) organic material (T) mica (T)
250	3.5	Quartz (A) stained with limonite in part; clay nodules (S) limonitic, pale grayish-white in part; siderite nodules (S) pyrite (S) mica (S)
PAN	96.4	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-2, 14 TO 22 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) pyrite (S) dolomite nodules (S) light-tan; manganiferous material (S) chert (T) organic material (T)
100	0.3	Quartz (A) clay nodules (S) limonitic; dolomite nodules (S) light-tan; pyrite (S) manganiferous material (S) organic material (S) mica (T)
250	2.2	Quartz (A) siderite nodules (C) clay nodules (S) limonitic, white in part; organic material (S) mica (S)
PAN	97.4	Silt (A) clay (S)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-5, 6 TO 27 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) clay nodules (C) limonitic, pale grayish-white in part; pyrite (C) organic material (T)
100	0.3	Quartz (A) clay nodules (C) limonitic, pale grayish-white in part; pyrite (C) organic material (T)
250	3.9	Quartz (A) clay nodules (C) limonitic; pyrite (S) manganiferous material (S) organic material (T)
PAN	95.7	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-8, $\frac{6}{30}$ TO $\frac{15}{42}$ FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.6	Lime nodules (A) pale grayish-white; quartz (C) clay nodules (S) limonitic; pyrite (S)
100	0.1	Lime nodules (A) pale grayish-white & white; quartz (C) mica (C) clay nodules (C) limonitic; pyrite (S) organic material (S)
250	3.0	Quartz (A) lime nodules (C) pale grayish-white & white; mica (C) clay nodules (C) limonitic
PAN	96.3	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-10, 5 TO 40 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	1.0	Lime nodules (A) white; clay nodules (C) limonitic & manganiferous; quartz (S) pyrite (S) organic material (T)
100	0.4	Lime nodules (C) white; clay nodules (C) limonitic & manganiferous; quartz (C) pyrite (S)
250	3.0	Quartz (A). lime nodules (C) white; clay nodules (C) limonitic and manganiferous; mica (C)
PAN	95.6	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-12, 3 TO 40 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.2	Lime nodules (A) light-tan; quartz (C) clay nodules (S) limonitic and manganiferous in part
100	0.1	Quartz (A) lime nodules (C) light-tan; clay nodules (S) manganiferous and limonitic; pyrite (T) mica (T)
250	4.4	Quartz (A) lime nodules (C) light-tan; clay nodules (C) limonitic and manganiferous; pyrite (S) mica (S)
PAN	95.3	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-13. 22 TO 32 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	Nil	Quartz (A) lime nodules (C) pale grayish-white & light-tan; clay nodules (T) limonitic & manganiferous
100	Nil	Quartz (A) stained with limonite in part; lime nodules (C) pale grayish-white & white; pyrite (S) manganiferous material (S) organic material (T)
250	6.6	Quartz (A) mica (C) lime nodules (S) manganiferous material (S)
PAN	93.4	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-14, 2 TO 42 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	Nil	Quartz (A) clay nodules (C) limonitic & manganiferous; siderite nodules (S) organic material (S) pyrite (T)
100	0.1	Quartz (A) stained with siderite in part; siderite nodules (C) clay nodules (C) limonitic & manganiferous; mica (S) pyrite (S) organic material (S)
250	3.5	Quartz (A) stained with siderite in part; clay nodules (C) limonitic and manganiferous; mica (S)
PAN	96.4	Silt (C) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-16, 10 TO 22 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (C) lime nodules (C) white; pyrite (C) clay nodules (C) limonitic, white in part; organic material (S) manganiferous material (T)
100	0.2	Quartz (A) clay nodules (C) limonitic; lime nodules (C) white; pyrite (C) organic material (S)
250	9.8	Quartz (A) clay nodules (C) limonitic; lime nodules (S) white; pyrite (S) organic material (S)
PAN	89.9	Quartz (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-18, 19 1 TO 31 8 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) clay nodules (C) limonitic & light-gray in part; pyrite (C) organic material (S)
100	0.2	Quartz (A) clay nodules (C) limonitic & manganiferous in part; dolomite nodules & spherulites (C) cream-colored, white & light-tan; pyrite (S) chert (T) mica (T) organic material (T)
250	5.0	Quartz (A) clay nodules (C) limonitic & manganiferous in part; dolomite nodules & spherulites (S) cream-colored, white & light-tan; mica (S)
PAN	94.7	Silt (C) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-19, 19 1 TO 31 10 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) clay nodules (C) limonitic; pyrite (C) lime nodules (T) pale-gray; organic material (T)
100	0.1	Quartz (A) clay nodules (C) limonitic; pyrite (C) magnetite (S) lime nodules (T) pale-gray; organic material (T)
250	2.0	Quartz (A) clay nodules (C) limonitic; pyrite (S) magnetite (S)
PAN	97.8	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-23, 1 TO 10; 15 TO 21; 23 TO 28 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	Nil	Quartz (A)
100	0.1	Quartz (A) clay nodules (C) limonitic; organic material (S) pyrite (S)
250	2.6	Quartz (A) stained with limonite in part; clay nodules (C) limonitic; organic material (S) pyrite (S) mica (S)
PAN	97.3	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-25. 22 TO 32 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) stained with siderite in part; siderite nodules (C) pyrite (S) clay nodules (S) pale grayish-white; organic material (S) mica (T)
100	0.4	Quartz (A) stained with siderite in part; siderite nodules (C) clay nodules (C) pale yellowish-tan; pyrite (S) organic material (T)
250	5.1	Quartz (A) stained with siderite in part; siderite (C) clay nodules (C) pale yellowish-tan; pyrite (S) mica (S)
PAN	94.4	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-30, 0 TO 19 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.4	Quartz (C) clay nodules (C) limonitic & manganiferous; organic material (C) chert (S)
100	0.4	Quartz (C) clay nodules (C) limonitic & manganiferous; organic material (C) chert (S)
250	6.6	Quartz (A) clay nodules (C) limonitic & manganiferous; organic material (C) chert (S) mica (S)
PAN	92.6	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-35, 2 TO 22 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	1.0	Quartz (A) clay nodules (C) hematitic, limonitic & manganiferous in part; lime nodules (S) light-tan; chert (T) organic material (T)
100	2.3	Quartz (A) stained with hematite in part; clay nodules (C) hematitic, limonitic in part; lime nodules (S) light-tan
250	8.0	Quartz (A) stained with hematite in part; lime nodules (S) light-tan and white; mica (S) pyrite (T) organic material (T)
PAN	88.7	Silt (C) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-38, 1 TO 13 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	0.1	Quartz (A) organic material (C) clay nodules (C) limonitic, manganiferous in part; chert (S) pyrite (T)
100	0.2	Quartz (A) organic material (C) clay nodules (C) limonitic, manganiferous in part; chert (T) pyrite (T)
250	6.8	Quartz (A) clay nodules (C) limonitic, manganiferous in part; organic material (C) mica (S)
PAN	92.9	Silt (A) clay (S)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-42, 1 TO 12 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	9.2	Quartz (A) stained with limonite in part; clay nodules (C) limonitic and manganiferous; chert (T) organic material (T)
100	5.2	Quartz (A) stained with limonite in part; clay nodules (C) limonitic and manganiferous; organic material (T)
250	5.3	Quartz (A) stained with limonite in part; clay nodules (C) limonitic and manganiferous; pyrite (T)
PAN	80.3	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-44 0 TO 14 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	2.0	Quartz (A) chert (C) clay nodules (C) limonitic, manganiferous in part; organic material (S)
100	1.0	Quartz (A) stained with limonite in part; chert (C) vari-colored; clay nodules (C) limonitic, manganiferous in part; organic material (S) pyrite (T)
250	1.6	Quartz (A) clay nodules (C) limonitic, manganiferous in part; chert (C) vari-colored; organic material (S)
PAN	95.4	Silt (A) clay (C)

TABLE 13 (Continued)

SCREEN ANALYSIS

TEST HOLE AJ-49, 5 TO 15 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35		
60	1.4	Quartz (A) organic material (C) clay nodules (S) limonitic & hematitic
100	0.8	Quartz (A) stained with limonite & hematite in part; organic material (C) clay nodules (S) limonitic & hematitic
250	0.8	Quartz (A) stained with hematite in part; organic material (C) mica (S)
PAN	97.0	Silt (C) clay (C)

TABLE 14
PHYSICAL PROPERTIES IN THE UNBURNED STATE

HOLE NO.	DEPTH	WATER OF PLASTICITY WET BASIS (PERCENT)	WATER OF PLASTICITY DRY BASIS (PERCENT)	LINEAR DRYING SHRINKAGE (PERCENT)	MODULUS OF RUPTURE lBS. SQ. IN.	PLASTICITY	EXTRUSION	WARPAGE	COLOR (DRY BAR)	REMARKS
PASCAGOULA CLAYS										
AJ 1	8-38'	21.24	27.00	7.0	495 c	Good	Good	Yes	Olive Green	c Test bars cracked on drying
AJ 2	14-22'	21.40	27.30	6.0	730 c	Good	Good	Yes	Olive Green	Data based on highest values
AJ 5	6-27'	21.60	26.50	7.0	985 c	Good	Good	Yes	Lt.Olive Green	as above
AJ 8	6-15' 30-42'	19.75	24.40	5.0	848 c	Good	Good	Yes	Olive Green	as above
AJ 10	5-40'	19.80	24.60	5.0	792 c	Good	Good	Yes	Olive Green	as above
AJ 12	3-40'	21.00	27.60	6.5	1140 c	Good	Good	Yes	Olive Green	as above
AJ 13	22-32'	20.10	25.50	5.5	760 c	Good	Good	Yes	Olive Green	as above
AJ 14	2-42'	19.00	23.40	4.5	908 c	Good	Good	Yes	Olive Green	as above
AJ 16	10-22'	17.40	21.10	5.5	910 c	Good	Good	Yes	Lt.Olive Green	as above
AJ 18	1-8' 19-31'	20.00	25.00	6.5	365 c	Good	Good	Yes	Olive Green	as above
AJ 19	1-10' 19-31'	20.40	24.65	4.5	850 c	Good	Good	Yes	Olive Green	as above
AJ 23	1-10' 15-21' 23-28'	21.50	27.40	6.5	470 c	Good	Good	Yes	Lt.Olive Green	as above
AJ 25	22-32'	22.80	29.50	7.5	485 c	Good	Good	Yes	Lt.Olive Green	as above
AJ 49	5-15'	23.50	30.80	9.0	243 c	Good	Good	Yes	Olive Green	as above
Average		20.70	26.00	6.1	713 c	Good	Good	Yes		as above

TABLE 14 (Continued)

PHYSICAL PROPERTIES IN THE UNBURNED STATE

HOLE NO.	DEPTH	WATER OF PLASTICITY WET BASIS (PERCENT)	WATER OF PLASTICITY DRY BASIS (PERCENT)	LINEAR DRYING SHRINKAGE (PERCENT)	MODULUS OF RUPTURE 1BS. SQ. IN.	PLASTICITY	EXTRUSION	WARPAGE	COLOR (DRY BAR)	REMARKS
ALLUVIUM CLAYS										
AJ 30	0-19'	20.60	26.00	7.5	670	Good	Good	Slight	Grayish Tan	
AJ 35	2-22'	18.60	23.00	8.5	430	Good	Good	Slight	Pink	
AJ 38	1-13'	21.30	28.00	8.5	500	Good	Good	Slight	Grayish Tan	
AJ 42	1-12'	20.80	26.20	8.5	457	Good	Good	Slight	Grayish Tan	
AJ 44	0-14'	21.00	26.42	8.5	745	Good	Good	Slight	Grayish Tan	
Average		20.56	25.92	8.3	560	Good	Good	Slight		

TABLE 15
PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPERATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
					PASCAGOULA CLAYS						
AJ 1	8-38'	2014	03	18.65	8.97	2.08	2.65	9.5	2640 c	Salmon	c Highest values used because of drying cracks
AJ 1	8-38'	2109	1	17.20	8.10	2.12	2.47	9.5	3050 c	Light Red	
AJ 1	8-38'	2167	4	13.10	6.45	2.06	2.38	10.0	3480 c	Light Red	as above
AJ 1	8-38'	2232	6	11.45	7.60	2.06	2.32	10.0	3740 c	Dark Red	as above
AJ 2	14-22'	2014	03	12.90	5.80	2.22	2.56	11.0	4520 c	Light Red	as above
AJ 2	14-22'	2109	1	7.90	3.47	2.24	2.47	11.0	2280 c	Dark Red	as above
AJ 2	14-22'	2167	4	4.64	2.08	2.22	2.34	10.5	2720 c	Dark Red	as above
AJ 2	14-22'	2232	6	10.50	5.30	1.99	2.23	10.5	3430 c	Brown	as above
AJ 5	6-27'	2014	03	24.20	12.10	1.99	2.62	8.7	1750 c	Salmon	as above
AJ 5	6-27'	2109	1	20.70	10.70	1.99	2.55	9.0	2470 c	Salmon	as above
AJ 5	6-27'	2167	4	17.65	8.70	2.03	2.48	9.5	3120 c	Light Red	as above
AJ 5	6-27'	2232	6	19.30	9.71	2.20	2.44	9.5	3120 c	Light Red	as above

TABLE 15 (Continued)
PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPERATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN lB./SQ. IN.	COLOR	REMARKS
AJ 8	6-15' 30-42'	2014	03	17.25	8.25	2.10	2.54	8.5	2230 c	Light Red	c Highest values used because of drying cracks
AJ 8	6-15' 30-42'	2109	1	13.90	6.37	2.18	2.53	10.0	3080 c	Red	
AJ 8	6-15' 30-42'	2167	4	9.75	4.44	2.20	2.44	10.0	1190 c	Red	as above
AJ 8	6-15' 30-42'	2232	6	6.89	3.28	2.10	2.25	10.5	2320 c	Brown	as above
AJ 10	5-40'	2014	03	16.85	8.07	1.96	2.32	7.5	2480 c	Light Red	as above
AJ 10	5-40'	2109	1	15.60	7.55	2.06	2.47	9.0	3140 c	Red	as above
AJ 10	5-40'	2167	4	13.00	5.39	2.42	2.78	8.0	3050 c	Red	as above
AJ 10	5-40'	2232	6	5.55	2.73	2.02	2.20	9.0	3140 c	Brown	as above
AJ 12	3-40'	2014	03	21.70	9.72	2.02	2.52	8.5	2920 c	Light Red	as above
AJ 12	3-40'	2109	1	16.55	7.46	2.21	2.64	10.0	3030 c	Red	as above
AJ 12	3-40'	2167	4	9.00	4.22	2.13	2.25	10.0	3250 c	Red	as above
AJ 12	3-40'	2232	6	5.67	2.74	2.07	2.20	11.0	3000 c	Brown	as above

TABLE 15 (Continued)
PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPERATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
AJ 13	22-32'	2014	03	22.30	9.52	2.06	2.65	8.5	3320 c	Light Red	c Highest values used because of drying cracks
AJ 13	22-32'	2109	1	18.15	7.20	2.06	2.53	9.0	2580 c	Light Red	
AJ 13	22-32'	2167	4	14.90	6.23	2.40	2.78	8.5	N. D.	Light Red	as above
AJ 13	22-32'	2232	6	14.20	6.77	2.10	2.45	8.5	3240 c	Brown	as above
AJ 14	2-42'	2014	03	13.80	5.75	2.06	2.57	8.5	3620 c	Light Red	as above
AJ 14	2-42'	2109	1	21.00	9.65	2.18	2.76	8.5	3770 c	Red	as above
AJ 14	2-42'	2167	4	10.95	4.35	2.53	2.84	8.0	3300 c	Red	as above
AJ 14	2-42'	2232	6	9.59	4.75	2.05	2.31		2810 c	Brown	as above
AJ 16	10-22'	2014	03	20.40	7.60	2.22	2.59	7.5	2210 c	Light Red	as above
AJ 16	10-22'	2109	1	17.10	7.80	2.17	2.62	9.5	2950 c	Light Red	as above
AJ 16	10-22'	2167	4	16.60	7.60	2.19	2.63	9.5	3000 c	Red	as above
AJ 16	10-22'	2232	6	14.40	6.65	2.16	2.53	8.0	2490 c	Brown	as above

