Copiah County
Geology and Mineral Resources

ALVIN R. BICKER, JR.

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BULLETIN 110

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

March 17, 1969

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

Gentlemen:

I hereby transmit to you Bulletin 110 of the Mississippi Geological Survey, "Copiah County Geology and Mineral Resources," by Alvin R. Bicker, Jr., and others.

The cooperation of the Copiah County Board of Supervisors made possible this comprehensive study of Copiah County's mineral resources by allowing us to utilize the talents and facilities of testing laboratories and ceramic engineers. Combined with the excellent surface, subsurface and ground-water studies by the Survey Staff, this additional data adds much to the knowledge of Mississippi geology and will be another aid to the further development of Copiah County resources.

Respectfully submitted,

William H. Moore
Director and State Geologist

COPIAH COUNTY GEOLOGY AND MINERAL RESOURCES

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COPIAH COUNTY GEOLOGY

ALVIN R. BICKER, JR.

ABSTRACT

Copiah County is located in south central Mississippi. It is located in the Gulf Coastal plain physiographic province. The County ranks seventh in size within the State having an area of 781 square miles.

Geological units exposed at the surface are parts of the Miocene series of the Tertiary system and the Pleistocene and Recent series of the Quaternary system. The oldest unit exposed is the Catahoula formation. Other units at the surface listed in ascending order are the Hattiesburg formation of the Miocene series, the Citronelle formation, stream terraces and loess of the Pleistocene series. Strata of the Recent series is represented by stream terrace and alluvium.

Surface determination of structure is indefinite. Near surface beds show southward regional dip. Several anticlinal structures are apparent in the western part of the County. Five shallow piercement type salt domes are located within the County.

Surface rocks and minerals of economic importance include clay and natural clay mixtures for brick and tile manufacture, and sand and gravel for road building and the construction industry. Salt production is a possibility at one of the shallow salt domes.

INTRODUCTION

This report is the result of a combined geological and hydrological investigation of Copiah County, Mississippi. The purpose of the investigation was two-fold. First, an interpretation of the geology of the County and an appraisal of its potential mineral resources; second, to provide comprehensive data on the ground-water resources.

Field work for the investigation commenced in January 1967 and was concluded September 1968. Geological data collected show the character, distribution, and thicknesses of the various surface units and of the possible surface expression of subsurface structures which may affect these units. Special attention was given a search for materials of possible economic importance. Eight test holes were drilled in order to gain stratigraphic, lithological and hydrologic information. Eleven test holes were cored to obtain samples for various laboratory tests. Hydrologic data collected consisted of identification of aquifers, inventory of existing water wells, pumping tests and chemical analyses of potable water.

In addition to test holes drilled by the Survey, electrical logs and samples of water wells and oil test holes were used to supplement the data obtained through field investigation.

PREVIOUS INVESTIGATIONS

No comprehensive geologic report has been prepared for Copiah County, however, certain aspects of the geology and mineral resources have been the subject of various previous investigations.

Wailes[1] in 1854 discussed the Miocene strata which he found exposed along White Oak Creek and Bayou Pierre in northern and western Copiah County. Wailes called this strata Grand Gulf Sandstone. He briefly mentions the gravels he found in the locality as belonging to the Diluvium or Northern Drift.

Harper[2] in his report on the geology of the State in 1857 briefly records strata exposed in Copiah County. His discussion is restricted mainly to the Pebble Stratum which he considered to be Miocene.

Hilgard[3] in 1860 published the first comprehensive report on the geology of the State. He cites a number of outcrops in Copiah County. He named the Miocene outcrop the Grand Gulf Group and placed the terrace materials in his Orange Sand formation.

Logan[4] in 1908 gave a brief summation of the stratigraphy and clay industry in the County. In 1911 Logan[5] reported on the gravel found within the County.

Lowe[6] in 1919 and 1925 made revisions and corrections of his earlier report on the geology of the State. In these reports he included references to parts of Copiah County.

The United States Geological Survey has published a number of bulletins and professional papers that included some references to the geology of Copiah County. The Water Resources Division of the United States Geological Survey has published several reports concerning the water resources of the County.

DESCRIPTION OF THE AREA

LOCATION AND SIZE

Copiah County located in southwestern Mississippi, lies within the parallels 31°40′ and 32°05′ north latitude and the meridians 90°05′ and 90°45′ west longtitude. The County is a rectangular area containing some 499,840 acres or 781 square miles. It ranks seventh in area among the counties of the State. The County has a maximum north-south extent of 24 miles and a maximum east-west extent of 37 miles. The County is bounded on the north by Hinds County, on the east by Pearl River and Simpson Counties, on the south by Lawrence and Lincoln Counties and on the west by Claiborne and Jefferson Counties.

Figure 1.—Location of Copiah County.

ACCESSIBILITY

Copiah County enjoys a favorable location 18 to 52 miles south of Jackson. A modern interstate highway and other hard surfaced roads connecting the County with the State Capital gives the County accessibility to a large metropolitan area which serves as a market for products produced and offers employment to a number of County residents.

Interstate 55 and U. S. Highway 51 traverses the County from north to south connecting the centers of population with Jackson on the north and New Orleans, Louisiana to the south. State Highway 27 enters the County near the center of the northern boundary, proceeds southeastward to Crystal Springs and Georgetown then south along the eastern edge of the County.

State Highway 28 provides an east-west route across the County. The highway enters the eastern part of Copiah County near Georgetown, proceeds westward to Hazlehurst then to the southwest corner of the County and on to Natchez.

State Highway 18 crosses the northwest corner of the County, connecting this area with Jackson to the northeast and Port Gibson and Natchez to the southwest.

A good system of County maintained roads provides access to most areas of the County. Many miles of road in this system are hard surfaced. Other roads are well maintained and are usable even in periods of excessive rainfall. Only in the remote areas where topography offers a hinderance to construction and maintenance of roads is travel difficult. Five bridges cross the Pearl River, providing accessibility to the east. From north to south, these bridges are located at the Hinds-Copiah boundary; near Gatesville in sec. 20, T. 2 N., R. 1 E.; near Hopewell in sec. 3, T. 1 N., R. 1 E.; east of Georgetown in sec. 31, T. 1 N., R. 1 E., and near Rockport in sec. 31, T. 10 N., R. 21 W. All roads servicing these bridges are hard surfaced and well maintained.

Three rail lines provide railroad transportation for the County. The Gulf, Mobile and Ohio Railroad extends from north to south along the eastern boundary of Copiah County connecting this area with Jackson and New Orleans. The Illinois Central Railroad main line crosses the County from north to south, connecting the larger towns with Jackson and New

Orleans. The Little J Branch line of the Illinois Central system closely follows the route of State Highway 18 across the northwestern corner of Copiah County serving the community of Carpenter.

POPULATION

The Mississippi Official and Statistical Register shows the 1960 census of Copiah County population to be 27,051. This figure is a decrease of 11.4% from the 1950 census figure of 30,493. Of the total approximately 39 per cent of the County's population live in towns and villages. The 1960 population of the towns and villages are as follows: Beauregard (193), Crystal Springs (4496), Gallman (100), Georgetown (285), Hazlehurst (4206), and Wesson (1157).

Other communities shown on the general highway map are Allen, Ashley, Barlow, Bowerton, Carpenter, Dentville, Gallatin, Gatesville, Glancy, Hopewell, Martinsville, Peetsville, Pleasant Hill, Rockport, Sand Hill and Stronghope.

The majority of the people, both rural and urban, reside in the eastern half of the County. Topography and transportation have been controlling factors of population distribution.

CULTURE AND INDUSTRY

Figures supplied by the Mississippi Employment Security Commission show their estimate of the 1967 annual civilian labor force to be 8120 persons. Of this figure 560 are listed as unemployed, or 6.9 per cent of the total work force, leaving a total of 7560 persons employed.

The employed are divided into three classifications: (1) non-agricultural wage and salary workers, (2) other non-agricultural (3) agricultural. The non-agricultural wage and salary group has a total of 5030 persons employed in various types of manufacturing, mining, construction, services and government. The other non-agricultural group contains 1200 employed as domestics and self-employed. The agricultural group lists 1330 persons in both wage and salaried category and self-employed.

The 1967 edition of the Mississippi Manufacturers Directory published by the Mississippi Research and Development Center lists 22 manufacturing establishments in Copiah County. Several gravel operations do not appear in the Directory and it is possible other lumber concerns are not represented. The establishments listed are engaged in manufacture of wearing apparel, food processing, lumber and wood products, furniture and fixtures, electrical machinery and components and mining.

CLIMATE

The climate of Copiah County is moderate. Rarely do temperatures exceed 100 degrees nor fall below zero. Climatological data given herein shows that for the past 10 years the average annual temperature to be 64.2 degrees. Absolute maximum of 103 degrees during the 10 year period was recorded in June 1963. Absolute minimum of minus two degrees was recorded during January 1961. Temperature extremes are of short duration, usually occurring over a period of several days.

Average annual rainfall during the same period has been 53.87 inches. The larger amounts usually occur during the winter and spring months. The largest yearly rainfall was 74.02 inches recorded in 1961. Excessive amounts occurred during both winter and summer months of 1961. Least annual rainfall occurred during 1965 when 42.20 inches were recorded. Climatological data given in Table 1 was recorded at a station located approximately four miles northeast of Crystal Springs. A station located in southwestern Copiah County near the community of Allen was not in operation during the entire 10 year period used in compiling the Table. However, temperature and precipitation data recorded at the station near Allen compare very favorably to those recorded in the northeast part of the County. These recordings show slightly lower temperature readings and rainfall amounts.

TOPOGRAPHY

Figure 2 shows the topographic map quadrangles available for Copiah County. A greater portion of the County has adequate coverage. The eastern part located in Ranges 1 and 10 East and the southern two-thirds of Township 9 North, Ranges 5, 6, 7, 8 and 9 East are mapped on the scale of 1:250,000. This scale map has a contour interval of 50 feet which results in the omission of much topographic detail.

Table 1.—Normal, Monthly, Seasonal and Annual Temperature and Precipitation at Crystal Springs, Copiah County, Mississippi.

Month	Temperature			Precipitation		
	Average	Absolute maximum	Absolute minimum	Average	Absolute maximum	Absolute minimum
	F°	F°	F°	Inches	Inches	Inches
December	48.2	80	5	5.41	9.59	1.50
January	45.3	79	—2	5.06	9.63	1.91
February	48.6	83	9	4.70	8.62	2.45
Winter	47.4	83	—2	15.17	23.97	8.79
March	56.0	86	19	4.64	11.13	1.13
April	65.7	90	29	3.69	10.88	.66
May	71.8	95	39	4.16	9.66	.81
Spring	64.5	95	19	12.49	21.80	8.43
June	77.3	103	46	5.82	9.47	1.53
July	80.2	100	50	4.64	9.24	1.80
August	79.5	100	54	2.67	12.65	1.82
Summer	79.0	100	46	13.13	21.01	8.75
September	75.2	99	36	3.58	6.06	.20
October	65.3	95	26	4.07	10.77	.05
November	57.7	86	19	5.43	9.08	.64
Fall	66.1	99	19	13.08	20.25	4.40
Year	64.2	103	—2	53.87	74.02	42.20

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, 1958 through December, 1968.

The Terry quadrangle was originally issued in 1937. This map has a scale of 1:62,500 and a contour interval of 20 feet. Other surveyed portions of the County are mapped as 7.5 minute quadrangles and were published in 1962 and 1963. These maps are on a scale of 1:24,000 and have a contour interval of 10 feet. Included in these latter quadrangles are Barlow, Crystal Springs, Dentville, Dentville N. W., Gallman, Hazlehurst, Shady Grove, Smyrna, Utica East and Utica West.

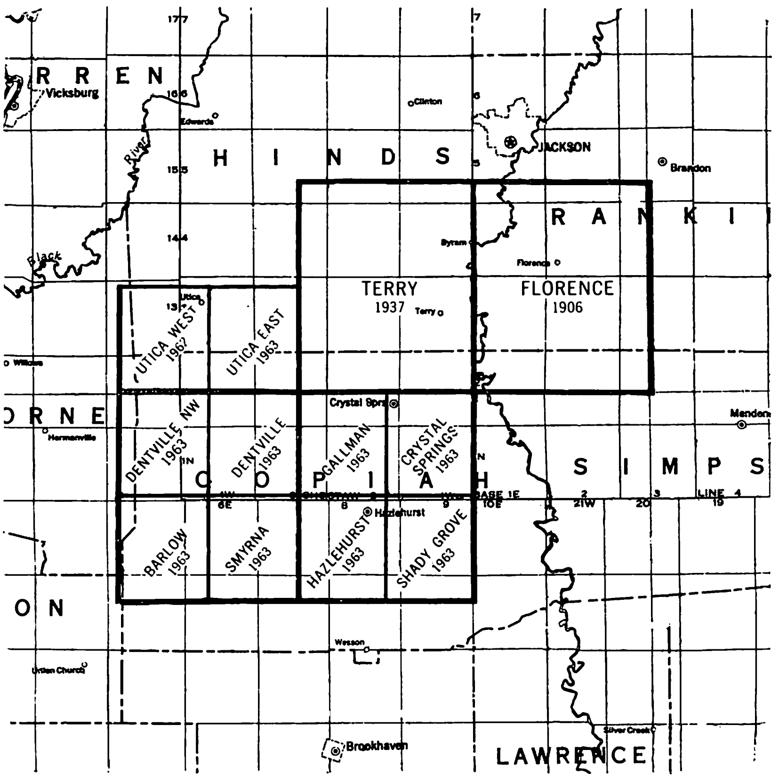

Figure 2.—Topographic map coverage of Copiah County.

Topographic maps of Copiah County and other areas of Mississippi may be secured at the offices of the Mississippi Geological Survey, 2525 North West Street, Jackson, Mississippi. An index to topographic coverage is available upon request. Orders are accepted by mail. Mailing address of the Survey is P. O. Box 4915, Jackson, Mississippi 39216.

The State of Mississippi is within the Gulf Coastal Plain Physiographic Province. The State has been subdivided into twelve districts. Copiah County is located within the Long Leaf Pine Hills or Piney Woods district, which embraces nearly all of the southern half of the State. The County can be further divided into the upland areas, intermediate or rolling hill areas and the lowland areas.

The upland area encompasses the larger part of Copiah County. Topographic features vary from rolling plains to rugged hills. Generally, elevations within the upland areas range from near 300 feet to more than 500 feet above sea level. A prominent ridge extends north and south through the east central part of the County, roughly paralleling the Illinois Central Railroad and U. S. Highway 51. This ridge separates the Pearl River and the Bayou Pierre drainage basins. Elevations along most of the divide are between 450 feet and 500 feet above sea level. However, the extreme northern end has elevations as low as 400 feet. At the northern end erosion has removed most of Citronelle material leaving only isolated remnants. The underlying Miocene strata are more resistive to erosion and present a more gentle topography.

Highest elevations in the County are located in the upland area in the Southwestern region in Township 9 North, Ranges 5, 6 and 7 East. In this area a high plain separates the Bayou Pierre and Homochitto River drainage basins. This high upland possibly represents the remains of the original Citronelle surface. The plain presents a rolling type topography bordered by steep valleys and rugged hills.

The rolling hills are products of erosion of the upland areas and are underlain by Miocene strata and some alluvial terrace materials. The most prominent rolling hill area is located in a north-south belt separating the eastern upland areas from the Pearl River alluvial plain. This type of topography has developed adjacent to the White Oak Creek alluvial plain across the northern tier of townships. Isolated rolling hills have developed near Bayou Pierre and its other tributaries. At many locations in this area rugged upland type topography borders the alluvial plains without intervening hills.

The lowland areas are composed of the alluvial plains developed by the major streams and their tributaries. Topography is mostly inclined or flat low plains with small relief features formed by abandoned stream channels, natural levees, terraces, bars, alluvial fans and other minor features formed by flooding and shifting of stream channels.

Elevations on the Pearl River alluvial plain range from an average of approximately 240 feet above sea level in the northern part of the County to about 200 feet above sea level at the Copiah-Lawrence boundary. The width of that part of the Pearl River alluvial plain located within Copiah County varies from slightly less than one-quarter mile to as much as four miles.

The alluvial plain of Bayou Pierre enters Copiah County from Lincoln County. At the point of entry the plain is at an elevation of approximately 350 feet above sea level. At the Copiah-Claiborne County boundary the plain has descended to an elevation of 140 feet above sea level. The lowest elevations to be found in the County are located at the southwestern boundary. Width of the alluvial plain varies from less than one quarter mile at its point of entry to more than two miles at the Copiah-Claiborne County boundary.

That part of the Homochitto River located in Copiah County has developed an alluvial plain of small areal extent. The plain rarely exceeds one quarter mile in width. Elevation of the plain varies from 350 to 400 feet above sea level.

DRAINAGE

Copiah County lies within three drainage basins, the Pearl River, Bayou Pierre and the Homochitto River. Approximately 427 square miles or about 55 per cent of the County is drained by Bayou Pierre and its tributaries. The Pearl River and tributaries drain about 309 square miles or 40 per cent of the County. The Homochitto River drains an area of 45 square miles in southwestern Copiah County.

The headwaters of Bayou Pierre form to the south in northern Lincoln County and the stream flows northward through west-central Copiah County. In the latitude of Township 9 North the river course turns westward and continues to the Copiah-Claiborne County boundary. Principal tributaries to Bayou Pierre are Fosters Creek, Turkey Creek, and White Oak Creek. In addition to the above there are many smaller tributaries, some of which have established base flows.

Pearl River, which forms the eastern boundary of the County, flows southward. Bahala Creek, Copiah Creek and Brushy Creek are the major tributaries of Pearl River. Numerous smaller tributaries drain into the Pearl. Many of these smaller streams have established base flows fed by springs developed in the Citronelle and terrace deposits.

Most of the Homochitto River flows in a westerly direction. Only near the Copiah-Lincoln County boundary does the river change direction and begin a southward flow.

SYSTEM	SERIES	STRATIGRAPHIC UNIT	THICKNESS (feet)	LITHOLOGIC CHARACTER
QUATERNARY	RECENT	Alluvium	0–80	Fine – to coarse–grained sand, gravel, silt and clay. Some organic material.
	PLEISTOCENE	Loess	0–8	Tan – to brown silt. In eastern Copiah County represented by weathered silt. Often referred to as brown loam.
		Pre–Loess Terraces	0–80	Fine – to coarse–grained sand. Scattered gravel. Clay lenses. Organic material.
		Citronelle Formation	0–100	Fine – to coarse–grained sand, abundant chert and quartz gravel. Clay lenses.
TERTIARY	MIOCENE	Hattiesburg	0–400	Clay, blue to brownish–gray, weathers to reddish–brown and gray mottled with purple, abundant ferruginous nodules.
		Catahoula	500–900	Clay, gray to tan; sand, fine–to coarse–grained, locally indurated; White to gray silt.

Figure 3.—Generalized section of exposed strata in Copiah County.

STRATIGRAPHY

GENERAL STATEMENT

The strata exposed at the surface in Copiah County are commonly assigned to the Miocene, Pleistocene and Recent series. Materials found at the surface are classified as clastic sediments, being composed of clay, silt, sand and gravel. These materials were deposited in deltaic, fluvial and aeolian environments. The Miocene strata generally dip to the south with minor local variations. Pleistocene and Recent sediments do not show true dip or reflect deeper subsurface dip. The oldest Miocene sediments are found at lower elevations near the Copiah-Hinds County line. Material herein assigned to the Pleistocene is found in the upland areas unconformably overlying the subjacent Miocene beds. Pleistocene and more recent sediments obscure much of the Miocene strata, therefore the total section is not exposed. A generalized section of the exposed strata is shown in Figure 3. Areal extent of the various strata can be seen on the Geologic Map, Plate 1.

MIOCENE SERIES

CATAHOULA FORMATION

The first accurate description of Miocene strata in Copiah County was made by Hilgard.[7] Although Hilgard did not place this exposed material definitely in the Miocene series, he recognized its stratigraphic position as being of later age than strata of the Vicksburg Group and younger than deposits which he called Stratified Drift.[8] He designated this material the Grand Gulf Group. Several of his observations on this later Tertiary strata within Copiah County are as follows:

> "Between Terry and Crystal Springs, ledges of white sandstone are exhibited in several cuts—generally soft, and alternating with materials still softer; the true "Grand Gulf rock" is found there also, however. It is said to be very abundant in the heads of Bayou Pierre generally.
> On the portion of Pearl River embraced in Simpson and Copiah, both gray or blue clays, and sandstone ledges, appear in several localities, both on the river banks and on the confluents. Thus on S. 27, T. 9, R. 21 W., on Pearl River, where gray and reddish gray clay occur interstratified with sandstone ledges......"

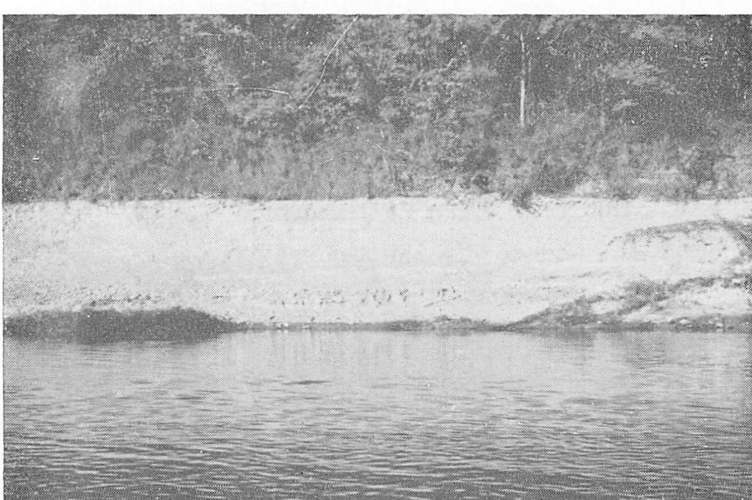

Figure 4.—Silty Catahoula clay exposed in bank of Pearl River. Alluvium at this location only a few feet thick. Location in SE¼, sec. 4, T. 1 N., R. 1 E. October 1967.

L. C. Johnson in 1893 discussed his observations of the Miocene strata in Mississippi.[9] He concurred with Hilgard's age of the Grand Gulf in that it should be Miocene. He further recognized two additional phases of the Grand Gulf group, subdividing the Grand Gulf into four phases. (1) the quartizitic phase, (2) the silicious phase or Ellisville phase, (3) less silicious or Hattiesburg phase and (4) the Pascagoula phase.

The name Catahoula was first introduced by Veatch[10] in 1905 for exposures of Miocene strata he observed in Catahoula Parish, Louisiana, which is located directly west of the type locality of the Grand Gulf of Hilgard. Veatch proposed the name as a replacement for the lower part of the Grand Gulf group which he considered to be encumbered with too many younger formations.

In Copiah County outcrops of the Catahoula formation are found in the northern two-thirds of the County. In much of its outcrop area the Catahoula is overlain by the Citronelle, other terrace materials, alluvium and loess.

In Copiah County the Catahoula formation consists predominantly of clays and silts. Sands and sandstones are present in lesser amounts. Carbonaceous material is noted in the form of lignitic clays. On the outcrop the clay is from buff to gray in color. At many outcrops the lighter colored clays are mottled with limonitic staining. In the banks of the Pearl River between Georgetown and Rockport, the interstratified clay and sandstone are red in color, due no doubt to some hydrous oxide of iron. The unweathered clay in the subsurface may vary from gray to brown in color. The clays are commonly massive, but locally may be interstratified with silts and/or sands. Most of the clay contains varying amounts of silt or sand, but several outcrops have thin beds of clay that appear to be free of sand or silt.

Sands found within the Catahoula formations are present as lenses or discontinous beds. Those exposed at the surface are locally cemented to form sandstones of varying degrees of hardness. The exposed sands and sandstones are generally gray in color, however, at some localities the exposed sandstone has a distinctive white color which is imparted to the sandstone by interstitial kaolinitic material. Dense sandstone can be found

Figure 5.—Catahoula clay exposed in roadcut. Location in NW¼, sec. 4, T. 10 N., R. 7 E. July 1968.

at scattered localities within the outcrop belt. The indurated sandstones are undoubtedly a product of weathering and are presumed not to extend below the zone of weathering. During field investigations no indurated sands were found in unweathered material. The sands found during test hole drilling were poorly cemented or totally unconsolidated. The sands are composed mostly of quartz grains with some black chert grains and heavy minerals. Pyrite grains and flakes of mica are common to a number of sand bodies. Thickness of the sand bodies varies from a few inches to over two hundred feet. In test holes drilled the thickest body of sand penetrated was eighty-eight feet. Test Hole AK-21, located in sec. 1, T. 10 N., R. 2 W., penetrated a sand body between the depths of 232 feet and 320 feet. Electrical logs of oil test wells record sand bodies more than two hundred feet thick with small clay stringers. Sand bodies observed on the outcrop were limited to only a few feet in thickness.

The entire thickness of the Catahoula formation cannot be observed at the surface in Copiah County. The lower contact with the Vicksburg group is found to the north in Hinds County and at the northern boundary of Copiah County the thickness of the Catahoula is approximately 500 feet.

The formation thickens to the south and near the southern border it attains the maximum thickness of approximately 875 feet. The electrical log of the Sun Oil Company No. 1 McIntosh in sec. 35, T. 9 N., R. 8 E., shows 870 feet of strata that is possibly Catahoula. Sample examination of the well cuttings from this interval shows material that is characteristic of the formation. Numerous exposures of the Catahoula formation can be observed in the road cuts in the northern part of the outcrop area. Some of the better and more accessible outcrops can be found along Highway 27 between Crystal Springs and Georgetown. Excellent exposures are found along Bushy and Copiah Creeks near the lower reaches of the streams. The formation can be observed almost continuously along the banks of the Pearl River during low water periods.

The contact of the Catahoula formation with strata of the subjacent Vicksburg group can not be observed at the surface within the confines of Copiah County, and due to the depth of this contact only one test hole was drilled deep enough to penetrate the Catahoula-Vicksburg contact. The contact in surrounding counties has been discussed in previous reports. Some of the earlier reports disagree as to whether the contact is conformable or unconformable. The author agrees more with later reports in which results of more intensive investigations support the findings of the author. Moore [11] observing the contacts at the surface and in cores in Hinds County stated that the contact appeared to be conformable in some localities where there may be no distinguishable break between clays of the upper Vicksburg group and those of the overlying Catahoula. However, at other localities he found abrupt changes in lithology and in places unusually thin upper Vicksburg sections. Moore called the contact disconformable. Mellen [12] stated that in Warren County abrupt changes in lithologies existing between the Vicksburg and Catahoula is conclusive evidence of unconformable relationship. The writer [13] discussed a number of unconformable contacts shown in the records of test holes drilled in Claiborne County.

As stated previously, only one test hole penetrated the Catahoula-Vicksburg contact. Data obtained from this test is not sufficient to allow a determination of the relationship between the formations. A number of electrical logs of oil test wells were available for study. Only one of these logs shows a departure from what may be considered normal depositional sequence. The log of the Kinard No. 1 Smith located in sec. 27, T. 12 N., R. 5 E., shows a portion of the upper Vicksburg section to be missing. Although it may be presumptuous to state that the Catahoula-Vicksburg contact is unconformable in Copiah County using only data from the above well it is pointed out that available data is widely dispersed about the County and that the same stratigraphic conditions could exist in other areas. In view of the fact that the contact is unconformable to the north in Hinds County and to the west in Claiborne County the writer must term the Catahoula-Vicksburg contact unconformable in Copiah County.

The contact between the Catahoula formation and overlying strata may be varied. In much of its outcrop area the Catahoula is overlain by the Citronelle formation or terrace deposits of younger age. All of these contacts are unconformable. The Catahoula-Hattiesburg contact poses a different problem. Other writers discussing the Catahoula-Hattiesburg contact have termed the contact both conformable and nonconformable. Veatch[14] called the contact between the Catahoula and the overlying

Figure 6.—Catahoula clay overlain by loess. Location in NE¼, sec. 31, T. 2 N., R. 4 W. July 1968.

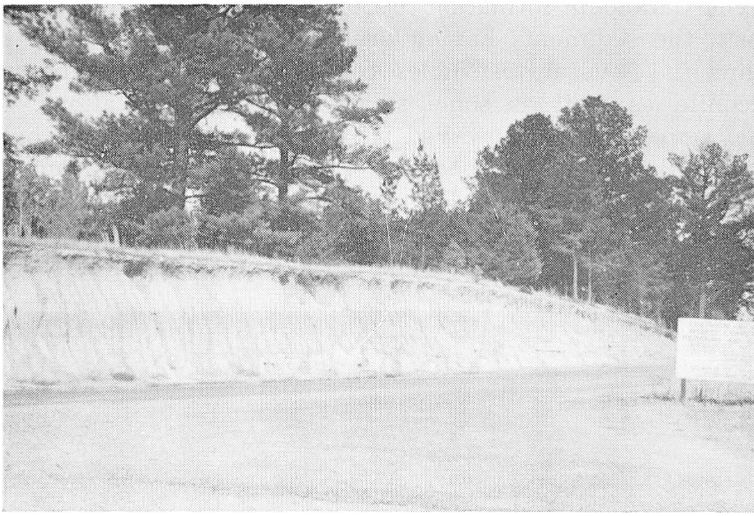

Figure 7.—White kaolinitic Catahoula sandstone overlain by loess. Sandstone is at roadbed level. Location is in NW¼, NE¼, sec. 32, T. 10 N. R. 4 W. July 1968.

Fleming formation conformable. Matson[15] in his paper on the Catahoula sandstone called the contact with the overlying Hattiesburg formation conformable. Foster[16] indicates a small unconformity between the Catahoula and Hattiesburg formations in Forrest County.

In Copiah County no actual contact of the Catahoula and Hattiesburg formations was observed. The contact was covered by surficial material or so obscure that it could not be located. However, core hole data and several outcrops indicate the possibility of a basal sand within the Hattiesburg. Figure 10 shows a roadcut outcrop located in the NW/4, NE/4, SW/4 of sec. 5, T. 9 N., R. 5 E. At this outcrop Hattiesburg clay containing ferruginous nodules overlies a two foot section of gray, medium-grained, indurated sandstone. Several hundred feet north of this outcrop and at a thirty foot lower elevation, white, kaolinitic sandstone of the Catahoula formation is visible in the road bank. The writer believes that the gray, indurated sandstone present at the base of the outcrop shown in Figure 10 is a basal Hattiesburg sand and represents a slight unconformity between the Catahoula formation and the overlying Hattiesburg formation.

The Catahoula formation in Copiah County is a non-marine deposit, the sediments having been deposited in a deltaic environment. Several test holes contained rare occurrences of glauconite as well as some small siderite concretations. No faunal remains were observed within the formation in Copiah County. Berry [17] described the flora he observed from the Catahoula. He reported *Palmoxylon cellulosum*, a specie of palm wood from the Bayou Pierre near the Claiborne-Copiah County boundry. Hilgard [18] reported a profusion of fossil wood,

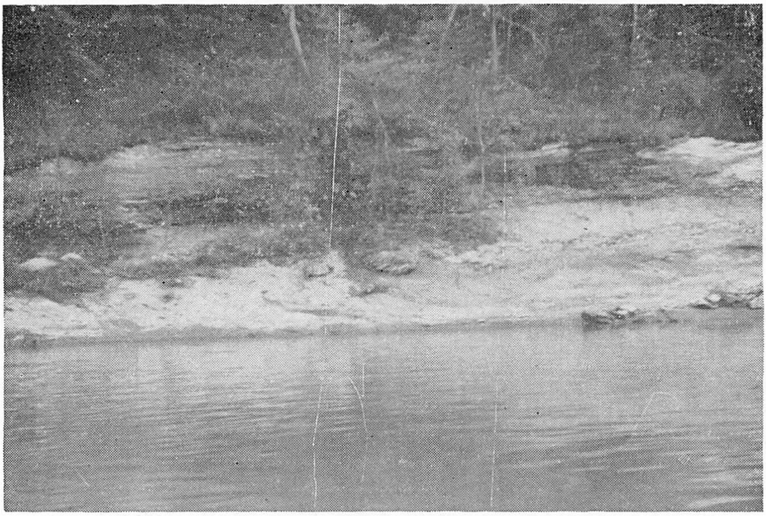

Figure 8.—Silty Catahoula clay exposed in east bank of Pearl River. Parts of silified log exposed near center of photograph. Location in SE¼, sec. 6, T. 2 N., R. 1 E. October 1967.

remains of dicotyledons, conifers and palm wood, from different localities in the State. Figure 8 shows fossil logs embedded in the Catahoula formation in the east bank of the Pearl River in the SE/4 of sec. 6, T. 2 N., R. 1 E. Fossil wood can also be found in the valley of White Oak Creek, however, the origin of the fossil wood found in this area has not been established.

HATTIESBURG FORMATION

The name Hattiesburg was first used by Johnson [19] in 1893 for that part of the Grand Gulf group exposed at Hattiesburg, Mississippi. Johnson considered the formation at Hattiesburg less silicious than that part of the formation exposed near Grand

Gulf. In Copiah County the outcrop area of the Hattiesburg formation is limited to the southern one-third of the County. At its northern limits the formation is found at the higher surface elevations. In a large part of the outcrop area the Hattiesburg is overlain by the Citronelle formation, other terrace materials, loess and surficial material.

The formation as exposed at the surface consists mainly of silty clays with minor amounts of sand. In the weathered surface exposures the clays are predominantly tan to moderate reddish brown in color. However, some dark-gray to greenish-gray clays can be observed. Unweathered material obtained from core holes show the Hattiesburg to contain clays that are gray, grayish brown and blue. The blue clay weathered rapidly to a greenish-gray color.

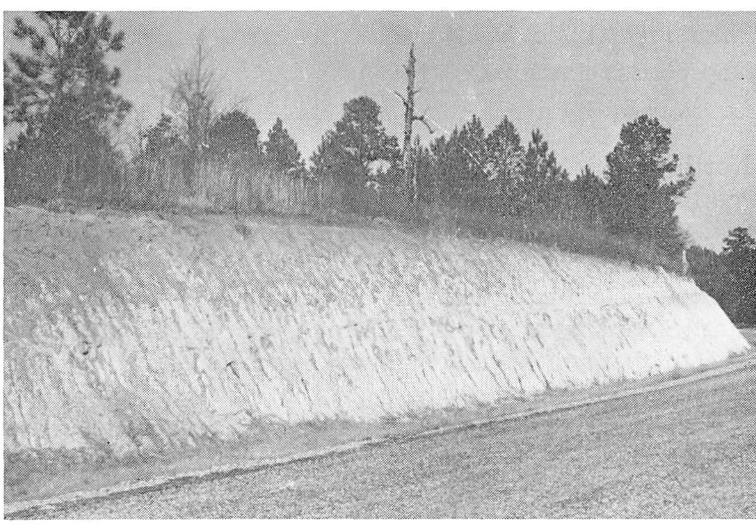

Figure 9.—Hattiesburg clay exposed at road intersection in SE¼, SE¼, sec. 5, T. 10 N., R. 5 E. July 1968.

At some surface exposures ferruginous concretions are abundant. At a road intersection of a recently completed county road located in the NW/4, SE/4, SW/4, of sec. 5, T. 9 N., R. 5 E., twelve feet of Hattiesburg clay is exposed which contains numerous concretions. The clay is tan in color and the concretions appear as bright to dark-red, rounded or spherical clay balls. Some of the clay balls at or near the surface of the outcrop had been weathered for a sufficient period of time to have begun oxidization. The surface of the concretions were in various stages of alteration to limonite. The clay matrix surrounding the concretions had been stained for a distance of several inches. Color of the staining was various shades of red. The predominant reddish brown colors observed in the Hattiesburg formation in Copiah County may originate in this way. Chemical analysis of the clay ball concretions which were collected in fresh or unoxidized condition show the following constituents:

Silicon Dioxide (SiO_2)	65.81%
Aluminum Oxide (Al_2O_3)	12.05%
Ferric Oxide (Fe_2O_3)	17.50%
Magnesium Oxide (MgO)	0.14%
Sodium Oxide (Na_2O)	0.02%
Potassium Oxide (K_2O)	0.03%
Phosphorus Pentoxide (P_2O_5)	0.10%
Loss on Ignition	4.35%

North of this outcrop approximately two-tenths of a mile the Hattiesburg is exposed in the road bank. The weathered surface of this exposure is almost covered with concretions. The concretions have been exposed for a sufficient length of time to have completely altered to limonite. Vestal[20] reported the Hattiesburg formation in Adams County to contain dense concretions that appear to be impure iron carbonate that oxidizes to limonite. Williams[21] states that the Hattiesburg formation in Forrest, Perry and Greene Counties was reddish brown and light chocolate in color. Personal communications with Williams indicate abundant limonite concretions within the Hattiesburg formation in these counties, similar to the concretions found in Copiah County.

