MISSISSIPPI STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph. D.
Director

BULLETIN 52

CHOCTAW COUNTY MINERAL RESOURCES

GEOLOGY
By
FRANKLIN EARL VESTAL, M. S.

TESTS
By
THOMAS EDWIN McCUTCHEON, B. S., Cer. Engr.

UNIVERSITY, MISSISSIPPI
1943

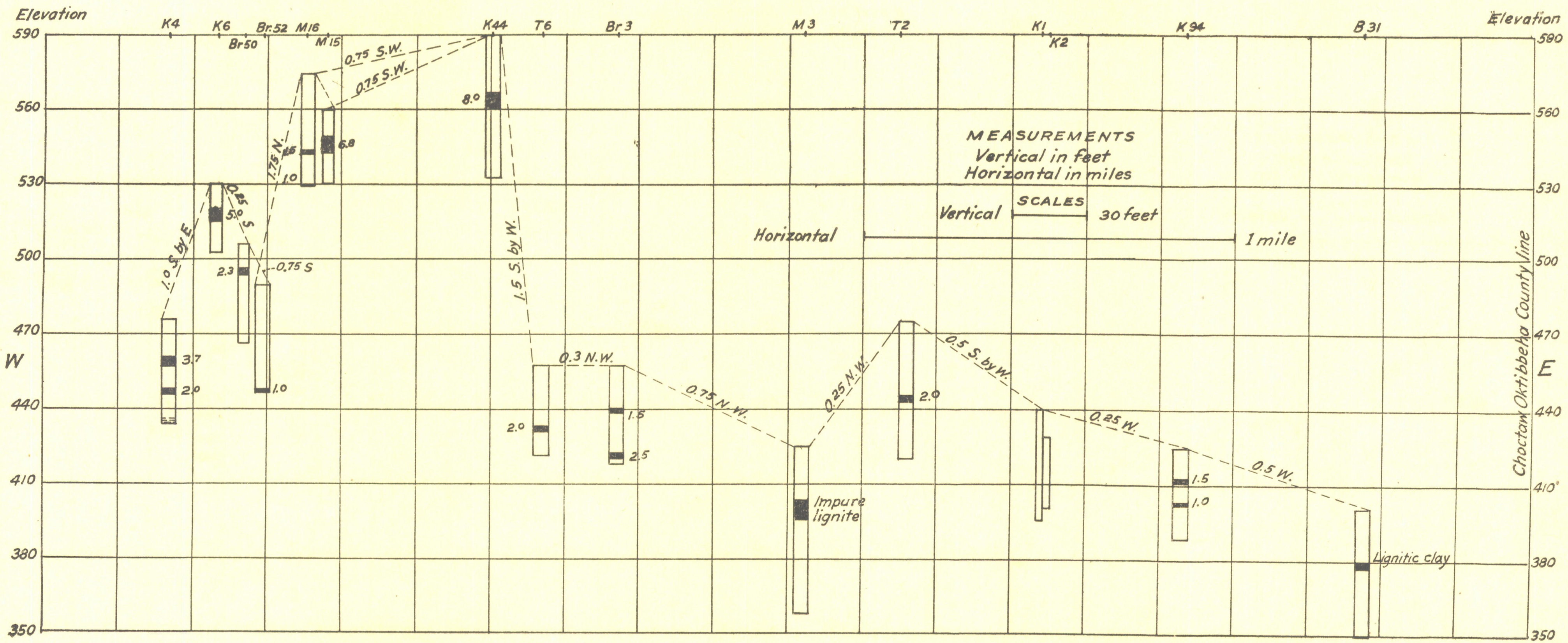

Plate 1A.—Vertical and horizontal distribution of lignite beds along Highway 12 and the Illinois Central Railroad east of Ackerman, as shown by test holes.

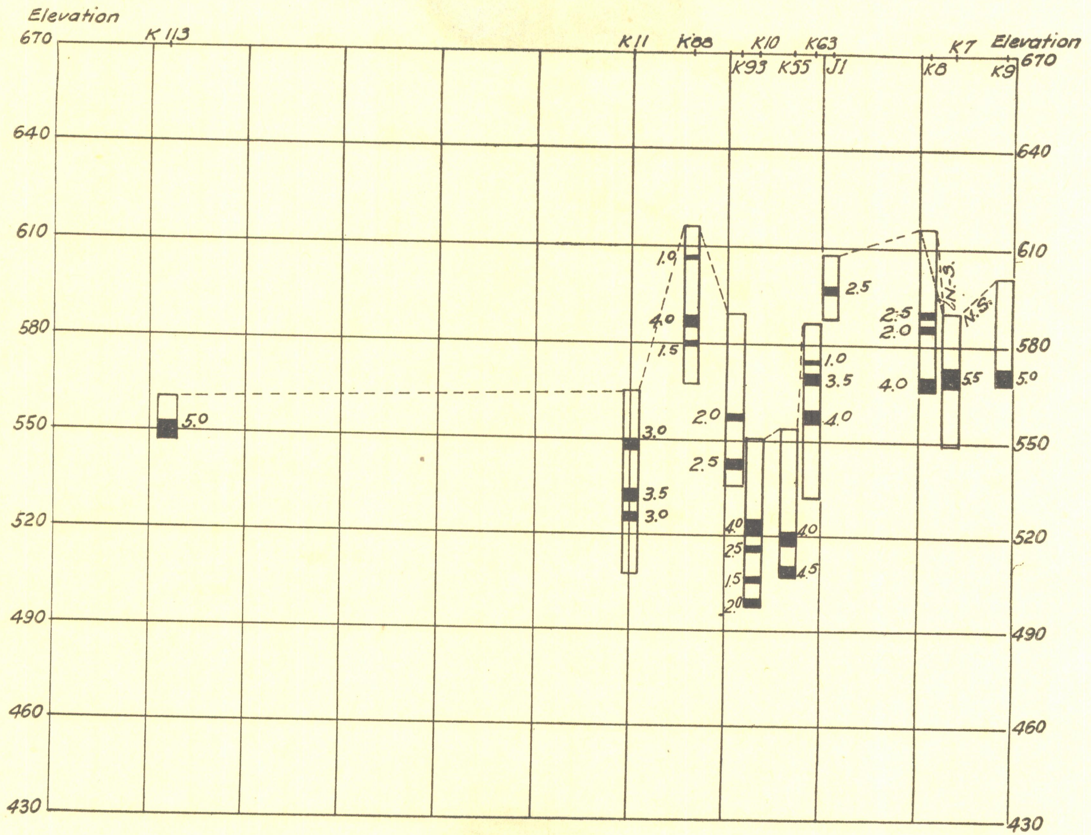

Plate 1B.—Vertical and horizontal distribution of lignite beds in the Lake Choctaw district, as shown by test holes.

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Prepared in cooperation with the Choctaw County citizens and
the WPA as a report on O. P. 65-1-62-137

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1943

LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
April 13, 1943

To His Excellency
Governor Paul Burney Johnson, Chairman, and
Members of the Geological Commission
Gentlemen:

Herewith is Bulletin 52, Choctaw County Mineral Resources, Geology by Franklin Earl Vestal, M.S. and Tests by Thomas Edwin McCutcheon, B.S., Cer. Engr. It is published as a fulfillment in part of the sponsorship pledge of the Mississippi State Geological Survey in order to secure Federal WPA funds —even though that organization was closed by Federal decree on March 6, 1943.

The geologic part by Mr. Vestal reveals the painstaking scientific investigations so characteristic of the author, and demonstrates his superior command of English, a necessary adjunct that is also wholly compatible with good work.

In keeping with the Director's instructions in the mineral surveys of all counties to determine first the formation sequence and then the distribution, approximately half of the report is devoted to the pure science of stratigraphy. As a result of this policy the stratigraphy of some seventeen counties has already been determined—scientific information that has served as a sound basis for the present mineral surveys and that will serve as a like basis for any economic geological industrial development of the future.

The economic geology part of the report records a rather wide distribution of clays: namely, those of the Ackerman formation northeast of Ackerman, in the vicinity of Choctaw Lake, and along upper Sand Creek; those of the Holly Springs formation in the Panhandle and in the French Camp region; to mention only the more important. This part of the report recorded lignite in 72 holes of the 332 that were bored in the county, but, unfortunately, it was well-nigh impossible to obtain a sample without sand and clay contamination from the walls of the test holes. As in so many other counties sand is abundant, but it yet remains the problem of the Mississippi State Geological Survey to discover a commercial way of purifying these ferruginous sands for glass and other purposes.

As usual the few pages of tables in the Tests part give but a slight conception of the enormous amount of laboratory work involved in the testing of the material. The tests show clays suitable for art pottery, yellow ware, kitchen ware, stone ware, for the major ingredient in chemical stone ware, for medium-duty refractory bond clay for use in retorts, crucibles, and saggers—not to mention the more common wall tile, facing brick, and flower pots.

As in the mineral surveys of the other counties, the WPA provided the field working force for drilling and collecting of the samples in Choctaw County. The Exchange Club of Ackerman initiated the interest in a county survey. To members of this club in particular, to the Board of Supervisors, and to the citizens of the county as a whole, all of whom acted as cosponsors, the Mississippi State Geological Survey is under obligation.

Very sincerely and respectfully,
William Clifford Morse,
State Geologist and Director

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CHOCTAW COUNTY MINERAL RESOURCES

GEOLOGY

FRANKLIN EARL VESTAL, M. S.

INTRODUCTION

Choctaw County is an area of 417 square miles[1] a little north of the east-central part of Mississippi (Figure 1). More specifically,

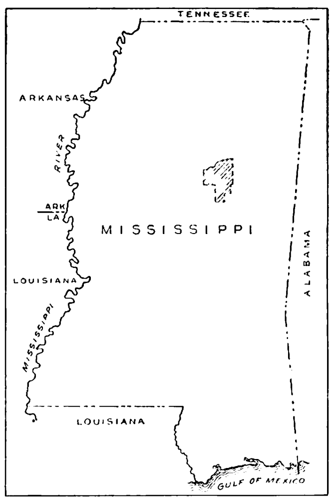

Figure 1.—Location of Choctaw County.

its western boundary is about 50 miles northeast of the geographical center of Mississippi and its eastern boundary 45 miles west of the Alabama line[2]. Its irregular shape is due only partly to a natural boundary, the rather crooked Big Black River on the north; it seems to be due chiefly to the peculiar positions and lengths of the remaining boundaries, all of which are straight lines. The writer is not familiar with the history of the county, but has reason to suspect that considerable artful dodging and mental travail were involved in the effort to so place these boundaries that everybody would be pleased, and that finally they were dropped down more or less at random. The result was that the part of the county south of the line between Township 16 North and Township 17 North consists of three townships, of which the southernmost, jutting southwards from the other two, is known as the "Panhandle." The maximum north-south dimension of the county is 29 miles, and the east-west dimension 21 miles.[2] Choctaw County is bounded on the north by Webster, on the east by Oktibbeha, on the south by Winston and Attala, and on the west by Attala and Montgomery.

The population of Choctaw County numbered 13,548 in 1940, a number which represented a nearly 10 percent increase over 1930.[1] In a sense, all can be classed as rural, inasmuch as Ackerman, the largest town, had a 1940 population of only 1,528.[1] Agriculture is the chief occupation, but lumbering is of considerable importance also.[2] Corn is the leading crop, but cotton is still given a relatively large acreage because it is the cash crop;[2] lespedeza has lately risen to some prominence as a cash crop, and oats, formerly next to corn in importance, are still grown in places over the county. Numerous other plants are cultivated, chief of which are sugar cane, sorghum, peanuts, potatoes, garden vegetables, and fruit.[2] Livestock is represented by cattle, hogs, mules, and poultry chiefly, but these are not so numerous as might be expected in an almost exclusively agricultural community. The lumber industry draws its raw material from the remnants of upland and bottom land forests of yellow pine and hardwoods, and, although it can not be said to equal the proportions attained at times in the past, it remains moderately flourishing. Portable sawmills are operating or have operated in all the wooded areas. Logging trucks are numerous on the roads. Sawmill and lumber plants are busy at Ackerman, Weir, and Reform, and in scattered rural districts.

The towns and villages of Choctaw County are: Ackerman, Weir, Reform, Chester, French Camp, and Fentress. The town of Mathiston, on U. S. Highways 15 and 82 some 16 miles north of Ackerman, is partly in Choctaw County, but for the most part in Webster. All the towns and villages are centers of farming and lumbering communities. Country stores are scattered over the county, chiefly at crossroads. Both Ackerman and Chester are considered county seats, but the county officers make Ackerman their headquarters, and a new court house has recently been completed there. Several modern consolidated schools have taken the places of the old time one-room, one-teacher schools, except for the negroes.

The road system is both good and bad. U. S. Highway 15, a ribbon of black top which lies north-south across the eastern part of the county within Range 11 East, is perhaps as fine an example of this kind of road as exists anywhere in the country. So also is the paved part of Highway 12 (State highway) from Ackerman southwest to the Attala County line; the same highway east of Ackerman is graveled. Other main graveled roads are: Highway 9, leading north-northwest from Ackerman and joining U. S. Highway 82 at Eupora in Webster County; the old Ackerman-French Camp road; the Weir-French Camp road; the Weir-Panhandle road, and the road from Highway 9 to Chester and beyond. In fact, most of the commonly traveled roads of the county are metaled, and can be traveled at any time of year, although they are apt to be heavy and slippery when wet, more so in some spots than in others, and are dusty when dry. Some few country roads providing access to more or less isolated farm communities, not being metaled, are almost if not entirely impassable in wet weather, and very rutty and rough in dry weather. The map of the county shows a network of roads which, at first glance, reveals little or no system; but in the very hilly districts of the eastern part the better roads keep pretty much to the ridge crests.

Two railroad systems are represented in Choctaw County. The Gulf, Mobile, & Ohio (old Gulf, Mobile, & Northern) extends north-south across the eastern part of the county west of and roughly parallel with U. S. Highway 15, via Ackerman, Reform, and Mathiston. The Illinois Central (Aberdeen branch) lies northeast-southwest across the south-central part of the county through Ackerman and Weir. The northern part is served by the Columbus and Greenville branch of the Southern System, which roughly parallels the northern boundary in Webster County a little north of Big Black River.

The Tennessee Valley Authority transmission line extends northwest-southeast across the northeastern part of the county, and branch lines convey electric current to several districts.

Choctaw County includes several square miles of National Forest—the west end of the Northeast Mississippi Forestry and Grazing Project—east and southeast of Ackerman. This area is part of the picturesque Noxubee Hills. Its outstanding feature is Lake Choctaw, a 100-acre lake created by the damming of a headwater tributary of Noxubee River below the junction of three or four small forks.

The lake and the entire landscape centering about it, in their setting of wooded hills, constitute one of the most beautiful regions in the State of Mississippi.

PHYSIOGRAPHY

PROVINCES

Except for the extreme northeastern corner which is in the Flatwoods, Choctaw County is located in the North Central Hills physiographic province and forms a part of Foster's[3] "Red Hills Phase" of the province.