TABLE 15 (Continued)
PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPER-ATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
AJ 18	1-8' 19-31'	2014	03	14.20	6.77	2.09	2.47	10.0	2950 c	Light Red	c Highest values used because of drying cracks
AJ 18	1-8' 19-31'	2109	1	13.10	6.10	2.16	2.47	10.0	3400 c	Red	
AJ 18	1-8' 19-31'	2167	4	9.47	4.19	2.32	2.55	10.0	1975 c	Red	as above
AJ 18	1-8' 19-31'	2232	6	12.40	6.15	2.01	2.30	9.0	1480 c	Brown	as above
AJ 19	1-10' 19-31'	2014	03	12.60	6.24	2.19	2.54	9.0	2090 c	Light Red	as above
AJ 19	1-10' 19-31'	2109	1	9.95	4.36	2.27	2.52	9.0	3300 c	Red	as above
AJ 19	1-10' 19-31'	2167	4	7.05	3.52	2.00	2.16	9.0	N. D.	Red	as above
AJ 19	1-10' 19-31'	2232	6	7.64	3.60	2.12	2.30	9.5	2650 c	Brown	as above
AJ 23	1-10' 15-21' 23-28'	2014	03	15.95	7.15	2.07	2.47	9.5	2000 c	Light Red	as above
AJ 23	1-10' 15-21' 23-28'	2109	1	13.30	6.25	2.12	2.46	10.0	2740 c	Light Red	as above
AJ 23	1-10' 15-21' 23-28'	2167	4	5.70	1.92	2.19	2.21	9.0	2490 c	Red	as above
AJ 23	1-10' 15-21' 23-28'	2232	6	9.30	4.48	2.07	2.28	10.5	3640 c	Brown	as above

TABLE 15 (Continued)

PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPERATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
AJ 25	23-32'	2014	03	16.00	7.00	2.13	2.53	8.5	2950 c	Light Red	c Highest values used because of drying cracks
AJ 25	23-32'	2109	1	13.10	6.00	2.19	2.52	9.0	3220 c	Red	
AJ 25	23-32'	2167	4	10.00	4.50	2.22	2.47	12.5	3500 c	Red	as above
AJ 25	23-32'	2232	6	10.50	4.15	2.17	2.41	12.5	3300 c	Brown	as above
AJ 49	5-15'	2014	03	13.90	6.70	2.09	2.42	12.5	367 c	Light Buff	as above
AJ 49	5-15'	2109	1	5.90	2.70	2.16	2.17	12.5	2620 c	Buff	as above
AJ 49	5-15'	2167	4	5.92	2.81	2.12	2.24	12.5	3780 c	Buff	as above
AJ 49	5-15'	2232	6	15.15	7.10	1.87	2.16	12.0	N. D. c	Gray	as above
						ALLUVIUM	CLAYS				
AJ 30	0-19'	2014	03	29.40	15.60	1.88	2.67	10.0	946	Buff	
AJ 30	0-19'	2109	1	27.80	14.65	1.89	2.56	9.7	1540	Buff	
AJ 30	0-19'	2167	4	28.00	14.70	1.91	2.65	10.0	2180	Salmon	
AJ 30	0-19'	2232	6	25.00	13.20	1.90	2.54	10.0	1550	Light Red	

TABLE 15 (Continued)

PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPER-ATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
AJ 35	2-22'	2014	03	31.20	14.25	1.88	2.72	8.5	515	Buff	
AJ 35	2-22'	2109	1	31.00	16.25	1.87	2.72	9.0	550	Buff	
AJ 35	2-22'	2167	4	27.60	14.95	1.84	2.55	9.0	880	Buff	
AJ 35	2-22'	2232	6	23.90	12.60	1.89	2.48	9.5	880	Buff	
AJ 38	1-13'	2014	03	34.70	19.40	1.78	2.73	9.3	426	Buff	
AJ 38	1-13'	2109	1	32.60	17.90	1.82	2.69	9.5	610	Salmon	
AJ 38	1-13'	2167	4	31.10	17.20	1.83	2.66	9.5	840	Light Red	
AJ 38	1-13'	2232	6	29.70	16.25	1.78	2.52	9.5	950	Light Red	
AJ 42	1-12'	2014	03	29.50	15.50	1.90	2.70	9.3	623	Buff	
AJ 42	1-12'	2109	1	27.50	14.25	1.92	2.66	9.5	750	Buff	
AJ 42	1-12'	2167	4	26.00	13.40	2.00	2.76	9.5	1230	Light Red	
AJ 42	1-12'	2232	6	24.20	12.40	1.95	2.58	9.5	1185	Light Red	

TABLE 15 (Continued)
PYROPHYSICAL PROPERTIES

HOLE NO.	DEPTH	TEMPERATURE °F.	AT CONE	POROSITY (PERCENT)	ABSORPTION (PERCENT)	BULK SPECIFIC GRAVITY	APPARENT SPECIFIC GRAVITY	TOTAL LINEAR SHRINKAGE (PERCENT)	MODULUS OF RUPTURE IN 1B./SQ. IN.	COLOR	REMARKS
AJ 44	0-14'	2014	03	28.00	14.50	1.93	2.68	10.0	1210	Salmon	
AJ 44	0-14'	2109	1	25.30	12.90	1.96	2.62	10.5	2170	Light Red	
AJ 44	0-14'	2167	4	23.00	11.75	2.05	2.53	10.5	2340	Light Red	
AJ 44	0-14'	2232	6	22.90	11.70	1.96	2.55	10.0	2460	Light Red	

SUBSURFACE STRATIGRAPHY OF GEORGE COUNTY

THEO H. DINKINS, JR.

ABSTRACT

The stratigraphic column applicable to the subsurface of George County includes strata from the Sligo formation of Lower Cretaceous age to the Hattiesburg formation of Miocene age.

The formations, their lithic and faunal content and their contacts are discussed in general only. The diversity of sedimentary sequences in George County necessitates subsurface correlations based on both key or index fossils and lithostratigraphic data. When feasible, correlations in this report are based on lithology.

Although potential oil and gas reservoirs, ranging in age from Lower Glen Rose to lower Miocene, have been tested, the search for hydrocarbons has been unproductive. Though numerous potential reservoirs exist, the Smackover formation, so far untested in George County, is regarded as the most favorable objective for future drilling programs.

STRATIGRAPHY

GENERAL STATEMENT

The stratigraphic column applicable to the George County subsurface follows the terminology now in general use in Mississippi. This column, with the range of thickness of the units and their general lithologic descriptions, is shown by Plate 1, Dinkins. Because of the standard use of this terminology, no derivation of nomenclature is given.

Formations, their lithic and faunal content and their contacts are discussed in general only. Incomplete suites of samples, extended sample interval, generally poor quality of the cuttings, lack of cored sections and incomplete sampling technique, particularly of the Teritary sediments and the Upper Cretaceous chalks of the Selma group causes variations in correlation points which may or may not be due to actual thinning or thickening of sections.

The diversity of sedimentary sequences in George County necessitates subsurface correlation based on both key or index fossils and lithostratigraphic data. Faunal zones in the Tertiary strata are based on Gravell and Hanna's subsurface Tertiary zones of correlation.[1] Some of the formations may be delimited solely on the basis of index fossils. Others, possessing rather distinct lithology, may be separated from adjacent units either by their lithic or faunal content. When feasible, correlations in this report are based on lithologic characteristics and supplemented with paleontological and electrical log data. As such, many of the units are distinguishable from adjacent formations by reasonably obvious gross lithologic characteristics and are simple, practical, mappable rock-stratigraphic units. The writer's conclusions as to the nature of these formational contacts is based on the gross character of the sediments on either side of the contacts and regional geologic aspects.

Existing deep well data in George County is limited to the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W. At total depth, this well had drilled into the Sligo formation. Correlations, lithologic descriptions and contact relationships from the Mooringsport to the Sligo are restricted to the No. 1 B. E. Green Estate et al.

Much of the Lower Glen Rose in this area was deposited in a near-shore to marine environment. Facies changes, incomplete sample suites and lack of deep well control in George County make differentiation of these deeper formations difficult. Regional and area geologic aspects were taken into consideration in the placement of these formation contacts.

SLIGO FORMATION

The oldest stratigraphic unit encountered in George County is the Sligo formation. One well, the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W., encountered a 170 foot sequence of alternating shales and sandstones of Sligo age. At total depth, the well had not penetrated the entire thickness of the Sligo shale and sandstone sequence.

The Sligo shales are predominantly silty and finely micaceous and dark-red and maroon in color, however, minor amounts of black splintery shale are also present. Rare red nodular limestones were noted in the cuttings.

Sligo sandstones are red and white, usually micaceous and rarely lignitic fine- to medium-grained and are generally argillaceous. In the Sligo sequence encountered, the red sandstones are subordinate to the white sandstones.

System	Series	GROUP	FORMATION	THICKNESS (feet)	LITHOLOGY
Tertiary	Miocene		Hattiesburg	440-550	Pale-gray to white sands, conglomeritic sands and loosely consolidated variably clayey occasionally lignitic or carbonaceous sandstones. Pale-gray and light-gray generally finely lignitic or carbonaceous silts. Occasional quartz and chert pebbles. Thin zones of lignitic or carbonaceous matter. Pale-gray, light-gray and light-tan generally finely lignitic or carbonaceous variably silty and sandy clays.
			Catahoula	385-520	Catahoula sandstone member - White sands, conglomeritic sands and loosely consolidated sandstones. Pale-gray and light-tan silty clays. Traces of lignitic or carbonaceous clays and lignitic material. Thin zone of siderite concretions. Occasional vari-colored chert and quartz pebbles. Heterostegina limestone member - Pale grayish-white to cream-colored dense to chalky to calcarenitic variably fossiliferous limestones and coquinoid limestones. Light-gray, pale-gray, gray and light-tan aphanitic to very finely crystalline variably fossiliferous rarely sandy dolomites. Light-gray and pale-gray variably calcareous and fossiliferous clays and silty clays.
	Oligocene		Chickasawhay	20-40	Pale grayish-white and white chalky fossiliferous variably sandy aphanitic to calcarenitic limestones. Light-tan dense to very finely crystalline variably fossiliferous dolomites. Pale-gray fossiliferous slightly calcareous clays.
		Vicksburg	Bucatunna	25-45	Dark-gray usually finely lignitic or carbonaceous occasionally bentonitic sparingly fossiliferous and calcareous clays with a few thin silt laminae. Rare thin pale-gray to white clayey sandstones and pale-gray chalky clayey fossiliferous rarely glauconitic slightly sandy marls. Rare bentonite.
			Vicksburg "Limestone"	25-45	Vicksburg "limestone" consists of two limestone sequences, Marianna formation and Glendon formation. White to pale grayish-white fossiliferous slightly sandy and glauconitic dense and chalky to calcarenitic limestones. Light-gray and pale-gray variably fossiliferous bentonitic and calcareous clays. Traces of bentonite.
			Red Bluff	55-155	White and pale grayish-white chalky fossiliferous glauconitic limestones and calcarenitic limestones. Light-gray and pale-gray slightly calcareous fossiliferous sparingly glauconitic sometimes finely lignitic or carbonaceous clays.
	Eocene	Jackson	Yazoo (Ocala facies)	100-190	White and pale grayish-white fossiliferous chalk, calcarenites and calcarenitic limestones. Basal zone of light bluish-gray and pale-gray calcareous fossiliferous sparingly glaunconitic clays.
			Moodys Branch	15-30	Pale-gray and pale grayish-white chalky to dense glauconitic fossiliferous sandy limestones. Pale-gray and pale greenish-gray calcareous to limy glauconitic and fossiliferous sandstones. Light-gray and pale greenish-gray clayey calcareous highly glauconitic fossiliferous variably sandy marls.
		Claiborne	Cockfield	15-40	Pale grayish-white and white silty variably sandy very finely glauconitic sparingly fossiliferous calcarenitic limestones. Pale grayish-white very finely glauconitic sparingly fossiliferous limy very fine-grained sandstones and siltstones. Pale-gray, light-gray and light-green variably glauconitic and silty clay shales.
			Cook Mountain	95-160	Cream-colored and white variably glauconitic fossiliferous rarely sandy calcarenites. Calcarenitic and aphanitic limestones with alternating light-gray, light-green and light greenish-gray usually glauconitic and fossiliferous clay shales.
			Kosciusko	15-40	White variably sandy generally glauconitic chalky limestones and calcarenitic limestones with interbedded light-green and light greenish-gray glauconitic clay shales.
			Zilpha	90-135	Interbedded light-gray and light-green sparingly fossiliferous glauconitic clay shales and white and pale grayish-white fossiliferous glauconitic chalks and chalky limestones.
			Winona	50-75	Light-green and light greenish-gray glauconitic sparingly fossiliferous clay shales. Pale grayish-white slightly fossiliferous marls or chalks.
			Tallahatta	45-100	White and pale grayish-white finely micaceous and glauconitic calcareous to limy sparingly fossiliferous siliceous claystones and siltstones with interbedded green, light-green and light greenish-gray clay shales.
		Wilcox	Wilcox (undifferentiated)	1875-2260	Gray, dark-gray and black usually silty and occasionally sandy fossiliferous and lignitic or carbonaceous shales and clay shales. Thin zones of lignite. Tan, brown, gray and light-gray silty glauconitic and sparingly fossiliferous impure limestones and calcareous clay ironstones. Rare thin zones of megafossil fragments. Gray argillanceous micaceous occasionally calcareous to limy lignitic or carbonaceous siltstones. White, gray and green generally argillaceous micaceous glauconitic and fossiliferous sandstones and rare sideritic and pyritic sandstones. White, tan, brown and ochre fossiliferous and glauconitic limestone (Salt Mountain Limestone).
	Paleocene	Midway	Midway Shale (Porters Creek)	775-1000	Gray to black silty occasionally fossiliferous finely micaceous and lignitic or carbonaceous shales. Thin beds of lignite and zones of brown and reddish-brown clay ironstones. Light-gray and gray argillaceous silts and siltstones. White to gray generally argillaceous occasionally calcareous to limy and glauconitic slightly micaceous and lignitic or carbonaceous sandstones.
Upper Cretaceous	Gulf	Selma	Navarro Taylor Austin	1205-1375	Predominantly pale-gray, light-gray and white fossiliferous chalks with interbedded and intercalated dark-gray and black commonly flakey and splintery shales and fossiliferous shales. Traces of pale-gray and light-gray bentonite.
		Eutaw	Eagle Ford	165-275	Dark-gray and black flakey and splintery silty and finely micaceous shales slightly sandy shales calcareous and fossiliferous shales and carbonaceous and lignitic shales. White and pale-gray calcareous glauconitic micaceous and sparingly fossiliferous sandstones. White and light-gray usually calcareous and glauconitic siltstones.
		Tuscaloosa	Upper Tuscaloosa	275-515	Dark-gray and gray generally flakey and splintery shales. Red and purple shales. Light-gray, gray and light greenish-gray mudstones with occasional siderite concretions. Ochre, light-red and purple mudstones. White occasionally cherty sideritic and glauconitic and sparingly fossiliferous sandstones.
			Middle Tuscaloosa	370-515	Dark-gray and black flakey and splintery finely micaceous and commonly carbonaceous or lignitic shales. Light-gray and light-green mudstones. White and pale-gray calcareous argillaceous generally glauconitic sandstones and siltstones. Thin light-gray and light brownish-gray "speckled" fossiliferous chalk or chalky limestones.
			Lower Tuscaloosa	530-775	Dark-gray, gray and black finely micaceous shales flakey and splintery shales and rarely calcareous and fossiliferous shales. Dark-red and red finely micaceous shales. Vari-colored mudstones and mottled mudstones. White variably silty lenticular to massive and conglomeritic sandstones, ashy sandstones, glauconitic and calcareous sandstones. Vari-colored quartz and chert pebbles and chips.
Lower Cretaceous	Comanche	Washita - Fredericksburg	Dantzler	925-1070	Dark-red, red and dark-maroon silty finely micaceous shales. Dark-gray and black flakey and splintery shales. Vari-colored mudstones and mottled mudstones. Nodular limestones. White silty, micaceous and generally calcareous sandstones and siltstones. Red sandstones.
			Washita-Fredericksburg (undifferentiated) "Limestone Unit"	1205-1290	Dark-red, dull red and maroon silty finely micaceous shales. Dark-gray and black finely micaceous flakey and splintery rarely fossiliferous shales. Light-gray and pale-gray mudstones and mottled mudstones. White generally calcareous and micaceous and rarely fossiliferous glauconitic and chloritic sandstones. Red and light-red sandstones. Pale grayish-white to light-gray chalky to dense fossiliferous and pseudo-oolitic or spherulitic occasionally glauconitic limestones.
		Trinity	Paluxy	1030	Dark-red and maroon silty micaceous shales and slightly sandy shales. Black shales. Light-gray and light-green mudstones. White, red and light-red micaceous sandstones.
		Trinity; Sub - Group; Upper Glen Rose (Restricted)	Mooringsport	580	Dark-red and maroon silty shales. Black flakey and splintery shales and rarely fossiliferous shales. Light-gray mudstones. White and red micaceous and calcareous sandstones. Light-gray, pale-gray and gray fossiliferous and pseudo-oolitic or spherulitic limestones. Anhydrite.
			Ferry Lake	160	Black shales and flakey and splintery shales. Light-gray, pale-gray and gray fossiliferous oolitic and pseudo-oolitic or spherulitic limestones. Anhydrite.
		Trinity; Sub - Group; Lower Glen Rose	Rodessa	500	Dark-red and maroon generally silty finely micaceous shales. Black occasionally calcareous sparingly fossiliferous shales and flakey and splintery shales. Light-gray, gray and pale-gray fossiliferous and pseudo-oolitic or spherulitic and occasionally oolitic limestones. White usually calcareous and micaceous and rarely fossiliferous sandstones. Red, light reddish-white, light-green and gray micaceous sandstones and calcareous sandstones. Anhydrite.
			Pine Island	240	Black calcareous sparingly fossiliferous shales and flakey and splintery shales. Dark-red and maroon shales. Light-gray, pale-gray and gray fossiliferous oolitic and pseudo-oolitic or spherulitic limestones. White and light-gray generally calcareous micaceous and rarely fossiliferous sandstones and siltstones.
			Sligo	170+	Dark-red and maroon silty finely micaceous shales. Black flakey and splintery shales. Red and white generally argillaceous and micaceous sandstones. Traces of lignitic or carbonaceous sandstone.