The thickness of the Hattiesburg formation in Copiah County varies from zero along the updip limit to a maximum of 400 feet at the southern border of the County. An oil test drilled in 1956, located in sec. 35, T. 9 N., R. 8 E., near the town of Wesson, penetrated 400 feet of sediments that are assigned to the Hattiesburg formation. This thickness compares favorably with that obtained by calculating the thickness of the formation using a projected dip from known near surface dips.

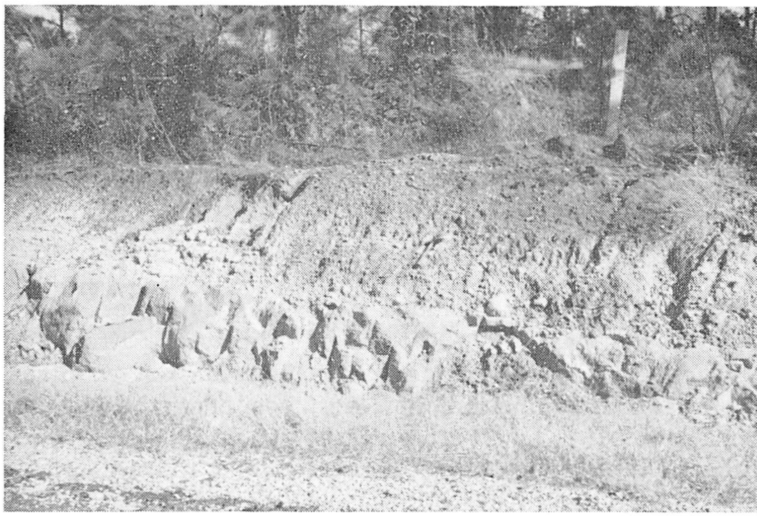

Figure 10.—Hattiesburg sandstone overlain by silty clay. Numerous ferruginous concretions occur in the clay. Location is NE¼, SW¼, sec. 5, T. 10 N., R. 5 E. July 1968.

The contact of the Hattiesburg with the underlying Catahoula was discussed previously. The strata overlying the Hattiesburg may be Citronelle or younger. The contact is an abrupt change from clays of the Hattiesburg to silt, sand, gravels and clays of the Citronelle or later terrace deposits. The contact is covered in most localities by soils or colluvium and is not easily observed. One of the better outcrops where the contact can be observed is located in the NW/4, NE/4, NW/4 of sec. 5, T. 9 N., R. 8 E. At this location the road bed descends from a ridge formed by Citronelle deposits to rolling topography underlain by Hattiesburg sediments. The contact lies at an elevation of 410 feet and is located near the base of the hill.

In Copiah County the Hattiesburg formation is essentially a non-marine deposit. The type of sediments show that they were deposited in a near shore environment much like those of the Catahoula formation. No faunal fossils were observed in the Hattiesburg of Copiah County. The writer did not observe any floral fossils, however, the presence of lignite and organic material in the samples of core tests show the probability of such existence. Berry [22] reported the presence of *Palmoxylon mississippense, Palmoxylon remoyum,* and *Palmoxylon ovatum,* species of palm wood, in the Miocene sediments of Adams County. This fossil flora is undoubtedly from the Hattiesburg formation.

CITRONELLE FORMATION

The Citronelle formation was named by Matson[23] for exposures at Citronelle, Mobile County, Alabama. He proposed the name as a replacement for a portion of the deposits formerly classified as Drift, Orange Sand and Lafayette. Matson felt that the older names included deposits that were older and younger than those of the Citronelle. The term Citronelle has been an acceptable formation name since Matson proposed it. The age of the formation, however, has been the subject of much debate. It is not the purpose of this report to review the arguments as to a Pliocene or Pleistocene age for the formation. The writer favors an early Pleistocene age and hereby assigns the Citronelle to that period for this report.

Citronelle deposits cover approximately thirty per cent of the surface of Copiah County. The formation originally covered the entire surface of the County. Subsequent erosion has since removed the formation from many areas, leaving the upland plains and divides capped by the formation.

Figure 11.—Cross-bedded Citronelle sand and gravel. Location at gravel pit in SE¼, SE¼, sec. 31, T. 2 N., R. 1 W. March 1968.

The formation is predominantly sandy with local lenses or layers of clay and gravel. Where present the gravels are usually concentrated near the base of the formation and decrease generally upward through the section. Exceptions are found, however, most notably in the deposits near Crystal Springs which are being heavily mined. At this locality gravels occur throughout the formation. This condition undoubtedly exists at other localities within the County and suggests that at the time of deposition these areas were in the vicinity of principal drainage.

Figure 12.—Quartz boulder in Citronelle deposits. Location near center of sec. 29, T. 2 N., R. 3 W. July 1968.

The colors of the Citronelle deposits in Copiah County are varying shades of red. In exposures which have not been subjected to much weathering or affected by circulation of iron rich ground water the colors are lighter shades of red and a distinctive pink. Consequently, where the formation consists chiefly of sand weathering has been more effective and the circulation of ground water greater causing the formation to be a deeper shade of red. The predominance of darker colors of orange and red led to the early designation of the formation as the "Orange sand."

Gravel found within the formation is generally composed of chert with smaller percentages of quartz. The pebbles exhibit varying degrees of roundess from sub-angular to well-rounded. The pebble material is a poorly sorted aggregate that ranges from granule size to cobble size with frequent occurrences of material that is of boulder size. This boulder size material sometimes appears to be erratic as some boulders are sandstone. The chert gravel contains many fragments of corals, crinoid stems and other remains which indicate a Paleozoic origin.

Thickness of the Citronelle formation in Copiah County varies from a few feet to a maximum of approximately one hundred feet. Generally, the thickness is governed by the topography of the eroded Citronelle surface. Local variations may occur, however, due to the unconformable contact of the formation with the underlying Miocene. The thickest section is found along the divide between the Pearl River and Bayou Pierre drainage basins where surface elevations approach 500 feet above sea level. Comparable thicknesses should be found in the southwest portion of the County where similar surface elevations exist.

As noted above the contact of the Citronelle formation with subjacent strata is unconformable. In the northern and central part of the County the Citronelle overlies the Catahoula. Southward the formation rests on strata of Hattiesburg age. Generally, the contact is sharp where the Citronelle overlies clays of either the Catahoula or Hattiesburg formations. At some localities difficulty in identifying the contact may arise where the Citronelle overlies sands of Miocene age. In these areas microscopic examination of the sands is necessary to identify the age of the material. Generally, the Miocene sands can be identified as being more sub-angular, having a different clay mineral association and a greater heavy mineral grain concentration.

In localities where the Citronelle overlies clay, ferruginous sandstone or siltstone can be observed in the basal part of the formation at or near the contact. On surface outcrops the material was observed in the form of layers a few inches thick. Water well drillers report numerous occurrences of iron rock or iron stone within the basal zone. Some of these reports show thicknesses of the iron rock to reach a maximum of four feet. These ferruginous concentrations are not limited to the Citronelle formation. The author found similar material in the basal section of other terrace deposits in Copiah and surrounding counties.

The Citronelle formation is overlain by loess and loessal soils. In the southwestern part of the County four to six feet of highly weathered loess can be found overlying the Citronelle. The contact is unconformable and is easily identified on a fresh exposure. Several good exposures were observed in recently excavated road cuts along State Highway 547 in sec. 11, T. 9 N., R. 5 E. Eastward the loess becomes thinner and weathering has reduced the silt to residual soils locally called brown loam.

The base of the Citronelle formation is found at elevations ranging from approximately 375 feet to 430 feet above sea level. The lower elevations are found in the northeast part of the County in the vicinity of Crystal Springs and the higher elevations are found near the southern boundary of the County. This suggests northward inclination of the base of the Citronelle. On a structure map constructed with the base of the Citronelle as a datum, Doering [24] shows an embayment in the Pearl River Valley which could account for the lower elevations near Crystal Springs. In the western part of the County sufficient contacts were not observed to ascertain accurately the inclination of the base. Observations made indicate the base to be nearly level in this area of Copiah County. The writer suggests that the northward flow of Bayou Pierre possibly indicates post depositional uplift near the southern border of Copiah County which raised the base of the Citronelle from an original southward inclination to its present near horizontal position.

PRE-LOESS TERRACE DEPOSITS

Sand and gravel deposits not mapped as Citronelle or as recent alluvial deposits are designated as pre-loess terrace deposits. Moore [25] mapped a number of these deposits in Hinds County and introduced the term of pre-loess terrace deposit. The writer used the same term for similar deposits in Claiborne County. Criteria for designation of these deposits as pre-loess terraces in these two adjoining counties was based mainly on elevations of the deposits. In Copiah County elevations alone cannot be used to distinguish the deposits from the Citronelle formation. At some localities, terrace deposits herein identified as pre-loess terraces have comparable elevations to the Citronelle deposits and the two deposits may even adjoin. At these locations pre-loess terraces were identified by their depositional and lithological characteristics.

The pre-loess terrace deposits are apparently directly related to stream and stream valley development. Composition of the deposits indicates that materials were derived from nearby sources. These deposits consist of sands, gravels, silts and clays. At the higher levels materials forming the terrace deposits are mainly sands with minor amounts of gravel. These gravels are similar in character to the materials found in the Citronelle formation from which the terrace materials were derived. Figure 13 shows a pre-loess terrace deposit overlying Miocene strata and abutting Citronelle deposits. Location of the outcrop is in the SW/4 of sec. 32, T. 1 N., R. 1 W. Elevation of the base of the terrace deposit is 380 feet above sea level. Composition of the deposit is almost entirely sand with some silty and ferruginous

Figure 13.—Pre-loess terrace overlying Catahoula clay. The pre-loess terrace abuts Citronelle deposits near the right one-quarter of photograph where the Catahoula clay disappears at road bed level. Location in NE¼, SW¼, sec. 32, T. 1 N., R. 1 W. 1966.

material included. The fresh exposure of the pre-loess terrace differs greatly in appearance from the Citronelle material that adjoins it. The pre-loess terrace shows definite bedding with well sorted sand whereas the Citronelle formation is composed of a heterogeneous mixture of sand, silt and gravel. That part of the exposure identified as pre-loess terrace is described as follows:

	Feet	Feet
Loessal soil		1
silt	1	
Pre-loess terrace deposits		18.5
silt, tan, sandy with some gravel	1	
sand, medium-to coarse-grained in alternating light and dark colored layers 2 to 3 inches thick	15	
sand, medium-grained, yellow, massive	2	
sandstone, ferruginous, thin beds 2 to 6 inches thick	0.5	
Miocene (Catahoula formation)		12
clay, light to dark gray silty	12	

Figure 14.—Pre-loess terrace overlain by loess. Note cross-bedding in terrace. Location is roadcut in SE¼, NW¼, sec. 24, T. 1 N., R. 4 W. July 1968.

Figure 15.—A portion of pre-loess terrace composed of white, sandy silt derived from Miocene strata. Location is in SE¼, NW¼, sec. 24, T. 1 N., R. 4 W. July 1968.

In pre-loess terrace deposits located at progressively lower elevations, material derived from exposed Miocene strata can be found interbedded with material derived from the Citronelle formation. Figure 14 shows a section of a pre-loess terrace deposit exposed in a road cut in the NW/4 of sec. 24, T. 1 N., R. 4 W. Elevation of the outcrop is approximately 300 feet above sea level. In this outcrop material derived from Miocene strata can be observed interbedded with Citronelle material and grading laterally into each other.

LOESS

A thin mantle of loess or loessal soils covers all but the extreme eastern part of Copiah County. The loess or its weathered equivalent "brown loam" thins eastward. Maximum thicknesses are found in the upland areas near the Copiah-Claiborne County boundary. In this area thicknesses of 8 feet were found.

All loess observed in Copiah County has a tan to reddish-brown color. The color is imparted by the weathering or oxidizing of iron minerals. The loess consists chiefly of quartz with varying amounts of clay, iron minerals, calcite, dolomite and feldspar. The constituents are all silt size particles within the range of 0.05 to 0.005 millimeter in diameter. Mineral composition of the loessal soils or brown loam varies more than the loess. In areas of thin loess the underlying materials greatly influence soil development.

Although there are many species of pulmonate gastropods, land snails, present in the loess in Hinds and Claiborne Counties, none were observed in Copiah County.

In the western part of the County contacts of the loess with the underlying formation are sharply defined. The contact in this area is disconformable. To the east in the area of thin soils the contact of the brown loam with the underlying formations is gradational in many localities and is a result of colluviation.

ALLUVIUM

All the larger streams and their major tributaries have developed extensive alluvial plains. The alluvium consists of discontinuous beds of clay, silt, sand and gravel. The beds are generally stratified with the larger material near the base overlain by sand, silt and clay.

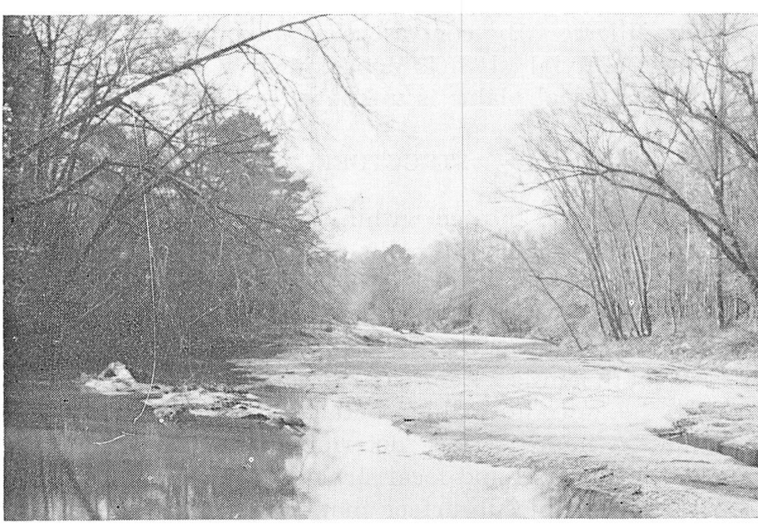

Figure 16.—Gravel choked stream bed of Foster Creek, a major tributary of Bayou Pierre. Location in NW¼, NW¼, sec. 16, T. 1 N., R. 4 W. July 1968.

The alluvial plain of the Pearl River is the largest within the County in areal extent. That part of the plain in Copiah County varies from less than one-quarter mile to more than four miles in width with the average width being approximately two miles. Thickness of the alluvial plain varies. Miocene strata crop out in many localities in the stream channel. Some of the outcrops extend continuously for long distances indicating that bedrock is near the surface. Tributaries of the Pearl River have alluvial plains that vary from approximately one-quarter mile to one mile in width. The gradients of the tributaries are very steep and near the upper parts of the streams the thickness of the alluvial plains may exceed that of the Pearl River alluvial plain.

The alluvial plain of Bayou Pierre averages more than one mile in width. Maximum width rarely exceeds two miles. Thickness of the Bayou Pierre alluvial plain is greater than that of the Pearl River Plain. Reports from water wells drilled within the Bayou Pierre alluvial plain show that the maximum thickness is as much as 75 feet. The major tributaries of Bayou Pierre are Foster Creek and White Oak Creek. The alluvial plains of the tributaries vary. White Oak Creek plain attains a maximum width of more than two miles near its confluence with Bayou Pierre. By contrast the maximum width of the Foster Creek alluvial plain is approximately one mile. Thickness of these alluvial plains is unknown.

STRUCTURE

Copiah County is located within the Mississippi interior salt basin, south of the Jackson uplift and east of the axis of the Mississippi embayment. Regional dip of the surface strata is to the south with local variations to the southeast and southwest. Magnitude of the dip of the surface strata is approximately 40 to 50 feet to the mile. Lenticularity of the exposed Miocene strata and the unconformable contact of the overlying Citronelle formation make surface determination of dip impossible. Therefore, the regional and local structural determinations were made with the use of subsurface maps.

Structure maps were prepared using the following as mapping horizons. The datums listed in ascending order are the

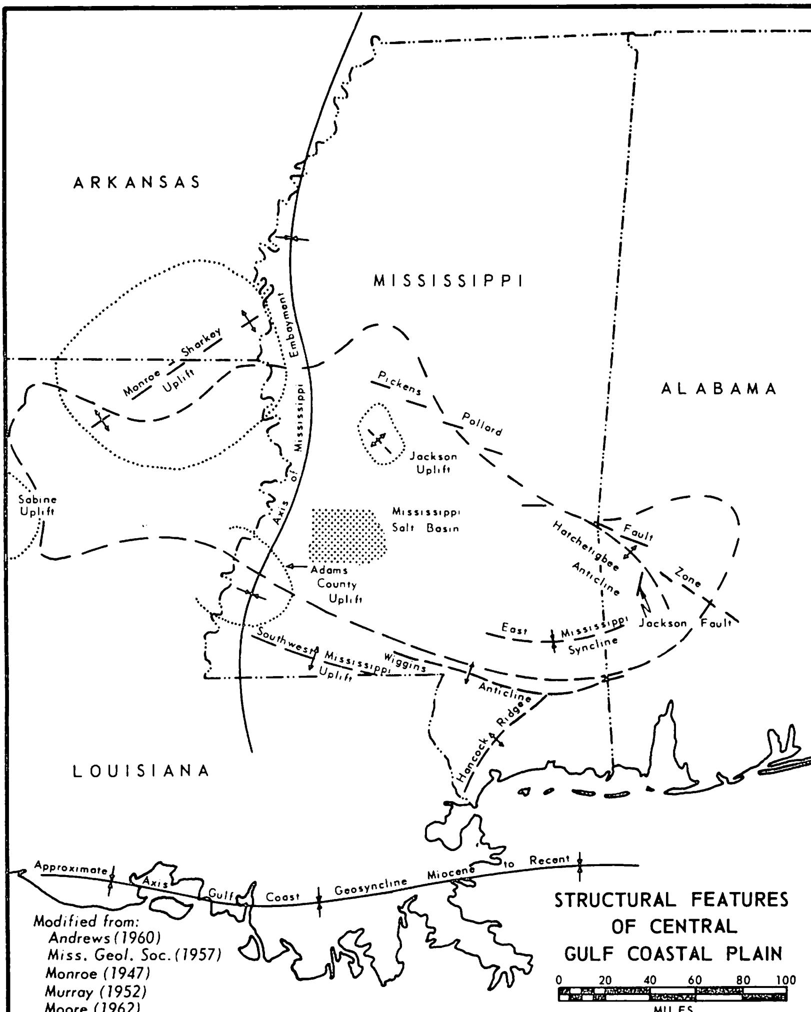

Figure 17.—Structural features of Central Gulf Coastal Plain. Copiah County shown as stipled area.

Top of the Lower Cretaceous, Top of the Moodys Branch and Top of the Glendon Limestone. The maps were constructed from datums obtained from electrical logs of oil tests and water wells. The datums were confirmed by sample examination. Only those wells from which data could be acquired are shown on the Moodys Branch map and the Glendon Limestone map.

Figure 18 shows the structural configuration on top of the Lower Cretaceous. The northern and eastern parts of the County show the influence of regional dips and probably some influence of the Jackson Uplift. The regional dip in this area is to the southwest. A prominent syncline is located in the southern part of the County, centered in Townships 9 and 10 North, Range 8 East. Several prominent anticlinal features are apparent in the west central and southwestern parts of the County.

The north-south anticlinal feature centered in Range 7 East is in trend with the Brookhaven Oil Field, which is located approximately 5 miles south of the Copiah-Lincoln County boundary. This anticlinal feature probably reflects a deep-seated salt ridge. A number of oil tests have been drilled along this

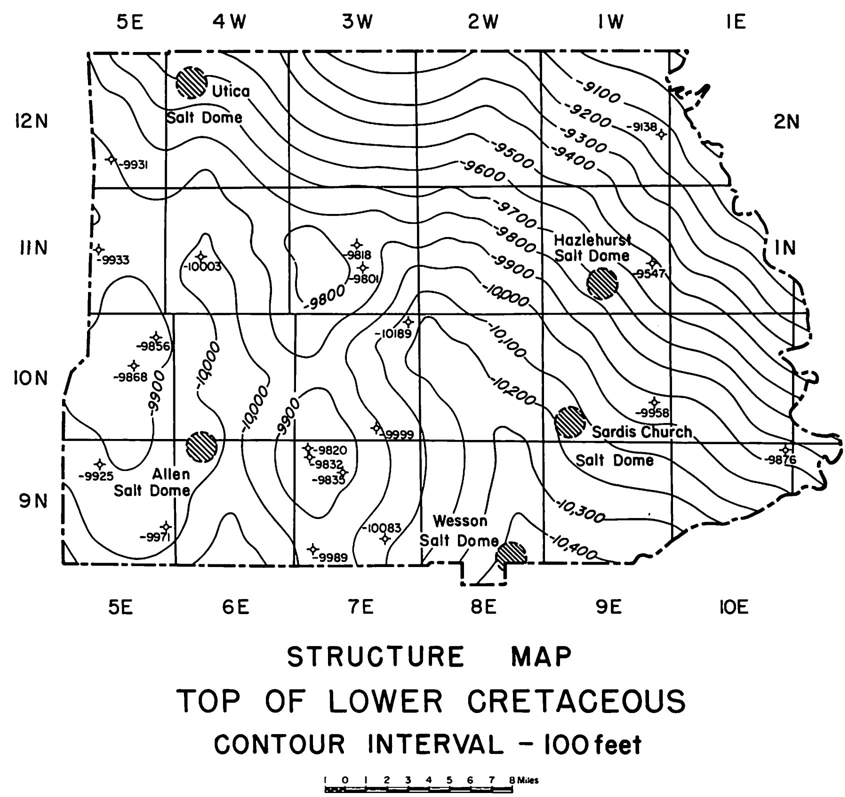

Figure 18.—Structure map, top of Lower Cretaceous formation.

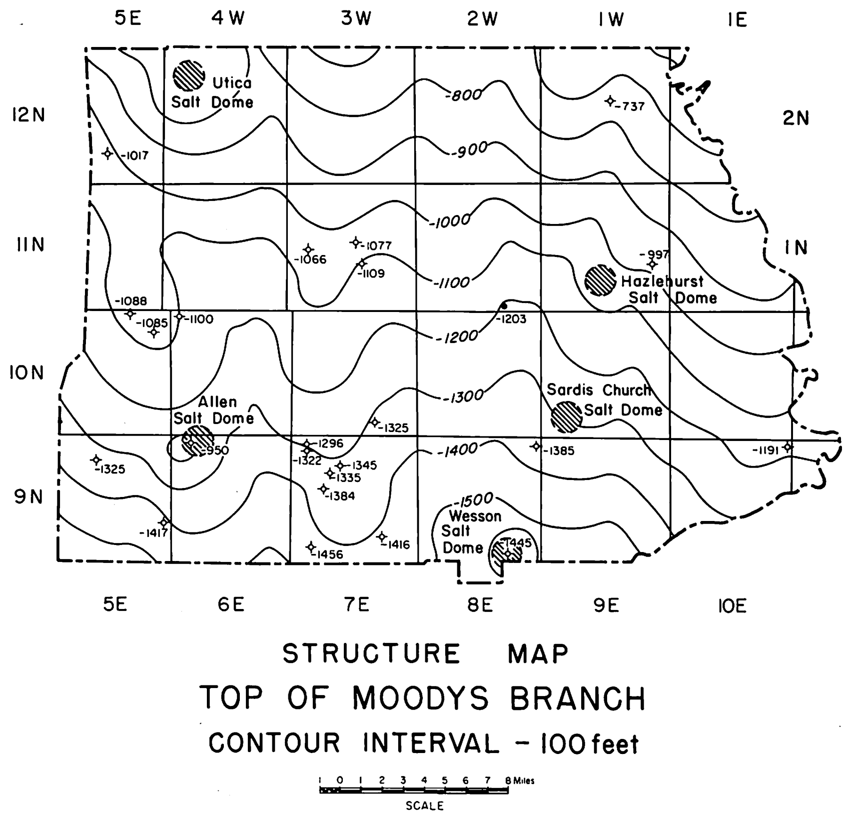

Figure 19.—Structure map, top of Moodys Branch.

structural feature. The Sun Oil Company, No. 1 Southern Package Corporation test, located in sec. 6, T. 9 N., R. 7 E., recorded significant shows of gas and condensate from a Rodessa zone between 14,934 feet and 14,960 feet.

Structure maps contoured using the Moodys Branch and Glendon limestone as datums (Figures 19 and 20) show the structural features losing much of their identity at shallower depths and being represented by nosing.

The cross hatched circles shown on the structure maps represent known piercement type salt domes. In each dome the caprock and salt stock penetrated into the Wilcox formation to varying degrees. Stratigraphic sequences of test wells at each dome show that locally complex structural conditions can be expected at each dome where salt penetration was greatest.

In the Allen and Wesson domes the caprock can be reached at depths of 2517 feet and 3394 feet below the ground surface. At these domes normal stratigraphic sequences exist. The only departure from normal conditions is thinning of the formations overlying the caprock. At the Hazlehurst, Sardis Church and Utica domes the top of the caprock is reached at the depths of 1460, 1471 and 2830 feet, respectively. Abnormal stratigraphic sequences are encountered above the caprock at the three domes. The formations of the Oligocene series and various parts of the upper Eocene series are absent. In the subsurface strata at the Sardis Church dome, beds of abnormal thickness representing

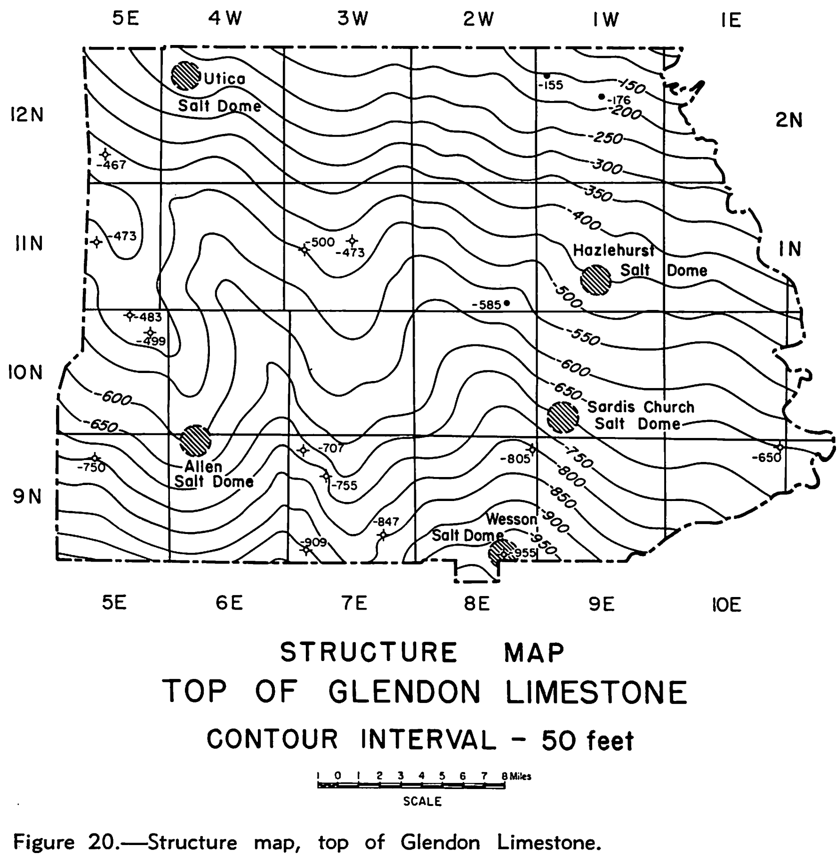

Figure 20.—Structure map, top of Glendon Limestone.

formations of the Eocene series suggests highly tilted beds associated with faulting.

ECONOMIC GEOLOGY

GENERAL STATEMENT

One of the primary purposes of the investigation of the geology and mineral resources of Copiah County was to locate and report mineral deposits of known or probable economic

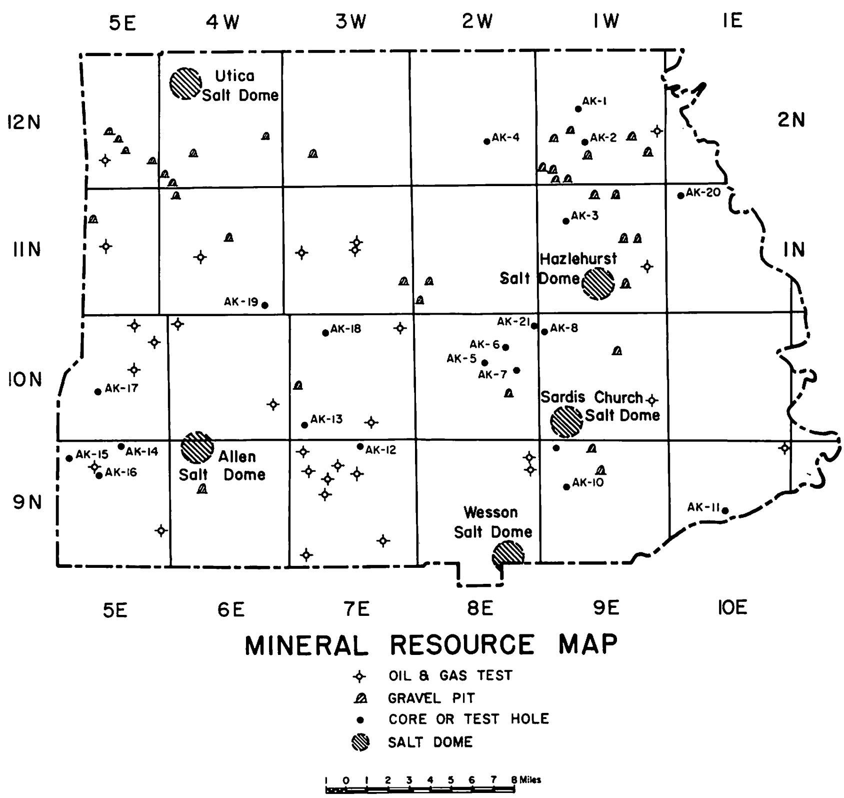

Figure 21.—Mineral Resource Map.

value. Selection of samples to be tested was limited to areas where outcrops indicated favorable material. Other factors such as accessibility, thickness and overburden were additional criteria observed in sample selection. Nineteen samples of clay were selected for chemical and ceramic testing.

The chemical analyses of the samples were made by Shilstone Testing Laboratory. Ceramic tests were conducted by Thomas E. McCutcheon, Ceramic Engineer. In conjunction with the ceramic testing, the residues from the screen analysis were examined and described by William H. Moore, State Geologist.

NATURAL CLAY MIXTURES

The term clay is commonly used to refer to a wide range of chemical and physical compositions. Grim[26] 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 and soils, etc. As a rock term it is difficult to define precisely, because of the wide variety of materials that have been called clays. In general the term clay implies a natural earth, fine-grained material which develops 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 . . . . As a particle-size term, the clay fractions 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."

In recent publications of the Geological Survey the term natural clay mixtures has been used to describe material from the Miocene series. Moore[27] introduced the term for the silty and sandy clays from the Catahoula formation in Hinds County. Williams[28] used the term for some of the Miocene clays in George County. Inasmuch as the Miocene strata in Copiah County consist of silty and sandy clays similar to that found in Hinds County it is appropriate to retain the term natural clay mixtures in describing the material.

The material from the Catahoula and the Hattiesburg formations are very similar upon visual examination. In general material from both formations contains large amounts of silt, sand and carbonaceous matter. In appearance the clays differ mainly in the color of the weathered material on the face of the outcrop. Generally, the weathered Catahoula clay is lighter in color than clay from the Hattiesburg. However, core samples show that in some localities the unweathered Catahoula clay is dark grayish-brown in color.

Ceramic tests performed on the Catahoula and Hattiesburg clays from Copiah County show that most of the samples could be placed into one group having common plastic and burning properties. Differences in the samples are mainly in sand or silica content. Most of the clays can be utilized in the manufacture of heavy clay products. Results of the ceramic tests and chemical analyses of the Catahoula and Hattiesburg clays are given in the section Copiah County Clay Tests.

SAND AND GRAVEL

Sand and gravel are important materials in the construction industry and are of growing importance in an expanding economy. About 96 percent of the sand and gravel produced in the State during 1967 was used as an aggregate material for the construction of roads, bridges and buildings, the remaining 4 percent was used as railroad ballast, fill sand and gravel and molding sand.

Copiah County is located near the rapidly expanding market of the metropolitan area of Jackson. Figures supplied to the Bureau of Mines show that Copiah leads all the counties within the State in the production of sand and gravel. All of the sand and gravel produced in the County is reported to be used in the construction industry.

Sand and gravel deposits are numerous and widespread about the County. The deposits occur in the Citronelle formation, lower terrace deposits and in stream alluvium. At the present time commercial mining is predominantly from deposits in the Citronelle formation near the town of Crystal Springs. To keep transportation cost low the commercial operations are located as near as possible to the large market area of Jackson. Thicknesses of these Citronelle deposits vary from about 50 feet to 100 feet. Average thickness in the area is 75 feet.

At these quarries sand and gravel are excavated by hydraulic dredge and drag line. After washing to remove the clay and silt size particles the sand and gravel is separated by screen classifers into specific sizes to be stockpiled for later distribution. Shipment to distribution centers is by truck.

Many other gravel pits developed in the Citronelle formation are located at various points about the County. These pits were developed to serve local needs in the construction of roadways

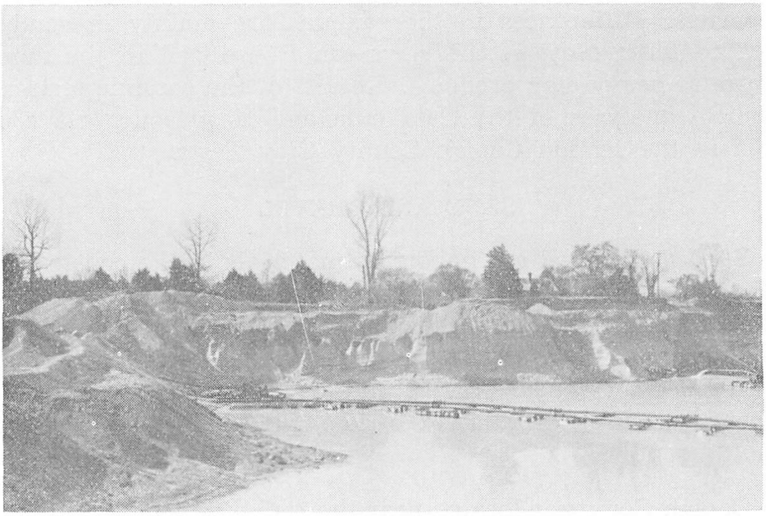

Figure 22.—Excavating sand and gravel by hydraulic dredge. Material is transported to classifier screens by pipeline. Location at gravel pit in SE¼, SE¼. sec. 31, T. 2 N., R. 1 W. March 1968.

and mining is conducted only as the need arises. However, their existence illustrates the widespread distribution of heavy aggregate material to be found in the Citronelle.

Deposits of sand and gravel also occur in the alluvial plains and stream beds of most of the streams in the County. These alluvial deposits have been mined periodically for a number of years in the stream bed of Bayou Pierre. Mining operations consist of dredging the material from a point bar and pumping it to screening and washing plants located on the river banks. Stream action rebuilds sand and gravel deposits over a period of time in a dredged out area. This renewal of the deposit provides an area in the same part of the river which can be mined again.

Figure 23.—Excavating sand and gravel by dragline. Conveyor transports material to classifier screen. Location at gravel pit in SW¼, NW¼, sec. 31, T. 2 N., R. 1 W. March 1968.

Figure 24.—Gravel accumulation on point bar in Bayou Pierre. Location in NE¼, SW¼, sec. 1, T. 1 N., R. 4 W. July 1968.

Other parts of the alluvial valley near the present stream contain deposits of sand and gravel. These concentrations are frequently overlooked because they are overlain by soil and vegetation. The presence of the deposits can only be determined by physical exploration.

A sample of sand from a sandbar in the Pearl River, located south of Georgetown in the NW¼ of sec. 13, T. 10 N., R. 10 E., was tested to determine the sand's potential for industrial uses. Table 2 shows the results of the chemical and screen analyses. The analyses indicate that the sands have possible use in the manufacture of some types of glass and other products requiring a high-silica sand.