DRAINAGE

The county includes parts of three major drainage basins: the Tombigbee, the Big Black, and the Pearl. The streams of the southeastern part, east of an irregular north-south divide nearly coincident with Highway 15 and south of the Spring Hill Church road extending east from Williams Station, are tributaries of branches of the Tombigbee; the chief of these drainage courses are Noxubee and Little Noxubee Creeks, Bogue Fallah, and Sand Creek. The northwestern half of the county, northwest of a divide extending from Williams Station southwest almost parallel with Besa Chitto Creek to Attala County, is drained by the Big Black system, the largest branches being Pigeonroost, Big Bywy, Little Bywy, McCurtins, and Poplar Creeks, although numerous others might be named. The drainage courses of the southern part of the county and an area in the central part belong to the Pearl River system; the most prominent streams are Yokahockany River and Besa Chitto, Tibby, Lobutcha, and Tallahaga Creeks. Each of the larger streams has a number of tributaries, and these in turn have their feeders down to the smallest, the entire pattern being tree-like, or dendritic, as is commonly the case where a drainage system is developed in flat-lying or very low-dipping beds.

A mean annual rainfall of some 50.42 inches contributes materially to the run-off and the consequent development of a multitude of gullies and other water-courses. The rainfall is about evenly distributed through winter, spring, and summer, being slightly greater during the winter, but the fall precipitation is only about half that of winter.[2] The relatively frequent hard downpours and the steep slopes tend to increase run-off, but these factors are offset to some extent over most of the area by pervious rock materials and a pretty general cover of forest or cultivated plants. In localities where this balance has been upset in favor of erosion, as by removal of the protective cover, gullying of the hillsides has been intensive, and immense quantities of soil and rock waste have been carried into the valleys.

The larger of the streams are of low gradient except near their heads, and flow sluggishly in wide bottoms. Big Bywy, Middle Bywy, Besa Chitto, and Yokahockany have been canalized to expedite the run-off. Canalization was made necessary by the choking of the original streams by slope wash, especially from cultivated areas in the bordering hills.

Choctaw County is almost astride the divide which separates the Mississippi River drainage from the Gulf drainage.

TOPOGRAPHY AND RELIEF

In general, Choctaw is a hill county, although it includes a considerable area of stream flats. The topography as a whole has reached maturity in the cycle of erosion; that is, it is characterized by slopes, thoroughly dissected upland, and relatively wide flats. The influence of the rock material on the topographic forms is marked in various places: where sand predominates, slopes are steeper and elevations greater; a notable proportion of sandstone conditions the steepest slopes and the greatest elevations. The most rugged region is the Noxubee Hills in the eastern part of the county, but the Ironstone Hills, in the southern part, just east of the western boundary of the Panhandle, are almost equally rugged. Both are dissected cuestas, of which the northeast and east slopes are steep, and the west and southwest slopes gentle. Westward from the Noxubee Hills, where the drainage is southwest and south, the valleys are bordered on the southeast by steep bluffs which may be as much as 100 feet high, but on the north and northwest the uplands are inconspicuous. Drainage from the top of the higher south wall of a valley goes southwards for the most part to a large stream which may be several miles away, instead of to the stream at the foot of the bluff. In other words, the streams flow down the dip of the strata and shift their channels southward in the general direction of dip, forming cuestas.[2] Such features are noticeable along all the larger streams—Big Black River, Big Bywy Creek, Yokahockany River, and Tibby Creek. Thus the valleys themselves are being shifted southward by lateral planation of the streams along their south walls and aggradation on their plains and along their north walls. These processes have created valleys of remarkable width in relation to their length. Foster[3] states that cuesta development on a minor scale is "more or less characteristic throughout the area" of the North Central Hills, and calls particular attention to the prominent cuesta formed by the outcropping Tallahatta claystone, sandstone, and quartzite. The Ironstone Hills of Choctaw County seem to be part of this cuesta.

Viewed in its entirety, the surface of the county is very uneven; it is what is visible of an unconsolidated terrane cut in all directions and to various depths by running water, and seems a tangle of elevations and depressions, but in fact it is part of the surface of an old plateau which sloped gently southwards and westwards. The county is notably high and rugged: local relief may be 200 to 250 feet, and the maximum county relief is about 300 feet. Elevations above mean Gulf level of more than 600 feet have been determined; for example, Williams Hill, crossed by Highway 15 some 5 miles north of Ackerman, has an elevation of about 628 feet.

STRATIGRAPHY

SUMMARY

A summary of the classification and a description of the rock bodies which crop out in Choctaw County may be presented in tabular form.

Psychozoic group — Feet

Holocene system

Recent series

Recent formation

Rock waste: It includes the residual mantle of soil and other loose rock material, also transported rock debris in the form of colluvium, talus, and alluvium, especially flood-plain and channel material; it is composed of many kinds of rock waste, but chiefly sand, silt, and clay, which may be mixed or sorted into bodies of relatively pure material, each of a type. Estimated maximum 50

Unconformity

Cenozoic group

Pleistocene system

.... series

.... formation

Sand, silt, clay, unconsolidated as a whole, but better sorted and the units more compact in general and including more local consolidation than exists in the Recent formation; chiefly terraces, but possibly some loessial sediment from which the Brown Loam is derived. Estimated 25

Unconformity

Eocene system

Claiborne series

Tallahatta formation

Neshoba member: Sand, red-brown, light-brown, yellow, medium to coarse, irregularly bedded; some ferruginous sand rock. Basic member: claystone or siltstone lenses or irregular bodies or stringers at different levels; a few thin quartzite beds, possibly. Meridian member: Sand, coarse to fine, micaceous, dull-white, yellow, brown, or red; in many places contains ferruginous sandstone masses or concretions or silty limonite; cross-bedding is the rule; includes bowlders, especially towards the base, and probably thin quartzite beds 153

Disconformity

Wilcox series

Holly Springs formation

Sand, sandstone, clay-shale, clay, silt, lignite, silty limonite and siderite: The sand is coarse to fine, commonly highly colored by iron oxide, but may be bluish, greenish-gray, or white; micaceous; featured by diagonal and other irregular bedding and lamination. Masses of ferruginous sandstone and silty limonite are bedded with the sand locally, and clay-shale phases are present at various horizons and localities. Clay, much of it white and pink, is disseminated through the sand as balls or pellets, laminae, and stringers, or aggregated as larger irregular bodies at various levels, notably near the middle of the formation. The uppermost 50 feet or so of the unit are largely gray and lignitic clay associated with some lignite and limonite-siderite concretions. A few lignite seams, mostly thin, are included in the section. Most of the clay is silty, and some units of almost pure silt are present. In general, the basal third of the formation is sand, containing only minor proportions of other materials; the middle third is sand, clay-shale, clay, and lignite, and the upper third chiefly clay, lignite, silt, and iron ore. Estimated maximum 300

Disconformity

Ackerman formation

Sand, sandstone, clay-shale, clay, silt, lignite, iron ore: A variable thickness of strata (Fearn Springs unit) in the lower part of the formation but not present everywhere along the strike consists of silty sand, sandy and silty clay-shale, gray and white silty clay, lignite, ferruginous sandstone and siltstone, most of this entire body of materials being micaceous and irregularly-bedded. Above these beds where they are present, and resting on older beds in many places, is a basal sand, coarse to fine micaceous cross-laminated white, brown, and yellow, which may contain grit and pebbles and includes irregular masses of ferruginous sandstone and silty limonite; the remainder of the formation is clay, sand, silt, and lignite chiefly, the clay being gray, lignitic, and silty for the most part, interbedded with lignite and enclosing thin layers of concretionary silty siderite or limonite. Estimated maximum 300

Unconformity

Midway series

Porters Creek formation

Clay, sand, silt, clay-shale, siderite: The major part of the formation as a whole is dense, closely-jointed clay or clay-shale, but the upper part, which has an outcrop area in Choctaw County, is a laminated clay, micaceous, and very silty or sandy, including lenses and beds of cross-laminated fine micaceous sand, and beds of silty siderite; a little white and light-gray clay, including kaolin, and bauxite, in the top of the formation or the basal part of the Wilcox. Estimated (Choctaw) .... 75.

THE PORTERS CREEK FORMATION

The Porters Creek formation as a whole consists of clay chiefly, as the commonly applied name, "Porters Creek clay," indicates; but marl, sand, silt, shale, ferruginous sandstone and claystone, lignite, and some minor mineral substances are included. Mellen[4] reported that in Winston County the lowermost 50 feet or so of the formation is for the most part a fossiliferous silty clay enclosing scattered lentils of sandy, glauconitic, calcareous material which also is fossiliferous. In fact, the lower two-thirds or three-fourths of the formation are at least sparingly fossiliferous. Overlying the basal strata is the main body of the formation, the part commonly thought of when the formation is referred to as "Porters Creek clay." It is a dark-gray to almost black dense firm clay or clay shale, closely jointed, a little silty, carbonaceous, and very finely laminated.[4] An outstanding characteristic is that this clay, at least where it has been affected by weathering, breaks into rounded lumps, each of which may separate into concentric shells by conchoidal fracture. The shells break up into flakes and the disintegration process continues until the outcrop shows only small flakes and fine particles of clay which are almost white when dry, but when wet form a sticky, heavy, extremely tenacious mud. According to Mellen,[4] this central or main body of the Porters Creek is 350 to 450 feet thick in Winston County, and is overlain by 50 to 100 feet of silty, somewhat glauconitic, micaceous, sandy, distinctly laminated clay, containing small beds or lenses of sand and beds of silty siderite. He states that the upper part of the Porters Creek is equivalent to the Naheola of Alabama, and his correlation table shows it equivalent to a little more than the lower half of the Naheola.[4]

Lowe[6] describes the typical Porters Creek material, and adds: "The clay varies from this typical character at many places. Locally it becomes highly lignitic and is associated with small deposits of lignite; and in places it becomes sandy and micaceous and thin-bedded. These variations occur especially toward the western border of the formation. . ." He mentions also "thin beds and lenticular concretions of spathic iron ore," chiefly "well up toward the contact with the Wilcox," and commonly associated with beds of lignite or lignitic clays.

The Porters Creek formation underlies the Flatwoods physiographic belt, with which it is commonly associated, but not all of the Porters Creek outcrop area is typical Flatwoods; much of it has a rolling or hilly topography. The belt of outcrop strikes west of north and east of south in the latitude of Choctaw County, and has a width of perhaps 10 miles. Calculations and estimates of the thickness of the formation vary greatly: the maximum thickness given by Lowe[6] is 200 feet, but, as already stated, Mellen[4] computed the thickness as 500 feet or more in Winston County. Grim[7] gives a maximum of 800 feet.

The areal geology map of Mississippi which accompanies U. S. Geological Survey Water-Supply Paper 576[8] shows a part of the Porters Creek formation underlying a small area in the northeastern corner of Choctaw County. The writer of the present report verified the presence of Porters Creek materials here. In northwestern Oktibbeha County, about two miles southeast of the northeastern corner of Choctaw County, and a little east of the junction of the Sturgis-Maben road with U. S. Highway 82, a good section of upper Porters Creek or lower Wilcox sandy and silty clay shales, thin sand lentils, and siderite concretions, has been revealed by gullying along the north side of the old Maben-Starkville road, between it and Highway 82. In the southwest wall of the valley of Trim Cane

Creek, some 5 miles south of Highway 82 and a mile south of the Oswalt store, the walls of a cut for the Sturgis-Maben road are black Porters Creek shale, which is overlain by Ackerman sand near the top of the hill (Figure 2). Four miles still farther south the Midway-Wilcox contact is well exposed in a gully on the east side of this same road—the typical clay-pellet structure so marked in the

Figure 2.—Midway-Wilcox contact on the Maben-Sturgis road in western Oktibbeha County, 5 miles south of U. S. Highway 82. February 18, 1943.

Betheden zone and in the overlying sands is prominent here. The upper Midway sandy and silty micaceous shales and sands crop out extensively east and south of Sturgis, being especially well exposed in Illinois Central Railroad cuts 1 1/2 miles east of Sturgis and in the south wall of the valley of Sand Creek 1 mile south of Sturgis. A bauxite deposit, on or a little above the Midway-Wilcox contact, caps one of the highest hills of the region a mile east of Sturgis, and in the sand walls of Highway 12 cuts, just outside the town to the northeast, are lentils and stringers of white and pinkish clay balls or pellets such as commonly are present just above the contact. This sand may be basal Ackerman or basal Fearn Springs terrane.

The area west of Sturgis in Oktibbeha County is mainly a wide lowland and has no significant outcrops; but test holes near the Oktibbeha County-Choctaw County line along the Illinois Central Railroad right-of-way penetrated strata which may belong to the Porters Creek. One hole, at Cannon, almost on the county line, reached a depth of 43 feet, of which the last 25 feet were through dark-blue to black fine very micaceous sand containing thin layers of clay; this sand could be a part of the Porters Creek; it is overlain by yellow sand. Another boring, just across the line in Oktibbeha County, penetrated to a depth of 22.5 feet through brown sand, possibly basal Ackerman or part of the Fearn Springs terrane. Another test hole, 1/4 mile north by west of Berry Thomas School and 80 feet below it, found light-gray sandy clay, light-gray sand, blue clay and sand with gravel (possibly marcasite concretions), and 20 feet of black lignitic sandy clay underlain by blue micaceous sand. These three holes are within 3/4 mile northeast-southwest, and at about the same elevation.

Mellen[4] applied the name "Betheden formation" from Betheden, Winston County, to a body of residual rock material composed of bauxite, kaolin, bauxitic and kaolinitic clays, and lignite—in short, to "all residual material at the top of the Midway and below the Midway-Wilcox unconformity." He states that the lower contact is gradational into the Porters Creek formation, and the upper is unconformable with the Fearn Springs or the Ackerman. The maximum thickness is given as about 25 feet. Although the Midway-Wilcox contact is present at the surface in northeastern Choctaw County, and probably was reached by test holes farther south, and although lignite and light-gray to white clay near the contact horizon may be part of the Betheden as recognized by Mellen, differentiation of the Betheden from underlying or overlying formations is not considered practicable in Choctaw County on the basis of field evidence.

THE ACKERMAN FORMATION

The name "Ackerman formation" was applied by Lowe[6] in 1913 to the basal strata of the Wilcox series, from Ackerman, the main county-seat of Choctaw County, near which the beds are prominent. The type locality of the formation is at Blantons Gap, a 275-yard cut for the Aberdeen Branch of the Illinois Central Railroad through the ridge which separates the Big Black drainage basin from the basin of the Noxubee.[6] Blantons Gap, the southwest end of which is about 1/2 mile east of the corporate limits of Ackerman, exposes a section which Lowe says is the best exposure of these Wilcox strata in the state. He and most writers since have included in the Ackerman formation all the terrane between the Midway Porters Creek below (or the equivalent of the Naheola of Alabama) and the Holly Springs above. Lowe recognized no erosional unconformity between the Midway and the Wilcox beds in Mississippi indicating an interruption of sedimentation; he states: "the plane marking the division between the two is physically rather arbitrary than exact," but refers to paleontologic evidence adduced by Berry of a notable time break from Porters Creek to Ackerman deposition. Furthermore, he states that no apparent general unconformity separates the Ackerman from the Holly Springs, although the division is sharp at places along the contact, and Holly Springs structure suggests local unconformities.[6]

Mellen[4] found Lowe's original Ackerman formation to consist of two fairly well-defined divisions, a lower, which he named the Fearn Springs formation, and the Ackerman proper above. The Midway-Wilcox contact he recognized to be at the same relative position as determined by Lowe and others—that is, at the top of the Naheola equivalent or the Porters Creek where the Naheola is missing; but he gave the Naheola equivalent in Mississippi a new name, "Betheden," from exposures near Betheden, in Winston County. Furthermore, whereas Lowe[6] mentioned only bauxite and red and yellow sands as composing the equivalent of the Naheola formation in Mississippi, and failed to note stratigraphic evidence of a great time interval between Midway and Wilcox deposition, Mellen[4] found bauxite, kaolin, bauxitic and kaolinitic clays, and lignite in the Naheola equivalent at the top of the Midway, all of which he considered residual, the products of deep leaching through a time interval of at least 1,000,000 years prior to the initiation of Wilcox deposition. Also he found evidence of severe erosion: in places the Fearn Springs formation missing and the Ackerman resting directly on the Betheden, or even both Fearn Springs and Betheden missing and the Ackerman resting on the unaltered Porters Creek.