Stratigraphic column of subsurface of George County

An incomplete suite of samples through the Sligo-Pine Island contact prevents any conclusions concerning contact relationships. Regional geologic aspects, as well as, the lithology of the samples examined, indicate that the Sligo sediments were deposited in an environment which may have been transitional into the overlying Pine Island formation.

PINE ISLAND FORMATION

The Pine Island consists of a 240 foot shale, sandstone and limestone sequence which includes those beds between the basal Rodessa limestones and the top of the Sligo formation.

The upper part of the Pine Island is a shale, sandstone and limestone section. The upper 40 feet consists of light-gray, pale-gray and gray pseudo-oolitic or spherulitic, oolitic and fossiliferous limestones with subordinate amounts of black rarely limy and sparingly fossiliferous shale and white fine-grained calcareous micaceous sparingly fossiliferous sandstone. The upper few feet of the limestone section is characterized by scattered faint ochre colored oxidation or selective replacement of the fossils.

The remaining 200 feet of the Pine Island consists of alternating black shales, light-gray very fine-grained calcareous micaceous sandstones and siltstones, white very fine- and fine-grained calcareous micaceous sandstones, rare thin light-gray and pale-gray fossiliferous and pseudo-oolitic or spherulitic limestone stringers. Rare traces of red fine-grained sandstone and dark-red and maroon shale are present in the lower half of the formation.

The top of the Pine Island is placed below the basal pseudo-oolitic and oolitic limestones of the Rodessa formation. The contact between the Rodessa and Pine Island formations appears to be conformable.

RODESSA FORMATION

The Rodessa consists of a 500 foot sequence of shales, sandstones and limestones with a thin stringer of white anhydrite near the top of the formation.

The shales are dark-red, maroon and black. Usually the dark-red and maroon shales are silty and finely micaceous. Some of the black shales are limy and sparingly fossiliferous. Rodessa sandstones are predominantly white very fine- and fine-grained and usually calcareous and micaceous. Subordinate amounts of red and light reddish-white fine-grained sandstone and light-green and gray fine-grained calcareous and micaceous sandstones are also present. Some of the red sandstones are calcareous. The limestones are light-gray, gray and pale-gray, fossiliferous and pseudo-oolitic or spherulitic and occasionally oolitic.

The top of the Rodessa is placed at the conformable contact between the limestones of the upper Rodessa and the basal massive anhydrite of the Ferry Lake formation.

The upper 80 feet of the Rodessa consists of light-gray, gray and pale-gray fossiliferous and pseudo-oolitic or spherulitic limestones, subordinate amounts of black shale and a stringer of white anhydrite, approximately 40 feet thick.

The remainder of the upper one-half of the formation is a shale and sandstone sequence. Dark-red and maroon silty finely micaceous shales are predominant in this section. Red sandstones in the Rodessa are restricted to this interval. These red sandstones are fine-grained and some are calcareous. The white sandstones are very fine- and fine-grained calcareous and micaceous.

The lower 200 feet of the Rodessa is a sequence of shale, sandstone and limestone. The shales are dark-gray and black, flakey and splintery and rarely fossiliferous. Sandstones are very fine- to fine-grained, are white, calcareous, micaceous and rarely fossiliferous. Lower Rodessa limestones are light-gray, pale-gray and gray fossiliferous pseudo-oolitic or spherulitic and occasionally oolitic. The basal 20 feet of the Rodessa formation consists of a light-gray, gray and pale-gray fossiliferous sparingly oolitic quite pseudo-oolitic or spherulitic limestones. The pseudo-oolites or spherulites in this limestone are quite numerous and are noticeably smaller than those encountered in the limestones above or below.

FERRY LAKE FORMATION

The Ferry Lake in the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W., consists of a 160 foot sequence of interbedded and intercalated white anhydrite, black shales and flakey and splintery shales and light-gray, gray and pale-gray fossiliferous oolitic and pseudo-oolitic or spherulitic limestones.

The top of the formation is placed at the contact of the massive white anhydrite of the Ferry Lake with the basal gray fossiliferous limestones of the overlying Mooringsport formation. The contact of the Ferry Lake with the Mooringsport is conformable.

MOORINGSPORT FORMATION

Mooringsport sediments in George County consist of an upper section of shales, thin sandstones and rare mudstones and a lower section of shales, limestones and thin sandstones with a thin anhydrite stringer approximately 140 feet above the base of the formation. The Mooringsport in the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W., is 580 feet thick.

The upper half of the Mooringsport is essentially a red bed sequence. The shales are predominatly dark-red and maroon and are variably silty near the contact of the Mooringsport with the overlying Paluxy formation. Subordinate amounts of black flakey and splintery shale and traces of light-gray mudstone are present in this section. Red and white, very fine- and fine-grained sandstones are present in equal amounts. The white sandstones are calcareous and micaceous. Some of the red sandstones are slightly calcareous.

The Mooringsport-Paluxy contact is regarded as transitional and in this report is drawn at the base of a sequence of very fine-, fine-, and fine- to medium-grained micaceous sandstones and silty, slightly sandy micaceous shales.

Limestones and shales constitute the greater part of the lower half of the Mooringsport. Minor amounts of white, very fine- and fine-grained calcareous and micaceous sandstones and a thin stringer of white anhydrite are present in this lower sequence. Black flakey and splintery shales predominate over dark-red and maroon shales. A thin stringer of white anhydrite, probably no more than 10 feet thick, is developed approximately 140 feet above the base of the formation. The limestones are light-gray, pale-gray and gray and are fossiliferous and pseudo-oolitic or spherulitic. The basal beds of the Mooringsport consist of light-gray, pale-gray and gray fossiliferous and pseudo-oolitic or spherulitic limestones and thin black flakey and splintery rarely fossiliferous shales.

PALUXY FORMATION

Six wells have been drilled into the Paluxy sand and shale sequence. Only one well, the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W., is known to have penetrated the entire thickness of the Paluxy in George County. The Paluxy is 1030 feet thick in the No. 1 B. E. Green Estate et al. No samples or electrical log data were available on the Davis No. 1 Green in sec. 42, T. 1 S., R. 8 W. At total depth of 11,522 feet, the Davis No. 1 Green was probably in basal Paluxy sediments.

The Paluxy formation is a sequence of alternating sandstones, shales and a few thin mudstones. The white sandstones range from very fine- to coarse-grained, but are predominantly fine- and medium-grained and are usually micaceous (muscovite and biotite) and occasionally are calcareous. The coarser-grained sandstones are generally present at or near the top of the formation. Occasionally small quartz pebbles are noted in conjunction with these coarser sands. Red and light-red very fine- to medium-grained generally micaceous sandstones are present throughout the Paluxy sequence. Paluxy shales are, for the most part, dark-red and maroon, usually silty and micaceous. Some of these "red" shales are slightly sandy. Minor amounts of black shale and light-green and light-gray mudstones are present in the Paluxy.

WASHITA-FREDERICKSBURG GROUP

GENERAL STATEMENT

In George County, the Washita-Fredericksburg group is divisible into an upper clastic sequence, Dantzler formation, and a lower clastic-carbonate sequence commonly referred to in the petroleum industry as the Limestone Unit. In this report, this lower sequence will be referred to as the Limestone Unit. Six oil tests, located in the western part of the County, are known to penetrate the Washita-Fredericksburg sediments.

LIMESTONE UNIT

The Limestone Unit is an undifferentiated sequence of shales, mudstones, sandstones and limestones. A general north-south section in the western half of the County shows a gradual southward thickening ranging from 1205 feet in the northwestern part of the County to 1290 feet in the southwestern part of the County. True dip on beds at this depth is probably to the west and southwest, but due to the lack of deep well control, the westward thickening cannot be demonstrated.

The shales are dark-red, dull-red and maroon silty and finely micaceous and dark-gray and black commonly finely micaceous flakey and splintery and rarely fossiliferous. Mudstones are generally light-gray and pale-gray in color and are occasionally mottled ochre and red. Traces of mudstone containing inclusions of carbonaceous material are present. The sandstones are white, light-red, red and are very fine- and fine-grained. Only minor amounts of siltstone are present in this section. The white sandstones are generally calcareous and micaceous (muscovite and biotite) and rarely fossiliferous glauconitic and chloritic. Rare traces of very fine-grained sandstone and siltstone containing lignitic or carbonaceous materials were noted in the cuttings. Limestones range in color from pale grayish-white to light-gray. They are chalky to dense, usually either fossiliferous and/or pseudo-oolitic or spherulitic and occasionally glauconitic.

The top of the Limestone Unit, in this report, is picked at the first appearance of fossiliferous and/or pseudo-oolitic or spherulitic limestones in the cuttings. The contact of the Limestone Unit with the overlying Dantzler formation is regarded as transitional. No evidence of an unconformity was noted.

The upper half of the Limestone Unit consists of alternating shales, mudstones, sandstones and limestones. Red sandstones are subordinate to white sandstones. Occurrences of glauconitic limestone are restricted to the upper half of this unit. Within the upper 300 feet, a thin limestone charaterized by partially oxidized or selectively replaced fossils serves as an area marker in the otherwise undifferentiated sediments. This zone is usually encountered 200 to 260 feet below the top of the formation within the County. The partially oxidized or replaced fossils have an ochre and/or buff color. Another thin zone may be present at the top of the Limestone Unit in the Central Oil-Zack Brooks No. 1 B. E. Green in sec. 39, T. 1 S., R. 7 W. Although two such zones are known to exist within the State, this upper zone in the No. 1 B. E. Green may be due to contamination of the samples. Until such time as additional wells test this section, only one zone can definitely be placed in this sequence in George County.

The lower half of the Limestone Unit is a shale, mudstone sequence with only rare thin stringers of limestone in the upper part. More red sandstones are present in this lower half of the Unit. Black shales are subordinate to the red shales.

DANTZLER FORMATION

The Dantzler formation (top of Lower Cretaceous) is a 925 to 1070 foot undifferentiated predominantly clastic sequence of alternating shales, mudstones, sandstones, siltstones and rare nodular limestones. Variations in thickness of this interval are due, in part, to the unconformable Dantzler-Lower Tuscaloosa contact. Typically, the Dantzler progressively thickens southward within the County.

Shales, for the most part, are dark-red, red, dark-maroon and maroon in color and are silty and finely micaceous. A few dark-gray and black shales and flakey and splintery shales are present. They are usually found in the lower half of the formation. Vari-colored mudstones, red, light-gray, pale-gray, purple, ochre and green, are found throughout the formation. Some of the mudstones are mottled. The mudstones are subordinate to the shales. The white sandstones are generally fine- and medium-grained, usually slightly silty and micaceous and occasionally calcareous. Lesser amounts of white very fine-grained sandstone, calcareous sandstone and siltstone are present throughout the formation. A few thin zones of medium- to coarse-grained sandstone were noted, in several wells, in the upper half of the Dantzler. Red sandstones are subordinate to white sandstones. These red sandstones are very fine- and fine-grained and are found throughout the formation, but are generally more persistent in the lower half.

The top of the Dantzler formation is placed below the basal conglomeritic sandstones of the Tuscaloosa group. This contact is unconformable and is usually easily distinguishable in cuttings. The top of the Lower Cretaceous (top of the Dantzler formation) in George County is generally picked on the first appearance, in cuttings, of dark-red, red, dark-maroon or maroon silty finely micaceous shales with associated fragments of light-gray, pale-gray or red nodular limestone below the basal conglomeritic sandstones of the Tuscaloosa. Due to the unconformable contact, the top of the Dantzler may not be a distinct shale section, but may consist of a sequence of thin alternating sands, mudstones and shales with accompanying fragments of nodular limestone. A distinct change in grain size from the coarser conglomeritic basal Tuscaloosa sandstones to the generally finer-grained sands of the Dantzler formation is usually easily noted in the cuttings. Electrical correlations of the top of the Lower Cretaceous may be lower than the actual lithologic top. Sample work, supplemented with electrical log data is the only reliable method of accurately determining the top of Lower Cretaceous in George County.

TUSCALOOSA GROUP

GENERAL STATEMENT

In the subsurface of George County, the Tuscaloosa group is divided into the following formations: Lower Tuscaloosa, Middle Tuscaloosa and Upper Tuscaloosa. The Tuscaloosa group thickens to the west and southwest.

LOWER TUSCALOOSA FORMATION

The Lower Tuscaloosa varies from 530 to 755 feet in thickness. This variation in thickness is due, for the most part, to the unconformable surface upon which it was deposited. The Lower Tuscaloosa, in George County, consists of two distinct separable lithic units. The lower unit consists of generally massive, porous, usually "coarser" sandstones with minor amounts of shale and mudstone. This lower unit is conglomeritic in part. This upper unit is composed of alternating shales, minor mudstones and "finer," usually glauconitic sandstones and siltstones.

This lower unit is commonly referred to as the "massive sandstone section." The unit consists of a series of massive fine- to coarse-grained sandstones with minor amounts of alternating shale and mudstone. The sandstones are typically conglomeritic, consisting of a fine- to coarse-grained sand fraction, however, some of the sandstones may be fairly well sorted. These massive sands were probably deposited rapidly in a shallow-water environment. The winnowing action of the environment produced generally "clean" massive sands. Incorporated vari-colored quartz and chert pebbles and chips may occur throughout the "massive sandstone section" but more commonly are found in the lower half of the unit. Small vari-colored quartz and chert grains may be common in these sandstones. These massive sands are usually non-calcareous porous and slightly micaceous and silty. Rare traces of sideritic sandstone were noted in several wells. The coarser sand grains are generally sub-rounded. Ashy sandstones were noted in the basal sections of several wells. The shales are dark-gray, black and various shades of red and may be finely micaceous and silty. Dark-gray and black shales predominate over the red shales in this lower unit. Vari-colored mudstones, light-gray, gray, light-green, light-red and ochre, and mottled mudstones are typical of the "massive sandstone section." The light-gray and gray mudstones frequently contain siderite concretions. The "massive sandstone section" thickens generally to the west and southwest from 140 feet in the northeastern part of the County to a maximum of 370 feet in the western half of the County. The varying thickness of this unit is due, in part, to the eroded surface upon which it was deposited.

As typically developed, the "massive sandstone section" consists of massive sandstones with alternating minor amounts of shale and mudstone. In some areas, the sands are not well developed and proportionately larger amounts of shale and mudstone are present.

Where the basal glauconitic sandstones of the upper unit of the Lower Tuscaloosa are massive and porous, electrical log correlations of the "massive sandstone section" may be picked at a point higher than the actual lithologic top. Sample work is the only reliable means of correlation in this clastic section.

The upper unit of the Lower Tuscaloosa, consisting of alternating, sandstones, siltstones, shales and rare amounts of mudstone, is generally referred to as the "stringer sandstone section." This sequence varies from 320 to 480 feet in thickness. This upper unit, in many of the wells examined, is characterized by more or less lenticular sandstone development. The shales are dark-gray and black and are generally flakey and splintery and finely micaceous. Some of the shales are slightly calcareous and rarely fossiliferous. Only rare traces of light-gray and gray mudstone were noted in the "stringer sandstone section." The sandstones and siltstones are predominantly white generally glauconitic calcareous slightly silty and rarely fossiliferous. They range in grain size from silt to medium-grained. Some of these sandstones and siltstones are light shades of gray.

The top of the Lower Tuscaloosa is placed at the first occurrence of glauconitic sandstones stratigraphically below the dark-gray and black shales of the Middle Tuscaloosa. In many wells, a thin lentil or lentils of light-gray or light brownish-gray "speckled" fossiliferous chalk or chalky limestone was noted immediately above or at the top of the Lower Tuscaloosa.

MIDDLE TUSCALOOSA FORMATION

The lithology of the Middle Tuscaloosa is consistent, being predominantly dark-gray and black flakey and splintery finely micaceous and commonly finely carbonaceous or lignitic shales. There are also minor amounts of light-gray and light-green mudstone and a few thin beds of white to pale-gray very fine-grained calcareous argillaceous and usually glauconitic sandstone and siltstone. Basal beds of the formation may contain a thin lentil of light-gray or light brownish-gray "speckled" fossiliferous chalk or chalky limestone.