Table 2.—Chemical and Screen Analyses of Sand Sample AK-21

Heavy minerals	0.556%
Silica (SiO_2)	98.340%
Iron (Fe_2O_3)	0.246%

Screen Size	Per Cent Retained
16 m	0.19
20 m	0.16
30 m	0.67
40 m	4.52
50 m	30.02
70 m	42.32
100 m	17.04
140 m	5.48
Pan	0.50

OIL AND GAS

A total of 62 test wells have been reported to have been drilled in Copiah County. Of this number, one-half or 31 of the tests were less than 5000 feet in depth. Thirteen of these shallow tests were drilled at salt dome locations with sulphur as the main objective. The remainder of shallow wells were drilled as stratigraphic tests. Two of the deeper wells tested the Hosston formation. The majority of the tests were stopped in strata of the upper part of the lower Cretaceous.

Several of the test wells reported shows of oil and gas. One well, the Sun Oil Company, No. 1 Southern Package Corporation, located in sec. 6, T. 9 N., R. 7 E., reported gas and condensate from the interval, 14,934 feet to 14,960 feet, a zone in the Rodessa formation.

The subsurface contains many feet of strata which could serve as reservoirs. Detailed description of the stratigraphy accompanies this report. Structural features which lead to entrapment of hydrocarbons are present within the County. Possible future exploration will lead to discovery of hydrocarbons.

SALT

There are five relatively shallow piercement salt domes which have been proven by drilling in Copiah County. The domes listed in chronological order of their discovery are: the Sardis Church Dome located in sec. 29, T. 10 N., R. 9 E.; the Allen Dome in sec. 5, T. 9 N., R. 6 E.; the Hazlehurst Dome in sec. 28, T. 1 N., R. 1 W.; the Utica Dome in sec. 8, T. 2 N., R. 4 W.; and the Wesson Dome in sec. 35, T. 9 N., R. 8 E. Table 3 shows the depths to the caprock and salt at each dome.

At least one test well was drilled at each of the domes. The Allen Dome was the location of two test wells and the Sardis Church Dome was explored by seven test wells. At the Sardis Church dome sulphur was the primary objective of the test wells. The domes vary greatly in size and in depths beneath the surface. None of the domes have been precisely delineated by test wells. Although the domes have not been promising for production of oil or gas they do offer a future potential for the production of salt and derivatives of salt chemistry.

TABLE 3.—Salt Domes in Copiah County

Name	Depth to Caprock	Depth to Salt
Sardis Church	1471 feet	N.R.
Allen	2517 feet	2844 feet
Hazlehurst	1460 feet	N.R.
Utica	2830 feet	3135 feet
Wesson	3394 feet	N.R.

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CORE HOLE AND TEST HOLE RECORDS

The following are descriptions of cuttings and cores from tests drilled during the field investigations of the mineral resources of Copiah County. The prefix AK is the code designation for Copiah County in the Survey's County Sample Index System. The prefix aids in the permanent indexing and identification of all material secured and tested in the course of geological and mineral investigation.

Location of each test and core hole was accomplished with the aid of topographic maps where available. Approximate footage noted in the location descriptions was scaled from the topographic maps using an engineer's scale. Elevations noted are ground elevations at the drill site, these elevations were interpreted directly from the topographic map or secured with the aid of a Paulin Altimeter.

The purpose for drilling each test is stated in the heading of each hole along with information concerning the availability of an electrical log. All thicknesses and depths are in feet.

AK-1

Location: Approximately 1100 feet west of the east line and 2100 feet north of the south line of Sec.17, T.2N., R.1W.

Elevation: 410 feet (topographic map) Date: June 14, 1967

Purpose: Drilled to 370 feet for stratigraphic information. No electrical log available.

Thickness	Depth	Description
		Citronelle formation
30	30	Sand, red, fine-grained, abundant unsorted chert gravel.
11	41	Sand, red, fine-grained, some gravel, abundant multi-colored clay.
		Catahoula formation
19	60	Silt, light gray-green, micaceous, clayey.
10	70	Clay, gray-green, slightly silty, plastic.
30	100	Clay, light gray-green, very silty, scattered limonitic staining.
20	120	Silt, light-gray, slightly sandy.
20	140	Silt, light-gray, becoming clayey, with scattered large quartz grains.
20	160	Clay, light-gray, very silty.
40	200	Clay, light-gray, mottled, silty, scattered pyrite nodules.
10	210	Silt, light-gray, slightly sandy.
10	220	Sand, fine-grained, some red-brown silty clay.
20	240	Silt, light-gray to brown with some fine-grained sand.
20	260	Silt, light-gray to green.
10	270	Sand, very fine- to fine-grained, micaceous.
10	280	Silt, light-gray to tan, sandy.
10	290	Clay, light gray-green, very silty, sandy.
10	300	Sand, fine- to medium-grained.
20	320	Silt, light-gray, slightly sandy.
10	330	Sand, very fine- to fine-grained.
10	340	Silt, light-gray, sandy.
10	350	Sand, very fine- to fine-grained, kaolinitic.
20	370	Sand, fine- to medium-grained.

AK-2

Location: In pasture near center of NW/4, Sec.28, T.2N., R.1W.

Elevation: 355 feet (topographic map) Date: June 27, 1967

Purpose: Drilled to 610 feet for stratigraphic information. Electrical log to total depth.

Thickness	Depth	Description
		Alluvium
11	11	Sand, fine- to coarse-grained, abundant gravel.
		Catahoula formation
19	30	Silt, light-yellow to light-gray, clayey.
20	50	Silt, light-gray.
30	80	Clay, gray-green, very silty, micaceous.
10	90	Silt, light-gray, micaceous.
10	100	Sand, light-gray, fine-grained, silty.
26	126	Sand, medium- to coarse-grained.
16	142	Silt, light-gray, slightly sandy.
18	160	Sand, fine- to medium-grained with streaks of light-gray silt.
18	178	Silt, light-gray, sandy.
35	213	Clay, light gray-green, slightly silty.
15	228	Sand, fine-grained, silty.
38	266	Clay, light-gray, silty.
34	300	Sand, medium- to coarse-grained.
36	336	Silt, light-gray, slightly silty.
14	350	Sand, fine-grained, silty.
12	362	Silt, light-gray, sandy.
13	375	Sand, fine- to coarse-grained, silty, micaceous, pyrite, some glauconite.
27	402	Silt, light-gray, sandy.
28	430	Clay, light-gray, silty, micaceous.
40	470	Clay, gray to brown, silty, slightly sandy.
26	496	Silt, light-gray.
26	522	Clay, light-gray, silty.
		Vicksburg group (Bucatunna clay)
70	592	Clay, light to medium-gray, carbonaceous.
		Vicksburg group (Byram marl)
18	610	Marl, light gray-green, fossiliferous, glauconitic.

AK-3

Location: In pasture on flood plain of Little Copiah Creek. Approximately 2400 feet from west line and 700 feet from south line of Sec.8, T.1N., R.1W.

Elevation: 365 feet (topographic map) Date: July 7, 1967

Purpose: Drilled to 650 feet for stratigraphic information. Electrical log to total depth.

Thickness	Depth	Description
		Alluvium
10	10	Sand, coarse-grained, unsorted chert gravel, tan silt.
10	20	Clay, gray to yellow, silty, sandy.
		Catahoula formation
46	66	Sand, fine- to medium-grained, slight iron staining.
10	76	Clay, light-gray, silty.
20	96	Sand, fine- to medium-grained, some kaolinitic material.
84	180	Clay, light-gray, silty, micaceous, with scattered multi-colored clay.
10	190	Silt, light-gray, sandy.
22	212	Sand, fine- to very coarse-grained, angular to sub-angular, poorly sorted.

18	230	Silt, light-gray, sandy, micaceous.
6	236	Sand, coarse-grained.
28	264	Clay, light-gray, silty.
14	278	Silt, light-gray.
6	284	Sand, fine- to medium-grained, silty.
26	310	Silt, light-gray to green, slightly sandy.
16	326	Sand, fine- to medium-grained.
34	360	Silt, light-gray, slightly clayey.
14	374	Clay, light-gray to green, silty, sandy.
10	384	Sand, very fine-grained, silty.
46	430	Clay, light-gray, silty.
12	442	Silt, light-gray, pyritic.
32	474	Clay, light-gray to green, pyritic, micaceous.
6	480	Sand, fine- to medium-grained, abundant pyrite.
34	514	Clay, light-green to gray, micaceous, silty.
28	542	Silt, light-gray, sandy, micaceous.
24	566	Clay, light-gray, sandy, silty.
16	582	Silt, light-gray, sandy.
18	600	Sand, fine- to medium-grained.
10	610	Clay, light-gray, silty.
30	640	Sand, very fine- to fine-grained, silty.
10	650	Clay, light-gray, silty, micaceous.

AK-4

Location: In pasture 1200 feet west of paved road. Approximately 2300 feet west of the east line and 400 feet south of the north line of Sec.27, T.2N., R.2W.

Elevation: 342 feet (topographic map) Date: August 1, 1967

Purpose: Drilled to a total depth of 530 feet for stratigraphic information. Electrical log to 366 feet.

Thickness	Depth	Description
		Alluvium
10	10	Silt, tan, very sandy.
20	30	Sand, coarse-grained, silty, clayey, abundant gravel.
		Catahoula formation
18	48	Clay, light-gray, silty, slightly sandy.
32	80	Clay, light-gray to tan, slightly silty.
12	92	Clay, light-gray to tan, very silty.
10	102	Silt, light-gray, sandy.
38	140	Sand, very fine- to fine-grained, silty.
90	230	Silt, light-gray, micaceous, sandy.
86	316	Sand, fine-grained, silty, some kaolinitic material, rare glauconite.
50	366	Clay, light-gray to yellow, slightly silty.
14	380	Silt, light-gray, slightly sandy, micaceous.
10	390	Sand, fine- to coarse-grained, pyrite.
20	410	Clay, gray to green, silty, sandy.
10	420	Sand, fine-grained, silty, clayey.
10	430	Clay, gray, silty, sandy.
30	460	Sand, fine- to medium-grained slightly silty, rare glauconite.
70	530	Sand, very coarse-grained, thin stringers of clay.

AK-5

Location: In pasture in NW/4 of SE/4 of NE/4 of Sec.15, T.10N., R.8E.

Elevation: 390 feet (topographic map) Date: August 4, 1967

Purpose: Drilled to 400 feet for stratigraphic information. Electrical log to 398 feet.

Thickness	Depth	Description
		Hattiesburg formation?
10	10	Clay, light-gray to tan, very silty, slightly sandy.

		Catahoula formation
18	28	Silt, light-gray to yellow, slightly sandy, micaceous.
2	30	Sand, fine- to coarse-grained.
12	42	Clay, light-gray to green, silty, micaceous.
14	56	Sand, fine-grained, silty.
11	67	Silt, light-gray, clayey.
67	134	Sand, very fine- to fine-grained, silty, clayey.
56	190	Clay, light-gray, silty.
30	220	Clay, light-gray.
54	274	Sand, medium- to coarse-grained.
6	280	Clay, light-gray, silty, sandy, pyrite.
4	284	Sand, fine-grained.
12	296	Silt, light-gray, sandy.
58	354	Clay, gray to green, silty.
6	360	Silt, light-gray.
8	368	Sand, fine-grained.
16	384	Silt, light-gray, sandy.
14	398	Clay, green to gray, silty, micaceous.

AK-6

Location: In pasture approximately 400 feet north of the south line and 2100 feet east of the west line of Sec.11, T.10N., R.8E.

Elevation: 474 feet (topographic map) Date: August 8, 1967

Purpose: Drilled to 410 feet for stratigraphic information.

Thickness	Depth	Description
		Catahoula formation
10	10	Silt, light-gray, tan, yellow.
26	36	Clay, light-gray, finely micaceous, slight limonitic staining.
24	60	Silt, light-gray, clayey, very sandy.
40	100	Sand, very fine- to fine-grained, very silty, some kaolinitic material, traces of siderite.
20	120	Sand, fine-grained, silty.
20	140	Sand, medium- to coarse-grained.
36	176	Silt, light-gray, very sandy.
22	198	Clay, light-gray, silty, micaceous.
20	218	Sand, fine- to coarse-grained, silty, some pyrite.
42	260	Sand, mostly coarse-grained, slightly silty.
14	274	Sand, fine-grained, silty.
16	290	Silt, light-gray, sandy.
30	320	Clay, light-gray, very silty, slightly sandy.
38	358	Silt, light-gray, clayey, very sandy.
34	392	Clay, light-gray, silty.
18	410	Silt, light-gray, sandy, micaceous.

AK-7

Location: In pasture in the SE/4 of NE/4 of SE/4 of Sec.14, T.10N., R.8E.

Elevation: 347 feet (topographic map) Date: August 10, 1967

Purpose: Drilled to 400 feet for stratigraphic information. Electrical log to 397 feet.

Thickness	Depth	Description
		Alluvium
30	30	Clay, light-gray to tan, silty, sandy.
		Catahoula formation
40	70	Silt, light-gray, sandy, with stringers of lignite.
40	110	Sand, fine- to medium-grained, some pyrite, kaolinitic material.
8	118	Silt, gray to brown, carbonaceous.

16	134	Clay, greenish gray, micaceous, slightly sandy.
12	146	Clay, greenish gray, very silty.
10	156	Clay, gray to green, blocky, hard.
28	184	Silt, light-gray, micaceous, sandy.
14	198	Clay, light-gray, silty.
30	228	Sand, fine- to medium-grained, with stringers of light-gray silty clay.
18	246	Sand, coarse-grained, micaceous, some pyrite.
34	280	Silt, light-gray, sandy.
50	330	Clay, light-gray, slightly silty.
24	354	Sand, fine- to medium-grained, silty, micaceous.
18	372	Silt, light-gray, sandy.
28	400	Clay, light-gray, silty, micaceous.

AK-8

Location: In pasture approximately 1000 feet east of farm to market road 472, and 2000 feet northeast of Hazlehurst's water wells in the Shady Grove field. Approximately 1000 feet east of west line and 800 feet north of south line of Sec.6, T.10N., R.9E.

Elevation: 340 feet (topographic map) Date: August 14, 1967

Purpose: Drilled to 350 feet for stratigraphic information. Electrical log to 348 feet.

Thickness	Depth	Description
		Citronelle formation
30	30	Sand, coarse-grained, well-rounded, silty, heavy limonitic staining.
25	55	Silt, tan to red, sandy.
		Catahoula formation
19	74	Clay, light-gray, micaceous, slightly silty to silty.
26	100	Clay, light-gray, micaceous with heavy limonitic staining.
26	126	Silt, light-gray, slightly sandy.
14	140	Sand, coarse-grained, very silty.
8	148	Clay, light-gray, slightly sandy.
28	176	Sand, coarse-grained, with large grains of chert.
12	188	Sand, medium- to coarse-grained, silty.
38	226	Clay, greenish gray, finely micaceous.
36	262	Clay, greenish gray, very silty.
54	316	Sand, medium- to coarse-grained, with dark grains of chert and igneous materials.
34	350	Clay, light-gray, silty, finely micaceous.

AK-9

Location: On the east shoulder of a county maintained road, approximately 2050 feet from the north line and 450 feet from the east line of Sec.6, T.9N., R.9E.

Elevation: 360 feet (topographic map) Date: August 15, 1967

Purpose: Cored to 30 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Hattiesburg formation
10	10	Clay, tan, silty, sandy.
		Catahoula formation
5	15	Clay, light greenish gray, slightly silty, micaceous.
7	22	Clay, light-gray, slightly silty, with scattered limonitic nodules.
8	30	Clay, gray, finely micaceous.

AK-10

Location: In roadbed of logging trail, 50 feet east of paved county road. NW/4 of NW/4 of Sec.20, T.9N., R.2E.

Elevation: 357 (Altimeter) Date: August 17, 1967

Purpose: Cored to 30 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Colluvium
10	10	Clay, gray to yellow, very sandy and silty.
		Hattiesburg formation
2	12	Clay, light-gray, slightly silty, sandy.
12	24	Clay, grayish red, mottled, silty.
6	30	Clay, grayish red, very silty and sandy.

AK-11

Location: In pasture 50 feet west of county road, near the center of E/2 of NE/4 of Sec.21, T.9N., R.10E.

Elevation: 326 feet (Altimeter) Date: August 18, 1967

Purpose: Cored to 28 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Colluvium
2	2	Silt, red, brown, gray.
		Hattiesburg formation
17	19	Clay, grayish red to brown, slightly silty.
5	24	Clay, pale-gray, finely micaceous, silty.
4	28	Sand, gray, fine-grained, silty.

AK-12

Location: In pasture in the SE/4 of NW/4 of Sec.3, T.9N., R.7E.

Elevation: 330 feet (topographic map) Date: August 22, 1967

Purpose: Cored to 34 feet to obtain samples for testing.

Thickness	Depth	Description
		Loessal soil
2	2	Silt, tan, slightly sandy.
		Hattiesburg formation
9	11	Silt, reddish orange, clayey.
3	14	Sand, gray, very fine- to fine-grained, silty.
5	19	Clay, tan, silty.
1	20	Sand, tan, fine-grained.
14	34	Clay, gray to tan, micaceous, silty.

AK-13

Location: In pasture 1000 feet northwest of barn, approximately 2300 feet south of the north line and 2000 feet west of the east line of Sec.31, T.10N., R.7E.

Elevation: 375 feet (topographic map) Date: August 24, 1967

Purpose: Cored to 30 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Loessal soil
1	1	Soil, clayey, silty.
		Hattiesburg formation
10	11	Clay, brown to gray, silty.
3	14	Sand, tan, fine-grained, silty.
16	30	Sand, tan, fine-grained.

AK-14

Location: In pasture 50 feet southeast of intersection of paved road with dirt road, approximately 1600 feet east of the west line and 250 feet south of the north line of Sec.3, T.9N., R.5E.

Elevation: 324 feet (topographic map) Date: August 25, 1967

Purpose: Cored to 38 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Loessal soil
2	2	Silt, reddish brown.
		Hattiesburg formation
8	10	Clay, greenish gray, slightly sandy.
8	18	Clay, dark-gray, slightly silty.
12	30	Clay, grayish brown, finely micaceous.
7	37	Clay, blue-green, blocky, micaceous.
1	38	Sand, fine-grained, silty.

AK-15

Location: In bed of logging trail 50 feet north of paved road approximately 800 feet north of the south line and 400 feet east of the west line of Sec.5, T.9N., R.5E.

Elevation: 335 feet (topographic map) Date: August 29, 1967

Purpose: Cored to 14 feet to obtain samples for testing.

Thickness	Depth	Description
		Loessal soil
2	2	Silt, tan.
		Hattiesburg formation
2	4	Clay, red, silty, ferruginous nodules.
10	14	Sand, gray, very fine- to fine-grained.

AK-16

Location: In field 200 feet south of an abandoned house approximately 2000 feet west of the east line and 2200 feet south of the north line of Sec.8, T.9N., R.5E.

Elevation: 352 feet (topographic map) Date: August 29, 1967

Purpose: Cored to 14 feet to obtain samples for testing.

Thickness	Depth	Description
		Loessal soil
2	2	Silt, tan.
1	3	Clay, yellow, sandy, silty with some gravel and ferruginous material.
		Hattiesburg formation
3	6	Clay, gray, silty, micaceous, with ferruginous nodules.
3	9	Clay, gray, sandy, with ferruginous nodules.
5	14	Sand, gray, clayey with widely scattered ferruginous nodules.

AK-17

Location: In pasture 50 feet north of paved road and 200 feet east of summit of hill, approximately 1200 feet west of the east line and 2600 feet south of the north line of Sec.21, T.10N., R.5E.

Elevation: 300 feet (topographic map) Date: August 30, 1967

Purpose: Cored to 14 feet to obtain samples for testing.

Thickness	Depth	Description
		Loessal soil
1	1	Silt, gray.

		Loess
5	6	Silt, tan.
		Catahoula formation
5	11	Clay, gray, silty, sandy.
3	14	Sand, fine- to medium-grained.

AK-18

Location: In pasture 50 feet south of dirt road and 200 feet south of farm house, approximately 900 feet west of the east line and 300 feet north of the south line of Sec.5, T.10N., R.7E.

Elevation: 320 feet (topographic map) Date: August 30, 1967

Purpose: Cored to 22 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Loess
6	6	Silt, tan.
		Catahoula formation
7	13	Clay, gray, sandy, very silty.
2	15	Sand, fine- to medium-grained, silty.
6	21	Clay, light-gray, silty.
1	22	Sand, gray, fine- to medium-grained.

AK-19

Location: In pasture 400 feet north of road and 400 feet northwest of pond, approximately 200 feet east of west line and 2900 feet south of north line of Sec.36, T.1N., R.4W.

Elevation: 305 feet (topographic map) Date: August 30, 1967

Purpose: Cored to 42 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Loessal soil
2	2	Silt, tan.
		Catahoula formation
3	5	Clay, light-gray, silty.
24	29	Clay, light-gray to gray, plastic.
13	42	Clay, greenish gray, plastic.

AK-20

Location: In pasture 200 feet north of Highway 27 on the north slope of hill adjacent to prominent Miocene outcrop in the NW/4 of the SE/4 of Sec.6, T.1N., R.1E.

Elevation: 310 feet (Altimeter) Date: August 31, 1967

Purpose: Cored to 24 feet to obtain clay samples for testing.

Thickness	Depth	Description
		Loessal soil
1.5	1.5	Soil, tan, silty.
		Catahoula formation
4.0	5.5	Clay, light-gray, slightly silty.
6.0	11.5	Clay, light-gray, plastic, slightly silty.
1.0	12.5	Clay, light-gray, silty, heavy limonitic staining.
10.5	23.0	Clay, light-gray, slightly silty, micaceous.
0.5	23.5	Sand, fine-grained, kaolinitic.
0.5	24.0	Sand, light-gray, indurated.

AK-21

Location: In pasture 200 feet southeast of Highway 28. Approximately 2000 feet north of the south line and 75 feet west of the east line of Sec. 1, T.10N., R.2W.

Elevation: 445 feet (topographic map) Date: September 10, 1968

Purpose: Drilled to 350 feet for stratigraphic information. Electrical log to 348 feet.

Thickness	Depth	Description
		Citronelle formation
26	26	Sand, red, medium- to coarse-grained.
24	50	Clay, multi-colored, sandy, small amount of gravel.
		Catahoula formation
38	88	Clay, light-gray, silty.
28	116	Silt, light-gray, clayey, micaceous.
50	166	Sand, fine- to medium-grained, silty, some clay.
66	232	Clay, light-gray, silty, micaceous.
48	280	Sand, coarse- to very coarse-grained, dark grains of chert.
20	300	Sand, medium- to coarse-grained, some limonitic staining.
20	320	Sand, fine- to medium-grained.
30	350	Clay, light-gray, slightly silty to silty.

WATER RESOURCES OF COPIAH COUNTY

THAD N. SHOWS

ABSTRACT

Copiah County is underlain by aquifers containing an abundance of ground water that requires a minimum of treatment for most uses. All municipal and industrial water supplies are from wells. Ground-water pumpage in the County is estimated to be about 8 mgd (million gallons per day).

Aquifers in Copiah County are unconsolidated deposits of sand and gravel. Fresh water is available to a depth of more than 2,400 feet below sea level. The age of the deposits which contain the aquifers are from Eocene (Kosciusko formation) to Recent (Alluvium). The majority of the wells are less than 600 feet deep and yield up to 300-400 gpm (gallons per minute). The shallow Citronelle and Miocene aquifers offer the greatest potential for developing large ground-water supplies in Copiah County. Generally, the aquifers dip to the southwest at about 40 feet per mile. Several of the aquifers tested have transmissibilities above 100,000 gallons per day per foot but the average aquifer has about 30,000-40,000 gallons per day per foot. Water levels in the major aquifers are slowly declining at a rate of 1 or 1½ feet per year in the areas of heavy pumpage.

The quality of ground water generally is good with low dissolved solids, low hardness and low ph. Color is normally not a problem in the shallow aquifers.

Surface water of good quality is available in Copiah County if storage facilities are provided. The major streams in Copiah County are Copiah Creek, Bayou Pierre and the Pearl River. The flow during an average year in the Pearl River at Rockport is 5932 cfs (cubic feet per second). Copiah Creek and Bayou Pierre are both small and during most of the year the flow is slightly above the minimum. Minor flooding along the flood-plains occurs on most of the streams after heavy rains.

The quality of the surface water is generally good. The water has low dissolved solids, low hardness and low ph. Color is seldom a problem in the surface water. Water in the Pearl River (1968) is of poor quality because of the objectionable upstream organic pollution. This limits the usefullness of the Pearl River for industrial purposes unless water-quality requirements are low.

INTRODUCTION

An evaluation of the water resources of Copiah County was imperative in studying the mineral resources of the County because of the important role that water has in the economy of the area. Information on water as to quantity, quality and availability is important in the orderly development of municipal and industrial growth. Prospective and existing industry must be assured a plentiful supply of water for continual progress in the County.

Presently, all municipal and industrial supplies are from ground-water reservoirs and only a few irrigation systems scattered over the County use surface water. The growth of the population centers will increase the water demand for those areas. Future need should be considered and plans made to provide an adequate water source. Industrial water needs have to be met if the County continues to be competitive in seeking new industry. Most industrial water is primarily used for cooling purposes and generally the quality requirements are not as critical as for municipal use. Therefore, surface water may be utilized for industrial cooling use. Surface water impoundments require adequate source streams, quality control and reliable dam-sites along with public support for the projects.

Information on the water resources is intended to serve as a guide for water-supply development in Copiah County. Individual water problems have to be dealt with on a local basis and local planners should consider the entire hydrologic system in providing adequate water supplies.

COOPERATION AND ACKNOWLEDGEMENTS

The mineral resources investigation of Copiah County was begun in January 1967, by the Mississippi Geological Survey. An intensive study of the water resources of the County was begun in the summer of 1967. Valuable cooperation and information was furnished by many individuals and governmental organizations. The water managers of Crystal Springs and Hazlehurst were patient and helpful in providing assistance during the investigation. The many well owners and water well contractors provided valuable information on the wells within the County. The late Mr. W. L. Reno of Hazlehurst provided assistance, advice and encouragement on locating ample water for the future need of Copiah County.

PRESENT WATER USE

Total ground-water use in Copiah County is estimated to be about eight mgd (million gallons per day). The greatest amount of water is used for municipal and industrial purposes and most of this for cooling purposes with only a small percentage actually consumed.

The heaviest withdrawal of water is in the Hazlehurst (1½ mgd) and Crystal Springs (4½ mgd) areas. Large volumes of water are pumped for the gravel mining operation southeast of Crystal Springs and are included in the total for Crystal Springs. Most of the water used in the mining and washing operation, except the amount lost through evaporation, percolates back into the gravel and replenishes the ground-water reservoir.

The remaining part of the County is rural with no appreciable concentration of water withdrawal. Numerous rural water systems are installed or have been proposed throughout the County. This will increase water usage and pumpage. Several of the rural systems plan to purchase water from the nearby towns of Hazlehurst or Crystal Springs.

The U. S. Department of Agriculture (Soil Conservation Service) has preliminary plans to construct several reservoirs on Copiah Creek and Bayou Pierre. These multi-purpose reservoirs are planned for flood control, recreation and possible source of water supply, with emphasis on providing recreation facilities and flood control. The Pearl River, which forms the eastern boundary of the County, could be used extensively for boating and fishing. The Pearl River Waterway District is stressing the recreational importance of the River particularly as a boatway to the Gulf of Mexico. The U. S. Army Corps of Engineers has initiated snagging operations on the Pearl River from Bogalusa, Louisiana to Columbia, Mississippi.

GROUND WATER

OCCURRENCE

Ground-water reservoirs supply all of the water used in Copiah County with the exception of local irrigation systems. Ground water is defined as any water found beneath the surface of the ground that is in the zone of saturation. The zone of saturation is that portion of the earth's upper crust in which pores, joints and openings are filled with water. Ground water may seep out onto the surface through springs or seeps and become surface water and vice versa. Ground water and surface water are ultimately dependent on precipitation.

Ground-water reservoirs are commonly called aquifers. An aquifer is any water-bearing unit (generally sand or gravel in Copiah County) capable of yielding water to wells. The three main uses of aquifers are to filter, transmit and store water. Water is filtered as it passes into the intake of the aquifer which is usually the outcrop area or adjacent permeable beds and through the aquifer material to the point of withdrawal. The water is slowly (a few feet per year) moving within the aquifer from the intake or recharge area until it is discharged at wells, springs, seeps or other aquifers which represent an underground pipeline. The aquifer represents a large underground reservoir for storing the water until it is discharged or used. Many geologic units have a relatively large capacity to store water, but their pipeline or conduit function is so limited that they cannot transmit water to wells at sufficient rates to be useful as productive aquifers. The ease with which water passes through the aquifer material is determined by the shape, size, assortment and degree of compaction of the grains.

Most aquifers in Copiah County are composed of sand, gravel and silt or mixtures of these and are present as unconsolidated sediments. Wells are commonly screened with a commercial screen or perforated pipe to allow the water to enter the well from the aquifer.

Water enters the permeable geologic units in their outcrop areas and moves in a generally southwesterly direction (general dip of the beds) toward areas of discharge. Water levels are lowered in the aquifers in the vicinity of discharge, and the lower water levels change the direction of ground-water movement.

Aquifers are classed as water-table or artesian depending on whether the water level is within the aquifer and unconfined or whether it is confined. Water in a water-table well stands at about the same level as in the aquifer outside the well. Water-table aquifers receive recharge mainly from local precipitation and results in a seasonal fluctuation of the water level. The base flow of streams are supplied largely from the discharge of water-table aquifers. Aquifers in the Citronelle, terrace and alluvium deposits generally are classed as water-table aquifers.

Artesian aquifers are confined by impermeable beds, usually clay, and the water in wells will rise above the top of the water-bearing material. Artesian conditions are present throughout Copiah County and usually occur at deeper depths than the water-table aquifers. The majority of wells in Copiah County are completed in artesian aquifers even though the water level does not reach the surface. Some people have the idea that artesian aquifers are restricted to those that flow. This is not the case. Artesian wells located in the deeper stream valleys usually have a water level above the surface and thereby flow.

Water quality changes as the water moves down the dip from the outcrop to areas of discharge. Dissolved solids content usually increases down the dip due to more mineral matter being dissolved by the water and the type of the water changes from calcium to sodium bicarbonate. The deeper water is usually softer because the calcium and magnesium content (which indicates hardness) has been decreased by ionic exchange for sodium. The pH of the water generally increases down the dip and iron concentrations are reduced. Also, generally water color increases down the dip and most of the deeper aquifers contain highly colored water.

Ground-water temperature, except in shallow water-table wells, does not vary with seasonal changes in air temperature. Water of a constant temperature is advantageous for most cooling purposes. The temperature of shallow ground water is about 64° F. which corresponds to the mean annual air temperature. The geothermal gradient in Copiah County is 1° F. increase in temperature for about every 75-80 feet of depth. To make accurate water temperature measurements, the water temperature should be measured in a large capacity well that has been operating a sufficient time for the temperature to equalize in the well.

DEPTH, LITHOLOGY AND THICKNESS OF AQUIFERS

Fresh-water (less than 1000 parts per million dissolved solids) aquifers are available in Copiah County to depths of 2400 feet below sea level. The base of fresh water is from less than 400 feet to slightly more than 2400 feet below sea level (fig. 1). Most of the County is underlain by fresh-water aquifers to about 2000 feet below sea level (table 1). The shallowest fresh water occurs in the extreme southwestern part of the County located in Township 9 and 10 North, Range 5 East; Township 9 North, Range 6 and 7 East and over some salt domes. All of the known water wells are shallower than the base of fresh water. The majority of the thicker sands are present at shallow depths and probably would not exceed 1000 feet anywhere in the County.

A test well (J28) for the town of Hazlehurst completed in the Kosciusko formation (Sparta) at a depth of 2575 feet is the deepest known water well in the County. The major supply

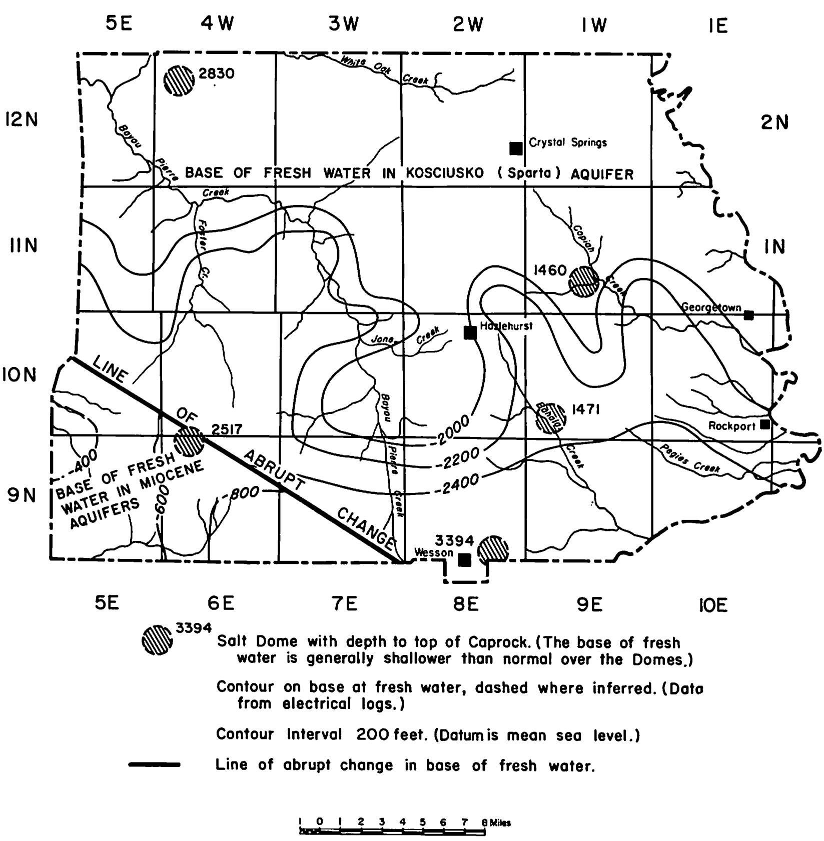

Figure 1.—Configuration of the base of the fresh-water in Copiah County.

Table 1.—Stratigraphic column and water resources in Copiah County, Mississippi.

SYSTEM	SERIES	GROUP	STRATIGRAPHIC UNIT	THICKNESS	WATER BEARING CHARACTERISTICS
QUATERNARY	RECENT		Alluvium	0-80	Not an important aquifer, except for shallow domestic wells in the larger stream valleys. The deposits appear thicker in the Bayou Pierre and Pearl River Valleys.
	PLEISTOCENE		Loess	0-8	Not an aquifer.
			Terrace	0-80	Not an important aquifer, except for shallow domestic wells.
			Citronelle formation	0-100	An important aquifer in the vicinity of Crystal Springs. Most of the shallow industrial and municipal wells in the Crystal Springs area are completed in the Citronelle aquifer. The water from the Citronelle is typically acidic and contains low dissolved solids.
TERTIARY	MIOCENE		Hattiesburg	0-400	An important source of water in Copiah County. Most of the large wells in the County, except for the wells in the vicinity of Crystal Springs, are completed in the Miocene deposits. The water quality is generally suitable for most purposes with minor treatment. The water usually contains low dissolved solids, low iron content and is slightly acidic.
			Catahoula formation	500-900	
	OLIGOCENE	VICKSBURG	Undifferentiated	80-100	Not an aquifer.
			Forest Hill	80-100	Generally not an aquifer. A potential aquifer in the northeastern corner of Copiah County near the Hinds County boundary. The water from the Forest Hill is highly colored in Copiah County.
	EOCENE	JACKSON	Yazoo clay	400-500	Not an aquifer.
			Moodys Branch	15-20	Not an aquifer.
			Cockfield	100-500	Not an important aquifer. Small domestic wells are possible in the Cockfield aquifer near the Hinds-Copiah boundary. Water from the Cockfield is highly colored in Copiah County.
			Cook Mountain	350-400	Not an aquifer.
			Kosciusko (Sparta)	400-600	Not an important aquifer. Colored water and low permeabilities are typical of the Sparta sand throughout most of Copiah County. The aquifer may be a potential source for industrial water in the northern half of Copiah County.

wells (fig. 2) in the County range in depths from about 100 to 400 feet in depth (table 2). The aquifers which are mostly beds of sand and gravel or zones of sand dip gently to the southwest at about 40 feet per mile.