The Ackerman formation has been described by many writers on geology, of whom some have added new data to the original definition and description by Lowe, and others have merely repeated his description, in substance. The main features of the formation as set forth by Lowe[5] may be summarized: The Ackerman consists of fresh-water and swamp deposits of sands, clays, and lignites. The clays are gray and lignitic where pure, or bluish or greenish where more sandy; the lignite includes many beds, some of which are of good quality and thickness. Thin beds or flat lenticular concretions of iron carbonate or spathic iron ore are present here and there with other materials, especially in association with lignitic sands or clays and lignite. The proportion of lignite and of sand increases towards the top of the formation. In general, regularity of deposition and continuity of beds are marked in the Ackerman as compared with other Wilcox formations. The width of the Ackerman belt of outcrop is about 22 miles in northern Mississippi, the thickness of the formation some 550 feet to 600 feet, and the dip 25 to 30 feet a mile westward. The topography of the outcrop belt is described as gently rolling near the Flatwoods on the east, to rolling and hilly farther west.

Stephenson[8] assigns a thickness of 300 to 550 feet to the Ackerman beds, and a width of 3 to 15 miles to their outcrop belt.

The most recent description of the Ackerman formation of Mississippi is given by Mellen,[4] who conducted a geological and mineral resources survey of Winston County. He summarizes its lithology in that county thus:

"Clay, laminated silty, containing comminuted plant remains and leaf impressions; and massive or laminated silt;

Underclay, and silty lignitic clay, regularly deposited successions of lignite;

Silt, or silty clay, evenly bedded, laminated, containing comminuted plant fragments;

Basal sand, highly cross-bedded containing sporadic accumulations of grit and pebbles and sporadic cobbles and bowlders."

He estimates the thickness of the Ackerman formation in Winston County as 300 to 400 feet, and assigns a maximum thickness of 125 feet to the basal sand member.

It will be noticed that Lowe, in his description of the lithology of the Ackerman beds, fails to mention the thick basal Ackerman sand emphasized by Mellen. His reference to the "zone of red sands and bauxite toward the base,"[6] which zone he correlates with the Naheola, probably was intended to apply to material immediately overlying the Porters Creek, which Mellen assigns to the Betheden or the Fearn Springs. No thick grit-bearing and bowlder-bearing sand in the Ackerman well above the Midway terrane is referred to by Lowe.

The Ackerman formation outcrops in western Oktibbeha County and in Choctaw County exhibit a ragged areal pattern, but in general lie within the limits of a southeast-northwest belt which ranges in width northeast-southwest from 7 miles or more to less than 6. Along the valley of Big Black River, on the northern boundary of Choctaw County, the Ackerman strata crop out for a distance of at least 10 miles; but along the Illinois Central Railroad the outcrop belt is only about 6 miles in width. Much of this great variation of width of outcrop belt is due to a topography of moderate to slight relief along the Big Black, and of relatively considerable relief in the Noxubee Hills; but evidence exists that the irregularity of areal pattern is related to some extent to structure, as discussed in the part of this paper which deals with structure.

The lithology and stratigraphic relationships of the Ackerman beds are indicated in the descriptions of sections and outcrops which follow.

Mellen[4] applied the name "Fearn Springs formation," from Fearn Springs, in eastern Winston County, to a body of strata lying, where present, on the eroded surface of the Midway series, and possibly equivalent to the Ackerman terrane of Alabama as defined by Cooke. These beds had been considered, up to the time of Mellen's study of the stratigraphy of Winston County, the lower part of the Ackerman formation, although he states that they are disconformable below the basal Ackerman sand.[4]

Lowe[6] states that the lowermost beds of the Ackerman, beds grouped by Mellen in his Fearn Springs formation, are prevailingly gray clays similar to the Porters Creek clays, interbedded with some lignite which may contain considerable marcasite.

Mellen[4] describes a complete section of the Fearn Springs formation as consisting of sand, clay, and silty material, a feature being a basal 8-foot bed of cross-bedded sand containing large flakes of muscovite and "thin and irregular lenses of stoneware clay and re-worked bauxite." The clay above the basal sand is laminated, micaceous, and very silty, and is succeeded by very ferruginous structureless silty material, probably derived by weathering from clay similar to the silty clay below. This section includes the entire Fearn Springs at this place, between the Porters Creek formation below and the Ackerman above, and the total thickness is only 25 feet.

The Fearn Springs of another Winston County section included 45 feet of strata, described as ferruginous siltstone; cross-bedded argillaceous sand containing a few balls and streaks of clay; laminated silty clay; and sandy laminated somewhat micaceous clay containing comminuted lignitic material and subordinate lenses of fine-grained sand. The maximum thickness of the formation in Winston County exceeds 50 feet.[4] Mellen emphasizes that "throughout the state, it (the Fearn Springs formation) contains ball-type clays, good stoneware clays, silty clays, silt, sand, lignite, and siderite."

In Choctaw County strata of the Fearn Springs zone are present in places, but because the positions of their lower and upper boundaries could not be determined accurately, the beds are included in the Ackerman, and not described as a separate formation. Ackerman outliers in western Oktibbeha County, which probably belong to these lower Wilcox beds, have been referred to. Bauxite, which is said to be part of the Betheden formation at the top of the Midway, lies at the summit of a high hill a mile or so east of Sturgis; and, in cuts for Highway 12 northeast of Sturgis, sand of bauxitic structure (pseudo-pisolitic) is exposed. Pseudo-pisolites are said to be one characteristic of Fearn Springs sand, particularly of the basal sand. These features of the Midway-Wilcox contact are 3 to 4 miles east of Choctaw County, and if the contact has the normal southwestward dip of 20 to 25 to 30 feet to the mile, they should lie 75 to 100 feet or more below the surface at the county line in this latitude if the surface were level. However, the bauxite is at the top of one of the most considerable elevations, probably 450 feet, of western Oktibbeha County; the eastern boundary of Choctaw County where Highway 12 crosses it is about 350 feet above mean Gulf level, and Sturgis, in front of the railroad station, is 333 feet. From these figures it would seem that the top of the Midway should be at or near the surface at the Choctaw-Oktibbeha County line east of Ackerman, especially as the Midway-Wilcox contact is one of unconformity. As already stated, several borings close to the line possibly penetrated Porters Creek beds.

Westward from the Oktibbeha County line the elevation along the Illinois Central Railroad increases 75 feet in 2 miles, being 425 feet at Fulcher. Obviously, then, if the bauxite east of Sturgis is in place, and the strata in this region have the normal southwestward dip, the Midway-Wilcox or the Porters Creek-Ackerman contact should be far below the surface at and near Fulcher.

About 1/4 mile south of Cannon, exposed by a road cut in the south wall of a tributary of Bogue Fallah, is a section which from its stratigraphic position probably should be included in the lower Ackerman. The outcrop shows several feet of shaly sand below, and red-brown sand above; in the lower member irregular lamination is conspicuous, mica is abundant, platy ferruginous sandstone or siltstone is developed at various levels, and fragments of silicified wood and other rock are strung along the bedding-planes. A feature of the lower gray, white, bluish, and yellow sand is large flattish ellipsoidal masses of silty limonite, which no doubt was at one time silty siderite, in the gully at the base of the exposure. These iron ore concretions suggest that the lower sand belongs in the lower Ackerman or Fearn Springs beds; as they seem to be in place, the material probably is not part of a terrace, although topographically it could be.

Reconnaissance along Bogue Fallah southeast of Fulcher discovered dark-blue micaceous sand cropping out in the floor of the Bogue a mile or more below the Illinois Central Railroad trestle and a thin seam of lignite perhaps 1/4 mile farther down (Sec. 23, T.17 N., R.11 E., NW. 1/4). In the southwest wall of the valley about 1 1/2 miles south by east of Fulcher, outcropping beds of gray clay, containing thin iron ore masses and overlain by very light-gray to white clay, suggest lower Ackerman beds.

SECTION EXPOSED IN THE WALLS OF THE ILLINOIS CENTRAL RAILROAD CUTS FROM A POINT 1/2 MILE EAST OF FULCHER STATION WESTWARD TO THE SOUTHWEST END OF THE LARGE CUT 4/5 MILE WEST OF FULCHER STATION.

	Feet	Feet
Psychozoic group, Holocene system		
Recent series		
Recent formation		1.0
Mantle rock: Weathered material—brown silty and clayey sand and fragments of brown sand rock; sandy loam soil	1.0	
Unconformity		
Cenozoic group, Eocene system		
Wilcox series		
Ackerman formation		106.6
Sand, coarse to medium micaceous; various shades of brown and yellow; dull white. This sand is laminated where it can be seen in place and undisturbed; the laminae are irregular: they may be diagonal or curved or wavy, and commonly are defined by iron oxide. At various levels the sand is cemented into hard ferruginous sandstone which follows the laminae and may be of contorted and bizarre shapes	23.0	
Local unconformity, or contemporaneous erosion surface		
Clay, golden yellow sandy, containing gray patches and streaks; probably it is the iron oxide-impregnated upper part of the interval next below	0.3	
Clay, light-gray, mottled with red iron oxide spots; slightly sandy; contains lumps from interval below, partly weathered; this interval may be a weathered phase of the subjacent interval	2.3	
Sand, much like that of the 10.5-foot interval below, but darker; light chocolate-brown, and darker toward the top of the interval; jointed irregularly, and golden yellow iron rust along joint-planes and fracture-planes; diagonal fractures; lumps may have light-gray film of clay on their surfaces; some conchoidal lumps, perhaps containing $FeCO_3$; material hardened by iron rust in places, and iron rust may weather out as plates	6.6	
Sand, indurated; cemented by golden yellow iron rust	0.3	
Sand, pale-yellow to yellowish or olive-drab or greenish-gray fine compact; sufficiently silty to be closely-jointed and breaks out in blocks with sharp edges; slightly micaceous; shot through with golden yellow rust streaks, especially along the joint-planes; the top 8 inches or so are darker gray and somewhat lignitic; to near foot of steep slope of gully	10.5	

Covered, except for poor exposures here and there of white and gray clay and platy ironstone. This interval is represented along the road north of Fulcher by poor exposures and much weathered material, as described in the interval next below. The base of the interval above is a little below the base of the south wall of the Illinois Central Railroad cut 0.8 mile west of Fulcher. This covered distance seems to include for the most part the intervals described above.	
Sand, silty and clayey, or clay, silty and sandy; exposures show weathered iron-mottled gray clay containing abundant platy iron oxide-cemented material; also some white plastic clay; platy ironstone abundant on the surface. The interval is not well exposed, and the thickness is indefinite, but over and above the thickness given for this interval, the upper part may be correlative with some of the lower part of the next interval	9.0
Silt, sand, clay, ironstone, etc.: Very irregularly bedded, conspicuously laminated; the laminae are black or brown, containing lignitic material; the contacts of the units trend diagonally at various angles, as if the material had been deposited under very disturbed conditions, or broken up later	10.0
Sand, yellow to light-brown to white, laminated, rather coarse, very micaceous; some mica flakes being 0.5 inch in diameter; contains fragments of whitish clayey or silty sand, fine to medium to coarse. Test-hole thickness	14.0
Clay or clay-shale, much jointed, light-gray to pale brown; much platy limonite along the joints and lamination planes and scattered abundantly over the surface above the weathered material	4.5
Clay, gray; shows above the subjacent interval as a dark lignitic somewhat indurated lumpy much jointed clay or clay-shale, with impure lignite at the base	2.5
Clay, light-gray, slickensided; yellow limonite along the joints; dark root imprints; only the upper part exposed	5.5?
Clay, gray sandy (test-hole)	6.5
Clay, light-gray sandy (test-hole)	3.5
Covered for a distance of about 415 yards; a test-hole at the west end of this distance and about 10 feet higher than the top of the interval next below was in dark-gray clay at a depth of 15 to 21 feet, which, allowing for dip, included that interval.	

Same material as that of the first and third intervals of the section, apparently, but much weathered; it grades into gray plastic clay mottled with red iron oxide spots towards the top, but this seems to be a weathered phase of the fresh type of material; the interval contains platy ferruginous sandstone or siltstone, which lies about on the weathered surface	5.5
Ironstone, siliceous; discontinuous blocks or flattish ellipsoidal masses having concentric structure, or thin hollow shells of ironstone; probably badly weathered iron carbonate; similar to the second interval	0.3
Clay-shale, sandy, iron-stained grayish-brown, as in first interval	1.4
Sandstone, ferruginous, clayey, brown to black; sand very fine; thickness irregular	0.2
Clay-shale, containing very fine sand; brownish-gray—light-gray mottled and streaked with iron rust, brown to black; dries dull iron-stained white	0.7
(Bottom of ditch north of track)	

From the top of the uppermost clay interval, the base of the sand body at the top of the section can readily be followed westwards to within 75 yards of the west end of the cut, by the features named below:

1. Irregular contact, somewhat sinuous, but dipping at a low angle westwards;

2. Ferruginous sandstone, about 4 inches thick, capping the clay just under the sand;

3. A yellow ocher layer under the sandstone, and weathered clay or sand beneath it;

4. Two petrified logs, each 2 feet or more in diameter, at the contact;

5. A spring of cold water at the contact in one place, and seepage pretty much all along the contact;

6. A lignitic bed at the top of the underlying strata here and there.

The two uppermost intervals below the contact vary laterally, but constitute a bed of very plastic clay several feet thick along the wall of the cut. Near the west end of the cut this clay bed, at least 4.5 feet thick, shows as a very light-gray almost white dense clay mottled with purple to pink or lilac spots. The pink mottling is continued eastwards also. At the west end in the north wall of the cut the top of the clay is very definitely lignitic.

In the walls of a cut for Highway 12 only a few rods north of the Fulcher railroad cut, and in the roadside gullies, strata of the lower part of the section just given are exposed, as they are also in the north wall of a similar cut across the valley east. About a mile northwest of Fulcher another Highway 12 cut exposes a face of the irregularly bedded sands of Intervals 12 and 13 of the Fulcher section. In Section 34, Township 18 North, Range 11 E., outcrops in both walls of the valley of Sand Creek show probably correlative materials. Test hole K43, in the north wall of the valley 42 feet above the creek, passed through 13 feet of gray clay streaked with red and yellow, underlain by 10.5 feet of gray and yellow sand, below which were 2.7 feet of gray clay underlain by 6.0 feet of gray clayey sand.