The top of the Middle Tuscaloosa appears to be transitional with the overlying Upper Tuscaloosa. The top of the formation is picked on a marked increase of dark-gray and black flakey and splintery finely micaceous shales stratigraphically below the porous basal Upper Tuscaloosa sandstones. The Middle Tuscaloosa varies from a minimum of 370 feet to a maximum of 515 feet, thickening in a southwesterly direction. The formation expands at the expense of the overlying Upper Tuscaloosa.

UPPER TUSCALOOSA FORMATION

The Upper Tuscaloosa consists of a 275 to 515 foot sequence of alternating shales, mudstones and somewhat lenticular sandstones. The formation is thicker in the north half of the County, with a progressive thickening trend to the west and southwest.

The shales are predominantly dark-gray and gray, generally flakey and splintery, however, some red shales are present. The red shales are restricted to the upper half of the formation. Some wells contain rare traces of purple shale in conjunction with these red shales. Mudstones are generally light-gray, gray or light greenish-gray in color and commonly contain spherical siderite concretions. Ochre, light-red and purple mudstones are generally present in association with red shales. Sandstones range from very fine- to medium-grained and, for the most part, are porous and occasionally contain random vari-colored chert grains. Some sandstones are sideritic. Glauconitic sandstones and sparingly fossiliferous sandstones are commonly present in varying amounts in the lower two-thirds of the formation.

The top of the Tuscaloosa group is placed at the first occurrence in cuttings of light-gray, pale-gray or light greenish-gray mudstones below the glauconitic sandstones of the overlying Eutaw. In some wells, minor amounts of red shale also serve as a lithic indicator of the uppermost beds of the Tuscaloosa group. Sample work is the only accurate method of determining the top of the Tuscaloosa group, as no reliable electrical log correlations exist.

EUTAW GROUP

GENERAL STATEMENT

In the subsurface of southeastern Mississippi, the Eutaw group consists of a lower section of interbedded glauconitic sandstones, siltstones and dark-gray and black flakey and splintery silty finely micaceous shales and an upper chalk section. In this report, that facies of the Eutaw which is represented by a chalk section is included in the overlying Selma group.

EAGLE FORD FORMATION (LOWER EUTAW)

The Eagle Ford consists of an interbedded sequence of shales, sandstones and siltstones 165 to 275 feet thick. In general, the Eagle Ford is thicker in the southern half of the County, expanding at the expense of the Upper Tuscaloosa. Eagle Ford shales are dark-gray and black flakey and splintery silty and finely micaceous. Some shales are slightly sandy. Others are slightly calcareous and fossiliferous and some are carbonaceous or lignitic. The sandstones are very fine- and fine-grained usually white calcareous glauconitic micaceous and occasionally sparingly fossiliferous. Some of the sandstones are pale-gray in color. Rarely, the sandstones contain random fragments of carbonaceous or lignitic material. Occasionally the lower Eagle

Ford sandstones are quite limy, glauconitic and contain megafossil fragments. The siltstones range in color from white to light-gray and are usually glauconitic and calcareous.

SELMA GROUP

In this report, the entire Upper Cretaceous chalk section is included in the Selma group. As restricted, this group includes beds of Austin, Taylor and Navarro age.

The lithology of the Selma is consistent, being predominantly chalks with interbedded and intercalated shales and traces of bentonite. Divisions within this homogeneous sequence are based on biostratigraphic evidence. Chief marker fossils are as follows: *Kyphopyxa christneri* — Austin age beds; *Stensionia americana* — Taylor age beds and *Globotruncana arca* — Navarro age beds (top of Upper Cretaceous). The Selma group varies from 1205 to 1375 feet in thickness, being thicker in the northeastern half of the County. Variance in sample intervals, 10 to 90 feet, distorts measurable thicknesses and necessitates averaging of division thicknesses.

The chalks are pale-gray, light-gray and white in color. Some chalks are quite argillaceous, others are nearly pure calcium carbonate. The basal Selma chalks tend to be argillaceous and may be slightly sandy. Minor amounts of pale-gray and light-gray bentonite are found throughout the lower two-thirds of the Selma, being restricted to beds of Austin and Taylor ages. The shales are dark-gray and black, commonly flakey and splintery and occasionally slightly calcareous and fossiliferous. The basal Selma contains shales which are silty to slightly sandy.

The chalk sequence of Austin age averages 329 feet. This section thickens generally to the west and southwest from a minimum of 285 feet in the northeastern part of the County to a maximum of 400 feet in the southwestern part of the County. The contact of the Austin with the underlying Eagle Ford is gradational.

Taylor age sediments thin to the west and southwest in George County from a maximum of 940 feet along the eastern boundary to a minimum of 720 feet in the southwestern part of the County. The Taylor averages 812 feet in thickness.

Navarro deposits thin from a maximum of 135 feet in the eastern part of the County to a minimum of 45 feet in the western portion. This variation in thickness is probably due to a combination of non-deposition and post-depositional erosion. The average thickness of the Navarro is 92 feet.

In some wells examination of the samples indicates that the first chalk encountered is Taylor in age. As indicated in the general statement on stratigraphy, the missing sediments may be due to actual thinning of the section or incomplete sampling techniques. Because of its homogeneous nature, sediments of the Selma group must be subdivided on faunal content. Available samples indicate that the Navarro sediments were either eroded or never deposited in some areas of George County.

MIDWAY GROUP

GENERAL STATEMENT

In this report, the Midway group of George County is represented by the Midway "shale" (Porters Creek formation). The Clayton chalk, basal Midway, does not appear to be present in the subsurface of George County. Clayton sediments were either eroded before deposition of the Midway shale, were never deposited or their absence may be due to incomplete sampling techniques.

MIDWAY SHALE (PORTERS CREEK FORMATION)

Unconformably overlying the Upper Cretaceous Selma chalk is a 775 to 1000 foot sequence consisting predominantly of clay shales, silts and subordinate amounts of sandstone. Defined as a rock-stratigraphic unit in this report, this sequence is probably all Porters Creek in age and is herein referred to as Midway shale.

The Paleocene-Eocene boundary has not been satisfactorily established in the subsurface of Mississippi. The recognizable sedimentary facies of the Midway and Wilcox groups are not exact time units. As defined herein, the Midway-Wilcox contact is placed at the base of the lowest sandstone sequence recognizable as a sedimentary facies of the Wilcox group. This contact is regarded as transitional.

Midway shales range from gray to black in color, are silty occasionally fossiliferous and finely micaceous and lignitic or carbonaceous. Thin beds of lignite are present in the Midway. In a few wells, thin zones of brown and reddish-brown clay ironstone were noted. Silts and siltstones are generally light-gray and gray and are usually quite argillaceous. Midway sandstones are very fine- to fine-grained and range from white to gray in color; however, most are light-gray and generally argillaceous. Some sandstones are calcareous to limy glauconitic slightly micaceous and contain rare inclusions of lignite or carbonaceous material. Small grains of tan and brown clay ironstone and white chert are occasionally present in Midway sandstones.

The Midway thickens generally to the south and west at the expense of the overlying Wilcox group. Thin sandstones, less than 10 feet in thickness are developed throughout the Midway. To the west and southwest, an erratic build-up of thicker sandstone bodies develops. These build-ups take place generally in the lower half of the Midway section, but some development is seen in the upper half. In the Crow Drilling Company and S. P. Borden No. 1 B. F. Green in sec. 3, T. 2 S., R. 8 W., a 170 foot sandstone section is developed in the lower half of the Midway.

WILCOX GROUP

In this report, the Wilcox group is treated as a rock unit and, as such, includes some strata which may be an arenaceous facies of late Midway age. Based on Loeblick and Tappan's work on the planktonic foraminifera of the Paleocene and lower Eocene[2], the Wilcox sediments, if classified as a time-rock unit, would be restricted to those sediments above the Salt Mountain Limestone and below the Tallahatta formation.

Except for a thin glauconitic fossiliferous limestone, the Salt Mountain, which is approximately in the middle of the group, the Wilcox is a lithologically undifferentiated sequence. The Salt Mountain probably never exceeds 10 feet in thickness throughout George County. No subsurface zonation or correlation, other than the Salt Mountain limestone, is attempted.

The Wilcox is a heterogeneous mass of interbedded, interlensing and interfingering shales, sandstones and siltstones with associated thin beds of lignite and clay ironstone. The Wilcox ranges in thickness from 1875 to 2260 feet, being thicker generally in the north half of the County, complementing the thinner section of the underlying Midway shale. The Wilcox sediments also thicken in a westerly direction.

Wilcox shales and clay shales are gray, dark-gray and black, usually silty, occasionally slightly sandy and fossiliferous and lignitic or carbonaceous. Often the shales are laminated with very fine-grained sandstones and siltstones. Thin seams of lignite or carbonaceous material and tan, brown, light-gray and gray silty glauconitic and sparingly fossiliferous impure limestone and calcareous clay ironstones occur in the Wilcox. Lignite or carbonaceous material is not characteristic of the uppermost beds. Occasionally chips and pebbles of light-gray and gray silty and occasionally glauconitic limestone, probably detrital in nature, are noted in the cuttings. Rare thin zones of concentrated megafossil fragments are present, generally in the upper half of the Wilcox group. Siltstones are, for the most part, various shades of gray and are argillaceous micaceous carbonaceous or lignitic and occasionally calcareous to limy. The sandstones range in color from white to gray and include various shades of green. Grain sizes of the sandstones are usually in the fine and medium range with only rare intervals of coarse-grained sandstones. Sandstones are generally argillaceous micaceous glauconitic and occasionally fossiliferous. Thin laminae and partings of shale are noted in many sandstones. Some sandstones contain fragments of clay ironstone and small chert grains. Traces of sideritic and pyritic sandstones are present in the Wilcox.

The Salt Mountain limestone is present throughout most of George County and is an excellent marker in the otherwise undifferentiated Wilcox sediments. This limestone is fossiliferous and glauconitic and varies in color from white to shades of tan, brown and ochre. A distinctive red and buff mottling is characteristic. This mottled appearance is probably the result of partial oxidation. The Salt Mountain carries the distinctive marker fossils *Discocyclina cookei* and *D. blanpiedi*.

The top of the Wilcox is placed at the first occurrence, in cuttings, of pale-gray or light-gray usually glauconitic and calcareous or limy and occasionally fossiliferous sandstones or limy argillaceous siltstones with associated light-gray and gray silty shales and clay shales stratigraphically below the pale-gray to white limy siltstones and claystones of the Tallahatta formation. The Wilcox-Tallahatta contact is regarded as transitional, for the most part. This transition zone, representing the fluctuating succession of one facies of deposition by another, has resulted in electrical log correlations which are lower, in many cases, than the actual lithic top.

CLAIBORNE GROUP

GENERAL STATEMENT

The Claiborne group in George County is a sequence of marine calcareous-argillaceous-arenaceous strata. The group includes, in ascending order, Tallahatta formation, Winona formation, Zilpha formation, Kosciusko formation, Cook Mountain formation and Cockfield formation. The Kosciusko and Cockfield formations are thin and have undergone facies changes.

Typically, the Kosciusko and Cockfield formations consist of arenaceous-argillaceous strata, however, in the subsurface of George County, they have undergone a facies change to calcareous-arenaceous sediments.

The nature of the formation contacts of the upper Claiborne group are difficult to determine. In many cases, the units comprising the upper half of the Claiborne group, the Kosciusko, Cook Mountain and Cockfield formations are distinguishable from adjacent formations by reasonably obvious gross lithologic characteristics, however, marker fossils are of primary importance in correlating this complex carbonate facies. With only well cuttings available, the writer's conclusions on the nature of these contacts is, of necessity, based on the gross character of the sediments on either side of the contacts. These predominantly clastic carbonate sediments were deposited in a shallow marine environment dominated by a high energy level. The carbonate grains are of subaqueous origin being both biofragmental and strictly clastic in nature. The sediments were current transported and sorted and mechanically deposited, for the most part, so that the accumulation has the structure of a detrital sediment. For the most part, the carbonate sediments of the upper Claiborne may be classified as either calcarenites or calcarenitic limestones.

In this high energy area, unconformable relationships may be the rule rather than the exception, as deposition, for the most part, was probably within effective wave base. The wave and current actions in this shallow marine environment undoubtedly had erosive effects, however, deposition is believed to have been essentially contemporaneous, resulting in a complex carbonate facies.

TALLAHATTA FORMATION

The Tallahatta formation (basal Claiborne) is a sequence of white and pale grayish-white very finely micaceous and glauconitic sparingly fossiliferous and calcareous to limy siliceous claystones and siltstones with interbedded green, light-green and light greenish-gray clay shales and glauconitic sparingly fossiliferous clay shales. Finely divided pyrite is commonly present in the claystones and siltstones. The basal Tallahatta generally contains some interbedded light-gray micaceous and occasionally fossiliferous clay shales.

The Tallahatta formation ranges in thickness from 45 to 100 feet, being thicker in the northeast half of the County, thinning to the southwest.

The distinctive lithic character of the Tallahatta is readily distinguishable in cuttings. The top of the Tallahatta formation is placed at the first occurrence, in cuttings, of white and pale grayish-white finely glauconitic claystones and siltstones below the Winona formation. The contact of the Tallahatta with the overlying Winona appears to be transitional.

WINONA FORMATION

The Winona consists predominantly of light-green and light greenish-gray clay shales and glauconitic and sparingly fossiliferous clay shales. A few thin lentils of pale grayish-white impure slightly fossiliferous marl or chalk were noted in the lower half of the Winona in most wells. Clay shales in the basal Winona are variably silty at the contact with the underlying Tallahatta.

The contact of the Winona with the overlying Zilpha appears to be gradational. The top of the Winona is picked on an increase of light-green and light greenish-gray glauconitic clay shales below the basal impure chalks and marls of the Zilpha.

The Winona thickens slightly in the southwest half of the County, complementing the southwesterly thinning of the underlying Tallahatta. The Winona varies from 50 to 75 feet in thickness.

ZILPHA FORMATION

The Zilpha formation is comprised of a 95 to 135 foot sequence of interbedded light-gray, brownish-gray and light-green sparingly fossiliferous glauconitic clay shales and white and pale grayish-white fossiliferous glauconitic chalks and chalky limestones. Alternating chalks or chalky limestones and clay shales characterize the upper half of the Zilpha. The lower half generally consists of an upper portion of clay shales with a basal sequence of interbedded chalks or chalky limestones and clay shales.

The Zilpha is thickest in the northeast half of the County, thinning to the southwest. The contact of the Zilpha with the overlying Kosciusko formation appears to be transitional, at least in part. At the end of Zilpha deposition, a shallow marine environment was initiated which was dominated by a high energy level so that submarine erosion and deposition were probably essentially contemporaneous.

KOSCIUSKO FORMATION

The Kosciusko-Cook Mountain contact is arbitrarily drawn at the point where sandy limestones appear in the cuttings below the predominantly clastic limestones of the Cook Mountain. Contact relationships probably vary locally from transitional to unconformable. Because of the poor quality of the cuttings and extended sample intervals, only approximate thicknesses and rather generalized lithologic descriptions are possible.

The Kosciusko is a sequence of white variably sandy generally glauconitic chalky limestones and calcarenitic limestones* with interbedded light-green and light greenish-gray glauconitic clay shales. Some of the limestones are slightly porous, however, the calcarenitic limestones appear to be generally well cemented.

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*Calcarenitic limestone — essentially an aphanitic limestone (grain size less than 0.06 mm.) which contains more than 10% carbonate sand grains.[3]

The Kosciusko averages 22 feet in thickness being thickest in the northeast half of the County.

COOK MOUNTAIN FORMATION

Cook Mountain sediments in George County are a sequence of shallow water carbonates with subordinate amounts of alternating light-gray, light-green and light greenish-gray usually glauconitic and fossiliferous clay shales.

The limestones are cream-colored and white variably glauconitic and generally consist of current-washed loosely comented carbonate sands with varying amounts of finely divided carbonate matrix material. Although this calcarenite* accumulation is the most striking lithologic component of the Cook Mountain formation, subordinate amounts of chalky aphanitic limestone and calcarenitic limestone are present. At the contacts with the adjacent formations, the limestones are generally slightly sandy and may be quite glauconitic. A thin sandy zone, not at a contact zone, was noted in a core sample from a well drilled in the southwestern part of the County. The poor quality of the cuttings prevented the determination of the extent of this zone.

These sediments are generally clean, current transported and sorted and mechanically deposited, and as such, this calcarenitic accumulation is often quite porous and has the structure of a detrital sediment.

The Cook Mountain limestone is commonly referred to as the Camerina limestone. The term Camerina limestone is derived from the distinctive marker fossil, *Camerina barkeri*, the primary marker fossil used in this report to determine the top of strata which is Cook Mountain in age.