Prediction of aquifer thickness and lithology is difficult due to the lenticular character of the Miocene and Citronelle deposits which are the principal aquifers for Copiah County. Lithologic changes occur in short distances and individual sand beds are hard to trace, especially along the dip of the beds. Fresh-water sands, as indicated on electrical logs, range in thickness from a few inches to two hundred thirty-five feet. The Miocene deposits in Copiah County are found from the surface to about 1400 feet in the vicinity of Wesson. Test drilling is recommended to determine the depth, thickness and character

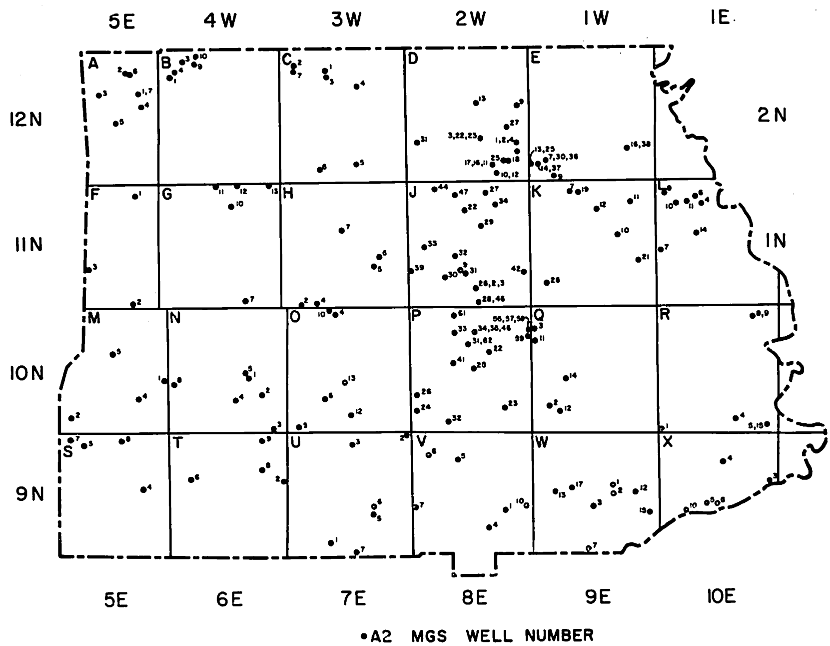

Figure 2.—Location of selected wells in Copiah County, Mississippi.

of aquifers underlying a particular site because of the lenticular nature of the beds.

WATER-BEARING UNITS

The principal water-bearing beds in Copiah County are the Miocene age beds of the Hattiesburg and Catahoula formations (tables 1 and 2). The Citronelle formation contains fresh water, but most of the unit is present at high elevations (plus 400 feet) and the base of the formation usually is near the water level. The alluvium and terrace deposits contain local aquifers in which small domestic wells are completed. The alluvium along the Pearl River contains aquifers which could furnish water to small wells in that area.

The older Kosciusko (Sparta) and Cockfield aquifers are not utilized in Copiah County. A deep test, 2798 feet deep, for the town of Hazlehurst, tested the Kosciusko aquifer (Sparta). The water in the Kosciusko was highly colored and the aquifer has a low transmissibility.

Table 2.—Records of selected wells in Copiah County.

Well No.: Numbers correspond to those on well-location maps, geologic sections, chemical-analysis tables, and pumping test tables.

Majority of wells are rotary drilled.

Water Level: Levels shown in feet are reported, and those measured are rounded off to nearest foot.

Elevation: Elevations determined mostly from topographic maps having contour intervals of 10 or 20 feet.

Method of Lift: A, Air Lift; C, Cylinder; F, Natural Flow; J, Jet; N, None; P, Pitcher; T, Turbine; S, Submersible; B, Bucket.

Use of Well: D, Domestic; I, Industrial; IR, Irrigation; N, None; O, Observation; P, Public Supply; S, Stock; T, Test.

Remarks: C, Chemical Analysis; O, Observation Well; P, Pumping Test.

Well No.	Owner	Year Com-pleted	Depth (Ft.)	Casing Diameter (In.)	Water-bearing Unit	Elev. of land surface datum (Ft.)	WATER LEVEL: Above (+) or Below Land Surface (Ft.)	WATER LEVEL: Date of Measure-ment	Method of Lift	Use	YIELD: Gallons Per Minute	YIELD: Date	Temperature (°F)	Remarks
A1	Branch Health Center	1962	143	4,2	Catahoula	174	18	5-18-62	S	P	10	1967	--	--
A2	F. A. Strong	1962	102	4,2	Catahoula	184±	20	1962	S	D	10	1967	--	--
A3	P. J. Booth	1963	180	2	Catahoula	156	18	1963	J	D & S	4-8	1967	--	--
A4	Earle Coleman	1959	155	2	Catahoula	205	30	1959	J	D & S	4-8	1967	--	Soft
A5	Willie T. Marshall	1953	100	2	Catahoula	160	+1	1953	F	D & S	1	1954	--	--
A6	T. H. Hughes	1954	183	2	Catahoula	171	+1	1954	F	D & S	1	1954	--	--
A7	H. M. Little	1964	122	2	Catahoula	170	2	1-10-67	J	D & S	4-8	1967	--	--
B1	Reedtown Water Assn.	1968	250	10,8	Catahoula	198	3	9-4-68	T	P	162	1968	--	--
B3	C. J. Rigby	1951	110	8,2	Catahoula	212	80	1951	J	D	4-8	1967	--	--
B4	Maurice Little	1959	114	2	Catahoula	210	14	1959	J	D & S	4-8	1967	--	--
B9	Utica Junior College	1959	296	4, 2	Catahoula	--	16	4-59	S	P	100	4-59	--	--
B10	Utica Junior College	1961	298	8	Catahoula	211	30	1-10-67	S	P	145	1-10-67	--	--
C1	C. C. Graves	1959	397	2	Catahoula	260	--	--	J	D	N	--	--	Abandoned
C2	F. F. Caraway	1963	222	2	Catahoula	280	90	1963	J	D	4-8	1967	--	Soft
C3	C. C. Graves	1960	306	2	Catahoula	260	40	1960	J	D	3	1967	--	--
C4	T. C. Strong	1931	72	8	Catahoula	265	18	1930	J	D	4-8	1967	--	Hard
C5	W. R. Sumrall, Jr.	1963	122	2	Catahoula	335	84	1963	J	D	4-8	1967	--	--
C6	L. D. Smith	1966	237	4	Catahoula	--	128	1966	J	D	4-8	1967	--	--
C7	Charles Simmens	1964	222	4	Catahoula	316	151	1-12-67	S	--	10	1967	--	+Fe

Table 2.—Records of selected wells in Copiah County.—(Continued).

Well No.	Owner	Year Completed	Depth (Ft.)	Casing Diameter (In.)	Water-bearing Unit	Elev. of land surface datum (Ft.)	Water Level: Above (+) or Below Land Surface (Ft.)	Water Level: Date of Measurement	Method of Lift	Use	Yield: Gallons Per Minute	Yield: Date	Temperature (°F)	Remarks
D1	Town of Crystal Springs	1946	101	10	Citronelle	468	68	6-55	T	P	102	11-27-66	--	Standby (Reservoir Well)
D2	Town of Crystal Springs	1949	115	8,6	Citronelle	--	63	9-49	T	P	272	9-49	--	--
D3	Town of Crystal Springs	1949	108	8	Citronelle	467	72	5-5-68	T	P	185	5-5-68	67	P
D4	Town of Crystal Springs	1958	108	12	Citronelle	460	70	5-9-68	T	P	--	--	--	(NE Gem Plant Well)
D9	Standard Oil Company	1965	162	4	Catahoula	421	74	7-29-65	S	I	10	1967	--	--
D10	Miss. Fed. Co-op. Well #2	1965	242	12	Catahoula	430	137	7-29-65	T	I	350	7-29-65	--	Pumps mud
D11	Miss. Fed. Co-op. Well #3	1965	86	12	Citronelle	410	24	7-29-65	T	I	300	7-29-65	--	--
D12	Miss. Fed. Co-op. Well #1	1965	117	12	Citronelle	450	55	7-29-65	T	I	350	7-29-65	--	--
D13	Frank Byrant	1965	412	6,2	Catahoula	355	86	11-22-65	S	D	10	11-22-65	--	--
D16	Texaco Service Station	1967	122	6	Citronelle	430	54	1-17-67	T	I	35	1-17-67	--	--
D17	Miss. Fed. Co-op. Well #4	1967	105	--	Citronelle	420	--	--	T	I	400	1-17-67	--	--
D18	Miss. Fed. Co-op. 4" Well	1965	122	4,2	Citronelle	452	52	1-8-65	S	I	--	--	--	--
D19	Jack Conn	1962	403	4,2	Catahoula	430	162	9-27-61	-	D	--	--	--	--
D22	Town of Crystal Springs	1961	107	12	Citronelle	450	62	10-25-67	T	P	259	5-68	--	P (Osburn Street Well)
D23	Town of Crystal Springs	1963	107	12	Citronelle	450	62	7-29-63	T	P	321	5-68	--	P (Railroad Street Well)
D25	Miss. Fed. Co-op. Well #5	1968	90	18,12	Citronelle	415	40	6-4-68	T	I	250	6-4-68	--	P
D27	Burney Community Water System No. 1	1965	128	4	Catahoula	460	54	7-16-68	S	P	25	7-16-68	--	C
D31	New Zion Baptist Church	1967	115	4	Citronelle	428	74	9-27-67	S	P	10	9-27-67	--	--
E7	Blain Sand & Gravel, Inc.	1966	116	12	Citronelle	470	86	6-28-68	T	I	628	6-28-68	67	P
E9	Blain Sand & Gravel, Inc.	1966	154	10	Citronelle	474	7	3-30-66	T	I	500	3-30-66	68	--
E11	Traxler Gravel Company	1967	143	10	Citronelle	482	83	1-6-67	T	I	100	1-6-67	--	--
E13	Traxler Gravel Company	1967	163	10	Catahoula	465	--	--	N	N	--	--	--	Abandoned
E14	Traxler Gravel Company	1967	123	10	Citronelle	465	70	9-20-67	T	I	100	9-20-67	--	--
E16	Traxler Gravel Company	1961	78	8	Citronelle	420	25	1961	T	N	--	--	--	Abandoned
E25	J. J. Fergerson Sand & Gravel Co.	1966	118	10,8	Citronelle	475	--	--	T	I	--	--	--	--
E30	Blain Sand & Gravel Co.	1968	132	12	Citronelle	463	65	5-9-68	T	I	--	--	--	Abandoned
E31	Blain Sand & Gravel Co.	1968	96	12	Citronelle	468	84	6-18-68	T	Aban.	250	6-18-68	--	T.H. #2 (P)
E36	Blain Sand & Gravel Co.	1968	120	12	Citronelle	470	85	7-31-68	T	I	554	7-31-68	67	P
E37	Traxler Gravel Company	1968	100	12	Citronelle	455	--	--	T	I	--	--	--	--
E38	Traxler Gravel Company	1966	106	10	Citronelle	420	28	1-13-66	J	I	--	--	--	--
F1	Sammy O. Quinn	1956	80	2	Catahoula	250	50	1956	J	D	4-8	1967	--	--
F2	W. P. Drummond	1947	69	8	Catahoula	350	62	5-10-67	J	D	4-8	1967	--	--
F3	H. M. Coen	1952	59	8	Catahoula	270	47	5-10-67	J	D	4-8	1967	--	+Fe

Table 2.—Records of selected wells in Copiah County.—(Continued).

Well No.	Owner	Year Completed	Depth (Ft.)	Casing Diameter (In.)	Water-Bearing Unit	Elev. of land surface datum (Ft.)	WATER LEVEL Above (+) or Below Land Surface (Ft.)	WATER LEVEL Date of Measurement	Method of Lift	Use	YIELD Gallons Per Minute	YIELD Date	Temperature (°F)	Remarks
G7	Mrs. W. W. Brown	1958	203	2	Catahoula	295	12	1-2-67	J	D & S	4-8	1967	--	--
G10	Bessie M. Bobbitt	1925	25	2	Alluvium	194	10	1-10-67	J	D	4-8	1967	--	--
G11	K. M. Dear Estate	1963	128	4	Catahoula	222	25	1-10-67	J	D	4-8	1967	--	--
G12	Harold Hood	1963	156	2	Catahoula	242	30	3-27-63	J	D	4-8	1967	--	--
G13	Joe Goza	1968	113	2	Catahoula	255	56	5-7-68	T	D	5	5-7-67	--	--
H2	J. H. West	1954	67	8	Terrace	280	47	1954	J	D & S	4-8	1967	--	--
H4	E. N. Browning	1962	48	8	Alluvium	243	--	--	C	D & S	2-4	1967	--	--
H5	Mrs. Maggie Murk	1958	61	8	Citronelle	437	48	3-8-67	J	D & S	4-8	1967	--	--
H6	J. L. Sullivan	1951	98	8	Citronelle	395	82	3-8-67	C	D & S	2-4	1967	--	--
H7	E. W. Carraway	--	65	8	Citronelle	288	45	1967	C	D & S	2-4	1967	--	+Fe
J2	R. C. Owens Lumber Company Well #2	1955	710	6,4	Catahoula	447	225	1955	T	I	15	1955	--	--
J3	R. C. Owens Lumber Co.	1957	270	6	Catahoula	464	101	8-29-67	T	I	--	--	--	--
J9	J. H. Williams	1950	406	4,2	Catahoula	--	156	1950	J	D	4-8	1957	--	--
J22	Methodist Youth Camp	1960	526	8,4	Catahoula	450	195	2-16-60	T	P	116	2-16-60	--	--
J26	R. C. Owens Lumber Co.	1967	257	6,4	Catahoula	455	93	9-23-67	S	I	75	9-23-67	--	--
J27	Rolling Hills Country Club	1963	158	6	Citronelle	454	67	1-64	T	P	200	1-64	--	--
J28	Town of Hazlehurst, Test Well	1961	2575	4	Kosciusko	460	280	11-5-64	S	N	38.5	11-5-64	98	2798 T.D., C, P, Aban.
J29	Gallman Water Assn., Inc.	1965	215	8,6	Catahoula	472	83	11-1-65	S	P	150	11-1-65	66	C, P
J30	Lenell May	1966	210	2	Catahoula	430	100	9-8-66	-	D & S	--	--	--	--
J31	J. H. Williams	1966	441	-	Catahoula	450	--	--	-	D	--	--	--	--
J32	James Barker, Jr.	1967	295	2	Catahoula	458	108	11-9-67	J	D & S	--	--	--	--
J33	Lamar Harbour	1967	161	2	Catahoula	430	105	7-67	J	D	3 1/2	7-67	--	--
J34	Crystal Springs Truck Crop Experiment Station	1968	217	8	Citronelle	495	111	4-24-68	T	P	34	4-24-68	--	+Fe, P
J39	Carl F. Waldeisen	1965	225	3	Catahoula	425	145	1-16-67	C	D	--	--	--	--
J42	Rupert Wilson	1954	238	2	Catahoula	450	90	1-16-67	A	D	--	--	--	--
J44	J. G. Singletary	1951	260	-	Catahoula	405	--	--	J	D	4-8	1967	--	--
J46	Town of Hazlehurst	1961	925	12,8	Catahoula	455	260	5-61	T	P	225	11-2-61	--	H_2S Odor (Jackson St. Well)
J47	Lake Copiah	1964	84	4	Catahoula	385	32	2-26-64	S	D	--	--	--	--

Table 2.—Records of selected wells in Copiah County.—(Continued).

Well No.	Owner	Year Completed	Depth (Ft.)	Casing Diameter (In.)	Water bearing Unit	Elev. of land surface datum (Ft.)	WATER LEVEL Above (+) or Below Land Surface (Ft.)	WATER LEVEL Date of Measurement	Method of Lift	Use	YIELD Gallons Per Minute	YIELD Date	Temperature (°F)	Remarks
K7	J. B. Walters	1957	104	8	Citronelle	458	82	9-5-57	C	I	4	9-5-57	--	+Fe
K10	Green Bro. Gravel Co. #1	1966	224	12	Catahoula	473	160	4-67	T	I	600	4-67	--	--
KII	George Sykes	1966	202	2	Catahoula	410	102	9-66	J	D	4-8	1967	--	--
K12	Harmony Ridge Water Assn., Inc.	1967	200	9,6	Citro. & Cata.	480	118	9-12-67	T	PS	180	12-6-67	66	--
K19	Edwin Vaughn	1962	137	4,2	Catahoula	462	88	1-30-67	S	D & I	--	--	--	--
K21	T. J. Bailey	1952	330	4	Catahoula	450	160	1-26-67	C	D	2-4	1967	--	--
K26	C. E. Miller	1958	200	4	Catahoula	385	60	1958	J	D	--	--	--	--
L4	T. C. Sandifer	--	244	2	Catahoula	--	+2	9-10-57	N	D	78	9-10-57	67	Flow
L6	Henry Berry	1965	282	2	Catahoula	421	+2	8-31-65	N	D & S	5	8-31-65	--	Flow
L7	J. C. Sojouner	1965	122	4	Catahoula	370	40	3-31-65	J	D & I	60	3-31-65	--	--
L9	Gates Howard	1962	207	2	Catahoula	390	109	10-15-67	J	D	--	--	--	--
L10	Harry T. Dulancy	1952	330	3	Catahoula	340	78	1-26-67	J	D	75	1-26-67	--	--
L11	R. L. Beall	1959	254	2	Catahoula	255	+1	1959	-	D & I	--	--	--	Flow
L14	Dorsey Byrd	1968	192	2	Catahoula	335	84	6-68	J	D & S	5 1/2	6-68	--	--
MI	W. W. Dixon	1945	85	8	Terrace	315	79	1957	C	D	--	--	--	+Fe
M2	W. C. Thetford	1960	80	2	Catahoula	--	25	5-12-67	J	D & S	5	5-12-67	--	+Fe
M4	Game & Fish Comm.	1960	135	4	Catahoula	--	81	3-4-60	J	D & S	6	3-4-60	--	--
M5	Game & Fish Comm.	1960	135	4	Catahoula	--	81	3-4-60	J	D	6	3-4-60	--	--
NI	Billy R. Hall	1968	151	4	Catahoula	329	81	9-19-68	S	D & S	10	9-19-68	--	--
N2	Herman Conn	1957	300	2	Catahoula	400	120	3-10-67	C	D & S	2-4	1967	--	+Fe
N3	Thompson Barlow	1964	246	4	Catahoula	470	122	5-30-67	S	D & I	--	--		C
N4	J. W. Hodges	1966	131	2	Catahoula	308	42	3-10-67	J	D	--	--	66	C
N5	Otho Hall	1961	135	2	Catahoula	310	80	5-10-67	J	D & S	--	--	--	--
N6	Mrs. Stella Barlow	--	--	-	--	--	+1	3-10-67	N	D	--	--	--	Spring
N8	Paul Edwards	1968	107	4	Catahoula	328	67	9-30-68	S	D & S	10	9-30-68	--	--
O4	Ed McCorroy	1957	135	2	Catahoula	290	60	1957	J	D & S	4-8	1957	--	--
O5	Eugene Barlow	1961	127	4	Catahoula	382	--	--	S	D & S	--	--	--	C
O6	W. W. Thurmond	1962	241	4	Catahoula	350	70	3-10-67	J	D & S	--	--	--	--
O10	I. D. Simmons	1962	110	8	Catahoula	292	70	5-67	J	D & S	4-8	1967	--	--
O12	Eugene Newman	1942	120	8	Catahoula	370	80	5-30-67	C	D & S	--	--	--	--
O13	Bayou Pierre Water Assn.	1968	468	8,6	Catahoula	330	72	8-5-68	T	P	154	8-5-68	69	C, P

Table 2.—Records of selected wells in Copiah County.—(Continued).

Well No.	Owner	Year Completed	Depth (Ft.)	Casing Diameter (In.)	Water bearing Unit	Elev. of land surface datum (Ft.)	WATER LEVEL: Above (+) or Below Land Surface (Ft.)	WATER LEVEL: Date of Measurement	Method of Lift	Use	YIELD: Gallons Per Minute	YIELD: Date	Temperature (°F)	Remarks
P22	A.Whittington	1952	298	4	Catahoula	405	120	1952	J	D & S	4-8	1957	--	--
P23	J. E. James	1952	205	2	Catahoula	390	--	--	C	D & S	2-4	1957	--	--
P24	C. L. Freiler	1950	246	4	Catahoula	415	200	1956	C	D & S	2-4	1957	--	--
P26	U. S. Forest Service	1957	370	2	Catahoula	445	--	--	C	D & S	2-4	1957	--	--
P28	Mrs. Zola Hickman	1949	660	3,2	Catahoula	435	160	1949	J	Dairy	4-8	1957	--	--
P31	Town of Hazlehurst	1963	450	20,12	Catahoula	430	160	10-63	T	P	560	3-15-64	70	Faler St. Well
P32	Martinsville Water Assn.	1966	269	-	Catahoula	450	--	--	N	N	--	--	--	T.H. #1, Abandoned
P33	Town of Hazlehurst	1961	481	18,12	Catahoula	415	152	7-61	T	P	393	7-61	--	Gallatin St. Well
P34	Town of Hazlehurst	1959	330	18,12	Catahoula	465	216	6-59	T	P	536	6-59	--	Sealed Health Dept.Well
P38	Town of Hazlehurst	1963	291	18,12	Catahoula	460	233	8-5-63	T	P	200	1967	--	Small Well
P41	Austin Road Company	1966	244	6	Catahoula	336	48	7-28-66	S	I	--	--	--	--
P46	Town of Hazlehurst	1948	341	16	Catahoula	435	176	1948	S	P	275	1948	--	Oil Mill Well
P56	Town of Hazlehurst	1966	300	12	Catahoula	435	111	1968	T	P	350	1966	--	P (Shady Grove #1)
P57	Town of Hazlehurst	1965	295	6,4	Catahoula	435	110	11-6-67	N	O	100	1965	68	P, O (6" Observ. Well)
P58	Town of Hazlehurst	1967	358	18	Catahoula	425	118	10-4-67	T	P	350	10-4-67	68	P (Shady Grove #3)
P59	Town of Hazlehurst	1967	307	4	Catahoula	425	118	11-20-67	N	O	--	--	--	4" Observ. Well)
P61	V.F.W. Post 2567	1968	186	4,2	Catahoula	450	90	2-6-58	S	R	10	2-6-58	--	--
P62	Town of Hazlehurst	1961	1150	9,7	Forest Hill	450	--	--	T	N	--	--	--	Test Well 6D
Q2	S & W Poultry Company	1956	260	3	Catahoula	328	60	1956	J	D & S	4-8	1957	--	--
Q3	George Marx, Jr.	1957	325	4	Catahoula	463	137	1957	S	D	18	1957	--	--
Q11	Town of Hazlehurst	1967	351	18,8	Catahoula	458	135	11-20-67	T	P	300	1967	--	Shady Grove #2
Q12	J. T. Sanderson	1963	300	2	Catahoula	375	70	4-20-67	J	D & I	4-8	1967	--	C
Q14	Walter Gandy	1955	325	2	Catahoula	420	--	--	C	D	--	--	--	C
R1	C. A. Roper	--	150	2	Catahoula	--	+1	1957	N	S	1	1957	68	Seismograph Hole
R4	B. F. Cammack	1951	183	4	Catahoula	--	+2	1951	N	D	6	1951	68	--
R5	W. R. Beasley	1956	396	2	Catahoula	--	+1	9-11-57	N	D	4	9-11-57	68	--
R8	Town of Georgetown	--	800	-	Catahoula	236	+2-3	1967	N	P	--	--	--	Colored Water
R9	Town of Georgetown	1965	761	6,4	Catahoula	236	+3-4	3-11-67	T	P	100	1968	74	Colored Water
R15	Mrs. L. H. Armstrong	1955	155	4	Catahoula	220	+1	1955	J	N	4-8	1967	--	+Fe
S4	G. B. Newell	1966	169	2	Catahoula	435	80	5-12-67	J	S	8-10	1967	--	--
S5	A. V. Leonard	1960	112	2	Catahoula	270	52	5-12-67	J	D & S	8-10	1967	--	+Fe
S7	R. L. Leonard	1964	100	4	Catahoula	290	25	5-12-67	J	D & S	20	5-12-67	--	--
S8	A. N. Del Rosso	1964	160	2	Catahoula	360	114	5-9-67	J	D & S	8-10	1967	--	--

Table 2.—Records of selected wells in Copiah County.—(Continued).

Well No.	Owner	Year Completed	Depth (Ft.)	Casing Diameter (In.)	Water bearing Unit	Elev. of land surface datum (Ft.)	Water Level: Above (+) or Below Land Surface (Ft.)	Water Level: Date of Measurement	Method of Lift	Use	Yield: Gallons Per Minute	Yield: Date	Temperature (°F)	Remarks
T2	M. M. Price	1928	100	6	Citronelle	490	90	5-19-67	C	D	2-4	1967	--	+Fe
T6	Garland Pitts	1965	110	4	Citronelle	495	82	5-9-67	S	D	10	1965	--	--
T8	Mrs. John R. Price	1964	115	8	Citronelle	475	101	3-10-67	C	D & S	2-4	1964	--	+Fe
T9	J. C. Shannon	1966	159	4	Catahoula	485	--	--	J	D	4-8	1966	--	--
U1	E. O. Smith	1957	130	2	Catahoula	470	120	5-30-67	J	D & S	4-8	1967	--	--
U2	I. W. Tanner	1961	180	2	Catahoula	360	98	4-26-67	J	D & S	4-8	1967	--	--
U3	Mrs. Tom Miller	1958	297	2	Catahoula	352	--	--	C	D & S	2-4	1967	--	--
U5	Pete Bland	1962	375	4	Catahoula	350	28	5-30-67	J	D & I	4-8	1967	--	+Fe
U6	G. S. Towns	1948	122	7	Catahoula	365	6	5-28-67	J	D & S	4-8	1967	--	+Fe
U7	R. A. Sandifer	1960	495	-	Catahoula	385	-	--	C	D & S	2-4	1967	--	--
V1	B. R. Duckworth	1956	120	8	Catahoula	--	100	1956	J	D	4-8	1957	--	--
V4	W. T. Miller	1956	286	4	Catahoula	--	110	1956	C	D & S	2-4	1957	--	--
V5	C. H. Hamilton	1957	453	2	Catahoula	--	297	1957	C	D & S	2-4	1957	--	--
V6	Reece May	1956	261	2	Catahoula	--	191	1956	C	D & S	2-4	1957	--	--
V7	Austin Road Company	1966	386	6,4	Catahoula	350	56	10-7-66	S	I	100	10-7-66	--	--
V10	J. R. Jackson	1964	127	2	Catahoula	335	97	5-8-67	J	D	4-8	1967	--	--
W1	W. P. Foster	1956	420	2	Catahoula	--	60	1956	J	D & S	4-8	1957	--	--
W2	M. L. Cagle	1955	407	2	Catahoula	320	39	1955	J	D & S	4-8	1957	--	--
W3	W. J. Butler	1953	407	2	Catahoula	330	48	4-25-67	J	D	4-8	1957	--	--
W7	William Dungan	1957	511	3,2	Catahoula	400	111	4-25-67	C	D & S	2-4	1967	--	--
W12	Early Leggett	1955	300	2	Catahoula	340	90	4-26-67	J	D & S	4-8	1967	--	--
W13	Zion Hill Baptist Church	1965	595	2	Catahoula	415	--	--	C	P	2-4	1967	--	--
W15	J. V. Elkins	1962	120	2	Catahoula	320	50	4-26-67	J	D	4-8	1967	--	--
W17	J. P. Martin, Jr.	1967	429	2	Catahoula	339	62	12-22-67	J	D	5	1967	--	--
X3	George F. Page	1951	502	2	Catahoula	218	+42	4-27-67	N	D & S	10	4-27-67	--	Low Fe
X4	L. J. Watts	1959	175	2	Catahoula	310	40	4-27-67	J	D & S	4-8	1967	--	+ Fe
X5	C. B. Cagle	1959	116	2	Catahoula	310	20	1959	J	D & S	4-8	1967	--	--
X6	F. A. Barlow	1937	84	8	Citronelle	330	76	1967	J	D	4-8	1967	--	--
X10	A. C. McCardle, Jr.	1959	410	2	Catahoula	435	180	1967	C	D & I	2-4	1967	--	+ Fe

Alluvium and Terrace Deposits

Alluvial deposits underlie most all of the major streams in the area (see Geologic Map). Thicknesses of these deposits are from a few feet along the smaller stream valleys to about 50-70 feet in the Pearl River and Bayou Pierre valleys. Alluvial deposits are composed of sand, silt, clay, gravel and mixtures of these. Local, shallow, domestic wells are screened in the alluvial aquifers, but generally the deposits are not continuous enough for large wells in Copiah County. In specific locations, the alluvium may contain fairly large bodies of sand which could furnish several large wells. Test drilling should be initiated to determine the presence, thickness and areal extent before any plans are made for completing large wells in the alluvium. Most water in the alluvium is under water table conditions and the water level fluctuates with precipitation.

Terrace deposits cover a large portion of Copiah County (see Geologic Map). These deposits cap most of the hills and frequently the hillsides, masking a large percentage of the bed rock outcrops. Thicknesses of the terrace deposits are from 10-30 feet. The terrace deposits contain sand, sandy clay, clay, gravel and mixtures of these. This is similar to the composition of the alluvial deposits. Local, domestic wells are completed in the terrace aquifers, but generally the terraces will not supply large wells.

Citronelle Formation

The Citronelle deposits occur typically at high elevations, above 400 feet, and cover a large portion of Copiah County (see Geologic Map). The Citronelle is composed primarily of gravel and sand with scattered clay lenses. The thicknesses of the Citronelle deposits are from 20 to 80 feet, but the Citronelle is usually missing in the valleys due to erosion. Large wells, 250-700 gpm, are completed near the base of the Citronelle in the vicinity of Crystal Springs.

The water level in the Citronelle is generally low in the vicinity of Crystal Springs, therefore, large yielding wells have to be screened in a zone that will yield a large amount of water to the wells without excessive drawdown. The town of Crystal Springs, the various gravel mining operations and a large vegetable canning plant, all in the northern part of the County, have wells completed in the Citronelle aquifer.

Miocene Deposits

The Hattiesburg and Catahoula deposits of Miocene age have the potential for supplying large amounts of water in Copiah County (table 1). The majority of the wells in the middle and southern part of the County are completed in these aquifers. The Miocene deposits (Hattiesburg and Catahoula undifferentiated) are composed of sand, sandy clay, clay and occasionally gravel. The sand beds are typically lenticular in outline and are not continuous in any large area. Most of the sand is fine-grained to medium-grained with most sand being slightly fine-grained. Thicknesses of the individual sand beds are from 6-270 feet.

Test drilling is recommended to determine the thickness and extent of Miocene aquifers before wells and well fields are planned for a particular location. Generally, the aquifers thicken and thin every few miles across the County.

The wells for the town of Hazlehurst and several rural water supply wells are completed in Miocene aquifers. The town of Wesson's water supply is from a series of springs a few miles east of town. Large wells are possible in the Wesson area and test drilling should prove the presence of thick sands in that general area. An electrical log on the Wesson Dome located one-half mile east of town indicated the following sand intervals below land surface: 382-480; 730-785; 835-855 and 1230-1258.

Test Drilling

The Mississippi Geological Survey drilled a total of nine test holes in the ground-water investigation of Copiah County (fig. 3). Most of the drilling was in the vicinity of Crystal Springs and Hazlehurst because of the heavy pumpage in these areas. The holes were drilled, electrically logged, and the drill cuttings placed in the State's sample library for additional study.

Four test holes were drilled in the vicinity of Crystal Springs for the purpose of locating Miocene aquifers which could be used for additional industrial or municipal supply. Results of the tests revealed several aquifers of varying thickness which could possibly be used as a source for water supplies. The

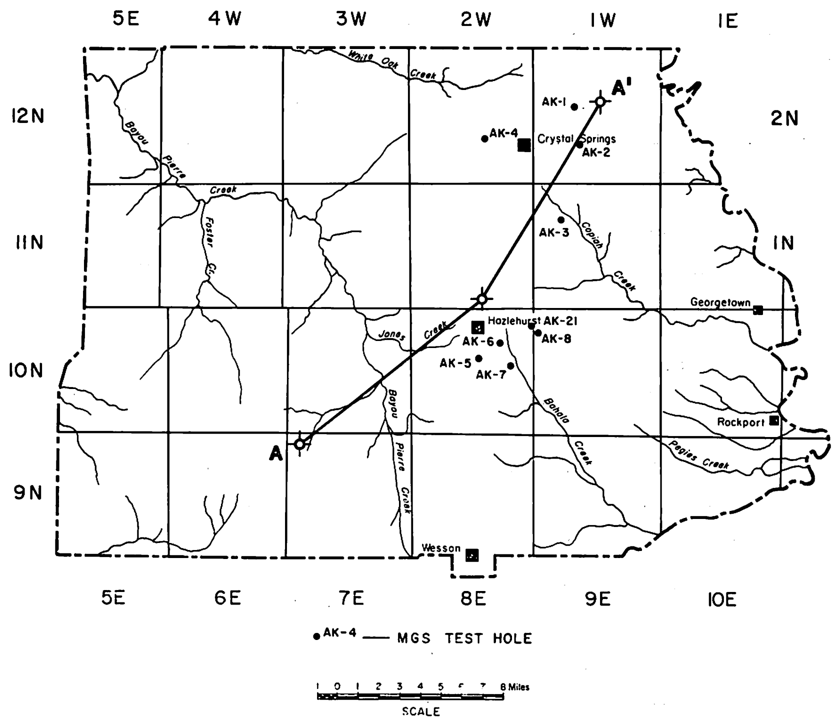

Figure 3.—Location of test holes drilled by Mississippi Geological Survey in the ground-water investigation and location of cross-section A-A′.

following table is a list of the wells with elevations above sea level, well depth, and the sand intervals picked from electrical logs (one drillers log—AK-1).

Well No.	Elevation	Well Depth	Sand Intervals
(AK-1)*	410	370	210-220 260-270 290-300 320-330 340-370
E35 (AK-2)	355	610	60-70 77-126 142-150 153-160 213-228 264-292 336-351 362-375 394-402
K28 (AK-3)	265	650	16-64 79-95 180-186 188-212 220-224 230-237 264-284 310-326 374-384 582-600
D26 (AK-4)	342	530	5-12 16-29 101-140 148-158 231-259 261-315 (366-380 380-390 410-420 430-530)*

* Drillers Log

Test Hole AK-4 (D26) indicated about 100 feet of sand of which the bottom 70 feet was coarse-grained. The shallow Citronelle aquifer presently being used in the vicinity of Crystal Springs probably offers the largest quantity of water at the most economical cost for municipal and industrial use. Detailed deeper drilling in the vicinity of Crystal Springs should reveal thick sand bodies in the deeper Miocene deposits. Thick Miocene sands are indicated by electrical logs from wells a few miles from Crystal Springs.

Five test holes were drilled in the vicinity of Hazlehurst to delineate the 250-350 foot aquifer of Miocene age which furnishes most of the water supplies in that area. Over the years, the town of Hazlehurst has drilled numerous test holes 400-500 feet deep to locate additional ground-water supplies within the city limits.

One test hole (J28) was drilled by the town in 1964 to a depth of 2798 feet, commercially logged, a pumping test run and a water sample was obtained from two sands in the Kosciusko aquifer near the bottom of the well. The water from the Kosciusko was found to contain 241 ppm color and the transmissibility as determined by a pumping test was 8000-10,000. This is a low transmissibility.

The test holes drilled near Hazlehurst by the Survey were located to the east and southeast of Hazlehurst (fig. 3) as no information was available in that area. Drilling results indicated that the 250-350 foot aquifer (principal aquifer for Hazlehurst) thins toward the east until it is indistinguishable about one mile from the center of town. The aquifer thickens to a maximum thickness of 88 feet (P63) in the vicinity of Shady Grove which is about four miles east of town. East of Shady Grove electrical logs indicate that the sand thins and it is reasonable to assume that it would thicken again in a few miles further east.

The following is a summary of the test holes drilled in the vicinity of Hazlehurst with well numbers, elevations, depths and sand intervals as taken from electrical logs.

Well No.	Elevation	Well Depth	Sand Interval
P42 (AK-5)	390	400	43-56 76-134 226-274 261-268
P43 (AK-6)	374	410	102-140 210-215 218-240 249-259 348-358
P44 (AK-7)	347	400	70-92 98-111 156-184 206-212 226-232 234-246 330-340 346-354
Q19 (AK-8)	430	350	10-30 146-184 262-315
P57	429	320	6-14 136-164 238-320
P59	425	340	6-26 130-200 273-332
P63 (AK-21)	445	349	6-22 86-94 96-109 116-166 185-192 232-320

The results of the test drilling, including previous drilling by the town, confirmed that the principal aquifer at Hazlehurst is a typical lenticular body. The aquifer is thick and continuous enough at Shady Grove to furnish large quantities of water to wells and well fields by following proper well spacing techniques. In all probability, additional wells can be drilled in the area by going a few miles farther east and north of the present well field at Shady Grove or a few miles (4-6 miles) to the west of Hazlehurst.