SECTION EXPOSED BY ILLINOIS CENTRAL RAILROAD CUT ABOUT 7/8 MILE ALONG THE TRACK WEST AND SOUTH OF FULCHER, AND BY A RAVINE IN THE HILL SLOPE ABOVE THE CUT

	Feet	Feet
Psychozoic group, Holocene system		
Recent series and formation		1.5
Subsoil and soil: The subsoil is a sandy clay loam, brown, and the soil a sandy loam, brown	1.5	
Cenozoic group, Eocene system		
Wilcox series, Ackerman formation		125.2
Covered to soil at top of hill, but presumably Ackerman; elevation about 585 feet	50.0	
Sand as below; some layers more silty or clayey than others	5.0	
Covered	5.0	
Sand, laminated clayey or silty; dove-gray to light-gray on surface; many laminae defined by rust; laminae very even, of uniform thickness	2.0	
Ferruginous platy material	0.2	
Sand, fine gray-green cross-laminated; many laminae defined by iron rust; two or three seams of platy ironstone; thin wedges of the underlying breccia are worked in toward the top, including very thin cross-laminated wedges of sand	2.0	
Sand, breccia, and covered: The interval is at least half covered, but here and there a breccia is exposed, composed of large to small lumps of laminated sky-blue silty sand or		

sandy silt in a matrix of brown to olive-drab sand. Some lentils of pure light-brown to grayish-green sand and some ferruginous levels and platy ferruginous sandstone 33.0

Sand, very silty, or silt, blue to gray laminated; in the weathered outcrop in the ravine it breaks out in conchoidal lumps coated with iron oxide, nearly white; the lumps are laminated, and do not break down readily, but are residual in the clayey sand, red 10.0

Sand and sandstone: The sand is coarse to medium, strongly iron colored, cross-laminated and micaceous; the sandstone

Figure 3.—Ackerman sand and sandstone, Illinois Central Railroad cut 7/8 mile west of Fulcher. February 11, 1943.

is very irregular, contorted, dense, ferruginous, maximum 1.2 feet thick; to track level; elevation about 460.0 feet. (Figure 3) 18.0

South of the ravine, level with or a little above the level of the top of the uppermost exposure of the section, is a bench or shelf, probably the top of an old landslip, and the breccia exposed in the ravine could possibly have some relation to this; however, the undisturbed state of the overlying laminated sands seems to be evidence against a relation between breccia and landslip.

The conspicuous features of the basal interval of this section are: the vivid colors of the sand (brown of various shades, red, and dull white); the intricate diagonal, horizontal, and curved lamination, especially directly beneath the sandstone; the white sand and clay stringers along the lamination planes; and the extreme irregularity of the masses of ferruginous sandstone and siltstone. Among the many remarkable shapes assumed by this rock, elongated curved-surfaced masses, roughly semi-cylindrical or even complete cylinders, are prominent, and botryoidal surfaces are not uncommon. This ferruginous rock extends along the top of the interval, dipping southwards 11 feet in a distance of 363 feet.

The exposure of the Ackerman sand in the Highway 12 cut about 300 yards north of the railroad cuts described shows very conspicuously white and iron oxide colored sand and especially the irregular masses of ferruginous sandstone. Neither bottom nor top of the unit can be found accurately here, but the thickness appears to be comparable with that shown in the railroad cuts. This level can be traced readily by its topographic expression. From a point on the railroad a little south of the first large cut west of Fulcher, the Ackerman sandstone can be seen in the second cut, the level of the same rock in the highway, where its position is marked by a definite bench, and the same feature in a local road leading north from Bethlehem Church on the highway.

A 43-foot boring 625 yards south by west of the railroad cut described above, and about 21 feet above track level in the cut, passed through 40 feet of brown and gray sand. This is less than 1/4 mile west of the cut.

Other Illinois Central Railroad cuts farther west and southwest expose Ackerman strata (Test holes K48, K6, and others not designated by letter), but the characteristics of the upper part of the Ackerman formation are best expressed by a description of the section at the type locality:

Section of test-hole 250 yards north of Blantons Gap and of south wall of Blantons Gap, Illinois Central Railroad right-of-way, 1/2 mile to 3/4 mile east of the town limits of Ackerman (Secs. 28 and 21, T. 17 N., R.11 E.)

	Feet	Feet
Psychozoic group, Holocene system		
Recent series and formation		1.0
Subsoil and soil: Clayey sand and sandy loam, brown, to crest of ridge, about 600 feet above mean Gulf level	1.0	
Cenozoic group, Eocene system		
Wilcox series, Holly Springs formation		57.0

Sandstone, ferruginous yellowish to brown to dark-red coarse-grained to fine-grained micaceous friable to extremely indurated; the more strongly indurated rock projects beyond the less indurated, giving the cliff a rugged appearance; individual masses have a maximum thickness of 6 feet; many large fallen masses form talus on a bench at the foot of the cliff. This rock forms the axis and crest of the ridge	16.0
Sand, red-brown at the northeast end of the exposure, but lighter brown to dull-white farther southwest; about midway of the length, the exposed sand is inter-lentiled with sand and clay conglomerate composed of lumps of clay in a matrix of sand, some of the clay lumps resembling bentonite in their light-yellow color and conchoidal fracture. In some places the clay lumps are distributed sparsely through the sand, but in other places are aggregated and very numerous; they may be rounded, discoidal or flattish, and are associated with streaks of purple sand. The largest clay bowlder seen was 8 inches in diameter and was embedded in light-gray to dull-white sand (Figure 4)	10.0
Sandstone, red-brown, cross-laminated	7.0
Sand, fine, sufficiently silty to become compacted and loosely indurated under the weather; dull golden-brown to brick-red, but featured by dull white specks all through it, giving	

Figure 4.—Eight-inch clay ball and irregular clay masses in the Holly Springs sand in the Ackerman-Holly Springs contact zone, southwest end of Blantons Gap.

it a speckled appearance; slightly micaceous. This may be the upper part of the second interval below it, the 5.0-foot interval 2.2

Covered, but probably the same as the subjacent interval; most of it on a bench or shelf formed by the erosion or artificial removal of the sand and sandstone from above the clay; large blocks of ferruginous sandstone talus cover much of this interval a few yards farther west 7.8

Figure 5.—Six-foot lignite bed at the top of the Ackerman formation, Blantons Gap.

Sand, brown medium-grained to fine-grained, slightly cemented towards the base; probably the basal part of the interval next above 5.0

Sand light bluish-gray on freshly exposed surface, but weathers almost white; shot through with yellow iron rust; sufficiently silty and clayey to cause it to harden under the air and a crust to form over it; fine-grained; no laminae are noticeable at this outcrop; iron oxide cemented towards the base 9.0

Erosional unconformity

Wilcox series, Ackerman formation 96.6

Clay, lignitic sandy jointed: The clay is dark-gray towards the base, grading to dark-brown to nearly black a foot or so above; chocolate-brown to lighter brown in the upper half; contains

ferruginous golden yellow bands 2 inches or less in thickness in the upper part; two distinct and other indistinct yellow laminae; a 0.5 inch ferruginous crust on top. In the opposite wall of the cut, not more than 100 feet northwest, thicknesses of 6.0, 7.0, and 7.5 feet were measured; the bed there thins northwards to 5.0 feet or less within a few yards, but has less clay and sand, and approaches pure lignite in places. Along the face of the south wall the interval pinches out to the west (Figure 5)	4.2
Clay-shale, very light-gray, and sand, fine, of same color; the shale is very sandy upwards; it contains golden-yellow iron streaks, notably at the base and in the middle; streaks of sand; root impressions and darker gray material appear toward the top. This interval measures 8.0 feet in thickness a little southwest and on the opposite side of the gap	7.0
Clay and sand, lignitic, and lignite, impure	1.0
Clay-shale, sandy, and sand, all very light-gray or greenish-gray; the clay-shale is towards the base, but the interval grades upwards into sand; a little marcasite present; root films or impressions near the top of the interval	5.0
Iron ore: Siderite or iron carbonate, unconnected flattish ellipsoidal masses, shelly, mostly oxidized to impure limonite	0.5
Silt, as the interval below, but somewhat lighter of color and more sandy; brown towards the top just under the iron ore	0.8
Silt, olive-drab, pale gray-green on exposed surface, but grades to dove-gray or slate-gray on a fresh fracture surface; very fine and soft	1.0
Clay-shale, dense slate-gray jointed	0.4
Sand, brown to black lignitic	0.3
Sand and iron carbonate ferruginous material: Brown iron-stained sand below, 0.5 foot, and red carbonate layer above, 0.5 foot; the red ironstone is indurated and forms a ledge layer of uniform thickness; this interval thickens westwards as a ferruginous band of rusty gray sand; sky-blue sand farther on. Dip S. 55°W. 2.8 feet in 110 feet	1.0
Clay-shale, very sandy and silty closely jointed, light-gray on joint surfaces, but brown on a fresh surface; it contains more sand upwards, and the uppermost 2 feet are lighter gray to pale greenish-gray, with sand interlaminated with clay-shale and clay; laminae ferruginous	5.0
Ironstone, iron carbonate and oxidized iron carbonate: A discontinuous layer of discoidal masses of ferruginous material now chiefly iron oxide, which was once iron carbonate, and some masses of which still have gray to white $FeCO_3$ centers	0.5

Clay-shale, light-gray very closely jointed pure; very slippery when wet	2.2
Clay, lignitic, black on weathered surface, some nearly pure lignite. The bed descends sharply to the south 2.2 feet in 92.5 feet and also thickens down dip; at a distance of 135 feet west of where the first measurement was made the layer is 1.9 feet thick including some ferruginous lignitic material and brown lignitic clay	1.9
Clay-shale; some streaks pure and others very silty and sandy; gray, bluish-gray to greenish-gray; sandy seams yellowish-gray to olive-drab; the upper 1 foot is laced with brown plant-root imprints; finely laminated, hackly fracture	3.6
Sand and clay, ferruginous, and a cylindrical mass of iron carbonate inside a limonite crust; iron layer, brick-red to yellow	1.0
Sand, gray micaceous very fine laminated; shaly on weathered surface because of silt and clay content; thin seams of ferruginous sandstone and bands of reddish to purplish sand	4.5
Clay-shale, light-yellowish to greenish-gray or olive-drab, containing a little fine sand; it is closely jointed and separates along the joint planes into irregular blocks; limonite stains on the joint faces between the small blocks, and thin sheets of black to dark-brown ferruginous material along the major joint-planes; carbonaceous matter films; the material is darker where fresh, as in the waterfall west of the track. Conchoidal fracture is somewhat marked	6.4
Clay, lignitic very dark-brown, black on a freshly exposed surface, coffee brown to reddish where weathered; shows also in the opposite wall of the cut; about	0.8
Clay-shale, light-gray to olive-drab or greenish; it breaks into blocks and resembles bentonite; shows also on the opposite side of the railroad, where leaf impressions were found in it	5.0
Sand, sandstone, shale, ferruginous; thin layers	0.9
Sand, olive-drab fine micaceous, cemented into crusts of ferruginous sandstone at bottom 2 to 3 inches	1.2
Clay-shale, dark-bluish gray to blackish-gray, with lignitic streaks; contains very fine sand, especially towards the top; slightly micaceous and contains a few marcasite concretions; 1 inch to 2 inches thick discoidal iron carbonate masses about 1.5 feet above the base of the interval arranged in a layer of separate discoidal pieces	4.3
Clay, gray sandy or silty (from test hole)	7.8
Lignite (from test hole)	2.3
Clay, light-gray sandy (from test hole)	8.0

Clay, light-gray (from test hole)	3.0
Clay, black (from test hole)	4.0
Clay, dark-gray (from test hole)	5.0
Clay, green silty (from test hole)	7.0
Clay, dark-gray; silty or containing fine sand (from test hole)	1.0

Numerous good exposures, in some places excellent exposures, of Ackerman strata can be seen throughout the Ackerman outcrop belt, especially in the Noxubee Hills. The middle and upper Ackerman beds are more conspicuous than the basal Ackerman sand, because of their lignite. A few of the best outcrops may be mentioned:

In the walls of the valley of Little Noxubee Creek 1/4 mile east of the old Ackerman-Louisville road and a mile or more east of the paved Highway 15 (Sec. 23, T.16 N., R.11 E., SW. 1/4), a section of upper Ackerman laminated silts, gray clays, lignitic clays, and lignite is exposed (Test hole K82).

A headwater fork of a tributary of Noxubee Creek which heads at Five Mile Spring (Sec. 15, T.16 N., R.11 E., SW. 1/4), some 75 yards east of U. S. Highway 15.

SECTION ALONG A SMALL VALLEY HEADING AT FIVE MILE SPRING AND OF SAND PIT WEST OF U. S. HIGHWAY 15 AND WEST OF THE SPRING.

	Feet	Feet
Cenozoic group, Eocene system		
Wilcox series, Holly Springs formation		50.3
Sand, coarse to fine, containing some grit and considerable ferruginous sandstone, especially at the base and within 10 to 15 feet of the top of the interval. The sand is red-brown to cream-colored to lemon-yellow or nearly white. In the lower part the interval contains a multitude of angular light-colored laminated clay and sand fragments, which give it the peculiar "clabber" appearance mentioned by Lowe; the "clabber" zone appears to be more or less sharply defined. To top of face of sand pit west of highway	50.0	
Sandstone and silty limonite, ferruginous and leaf-bearing. The spring flows over this sheet of rock (Figure 6)	0.3	
Disconformity		
Ackerman formation		71.3
Sand, silt, and clay, ocherous bright golden-yellow, containing thin sheets of ferruginous material	1.0	
Lignite, blocky brittle, impure where dry; grades upwards into sandy lignitic clay	1.5	

Underclay, light-gray stiff very plastic	1.3
Sand, fine gray	0.5
Covered	8.2
Silt or fine sand, greenish-yellow iron rusted lumpy, in spring gully	0.8
Covered	9.0
Sand, as in the fifth interval, containing iron-cemented levels; greenish-yellow, olive-drab, brown, rusty in streaks and spots; laminated, very compact. This sand is exposed in gullies in both walls of the main ravine, but neither bottom nor top is visible	10.0

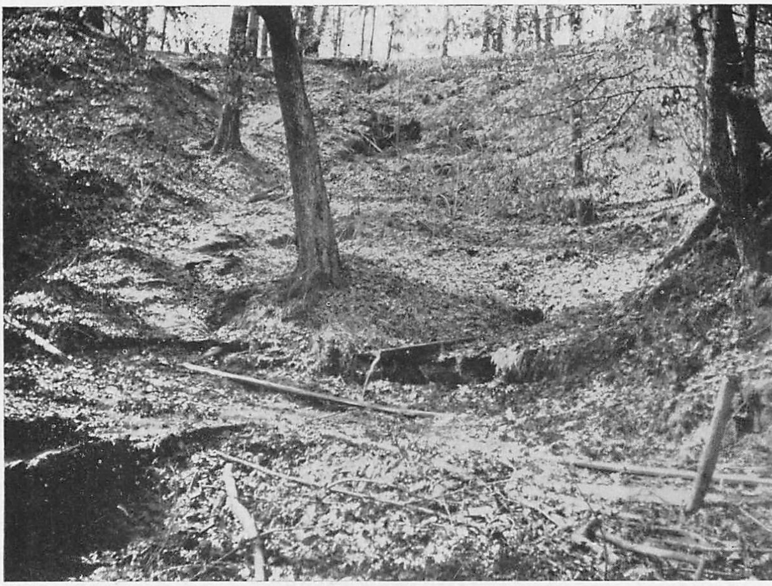

Figure 6.—Five Mile Springs at the Ackerman-Holly Springs contact. February 6, 1943.