While unconformable Cook Mountain-Cockfield contacts probably exist, they are not readily apparent, and the contact of the Cook Mountain with the overlying Cockfield formation is regarded as being transitional, for the most part. The Cook Mountain varies from 95 to 160 feet in thickness, being thickest in the northeast half of the County.

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* Calcarenite — carbonate sand (0.06 — 2.0 mm.) with less than 10% carbonate matrix material.[4]

COCKFIELD FORMATION

The Cockfield is composed of a sequence of interbedded pale grayish-white and white silty variously arenaceous very finely glauconitic sparingly fossiliferous calcarenitic limestones, pale grayish-white very finely glauconitic sparingly fossiliferous limy very fine-grained sandstones and siltstones and pale-gray, light-gray and light-green variously glauconitic and silty clay shales.

Cockfield limestones are generally slightly porous to nonporous and usually fairly well cemented. Some porous calcarenites are present. The distinct faunal and lithological character of the overlying Moodys Branch and the underlying Cook Mountain facilitates correlations of the Cockfield on a lithic basis. Characteristically, the calcarenitic limestones of the Cockfield are very fine to finely clastic and the sand fraction is of a noticeably finer grain size than that found in the overlying Moodys Branch. Perhaps the most diagnostic feature is the very finely divided glauconite associated with these limestones and siltstones. Glauconite associated with both the Cook Mountain and Moodys Branch sediments is of a larger grain size than that associated with the Cockfield. These reasonably obvious gross lithologic characteristics facilitate differentiation of the Cockfield from the underlying and overlying formations on a rock-unit basis.

Though a regional marine disconformity is reported to be present at the base of the Moodys Branch formation throughout most of the northern Gulf province, this unconformable relationship is not readily apparent in the subsurface of George County.

While there is a noticeable change from the calcarenitic limestones and siltstones of the Cockfield to the basal sandy limestones and limy sandstones of the overlying Moodys Branch, the gross lithology remains that of a shallow marine environment and the contact is regarded as being transitional.

The thickness of the Cockfield is fairly consistent throughout the County, averaging 24 feet.

JACKSON GROUP

MOODYS BRANCH FORMATION

The Moodys Branch consists of a sequence of limestones, sandstones and marls. The Moodys Branch is easily identifiable due to the abundance of well preserved fossils and its distinctive lithology.

The limestones are pale-gray or pale grayish-white chalky to dense glauconitic fossiliferous and generally quite sandy. Sand grains range from fine to coarse and are usually rounded to well rounded.

Moodys Branch sandstones are usually pale-gray and pale greenish-gray calcareous to limy glauconitic fossiliferous and the grains are usually sub-rounded to well rounded. The sandstones are fine- and medium-grained and usually contain some scattered coarse- and very coarse-grained sand and small quartz pebbles.

The marls are light-gray and pale greenish-gray clayey calcareous highly glauconitic fossiliferous and variably sandy. The sand ranges from fine- to coarse-grained and is usually rounded to well rounded.

Limestones and sandstones with associated marls usually predominate in the lower half of the formation with the upper half consisting of marls.

In this report, the Moodys Branch is defined on a lithologic basis. The sequence is distinctive and easily differentiated from the underlying and overlying formations. The Moodys Branch-Yazoo contact is gradational and the top of the Moodys Branch is placed at the point where the sand and glauconite content becomes negligible.

Numerous well preserved specimen of *Camerina jacksonensis* and *Operculina vaughani* are present in the Moodys Branch. In this carbonate facies of the Jackson group, they are not restricted to the Moodys Branch, ranging upward into the overlying Yazoo formation. The presence of these species, in cuttings has caused some subsurface workers to pick the top of the formation at a point higher than the lithologic top, as defined in this report. *Nonionella cockfieldenisis* is present in the basal strata of the Moodys Branch and this faunal zone has been used by some paleontologists as the top of the Cockfield formation.

The Moodys Branch varies from 15 to 30 feet in thickness. The formation averages 24 feet in thickness, being thickest in the northern half of the County.

YAZOO FORMATION

The gross lithology of the Yazoo formation, in the subsurface of Mississippi, is a bluish-gray calcareous fossiliferous clay with rare thin discontinuous soft argillaceous limestones. In southeastern Mississippi and over and along the Wiggins anticline, the Yazoo grades into a carbonate facies called the Ocala.

In George County, the Yazoo formation is represented by the Ocala facies. The Ocala facies is composed almost entirely of carbonate strata consisting of white and pale grayish-white fossiliferous calcarenitic limestone, calcarenite and chalk. A thin basal section of light bluish-gray and pale-gray calcareous fossiliferous clay is the only strata of the Yazoo formation in George County which cannot be classified as either a limestone or chalk. The lower part of the Yazoo generally contains a few scattered grains of glauconite.

The Yazoo formation in the northeastern two-thirds of the County consists of a sequence of white and pale grayish-white chalk and a few thin calcarenitic limestones. The calcarenitic limestone in this portion of the County is characterized by its lack of porosity, due to the abundance of a finely divided carbonate matrix materials.

In the southwestern third of the County, the upper half of the Yazoo formation consists of current-washed, generally loosely cemented, porous carbonate sands with varying amounts of finely divided carbonate matrix. This calcarenitic accumulation was deposited in a high-energy, shallow marine environment and has the structure of a detrital sediment. The lower half of the formation consists predominantly of chalk and some thin calcarenitic limestones.

Because of the complex carbonate facies of the Ocala in George County, no single zonation based on faunal zones or marker fossils is practical. In the northeastern two-thirds of the County zonation using the smaller foraminifera is suggested because of the character of the sediments. The chalky strata disintegrates easily providing well preserved smaller foraminifera. In this area, the faunal zones of Monsour [5] may be used for correlations. In the southwestern third of the County, the smaller foraminifera are usually badly preserved. In contrast, the larger foraminifera are ordinarily well preserved and index or key fossils rather than faunal assemblages are more applicable.

In this report the Yazoo formation is not divided into zones or faunal assemblages. In the northeastern two-thirds of the County, the formation is easily distinguishable on both a lithological basis and by distinctive electrical characteristics. In the southwestern third, neither lithology nor electrical characteristics are practical. In this portion of the County, strata from the Yazoo formation of Jackson age to the Vicksburg limestones of Oligocene age consists, for the most part, of an accumulation of calcarenites and calcarenitic limestones. The top of the Ocala is placed at the first appearance, in cuttings, of *Operculinoides ocalana* and/or *O. wilcoxi.*

Biostratigraphic correlations of Jackson and Vicksburg strata by several writers, the most recent by Deboo, [6] assign the uppermost member of the Yazoo, the Shubuta, to the Vicksburg group. In this report all members of the Yazoo formation are assigned to the Jackson group. Throughout much of the County, the Yazoo formation is defined as a rock-stratigraphic unit.

The Ocala varies from 100-190 feet in thickness, averaging 146 feet. The formation is thickest in the western half of the County. Strata of the Red Bluff are reportedly separated from the underlying Ocala by a marine disconformity. If this disconformity does extend into the subsurface of George County, the writer found no physical evidence of its existence and the contact between the Ocala and the overlying Red Bluff is regarded as being conformable. The writer is of the opinion that sedimentation was essentially contemporaneous through the contact zone, even in the high energy shallow marine environment in the southwestern third of the County. In this portion of the County, the complex carbonate accumulation, involving strata of both Jackson and Vicksburg age, cannot be differentiated on a lithologic basis. In the remainder of the County, the lithologic contrast between the white limestones and chalks of the Ocala and the light-gray to pale-gray calcareous and fossiliferous clays of the Red Bluff facilitate differentiation.

RED BLUFF FORMATION

Based on biostratigraphic evidence, various authors have considered the Red Bluff strata to range from Jackson to Vicksburg age. The writer prefers to place the Red Bluff in the Oligocene series, exclusive of the Vicksburg group.

The Red Bluff consists of a light-gray to pale-gray occasionally calcareous fossiliferous sparingly glauconitic and silty clays and finely lignitic or carbonaceous clays, soft chalky fossiliferous glauconitic limestones and calcarenitic limestones.

The Red Bluff formation in George County consists of marine clays and limestones. This sequence occupies the same stratigraphic position as the lagoonal to deltaic Forest Hill clays, silts and sands to the northwest. Hoppin's[7] work on oscillations in the Vicksburg stage, based on the foraminiferal content of cores taken from a well drilled in the County, indicates that the Red Bluff was deposited in deeper water than the overlying Vicksburg formation.

Throughout the northeastern two-thirds of the County, the uppermost portion of the Red Bluff consists of white and pale grayish-white fairly soft chalky fossiliferous generally quite glauconitic limestones a few calcarenitic limestones and minor amounts of pale-gray and light-gray occasionally calcareous fossiliferous slightly glauconitic and silty clay. Fossils in this interval, predominantly in the limestone, may be replaced by glauconite. The remaining portion of the formation in this part of the County consists of pale-gray and light-gray calcareous fossiliferous sparingly glauconitic occasionally finely lignitic or carbonaceous clays. A few thin beds of pale grayish-white and white soft chalky fossiliferous and variously glauconitic limestone are also present.

The depositional environment in this section of the County, with the exception of the Sinclair Oil & Gas Company No. 1 Luce Packing Company in sec. 10, T. 1 S., R. 6 W., appears to have been uniform. Sample and electrical log information indicate locally unstable conditions which resulted in the deposition of a sequence of thin limestones and clays in the lower half of the section.

A high-energy shallow marine environment in the southwestern third of the County, during Red Bluff time, deposited calcarenites, calcarenitic limestones and minor amounts of calcareous fossiliferous sparingly glauconitic clays.

The Red Bluff averages 99 feet in thickness, varying from 55 to 155 feet. Correlation points in this report are based primarily on sample work, and as such, this thickness of the Red Bluff sediments may or may not be due to actual thinning or thickening of the section, rather due to the poor quality of the samples. The formation is thickest in the eastern half of the County, complementing the eastward thinning of the underlying Ocala.

Oscillation charts prepared by Hoppin [8] from core samples on the United Gas Public Service Company No. 1 Luce Packing Company in sec. 25, T. 1 S., R. 6 W., shows a strong faunal break between the Red Bluff formation and the Vicksburg limestone. His interpretation and comments on these charts are summarized as follows: (1) the Red Bluff was deposited in deeper water than the overlying Vicksburg limestone, (2) lithology and fauna of the upper portion of the Red Bluff indicates clear water conditions, suggesting that the control is not entirely due to depth, but may also be a function of the type of bottom and clarity of water and (3) the difference in fauna between the two formations could be partly evolutionary and partly environmental.

The writer could find no lithologic evidence of an unconformable contact between the Red Bluff and the Vicksburg limestone. The concentration of glauconite and fossils replaced by glauconite, in the upper portion of the Red Bluff throughout the northeastern two-thirds of the County, may represent a period of slowed deposition. Though deposition may have slowed, it is believed that deposition was essentially contemporaneous through the Red Bluff-Vicksburg "limestone" contact, even in the high energy shallow water environment in the southwestern third of the County.

VICKSBURG GROUP

GENERAL STATEMENT

The Vicksburg group in George County includes, in ascending order, the Marianna formation, the Glendon formation and the Bucatunna formation.

The Mint Spring and Byram formations are not distinguishable as rock-stratigraphic units in this area. In more updip areas, these formations are easily distinguishable from the limestones of the Vicksburg group on the basis of their highly glauconitic and arenaceous lithology. In George County, strata equivalent to the arenaceous Mint Spring and Byram formations in updip areas, is limestone, and except for being slightly sandy and glauconitic, is lithologically undistinguishable from the limestones of the Marianna and Glendon formations. Strata equivalent to the updip Byram is grouped with the limestones of the Glendon. Equivalent strata of the updip Mint Spring is included in the limestones of the Marianna.

In this area, faunal zones using the larger foraminifera as index fossils, is the most satisfactory means of differentiating carbonate strata of Vicksburg age. Because of the poor quality of the samples, extended sample intervals and lack of core samples, true thicknesses of the Marianna and Glendon formations in this area are not satisfactorily differentiated by sample work. As the top of the Glendon formation (top of Vicksburg "limestone") as defined in this report, is the best mappable horizon, the Marianna and Glendon formations are not differentiated in this report, but are referred to collectively as the Vicksburg "limestone".

VICKSBURG LIMESTONE

As indicated on the correlation chart, Plate 1, Dinkins, the limestone sequence of the Vicksburg group in George County is referred to collectively as the Vicksburg "limestone". These limestones are white to pale grayish-white fossiliferous slightly sandy and glauconitic and dense to soft and chalky. The limestones are aphanitic to calcarenitic. Minor amounts of light-gray and pale-gray fossiliferous bentonitic slightly calcareous clays or clay shales are associated with these limestones. Traces of relatively pure, light and pale-green waxy bentonite were observed in some of the samples. Much of this bentonite is probably in place, but some may be cavings from the overlying Bucatunna formation.

Sample work indicates that the calcarenitic limestones are more prevalent in the southwestern third of the County, however, calcarenitic limestones are found, in varying amounts, throughout the County. These calcarenitic limestones vary from porous to non-porous.

In more updip areas the limestones of the Vicksburg group are characteristically glauconitic and slightly sandy. In this area, only the strata equivalent to the Mint Spring and Byram formations is slightly sandy and glauconitic. This sandy and glauconitic facies of the Vicksburg "limestone" is present generally throughout the northeastern two-thirds of the County.

Usually well-preserved specimens of the larger foraminifera are found in the cuttings and serve as the most satisfactory means of differentiating the Vicksburg "limestone" sequence. As defined in this report, the Vicksburg "limestone" is composed of two limestone sequences, the Marianna and the Glendon. The marker fossils, in descending order, are as follows: *Lepidocyclina supra* — Glendon formation and *Lepidocyclina mantelli* — Marianna formation.

The top of the Vicksburg "limestone" is placed at the first appearance, in cuttings, of white and pale grayish-white fossiliferous limestones and sparingly sandy and glauconitic limestones below the dark-gray clays of the Bucatunna formation. This limestone is generally quite fossiliferous, containing a number of *Lepidocyclina supra.* Porosity in these limestones appears to be, for the most part, primary, however, some porosity of secondary origin was noted. The contact between the Vicksburg "limestone" and the Bucatunna formation is sharp, but appears to be conformable.

The Vicksburg limestone averages 38 feet in thickness, varying from 25 to 45 feet. The sequence is thicker generally in the northern two-thirds of the County.

BUCATUNNA FORMATION

The Bucatunna consists predominantly of dark-gray usually finely lignitic or carbonaceous occasionally bentonitic sparingly fossiliferous and calcareous clays with a few thin silt laminae. In a number of wells, the upper half of the formation contains a thin bed of white or pale-gray fine-grained clayey sandstone or pale-gray chalky clayey fossiliferous slight to non-glauconitic and generally slightly sandy marl. Traces of pale-green and light-green bentonite were noted in samples of the Bucatunna. Hoppin [9] also reported bentonitic material in core samples from the United Gas Public Service Company No. 1 Luce Packing Company in sec. 25, T. 1 S., R. 6 W.

The thicker sections of Bucatunna are found in the central portion of the County. The Bucatunna averages 33 feet in thickness, varying from 25 to 45 feet.

CHICKASAWHAY FORMATION

The controversy concerning the Oligocene-Miocene boundary is centered around strata of Chickasawhay age. Murray [10] states that while there is no general agreement yet as to the particular age of Chickasawhayan strata, the bulk of recent paleontological evidence suggest an Oligocene age. In line with this evidence, the Chickasawhay formation is placed in the Oligocene series.

The top of the Chickasawhay is placed at the first appearance, in samples, of *Lepidocyclina* (*Eulepidina*) *favosa* and/ or *L.* (*Eulepidina*) *undosa.* Because of the poor quality of the cuttings and the extended sample intervals, an approximate average thickness of 30 feet is assigned to the Chickasawhay formation.

The Chickasawhay consists of pale grayish-white and white aphanitic to calcarenitic chalky fossiliferous variably sandy limestones, some light-tan dense to very finely crystalline variably fossiliferous dolomites and generally minor amounts of interbedded pale-gray fossiliferous slightly calcareous clays. Some of the limestones contain phosphatic fossil material.

Porosity in the limestones appears to be both primary and secondary. The calcarenitic limestones range from slightly porous to non-porous, depending on the amount of finely divided carbonate matrix and cement. Some solution porosity is noted in the limestones. Solution porosity is usually noted in the dolomites. The dolomites are generally quite porous. Both intercrystalline and solution porosity are usually present in the dolomites.

From the few suites of samples available through the Chickasawhay - Heterostegina limestone interval, no lithologic evidence of unconformable relationships was noted. In most of the County, the Heterostegina limestone (basal Miocene) rests directly on the underlying Chickasawhay limestone, and thus, precludes differentiation based on electrical log characteristics. Only in the northwestern part of the County can the Chickasawhay formation and the Heterostegina limestone be separated on the basis of electrical log characteristics. The predominant limestone lithology of both the Chickasawhay and Heterostegina necessitates differentiation based on marker fossils.