AQUIFER AND WELL HYDRAULICS

Transmissibility Permeability and Storage

Well production varies for a variety of reasons which include pump size, casing size, screen size, pump setting, water level and the hydraulics of the aquifer (amount of water that the aquifer will yield to the well). Well production is generally based on immediate need and provides no more than a hint of the aquifer potential. Most contracts on large wells in Mississippi are based on yield, and providing a specified yield is the responsibility of the contractor.

Aquifer and well characteristics may be found by means of pumping tests. A pumping test consists of pumping a well at a specified rate and observing the effects on the water level in the well being pumped and in any nearby observation wells which are screened in the same aquifer. Pumping tests provide valuable data on which the selection of the proper pumping equipment can be based. Properly planned and carefully controlled pumping tests reveal important facts about the ground-water reservoir which include transmissibility, permeability and storage coefficient. Production and specific capacity are a function of well characteristics and are revealed in analyzing the results of pumping tests. Quantitative values can be assigned to the ground-water resource only through knowledge of aquifer hydraulic characteristics. The following define the aquifers hydraulics in mathematical terms and help in comparing aquifers in the general area.[1]

Transmissibility (T) is the rate of flow of water through a vertical strip of the aquifer one foot wide under a hydraulic gradient of one foot per foot. Units are gallons per day per foot. Transmissibility is the index of an aquifer's ability to transmit water. An aquifer having low transmissibility has a high resistance to the flow of water; hence; wells tapping such aquifers generally have low specific capacities. Wells tapping aquifers having high transmissibility generally have large specific capacities.

Permeability (P) is the rate of flow of water through a one-foot-square section of the aquifer under the unit hydraulic gradient. Its units are gallons per day per square foot. It is commonly obtained by dividing the transmissibility by the aquifer thickness in feet.

Coefficient of storage (S) is a dimensionless figure that relates the volume of water an aquifer releases from storage per unit of surface area to the unit decline in the component of head normal to that surface. The coefficient of storage is an index of the amount of water released from storage in the aquifer. In conjunction with T it can be used to estimate the long- or short-term relationship between well yield and the consequent drawdown of the artesian surface. Storage coefficient of the artesian aquifers in Copiah County is estimated to be about .00001 which is about average for aquifers in the State.

Well Production is the pump discharge or flow of a well, in gallons per minute.

Specific capacity is the number of gallons per minute a well produces for each foot of drawdown, or lowering of the water level. It is obtained by dividing into the discharge rate the difference between static water level and pumping water level and is usually calculated for a one-day period to provide comparative values.

The practical application of measured or assumed aquifer characteristics is in predicting the yield from wells and the effect of ground-water withdrawal. Well characteristics affect the cost and economics of providing ground-water supplies.

It is important to know the potential of aquifers and to construct efficient wells that take the most favorable advantage of the aquifer potential.

Thirteen pumping tests were run on wells in Copiah County. The majority of the tests were run in the vicinity of Crystal Springs and Hazlehurst where most of the large wells are located (fig. 4). Several pumping tests were run on the supply wells of the rural water systems scattered over the County. Aquifer and well characteristics obtained in the tests (Table 3) represent most of the aquifers which are used in Copiah County. It is extremely difficult to predict values of transmissibility and permeability for a aquifer in a particular area of need. The aquifers are generally irregular in extent, thickness, and grain size distribution.

Pumping tests of aquifers in the County indicate that transmissibilities range from 4800 to 169,000 gpd (gallons per day)

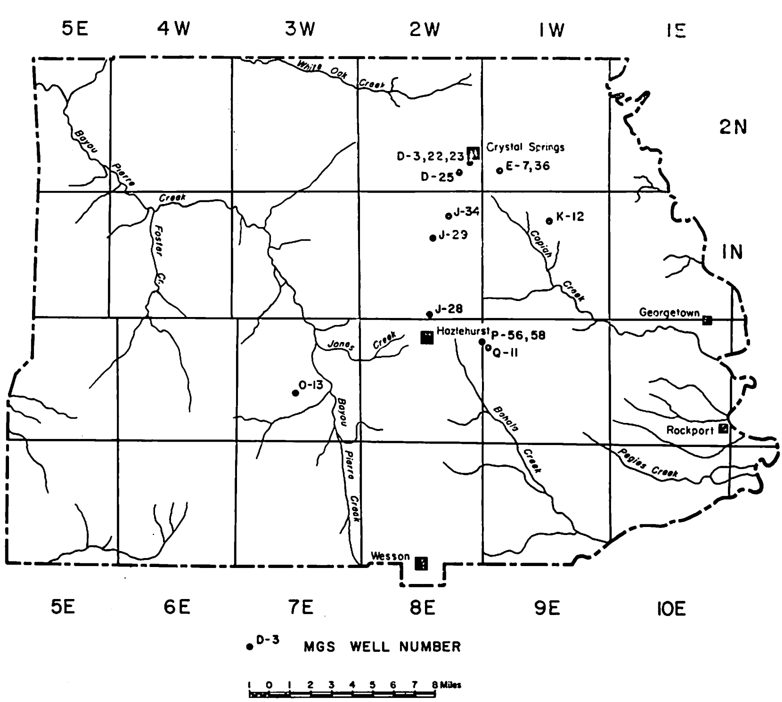

Figure 4.—Location of aquifer-tests in Copiah County.

Table 3.—Aquifer and well characteristics determined from pumping tests in Copiah County.

Well No.	Location of Test	Water-bearing Unit	Depth of Well (Ft.)	Aquifer Thickness (Ft.)	Coefficient of Transmissibility (gpd/ft.)	Coefficient of Permeability (gpd/ft.^{2})	Specific Capacity (gpm/ft. at the end of 24 hours)
D3	Town of Crystal Springs	Citronelle	108	36	55,000	1528	12.1
D22	Town of Crystal Springs	Citronelle	107	35	67,000	1914	32.3
D23	Town of Crystal Springs	Citronelle	107	23	32,000	1392	16.2
D25	South of Town of Crystal Springs	Citronelle	90	20	19,000	950	6.4
E7	Southeast of Town of Crystal Springs	Citronelle	116	80	169,000	2110	42.0
E36	Southeast of Town of Crystal Springs	Citronelle	120	86	163,000	1900	66.5
J28	Town of Hazlehurst, Test Well	Kosciusko	2575	100	8,000-10,000	80	2.0
J29	Town of Gallman	Catahoula	215	50	30,000	600	7.6
J34	Truck Crops Experiment Station	Citronelle	217	62	4,800	77	--
K12	Harmony Ridge	Catahoula	200	44	22,000	500	--
O13	Glancy, Bayou Pierre Water Assn.	Catahoula	468	52	11,000	212	5.1
P56	Shady Grove, #1	Catahoula	300	64	63,000	985	28.5
P58	Shady Grove, #3	Catahoula	358	68	32,000	470	14.5
Q11	Shady Grove, #2	Catahoula	351	65	43,000	660	24.9

per foot. In most artesian aquifers in Mississippi about .00001 cubic foot of water is released from storage per square foot of land area per foot drop in water level in the aquifer. The amount of storage is considerably higher, up to .3 cubic foot of water in water table aquifers.

One pumping test was run on the Kosciusko aquifer (Sparta) in a deep (2577 feet) test well for the town of Hazlehurst. The transmissibility was revealed to be about 8000-10,000 gpd per foot which is fairly low. Deep electrical logs (fig. 6) indicate that the Kosciusko is generally not a good aquifer and particularly the depth prohibits inexpensive well construction.

From electrical logs the Cockfield formation is estimated to have a lower capacity of transmissibility or capacity for yielding water to wells than the Kosciusko aquifers. Fairly large (200-300 gpm) producing wells in the Cockfield may be possible in the vicinity of the Hinds County line as the aquifer appears thicker with a higher transmissibility as indicated by the electrical logs in the area. Water from the Cockfield is reported to be highly colored in the northern part of Copiah County.

Transmissibility of the Miocene aquifers range from 4800 to 63,000 gpd per foot. Generally, the Miocene aquifers have an average transmissibility of about 30,000 gpd per foot. This will hold true provided an aquifer can be located with 30-40 feet of medium to coarse sand in the Miocene deposits.

Transmissibility of the Citronelle aquifer in the vicinity of Crystal Springs ranges from 19,000 to 169,000 gpd per foot as indicated by pumping tests. The wide variation in transmissibility is believed to be the result of the irregular character of the aquifer material.

Yields and Specific Capacities of Wells

Yields for the larger wells range from about 100 to 400 gpm (table 2). Well yields are ordinarily of little value in predicting aquifer performances. Wells are usually constructed to provide a specific amount of water and seldom develop the full potential of an aquifer. The majority of the larger wells (300-400 gpm) in Copiah County are constructed for municipal and industrial use in or near the towns (fig. 2). Most of the rural water system wells are designed to produce about 125-175 gpm. Electrical logs in the area indicate that shallow, thick beds of sand are present at various horizons which could supply fairly large capacity wells (300-400 gpm) with proper spacing and pumping procedure. Wells capable of producing 200-300 gpm and slightly higher yields are possible throughout most of the County. Test drilling is recommended at most locations because of the lenticular nature of the deposits.

Measured specific capacity of wells in Copiah County range from two to thirty-two gpm per foot. Specific capacity reflects both well construction and transmissibility of the aquifer and, therefore, should not be used to define aquifer characteristics.

WATER LEVELS AND MOVEMENT

Water levels range from above the land surface along the Pearl River to about 170-200 feet below land surface at Hazlehurst in the center of Copiah County. Most water levels are fairly shallow in the County with the exception of the Hazlehurst area, and generally the water level will be about the same level as the streams in the area. Deep water levels can be expected at higher elevations reflecting the elevation difference. Flowing wells are located along the Pearl River Valley in Copiah County where the elevation is low enough for the artesian pressure to force the water levels above the land surface. Occasionally a flowing well is reported in some of the deeper valleys in the interior of the County.

Water levels in the Miocene aquifer at Hazlehurst are deeper than normal as a cone of depression has been formed because of the large withdrawal of ground water in a relatively small area. The net drop in water level has been about one foot or less per year. The town recently (summer 1968) began pumping from a new well field near Shady Grove (approximately four miles to the east) and the pumpage from the new field should permit the water level in the downtown well field to recover. Two observation wells were completed in the principal aquifer at Shady Grove and one was equipped with a water level recorder to determine the trend of the water level over a long period of time. A water level recorder was installed in an abandoned well in the downtown well field. The water level is expected to decline at about one to one and one-half feet per year in the principal aquifer at Hazlehurst. A hydrograph of the water level on Well No. P-57 (fig. 5) illustrates the water level trend in the new well field at Shady Grove.

Water levels in the Citronelle aquifer in the vicinity of Crystal Springs have remained fairly constant with a drop of less than one foot per year. The water level at Blain Gravel and Sand Company Well No. E-31 (after well was installed) was 84 feet below land surface which is about the same level as the local streams. The town of Crystal Springs along with the gravel mining industry southeast of Crystal Springs pump large volumes of water from the Citronelle aquifer. Most of the water used in the gravel mining operation percolates and filters back into the highly permeable gravel. A large gravel pit

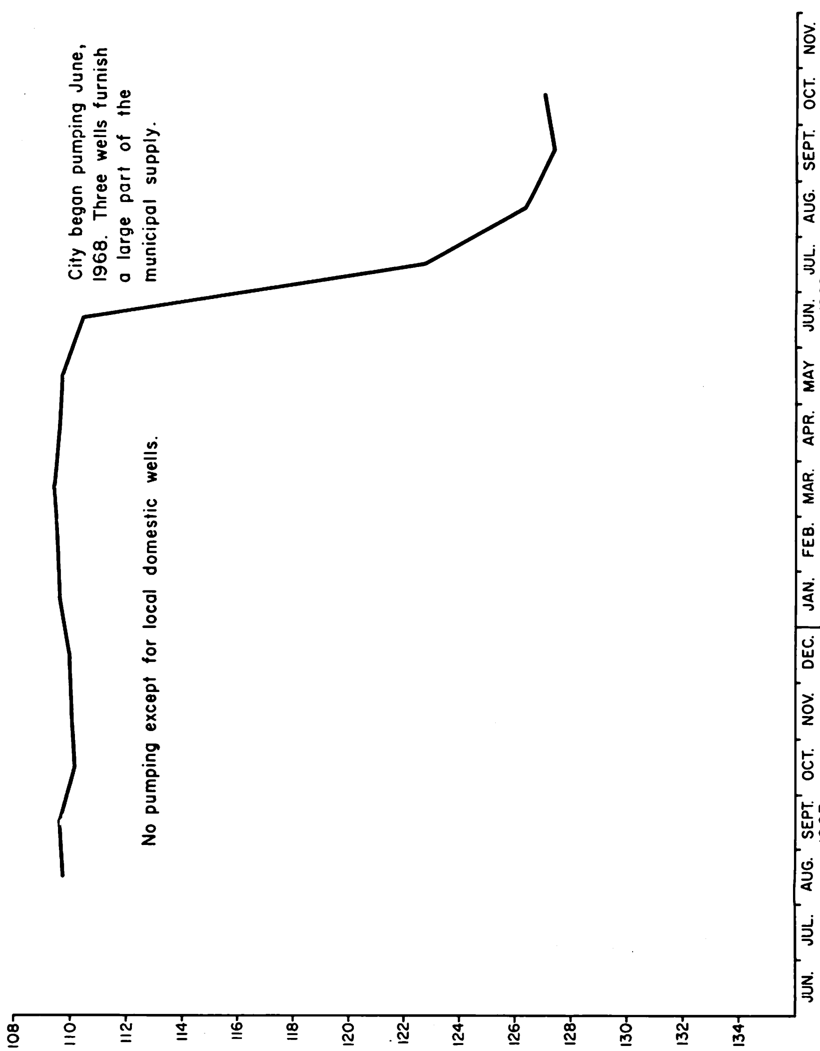

Figure 5.—Hydrograph of Town of Hazlehurst observation well (P-57) at Shady Grove.

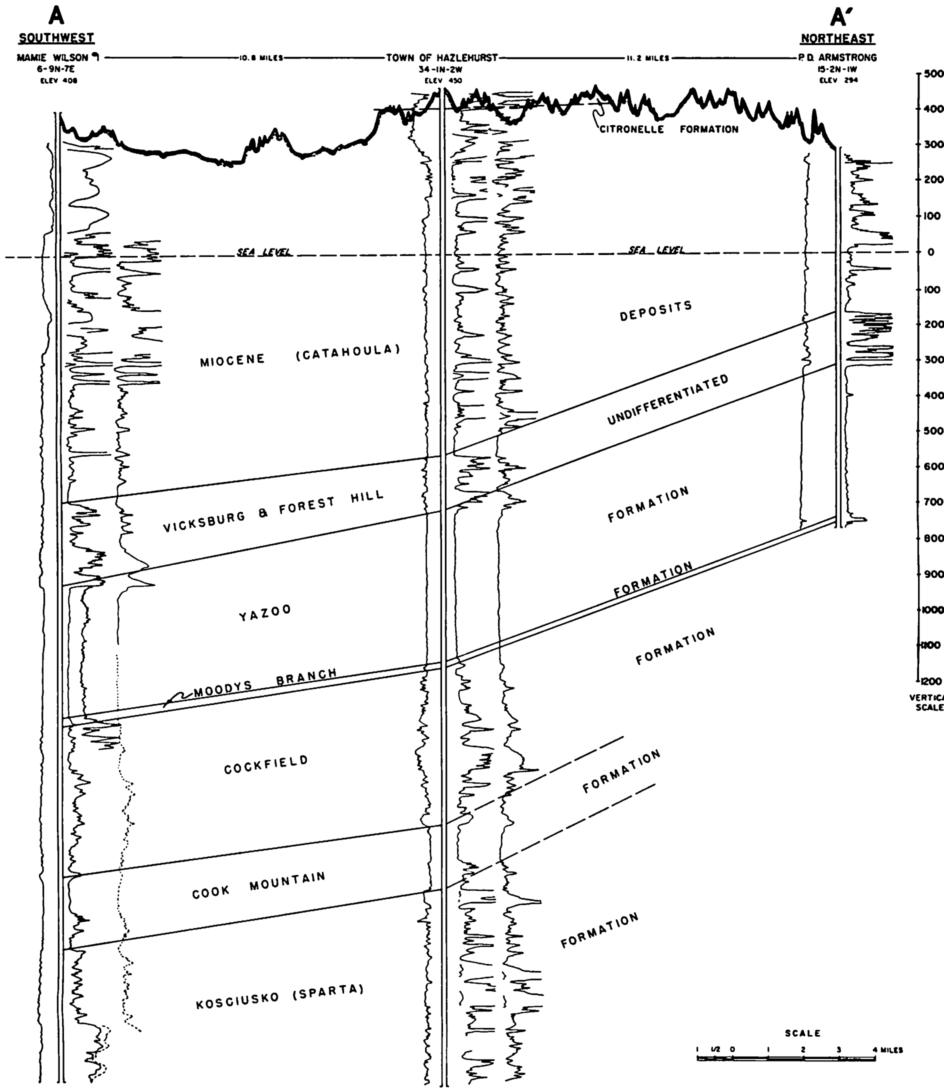

Figure 6.—Geologic cross-section A-A′.

southeast of Crystal Springs containing 10-20 feet of water was abandoned in the spring of 1968. The pit was completely dry in about two weeks as the water had percolated through the gravel base, emptying the pit.

The aquifers that underlie Copiah County are recharged several miles to the north and within the County (fig. 6). (See Geologic Map). The deeper the aquifers, the farther north is the surface recharge area. The 350 foot aquifer at Hazlehurst is probably replenished in an east-west band, ten to fifteen miles to the north. Some people have the idea that these aquifers are recharged many miles away in north Mississippi.

The movement of ground water is slow, only a few feet per year, and local droughts do not immediately cause a decline in the water levels of the artesian aquifers. The local terrace, alluvium and occasionally the Citronelle aquifers are directly affected by rainfall and their water levels vary according to precipitation.

Generally, ground water enters the recharge area and slowly moves down the dip of the aquifers in a southwesterly direction. Recharge is also through overlying sandy deposits and by intermovement between permeable aquifers under the right conditions.

Heavy pumping in a small area generally lowers the water level which in turn requires deeper settings for pumps. The steeper gradient of the water level increases the flow of water toward the wells. The deep water levels increase the pumping cost per unit volume of water and should be considered in designing wells and well fields. Well interference should be minimized by spacing wells optimum distances apart consistent with economy. Planned pumping schedules that distribute withdrawals among wells or well fields will help alleviate the water level decline.

QUALITY

The chemical character of ground water is determined chiefly by the minerals in the soil and rock in which it is found and by the length of time it is in contact with them. Differences in the quality of ground water reflect differences in the geologic environment of the water-bearing formations or aquifers. Water from shallow aquifers which are recharged only a short distance away is less mineralized (tables 5 and 6) than water from deep aquifers where the water is derived from distant sources.

Time of contact of the water with the aquifer material affects the amount of the different minerals that are dissolved.

In general, water from wells screened in highly permeable sands contains less dissolved solids than water from wells screened in sands with low permeabilities, provided the wells are the same depth.

As water moves down the dip it exchanges calcium to the aquifer material for sodium, and changes from a moderately hard water having low dissolved solids near the outcrop areas to soft water having higher sodium and dissolved solids concentration at greater distance down the dip. Most of the shallow

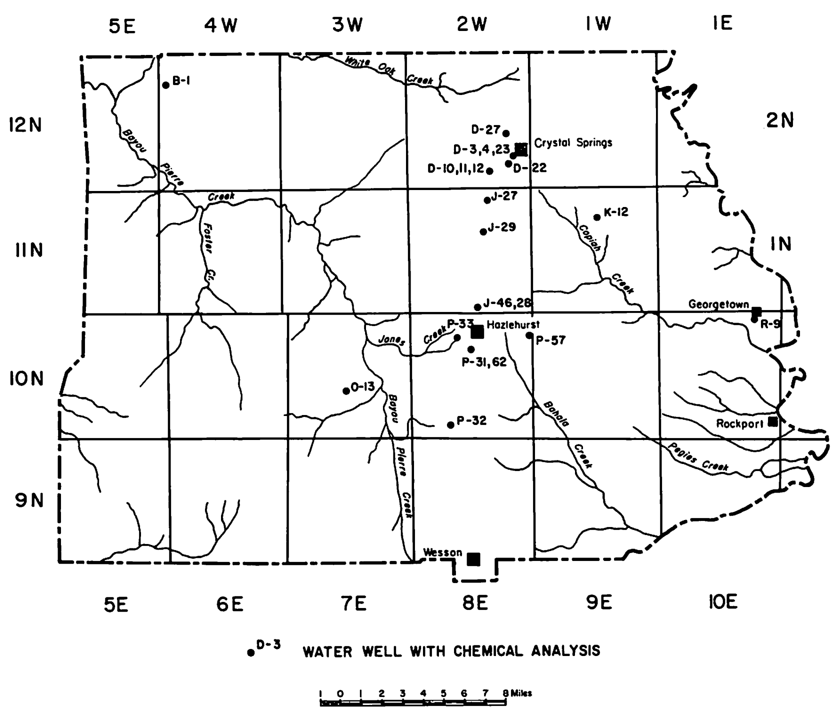

Figure 7.—Location of wells where chemical analyses are available in Copiah County.

wells (20-100 feet deep) in Copiah County yield water that is moderately hard with low dissolved solids (table 4) (fig. 7). The deeper wells yield water that is soft, containing a higher concentration of dissolved solids and considered to be a sodium-bicarbonate type (table 4).

Table 4.—Chemical analyses* of water from wells in Copiah County.

Well No.	Depth (Ft.)	Water bear-ing Unit	Date Analyzed	Silica (SiO_2)	Iron (Fe)	Cal-cium (Ca)	Sodium and Pot-assium (K) as Sodium (Na)	Sulfate (SO_4)	Chloride (Cl)	Flouride (F)	Total Dissolved Solids	Total Hardness as ($CaCO_3$)	pH	Color	Temperature (0° F)
B1	250	Catahoula	9-5-58	--	.2	--	--	--	7	--	--	150.0	7.5	--	--
D3	108	Citronelle	1-17-61	.8	Trace	18.91	24.75	25.51	61	0.1	145.63	74.8	5.3	--	--
D4	108	Citronelle	1-17-61	.4	Trace	7.21	2.99	12.02	24	0.1	59.24	34.8	5.3	--	--
D10	242	Catahoula	9-30-65	--	.1	1.20	62.26	53.98	9	0.2	176.20	4.0	6.1	5	67
D11	86	Citronelle	9-30-65	--	--	--	11.46	--	12	0.1	28.37	Trace	5.2	5	66
D12	117	Citronelle	9-30-65	--	--	--	13.07	3.45	12	0.1	33.43	Trace	5.2	5	66
D22	107	Citronelle	1-17-61	.8	Trace	6.73	10.21	16.13	18	0.1	64.49	34.0	5.4	--	--
D23	107	Citronelle	8-7-63	6.0	.2	7.21	8.18	17.88	15	--	67.90	37.0	5.2	--	66
D27	128	Citronelle	1-20-66	--	.2	--	--	--	37	--	--	24.0	6.3	--	--
J27	158	Citronelle	6-22-64	2.0	Trace	1.51	5.69	--	13	--	33.70	15.0	5.4	5	68
J29	215	Catahoula	1-9-67	--	.15	2.00	13.84	11.52	10	0.3	42.76	5.0	5.2	5	64
J46	925	Catahoula	1-30-62	2.8	--	1.6	53.59	9.71	3	0.8	135.27	4.0	8.4	30	75 Odor H_2S
K12	200	Citronelle-Catahoula	10-4-68	2.4	.2	3.61	6.48	--	10	0.1	27.89	9.0	5.4	5	66
O13	468	Catahoula	11-29-66	--	.3	--	--	--	8	--	--	Trace	6.9	--	--
O13	150	Catahoula	11-9-66	--	.1	--	--	--	30	--	--	14.0	5.3	--	--
P31	450	Catahoula	10-15-63	--	.3	--	--	--	--	--	--	--	7.6	--	70
P32	269	Catahoula	2-6-67	--	3.0	--	--	--	--	--	--	30.0	6.8	--	--
P33	481	Catahoula	8-16-62	10.4	.1	1.6	56.58	17.12	3	0.3	152.29	4.0	7.1	--	69
P57	298	Catahoula	7-8-65	--	.35	.80	--	--	10	--	--	16.0	5.4	5	68 Odor H_2S
P62	1150	Forest Hill	7-14-61	1.2	--	1.92	274.62	--	13	0.8	621.21	4.8	8.9	480	--
R9	761	Catahoula	1-23-67	4.4	--	--	237.23	14.48	11	0.8	559.02	Trace	8.6	250	74
Wesson's Springs		Citronelle	9-14-60	4.8	.3	1.28	14.03	Trace	2	--	25.21	3.2	5.4	--	--

*Chemical analyses from Mississippi State Board of Health

Table 5.—Source and significance of common mineral constituents and physical properties and characteristics of water. [11]

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. Water from wells generally contains more silica than water from lakes and streams.

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. U. S. Public Health Service standards set a limit of 0.3 ppm Fe and 0.05 ppm Mn in water used for interstate carriers. Iron can be removed by aeration, precipitation, 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 available hydrogen ions. Calcium and magnesium are the principal cause of hardness of water and contribute to the formation of scale in pipes, boilers, and hot-water heaters and form an objectionable curd with soap.

Sodium (Na) and potassium (K).—Compounds of sodium and potassium are abundant in nature and are highly soluble in water. Some ground water that is hard may, in passing through rock formations, undergo base exchange and become soft at greater depths.

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 where the alkalinity affects the corrosiveness of water.

Sulfate (SO^4).—Sulfate is dissolved mostly from soils and beds of shale and gypsum. In combination with calcium and magnesium, sulfate contributes in formation of hard scale and affects industrial use of water.

Chloride (Cl).—Chloride is in nearly all water in varying amounts. The chlorides of calcium, magnesium, sodium, and potassium are readily

Table 5.—(Continued)

soluble. Drainage from sewage, salt springs, and oil fields and other industrial wastes may add large amounts of chloride to streams and ground-water reservoirs. Small quantities of chloride have little effect on the use of water. Chloride imparts a salty taste with threshold varying with the individual.

Fluoride (F).—In nature fluoride occurs in fluorspar, cryolite, and some other minerals. Most natural water contains a little fluoride. U. S. Public Health Service drinking water standards recommend a limit varying from 0.7 to 1.0 ppm in areas having an annual average maximum daily temperature of 70.7 to 79.2 deg. F. According to Dean (1936), fluoride in large 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.

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. A national Research Council report by Maxcy (1950) 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.—Although the residue on evaporation to dryness does not coincide completely with the original material in solution, it is generally used synonymously with dissolved solids. Residue on evaporation includes organic matter and some water of crystallization. Few industrial processes can tolerate water containing an excess of 1,000 ppm dissolved solids.

PHYSICAL PROPERTIES AND CHARACTERISTICS

Color.—Color refers to the appearance of water that is free of suspended matter. It results 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; however, for many industrial purposes color is objectionable. It may be removed from water by coagulation, settling, and filtration.

Hydrogen-ion concentration (pH).—The pH is a measure of the activity of hydrogen ions in solution. A pH of 7.0 indicates a neutral solution. Values progressively lower than 7.0 denote increasing acidity, and those above 7.0 denote increasing alkalinity. As pH increases, the corrosiveness of water normally decreases, although excessively alkaline water may be corrosive to some metal surfaces. pH has

Table 5.—(Continued)

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 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 in tables of analyses is in degrees Fahrenheit and represents the temperature of the water at the time of sampling. Most ground-water measurements were made at the well head after sufficient water had been withdrawn to represent the approximate temperature in the formation. Ground water in a given locality is generally of constant temperature. The average temperature of water at shallow depths generally is about the same as the mean annual air temperature. It increases with depth at the rate of 1° for each 75 to 80 feet.

Corrosiveness.—A water that attacks metal is said to be corrosive. It frequently results in "red water," caused by precipitation of iron; however, not all red water is the result of corrosion. Water from some formations contains considerable iron in solution, which on being exposed to the air, precipitates readily and gives a red-water effect. Acidic waters are capable of causing corrosion of water pipes and water-heating systems. Preventive measures involve control of these active agents or minimizing their effects, and includes maintaining proper pH of the treated water. Electrolysis control inside steel reservoirs and protective coating on metal surfaces also are used for protection against corrosion. Free carbon dioxide and other gases normally are removed by aeration and, if necessary, neutralized by the addition of either lime or soda ash.

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 calcium carbonate equivalent. Carbonate hardness or "temporary hardness" is hardness equivalent to the bicarbonate and carbonate. "Permanent" or noncarbonate hardness is caused by the combination of calcium and magnesium with other ions. Scale caused by carbonate hardness usually is porous and easily removed, but that caused by non-carbonate 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 60 ppm or less is soft; 61 to 120 ppm is moderately hard; and more than 120 ppm is hard.

Table 6.—Water-quality tolerance for industrial application.

(American Water Works Association, 1950, Water quality and treatment, 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	(?)	...	...	...	C
Boiler feed:										
0-150	20	80	...	...	...	75	...	8.0+	3000-1000	
150-250	10	40	...	...	...	40	...	8.5+	2500-500	
250 psi and up	5	5	...	...	...	8	...	9.0+	1500-100	
Canning:										
Legumes	10	...	0.2	0.2	0.2	25-75	...	...	...	C
General	10	...	0.2	0.2	0.2	...	...	...	...	C
Carbonated beverages 3/	2	10	0.2	0.2	0.3	250	50	...	850	C
Confectionery	...	...	0.2	0.2	0.2	...	...	(4)	100	...
Cooling 5/	50	...	0.5	0.5	0.5	50	...	...	...	A,B
Ice (raw water) 6/	1-5	5	0.2	0.2	0.2	...	30-50	...	300	C
Laundering	...	...	0.2	0.2	0.2	50	...	...	...	
Plastics, clear, uncolored	2	2	.02	.02	.02	...	...	...	200	
Paper and pulp 7/										
Groundwood	50	20	1.0	0.5	1.0	180	...	...	...	A
Kraft pulp	25	15	0.2	0.1	0.2	100	...	...	300	
Soda and sulfite	15	10	0.1	.05	0.1	100	...	...	200	
Light paper, HL-grade	5	5	0.1	.05	0.1	50	...	...	200	B
Rayon (viscose) pulp:										
Production	5	5	.05	.03	.05	8	50	...	100	D
Manufacture	0.3	...	0.0	0.0	0.0	55	...	7.8-8.3	...	
Tanning 8/	20	10-100	0.2	0.2	0.2	50-135	135	8.0	...	
Textiles:										
General	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	0.2	0.2	0.2	20	...	...	...	

1/ Waters with algae and hydrogen sulfide odors are most unsuitable for air conditioning.
2/ Some hardness desirable.
3/ Clear, odorless, 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, as low value favors inversion of sucrose, causing 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/ $Ca(HCO_3)_2$ particularly troublesome. $Mg(HCO_3)_2$ tends to greenish color. CO_2 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 since cellulose absorbs iron from dilute solutions. Manganese very objectionable, clogs pipelines and is oxidized to permanganates by chlorine, causing 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.

Water percolating through the soil and aquifer material gathers carbon dioxide from organic matter and, therefore, increases the acid content of the water and lowers the pH. Most of the wells in Copiah County yield water which contains considerable carbon dioxide (20-80 ppm estimated) and the water is acidic. The carbon dioxide and acidic nature of the water causes the water to be corrosive to most metals. This corrosive water dissolves iron when in contact with iron-bearing minerals or iron in the well system. Occasionally domestic well owners report that their well produced good quality water for about one year and then the water began to contain a high concentration of iron minerals. The corrosive water takes about one year to dissolve the galvanized coating from the pipe and then iron shows up in the water. A non-corrosive type of well system (plastic pipe or coating) eliminates the majority of iron problems in wells which the corrosive water causes the excessive iron.

Iron concentrations in water from wells in Copiah County range from 0 ppm (Town of Crystal Springs-D11) to 3 ppm (Martinville Water Assn.-P32). Treatment of iron-bearing ground water usually consists of aeration to remove carbon dioxide and to raise the pH; followed by settling and filtration to remove the iron precipitates.

The silica content of ground water is generally higher than surface water because the water remains in contact with silicate minerals under conditions favorable to solution for a longer period of time. Measured silica concentration from wells in Copiah County range from 0 to 10 ppm.

Color is imparted to ground water by the passage of water through decaying vegetation; including lignite beds. Colored water is present in all of the deeper aquifers below the Miocene beds. The town of Hazlehurst tested the Kosciusko (Sparta) aquifer and found the water extremely dark with 241 units of color. A Forest Hill well, (P62, Town of Hazlehurst) 1150 feet deep, contained 480 units color. The town of Georgetown wells are about 900 feet deep in the lower part of the Miocene and the water is highly colored (250 ppm). About 80 percent of the wells in the Miocene aquifers show color of 20 units or less. Color may be removed by pH adjustment and coagulation by alum. The cost of color removal is high and most municipalities cannot afford the cost. It is much more practical to use other water supplies free of color.

WATER SUPPLY POTENTIAL

The ground-water supply potential for Copiah County is generally good. The Miocene aquifers offer the best potential for developing additional ground-water supplies over most of the County. The shallow Citronelle aquifers along with the Miocene aquifers are available for development in the Crystal Springs area and in the northern part of Copiah County. The underlying Forest Hill and Claiborne aquifers do not offer a large potential for ground-water supply in the County because the aquifers generally have a low transmissibility and wells yield highly colored water. Industrial development in the future may warrant the deeper aquifers being used as a source for cooling waters provided an adequate supply from the shallow aquifers cannot be found at a particular location.

SURFACE WATER

DRAINAGE

Copiah County is drained principally by three major streams which are: Pearl River, Copiah Creek and Bayou Pierre (fig. 3). The Pearl River is the largest of the streams and drains the eastern section of the County along with Copiah Creek. The Pearl River forms the entire eastern boundary of Copiah County. The headwaters of Bayou Pierre are south of Copiah County in Lincoln County and flow in a northerly direction through most of Copiah County. Bayou Pierre drains the major portion of the western part of the County and flows out of the County near Carpenter. Numerous smaller streams drain the remaining areas of the County but most have insignificant flow.

Copiah Creek drains an area of about 75 square miles in Copiah County and flows into the Pearl River south of Georgetown. Bayou Pierre (excluding the drainage area of White Oak Creek) has a drainage area of about 370 square miles in Copiah County and flows into the Mississippi River a few miles west of Port Gibson. The flood plain of the Pearl River is well developed into a flat, wide flood plain which is about three miles in width at Georgetown. Bayou Pierre and Copiah Creek have similar flood plains but are not as wide.

AVAILABILITY

The largest source of surface water in Copiah County is the Pearl River. During an average year, more than 5932 cfs[2] (cubic feet per second) (period of streamflow 1938-51) of water flows past the gauging station at Rockport which is located in the lower part of the County. The Pearl River at Rockport had a maximum flow of 54,600 cfs (February 20, 1946) and a minimum flow of 262 cfs (October 25, 1943) from streamflow records of 1938-51. Streamflow in the Pearl is generally maintained at an amount sufficient to supply large volumes of water during most of the year. Occasionally during extreme drought conditions (usually in the fall of the year) the flow will be low and a supply of water might not be available for a large (10 plus million gallons per day) user. The water quality of the Pearl is poor at the present time (1968), but remedial sewage treatment plans by the City of Jackson should clear up this condition in the future.

Copiah Creek is a potential stream for water supply in the eastern section of Copiah County, providing reservoirs are constructed to impound the water. Streamflow in Copiah Creek varies from a maximum flow of 22,000 cfs[3] (October 4, 1964) to a minimum flow of 7.14 cfs[4] (September 14, 1954). These flows were recorded at the Highway 28 gauging station which has a drainage area of 48.6 square miles. Flow in Copiah Creek is generally low with slightly above minimum flow most of the year except immediately after a rainstorm. Copiah Creek contains water of good quality and contains no apparent organic pollution. The channel of Copiah Creek is full of sand and gravel and the stream meanders along the stream bed.