Covered but probably sand, as above	17.5
Sand, silty fine greenish-brown to olive-drab, rust-flecked on surface; about 3.0 feet from the base of the exposure thin sheets of hard gray clay-shale come into the sand through a thickness of 0.8 foot	5.5
Mostly covered, but the material is similar to that of Interval 2 and uppermost Interval 3 in a place or two	6.5

Lignite, two levels: The top of the lower bed is the floor of the branch some 3 feet above the base of Interval 2, and above this lower lignite are 2.0 feet of bluish to dove-colored stiff compact sandy clay, on which lies the upper lignite, about 1 foot thick and dipping steeply down stream to the creek bed within a few feet. The shaly laminated lumpy sand, as in Interval 2, lies above the upper lignite, some 2 feet exposed. Apparently two seams of lignite were interbedded with the silty sand, and the upper has been involved in slumping	5.5
Sand, lumpy argillaceous or silty very fine bluish to olive-drab; covered by weathered material, but can be exposed by digging in the 5-foot face of the bank; may be slumped	?
Covered to level of swampy flat at the junction of head forks	4.0

In the walls of the valley of Noxubee Creek and tributaries along the Turner road which joins Highway 15 some 1/2 mile north of Five Mile Spring are exposures which show very well the laminated shales, silts, and sands of the upper Ackerman (Secs. 13 and 14, T.16 N., R.11 E.).

At the south point of Lake Choctaw (Sec. 11, T.16 N., R.11 E., NW. corner) is a fairly good outcrop of Ackerman lignitic clay, gray clay, and lignite (Test hole K11).

In a local road cut in the west wall of the valley of a small tributary of Sand Creek (Sec. 10, T.17 N., R.11 E., northern part) laminated beds of sand, shale, and silt of the middle Ackerman are well exposed. No lignite shows, but cross-lamination, diagonal bedding at various angles, and the peculiar breccia-like beds in which angular laminated clay or sand masses, large and small, are embedded in the sand in all sorts of relations to each other, are prominent.

The valley of American Legion Lake (Sec. 5, T.17 N., R.11 E., NW. 1/4) is cut in upper Ackerman beds except for the uppermost slopes.

SECTION OF THE FLOOR AND EAST WALL OF THE VALLEY OF AMERICAN LEGION LAKE (Figure 7)

	Feet	Feet
Psychozoic group, Holocene system		
Recent series and formation		1.5
Subsoil and soil: red sandy clay and brown clay loam or sandy loam	1.5	

Figure 7.—American Legion Lake, looking towards old road cut which exposes the Ackerman-Holly Springs contact. February 6, 1943.

	Feet	Feet
Cenozoic group, Eocene system		
Wilcox series, Holly Springs formation		15.5
Sand, massive in the exposure, brown to red-brown somewhat coarse, contains a little grit	15.0	
Sandstone, ferruginous, and silty limonite, leaf-bearing; varies in thickness and follows an irregular contact	0.5	
Ackerman formation		59.0
Clay, golden-yellow to light-yellow, mottled with very light-gray to dull-white, and some brown; probably weathered from material similar to that of underlying beds	9.0	
Sand, very fine, and silt: Very compact dark bluish-gray to black when wet, but dries very light-gray to dull-white; thinly and irregularly laminated, the laminae being defined		

by iron rust; diagonal joints; weathering causes parting along planes sub-parallel to the face of the exposure; to the base of the waterfall 50.0

The fine compact laminated material of Interval 1 forms a hard cliff over which the water of the lake outlet falls, and extends to a height of 50 feet above the valley floor below the fall. It is lighter of color above the vertical face, and varies somewhat in the relative

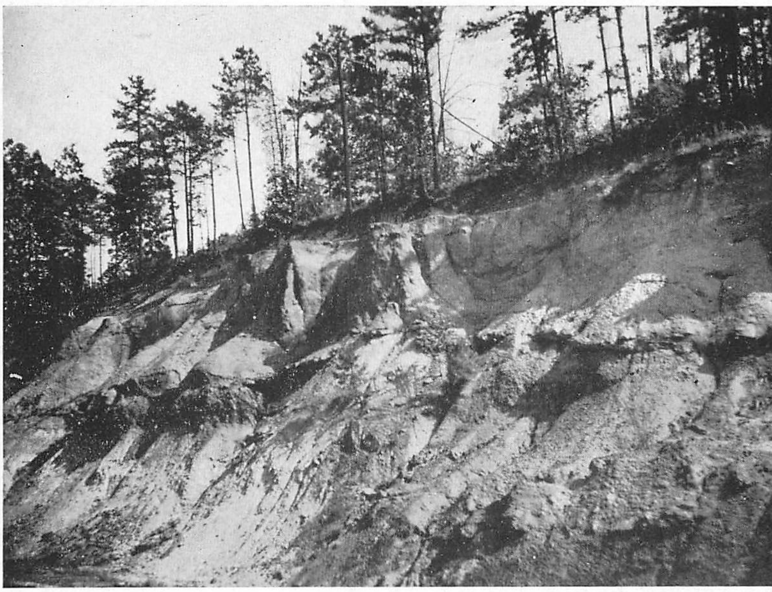

Figure 8.—Ackerman-Holly Springs faulted contact in the east wall of the Gulf, Mobile, & Ohio Railroad cut north of Williams Station.

proportions of sand, silt, and clay, but retains lamination, jointing, and limonitic stains. The major joints seem to be oriented northwest-southeast.

In the west wall of the valley lignitic clay is exposed a few feet below the Ackerman-Holly Springs contact, and is overlain by very light-colored clay and by yellow ocher. The tabular dense silty leaf-bearing limonite is better developed here than in the east wall; some blocks are 6 inches to 8 inches thick.

The walls of the Gulf, Mobile, & Ohio Railroad cut at Williams Station (Sec. 29, T.18 N., R.11 E., SW. 1/4), 4 1/2 miles north of Ackerman, show the Ackerman-Holly Springs contact (Figure 8).

The uppermost Ackerman is gray and lignitic clay (Test hole K56); the yellow ocher and silty limonite are present here, too, as in most other places on the contact.

At a local road junction 2 miles east of Reform (Sec. 15, T.18 N., R.11 E., NE. 1/4) the Ackerman gray clays, silts, lignitic clays, iron carbonate concretions, and a little lignite are well exposed in the road

Figure 9.—Basal Ackerman sand pit on the north side of U. S. Highway 82 in Mathiston, Webster County. February 16, 1943.

cuts in the east wall of the valley of King Creek. Steeply dipping bedding is a feature here.

The basal Ackerman sand shows prominently in a sand pit on the north side of U. S. Highway 82 in the northeast edge of Mathiston, Webster County, 1/2 mile or less north of the northern boundary of Choctaw County. The features are iron oxide-colored and white sand, cross lamination, and lentils of pisolitic sand or clay, pseudobauxite, in the body of red-brown sand (Figure 9).

Basal Ackerman sand and sandstone can be seen in places in western Oktibbeha County, notably on the Maben-Sturgis road, 2 1/2 to 3 miles east of the Choctaw County line. An outstanding example is an outlier about 1 1/2 miles south of the Oswalt store (Figure 2).

Here the Ackerman sand apparently lies unconformably on the Porters Creek shales. Black shale of the Porters Creek is well exposed in a large cut 100 yards north of and down slope from the sand.

Upper Ackerman beds crop out in numerous places west of Highway 15 in the southeastern and northern parts of the county, but the best outcrops are in the south wall of the valley of Big Black River and in hill slopes of the belt immediately south of the river valley. Perhaps the very best of these exposures is in a cut for an old north-south road near its junction with the LaGrange road, a mile south of Big Black River and 3 miles west of Highway 9 (Sec. 19, T.19 N., R.10 E., SW. 1/4).

At LaGrange (Sec. 14, T.19 N., R.10 E., SE. 1/4) the Ackerman-Holly Springs contact is very prominent at the base of a Holly Springs outlier. The silty limonite bed and associated ferruginous sandstone here form low ledges across the road, and pave the road with solid rock for several rods. The hill, one of the highest of the region, has a steep east slope, due to its rock capping.

Additional data concerning the Ackerman formation can be obtained from the test hole records, in each of which the age or probable age of the different beds passed through is indicated. The essential features of the Ackerman strata of Choctaw County may be briefly summarized:

1. The belt of outcrop strikes northwest-southeast, and ranges in breadth from 7 to 10 miles.

2. The beds vary widely in dip, but the normal dip, as present in the northern part of the county, is between 25 and 30 feet to the mile to the southwest.

3. The thickness of the formation could not be determined accurately, but probably does not exceed 300 feet.

4. The individual beds are fairly persistent, but lignite beds lens out, some of them in relatively short distances.

5. The rock material consists of sand, silt, shale, clay, and lignite chiefly, but considerable proportions of ferruginous sandstone, claystone or siltstone, limonite, and siderite are associated with the dominant beds. The basal sand is coarser than other sands, and con-

tains grit or even small pebbles in places. All sands and clays are silty, and beds of nearly pure silt have place in the column. In general the clays are light-gray or dark-gray; many are lignitic. Lamination is conspicuous in the silts, shales, and silty clays.

A deep well drilled at Ackerman in 1910 probably extended through the entire Ackerman formation, all of the Midway series, and a notable thickness of Cretaceous. Its depth was 1106 feet.

LOG OF WELL AT THE MUNICIPAL WATERWORKS, ACKERMAN[8]
(ALTITUDE OF MOUTH OF WELL 530 FEET ABOVE SEA LEVEL. ADAPTED FROM DESCRIPTION FURNISHED BY E. N. LOWE)

	Thickness		Depth	
	Ft.	in.	Ft.	in.
Ackerman formation:				
Yellow weathered clay	19	9	19	9
Sand	14	0	33	9
Clay	8	0	41	9
Sand and Clay	20	2	61	11
Yellow sand with some blue sand	20	0	81	11
Sand; includes 4 feet of lignite	21	3	103	2
Clay	18	4	121	6
Clay and lignite	19	9	141	3
Clay	18	4	159	7
Clay and lignite	57	11	217	6
Gumbo and lignite	38	2	255	8
Midway group (including Porters Creek clay above and Clayton formation below)				
Gumbo and soft clay	60	2	315	10
Clay	20	9	336	7
Sand and clay	19	8	356	3
Sand	20	5	376	8
Sand and gumbo	20	0	396	8
Gumbo	39	6	436	2
Gumbo and limestone	19	1	455	3
Limestone (6 feet hard)	22	6	477	9
Limestone and sand	22	0	499	9
Limestone (6 feet hard)	88	9	588	6
Selma Chalk: Black mud (?)	517	9	1106	3

THE HOLLY SPRINGS FORMATION

The Holly Springs formation was named by Lowe[5],[6] in 1913 from the town Holly Springs, the county seat of Marshall County, near which town the sands and clays of the formation are very prominent. Although the unit is composed so largely of sand that often it is called "Holly Springs sand,"[5] [6] it contains also a very considerable proportion of clay, much lignite associated with the clay, masses of ferruginous sandstone, a little iron carbonate, and a little siltstone. Mellen[4] describes a basal sand and overlying silty clay and lignite, similar to the stratigraphic sequence of the underlying Ackerman formation. The Holly Springs sand, according to Lowe's description, is commonly coarse-grained and micaceous and shows a variety of colors, white to yellow, red, and purple in the zone of oxidation, but bluish to greenish where oxidation has not been effective.[5] The sand grains are as a rule well rounded, and are cemented here and there into bodies of ferruginous sandstone. Minor structures—lamination, diagonal and circular; cross-bedding, flow and plunge structure; contemporaneous erosion surfaces, and intraformational local erosional unconformities are numerous in the sands. The clay may be lignitic dark-gray or light-gray, or pink or white; commonly it is aggregated in the form of lenses in the sand, and may contain beautiful leaf impressions. Lowe states that a zone of clay 100 feet or more thick, including pink and white ball clays suitable for stoneware, separates the Holly Springs sands into a lower and an upper member, at least in the northern part of the state, and conditions two distinct artesian water aquifers, capped respectively by the Holly Springs clay referred to and by the Grenada (Tallahatta) beds.[6] Clay is fairly abundant in the Holly Springs formation as a whole; much of it is silty. Associated with the clay lenses are great numbers of clay balls or irregular masses, disseminated rather sparsely through the sand or locally so closely aggregated that they constitute the greater part of the deposit. Individual masses may be of considerable size, perhaps of a weight of 100 pounds or more, but by far the most of them are small, giving the strata a peculiar "clabber" or curdled milk appearance. The colors of these clay fragments are light-gray, white, or pinkish, as of the larger clay lenses; many of them contain impressions of fossil plants, and as stated above, they are for the most part associated with the larger clay lenses. All these circumstances suggest strongly that the fragmental clay was torn from larger deposits by currents which transported the sand. That slumping of the clay due to undercutting by water was a leading process is suggested by the subangular shapes of the larger blocks, and that a larger or smaller part of the slumped material was carried some distance by the currents is indicated by the rounding of many of the fragments.[6]

The lignite of the Holly Springs formation is in the middle clay zone, chiefly in the form of lenses. Commonly it is associated with much lignitic clay, and the lenses are in most cases less than one foot thick.

The Holly Springs ferruginous sandstone was formed in the zone of oxidation by cementation of the sand grains by iron oxide and silica precipitated from solution in water during percolation of the water through the sands. It exists as large or small bodies of irregular shape in various stages of cementation; fluted sandstone and tubular concretionary rock are common.[6]

Lowe expressed the conviction that the characteristics of the Holly Springs sand, summarized in the foregoing paragraphs, suggested that it was deposited from strong currents of water which shifted direction at frequent intervals; furthermore, that the water was fresh, probably fluviatile. He believed that much of the material was reworked many times before final deposition.[6]

The Holly Springs formation has a thickness of 750 feet in the northern part of the state, according to Lowe,[5] who states also that the outcrop belt there is 25 miles or more in width, but narrows farther south.[6] The dip may average 24 feet to the mile westwards, and a little less towards the south. In the latitude of Ackerman the thickness is given as 288 feet.[6] The topography of the outcrop area is hilly and broken; the hills are relatively high and steep-sloped, and the valley bottoms flat. The uplands range from 150 to 250 feet above the streams, and 450 to 625 feet above sea-level, and the elevation of the sand belts is 150 to 200 feet greater than that of the clay belts.

The Holly Springs formation rests unconformably on the Ackerman. In Choctaw County, in the Blantons Gap section, Mellen found the disconformity marked by thin ferruginous sheets at the top of a 6.5-foot stratum of very silty laminated lignitic clay containing sand lenses. The writer of the present report confirmed Mellen's observations, as indicated in the description of the Blantons Gap section (see Ackerman formation). Another feature of the contact, also mentioned by Mellen,[4] is the clay pebbles and bowlders in the basal part of the Holly Springs sand (Figure 4). The formation also is disconformable with the overlying Hatchetigbee, according to Mellen,[4] but this relation was not observed in Choctaw County.

The characteristics of the Holly Springs formation as they were recognized some years ago are summed up in Stephenson's[8] description, quoted below:

"The formation is predominantly composed of irregularly and highly cross-bedded, more or less micaceous sand of white, light gray, or bluish or greenish gray color, which weathers on exposure to red, yellow, and purple and carries subordinate interbedded lenses of clay, generally of light color. Very fine gray laminated sand is common in the eastern counties. The formation ranges in thickness from about 160 feet near the Alabama line in Lauderdale County to a maximum of perhaps 600 feet in northern Mississippi. About midway of the formation in northern Mississippi is a zone of pink or white clay lenses, which more or less completely separates the lower from the upper half of the formation.