Due to the lack of adequate sample information and electrical log characteristics, only arbitrary thicknesses, based on available samples, is assigned to both the Chickasawhay formation and the Heterostegina limestone. Additional sample information will, no doubt, necessitate changes in these thicknesses.

MIOCENE SERIES

GENERAL STATEMENT

The Miocene strata discussed in this subsurface study, the Catahoula and Hattiesburg formations, consist predominantly of sand, silts and clays deposited in eastuarine and interdeltaic transitional environments during the regressive phase which followed the widespread transgression which ended the Oligocene period. The Heterostegina limestone (basal Miocene) was deposited in a shallow, near-shore marine environment.

Deposition of these strata is believed to be essentially continuous and formational contacts in the clastic strata are arbitrarily placed at the bases of coarse sands and pebbles, Plate 4, Williams.

CATAHOULA FORMATION

GENERAL STATEMENT

In this down-dip area, the Catahoula consists of an upper sand, silt and clay sequence and a basal limestone section. Being predominantly sandstone, this upper sequence is generally referred to as the Catahoula sandstone. The basal limestone section, Heterostegina limestone, derives its name from the distinctive marker fossils which are common in this zone.

HETEROSTEGINA LIMESTONE

The top of the Heterostegina limestone (Tatum limestone member of the Catahoula sandstone, Eargle [11]) is placed at the top of the first pale grayish-white to cream-colored limestones or light-grays and gray dolomites below the sands, silts and clays of the upper Catahoula. *Miogypsina sp.* and *Heterostegina sp.* are common in these carbonates, *Heterostegina texana* being used as the marker fossil for the Heterostegina limestone in this report.

The Heterostegina limestone member of the Catahoula formation consists predominantly of pale grayish-white to cream-colored limestones. The limestones are chalky coquinoid and calcarenitic fossiliferous and rarely sandy. The coquinoid and calcarenitic limestones are generally quite porous. Subordinate amounts of light-tan, pale-gray and light-gray and gray aphanitic to very finely crystalline dolomites and fossiliferous dolomites and light-gray and pale-gray slightly calcareous variably fossiliferous clays and silty clays are present in the Heterostegina zone. Phosphatic shell material is generally noted in association with the light-gray and pale-gray dolomites. The clays associated with the Heterostegina limestone increase in amount toward the northwestern one-third of the County. In the Ryan and Anderson, Inc. No. 1 J. J. Newman Lumber Company in sec. 9, T. 1 S., R. 8 W., a 40 foot sequence of clays separates limestones of the Chickasawhay formation from the limestones of the Heterostegina. The clays in the basal portion of the Heterostegina limestone section expand partially at the expense of the overlying limestones.

The Heterostegina limestone was deposited during the regressive phase of the widespread transgression which ended the Oligocene period. During the deposition of the Heterostegina limestone, there were generally local areas which were subjected to at least periodic subaerial emergence. Post-lithification processes include recrystallization, cavity filling and dolomitization. Gray, light-gray and pale-gray aphanitic to very finely crystalline dolomites, the cavities filled with cream-colored to white chalky limestone, were noted in the cuttings. Some light-tan soft very finely crystalline dolomites, with good intercrystalline porosity, except where cemented by subsequent precipitation of calcite, were noted in the Heterostegina limestone sequence. The Heterostegina limestone varies from 70 to 105 feet in thickness, thickening generally to the south and west. The Heterostegina limestone averages 82 feet in thickness in George County. As mentioned previously, this average thickness is arbitrary and subject to change as additional information becomes available. The depositional contact of the Heterostegina limestone with the overlying Catahoula sandstone sequence appears to be generally conformable. At the contact, the Heterostegina limestone is overlain by either silty to sandy clays or a thin basal sandstone. In those areas where the Heterostegina is overlain directly by a basal Catahoula sandstone, the uppermost limestone beds are slightly sandy. In samples from most of the wells examined, the uppermost limestone strata shows little or no evidence of post-lithification processes.

CATAHOULA SANDSTONE

In a study of the coastal counties of the State, Brown et al.[12] arbitrarily subdivided the Miocene strata using the concept that the zones of coarse sands and gravels represent bases of formations. Their correlation lines were drawn on the basis of the above concept, except where paleontological evidence dictated otherwise.

Their concept, of placing the zones of coarse sands and gravels at the bases of formations, is used by Williams, Plate 4. The top of the Catahoula formation in this report, is placed at the base of a zone of coarse sands and pebbles, considered in this report to be the base of the Hattiesburg formation. This correlation is substantiated by a correlative zone of fairly large light-brown and light-tan variably sandy siderite concretions in the uppermost part of the Catahoula.

The basal marine section of the Catahoula formation is overlain by sediments deposited mainly in estuarine and transitional environments. These sediments consist predominantly of very fine- to coarse-grained occasionally conglomeritic sands, loosely consolidated sandstones and subordinate amounts of pale-gray and light-tan clays and silty clays. Traces of gray lignitic or carbonaceous clays and lignitic material are present in the

Catahoula sandstone sequence. Occasionally vari-colored quartz and chert pebbles are found associated with the coarser sands. A correlative zone of fairly large light-brown and light-tan sandy siderite concretions occurs in the uppermost strata of the Catahoula formation in George County. This zone of siderite concretions serves as an excellent lithologic marker.

The Catahoula sandstone varies from 310 to 440 feet in thickness, thickening generally to the south and west. This variable thickness is due, in part, to probable unconformable contacts of the Catahoula with the overlying Hattiesburg formation. Though unconformable Catahoula-Hattiesburg contacts undoubtedly exist, the writer could find no evidence that deposition was not essentially contemporaneous through the contact zone.

HATTIESBURG FORMATION

Only a limited amount of reliable subsurface information is available on the Hattiesburg formation in George County. The poor quality of the available samples and the limited amount of electrical log information available at this shallow depth leaves much to be desired in any subsurface study of the Hattiesburg.

The Hattiesburg formation consists of a 440 to 550 foot sequence of sands, silts and clays and some lignitic or carbonaceous material deposited in transitional, estuarine and interdeltaic environments. As stated previously, the homogeneous character of much of the Miocene strata in this area necessitates arbitrary correlations based on zones of coarse sands and pebbles.

The sands range in size from very fine- to coarse-grained, although for the most part, they are in the fine and medium-grained range. Some zones of loosely consolidated sandstones are present in the Hattiesburg formation. Many of the sand bodies are clayey and some contain finely divided carbonaceous or lignitic material. Some of the sands are conglomeritic, containing quartz and chert pebbles. Pebbles of generally rounded, black, polished chert, are prominent and may serve as a lithologic indicator of Hattiesburg strata, at least locally. The sands and silts range from pale-gray to light-gray and light-tan in color, depending upon the amounts of clay and carbonaceous material contained in these sediments. The silts are predominantly pale-gray and light-gray in color as they generally contain finely divided lignitic or carbonaceous material. A few thin intervals of lignitic or carbonaceous material were noted in the samples, though most of this material is found finely disseminated throughout the Hattiesburg formation.

The clays are pale-gray to light-gray and light-tan in color and generally contain some finely divided lignitic or carbonaceous material. Some of the clays are sandy and most are silty to some extent, some being quite silty. A few quite small, light-tan siderite concretions were noted as inclusions in some of these clays. The occurrence of these small siderite concretions was rare and erratic and therefore not considered correlative.

Because of the lack of sufficient subsurface data on the Hattiesburg formation, little is known about contact relationships with the overlying Pascagoula formation. While locally unconformable Hattiesburg-Pascagoula contacts may exist, deposition was probably continuous, for the most part.

OIL AND GAS POSSIBILITIES

At present, there is no oil and gas production in George County. The subsurface of George County contains many feet of porous and permeable strata (both sands and carbonate rocks) and the possibility of oil and/or gas being trapped in these sediments should not be discounted.

The many feet of porous carbonate rocks, ranging from lower Miocene to Claiborne in age are potential reservoirs of oil and gas. In the past, these carbonates have not been productive of oil and gas, however, they should be considered in future drilling programs.

The Crow Drilling Company and S. P. Borden No. 1 B. F. Green, in sec. 3, T. 2 S., R. 8 W., penetrated a 170 foot sand section in the lower half of the Midway. Surrounding wells indicate poor sand development at this horizon. This thick sand development may be a channel-type deposit, however, its limits have not been defined and its potential is relatively untested. This thick sand body, with its limited extent, near-by source beds and overlying impervious strata, is a potential reservoir for hydrocarbons.

A questionable show of gas was reported from side-wall analysis of a Lower Tuscaloosa sand, near the top of the formation, in the R. G. Copeland et al. No. 1 Pascagoula Hwd. and Lumber Company in sec. 42, T. 2 S., R. 8 W. Another questionable show of gas was noted in the top of the Lower Tuscaloosa formation in the A. R. Temple and Crow Drilling Company No. 1 A. L. Dantzler et al. in sec. 10, T. 2 S., R. 9 W.

Numerous questionable shows of oil and/or gas were reported from side-wall core analysis in the Southern Natural Gas Company No. 1 B. E. Green Estate et al. in sec. 37, T. 1 S., R. 8 W. These questionable shows ranged from the Lower Tuscaloosa through the Paluxy. The most promising show of oil was from a sand at the top of the Paluxy formation which carried a light-tan oil stain.

To the west, in Pistol Ridge and Maxie fields (Pearl River and Forrest Counties), oil and/or gas are produced from the Wilcox, Eutaw, Tuscaloosa, Washita-Fredericksburg and Paluxy horizons. Under favorable structural and stratigraphic conditions, these same horizons may prove productive in George County.

The Citmoco Services, Inc. No. 1 Roy T. Boteler in sec. 19, T. 2 S., R. 4 W., Mobile County, Alabama, drilled to a total depth of 12,814 feet, with no detailed information being released. It was rumored that four or five zones in the Washita-Fredericksburg were tested, however, no details of these tests have been released. [13]

To the northeast, at Citronelle Field, in Mobile County, Alabama, oil is produced from several horizons in the Lower Glen Rose sediments. Only one well, the Southern Natural Gas Company No. 1 B. E. Green Estate et al. has tested Lower Glen Rose sediments in George County. Although no shows of oil or gas were noted in these sediments, this one deep test should not condemn this horizon in future drilling programs.

Two deep tests, to the west of George County, encountered hydrogen sulfide gas in the Smackover formation. These tests are located along the Wiggins anticline, part of which, extends through George County. In the early 1950's, the George Vasen No. 1 Fee in sec. 9, T. 2 S., R. 11 W., Stone County, Mississippi, encountered hydrogen sulfide gas at 20,300 feet.[14] No production was established from this zone. More recently, the Phillips Petroleum Company No. 1 Josephine "A," in sec. 35, T. 1 S., R. 10 W., Perry County, Mississippi, discovery well of Black Creek Field, tested hydrogen sulfide gas from a thin zone in the Smackover.[15] The hydrogen sulfide content of the gas in the No. 1 Josephine "A" is reported to have been 75% and is regarded as the highest concentration ever tested. Technical problems have delayed production, however, tests indicate that the well is capable of producing 47 long tons of sulfur per day.[16]

The writer regards the Smackover formation as the most promising horizon for future exploration of hydrocarbons within the County. With improved production techniques, the present market demand for sulfur and anticipated reserves should offset the cost of exploration at 20,000+ feet.

Recently, Pan American Sulfur Company acquired 50% interest in the No. 1 Josephine "A" well, as well as, a 50% interest in a lease on 100,000 acres in southern Mississippi. Pan American Sulfur Company will join Phillips in further evaluation of these properties and indicated that additional drilling will start soon.

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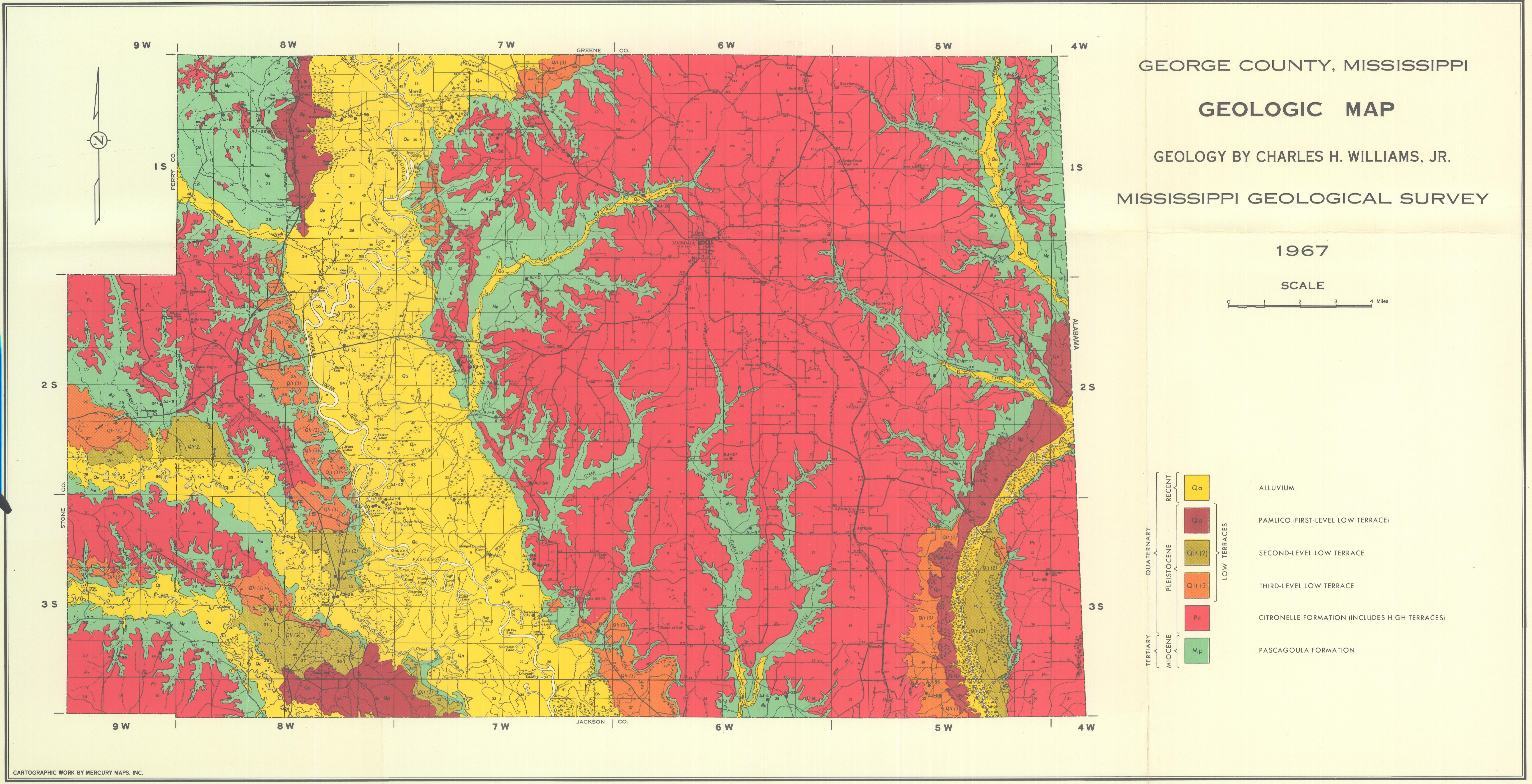
MISSISSIPPI GEOLOGICAL, ECONOMIC & TOPOGRAPHICAL SURVEY
WILLIAM HALSELL MOORE, DIRECTOR

BULLETIN 108
PLATE 1 (WILLIAMS)