Bayou Pierre drains the western two-thirds of the County and is the largest single stream in Copiah County other than the Pearl River. Bayou Pierre is similar to Copiah Creek, in flow and stream bed characteristics but has a larger drainage area. Recorded streamflow of Bayou Pierre at Carpenter ranges from a minimum of 25 cfs (September 18, 1947) period of record 1944-51, to a maximum of 29,500 cfs[5] (October 14, 1964) period of record 1944-67. The flow in Bayou Pierre is generally low during most of the year. The stream channel of Bayou Pierre is filled with sand and scattered gravel causing a meandering stream. Storage on Bayou Pierre and Copiah Creek would have to contend with sediment. This reduces the capacities of the reservoirs unless corrective measures are undertaken in the design of the reservoir. Reservoirs would be necessary to impound large quantities of water for a dependable water supply for industrial use.

LOW FLOWS

Low base-flow yields can be expected on the creeks within Copiah County. A dependable large surface supply of water would not be possible with the exception of the Pearl River. Copiah Creek had a minimum low flow of 7.14 cfs (September

14, 1954) and Bayou Pierre had a minimum of 25 cfs (September 18, 1947). The surficial deposits of the Citronelle formation occur at high elevations (400 feet plus) and in most cases a large portion of the unit occurs above the water table which does not sustain a large base-flow in the streams. The flow of the creeks is generally low.

The minimum low flows on the Pearl River at Rockport was 262 cfs (October 25, 1943). The Pearl River flow is large enough to maintain some industrial users during most of the year.

FLOODING

Flooding occurs during and immediately after periods of excessive rainfall on the streams or headwaters of streams. Losses by evaporation, transpiration and infiltration reduces the magnitude of the runoff below that of actual precipitation. Generally the flooding is confined to the immediate flood-plain or stream bed except after exceptionally high storm runoff. In the past, flooding has caused relatively light damage to crops, livestock and communities located in the areas immediately adjacent to the streams. However, care should be exercised in planning any type of industrial structure on the flood-plains, particularly that of the Pearl River.

Before any plans are finalized on building near a stream, the flood records and histories of local libraries, newspapers, and government agencies should be examined. Also, local residents should be contacted concerning flooding at any particular location.

QUALITY

Water Types and Range of Chemical Quality

Surface water in Copiah County is of good quality for most general industrial purposes. The water is generally a soft calcium bicarbonate type having low concentration of dissolved solids with no major concentration of iron or other undesirable minerals. The water is slightly acidic under natural conditions, and the color is not objectionable.

Water quality of the streams vary with discharge and other environmental conditions which are present at the time of sampling. Most of the streamflow consists of direct runoff at high flow but consists mainly of ground-water discharge at low flow. Generally the dissolved-solids concentration is lowest during periods of high flow and increases during low flow when ground water comprises most of the flow. Specific conductance is a rough measure of the mineral content of the water and reflects the total dissolved solids content of the water. Specific conductance measurements of the water from the various streams (fig. 8) (table 7) reflect the low dissolved solids concentration of the water during low flow.

The silica content in the streams will increase noticeably during periods of low flow when ground water is contributing the majority of the flow. Ground water is usually higher in silica content because of time-of-contact of silica bearing minerals with the ground water.

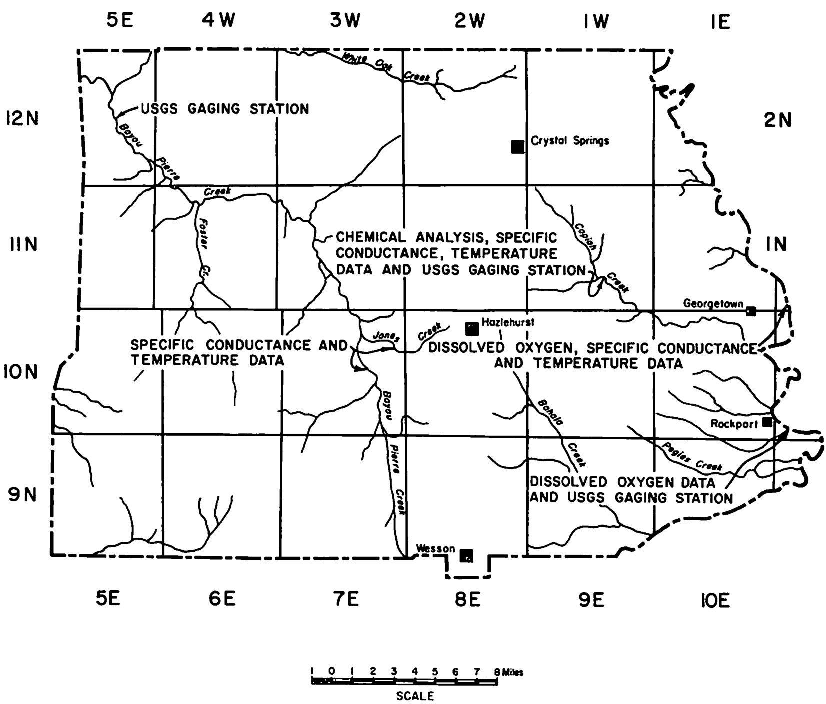

Figure 8.—Location of points on streams where specific conductance, temperature, dissolved oxygen and streamflow information is available in Copiah County.

Table 7.—Specific conductance and temperature of selected streams in Copiah County.

	Specific Conductance	Calculated Dissolved Solids	Temperature (F.°)	Stage	Time	Date
Pearl River at Georgetown	135	88	78	Low-Green Color	1:20 p.m.	9/26/67
	115	75	83	Low-Clear	10:43 a.m.	6/20/68
	138	90	85	Low-Muddy	1:15 p.m.	8/19/68
	140	91	75	Low-Green Color	1:40 p.m.	10/17/68
Copiah Creek at Highway 28	75	49	77	Low	11:30 a.m.	9/21/67
	85	55	76	Low	12:50 p.m.	9/26/67
	82	53	79	Slight-Rise Muddy	11:15 a.m.	6/20/68
	81	52	85	Low-Turbid	1:00 p.m.	8/19/68
	96	62	76	Low-Turbid	1:20 p.m.	10/17/68
Jones Creek at Highway 28	120	78	73	Low-Clear	12:00 Noon	6/20/68
	120	78	78	Low-Clear	4:15 p.m.	8/19/68
	110	71	70	Low-Clear	3:50 p.m.	9/30/68
	114	73	68	Low-Clear	12:55 p.m.	10/17/68
Bayou Pierre at Highway 28	38	25	74	High-Muddy	12:10 p.m	6/28/68
	60	39	81	Low-Muddy	4:00 p.m.	8/19/68
	60	39	71	Low-Murky	3:45 p.m.	9/30/68
	65	42	69	Low-Murky	12:45 p.m.	10/17/68

NOTE: To convert specific conductance to total dissolved solids, multiply by .65.

Table 8.—Chemical analyses of water from Copiah Creek at Highway 28, 6.25 miles east of Hazlehurst.

(Chemical analyses, in parts per million, November, 1965 to August, 1966)

Date of Collection	Discharge (cfs)	Silica (SiO)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (Residue at 180°C)			Hardness as $CaCO_3$		Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Color
															Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Non-carbonate				
11/4/65	10	14	0.00	3.1	1.0		8.7	2.0	13	2.4	9.7	0.1	8.6		62	0.08	1.66	12	1	1.1	82	5.6	10
12/8/65	10	14	0.06	2.7	1.3		8.3	1.7	13	2.6	9.3	0.1	4.4		67	0.09	1.79	12	1	1.0	77	5.8	10
1/17/66	34	12	0.07	4.5	0.7		5.5	2.2	15	5.6	6.9	0.1	1.8		58	0.08	5.31	14	2	0.6	66	---	20
2/23/66	36	14	0.01	4.4	1.0		6.4	1.4	15	6.8	6.9	0.0	1.7		56	0.08	5.43	15	3	0.7	72	6.0	5
3/28/66	15	6.8	.00	3.0	1.6		9.0	1.4	14	5.2	8.9	0.1	6.0		48	0.07	1.93	14	3	1.0	77	5.7	10
5/3/66	59	12	0.00	3.9	1.0		4.2	1.6	17	4.8	4.8	0.1	0.3		45	0.06	7.15	14	0	0.5	54	6.2	5
6/9/66	12	12	0.00	4.0	1.2		7.0	1.7	22	3.2	8.5	0.1	0.5		51	0.07	1.64	15	0	0.8	70	6.1	5
7/18/66	12.9	11	0.10	3.0	1.3		5.5	2.3	19	3.4	4.0	0.0	1.0		56	0.08	1.94	15	0	0.7	61	5.7	30
8/30/66	9.1	13	0.00	2.3	1.2		10.0	2.3	26	5.0	8.0	0.1	0.0		52	0.07	1.26	11	0	1.3	74	5.9	0

* Resource Data - "Water Resources Data for Mississippi - 1966"
U. S. Department of the Interior, Geological Survey

Record of chemical analyses of Copiah Creek (table 8) illustrates the typical low pH and low dissolved solids of the small streams in the County.

Organic material is reported to be causing pollution on the Pearl River (tables 9 and 10) and the source is upstream from Copiah County.[6] The City of Jackson (located on the Pearl River north of Copiah County) has plans to install a sewage treatment plant for treating its sewage. Jackson is presently (1968) dumping a large part of its sewage into the Pearl River untreated. The Pearl River along the entire boundary of Copiah County has been classified for recreational purposes according to the Mississippi Air and Water Pollution Commission[7] even though admittedly the water does not meet the classification at the present time. Recreation includes such water contact

Table 9.—Oxygen deficiency and flow in the Pearl River at Georgetown.

Date	Time Sampled	Temperature (°F)	DO Saturated (ppm)	DO Observed (ppm)	Percent Saturation of DO	Deficit (ppm)	Flow (mgd)
10/17/66	1520	69	9.1	5.8	64	3.3	338
10/17/66	1900	69	9.1	5.7	63	3.4	338
10/17/66	2200	69	9.1	5.3	58	3.8	338
10/18/66	0100	67	9.4	5.5	59	3.9	338
10/18/66	0400	65	9.5	5.5	58	4.0	338
10/18/66	0700	66	9.4	5.4	57	4.0	338
10/18/66	1145	64	9.5	5.4	57	4.1	338
6/6/67	1315	75	8.5	4.9	58	3.6	1090
6/6/67	1630	75	8.5	5.4	63	3.1	1090
6/6/67	2020	75	8.5	5.4	63	3.1	1090
6/7/67	0200	74	8.7	5.6	64	3.1	1090
6/7/67	0505	73	8.6	5.8	67	2.8	1090
6/7/67	0800	74	8.7	5.8	67	2.9	1090
6/7/67	1055	75	8.7	6.1	70	2.6	1090
6/7/67	1300	76	8.5	6.1	72	2.4	1090

*Source of Data - U. S. Geological Survey, Water Resources Division
DO - Dissolved Oxygen

Table 10.—Oxygen deficiency and flow in the Pearl River at Rockport.

Date	Time Sampled	Temperature (°F)	DO Saturated (ppm)	DO Observed (ppm)	Percent Saturation of DO	Deficit (ppm)	Flow (mgd)
10/17/66	1605	69	9.2	8.2	89	1.0	413
10/17/66	1920	69	9.2	8.0	87	1.2	413
10/17/66	2220	69	9.2	7.7	84	1.5	413
10/18/66	0130	67	9.4	7.5	80	1.9	413
10/18/66	0430	67	9.4	7.6	81	1.8	413
10/18/66	0730	66	9.4	7.4	79	2.0	413
10/18/66	1215	66	9.4	7.4	79	2.0	413
6/6/67	1420	74	8.7	5.5	63	3.2	1420
6/6/67	1705	76	8.5	5.7	67	2.8	1420
6/6/67	1955	75	8.5	5.6	66	2.9	1420
6/6/67	2330	74	8.7	5.6	64	3.1	1420
6/7/67	0220	74	8.7	5.6	64	3.1	1420
6/7/67	0525	74	8.7	5.7	65	3.0	1420
6/7/67	0825	74	8.7	5.8	67	2.9	1420
6/7/67	1120	75	8.5	6.1	72	2.4	1420
6/7/67	1355	76	8.5	6.4	75	2.1	1420

*Source of Data - U. S. Geological Survey, Water Resources Division
DO - Dissolved Oxygen

activities as swimming and water skiing. The following is taken from the Commissions water quality criteria for interstate and coastal waters, Regulation 1-67 A.[8]

> *Recreation*: Waters in this classification are to be used for recreational purposes, including such water contact activities as swimming and water skiing. The waters shall also be suitable for use for which waters of lower quality will be satisfactory.
>
> In assigning this classification to waters intended for water contact sports, the Commission will take into consideration the relative proximity of discharge of wastes and will recognize the potential hazards involved in locating swimming areas close to waste discharges. The Commission will not

assign this classification to waters, the bacterial quality of which is dependent upon adequate disinfection of waste and where the interruption of such treatment would render the waters unsafe for water contact sports.

a. *Dissolved Oxygen*: There shall be no oxygen demanding substances added which will depress the D. O. content below 4.0 mg/1.

b. pH: The pH shall not be caused to vary more than 1.0 unit above or below normal pH of the waters and lower value shall be not less than 6.0 and upper value not more than 8.5.

c. *Temperature*: Shall not be increased more than ten degrees F (10°F) above the natural prevailing background temperatures, nor exceed a maximum of 93°F after reasonable mixing.

d. *Bacteria*: Fecal coliform not to exceed 1000 per 100 ml. as a monthly average value (either MPN or MF count); not exceed this number in more than twenty percent (20%) of the samples examined during any month; nor exceed 2,400 per 100 ml. (MPN or MF count) on any day.

e. *Specific Conductance*: There shall be no substances added to increase the conductivity above 1000 micromhos/cm for fresh water streams.

f. *Dissolved Solids*: There shall be no substances added to the waters to cause the dissolved solids to exceed 750 mg/1 as a monthly average value, nor exceed 1500 mg/1 at any time.

g. *Toxic Substances, Color, Taste and Odor Producing Substances*: There shall be no substances added, whether alone or in combination with other substances that will render the waters unsafe or unsuitable for water contact activities, or impair the use of waters requiring lesser quality.

The Pearl River Valley Commission is promoting interest in developing the recreational features of the river. Local fishermen use the Pearl River in the southern part of the County.

Water Pollution Restrictions by Mississippi Law

The State of Mississippi, as implemented by the Mississippi Air and Water Control Commission, legislative act of 1966 has the authority to control pollution on the streams in the State. The Commission has adopted regulations which include issuing a permit to operate existing waste disposal systems and issuing a permit to construct or operate a new facility. The Commission should be contacted before plans are finalized in building a new plant which will discharge waste into any streams in the State of Mississippi.

WATER SUPPLY POTENTIAL

Limits of Natural Supply

Copiah County does not contain an abundance of surface water. The Pearl River is the largest stream in the area and has the potential of providing a large amount of water during most of the year without storage. Water in the Pearl River is reported to be of poor quality at the present time because of upstream organic pollution.

Throughout the remainder of the County, surface water development depends on construction of reservoirs due to the low flow of the streams. Large quantities of good quality water is available on Bayou Pierre and Copiah Creek provided storage facilities are constructed.

Water in Bayou Pierre and Copiah Creek, as well as the other small streams, are low in mineral content, soft and essentially free of organic pollution. The flow from the sewage lagoons of Crystal Springs and Hazlehurst ultimately drain into Copiah Creek. The lagoons provide about 85 percent reduction of BOD (Biochemical Oxygen Demand) of the sewage before discharging into Copiah Creek. The State Board of Health recommends that the sewage discharge from the lagoons not be allowed to flow into any reservoirs. Water stored in reservoirs should compare with the water in the streams and the quality may be raised, especially the pH of the water may be improved by storage.

The final design of a water-supply reservoir should consist of a study of the flow characteristics of the stream, the pattern of draft, topography and soil conditions, evaporation and seepage losses, sediment deposition, flood potential and legal restrictions. The U. S. Soil Conservation Service in connection with its watershed work plans is planning several reservoirs on Copiah Creek and Bayou Pierre in Copiah County.

Impoundment of water in open reservoirs without clearing land areas leads to temporary deterioration of water quality. When the reservoir area is flooded, the vegetation dies and organic matter is released to the water. Algae and other micro-organisms flourish. Odor, taste, and color are imparted to the water, rendering it unsuitable for most domestic and some industrial uses. The stabilization rate in shallow reservoirs is greater than in large deep reservoirs. Ninety percent reduction of color and micro-organisms in shallow uncleaned reservoirs is affected in twelve to sixteen years; whereas, the same reduction in large deep reservoirs under the same conditions will take as long as twenty to twenty-four years. Reservoirs which have been cleaned properly do not need a stabilization period to use the water.[9]

Reducing conditions at the bottom of deep reservoirs during summer seasons tend to hold in solution undesirable chemicals, such as iron and manganese, that may be present. Water withdrawn from the bottom of a reservoir can contain these impurities.

Water turbidity is generally low and the composition of the water is essentially constant in a reservoir or lake. Reservoirs are usually designed with the idea that after a number of years silt becomes a problem in occupying more and more of the water area. Remedial measures to help alleviate the silt problem should be included in the design of the reservoirs.

Water Use Restrictions by Mississippi Law

The State of Mississippi, through the Board of Water Commissioners, in the legislative act of 1956, controls the appropriation of water from the streams of the State.[10] The responsibilities of the Board include the issuance of water permits, protection of existing water rights, and controlling the future additional appropriation of water so as to insure its most advantageous use. The law states that water in any water course, lake or other natural water body of the State is subject to appropriation in accordance with the provisions of the law.

The Board of Water Commissioners has the authority to permit the appropriation of water of any stream only in excess of the established average minimum flow. The average minimum flow of a stream is defined in the Mississippi water law as follows: "the average of the minimum daily flow occurring during each of the five (5) lowest years in the period of the preceding twenty (20) consecutive years." The Board may authorize an appropriator to use the established minimum flow for industrial purposes when such water shall be returned within a reasonable time, as specified by the Board in its authorization, to the stream at a point downstream from its place of withdrawal. This appropriation is made only if the Board determines that such action will not result in any substantial detriment to the property owners affected thereby or to the public interest.

CONCLUSIONS

An abundance of ground water underlies Copiah County and at most localities the users are able to find enough water for the present and immediate future needs.

The shallow Citronelle sand and gravel deposits supply most of the municipal, industrial and domestic needs in the Crystal Springs area. Miocene aquifers which are below the Citronelle underlie the entire County and offer the best potential for supplying ground water over a wide area. All municipal and most industrial water users will probably continue to use ground water for their main source of supply. Test drilling is recommended to locate the particular aquifers which might underlie an area of need.

Surface water of good quality is not available without storage in any moderate to large amounts in Copiah County. Adequate storage facilities on Copiah and Bayou Pierre Creeks would provide ample surface water for recreational and some industrial needs in the future provided the partially treated sewage is not allowed to enter the reservoirs. The Pearl River would provide a large water supply for industrial purposes provided the quality standards are not too high and the pollution is abated upstream.

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SUBSURFACE STRATIGRAPHY OF COPIAH COUNTY

THEO H. DINKINS, JR.

ABSTRACT

The stratigraphic column applicable to the subsurface of Copiah County includes strata from the Hosston formation of Lower Cretaceous age to the Bucatunna formation of Oligocene age.

The formations and their contacts are discussed in general terms. Formations discussed in this report, with the exception of the Clayton formation, are based on rock unit subdivisions and should be regarded as such.

The search for oil and gas, based primarily on structural prospects, has been disappointing. Future exploration with more emphasis on possible stratigraphic accumulations may prove favorable.

The five known piercement-type salt domes are apparently the result of secondary stages of growth. These domes exhibit growth more or less contemporaneous with deposition, for various lengths of time.

STRATIGRAPHY

GENERAL STATEMENT

The stratigraphic column applicable to the Copiah County subsurface follows the terminology now in 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 of these units is given.

With the exception of the Selma-Clayton contact, the correlations in this report are based on rock-stratigraphic units. The units are defined primarily on lithologic characteristics and supplemented with paleontological and electrical log data. Correlations are constituted so that their boundaries are as sharp and distinct as possible, being drawn on practical mappable rock units which are distinguishable from adjacent formations by reasonably obvious gross lithologic characteristics.

Contact relationships discussed in this report are based on extensive examination of samples. The writer's conclusions on the nature of these formational contacts is, of necessity, based on the gross character of sediments on either side of the contacts. Quality of the samples, lack of cored sections at the formation contacts and incomplete sampling techniques leaves much to be desired in any study of contact relationships. Until such time as the contact zones are cored, actual contact relationships will be subject to conjecture.

HOSSTON FORMATION

The oldest strata penetrated in Copiah County, other than salt, is the Hosston formation of Lower Cretaceous age. Only two wells, the Gulf Oil Corporation No. 1 Gatesville Unit 24-10 in sec. 24, T. 2 N., R. 1 W., and the Gulf Refining Co. (formerly Panuco Oil Leases) No. 1 W. B. Purser et al in sec. 15, T. 1 N., R. 3 W., penetrate Hosston age sediments. At total depth, the No. 1 Gatesville Unit 24-10 penetrated 703 feet of Hosston strata consisting of alternating sandstones and shales. The No. 1 Purser et al penetrated only 67 feet of Hosston.

The Hosston-Sligo contact is placed at the top of a fine-and medium-grained sandstone sequence stratigraphically below the lowest shale sequence of the Sligo formation. A cored Hosston-Sligo contact in the No. 1 Purser et al suggests that the Hosston sediments were followed, without conspicious evidence of unconformity, by a basal Sligo sequence of interbedded dark-red, dull-red and dark-gray silty sandy micaceous shales with minor amounts of interspersed very fine-grained sandstones, siltstones and gray sandy mudstones.

Hosston sandstones are white and red, fine- to coarse-grained, occasionally conglomeritic and calcareous, generally micaceous and rarely lignitic. The red sandstones tend to be finer-grained than the white sandstones. Traces of fine-grained sandstone, containing inclusions of dead black oil were noted in the uppermost beds of the Hosston in the No. 1 Gatesville Unit 24-10. The shales are predominant dark-red, dull-red and maroon, silty micaceous and occasionally sandy. Minor amounts of purple and dark-gray shales and gray and green mudstones and traces of nodular limestones were noted.

SLIGO FORMATION

The Gulf Oil Corporation No. 1 Gatesville Unit 24-10 and the Gulf Refining Company (formerly Panuco Oil Leases) No. 1 Purser et al penetrated a 247 to 285 foot Sligo sequence, respectively. Although deep control is limited, the Sligo appears to thicken downdip or to the southwest. Little evidence

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BULLETIN 110
PLATE 1 (DINKINS)

System	Series	Group	FORMATION	THICKNESS (Feet)	GENERAL LITHOLOGY
TERTIARY	OLIGOCENE	VICKSBURG	Bucatunna formation	0-70	Gray and dark-gray finely lignitic or carbonaceous clays and silty very finely micaceous clays.
			Byram formation	0-10	Pale greenish-gray calcareous glauconitic fossiliferous generally quite sandy marls.
			Glendon formation	0-30	Pale-gray to cream-colored fossiliferous glauconitic sparingly sandy limestones. Pale grayish-white to pale-green fossiliferous glauconitic variably sandy marls.
			Mint Spring formation	0-50	Pale grayish-white to pale grayish-green fossiliferous glauconitic calcareous sands and marls.
			Forest Hill formation	0-180	Lenticular to massive micaceous clayey lignitic or carbonaceous sandstones and siltstones. Gray silty micaceous finely lignitic or carbonaceous clays and occasional thin beds of lignite.
	EOCENE	JACKSON	Yazoo formation	0-470	Light bluish-gray and pale gray calcareous fossiliferous variably glauconitic clays with some thin white and cream-colored chalky glauconitic limestones or marls.
			Moodys Branch formation	0-25	Greenish-gray calcareous fossiliferous clayey glauconitic sands and pale-gray glauconitic calcareous fossiliferous sandy marls.
		CLAIBORNE	Cockfield formation	0-555	Light-to dark-gray silty occasionally sandy and lignitic or carbonaceous clays and clay shales. Argillaceous occasionally micaceous and lignitic or carbonaceous and rarely glauconitic sandstones and siltstones. Thin reddish-brown to tan occasionally sandy and glauconitic clayironstones and tan to gray variably silty sandy argillaceous occasionally lignitic limestones.
			Cook Mountain formation	0-290	Upper sequence of light-gray finely lignitic or carbonaceous clays and clay shales with subordinate amounts of sparingly glauconitic fossiliferous calcareous shales. Lower sequence of pale-gray to white impure silty glauconitic fossiliferous chalks with minor amounts of interbedded light-gray to gray variably glauconitic and fossiliferous clay shales.
			Kosciusko formation	0-840	Clayey variously lignitic or carbonaceous micaceous rarely glauconitic and calcareous sandstones and siltstones. Rare sandy argillaceous and lignitic limestones. Variably sandy rarely glauconitic clayironstones. Silty variably sandy and lignitic or carbonaceous clays.
			Zilpha formation	0-460	Gray, slightly lignitic or carbonaceous fossiliferous, variably glauconitic clay shales with an upper sandy facies.
			Winona formation	30-210	Pale-gray to white impure glauconitic fossiliferous chalks and interbedded light-gray and greenish-gray slightly fossiliferous and glauconitic clay shales.
			Tallahatta formation	10-570	Pale grayish-white and white very finely glauconitic and micaceous fossiliferous calcareous to limy siltstones and claystones with interbedded light-green and light greenish-gray glauconitic fossiliferous clay shales.
		WILCOX	Wilcox (undifferentiated)	3190-3495	Gray to black carbonaceous micaceous shales. Argillaceous, usually lignitic or carbonaceous occasionally calcareous glauconitic and fossiliferous and rarely lignitic and pyritic sandstones and siltstones. Thin argillaceous silty micaceous lignitic generally sandy, occasionally glauconitic and sparingly fossiliferous limestones. Thin seams of lignite and variably sandy glauconitic clayironstones.
	PALEOCENE	MIDWAY	Midway (Porters Creek formation)	805-1120	Gray to black, occasionally finely micaceous and flakey and splintery shales. Rare traces of bentonite.
			Clayton	20-70	Pale-gray and light-gray argillaceous slightly bentonitic chalks. Gray and dark-gray shales.
UPPER CRETACEOUS	GULF	SELMA	(Navarro age beds) (Taylor age beds) (Austin age beds)	845-1130	Pale-gray and light-gray impure, occasionally slightly bentonitic and micaceous chalks. Dark-gray to black occasionally flakey and splintery finely micaceous shales, slightly calcareous shales and coarsely micaceous calcareous slightly glauconitic shales. Rare traces of bentonite. Traces of calcareous and chalky glauconitic sandstone.
		EUTAW	Eagle Ford formation (Lower Eutaw)	280-380	Dark-gray and black finely micaceous shales and flakey and splintery shales. Calcareous glauconitic variably fossiliferous and micaceous sandstones.
		TUSCALOOSA	Upper Tuscaloosa	510-740	Light-gray, gray, dark-gray, red and dark-red occasionally micaceous shales. Pale-gray, light gray, gray, red, purple, lavender, ochre and light green mudstones and mottled mudstones. Variably silty micaceous and ashy sandstones. Traces of sideritic sandstones and calcareous glauconitic slightly fossiliferous sandstone. Rare traces of red sandstone.
			Middle Tuscaloosa	90-195	Dark-gray and black flakey and splintery shales and finely micaceous shales. Vari-colored mudstones. Subordinate amounts of silty to limy, usually micaceous and glauconitic rarely ashy sandstones and siltstones. Few thin lentils of argillaceous "shelly" limestone.
			Lower Tuscaloosa	175-290	Upper sequence of alternating dark-gray and black shales, mudstones and lenticular calcareous rarely fossiliferous, glauconitic sandstones and siltstones. Lower sequence of lenticular to massive commonly conglomeritic ashy chloritic sandstones and subordinate amounts of dark-gray to black and dark-red shales and vari-colored mudstones.
LOWER CRETACEOUS	COMANCHE	WASHITA FREDERICKSBURG	Washita-Fredericksburg	1300-2100	Dark-red, dull-red and maroon silty finely micaceous shales. Subordinate amounts of dark-gray and black shale and slightly calcareous and fossiliferous shale. Finely micaceous occasionally calcareous glauconitic and sparingly fossiliferous sandstones. Pale-gray to brown dense to chalky fossiliferous and occasionally glauconitic and pseudo-oolitic or spherulitic limestones.
		TRINITY	Paluxy	1200-1500	Dark-red, dull-red and maroon silty micaceous and occasionally sandy shales. Subordinate amounts of dark-gray and black shales and vari-colored mudstones. Red and white commonly finely micaceous and occasionally calcareous and conglomeritic sandstones.
		TRINITY — Sub-group: UPPER GLEN ROSE Restricted	Mooringsport	440-840	Dark-red and maroon silty finely micaceous shales. Subordinate amounts of dark-gray and black flakey and splintery shales and light-gray to gray variably fossiliferous and pseudo-oolitic or spherulitic limestones. Red and white finely micaceous variably calcareous sandstones.
			Ferry Lake	155-230	White anhydrite. Black shales and calcareous shales. Light-gray and gray fossiliferous pseudo-oolitic or spherulitic and occasionally oolitic limestones.
		TRINITY — Sub-group: LOWER GLEN ROSE	Rodessa	600-720	Dark-red, dull-red and maroon silty finely micaceous shales. Gray to black commonly flakey and splintery calcareous and occasionally fossiliferous shales. Minor amounts of light-gray to light-green mudstone. White anhydrite. Pale-gray to dark-gray fossiliferous variably pseudo-oolitic or spherulitic and rarely oolitic limestones. Red and white generally finely micaceous variously calcareous and sparingly fossiliferous sandstones.
			Pine Island	230-245	Dark-gray and black, generally flakey and splintery occasionally calcareous and fossiliferous shales. Generally calcareous silty rarely fossiliferous sandstones and siltstones. Light-gray to gray fossiliferous generally argillaceous and silty, rarely sandy limestones. Minor amounts of dark-red and maroon silty finely micaceous shales and light-gray and light-green mudstones.
			Sligo	247-285	Dark-red, dull-red and dark-gray to black silty finely micaceous shales. Red and white slightly micaceous sandstones and calcareous and fossiliferous sandstones. Traces of gray mudstone.
	COAHUILA		Hosston	703+	Dark-red, dull-red and dark-gray silty slightly sandy micaceous shales. Minor amounts of gray and green mudstone. Red and white generally micaceous, occasionally calcareous and conglomeritic sandstones.

Stratigraphic column of subsurface of Copiah County exists that these Sligo-Pine Island contacts are unconformable, but rather appear to be transitional.

The Sligo sequence in the No. 1 Gatesville Unit 24-10 consists of interbedded dark-red, dull-red and dark-gray to black silty finely micaceous shales, very fine- to coarse-grained slightly micaceous sandstones, calcareous sandstones and red very fine- to fine-grained sandstones. Rare traces of gray mudstone and fossiliferous sandstone are also present.

To the southwest, the shale to sandstone ratio increases in the No. 1 Purser et al. Dark-gray and black shales and gray mudstones become more numerous. Both the shales and sandstones tend to be somewhat calcareous. Red sandstones are conspicuously absent from the Sligo sequence in the No. 1 Purser. A thin gray silty argillaceous limestone is also developed in the upper half of the formation.

The top of the Sligo in this report is placed below the lowest limestone or limestone and sandstone sequence of the Pine Island formation. This placement results in the uppermost beds of the Sligo consisting of dark-red and dull-red silty micaceous shales, rather than at the top of the first sandstone stratigraphically below the Pine Island formation. Shows of oil were noted in the Sligo in both the No. 1 Gatesville Unit 24-10 and the No. 1 Purser et al.

PINE ISLAND FORMATION

The Pine Island formation varies from a minimum thickness of 230 feet in the No. 1 Gatesville Unit 24-10 to a maximum of 245 feet in the No. 1 Purser et al. The Sun Oil Company No. 1 Southern Package Corporation in sec. 6, T. 9 N., R. 7 E., tested 233 feet of Pine Island sediments, but failed to penetrate the entire Pine Island formation.

This southwestward thickening wedge of near shore to marine sediments is comprised of a sequence of shales, sands, siltstones and argillaceous limestones and minor amounts of light-gray, light-green and pale-green mudstones.

The shales are predominantly dark-gray and black, generally flakey and splintery, commonly calcareous and occasionally fossiliferous. An hydrogen sulfide odor was noted on fresh breaks from some of these dark-gray and black shales recovered by coring. Some of these dark-gray and black shales are silty and finely micaceous. Only minor amounts of dark-red and maroon silty finely micaceous shale are present.

Pine Island sandstones are white, very fine- to fine-grained, generally calcareous, silty, rarely fossiliferous and occasionally sparingly lignitic or carbonaceous. The siltstones are generally calcareous and slightly to sparingly micaceous. Sandstone with inclusions of dead black oil and gilsonite were noted in the No. 1 Southern Package Corporation.

The limestones are light-gray to gray, fossiliferous, generally argillaceous and silty and rarely sandy. Thin limestones developed in the uppermost Pine Island sediments in the No. 1 Gatesville Unit 24-10 and No. 1 Southern Package Corporation are characterized by scattered faint ochre colored oxidation or selective replacement of the fossils. This thin zone of oxidation or selective replacement was not noted in the No. 1 Purser et al. However, a complete suite of samples of this interval was not available.

The top of the Pine Island is placed at the first occurrence, in cuttings, of dark-gray and black flakey and splintery shales and/or gray or light-gray fossiliferous limestones with scattered faint ochre colored oxidation or selective fossil replacement below the basal fine and medium grained sandstones of the overlying Rodessa formation. Deposition is believed to have been essentially contemporaneous throughout the Pine Island-Sligo contact. No conclusive evidence of unconformable Pine Island-Rodessa contacts was noted, and the contact is regarded as transitional. The dark-gray and black shales of the uppermost Pine Island become silty near their contact with the overlying basal Rodessa sands. The basal few feet of the Rodessa sandstone tend to be silty and slightly argillaceous.

RODESSA

The top of the Rodessa formation is placed below the lowest massive anhydrite of the Ferry Lake formation. The contact of the gray and dark-gray fossiliferous and pseudo-oolitic or spherulitic limestones of the upper Rodessa with the over-lying massive white anhydrite is sharp but is regarded as being conformable.

The Rodessa consists of a sequence of shales, mudstones, limestones, sandstones and siltstones with a thin stringer of anhydrite in the upper part of the formation. The Rodessa varies from a minimum of 600 feet in thickness in the No. 1 Gatesville Unit 24-10 in the northeastern corner of the County, to a maximum of 720 feet in the No. 1 Southern Package Corporation in the southern part of the County. Downdip, the Rodessa sediments become progressively more marine with increasing amounts of limestone, calcareous fossiliferous shale and calcareous and fossiliferous sandstone.

Rodessa shales are dark-red, dull-red, maroon, gray, dark-gray and black. The "red" shales are generally silty and finely micaceous. The gray, dark-gray and black shales tend to be less silty and micaceous than the "red" shales and are commonly calcareous flakey and splintery and occasionally fossiliferous. Relatively minor amounts of light-gray, gray, light-green and light greenish-gray mudstones are present throughout the Rodessa.

The limestones are pale-gray to dark-gray in color, are fossiliferous and variably argillaceous and pseudo-oolitic and only rarely oolitic. Traces of limestone with scattered solution cavities were noted in the upper part of the Rodessa in the California Company No. 1 Magnolia Textiles, Inc., in sec. 9, T. 9 N., R. 7 E. In the Gulf Oil Corporation No. 1 Gatesville Unit 24-10, limestone development in the Rodessa is restricted to the upper part of the formation. Downdip, the limestone stringers become more numerous and are generally present throughout the formation.

Rodessa sandstones are red and white and predominantly in the very fine- to fine-grained range, with a few intervals of coarser, sometimes conglomeritic sands. These coarser sands are common to the persistent basal Rodessa sandstone developed throughout the County. Red sandstones are restricted to the lower two-thirds of the formation. Rodessa sandstones are generally micaceous and variably calcareous. Minor amounts of sandstone with finely disseminated lignite or carbonaceous material are also present. Downdip, a few scattered intervals of sparingly fossiliferous sandstones are developed. The siltstones are usually finely micaceous and most tend to be calcareous.

FERRY LAKE FORMATION

Conformably overlying the Rodessa is a 155 to 230 foot sequence of massively bedded white to light-gray anhydrites with associated dark-gray and black flakey and splintery shales and pale-gray to black fossiliferous, oolitic and pseudo-oolitic or spherulitic limestones.

The distinctive character of the massively bedded anhydrites of the Ferry Lake renders the formation a key marker in wells drilled through this horizon.