"The Holly Springs sand rests, probably with unconformity, on the Ackerman formation. . . . The strata that compose the Holly Springs dip to the west at the rate of 15 to 20 feet to the mile, and the formation disappears beneath the overlying younger Eocene formations."

The composition, stratigraphic relations, and other features of the Holly Springs formation of Choctaw County, as determined by the present survey, will appear from descriptions of outcrops and logs of test holes which follow.

The Ackerman-Holly Springs contact is clearly exhibited at a number of places, the most prominent of which, described in the discussion of the Ackerman formation, are: Five Mile Spring (Figure 6); Blantons Gap (Figure 5); American Legion Lake and LaGrange Church. The lower Holly Springs sands, a little above the contact, may be seen at all these places, the oxidized phase being very conspicuous. In the northwestern edge of the town of Ackerman, a cut for the Gulf, Mobile, & Ohio Railroad at Highway 12 bridge over the cut, has exposed the highly cross-laminated sands of the basal Holly Springs (Figure 10), which here are greenish-gray to yellowish-gray or whitish, but are incipiently oxidized, as indicated by rust-defined laminae and limonite seams along the contacts of the cross-bedded units. The sand here is notably clayey and silty. In the walls of a cut for Highway 9, a little northwest of the railroad cut, oxidized sand of the lower Holly Springs is prominent.

North of Ackerman 4 1/2 to 5 miles, in the vicinity of Williams, several cuts for Highway 15 have been made in red-brown, yellow, and white Holly Springs sand, and a little below the summit of

Williams Hill some white and pinkish silty clay is exposed. Ferruginous sandstone also is abundant here, where the elevation is more than 600 feet above mean Gulf level.

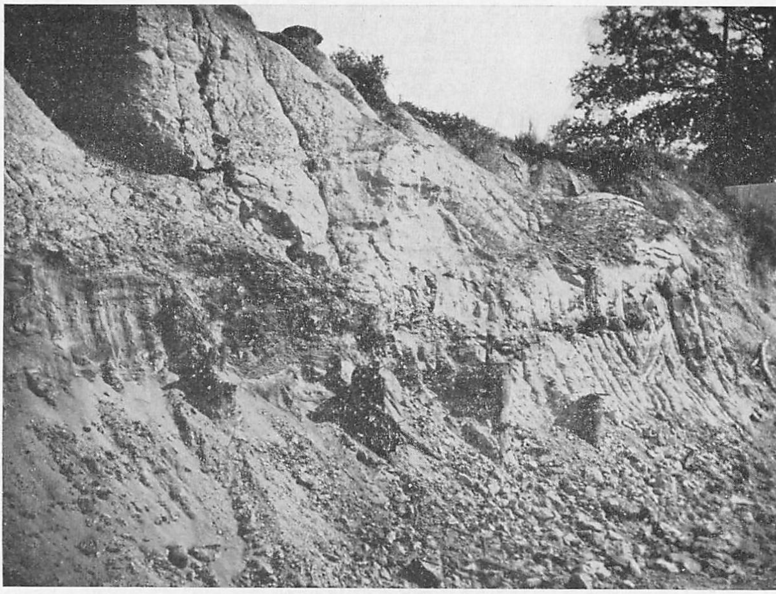

Figure 10.—Holly Springs sands in the walls of the Gulf, Mobile, & Ohio Railroad cut at Highway 12 overpass, Ackerman.

On the Chester-Salem Church road, about 3/4 mile northwest of Chester (Sec. 4, T.17 N., R.10 E., eastern part) a large pit excavated by the highway construction force exposes 60 to 75 feet of Holly Springs sand. The vertical face of the pit is 60 feet high in one place. The sand shows the usual variety of oxidation colors and irregular lamination. A strong spring in the hollow east of the pit 100 feet below the top of the hill may mark the Ackerman-Holly Springs contact; it is reported also that a vigorous flow of water was encountered in the bottom of the pit.

About 3/4 mile farther northwest, on the same road, an outcrop in the east wall of the valley of a tributary of Little Bywy is featured by conspicuous irregularity of bedding (Figure 11).

Good outcrops of the Holly Springs sands are very numerous, but only a few of the best have been mentioned. Another which merits notice has been formed by erosion along an old road some

3.5 miles north by east of Weir and 300 yards east of Mount Zion Church, in the east wall of the valley of Besa Chitto (Sec. 29, T.17 N., R.10 E., NE. 1/4).

Well above the base of the Holly Springs is a zone of silty lignitic clay, associated with some lignite and sand and limonite

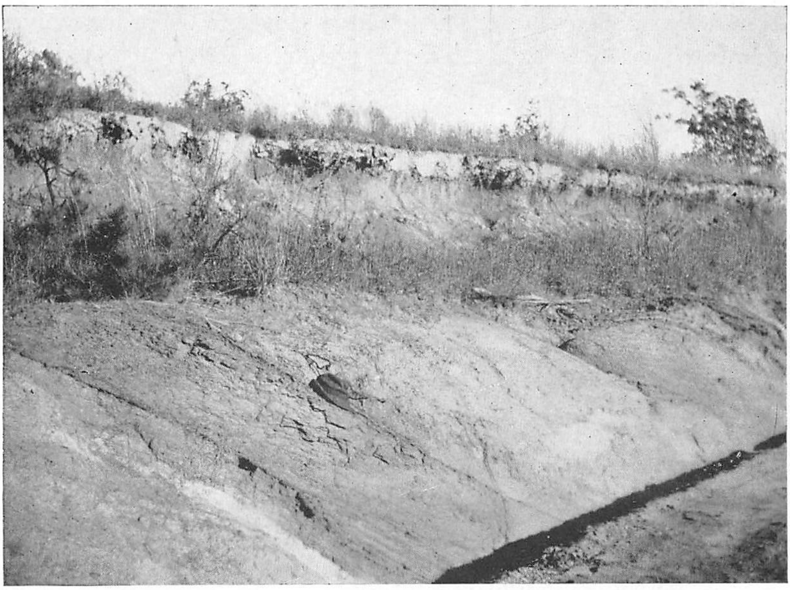

Figure 11.—Cross-lamination and bedding in the Holly Springs sand, Chester-Salem Church road cut east of Salem Church. November 25, 1942.

which was once silty siderite. These beds crop out in a number of places, notably along Highway 9 on both sides of Log Branch of Middle Bywy. Lignite and gray and blue clay were encountered in several test holes in this region (K20, K52, K53, K54). At Chester lignite crops out in one or two places. In fact, the Holly Springs formation in Choctaw County contains a very considerable proportion of clay or clay-shale, silt, and lignite, scattered through the entire unit, but especially abundant in the upper two-thirds. Most of the test holes in the Holly Springs outcrop belt penetrated at least some clay. The uppermost part of the formation is here considered to include the terrane assigned by Mellen[4] in Winston County to the Hatchetigbee formation, inasmuch as reconnaissance over the central and western parts of Choctaw failed to find any cyclothem sequence above and distinct from the Holly Springs.

The geologic map of Winston County[4] shows the Holly Springs-Hatchetigbee contact at the Choctaw County line, the southern boundary of the Panhandle, about 4 miles east of Attala County and extending up ridges into Choctaw at two places on the eastern boundary of the Panhandle. Outcrops of gray clay and dark lignitic clay and bands of lignite smut are numerous in the central and southwestern Panhandle, and much gray clay and some lignite were encountered in the test holes in that region (K98-101; K106-110);

Figure 12.—Silty siderite-limonite concretions, Weir-French Camp road. February 10, 1943.

these are thought to belong to the upper Holly Springs. The section described in the discussion of the Tallahatta includes good examples of these beds.

Mellen[4] found the upper Holly Springs in Winston County to consist of silty laminated clay, and the top material in at least one place to be "a somewhat weathered highly plastic underclay." Sections of strata similar to those which crop out in the Panhandle are exposed in many places in western Choctaw County, notably in the vicinity of French Camp (T.17 N., Rs.8 E. and 9 E.); along the Weir-Kenago road (T.17 N., R.9 E.); and in the vicinity of Free Will

Church and Williams Spring (T.18 N., R.8 E.). A feature of the upper Holly Springs strata is a discontinuous layer of masses of iron ore, now chiefly silty limonite, but almost certainly originally silty iron carbonate. The individual mass commonly is flattish ellipsoidal or roughly lenticular of shape, but may be irregular, and ranges in dimensions from only a few inches in length and width to a yard or more in length, 2 feet in width, and a foot or more in thickness. These bodies appear to be concretions: They exfoliate and separate into concentric shells under the attack of the weather; in position they occupy a definite zone or level and conform with the dip of the enclosing strata, although they do not form a continuous bed. That the layer is fairly persistent is attested by its presence at the surface in numerous places from the southern boundary of the county to the northern. It constitutes a definite horizon marker about 35 feet below the top of the Holly Springs formation as defined in this report, or 35 feet below the base of the Meridian sand, which is the base of the Claiborne series. A few places where this iron ore layer appears at the surface are designated here:

T.15 N., R.10 E., Sec. 7, SE. 1/4, in the Panhandle
T.16 N., R.10 E., Sec. 35, SW. 1/4
T.17 N., R.9 E., Sec. 32, NE. 1/4 (Figure 12)
T.18 N., R.9 E., Sec. 31, northern part
T.18 N., R.8 E., Sec. 13?

The Holly Springs-Tallahatta contact (Wilcox-Claiborne) is in general not sharply exposed in Choctaw County. Some outliers of Meridian sand east of the contact of the main bodies of the two formations are only a few feet or a few yards above outcrops of gray clay or lignite or both, but have the actual contact concealed by sand from above.

THE TALLAHATTA FORMATION

The Tallahatta formation, Claiborne Series, is, in the view of several geologists, composed of the Meridian member below and the Basic above. Grim[7] included the Winona as a third member, but subsequent study has shown that "the Winona overlies the Basic disconformably, and that the Winona is the conformable basal member of the Lisbon formation."[4] Foster[9] ranked the Meridian as a formation, and Thomas[10] considered it uppermost Wilcox.

The part of the Tallahatta formation in Choctaw County consists of the Meridian sand at the base, bodies of claystone or siltstone which may be representative of the Basic in the middle, and the Neshoba sand above. The claystone is both underlain and overlain by sand and has the appearance of a lens or irregular body or bodies within a sand formation, a discussion of which will appear in the description of sections.

The latest areal geology map of the Claiborne terrane of Mississippi[10] shows strata of the lowermost formation (the Tallahatta) extending as a narrow tongue northeastwards into the Panhandle of Choctaw County for a distance of perhaps 2 miles from the southwest corner, and also touching the southwest corner of Township 17 North, Range 8 East, 2 1/2 miles west of French Camp. No discussion of these small areas is included in the bulletin which the map accompanied. The Tallahatta shown by this map does not, however, include the Meridian sand, which, as stated above, is assigned to the Wilcox by the author of the bulletin.[10] The areal geology map (Plate 2) which accompanies U. S. Geological Survey Water-Supply Paper 576[8] shows the undifferentiated Tallahatta taking in a very small part of the southwest corner of the Panhandle.

The outcrop belt of the Tallahatta, or, rather, of the lower Tallahatta, strikes southeast-northwest across the western part of Choctaw County. Outliers of Meridian sand were found as far east as Sec. 8, T.15 N., R.10 E., in the Panhandle, and Sec. 5, T.18 N., R.8 E., in the northwestern corner of the county. As are the patterns of the outcrop belts of the other formations, so the pattern of the Tallahatta belt is irregular in the extreme, but the maximum width of the belt probably is not more than 7 miles. The topography is hilly where controlled by the Meridian sand, but much of the area within the belt of outcrop is of low relief because controlled by the underlying clays of the upper Holly Springs, which have been reached by the water-courses.

The sections described below are the best of the Tallahatta that were found in the county.

SECTION EXPOSED BY ROADSIDE RAVINES, ROAD CUTS, AND HILL SLOPES ALONG ROADS EXTENDING NORTH BY EAST AND EAST BY SOUTH, SECS. 7 AND 8, T.15 N., R.10 E.

	Feet	Feet
Psychozoic group, Holocene system		
Recent series and formation		2.0

Mantle rock, including soil: Brown silty sand and dark to gray sandy loam to top of hill south of road junction 2.0

Cenozoic group, Eocene system
Claiborne series, Tallahatta formation 75.5

Neshoba member: Sand, red-brown, light-brown, yellow, medium-grained to coarse-grained, irregularly bedded; some ferruginous sand rock 20.0

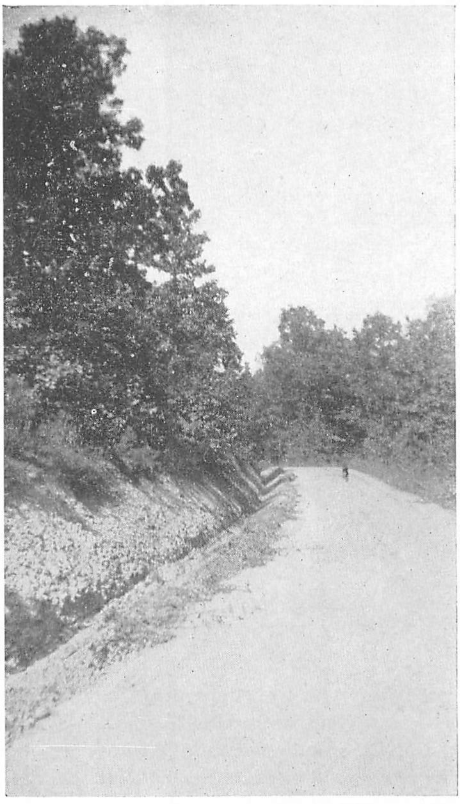

Figure 13.—Tallahatta (Basic) claystone or siltstone in road cut at road junction (Sec. 8, T.15 N., R.10 E.), western part of Panhandle.