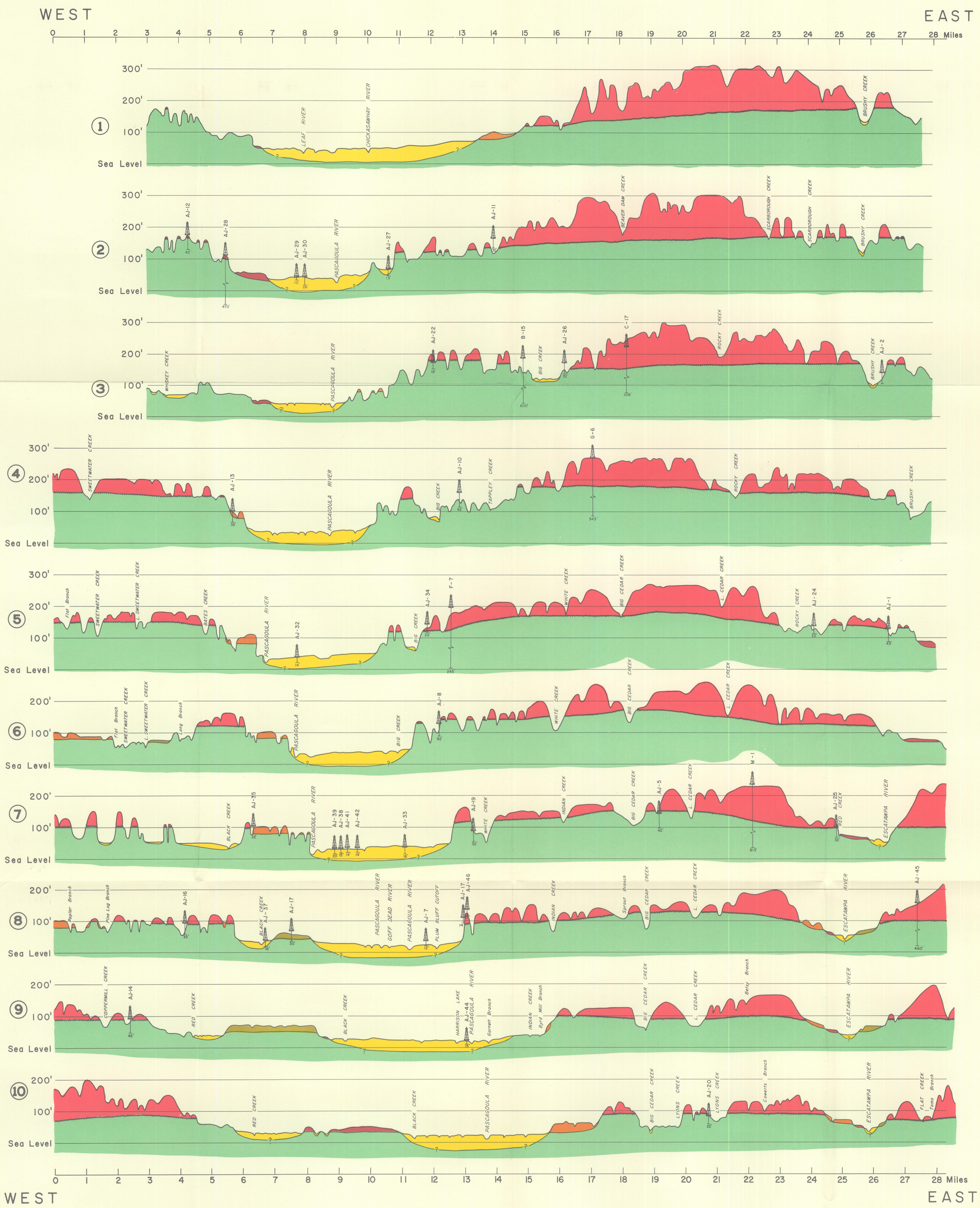
GEORGE COUNTY, MISSISSIPPI

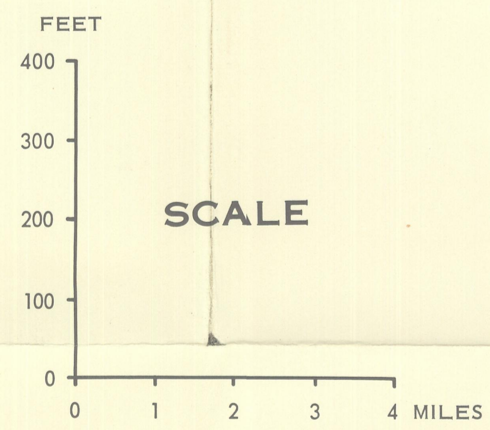
EAST - WEST CROSS SECTIONS

GEOLOGY BY CHARLES H. WILLIAMS, JR.

MISSISSIPPI GEOLOGICAL SURVEY

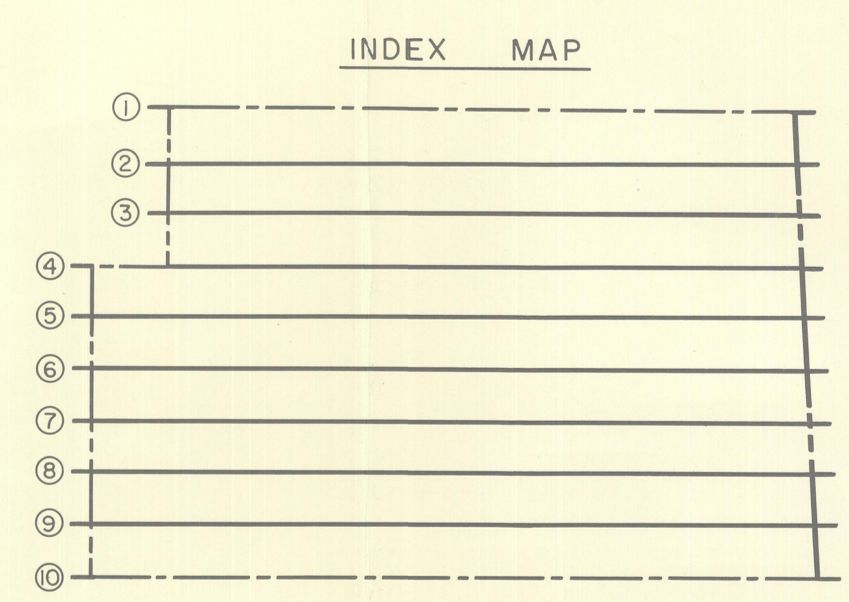
1967

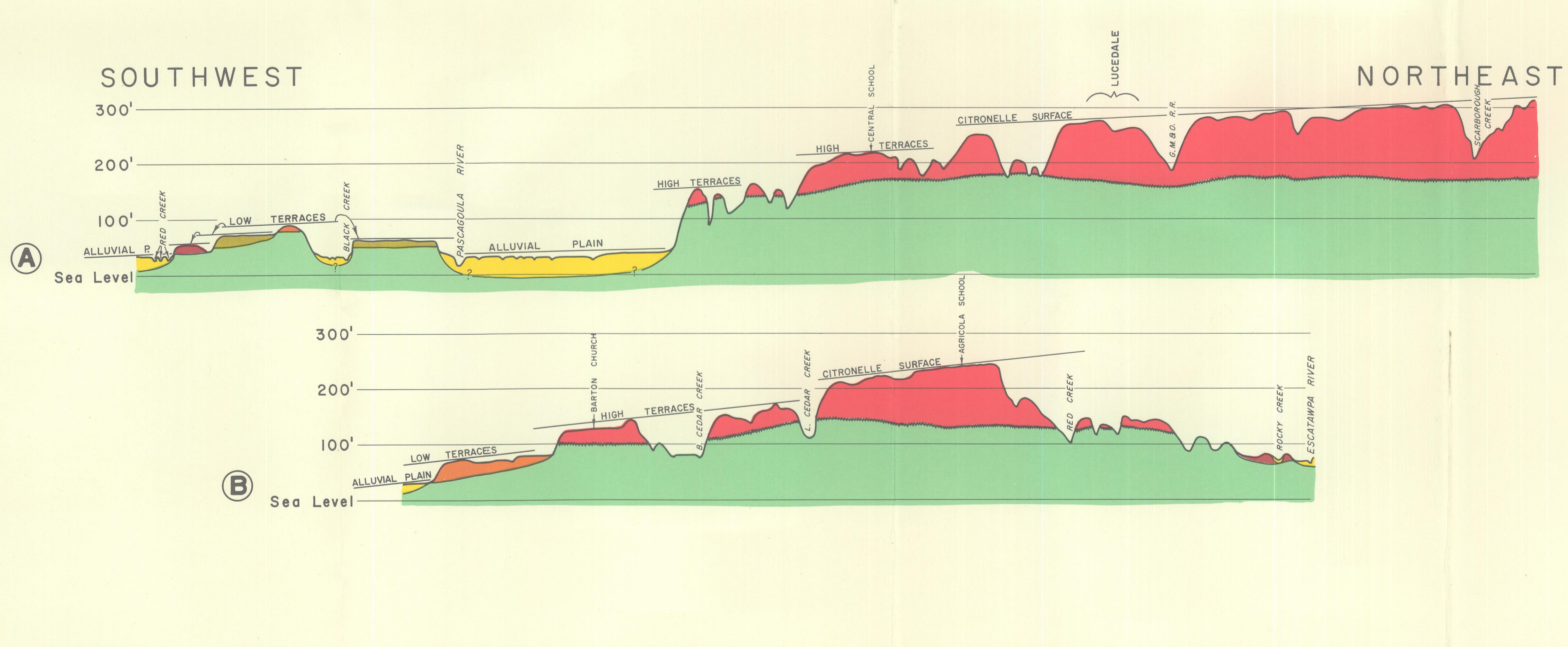




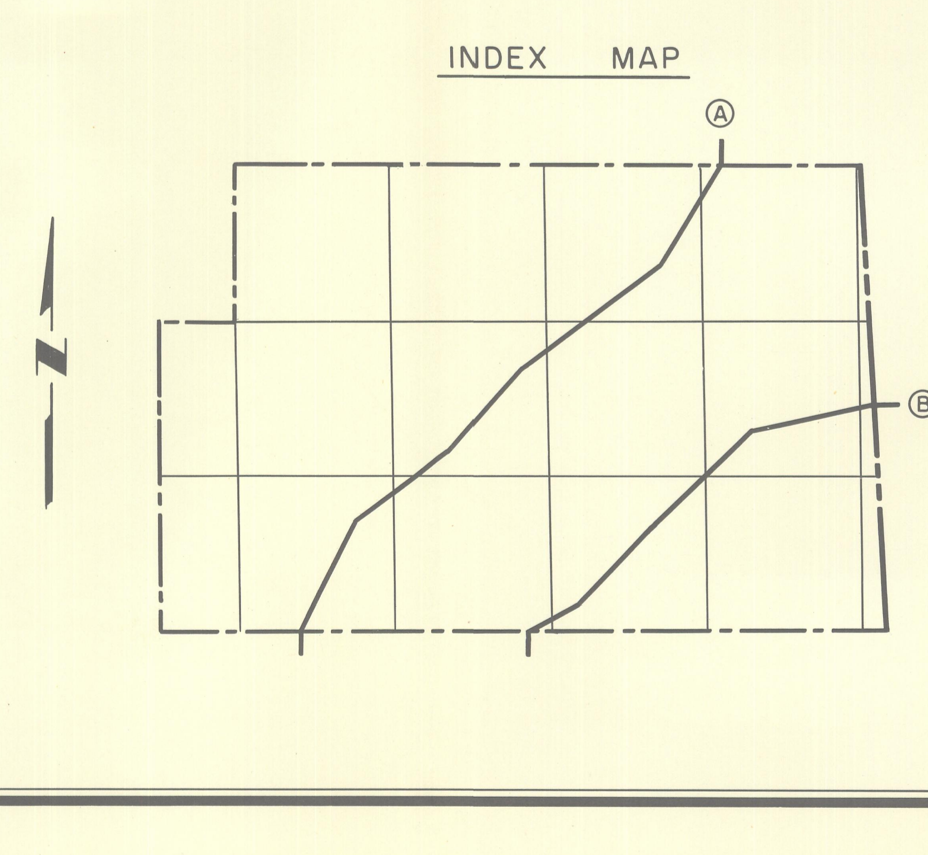
QUATERNARY	RECENT	Qa	ALLUVIUM
	PLEISTOCENE	Qp	PAMLICO (FIRST-LEVEL LOW TERRACE)
		Qlt (2)	SECOND-LEVEL LOW TERRACE
		Qlt (3)	THIRD-LEVEL LOW TERRACE
		Pc	CITRONELLE FORMATION (INCLUDES HIGH TERRACES)
TERTIARY	MIOCENE	Mp	PASCAGOULA FORMATION

LOW TERRACES (Qp, Qlt (2), Qlt (3))





NORTHEAST - SOUTHWEST CROSS SECTIONS



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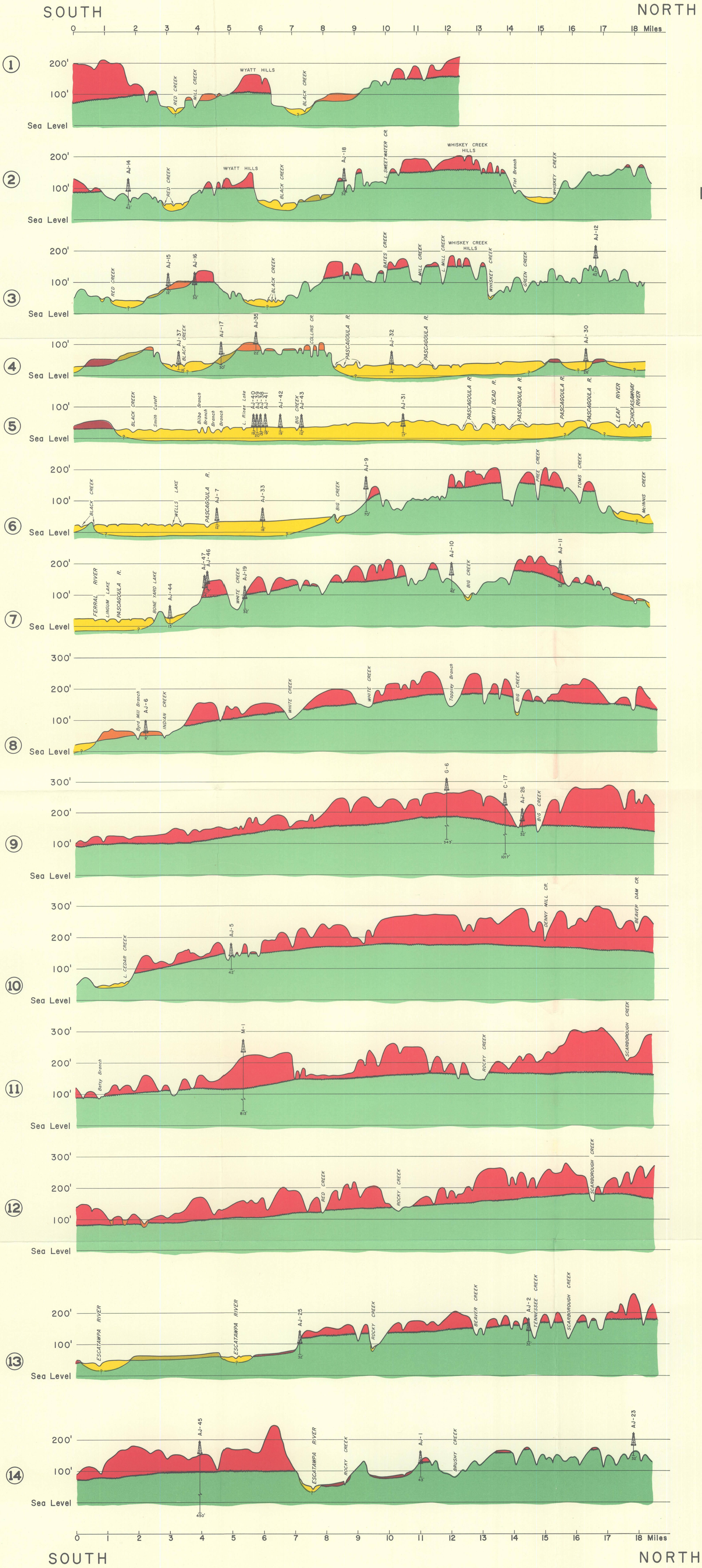


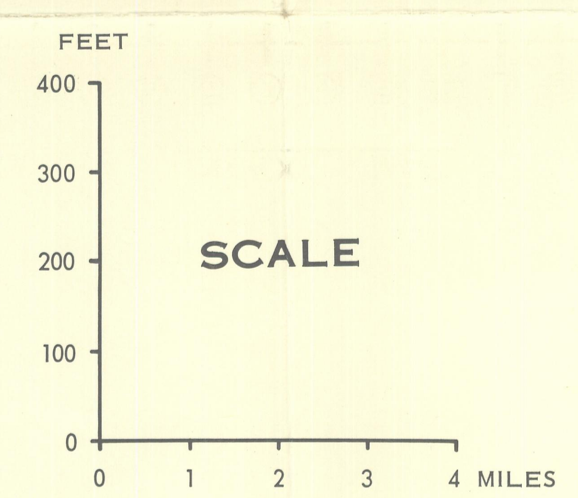
GEORGE COUNTY, MISSISSIPPI

NORTH - SOUTH CROSS SECTIONS

GEOLOGY BY CHARLES H. WILLIAMS, JR.