The top of the formation in Copiah County is placed at the contact of the massive anhydrites with the light-gray and gray fossiliferous and pseudo-oolitic or spherulitic limestones of the overlying Mooringsport formation. As with the Rodessa-Mooringsport contact, the contrasting lithologies of the massive anhydrites of the Ferry Lake with the basal limestones of the Mooringsport is sharp, but is believed to be conformable.

MOORINGSPORT FORMATION

In this report, the top of the Mooringsport is picked on a marked increase of dark-red and maroon shales and associated pale-gray to light-green mudstones below the lowest sandstones of the Paluxy formation. The Mooringsport-Paluxy contact is transitional and thickness variations of up to 400 feet exist within the County. The Mooringsport varies from a minimum of 400 feet in the No. 1 Gatesville Unit 24-10 to a maximum of 840 feet in the No. 1 Purser et al. This 400 foot thickness variation between the No. 1 Gatesville Unit 24-10 and the No. 1 Purser et al appears to be due to basinward facies change as well as depositional thickening.

With the exception of a few thin limestones in the No. 1 Purser et al and the No. 1 Southern Package Corporation wells, the upper half of the Mooringsport is a shale, mudstone and sandstone sequence. The shales are predominantly dark-red and maroon, silty and finely micaceous. Subordinate amounts of dark gray and black flakey and splintery shales and light-gray, gray, light-green and light greenish-gray mudstone and sparingly lignitic mudstones are also present, with increasing amounts being present downdip. Rare traces of pale-gray and red nodular limestone and one thin discontinuous bed of lignite were also noted. Mooringsport sandstones are red and white very fine- and fine-grained, commonly finely micaceous, occasionally calcareous and rarely lignitic. Only a few thin zones of medium-grained sandstones are present in the Mooringsport.

The lower half of the Mooringsport consists of a sequence of interbedded shales, mudstones, sandstones and limestones. Pale-gray, light-gray and gray, variably fossiliferous and pseudo-oolitic or spherilitic limestones are developed generally throughout the lower part of the Mooringsport, becoming more numerous toward the base of the formation. Increasing amounts of dark-gray and black flakey and splintery shale and light-gray and gray mudstones are present in the lower half of the formation.

PALUXY FORMATION

Paluxy sediments in Copiah County consist of a sequence of alternating shales and sandstones and minor amounts of mudstone and nodular limestone. Present deep control indicates that the Paluxy is thickest in the northwestern half of the County, with a maximum thickness of 1500 feet of Paluxy being penetrated in the Jett Drilling Company No. 14-5 Federal Land Bank, sec. 14, T. 10 N., R. 5 E. The Paluxy varies from 1200-1500 feet in thickness.

Paluxy shales are predominantly dark-red, dull-red and maroon silty micaceous and occasionally slightly sandy. Subordinate amounts of dark-gray and black shales and flakey and splintery shales are present in the Paluxy, being more numerous in the lower half of the formation. Minor amounts of light-gray, gray and green mudstones and pale-gray and tan nodular limestone are present throughout the Paluxy.

Paluxy sandstones are red, light-red and white, very fine- to coarse-grained and are commonly finely micaceous and occasionally calcareous. Subordinate amounts of very fine- to coarse-grained, occasionally conglomeritic sandstone are also present in the Paluxy. Generally the coarser conglomeritic sands are present in the upper half of the formation, however, a few thin zones of coarser sands are present in the lower part of the Paluxy. Occasionally a few scattered small quartz pebbles are noted in conjunction with the coarser sands. Minor amounts of very fine- and fine-grained lignitic or carbonaceous sandstone were also noted.

The top of the Paluxy in this report is based on sample work and, therefore, does not necessarily correspond to correlations based on electrical logs. The top of the Paluxy is placed at the top of a sequence of fine- and medium-grained sandstones stratigraphically below the lowest shale or sandy shale sequence of the Washita-Fredericksburg.

Paluxy sandstones are, as a whole, coarser than Washita-Fredericksburg sandstones and more red sandstones are present in the Paluxy.

WASHITA-FREDERICKSBURG GROUP

Sediments of the Washita-Fredericksburg group are the youngest strata of Lower Cretaceous age in Copiah County. Copiah County lies north of the eroded updip limit of the Dantzler facies of the Washita-Fredericksburg and, therefore, the Washita-Fredericksburg sediments within the County are treated as an undifferentiated sequence. This sequence of shales, sandstones, thin limestones and mudstones thickens from 1300 feet in the northern part of the County to over 2100 feet in the southwestern part of Copiah County.

The top of Lower Cretaceous is placed at the unconformable contact of eroded shales, mudstones and sandstones of Washita-Fredericksburg age with the basal ashy conglomeritic sandstones of the overlying Tuscaloosa group. The contact is sharp and usually easily distinguishable in cuttings as well as on electrical logs. Fragments of vari-colored nodular limestones, commonly present in samples of Washita-Fredericksburg sediments, also serve as a lithologic indicator. These fragments of nodular limestone may or may not be present in the first few samples of Lower Cretaceous strata. This is because the surface of the Washita-Fredericksburg is highly eroded.

Washita-Fredericksburg shales are predominantly dark-red, dull-red and maroon silty and finely micaceous. Subordinate amounts of dark-gray and black shale and sparingly calcareous and fossiliferous shale are also present, being commonly associated with thin-bedded limestones.

Washita-Fredericksburg sandstones vary from very fine- to medium-grained with only rare thin discontinuous intervals of medium- to coarse-grained sandstones. The sandstones are predominantly fine-grained white, generally finely micaceous, occasionally calcareous glauconitic and sparingly fossiliferous. Red and light-red very fine-grained and fine-grained sandstones are generally restricted to the lower third of the Washita-Fredericksburg group, except updip in the northeastern part of the County in the Gulf Oil Corporation No. 1 Gatesville Unit 24-10 in sec. 24, T. 2 N., R. 1 W., where red sandstones are present within 300 feet of the top of Lower Cretaceous. Coarser-grained sandstones, though minor in amount, are generally developed in the lower part of the Washita-Fredericksburg. The glauconitic and fossiliferous sandstones are commonly associated with limestones. However, isolated occurrences of both types of sandstone were noted which were not associated with limestones. Minor amounts of finely micaceous calcareous siltstones and finely lignitic or carbonaceous sandstone were also noted.

Washita-Fredericksburg limestones are pale-gray, light-gray and brown, dense to chalky, fossiliferous and occasionally glauconitic and pseudo-oolitic or spherulitic. These thin-bedded limestones are best developed in the middle portion of the Washita-Fredericksburg group. Downdip, the limestones become more numerous and are developed at successively higher stratigraphic intervals. In most of the wells examined, which penetrated the Washita-Fredericksburg sediments, the upper few feet of Washita-Fredericksburg limestone encountered was characterized by what appears to be partial oxidation or selective replacement. The ochre color of this oxidation or selective replacement is fairly distinct in its contrast to the color of the limestones.

Subordinate amounts of pale-gray, light-gray, green, lavender and ochre mudstones and mottled mudstones are present in the Washita-Fredericksburg sediments, being most numerous updip to the northeast.

TUSCALOOSA GROUP

GENERAL

In the subsurface of Copiah County the Tuscaloosa group is divided into Lower Tuscaloosa, Middle Tuscaloosa and Upper Tuscaloosa. The Tuscaloosa group thickens to the south, thinning locally on structure.

LOWER TUSCALOOSA FORMATION

The Lower Tuscaloosa in Copiah County consists of two distinct separable lithic units. The lower unit is a sequence of massive conglomeritic porous sandstones and subordinate amounts of shale and mudstone. The upper unit is composed of alternating shales, mudstones and lenticular very fine- to fine-grained usually glauconitic sandstones and siltstones. The Lower Tuscaloosa varies from 175 to 290 feet in thickness. The variations in thickness are due primarily to the unconformable surface upon which it was deposited. The thicker sections of Lower Tuscaloosa sediments were deposited in those areas which were topographically lowest on the pre-Tuscaloosa erosional surface. The thickening is principally in the lower conglomeritic unit.

The fine- to coarse-grained massive conglomeritic ashy chloritic sandstones of the lower lithic unit are pale-gray, light-gray, pale-green and white. These sandstones commonly contain, as inclusions, fragments of shale, mudstone and lignitic material, some mica and pebbles and chips of vari-colored quartz and chert. The finely divided chlorite contained in these sands produces the faint green color inherent in the basal Tuscaloosa sediments in Copiah County. Subordinate amounts of gray, dark-gray, black, red and dark-red shales and light-gray, pale-gray, light-green and purple mudstones are interbedded with the basal conglomeritic sands.

The upper unit of the Lower Tuscaloosa is a sequence of alternating very fine- to fine-grained sandstones, siltstones, shales and subordinate amounts of mudstones. The sandstones and siltstones are characteristically glauconitic finely micaceous calcareous slightly silty and rarely fossiliferous and lignitic or carbonaceous. These sandstones and siltstones are predominantly white, however, some are light shades of gray. The shales are predominantly dark-gray and black flakey and splintery, commonly finely micaceous, occasionally slightly sandy and rarely calcareous and fossiliferous. Subordinate amounts of dark-red and purple shales and gray, light-gray and light-green mudstones may be present in the lower part of this upper unit, proportionately more being present updip.

The top of the Lower Tuscaloosa is placed at the first occurrences of glauconitic sandstones stratigraphically below the dark-gray and black shales of the Middle Tuscaloosa. In a number of wells, particularly in the southwestern half of the County, a few thin pale-gray to light- gray and light-tan or brown argillaceous "shelly" limestone lentils are present at or directly above the top of the Lower Tuscaloosa. The Lower Tuscaloosa-Middle Tuscaloosa contact is conformable.

MIDDLE TUSCALOOSA FORMATION

The Middle Tuscaloosa is a sequence of predominantly dark-gray and black flakey and splintery shales and finely micaceous shales, some vari-colored mudstones and subordinate amounts of pale-gray to white very fine-grained, silty to limy, usually micaceous and glauconitic, rarely ashy sandstones and siltstones. A few thin argillaceous "shelly" limestones are also present in the Middle Tuscaloosa sequence, generally being present in the lower part. In several wells, thin limestones were also noted at or near the top of the Middle Tuscaloosa. Downdip, the vari-colored mudstones present in updip Middle Tuscaloosa sections grade into subdued shades or light-gray, gray and light-green.

The top of the Middle Tuscaloosa is picked on the appearance, in cuttings, of dark-gray and black shales and flakey and splintery shales below the basal fine- to medium-grained, generally calcareous glauconitic silty, often fossiliferous sandstones of the Upper Tuscaloosa. The top of the Middle Tuscaloosa formation appears to be transitional with the overlying Upper Tuscaloosa sediments. The Middle Tuscaloosa, varying from 90 to 195 feet, expands at the expense of the overlying Upper Tuscaloosa. The formation thickens to the south and southwest.

Lateral facies variations, as in the Cities Service Oil Company, No. 1 C. S. Bailey, sec. 24, T. 1 N., R. 1 W., often result in electrical log correlations of the top of the Middle Tuscaloosa being placed at a somewhat higher point than the actual top determined by samples. A lateral facies change, resulting in predominantly shale and silt deposition in the lower 180 feet of the Upper Tuscaloosa formation, in the No. 1 Bailey produced a sedimentary sequence which, based on electrical log characteristics, would indicate an unusually thick Middle Tuscaloosa section. Lithologically, this upper part of the seemingly expanded section of Middle Tuscaloosa consists of dark-red and red shales, vari-colored mudstones and silts. Only the basal sequence of the Upper Tuscaloosa in the No. 1 Bailey, a thin sequence of glauconitic fossiliferous calcareous sandstones overlying the dark-gray and black flakey and splintery shales of the Middle Tuscaloosa, is characteristic of basal Upper Tuscaloosa sediments in Copiah County.

UPPER TUSCALOOSA FORMATION

The Upper Tuscaloosa consists of a 510 to 740 foot sequence of interbedded shales, mudstones and somewhat lenticular sandstones. The formation is thicker in the north half of the County, complimenting the general northward thinning of the underlying Middle Tuscaloosa.

Upper Tuscaloosa shales are light-gray, gray, dark-gray, red and dark-red and occasionally micaceous. The mudstones are vari-colored pale-gray, light-gray, gray, red, purple, lavender, ochre and light-green and are commonly mottled. Siderite concretions are commonly noted as inclusions in the pale-gray, light-gray, gray and light-green mudstones. Some of the mudstones are sparingly lignitic, however, only rare traces of lignite were noted in the samples.

The sandstones are predominantly white, generally porous, commonly contain random grains of vari-colored chert, are variably silty, micaceous and ashy and rarely sideritic. The sandstones vary from very fine- to coarse-grained, however most are in the fine- to medium-grained range. Calcareous, glauconitic, variably fossiliferous sandstones are commonly noted in the basal 50 to 100 foot sequence in most wells examined. A few thin zones of medium- to coarse-grained sandstone with associated chert and quartz pebbles and chips were noted in the Upper Tuscaloosa. Traces of red sandstones were noted in only one well, the Gulf Oil Corporation No. 1 Gatesville Unit 24-10, sec. 24, T. 2 N., R. 1 W., in the northeast corner of the County.

The top of the Tuscaloosa in this report is placed at the first appearance, in cuttings, of pale-gray, light-gray, gray or light-green mudstones stratigraphically below the characteristically glauconitic basal sandstones of the overlying Eutaw group.

In some of the wells examined, basal Eutaw sandstones, immediately overlying Tuscaloosa sediments, are not glauconitic, but contain random vari-colored chert grains. The dark-gray and gray shales of the uppermost Tuscaloosa beds are indistinguishable from those of the overlying Eutaw group. No apparent break in sedimentation is indicated by the gross lighology at the Tuscaloosa-Eagle Ford (Lower Eutaw) contact and the contact is regarded as transitional. Sample work is the only accurate method of determining the contact between the Tuscaloosa and the overlying Eutaw group, as no reliable electrical log correlations exist.

EUTAW GROUP

GENERAL

In the subsurface of central and eastern Mississippi, the Eutaw consists of interbedded glauconitic sandstones and dark-gray and black micaceous shales stratigraphically below the chalks of the Selma Group. In these areas where no marked lithologic break exists between the Eagle Ford and Eutaw sediments, they are treated as a single depositional unit. Basinward, Eutaw age sediments grade, in descending order, into argillaceous chalks and dark-gray and black micaceous sparingly fossiliferous shales and very fine-grained glauconitic sandstones and siltstones and a lower sequence of interbedded fine- to medium-grained calcareous glauconitic, commonly fossiliferous sandstones and dark-gray and black shales. In these basinward areas, where beds of Eutaw age are represented by a chalk facies, the Eagle Ford sediments are separable. In this report, the chalks of Eutaw age (Austin) are not included in the Eutaw group but are combined with the chalks of the overlying Selma group.

EAGLE FORD (LOWER EUTAW)

Throughout Copiah County, with the exception of the Gulf Oil Corporation No. 1 Gatesville Unit 24-10 in sec. 24, T. 2 N., R. 1 W., the term Eagle Ford is applied to those sediments between the base of the Selma chalks and the top of the Tuscaloosa group.

The top of the Eagle Ford is placed at the first appearance, in cuttings, of dark-gray and black finely micaceous, usually flakey and splintery, occasionally lignitic or carbonaceous shales and/or associated minor amounts of very fine-grained calcareous micaceous glauconitic sandstones and siltstones stratigraphically below the Selma chalks.

Throughout the County, approximately the upper two-thirds to three-quarters of the Eagle Ford is a sequence of predominantly dark-gray and black, generally finely micaceous flakey and splintery, occasionally lignitic shales and subordinate very fine-grained calcareous micaceous glauconitic, occasionally lignitic or carbonaceous sandstones and siltstones. The lower one-third to one-quarter of the Eagle Ford is an interbedded sequence of fine- to medium-grained calcareous, glauconitic, variably fossiliferous and micaceous sandstones, some containing rare scattered fragments of lignitic material. The Eagle Ford facies of the Eutaw group varies from 280 to 380 feet in thickness being generally thicker in the northeast half of the County. The Eagle Ford expands at the expense of the overlying Selma chalks.

The Eutaw sediments in the No. 1 Gatesville Unit 24-10 are more typical of the Eutaw sediments in central and eastern Mississippi being a sequence of interbedded glauconitic sandstones and dark-gray and black micaceous shales stratigraphically below the Selma chalks. Thickening at the expense of the overlying Selma chalks, the Eutaw sediments in this well reach a thickness of 600 feet.

SELMA GROUP

In this report the Selma group includes the entire Upper Cretaceous "chalk" section. As defined, this 845 to 1130 foot section includes beds of Navarro, Taylor and Austin age.

The Selma group in Copiah County is divisible into three more or less distinct lithologic units; an upper chalk and shale section, a middle "micaceous shale" section, and a lower chalk and shale section. The Selma is not divided into formations in this report, and no attempt is made to differentiate restricted paleontologic zones.

The upper lithologic division of the Selma group consists of interbedded light-gray and pale-gray to white argillaceous and occasionally slightly bentonitic and micaceous chalks and dark-gray and black occasionally flakey and splintery and finely micaceous shales. Some of the shales are slightly calcareous.

Traces of light-gray, light-green to gray and white bentonite is occasionally observed in samples.

The middle division of the Selma group is a rather distinctive sequence of dark-gray and black generally coarsely micaceous, occasionally glauconitic and sandy shales. Minor amounts of light-gray very fine- to fine-grained calcareous glauconitic sandstone and light-gray to gray argillaceous, occasionally micaceous chalk are also present in this middle unit.

The lower division of the Selma group consists of interbedded light-gray to gray argillaceous, occasionally glauconitic and gray, dark-gray and black, occasionally flakey and splintery finely micaceous shales. Some of the shales are slightly calcareous. Minor amounts of very fine- to fine-grained silty micaceous glauconitic, commonly calcareous sandstone are generally present in association with the glauconitic chalks of this lower division.

The Selma group thins from the base upward complementing the expansion of the underlying Eutaw sediments and locally over areas which were topographic highs during Selma deposition.

Though the upper part of the Selma group (top of Cretaceous) and the overlying Clayton formation (basal Paleocene) are lithologically similar, the top of the Selma may readily be differentiated from the Clayton by electrical log characteristics. These electrical log correlations are substantiated by paleontological evidence. The chief microfaunal marker for the chalks of the uppermost Selma (Navarro) is *Globotruncana arca.* Microfaunal evidence indicates that the Selma-Clayton contact is unconformable.

MIDWAY GROUP

CLAYTON FORMATION

The Clayton formation is a 20 to 70 foot sequence of pale-gray and light-gray argillaceous, slightly bentonitic chalks and gray and dark-gray shales with minor amounts of pale-gray, light-gray and gray bentonite. The Clayton averages 47.5 feet in thickness being generally thicker in the southwest and western parts of the County. Variations in thickness are due in part to the unconformable Selma-Clayton contact. However, local thinning over topographically high areas undoubtedly occurred.

MIDWAY SHALE (PORTERS CREEK FORMATION)

Conformably overlying the Clayton formation is a homogeneous lithic unit comprised of gray, dark-gray and black, occasionally finely micaceous flakey and splintery shales. Rare traces of light-gray and gray bentonite were also noted in some wells. This rather distinctive shale unit is generally referred to as Midway shale. As defined this shale is probably all Porters Creek in age.

The Midway shale varies in thickness from 805 to 1120 feet, thickening in a southwesterly direction. Downdip thickening is accomplished primarily by a facies invasion of the basal Wilcox sediments, as classified in this report, by the Midway shale.

The top of the Midway group is picked on a marked increase of gray, dark-gray and black shales below the lowest sandstone sequence of the overlying Wilcox group. As defined in this report, the Midway-Wilcox contact is transitional.

The Paleocene-Eocene boundary has not been satisfactorily established in the subsurface of Mississippi. A time-rock unit concept, based on restricted faunal zones, would greatly expand the thickness of the Paleocene beds to include substantial amounts of the overlying strata now classified as Wilcox. Because of its general acceptance as a rock unit, perpetrated mainly by a need for a reliable and easily identifiable electrical log correlation, the Midway shale is treated as a rock unit. In this sense the Paleocene sediments are restricted to a basal calcareous unit, the Clayton formation, and an upper shale unit, the Midway shale. The Paleocene does not include that facies of Midway deposition lithologically similar to Wilcox sediments.

WILCOX GROUP

In this report the Wilcox is treated as a rock unit rather than a time-rock unit, and as such, incorporates an arenaceous facies of late Midway age.

The sediments classified as Wilcox in this report are a heterogenous mass of complexly interbedded, interfingering and interlensing shales, sandstones, siltstones, and thin lignites, limestones and clayironstones. The Wilcox varies from 3190 to 3495 feet in thickness, thickening to the south and southwest. The depositional pattern generally conforms to the structural configuration presented on the Lower Cretaceous structure map (fig. 18, Bicker).

Wilcox shales and clay shales are gray, dark-gray and black and generally silty and micaceous. Some slightly calcareous and sparingly fossiliferous shales were also noted in the Wilcox, being closely associated with other calcareous and/or fossiliferous sediments.

The sandstones vary from white to gray and are predominantly in the fine- and medium-grained range. These Wilcox sandstones and siltstones are variously argillaceous to limy, usually lignitic or carbonaceous, occasionally glauconitic and fossiliferous. Some of these sandstones contain grains of chert and fragments of limestone and clayironstone. Traces of pyritic and sideritic sandstones are also present.

Lignite is found disseminated throughout the sandstones, shales and thin-bedded limestones and in thin seams. Thin brown to reddish-brown occasionally sandy glauconitic clayironstones are also found scattered throughout the Wilcox. Some of these clayironstones are slightly calcareous.

Wilcox limestones are varying shades of gray, argillaceous silty micaceous lignitic, generally sandy and occasionally glauconitic and sparingly fossiliferous. These thin-bedded limestones serve to record brief periods of transgression during Wilcox deposition. The thin-bedded, discontinuous character of these limestones is indicative of the locally fluctuating depositional environments during Wilcox time.

The top of the Wilcox is picked on the first occurrence in cuttings of very fine- and fine-grained glauconitic calcareous, occasionally fossiliferous sandstones with associated gray silty shales and clay shales stratigraphically below pale-gray and white limy, finely glauconitic siltstones of the Tallahatta formation. The contact zone in many instances appears to be transitional. However, unconformable conditions exist locally over the known salt domes.

MIDDLE AND UPPER EOCENE
CLAIBORNE GROUP AND JACKSON GROUP

GENERAL

Sediments of the Claiborne and Jackson groups were greatly effected by shallow salt piercement. Time of uplift and rate of growth are reflected in the depositional environments, truncation and/or non-deposition and high angle bedding of the sediments over the crestal areas and flanks of the five known salt domes in Copiah County. Normally, depositional patterns tend to conform to the structural configuration presented on the Lower Cretaceous structure map (fig. 18, Bicker).

CLAIBORNE GROUP

TALLAHATTA FORMATION

The Tallahatta formation (basal Claiborne) consists of a sequence of pale grayish-white and white very finely glauconitic calcareous to limy slightly fossiliferous very finely micaceous siltstones and claystones with subordinate amounts of interbedded light-green and light greenish-gray glauconitic fossiliferous clay shales. Excluding the abnormal thicknesses of Tallahatta encountered over the crestal areas and on the flanks of the known salt domes within the County, the Tallahatta averages 110 feet in thickness.

The Tallahatta varies from 10 to 570 feet in thickness, the wide divergence in formation thickness being directly related to salt uplift. Wells encountering high angle beds penetrate unusually thick sequences of Tallahatta sediments. Several wells located on the Sardis Church Dome, T. 10 N., R. 9 E., encountered high angle Tallahatta strata. Up to 570 feet of Tallahatta sediments were penetrated by the Freeport Sulphur Company, No. 1 Southern Package Corporation, sec. 29, T. 10 N., R. 9 E. Tallahatta sedimentation occurring over topographically high areas, such as the Utica Dome, T. 12 N., R. 5 W., the Wesson Dome, T. 9 N., R. 8 E., the Allen Dome, centered in the northwest corner of T. 9 N., R. 6 E., and the Hazlehurst Dome, T. 1 N., R. 9 E., resulted in depositionally thin sequences of Tallahatta strata. These depositionally thin Tallahatta sediments are commonly pale-gray to light-gray very finely glauconitic silty limestones.

The top of the Tallahatta formation is usually placed at the first occurrence in cuttings of white and pale-grayish-white very finely glauconitic siltstones below the glauconitic chalks of the overlying Winona formation. The contact of the Tallahatta with the Winona appears to be transitional with deposition being essentially contemporaneous through the Tallahatta-Winona contact, even over the shallow salt domes which created topographic highs during Tallahatta deposition. In fact, some unusually thin lower Claiborne (Tallahatta-Winona) sequences possess such lithologic similarity that they are best treated as undifferentiated Tallahatta-Winona.

WINONA FORMATION

The Winona consists of 30 to 210 feet of pale-gray to white impure glauconitic fossiliferous chalks and minor amounts of light-gray and greenish-gray slightly glauconitic and fossiliferous clay shale. The glauconite present in the Winona is usually considerably larger than the glauconite found in the underlying Tallahatta formation. Glauconite is fairly evenly distributed throughout the Winona. There is usually a concentration of glauconite in the basal Winona sediments.

None of the thicker sequences of Winona could be attributed to high angle bedding. High angle bedding as a result of salt uplift undoubtedly occurs around the Sardis Church Dome.

The top of the Winona is usually picked on the first occurrence in samples of pale-gray and white glauconitic chalks below the basal light-gray to gray calcareous clay shales of the Zilpha formation. Unusually thin sequences of Winona sediments resulting from depositional thinning over topographically high areas are commonly pale-gray to light-gray glauconitic silty limestones. Chalky glauconitic marly strata is also characteristic of depositionally thin sequences of Winona sediments.

ZILPHA FORMATION

Overlying the Winona is a homogeneous sequence of gray slightly lignitic or carbonaceous fossiliferous, variably glauconitic clay shales, with an upper sandy phase, ranging from 0 to 460 feet in thickness. Occasional thin lentils of brown and reddish brown slightly calcareous clayironstone, variously glauconitic and fossiliferous clayironstones and impure chalk also are present in the Zilpha. The basal Zilpha strata is characteristically calcareous and variably glauconitic.

The upper sandy facies of the Zilpha consists of an interbedded sequence of clay shales and fine to medium-grained variably glauconitic micaceous sandstones, usually with scattered inclusions of dark mineral grains, lignitic or carbonaceous material and fossils. This sandy facies and the transitional nature of the Zilpha-Kosciusko contact has resulted in electrical log correlations which are lower in most cases than the actual top of the Zilpha formation. In most electrical log correlations this sandy phase is commonly included in the overlying Kosciusko formation. However, the marker fossil, *Cyclammina caneriverensis,* is present throughout this transitional facies.

The Zilpha-Kosciusko contact is transitional. Because of the fluctuating succession of one facies of deposition by another, the boundary between these two units tends to oscillate up and down, so that precise correlation is dependent on marker fossils. In this report the top of the Zilpha is placed at the base of the last massive sandstone sequence of the Kosciusko.

KOSCIUSKO FORMATION

Overlying the Zilpha is a 0 to 840 foot sequence of sandstones, siltstones, clays, clayshales, clayironstones and thin-bedded lignites and silty sandy argillaceous limestones.

The clays and clay shales are light-gray to dark gray, usually silty, occasionally sandy and commonly lignitic or carbonaceous. Kosciusko sandstones and siltstones are prodominantly white to light-gray. The sandstones range from very fine- to coarse-grained. Small, clear quartz pebbles are commonly associated with the zones of coarser sandstones. Both sandstones and siltstones are argillaceous, occasionally calcareous, micaceous and lignitic or carbonaceous and only rarely contain scattered grains of glauconite. A few thin intervals of light-tan siltstones and sandstones were also noted, the color being due to mineral staining, probably siderite. The clayironstones are reddish-brown, brown or tan, slightly calcareous and occasionally sandy and glauconitic. The limestones are brown, tan and varying shades of gray and variably silty sandy argillaceous and occasionally contain fragments of lignitic or carbonaceous material.

Depositionally thin Kosciusko sediments over the shallow salt domes are commonly quite calcareous. Much of the sandstone is calcareous to limy and fragments of lignitic or carbonaceous material are commonly incorporated in these calcareous sediments. The top of the Kosciusko formation is placed at the first occurrence, in cuttings, of argillaceous lignitic or carbonaceous sandstones below the light-gray sparingly glauconitic clay shales and white glauconitic chalks of the overlying Cook Mountain formation. In some of the wells examined, a thin zone consisting of light-gray to gray silty clay shales exists between strata of definite Kosciusko or Cook Mountain lithology. In other wells the glauconitic chalks of the Cook Mountain appear to disconformably overlie Kosciusko sands, so that contact relationships vary from apparently transitional to disconformable.

COOK MOUNTAIN FORMATION

The Cook Mountain formation is a sequence of clays, clay shales, chalks and chalky limestones, thickening in a general southwesterly direction primarily at the expense of the overlying Cockfield formation. The Cook Mountain varies from 0 to 290 feet in thickness.

The upper part of the Cook Mountain consists of light-gray finely carbonaceous clays and clay shales with subordinate amounts of sparingly glauconitic fossiliferous calcareous shales. Expansion of this upper unit of the Cook Mountain is the result of a facies change. As mentioned previously, this expansion takes place at the expense of the overlying Cockfield formation. The top of the Cook Mountain is picked on a general increase of light-gray clay shales stratigraphically below the basal fine and medium-grained sandstones of the Cockfield. At the contact the clay and clay shales of the uppermost Cook Mountain become varibly silty and sandy. The Cook Mountain - Cockfield contact is transitional.

The lower part of the Cook Mountain is a sequence of pale gray to white impure silty glauconitic fossiliferous chalks with generally minor amounts of interbedded light-gray and gray variably glauconitic and fossiliferous clay shales. As mentioned previously under the discussion on the Kosciusko formation, a basal clay shale sequence of variable thickness classified in this report as Cook Mountain strata may represent a thin transiton zone.

Locally over some of the shallow salt domes, Cook Mountain sediments consist of depositionally thin clay shales and white glauconitic fossiliferous limestones.

COCKFIELD FORMATION

The Cockfield formation consists of a 0 to 555 foot sequence of sandstones, siltstones, clays and thin beds of lignite and clayironstone. The Cockfield thickens in a general southwesterly direction.

The sandstones range from very fine- to medium-grained, generally argillaceous or clayey, variously lignitic or carbonaceous and micaceous. A few thin zones of sparingly glauconitic sandstone were noted in some of the wells examined. Cockfield siltstones are usually argillaceous or clayey micaceous and variably lignitic or carbonaceous.

Locally, light-gray and brown sandy argillaceous, sparingly lignitic or carbonaceous limestones and brown and light grayish-brown calcareous to limy sandstones were deposited over the shallow salt domes. Argillaceous material incorporated in these calcareous sediments is responsible for the predominantly brown to gray color.

Cockfield clays are light-gray to gray, usually silty, variably sandy and lignitic or carbonaceous. The clayironstones are brown to reddish-brown, occasionally slightly sandy and rarely slightly calcareous and glauconitic.

The top of the Cockfield is placed at the first occurrence of lignitic clays or argillaceous lignitic siltstones or sandstones below the limy glauconitic fossiliferous sandy marls of the Moodys Branch. The Cockfield-Moodys Branch contact is disconformable. Reworked lignitic material from the Cockfield is occasionally noted in the basal strata of the overlying Moodys Branch.

JACKSON GROUP

MOODYS BRANCH FORMATION

The Moodys Branch consists of a sequence of greenish-gray calcareous, fossiliferous clayey glauconitic sands and pale-gray glauconitic fossiliferous sandy marls. Because of the persistent lithologic and electrical-log characteristics of this formation, the top of the Moodys Branch is generally used as a datum for semi-shallow structure maps.

The thickness of the Moodys Branch is fairly constant, averaging 18 feet in Copiah County. The thickness of the formation varies from 0 to 25 feet.

The contact of the Moodys Branch with the overlying Yazoo formation is gradational. As a rock-stratigraphic unit, the Moodys Branch-Yazoo contact is placed at that point where the sand and glauconite content become negligible.

YAZOO FORMATION

The Yazoo is a homogenous sequence of light bluish-gray and pale gray calcareous fossiliferous variably glauconitic clays with some thin soft white and cream-colored chalky and glauconitic limestone or marl beds usually in the basal part of the formation. Typically the Yazoo is quite limy and glauconitic and variably silty and sandy at its contact with the underlying Moodys Branch. The Yazoo varies from 0 to 470 feet in thickness, having an average thickness of 390 feet. The formation thickens in a general southwesterly direction.

The top of the Yazoo is placed at the first occurrence, in cuttings, of light bluish-gray calcareous clay stratigraphically below the light-gray to gray predominantly micaceous and lignitic or carbonaceous strata of the Forest Hill formation. The contrast in color is sharp.

Thicker sequences of Forest Hill strata, the lower portions of which are channel type deposits, undoubtedly were cut into the underlying Yazoo. These contacts are unquestionably unconformable. Contact relationships involving thinner Forest Hill sequences, consisting of silty clays and lenticular sandstones, are less evident. The actual contact may not be as sharp as indicated in cuttings. Until such time as cored Yazoo-Forest Hill contacts are available, actual contact relationships will remain unsolved and the Yazoo-Forest Hill contact must still be regarded as disconformable.

FOREST HILL FORMATION

In the past, various authors have considered the Forest Hill to be Eocene in age. However, it is now generally accepted to be Oligocene in age. In reality the Forest Hill formation is probably partly Eocene and partly Oligocene in age. For the purposes of this report and in concurrence with the presently accepted view, the Forest Hill is placed in the Oligocene as a formation.

The Forest Hill formation consists of a sequence of predominately very fine- to fine-grained lenticular micaceous clayey, commonly lignitic or carbonaceous sandstones and siltstones, gray silty micaceous finely lignitic or carbonaceous clays and occasional thin beds of lignite.

The average thickness of the formation is 75 feet. However, individual thicknesses vary from 0 to 180 feet. As indicated in the previous discussion of the Yazoo formation, these thicker sequences of Forest Hill strata are channel type deposits which expand at the expense of the Yazoo formation. The lower portions of these thicker Forest Hill sections generally consist of massive fine- to coarse-grained sands, with scattered small quartz pebbles and subordinate amounts of clay. The upper portions are similar to Forest Hill sequences of average thicknesses, being a sequence of silty lignitic or carbonaceous clays and fine lenticular sands.

Only one exception to the argillaceous-arenaceous-carbonaceous character of the Forest Hill strata was noted. A thin light-gray to pale-gray dense slightly pyritic limestone directly overlying the Yazoo formation was noted in the Freeport Sulphur Company No. 2 Southern Package Corporation, on the Sardis Dome.

The top of the Forest Hill is placed at the contact between the lignitic or carbonaceous clays, silts and sands of the Forest Hill and the calcareous fossiliferous sands and marls of the overlying Mint Spring. The contact is regarded as generally unconformable and is usually easily recognized in cuttings.

VICKSBURG GROUP

Classification of the Vicksburg Group as a rock-stratigraphic unit includes in ascending order: the Mint Spring formation, the Glendon formation (Vicksburg limestone), the Byram formation and the Bucatunna formation. This classification is applied to stratigraphic units which are divisible into formations both electrically and lithologically throughout the County and surrounding area.

The limestones of the Glendon develop locally at the expense of the associated marls of the Vicksburg group. Both the underlying Mint Spring marls and the overlying Byram marls are lithologically similar to the alternating marls separating the limestones of the Glendon. This intimate lithologic relationship necessitates arbitrary placement of formation contacts between the Glendon formation, the subjacent Mint Spring formation and the overlying Byram formation.

MINT SPRING FORMATION

The Mint Spring formation consists of a sequence of pale grayish-white to pale grayish-green fine- to medium-grained well rounded highly fossiliferous glauconitic calcareous sandstones and chalky fossiliferous glauconitic variably sandy marls. The sandy zones of the Mint Spring in several of the wells examined, were slightly pyritic. The average thickness of the Mint Spring is 32 feet, with individual thicknesses ranging from 0 to 50 feet.

The top of the Mint Spring is placed at the base of the lowest indurated limestone bed of the overlying Glendon formation. The contact is regarded as conformable.

GLENDON FORMATION

The Glendon formation is a sequence of alternating limestones and marls commonly referred to as the Vicksburg "limestone." The limestones are pale-gray to cream colored, dense to chalky, fossiliferous, glauconitic and sparingly sandy. The associated marls are pale grayish-white to pale-green, fossiliferous, glauconitic and variably sandy.

The Glendon has an average thickness of 21 feet but varies from 0 to 30 feet in thickness. Thickness variations of the Glendon are due, in part, to the fact that the limestones apparently expand at the expense of the associated marls of the Vicksburg group. Some of the thinning is due to the locally unconformable contact of the Glendon with the Catahoula formation.