Basic member: Siltstone or claystone, thin-bedded, much jointed and broken near surface of outcrop; lumps rounded, conchoidal, or platy or blocky; color of fresh material gray, but of weathered material almost white; finely laminated, oxidized in some degree; low specific gravity (Figure 13) 30.0

Meridian member: Sand, red-brown, light-brown, yellow, and white medium-grained to coarse-grained; laminated to cross-

laminated and otherwise irregularly bedded; also ferruginous sandstone and limonite, platy, concretionary, nodular	25.5	
Unconformity		
Wilcox series, Holly Springs formation		49.5
Covered, undetermined upper Holly Springs and lower Meridian, but dark, lignitic clay shows here and there in the lower part of the interval	5.0	
Clay, dark-gray lignitic very plastic, grading upwards into light-gray clay, iron oxide-mottled	1.5	
Clay, light-gray, rust-mottled, to olive-drab; sandy, blocky, laminae rust-defined; weathers to clay, light-gray mottled very plastic	10.0	
Clay, lignitic, and lignite smut	1.0	
Clay, light-gray, mottled with yellow rust; weathers to stiff, plastic tenacious clay	2.0	
Limonite masses, flattish ellipsodial or irregular lenticular, originally $FeCO_3$, and cores of some remain more or less weathered $FeCO_3$; they exfoliate and finally break down to shelly silty limonite fragments; layer discontinuous as in 7th interval from bottom, but the masses are much smaller, the largest being about 1 foot long	0.5	
Clay, light bluish-gray silty and sandy, interlaminated with clayey silt and sand; the laminae are defined by yellow limonite; the bed is very limonitic at the top	5.0	
Sand, fine, light-gray in lower part, grading upwards into black lignitic clayey and silty sand approaching sandy lignite in places	2.0	
Clay, lignitic dark-gray, brown, light-gray, containing golden limonite streaks; also thin impure lignite; dark-gray clay, 0.6 foot; lignite smut, 0.7 foot; chocolate-brown clay, light-gray clay, dark-gray clay; golden limonite band at the top	3.0	
Clay or clay-shale, as in 6th interval from the bottom, exposed in the floor of the gully; yellowish-green or greenish-yellow, with much yellow limonitic stain, and platy rust along the joints; minor structures are defined by limonite; a thin yellow band at the top	4.0	
Iron ore, pillow-shaped or flattish ellipsoidal or irregular masses up to 1.0 foot or more in diameter, now chiefly silty limonite; numbers of them have fallen from position and are lying in the gully; some masses a yard or more in length; the bed is discontinuous	1.0	

Clay or clay-shale, light-gray to olive-drab iron oxide-stained brown and yellow; slightly sandy; joints filled with rust plates	1.5
Clay, lignitic sandy, and lignite, impure brown	1.0
Clay to clay-shale, dark-gray to black, stiff, weathers to very plastic clay; indurated when dry	2.0
Clay, similar to Interval 2 below, but somewhat darker gray and mottled with brick-red iron oxide; darkens towards top and grades into interval above; contains selenite	3.5
Clay, bluish-white splotched with yellowish and pink iron oxide; slightly sandy; bedded; flattish pieces slightly indurated where fresh, but weather to very stiff plastic clay; grades into Interval 3 above	1.0
Covered to water-level under bridge at base of hill some 60 yards northeast of road junction	5.0

Test hole K110, started a little below the top of the Holly Springs part of the section described above, passed through most of the intervals of the section.

SECTION ALONG THE ROAD LEADING NORTHWARDS UP THE NORTH END OF THE IRONSTONE HILLS FROM SAME DATUM AS THAT OF THE PRECEDING SECTION (SECS. 7 AND 18, T.15 N, R10. E.)

	Feet	Feet
Psychozic group, Holocene system		
Recent series and formation		1.5
Mantle rock and soil, chiefly brown clayey and silty sand, and brownish to gray sandy loam; some fragmental sand rock	1.5	
Cenozoic group, Eocene system		
Claiborne series, Tallahatta formation		153.0
Neshoba member: Sand, red-brown at outcrop, but light-brown, yellow, or dull white beaenth the surface; medium-grained to coarse-grained micaceous; cross-laminated; contains some limonite and ferruginous sandstone. Bands and stringers of siltstone or claystone are worked into the basal zone, and some thin streaks of gray clay here and there	57.0	
Basic member: Siltstone or claystone, greenish-gray where fresh, but weathers dull white; much jointed (cf. Interval 19 of prior section)	10.0	
Meridian member: Sand, as in interval above the claystone; the exact position of the contact with the underlying beds was not determinable, because of sand from above; thickness given only approximate	66.0	

Covered; Tallahatta wholly or in part	20.0	
Unconformity		
Wilcox series, Holly Springs formation		22.0
Clay, lignitic dark-gray to light-gray and some yellow, as in the lower part of the preceding section	17.0	
Covered, probably Holly Springs	5.0	

The Basic siltstone or claystone appears in the first section at 70 feet above datum, and shows a thickness of about 30 feet, whereas in the second section, where it is a mile or more south by west of its position in the first section, the siltstone is 108 feet above the same datum, and has a thickness of only 10 feet. Normally the dip is southwest and should carry the unit perhaps 25 feet below its position in the first section; yet it is 38 feet above that position. Possibly this apparent reversal of dip is real, although no field evidence was found to support such a possibility; more likely the condition is due to general irregularity of the form of the claystone body, and to its wedging out towards the southwest, or to the presence of two or more separate bodies of claystone, overlapping. As already stated and as indicated in the sections, the claystone could be a large lens or irregularly shaped body or bodies enclosed by sand.

The claystone shows in a road cut about 1/4 mile east of the road junction near the top of the first section; but, outside the sections described, no outcrop other than this was found in the county (Sec. 8, T.15 N., R.10 E.).

Near the base of a hill in a wooded area a little east of the main outcrop of claystone, thin layers of gray to white quartzite are interbedded with sand. This horizon is below the base of the exposed claystone body, but may be in the base of the Basic or the upper part of the Meridian. In this connection it is interesting to note that erratic quartzite bowlders were found in the Meridian outcrop belt in the vicinity of French Camp.

The sand above the claystone is here assigned to the Neshoba member because of its stratigraphic position and its characteristics. Thomas[10] was the originator of the name "Neshoba sand" for the unit which he says overlies the Basic claystone and underlies the Winona greensand "throughout the central and northern portions" of the Claiborne outcrop area. He describes this sand as "non-glauconitic to sparingly glauconitic." Although it has been included in the basal Winona by most writers on the geology of the state, Thomas assigned it to the upper Tallahatta for reasons which he states: "1. It is the stratigraphic equivalent of part of the type Basic claystone section in Mississippi and of part of the type Tallahatta section of Choctaw County, Alabama. . . . . . . 2. The Neshoba sand is overlain and underlain by typical Basic material in Newton and Lauderdale Counties. 3. The Neshoba and Basic facies are intimately interlensed over a wide area, and the thickness of the Neshoba fluctuates inversely with the thickness of the Basic."

Mellen[10] favored including the Neshoba as a facies of the Basic. In older reports the material between the Basic and the typical Winona greensand is not treated as a separate unit. Stephenson[8] did not differentiate it from the remainder of the Winona member of the Lisbon formation. Grim[7] also apparently considered it a part of the Winona, but he believed the Winona to be upper Tallahatta rather than basal Lisbon.

According to Thomas,[10] the Neshoba lies conformably on the Basic. The outcrop in Choctaw County shows wedges and lentils and stringers of Basic claystone in the basal zone of the overlying Neshoba. The Neshoba sand itself in this section is red-brown to yellow or light-brown near the surface, but lighter-colored beneath; it is noticeably micaceous, and cross-bedded locally; also it shows pellets and stringers of gray clay, as well as sand concretions and some platy ferruginous sandstone. The Neshoba sand is marine and probably was deposited under near-shore conditions.[10]

Of the other exposures of Meridian sand in the county, a conspicuous example is along the Natchez Trace right-of-way about a mile northeast of French Camp. An upland area here is underlain by dull white, yellow, and brown sand which is largely oxidized to a deep red near the surface, and contains large numbers of fragments of ferruginous sandstone and concretions consisting of thin shells of cemented red sand containing loose sand. One test hole in this area passed through 23 feet of white, yellow, and pink sand; another through 26 feet of pink and yellow-streaked sand. Gray clay crops out in the water-courses below this elevation, and test holes below the base of the sand found beds of clay. The sand which forms the higher ground is believed to be an outlier of Meridian (Tallahatta) and the underlying clay to belong to the upper Holly Springs.

A short distance south of the sand hill was found a quartzite bowlder about 1.5-feet in diameter, possibly weathered from quartzite beds near the base of the Meridian sand. Two smaller quartzite bowlders were found 1/2 mile west of French Camp, and no doubt many more could be discovered in the same region if a search were made. All are thought to be derived from the Tallahatta.

Some 2 1/2 miles east of French Camp, at Mount Moriah Church on the French Camp-Weir road (Sec. 27, T.17 N., R.9 E., SW. 1/4),

Figure 14.—Basal Meridian sand (Sec. 10, SW. 1/4, or Sec. 15, NW. 1/4, T.17 N., R.9 E.), 3 miles north of Mount Moriah Church, exposed by the road cut and wash 250 yards east of Natchez Trace. February 12, 1943.

deep-red sand mixed with yellow, containing much fragmentary ferruginous sandstone and numerous concretions and capping a considerable elevation, may be a Meridian outlier. Three miles due north of this place (Sec. 10, SW. 1/4, or Sec. 15, NW. 1/4, T.17 N., R.9 E.) in an east-west road cut and a wash in the valley wall perhaps 250 yards east of the Natchez Trace right-of-way, is a good exposure of sand which is believed to belong to the basal Meridian (Figure 14). About 10 feet of dull white to pale yellowish highly micaceous and strongly cross-laminated sand show beneath a crust of ferruginous sandstone. The sand is coarse to medium, contains numerous clay and sand pellets along the lamination planes and many rust-defined laminae. Other features are botryoidal sandstone and silicified wood.

Another good outcrop of this sand is provided by a deep road cut in the south wall of the valley of Big Black River (Sec. 5, T.18 N., R.9 E., eastern part). Numbers of smaller outcrops can be seen in the western part of the county north of French Camp.

PLEISTOCENE AND RECENT DEPOSITS

Deposits of rock material which may have accumulated during the Pleistocene period probably can not be differentiated from those of later age, or possibly from some of earlier age. Perhaps some of the stream terraces of the county, none of which is of any considerable extent, are composed of sand and gravel and clay which have been in their present positions since Pleistocene times or even earlier. It is possible, too, that a part of the alluvium underlying the larger floodplains was deposited during the Pleistocene period, and no doubt the deeper part of the residual mantle in many places originated prior to the rather indefinite beginning of the time commonly referred to as "Recent." In few, if any places can the position of contact planes between Recent and pre-Recent materials be determined, even if such planes exist.

The post-Tallahatta deposits of Choctaw County, then, consist of unconsolidated sand, silt, and clay chiefly, but include also small proportions of bowlders, small gravel and grit, fragmental sand rock, lignite, and other mineral substances—in short, the waste material from weathering and erosion of all kinds of rock materials exposed to weathering agencies. It comprises the blanket of residuum, including the soil, over the country rock; the colluvium and talus of the lower slopes; the alluvium of the stream valleys and channels and the older alluvium or terrace materials of the second and third bottoms.

Every stream of any consequence has a flat of width disproportionately great to the size of the stream, but the most extensive bodies of alluvia are along Big Black and Yokahockany Rivers, and Big Bywy, Little Bywy, Tibby, and Besa Chitto Creeks.

The various kinds of materials mentioned above may be intimately mixed or sorted into bodies, each of its own kind and all interwedged or interlensed or bearing all sorts of other structural relationships. Commonly the older deposits are more compact and more firmly cemented than those of a later age, but all stages of gradation exist. The brown loam soil, which covers about 20 percent of the area of the county and probably formerly covered a much greater area, was derived from the loess, a Pleistocene formation.[2]

STRUCTURE

The structural features of the Choctaw County strata are of major and minor rank. The major features are regional dip, unconformities and disconformities, and a probable dome or anticline indicated by local reverse dips and possibly faults.

The normal regional dip is not uniform, but has been determined direct or calculated a number of times and at a number of places for the formations represented in Choctaw County. Reference has been made to the results of these measurements and calculations, but a brief summary may be pertinent here:

Porters Creek beds dip westward to southwestward at a degree which may vary from 15 feet to 20 or 25 feet to the mile.[6 8]

The strata of the Ackerman formation have been said to dip westward to southwestward 25 to 30 feet per mile.[8]

The Holly Springs beds were found to have a dip somewhat lower than that of the Ackerman 15 to 20 feet to the mile, but Lowe records a dip of 24 feet to the mile in the northern part of the State.[6 8]

The Tallahatta (Meridian sand) dips southwestwards 25 feet or more per mile.[8]

The present survey of Choctaw County did not make an accurate determination of the regional dip, but estimates can be made on the basis of the relative positions of key beds in test holes and outcrops. For example, the top of the Ackerman formation (Ackerman-Holly Springs contact) at the Highway 15 bridge over the Gulf, Mobile, & Ohio track at Williams Station (Figure 8) is at an elevation of 609 feet; the same contact in Blantons Gap, 5 1/2 miles south by east of Williams, along the strike, is at an elevation of approximately 550 feet. Probably this elevation difference of 59.0 feet is due chiefly to the disconformity between the two formations, and partly to the slight regional inclination to the south recognizable in all the Coastal

Plain units. The same contact in the northern part of the county where it crosses Big Black River (Sec. 26, T.19 N., R.9 E.) is about 355 feet above mean Gulf level. This point is approximately 12 miles northwest and 9 miles west of Williams, and 254 feet lower; the dip of the contact westwards is, then, 28 feet to the mile, and northwestwards 21 feet to the mile. Neither of these figures expresses the degree of maximum dip, of course, because the direction of maximum dip in Choctaw County is about S. 60° W. The layer of limonite or siderite-limonite concretions a little below the top of the Holly Springs formation may serve as another key horizon for calculation of dip. In the northeastern corner of the Panhandle (Sec. 35, T.16 N., R.10 E., SW. 1/4), this layer lies about 135 feet above its position at the southern end of the Ironstone Hills (Sec. 7, T.15 N., R.10 E., SE. 1/4), some 4 miles southwest. The approximate maximum dip in this region is, then, 34 feet to the mile.

At Tollison Station (Sec. 17, T.16 N., R.11 E., NW. 1/4) on the Gulf, Mobile, & Ohio Railroad, a white sand and a thin band of lignite smut may mark the position of the Ackerman-Holly Springs contact. The elevation here is 507.5 feet. Five Mile Spring, on the same contact 2 miles east of Tollison, has an elevation of about 565 feet. The dip westward here then is about 29 feet to the mile.

It would appear from the figures given that in general the regional dip in Choctaw County is almost southwest and varies in degree from 20 feet or less to 30 feet or more a mile; probably the average is nearer 30. No evidence was found by the present survey in the central and western parts of the county of irregularity of dip of a magnitude sufficient to suggest the presence of a structure favorable for the accumulation of oil and gas. However, the structural conditions in the eastern districts appear to be less simple.

Mississippi State Geological Survey bulletins published 20 years or more ago mention reverse dips shown by the Ackerman strata in Blantons Gap. Lowe[11] [12] states that toward the east end of the cut the beds dip west 10 feet in 100, are reversed toward the middle of the cut, and toward the west end have a west dip. He continues: "the top of this ridge (railroad level) is 547 feet, with a gentle slope toward the west, but a very pronounced slope toward the east, the track level dropping down 333 feet in 3 or 4 miles. How much of this is due to anticlinal folding. . . . . and how much to differential erosion, remains still unknown. Certain it is, however, that the crest of the ridge is a zone of appreciable folding [on] a limited scale, and it may be that the whole ridge represents an anticlinal fold on a large scale. It is a region worthy of more detailed study for oil structure." The reference to the Blantons Gap undulations of strata was repeated in a later publication.[6]

The description of the Blantons Gap section in the present report includes statements concerning structure. Interval 18, the 1.9-foot bed of lignitic clay and lignite, followed as a key bed, indicates a dip of the strata southwards 2.2 feet in 92.5 feet, or at the degree of about 125 feet to the mile. Hand-level readings made on Interval 22, the ferruginous sand and iron ore layer, showed a dip S. 55° W. of 2.8 feet in 110 feet, or 134 feet to the mile. It will be observed that the southwest dip is slightly steeper. Inasmuch as the key bed mentioned first above dips somewhat steeply westwards, rises towards the west and near the west end of the cut dips westwards as at the east end, the inference is warranted that the relatively high dips and the reverse dip are very local, but possibly are on the flank of a larger northwest-southeast or east-west flexure, as suggested by Lowe. Other evidences of crustal disturbance in this region are not lacking. The surface elevation increases from about 450 feet at the base of the Ackerman to 550 or more at the top; but this elevation difference combined with normal dip and the relief of the underlying and overlying surfaces is hardly sufficient to provide the stratigraphic interval necessary to include the entire thickness of the formation. The presumption is strong, then, that dips steeper than normal are present along this belt, even if such high dips were not proved to exist by actual observation and measurement, as in Blantons Gap or along the Lower Ackerman-Middle Ackerman contact.