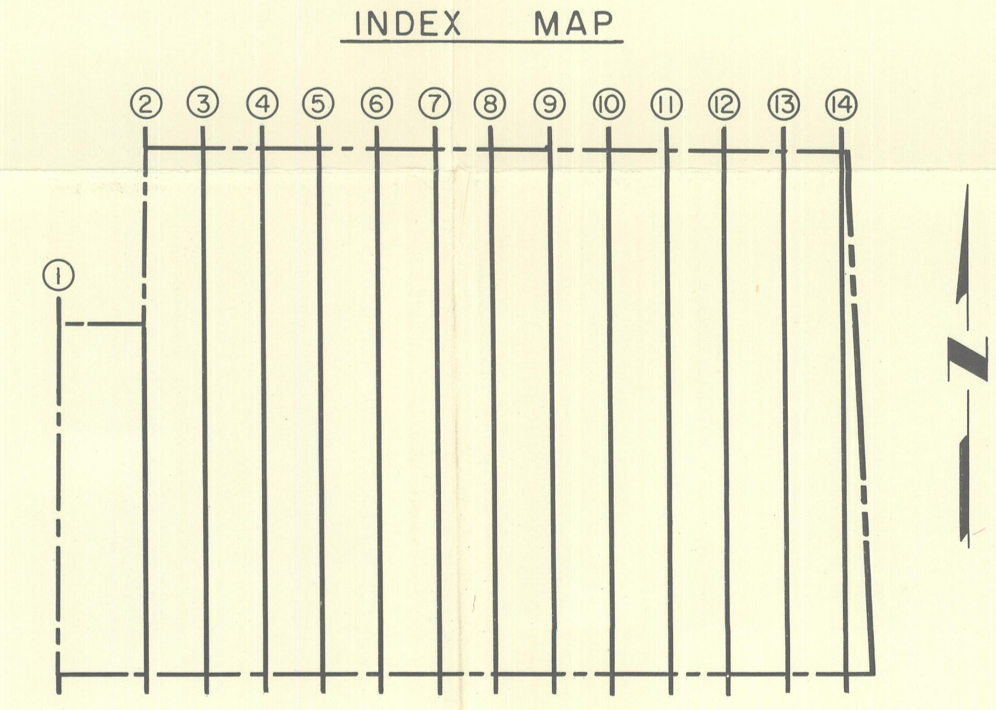
MISSISSIPPI GEOLOGICAL SURVEY

1967



QUATERNARY	RECENT		Qa	ALLUVIUM
	PLEISTOCENE	LOW TERRACES	Qp	PAMLICO (FIRST-LEVEL LOW TERRACE)
			Qlt (2)	SECOND-LEVEL LOW TERRACE
			Qlt (3)	THIRD-LEVEL LOW TERRACE
			Pc	CITRONELLE FORMATION (INCLUDES HIGH TERRACES)
TERTIARY	MIOCENE		Mp	PASCAGOULA FORMATION

INDEX MAP



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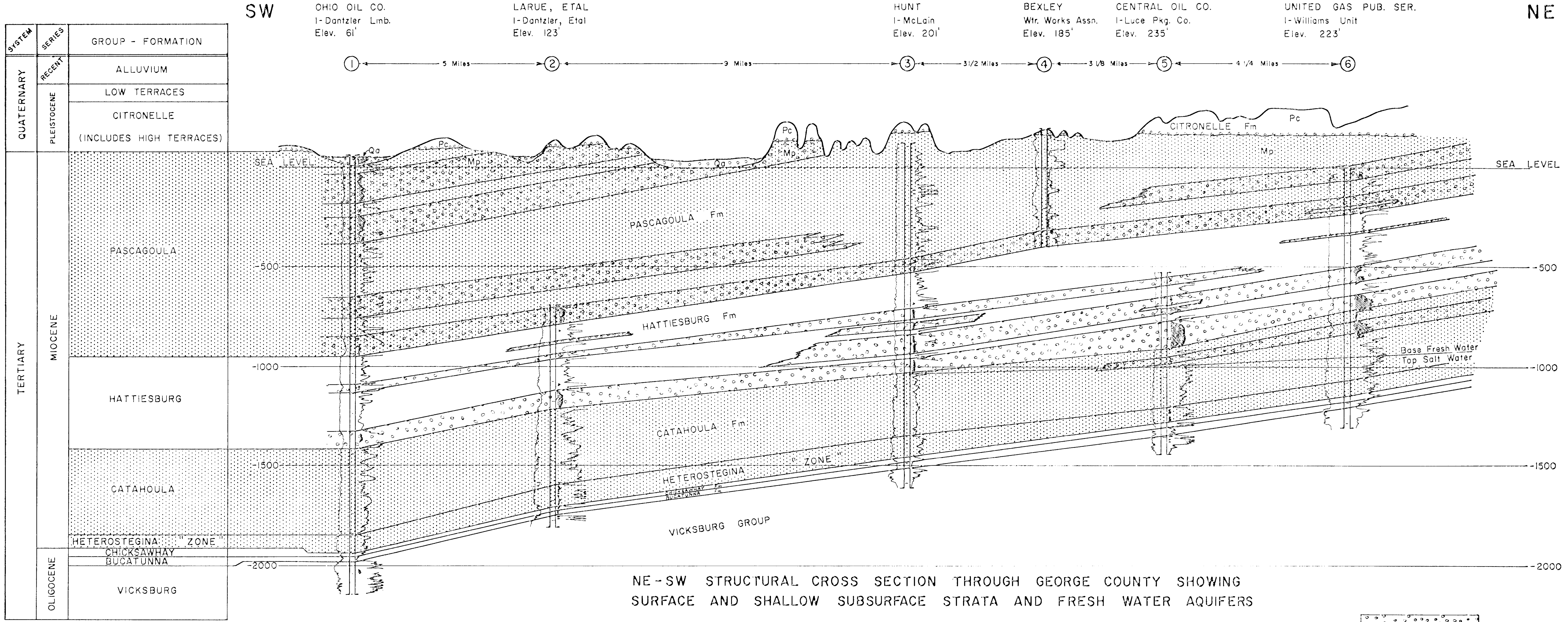
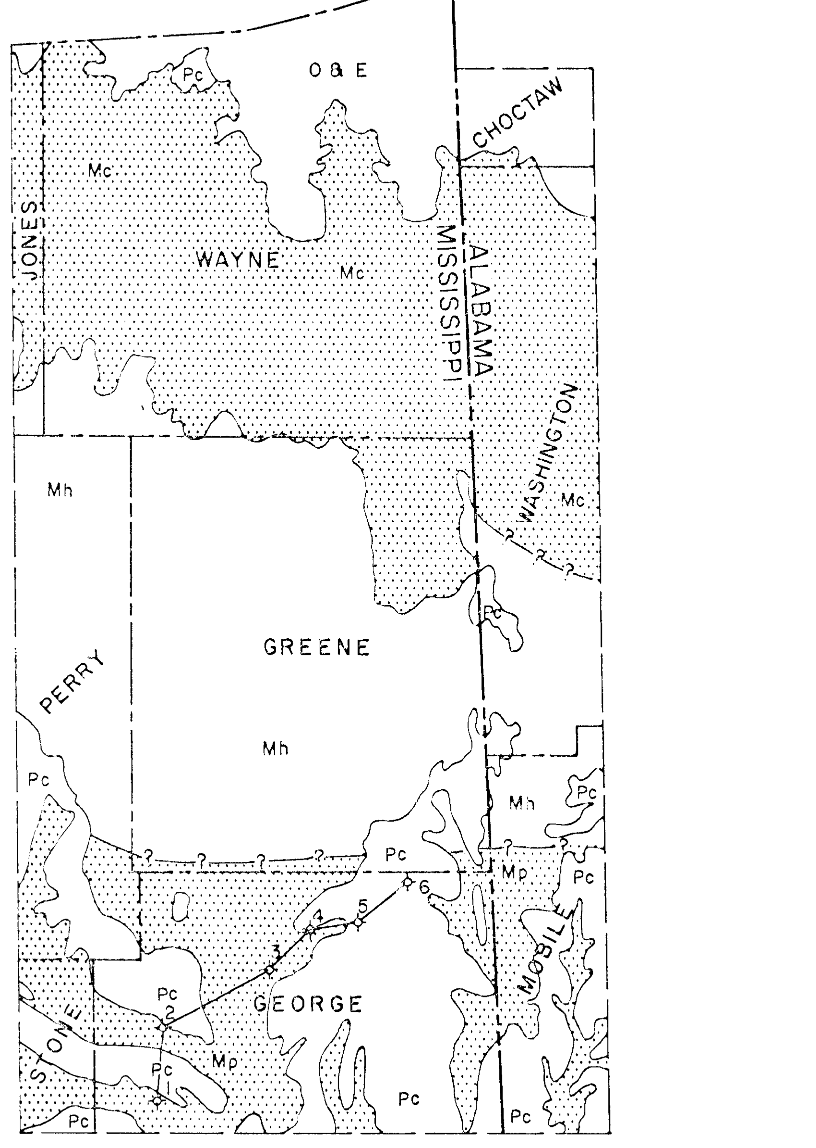


NE-SW STRUCTURAL CROSS SECTION THROUGH GEORGE COUNTY SHOWING SURFACE AND SHALLOW SUBSURFACE STRATA AND FRESH WATER AQUIFERS

SCALE
0 1 2 3 4 5 Miles

VERTICAL SCALE 1/4" = 100'

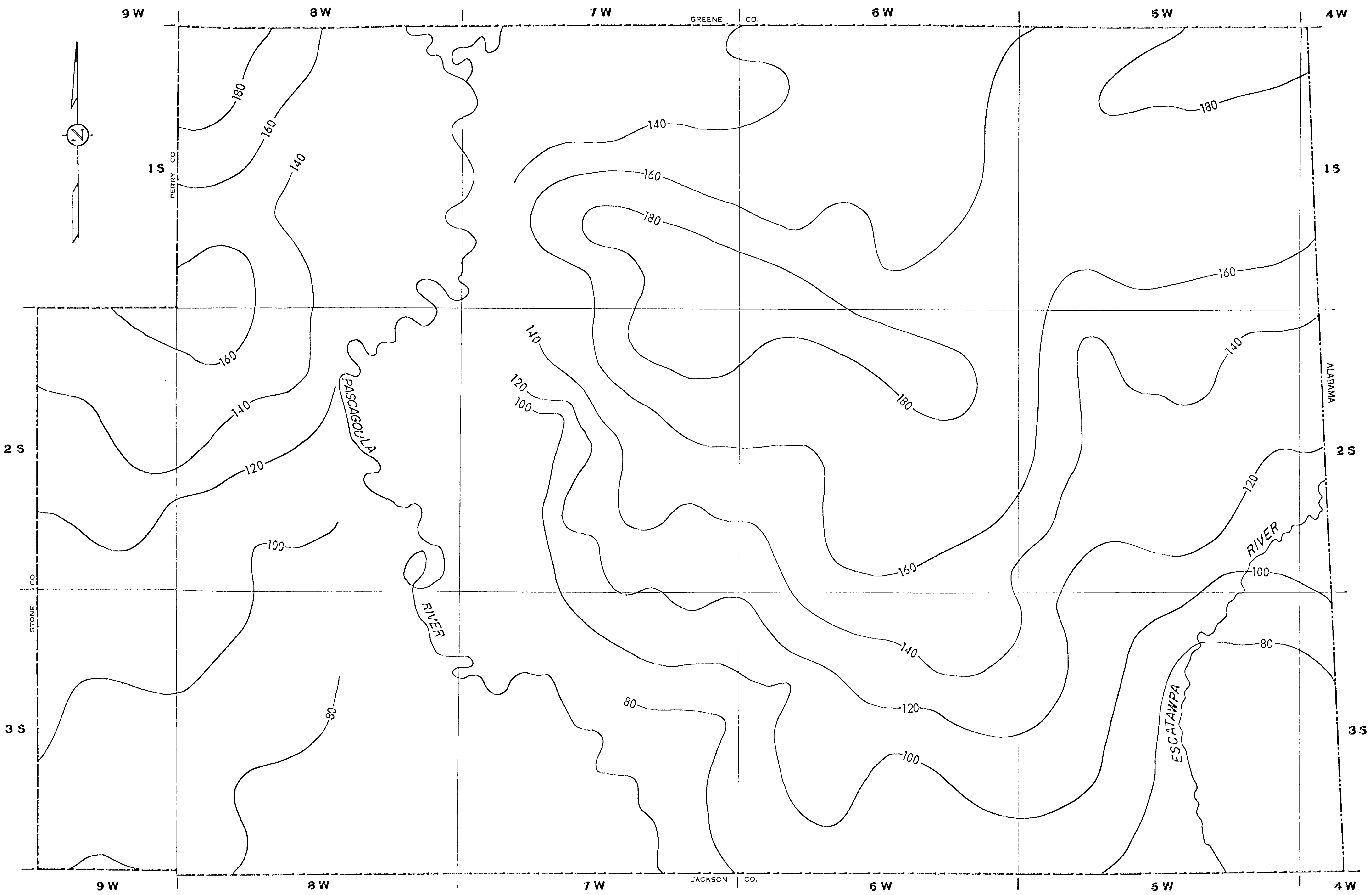
Fresh Water Aquifers



COMPILED FROM MISS. GEOL. SUR., 1966; MISS. GEOL. SOC., 1945; USGS, 1946

SURFACE OUTCROP MAP EXHIBITING CATCHMENT AREAS FOR GEORGE COUNTY AQUIFERS & LINE OF SECTION

Scale
10 0 10 20 30 40 Miles



GEORGE COUNTY, MISSISSIPPI

STRUCTURE MAP

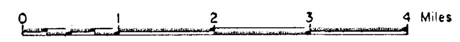
DATUM BASE OF CITRONELLE FORMATION

CONTOUR INTERVAL 20FT.
GEOLOGY BY CHARLES H. WILLIAMS, JR.

MISSISSIPPI GEOLOGICAL SURVEY

1967

SCALE



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98. Geologic Study Along Highway 25 from Starkville to Carthage: Tracy W. Lusk. 48 pp., 15 figs., 3 pl., 1963. $1.00
This is the fourth in a series of geologic studies made by the Survey along State Highways. Beds from Upper Cretaceous to Middle Eocene are profiled and described.

99. Attala County Mineral Resources: William S. Parks, et al. 192 pp., 32 figs., 6 pl., 12 tables, 1963. $2.00
The report contains additional sections: Attala County Ceramic Tests, by Thomas E. McCutcheon; Attala County Subsurface Geology, by William H. Moore; and Water Resources of Attala County, Mississippi, by B. E. Wasson.

100. The Mississippi Geological Survey, A Centennial: Contains: Report of a Geological Reconnaissance of Parts of the Counties of Yazoo, Issaquena, Washington, Holmes, Bolivar, Tallahatchie, Coahoma, Mississippi During the Months of October and November, 1870, by Eugene A. Smith; History of the Mississippi Geological Survey, by Ephraim N. Lowe; Memorial to Ephraim N. Lowe (1864-1933), by William C. Morse; Address at Recognition Dinner Honoring Dr. W. C. Morse and Prof. F. E. Vestal, upon their Retirements, by Frederic F. Mellen; Memorial to William Clifford Morse, by Franklin E. Vestal; Employment in the Mining Industry in Mississippi, by William T. Hankins; The Present Course of the Mississippi Geological Survey by Frederic F. Mellen and William S. Parks; The Survey's enabling act; List of State Geologists; Index to Bulletins 1-99, by William S. Parks. 183 pp., 32 figs., frontispiece. 1963. $2.00

101. An Investigation of Iron Ore of Mississippi: Marshall K. Kern, 77 pp., 11 figs., 6 tables, frontispiece. 1963. $1.00
Numerous test holes were drilled and many chemical analyses were made. A summary is given of ore produced and sold in the past and of the one smelting operation in 1913 at Winborn.

102. Mississippi Geologic Research Papers - 1963: Contains: Regional Stratigraphy of the Midway and Wilcox in Mississippi, by Edward H. Rainwater; Late Pleistocene and Recent History of Mississippi Sound Between Beauvoir and Ship Island, by Edward H. Rainwater; and Geology of Northeast Quarter of the West Point, Mississippi Quadrangle, and Related Bentonites, by Thomas F. Torries. 98 pp., 22 figs., 22 graphic logs, 3 tables, 1 plate. 1964. $1.00

103. Survey of Lightweight Aggregate Materials of Mississippi; Geology by William S. Parks; Economics by Clyde A. McLeod; and Tests by Allan G. Wehr. 115 pp., 18 figs., 10 tables. 1964. $2.00

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105. Hinds County Geology and Mineral Resources: by William H. Moore, and others. The report contains additional sections: Hinds County Structural Geology: by Alvin R. Bicker, Jr.; Hinds County Water Resources: by Alvin R. Bicker, Jr., et al; Hinds County Clay Tests: by Thomas E. McCutcheon; and Hinds County Mineral Industries: by William S. Parks. 244 pp., 82 Figs., Plates, tables and a surface geologic map in color. 1965. $3.00

106. Sediments and Microfauna off the Coasts of Mississippi and Adjacent States: Charles F. Upshaw, Wilgus B. Creath and Frank L. Brooks. 127 pp., 97 figs., plates and tables. Two plates in color. 1966. $2.00.

107. Claiborne County Geology and Mineral Resources: by Alvin R. Bicker, Jr. and others. The report contains additional sections: Subsurface Stratigraphy of Claiborne County: by Theo H. Dinkins, Jr.; Structure: by Charles H. Williams, Jr.; Claiborne County Tests: by Thomas E. McCutcheon. 177 pp., 74 Figs., Plates, tables and a surface geologic map in color. 1966. $2.00.