The top of the Glendon is placed at the top of the first indurated limestone ledge below the fossiliferous glauconitic marls of the Byram formation. The contact of the Glendon with the overlying marls of the Byram is normally conformable.

BYRAM FORMATION

The Byram formation consists of pale greenish-gray calcareous glauconitic fossiliferous, generally quite sandy marl. Rare occurrences of pyrite were noted in several wells.

The Byram has an average thickness of a little over 6 feet, with individual thicknesses varying from 0 to 10 feet. The variations in thickness are believed to be primarily due to local limestone development at the expense of the Byram marls.

The top of the Byram formation is placed at the normally conformable contact between the pale greenish-gray marls of the Byram and the dark-gray and gray finely lignitic or carbonaceous clays of the overlying Bucatunna formation.

BUCATUNNA FORMATION

The Bucatunna formation consists predominantly of gray and dark-gray finely lignitic or carbonaceous clays and silty and very finely micaceous clays. The Bucatunna also contains a few thin lentils of pale greenish-gray clayey slightly fossiliferous and sparingly glauconitic marl. Only a few scattered fossil fragments and rare grains of glauconite were noted in the predominantly clay sequence of the Bucatunna and these occurrences were generally confined to the basal beds.

The Bucatunna averages 49 feet in thickness, with individual thicknesses ranging from 0 to 70 feet. Variations in thickness are due primarily to unconformable contact between the Bucatunna clays and the overlying Catahoula sediments. Where fine- to coarse-grained sandstones of the basal Catahoula formation directly overlie the Bucatunna clays, the Bucatunna-Catahoula contact is undoubtedly unconformable. Other contact relationships are less evident. Such contacts appear to grade through a thin zone from the gray and dark-gray silty clays of the upper-most Bucatunna into pale-yellow and pale-gray silty and sandy clays of the Catahoula. No cores of such contacts were available and in reality these contacts are probably disconformable.

SALT DOMES

GENERAL

Five piercement-type salt domes are known to be present in the subsurface of Copiah County (fig. 18, Bicker.) The salt domes are: Hazlehurst Dome, Wesson Dome, Sardis Church Dome, Allen Dome and Utica Dome.

The generally inadequate well control on these domes prevents any comprehensive study. However, certain generalized statements regarding rate of growth and time of uplift may be inferred from the depositional environments reflected in the host sediments.

All of these piercement-type domes appear to be the result of a secondary age of growth occurring during deposition of Tertiary strata. Primary age of growth is believed to have occurred as early as Jurassic and/or Lower Cretaceous time, resulting in deep-seated, low relief doming.

With the beginning of this secondary age of growth, rapid growth resulted in the salt stocks piercing upward into Tertiary strata. Subsequent deposition resulted in salt uplift, more or less contemporaneous with deposition for varying lengths of time, so that Miocene sediments unconformably overlie depositionally thin and eroded or steeply upturned Tertiary strata.

Cap rock composed of light-gray to dark-gray fractured and brecciated limestones and dolomitic carbonates with veins of clear and yellow calcite and associated anhydritic strata overlie these piercing salt stocks.

HAZLEHURST DOME

The Hazlehurst Dome, located in sec. 28, T. 1 N., R. 1 W., was tested by the Stanolind Oil and Gas Company No. 1 T. A. Huntington. Cap rock was logged at a depth of 1460 feet, in strata of Wilcox age. The overlying Claiborne sediments are depositionally thin, with Miocene sediments unconformably overlying eroded Yazoo strata.

WESSON DOME

The Sun Oil Company No. 1 McIntosh encountered the top of cap rock at a depth of 3394 feet in Wilcox sediments. Overlying Claiborne sediments are depositionally thin. Only slight thinning appears to have occurred in the succeeding Jackson sediments as salt growth apparently ceased and normal deposition began to occur over the crestal area of the dome.

SARDIS CHURCH DOME

Sardis Church Dome sec. 29, T. 10 N., R. 9 E., has been tested by eight wells drilled by Freeport Sulphur Company. These tests encountered Miocene sediments unconformably overlying depositionally thin, eroded and steeply upturned strata varying from Eocene to Oligocene age. Cap rock was encountered as shallow as 1448 feet below the surface.

ALLEN DOME

Depositionally thin Claiborne, Jackson and Oligocene (Forest Hill) sediments were penetrated by the Sun Oil Company No. 2 Case Lumber Company, sec. 5, T. 9 N., R. 6 E., before encountering cap rock at a depth of 2447 feet, in Wilcox sediments. Other wells also reflect similar depositional thinning.

UTICA DOME

A depositionally thin sequence of Claiborne strata is unconformably overlain by Miocene sediments in the Sun Oil Company No. 1 Little in sec. 8, T. 2 N., R. 4 W. Cap rock was encountered in a core sample from 2634 to 2636 feet, with reported top of salt at a depth of 3135 feet.

OIL AND GAS POSSIBILITIES

The search for oil, gas and sulphur in Copiah County has been disappointing, with only scattered occurrences of oil and/or gas having been reported.

Shows of oil have been reported in Wilcox sediments in several wells. Copiah County is generally considered to be northeast of the more favorable areas for hydrocarbon production from the Wilcox. However, hundreds of feet of porous and permeable sands are present in the Wilcox and the possibility of future oil and gas production should not be discounted.

A spotted show of asphaltic oil was reported from the Freeport Sulphur Company No. 1 Allen, located on the Sardis Church Dome. No oil, gas or sulphur deposits were reported in any of the other wells drilled on these piercement-type domes.

However, a strong hydrogen sulfide odor was noticed when the dark cap rock carbonates were broken.

Slight shows of gas have been reported from Eagle Ford (Lower Eutaw) strata in several wells. The lower part of the formation contains adequate reservoir and source beds and should contain commercial quantities of hydrocarbons if tested in favorable structural or stratigraphic locations.

The conglomeritic ashy chloritic sands of the Lower Tuscaloosa have produced much oil and gas south of Copiah County in the Brookhaven Field, Lincoln County, Mississippi. While no encouraging shows of oil and gas have been reported in these sands in Copiah County, they possess excellent reservoir characteristics and should be given consideration in future drilling programs.

Traces of gas and/or oil have been reported in Washita-Fredericksburg and Paluxy sediments in several wells. Both of the units contain hundreds of feet of porous and permeable sands and should be tested further.

Gas and distillate were tested for several years from the basal Rodessa sandstone sequence in the Sun Oil Company No. 1 Southern Package Corporation sec. 6, T. 9 N., R. 7 E., before temporary abandonment. Asphaltic oil stain and gas odor have been reported in Rodessa sediments in at least three other wells. To date the most encouraging shows of oil or gas have been found in the basal Rodessa. The base of the Rodessa throughout the county is marked by a persistent fine- and medium-grained sandstone sequence. This basal Rodessa sandstone should be considered in any deep tests in the future.

Shows of oil have also been reported from the Pine Island, Sligo and Hosston formations. Only two tests have penetrated into sediments of Hosston age. These deeper objectives have not been sufficiently tested.

Even deeper objectives, the Smackover and Haynesville formations, should be considered as probable reservoirs for hydrogen sulfide gas.

While sufficient reservoir and source beds are present in the subsurface of Copiah County, to date they have failed to yield commercial quantities of hydrocarbons. Primary objectives, in the past, have been based on structural prospects, with little emphasis on stratigraphic possibilities. The depositional history of these sediments presents conditions favorable for the generation, migration and trapping of hydrocarbons. The hydrocarbons indigenous to these sediments may be concentrated in lenticular sands. Exploration for reservoirs in which entrapment is independent of structural closure, but rather governed by depositional controls, would require an exploration program oriented toward environmental concepts.

COPIAH COUNTY CLAY TESTS

THOMAS E. McCUTCHEON

INTRODUCTION

Clays from ten bore holes representing eighteen samples were furnished for ceramic testing and evaluation. The test work was done at the laboratory of the Ceramic Engineering School at the Georgia Institute of Technology under the supervision of the writer and Dr. Lane Mitchell, Director. Normal ceramic tests were conducted by standards prescribed by the American Ceramic Society. Screen analyses were made by the writer and the description of the residue was made by William H. Moore, State Geologist of Mississippi. Chemical analyses were made by the Shilstone Testing Laboratory of New Orleans, Louisiana.

Ceramic test data, screen analyses and chemical analyses are given here with comments.

COMMENTS

The clays from Test Holes AK-9, 10, 11, 12, 13, 14, 17 and 20 have common plastic and burning properties and vary, mainly in their content of excess sand which accounts for the difference in dry and fired strengths and absorption and porosity values at several fired temperatures. The fired colors of this group of clays range from salmon or light-red to the darker colors of red, including brown and purplish hues at elevated temperatures. The color development from low to high temperatures is dependent on the iron content of the clays and the degree of vitrification which in turn is governed in this group of clays by their excess silica (sand) content. Excess silica dilutes the clay and iron content. In another way of explanation, excess silica (sand) is refractory, retards vitrification and development of the red color of the iron-clay glass matrix. At temperatures below vitrification excess silica tends to expand and contract on heating and cooling. This expansion and contraction weakens the clay body by breaking minute ceramic bonds. In this way the clay may have low burned strength and high absorption values and the ultimate color development is delayed at low temperatures. At higher burning temperatures, some, if not all of the excess sand becomes a part of the ceramic matrix, losing its individual mineral characteristic and permitting the normal development of the clay to mature to a hard mass. When pre-formed the matrix is suitable for use in the manufacture of many structural products.

The principal clay mineral of this group of clays is considered to be a mixture of kaolinite and montmorillonite, inasmuch as the plastic, drying and burning characteristics of the clays exhibit properties of both clay minerals. The iron content of the clays which accounts for the red fired colors, is considered to be present as part of the complex clay mineral montmorillonite where iron has replaced alumina in the hydrous alumina silicate. Small amounts of magnesium and calcium can also be a part of the mineral montmorillonite.

The color of the raw clay can be misleading as to the fired color. For example, Sample AK-14, 30′-37′, is a very light-gray in its natural state and Sample AK-17, 6′-11′, is a yellowish brown. Both burn to red colors and the chemical analyses of both clays indicate practically the same iron content. Recent weathering (eon years) could have further disintegrated the mineral montmorillonite allowing part of its integral iron content to be converted to various iron oxides. These oxides as accessory minerals could account for the yellowish colors of some of the raw clays. The brownish colors are likely due to organic matter which burns out on firing.

In general terms, this group of clays, samples from Test Holes AK-9, 10, 11, 12, 13, 14, 17 and 20 represent ideal raw materials for a heavy clay products industry. In the old days one would have had to do nothing but form and burn these clays to make good brick. In our present time, clay products such as face brick, common brick, structural tile, conduit tile, fire-proofing and drain tile, as well as many other like products, are made to conform to rather exact specifications which necessitates the blending of clays, sand and calcined clays to produce competitive products.

The Copiah County clays, represented by the samples tested and referred to above, have the basic properties with minor adjustments that make them suitable for the major raw material for a heavy clay products industry.

Two samples of sandy clay from Test Hole AK-18, 6′-13′ and 15′-22′, differ from the other Copiah County clays tested. The sand content of the samples is very high. The iron content is unusually low. The clays are not very plastic. They have low dry and burned strengths, and burn to cream and buff colors over a long range of temperature. Although the fired colors of cream, buff and light-gray are very attractive, the clays if used alone are not suitable for the usual variety of structural clay products. They have value when blended with plastic cream to buff burning clays for producing commercial products in a light range of colors and also for blending with plastic red burning clay to control high drying and shrinking properties. The amount of clay from Test Hole AK-18 used in blending is limited as to quantity. Adding too much of the clay from AK-18 could introduce undesirable properties into the finished product.

The principal clay mineral of the samples from Test Hole AK-18 seems to be kaolinite as evidenced by plastic drying and firing properties. An extensive search in the area might reveal deposits containing less free quartz (sand) which would render the clay more suitable for light colored clay products and semi-refractory uses.

Samples from Test Hole AK-19 represent two kinds of clay. They are both very plastic and have good plastic properties. Clay from the interval 5′29′ has the highest alumina content of the Copiah County clays tested. Its iron content is also high. Screen analysis shows that 99.9+ percent of the clay passed through a 250 mesh screen. On drying, the clay developed cracks. The dry strength of 625 pounds per square inch does not represent the potential of the clay. If blended with 50 percent non-plastic material the dry strength would likely be considerably higher. On burning, further cracks developed and it was not practical to obtain fired data other than the color which was a range of reds. The characteristics of this clay indicate that the principal clay mineral content is montmorillonite. The clay has possibilities as a bond in foundry sand and in less plastic ceramic raw materials such as the loess to improve plastic and fired properties.

The clay represented by the Sample AK-19, 29′-42′, is somewhat like that in the interval 5′-29′ except that it is fairly carbonaceous and contains some pyrite, quartz and silt. It has less dry strength and more drying shrinkage. On burning, the clay tends to bloat (expand) and in this regard could be considered as a potential material for making lightweight aggregate. Due to its physical position with respect to the stratum above a blend of 50 percent of each clay was made and partially tested as a material for expanded clay aggregate. The test, though not completed for this report, indicates that the two clays from Test Hole AK-19 could be combined in a proportion (yet to be determined) suitable for making aggregate. Due to the carbonaceous content of the Sample AK-19, 29′-42′, it should be used with caution in heavy clay products manufacture.

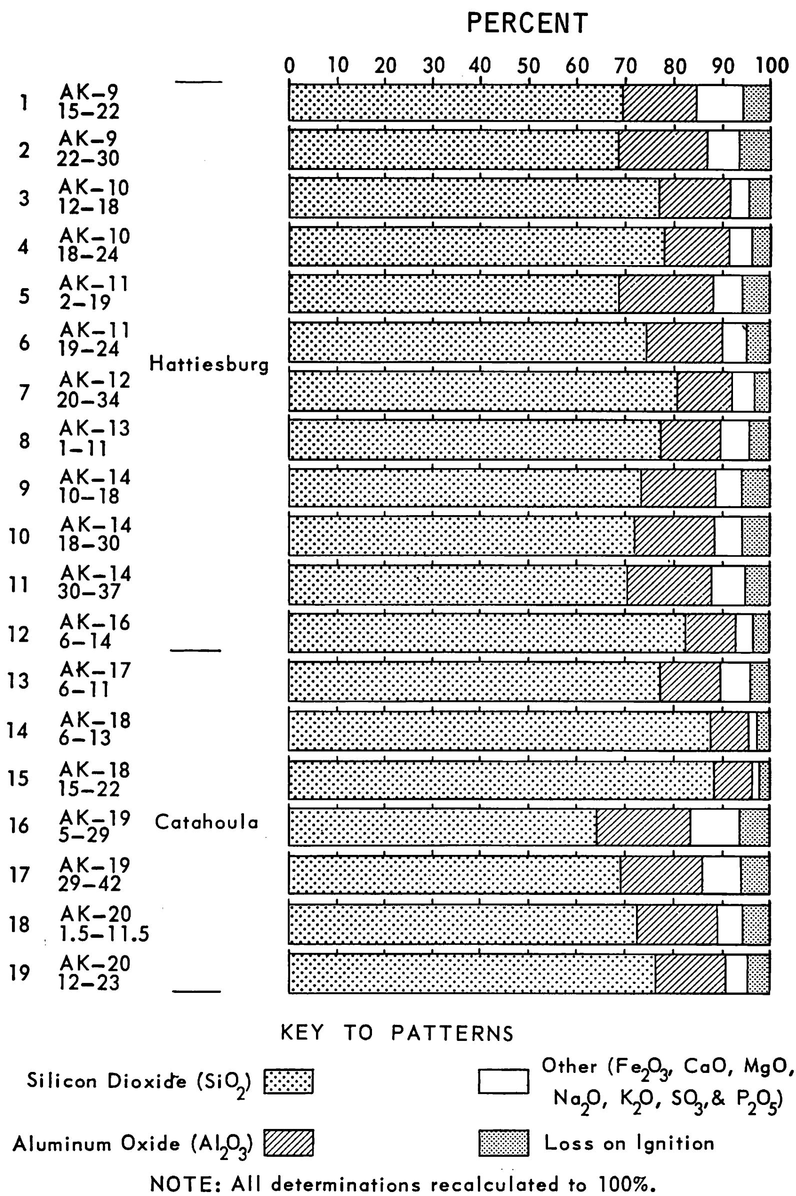

Figure 1.—Plotted chemical analysis of Copiah County clay samples tested. See data, Table 1.

TABLE 1.—Chemical Analyses of Clays, Copiah 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	TOTAL
AK-9 (15′-22′)	Hattiesburg	68.35	15.10	7.67	None	1.01	0.08	0.56	None	0.14	5.53	98.44
AK-9 (22′-30′)	Hattiesburg	67.59	17.83	5.81	None	0.74	0.04	0.13	None	0.14	6.14	98.42
AK-10 (12′-18′)	Hattiesburg	76.58	14.72	3.10	None	0.45	0.02	0.06	None	0.06	4.44	99.43
AK-10 (18′-24′)	Hattiesburg	77.01	13.20	3.57	None	0.73	0.04	0.09	None	0.05	3.85	98.54
AK-11 (2′-19′)	Hattiesburg	68.22	19.05	4.91	None	0.93	0.04	0.07	None	0.13	5.82	99.17
AK-11 (19′-24′)	Hattiesburg	73.22	15.49	3.69	None	0.78	0.06	0.36	None	0.08	4.80	98.48
AK-12 (20′-34′)	Hattiesburg	79.86	11.09	3.35	None	0.51	0.12	0.52	0.10	0.06	3.04	98.65
AK-13 (1′-11′)	Hattiesburg	77.43	12.47	4.16	0.27	0.74	0.19	0.28	None	0.11	4.26	99.91
AK-14 (10′-18′)	Hattiesburg	73.24	15.49	3.93	0.60	0.62	None	None	None	0.04	5.96	99.88
AK-14 (18′-30′)	Hattiesburg	71.72	16.25	3.92	0.74	0.90	0.03	0.08	None	0.08	5.74	99.46
AK-14 (30′-37′)	Hattiesburg	70.39	17.31	4.24	0.93	1.17	0.02	0.07	None	0.14	5.64	99.91
AK-16 (6′-14′)	Hattiesburg	82.27	10.26	3.41	0.14	0.30	0.01	None	None	0.05	3.27	99.71
AK-17 (6′-11′)	Catahoula	76.62	12.51	4.38	0.32	0.84	0.07	0.20	None	0.07	3.97	98.98
AK-18 (6′-13′)	Catahoula	87.60	8.02	1.17	0.18	0.14	None	None	None	0.04	2.43	99.58
AK-18 (15′-22′)	Catahoula	88.27	8.24	0.97	None	0.14	0.02	0.01	None	0.04	2.36	100.05
AK-19 (5′-29′)	Catahoula	63.75	19.04	7.04	0.86	1.56	0.05	0.44	None	0.11	6.02	98.87
AK-19 (29′-42′)	Catahoula	68.64	16.89	5.45	0.63	1.11	0.14	0.34	0.35	0.10	5.71	99.36
AK-20 (1.5′-11.5′)	Catahoula	73.29	16.76	3.93	0.32	0.49	0.06	0.02	None	0.04	5.73	100.64
AK-20 (12′-23′)	Catahoula	76.33	14.35	3.52	0.28	0.73	0.08	0.26	None	0.08	4.13	99.76

TABLE 2

SCREEN ANALYSIS

TEST HOLE AK-9, 15 TO 22 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	3.0	Dark silt nodules
60	1.6	Dark silt nodules (A) quartz (T) organic material (T) limonitic clay (T)
100	0.6	Dark silt nodules (A) limonitic clay (C) quartz (S) organic material (S)
250	2.8	Quartz (A) dark silt and clay nodules (C) limonitic clay (S) organic material (S) muscovite (S)
PAN	92.0	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-9, 22 TO 30 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Clay nodules (A) limonitic in part; quartz (C)
60	Nil	Clay nodules (A) limonitic in part; quartz (C) organic material (C)
100	0.2	Quartz (A) limonitic clay (C) clay nodules (C) organic material (C)
250	2.0	Quartz (A) limonitic clay (C) muscovite (S) organic material (S)
PAN	97.8	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-10, 12 TO 18 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Quartz (A) organic material (C)
60	Nil	Quartz (A) limonite (C) organic material (C) clay nodules (S) heavy minerals (S)
100	0.4	Quartz (A) organic material (C) limonite (S) heavy minerals (T)
250	9.0	Quartz (A) heavy minerals (T)
PAN	90.6	Clay (A) silt (S)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-10, 18 TO 24 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Silt nodules (C) quartz (C) limonitic silt nodules (C) organic material (S) limonite (S)
60	0.1	Quartz (A) clay and silt nodules (C) limonitic in part; limonite (C) organic material (S) chert (S) kaolin (T)
100	0.7	Quartz (A) clay nodules (C) limonitic in part; limonite (C) organic material (S) chert (T) kaolin (T)
250	11.8	Quartz (A) chert (T) heavy minerals (T)
PAN	87.4	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-11, 2 TO 19 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Quartz (A) organic material (C) limonite (S) chert (T) pyrite (T)
60	0.4	Quartz (A) limonite (C) chert (S) pyrite (S) organic material (S)
100	1.0	Quartz (A) limonite (C) organic material (S) pyrite (S) chert (T)
250	4.2	Quartz (A) limonite (S) pyrite (S) muscovite (S) heavy minerals (S)
PAN	94.4	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-11, 19 TO 24 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Organic material (A) limonite (C)
60	Nil	Limonite (A) quartz (C) organic material (S) clay nodules (S)
100	0.1	Quartz (A) limonite (C) organic material (S) clay nodules (T)
250	2.6	Quartz (A) limonite (S) muscovite (T) organic material (T)
PAN	97.3	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-12, 20 TO 34 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.1	Limonite (A) gypsum (S) clay nodules (S) organic material (S) quartz (T)
60	0.1	Limonite (A) gypsum (C) clay nodules (S) organic material (S) quartz (S)
100	0.4	Quartz (A) limonite (C) gypsum (C) organic material (C) muscovite (S) clay nodules (S)
250	19.4	Quartz (A) limonite (S) muscovite (T) gypsum (T) heavy minerals (T)
PAN	80.0	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-13, 1 TO 11 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Organic material (A) quartz (C) chert (C) limonite (C)
60	0.2	Limonite and limonitic clay (A) quartz (C) organic material (C) lignite (C) clay nodules (S)
100	0.4	Limonite and limonitic clay (A) quartz (C) organic material (C) lignite (C) clay nodules (S)
250	8.0	Quartz (A) limonite and limonitic clay (C) lignite (S) organic material (S) muscovite (S) heavy minerals (T)
PAN	91.4	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-14, 10 TO 18 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.1	Clay nodules (A) limonitic in part; quartz (C)
60	1.1	Clay nodules (A) limonitic in part; quartz (C) organic material (S)
100	3.6	Quartz (A) clay nodules (C) limonitic in part; organic material (S) heavy minerals (T)
250	5.8	Quartz (A) clay nodules (C) limonitic in part; heavy minerals (T)
PAN	89.4	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-14, 18 TO 30 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.2	Clay nodules (A) limonitic in part; limonite (S) organic material (S) quartz (T)
60	0.9	Clay nodules (A) limonitic in part; limonite (C) quartz (S) organic material (S)
100	1.4	Clay nodules (A) limonitic in part; limonite (C) quartz (S)
250	5.4	Clay nodules (A) limonitic in part; limonite (C) quartz (S) muscovite (T)
PAN	92.1	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-14, 30 TO 37 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.1	Clay nodules (A) organic material (S)
60	2.6	Clay nodules (A) quartz (T)
100	6.0	Clay nodules (A) organic material (T)
250	10.3	Clay nodules (A) muscovite (T)
PAN	81.0	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-17, 6 TO 11 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Quartz (A) limonite (C) organic material (S) chert (T)
60	1.0	Quartz (A) limonite (C) organic material (S) chert (S) heavy minerals (T) hematite (T)
100	10.6	Quartz (A) limonite (S) organic material (S) chert (T)
250	15.0	Quartz (A) organic material (S) limonite (T) clay (T) chert (T)
PAN	73.4	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-18, 6 TO 13 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Organic material (A) quartz (C) limonitic clay (C)
60	0.2	Quartz (A) organic material (C) limonitic clay (S)
100	8.0	Quartz (A) organic material (S) limonitic clay (S) lignite (S)
250	25.8	Quartz (A) lignite (T) chert (T)
PAN	66.0	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-18, 15 TO 22 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Quartz (A) organic material (C) limonite (S)
60	1.7	Quartz (A) clay (S) limonite (S) organic material (S) chert (T) heavy minerals (T)
100	8.0	Quartz (A) chert (T) heavy minerals (T)
250	15.2	Quartz (A) muscovite (T) chert (T)
PAN	75.1	Silt (A) clay (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-19, 5 TO 29 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Organic material
60	Nil	Limonitic clay nodules (A) quartz (C) organic material (C)
100	Nil	Limonitic clay nodules (A) quartz (C) organic material (C) lignite (S)
250	Nil	Limonitic clay nodules (A) clay nodules (C) quartz (C) organic material (C) lignite (S)
PAN	99.9 +	Clay (A) silt (S)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-19, 29 TO 42 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	Nil	Pyrite (A) organic material (C)
60	0.3	Pyrite (A) clay nodules (C) organic material (C) quartz (S)
100	0.8	Clay nodules (A) pyrite (C) organic material (S) quartz (S)
250	3.8	Clay nodules (A) pyrite (C) quartz (T)
PAN	95.0	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-20, 1.5 TO 11.5 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.4	Clay nodules (A) limonitic clay (S) quartz (T)
60	0.6	Clay nodules (A) limonite and limonitic clay (S) quartz (S) organic material (S)
100	1.6	Clay nodules (A) quartz (C) limonitic clay (S) organic material (S)
250	6.7	Clay nodules (C) quartz (C) limonitic clay (S) muscovite (T) heavy minerals (T)
PAN	90.7	Clay (A) silt (C)

TABLE 2.—(Continued)

SCREEN ANALYSIS

TEST HOLE AK-20, 12 TO 23 FEET

SIEVE SIZE (MESH)	PERCENT RETAINED	CHARACTER OF RESIDUE
35	0.2	Clay nodules (A) limonite (S) quartz (S) manganiferous material (S) kaolin (T)
60	0.6	Clay nodules (A) limonitic clay (C) organic material (C)
100	2.4	Quartz (A) clay nodules (C) limonitic clay (S) organic material (S) chert (T) muscovite (T)
250	10.6	Quartz (A) clay nodules (C) chert (T) heavy minerals (T) muscovite (T) kaolin (T)
PAN	86.2	Silt (A) clay (C)

TABLE 3

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
					HATTIESBURG					
AK 9	15-22'	16.90	20.20	5.5	985*	Good	Good	Some	Lt.-gray Gray	*Laminated
AK 9	22-30'	20.30	25.70	6.5	974*	Good	Good	Some	Lt.-gray Gray	*Laminated
AK 10	12-18'	15.50	18.35	6.2	797	Good	Good	Some	Lt.-tan	
AK 10	18-24'	18.90	23.40	7.5	857	Good	Good	Some	Lt.-tan	
AK 11	2-19'	16.80	20.40	4.5	1030*	Good	Good	Some	Tan	*Laminated
AK 11	19-24'	18.75	23.00	5.0	1126	Good	Good	Some	Lt.-gray	
AK 12	20-34'	16.90	20.40	5.0	925	Good	Good	No	Lt.-tan	
					CATAHOULA					
AK 13	1-11'	16.10	19.10	6.5	1125	Good	Good	No	Tan	
AK 14	10-18'	21.00	26.60	6.5	744	Good	Good	Some	Dark Brownish Gray	
AK 14	18-30'	22.20	28.60	5.5	1000*	Good	Good	Some	Light Tannish Gray	*Laminated
AK 14	30-37'	27.00	37.20	8.0	477* c	Good	Good	Some	Lt.-gray	*Laminated c Cracked
AK 17	6-11'	17.50	21.30	5.0	1060	Good	Good	Slight	Dark Tan	
AK 18	6-13'	12.25	13.95	4.0	35	Weak	Fair	No	Lt.-gray	

TABLE 3.—(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
AK 18	15-22'	10.58	11.80	3.0	105	Weak	Fair	No	Lt.-gray	
AK 19	5-29'	25.50	34.00	6.0	625* c	Good	Good	Yes	Green Gray	*Laminated c Cracked
AK 19	29-42'	21.20	27.00	9.0	185* c	Good	Good	Some	Dark Gray	*Laminated c Cracked
AK 20	1.5-11.5	20.40	25.50	6.0	857	Good	Good	Some	Lt.-tan	
AK 20	12-23'	18.50	22.40	5.5	874	Good	Good	Some	Lt.-gray	

TABLE 4

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
						HATTIESBURG					
AK 9	15-22'	2124	2	13.40	6.34	2.11	2.44	8.0	3240	Red	Black cored
AK 9	15-22'	2167	4	11.90	5.52	2.14	2.43	9.0	3380	Red	Black cored
AK 9	15-22'	2232	6	10.90	5.01	2.17	2.43	8.5	1960	Red	Black cored
AK 9	15-22'	2305	8	9.15	4.22	2.17	2.38	9.0	3475	Reddish Brown	Black cored
AK 9	22-30'	2124	2	8.90	4.00	2.21	2.42	9.7	5150	Red	Black cored
AK 9	22-30'	2167	4	7.90	3.59	2.20	2.39	10.0	4860	Dark Red	Black cored
AK 9	22-30'	2232	6	6.29	2.85	2.20	2.35	10.0	4550	Dark Red	Black cored
AK 9	22-30'	2305	8	9.55	4.46	2.06	2.27	10.0	3920	Reddish Brown	Black cored
AK 10	12-18'	2124	2	15.04	7.25	2.06	2.43	8.5	3160	Salmon	Yellow cored
AK 10	12-18'	2167	4	18.40	8.00	2.03	2.41	8.5	3230	Salmon	Yellow cored
AK 10	12-18'	2232	6	14.65	7.15	2.04	2.40	8.5	3000	Lt.-red	Yellow cored
AK 10	12-18'	2305	8	18.20	8.75	2.08	2.54	8.5	3020	Buff	Yellow cored

TABLE 4.—(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
AK 10	18-24'	2124	2	17.95	8.85	2.03	2.47	9.5	2200	Lt.-red	Yellow cored
AK 10	18-24'	2167	4	18.85	9.45	1.99	2.45	9.0	2540	Red	Yellow cored
AK 10	18-24'	2232	6	17.05	8.60	1.98	2.39	9.0	2650	Red	Yellow cored
AK 10	18-24'	2305	8	16.65	8.16	2.03	2.44	8.5	2450	Rose Gray	Yellow cored
AK 11	2-19'	2124	2	8.15	3.69	2.20	2.40	8.5	5350	Red	Black cored
AK 11	2-19'	2167	4	8.68	3.92	2.21	2.42	8.5	6200	Red	Black cored
AK 11	2-19'	2232	6	9.74	4.52	2.15	2.38	8.0	5280	Red	Black cored
AK 11	2-19'	2305	8	6.65	3.02	2.20	2.35	8.5	5440	Brown	Black cored
AK 11	19-24'	2124	2	13.90	6.70	2.08	2.41	9.0	3750	Lt.-red	Gray cored
AK 11	19-24'	2167	4	13.80	6.54	2.11	2.44	8.5	4600	Lt.-red	Gray cored
AK 11	19-24'	2232	6	9.90	4.76	2.08	2.30	9.0	4200	Lt.-red	Black cored
AK 11	19-24'	2305	8	9.00	4.38	2.10	2.21	8.5	4380	Grayish Pink	Gray cored

TABLE 4.—(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
AK 12	20-34'	2124	2	19.60	10.60	1.96	2.46	6.5	1160	Red	
AK 12	20-34'	2167	4	21.40	10.95	1.95	2.48	7.5	1278	Red	
AK 12	20-34'	2232	6	20.80	10.75	1.93	2.44	6.5	1250	Dark Red	
AK 12	20-34'	2305	8	17.90	9.15	1.96	2.49	7.0	1625	Brown	
						CATAHOULA					
AK 13	1-11'	2124	2	20.20	10.10	2.00	2.51	8.0	1800	Red	Small yellow core
AK 13	1-11'	2167	4	16.20	9.90	1.99	2.46	8.0	1560	Red	Small yellow core
AK 13	1-11'	2232	6	17.25	8.68	1.99	2.40	8.5	1645	Red	Small yellow core
AK 13	1-11'	2305	8	15.85	8.00	1.99	2.36	8.5	2440	Dark Red	
AK 14	10-18'	2124	2	17.75	9.35	2.01	2.37	9.5	2450	Salmon	Gray cored
AK 14	10-18'	2167	4	18.00	9.51	1.89	2.31	10.0	3300	Lt.-red	Gray cored
AK 14	10-18'	2232	6	13.10	6.53	2.01	2.31	10.0	2260	Red	Black cored
AK 14	10-18'	2305	8	14.60	7.40	1.98	2.32	10.0	2990	Rose Gray	Black cored

TABLE 4.—(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
AK 14	18-30'	2124	2	15.30	7.79	1.97	2.32	10.0	4330	Lt.-red	Black cored
AK 14	18-30'	2167	4	16.90	8.60	1.97	2.47	10.0	4760	Lt.-red	Black cored
AK 14	18-30'	2232	6	12.10	5.98	2.02	2.30	11.0	4590	Red	Black cored
AK 14	18-30'	2305	8	10.90	5.33	2.05	2.30	11.0	4380	Grayish Tan	Black cored
AK 14	30-37'	2124	2	19.65	10.30	1.90	2.36	13.5	3660	Lt.-red	Gray cored
AK 14	30-37'	2167	4	16.70	8.52	1.96	2.34	14.5	4650	Lt.-red	Black cored
AK 14	30-37'	2232	6	11.80	5.80	2.03	2.30	15.0	3950	Red	Black cored
AK 14	30-37'	2305	8	8.72	4.20	2.06	2.25	16.0	4025	Brown	Black cored
AK 17	6-11'	2124	2	15.20	4.15	2.07	2.44	7.0	2030	Red	Gray cored
AK 17	6-11'	2167	4	19.20	8.46	2.07	2.51	7.5	1590	Red	Gray cored
AK 17	6-11'	2232	6	15.44	7.55	2.12	2.41	7.5	2060	Red	Gray cored
AK 17	6-11'	2305	8	13.45	6.41	2.10	2.42	8.0	2140	Dark Red	Gray cored

TABLE 4.—(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 IB./SQ. IN.	COLOR	REMARKS
AK 18	6-13'	2124	2	23.55	11.90	1.98	2.59	4.5	396	Cream	
AK 18	6-13'	2167	4	24.30	11.70	1.99	2.59	3.5	294	Cream	
AK 18	6-13'	2232	6	22.70	11.50	1.98	2.56	3.5	865	Cream	
AK 18	6-13'	2305	8	23.00	11.75	1.96	2.55	5.0	132	Cream	
AK 18	15-22'	2124	2	21.61	10.90	1.98	2.52	2.5	170	Cream	
AK 18	15-22'	2167	4	21.70	10.80	2.00	2.56	3.2	490	Cream	
AK 18	15-22'	2232	6	20.60	10.20	2.02	2.54	3.5	1235	Cream	
AK 18	15-22'	2305	8	19.40	9.80	1.98	2.45	3.5	1060	Cream	
AK 20	1.5-11.5'	2124	2	16.10	8.00	2.10	2.40	9.5	3520	Lt.-red	Gray cored
AK 20	1.5-11.5'	2167	4	17.96	8.19	2.00	2.39	10.0	3500	Lt.-red	Gray cored
AK 20	1.5-11.5'	2232	6	14.87	6.86	2.02	2.35	10.0	3920	Red	Gray cored
AK 20	1.5-11.5'	2305	8	14.70	7.27	2.02	2.36	10.5	3640	Red	Gray cored

TABLE 4.—(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
AK 20	12-23'	2124	2	11.65	5.65	2.04	2.31	8.5	3500	Red	Black cored
AK 20	12-23'	2167	4	11.70	5.66	2.06	2.33	8.0	3040	Red	Black cored
AK 20	12-23'	2232	6	8.95	4.27	2.10	2.30	9.0	2490	Red	Black cored
AK 20	12-23'	2305	8	10.70	4.95	2.08	2.32	9.0	3270	Reddish Tan	Black cored

MISSISSIPI GEOLOGICAL, ECONOMIC & TOPOGRAPHICAL SURVEY
WILLIAM HALSELL MOORE, DIRECTOR

BULLETIN 110
PLATE 1 (BICKER)