In the east wall of the third cut for the railroad southwest of Fulcher, about a mile along the track from Fulcher, is an exposure of laminated loosely consolidated yellowish-green sand, banded by iron rust along some laminae. These beds show a south by southwest dip estimated to be 8° to 10°, and this steep dip is sustained in the next cut, about 100 yards farther south. Minor faulting may have taken place here, or slumping on a large scale. Possibly the strata are included in one limb of a fold; they are solidly in place, not broken up.

About 200 yards north of the entrance to the old lignite mine, a deep ravine on the west side of the railroad exposes several feet of thin beds below a large culvert. From the level of the second pool, 11 feet below the culvert, a fault-trace or joint-trace extends upwards in the vertical face of the outcrop; on the west side of this is dark lumpy clay-shale, and on the east side laminated greenish-gray to slate-gray sand, containing harder ferruginous layers. The beds on opposite sides of the plane of separation are dissimilar, but no other evidence of displacement, such as breaking up or tilting of the layers, was observed. A test hole 100 yards south of this outcrop and 37 feet higher reached a depth of only 25 feet through gray clay except for the lowermost interval, which was 4.5 feet of fine green sand, probably upper beds of the greenish-gray sand of the outcrop.

In the second cut southwest of Fulcher the ferruginous sandstone dips southwestwards 11 feet in 121 yards. The overlying sand and breccia also (Section described in discussion of Ackerman formation) appear to have an unusually high southward dip.

Prospect holes bored by the Mississippi Oil and Gas Co-operative Joint Stock Company in the vicinity of the lignite mine were reported to have passed through a 4-foot bed of lignite encountered at 124 feet, and a 7-foot bed struck at 200 feet. Neither of these seams has been reported in the outcrops to the east. Of course lignite bodies commonly are lens-shaped, and may pinch out in short distances; the seam worked in the mine was approximately flat-lying; but nevertheless the possibility that the lignite seams were faulted and eroded out of the section should be recognized.

Along Highway 12 from Bethlehem Church southwestwards up the mile-long hill (Sec. 16, T.17 N., R.11 E.) no rock material except sand is exposed. A quarter of a mile southeast of the base of the hill cross-bedded greenish-gray sand of Ackerman age crops out in a highway cut, and at the top of the long hill the Holly Springs sand is prominent. A section of a considerable part of the Ackerman formation and part of the Holly Springs must then be included in this hill along Highway 12, which trends in the direction of maximum dip; yet the relief is hardly 200 feet. The vertical interval occupied by this hill would seem to be hardly sufficient to include the entire upper Ackerman formation and part of the Holly Springs, unless dips are much steeper than normal or unless faulting has been prevalent.

The drainage pattern in the region east of Ackerman is suggestive of structure, also. The northernmost headwater branch of Bogue

Fallah rises in the corporate limits of Ackerman, flows northeast for 3 miles or so, and beyond the end of this stretch swings in a big curve to the southeast. Small tributaries of the Bogue likewise flow northeast and join their main at a high angle. Other streams farther north show a similar pattern.

The Ackerman-Holly Springs contact plane in the walls of American Legion Hut valley dips eastwards 50 feet in 1/2 mile (Sec. 5, T.17 N., R.11 E.); that this elevation difference is due entirely to the relief of the contact profile is improbable.

A little north of the Williams Station underpass (Sec. 29, T.18 N., R.11 E., SW. 1/4) the east wall of the Gulf, Mobile, & Ohio Railroad cut reveals four or five small faults or slips, one having a 5-foot to 6-foot throw involving the Ackerman beds below the Ackerman-Holly Springs contact. Lowe[6] refers to this small structural feature, but mentions only one fault.

In a road cut in the east wall of the valley of King Creek, some 2 miles east by south of Reform (Sec. 15, T.18 N., R.11 E.) an outcrop of Ackerman beds shows an east dip of at least 30° to 40°. Here large flattish ellipsoidal masses of silty limonite, which almost certainly were at one time siderite, interbedded with silt and clay-shale and lignitic clay, seem to indicate upper Ackerman strata. The steep dip at this locality may have resulted from faulting along a north-south axis.

The structural conditions described above may be expressions of a folding or doming of the strata in the eastern part of the county. Indeed, there is reason to believe that they are connected with a very considerable structural dome which according to private surveys has its apex south of Sturgis, Oktibbeha County. One map of the Sturgis dome shows the eastern Choctaw region on the west flank of the structure, and a large north-south fault in western Oktibbeha cutting the dome a little east of the apex. An offset of this major fault is shown trending southeast-northwest through T.18 N., R.11 E., Choctaw County, a little east of Reform, at the site of the steep dips mentioned above. The present writer endorses Lowe's opinion that the region east of Ackerman merits a more detailed structural study because of the possibility that the beds there may have been deformed in such a manner as to create a trap favorable for the accumulation of oil and gas.

Three major unconformities or disconformities are included in the strata of Choctaw County: (1) Midway-Wilcox, or Porters Creek Betheden-Fearn Springs; (2) Ackerman-Holly Springs; (3) Holly Springs-Tallahatta, or Holly Springs-Meridian. The relative magnitude of these stratigraphic breaks is suggested in the discussion of stratigraphy. Beyond question the Midway-Wilcox unconformable contact is the leading structural feature of this type.

Elevations of the base of the Tallahatta siltstone which appears in the Panhandle section range from 70 feet above datum at one point to 108 feet at a point a mile southwest, which should be at least 25 feet below the 70-foot point if thicknesses of strata were uniform and the normal southwest dip prevailed. The conditions here, however, are interpreted as indicating a large irregular body of siltstone, or two or more siltstone horizons, in the sand, rather than as an indication of a strong northeast dip.

Minor structures, especially cross-bedding and current bedding, are very numerous in the formations of the county, as has been mentioned in the description of the stratigraphy. In places this diagonal bedding or lamination persists over a considerable distance, and could easily be mistaken for true dip.

GEOLOGIC HISTORY

The geologic history of the region now included in Choctaw County of course began so far back in the past that almost it could be said to have no beginning. The same statement would apply, mutatis mutandis, to every other segment of the earth. For practical purposes, then, this summary begins the geologic history with the time represented by the oldest strata which crop out in the county. The Midway epoch was a time of quiet, much of which passed unrecorded, but must at the beginning have seen the slow feeding of fine sand, silt, and clay from the old Cretaceous surface into a very shallow sea where abundant marine life mingled its lime with the clastic sediments. The waters of the Gulf receded southwestwards across the limy mud, but advanced again over it, working over and distributing the older deposits as well as increased quantities of fine sand, silt, and clay transported from far to the north and northeast. Marine life was at a low ebb at this time. A second and much more extensive withdrawal of the salt water left the mud flats exposed to the assaults of wind and rain and the more effective but less obtrusive attacks of the sun and frost and warm, moist, quiet atmosphere. Land life, plant and animal, followed closely the retiring sea and quickly took possession of the relinquished territory. Then began ages of dominance by subaerial processes, at times quiet, at other times violent; swamp conditions developed and long periods of quiet permitted deep decay of the land, but crustal disturbances or increased precipitation, or both, in the region which provided the sediments finally interrupted the serenity of the lower lying areas. Swollen streams carried heavy loads of rock debris from the higher lands to the Choctaw County area, and swift currents eroded and re-distributed all materials available, leaving them lying as numerous units in somewhat complicated relationships. The first period of disturbance after the long quiet was succeeded by another quiescent interval at least locally, and this in turn was followed by unsettled conditions which inaugurated the Ackerman epoch. The story remained one of aerial and sub-aerial processes and land life over and on a surface of moderate relief. Subsequent time saw the surface lowered and the relief smoothed until widespread marsh conditions prevailed for a considerable time. The same succession of events was repeated: streams became active and built up a new land, the Holly Springs, on the old; but this, too, was worn low by the same tireless and relentless agencies, and relative quiet reigned again along a low coastal plain where swamp vegetation had established itself. In the same manner the Holly Springs age ended as disturbances were renewed in adjacent regions and fresh volumes of sand and silt were swept down into the shallow Gulf water which had occupied the Choctaw County area. Marine conditions and processes had returned, ushering in the Tallahata age.

ECONOMIC GEOLOGY

SUMMARY OF FIELD WORK

The geological and mineral resources survey of Choctaw County reached to every part of the county. Prospecting with the auger and the taking of samples were carried on wherever geologic conditions promised results; in general the holes were scattered pretty widely over the county (Plate 2), but of course the flood-plain areas and the sand belts were given less attention. A total of approximately 332 test holes were bored, and 196 large samples and several hundred smaller samples were taken. The test holes commonly were 5 inches to 6 inches in diameter and ranged in depth from 10 feet or less to 70 feet or more, but averaged 25 to 35. A record or log was kept of each boring; large samples for laboratory tests were taken of beds which were of sufficient thickness and close enough to the surface for development. Numerous small samples for verification or correction of records were taken.

CLAY

All formations which crop out in Choctaw contain abundant clay, but, as far as can be determined from surface exposures and shallow borings, the greater part of their thicknesses is made up of interbedded or interlaminated sand and clay and some lignite, most of the clay layers being too thin or admixed with sand to too great a degree to be of value. However, many beds of relatively pure clay of workable thickness and extent were found, and in a number of localities these strata are so situated geographically and topographically that economic development would be practicable if the properties of the clays should warrant it. The outstanding examples of such localities are discussed briefly:

I. In the Ackerman formation outcrop area:

1. Small areas along Highway 12 northeast and east by north of Ackerman (Test holes K4, T6, Br3, K33, K1, K94, B1, M2, T2, M3). Three or four good outcrops of gray and lignitic clays show between the C. A. Stacey residence and Fulcher, a mile west of the residence (Sec. 14, T.18 N., R.11 E.), near the tops of the ridges where the overburden is a film to 8 feet. Hole K94, farthest east, penetrated 18 feet of gray clay and two thin beds of lignite under 5 feet of clayey brown sand, underlain by yellow and gray sand. K28, about 1/4 mile southwest of K94, penetrated 16 feet of red, yellow, and gray clay above 28 feet of gray and yellow sand. K33 penetrated 25 feet of red-streaked and gray clay. It appears, then, that a very considerable thickness of clay is available along this part of Highway 12. The conditions for development are good, too: the overburden is thin near the highway on both sides and does not attain a prohibitive thickness for a hundred yards or more towards the north; a main highway is right at hand, and the Illinois Central Railroad, only a few hundred yards distant.

Farther west along Highway 12 conditions are reasonably satisfactory, too. A test hole about 1/2 mile northwest of K33 penetrated

28 feet of clay in a depth of 39 feet, and another hole, 1/4 mile farther northwest at the same elevation, passed through 21 feet of clay. Under small areas here the clay lies near the surface.

Test hole K4, on the northwest side of Highway 12, 1 1/2 miles west of Fulcher and 1/2 mile west of the Illinois Central Railroad, reached a depth of 41.0 feet of which 20.5 feet were gray and black clay, and 5.7 feet, lignite. The hole is located on the west slope of a low hill; the overburden was 11.5 feet of soil and sand, and probably averages about the same over a few acres.

2. The vicinity of Choctaw Lake. This beautiful little artificial lake, formed by the damming of the upper part of the valley of a headwater tributary of Noxubee River, is bordered, except on the outlet side, by clay and sand hills. Sections of the underlying beds are exposed in a number of places in the vicinity, and the present survey bored about 30 holes in the 4 square miles centering around the lake (K7, K8, K9, K10, K11, K12, K55, K63, K64, K66, K90, K91, K93, K113, etc.) A number of these holes penetrated several feet of clay; for example, K7, on the Webster road 3/4 mile northeast of the lake passed through clay beds its entire depth, 41 feet, except for 1 foot of soil and a 5.5-foot bed of lignite; K8, 1/4 mile south of K7, reached a depth of 50 feet, all of which was through clay except for 8.5 feet of lignite in three beds, and a little sand; and K9, perhaps 1/2 mile still farther south, penetrated some 21 feet of sandy clay in a depth of 33 feet. A strip along Webster road is topographically favorable for working, and, as indicated above, the overburden is thin; however, the road is likely to be very bad in wet weather. The lake is surrounded by slopes, and a few hundred yards back from the water, on the upper slopes and the crests of the ridges, particularly on the west side, such clay beds as are present are under a heavy overburden of sand; the few clay bodies within easy reach of the surface are widely scattered areally and very sandy and silty. Test hole K88, north of the lake and 95 feet above it, found very little clay; K89, 1/2 mile southwest of K88 and 82 feet above the lake, passed through 41 feet of red-brown, white, and gray sand. At the south end of the lake, however, several holes penetrated thick beds of gray clay (K10, K11, K55, K91, K93). Most of these holes are in a low ridge between two headwater branches of Noxubee River, where the sand overburden is moderate and a good gravel road is near, leading to U. S. Highway 15 (pavement) a mile to the west. A mile and a quarter

south of Lake Choctaw, several test holes (K25, K45, K46, K62, K77, K86) along the Turner road which extends east from U. S. Highway 15 (Secs. 12, 13, 14, 15, T.16 N., R.11 E.), penetrated thick beds of clay under relatively light overburden. The road is in reasonably good shape and the topography near the highway is rolling.

3. Upper Sand Creek (Sec. 34, T.18 N., R.11 E., and Sec. 3, T.17 N., R.11 E.). In this area are several clay outcrops, and test holes K29, K43, and K75 penetrated thick beds of gray clay within a few feet of the surface. This region is hilly and the roads are bad; it is a little more than 2 miles east of U. S. Highway 15 and the Gulf, Mobile, & Ohio Railroad.

4. The vicinity of Reform. Three test holes at Reform, east of the school building and Highway 15, and west of the Gulf, Mobile, & Ohio Railroad, a short distance west of the old lignite pit, passed through thick clay strata, but unfortunately water was abundant. Topographically and with relation to transportation routes, the location is ideal. A fourth test hole, at the road junction 0.5 mile east of Reform, reached a depth of 44 feet, all beds penetrated being clay except for 3 feet of sand at the top and 8 feet of lignite between 31 and 39 feet. Other working conditions are good here, but water was encountered at 14 feet. Two other test holes, some 1/3 mile still farther east, penetrated 14 feet and 21 feet of gray clay under a light overburden of sand in a region topographically favorable for development.

5. Along Highway 15 north of Sherwood and 1 mile to 2 miles south of Mathiston, gray and lignitic clays show in a few places. Test holes K18, K19, and K32 were bored in this locality. K19 was located at the top of a ridge east of the highway and across the highway from clays exposed by a gully. The hole went through 36 feet of clay and 7 feet of lignite; water was encountered at 21 feet. Conditions here are very favorable for working of the clay beds: the topography is rather gently rolling, the paved highway is right at hand, and the Gulf, Mobile, & Ohio Railroad some 200-300 yards east. Hole K18, 0.5 mile north of K19, 100 feet west of the railroad, and some 200 yards east of Highway 15, penetrated 35 feet of clay, the depth of the hole. Hole K32, some 1/3 mile still farther north, east of the highway and west of the railroad, penetrated clay from the surface to a depth of 28 feet, and beneath it 21 feet of a mixture of clay and yellow sand. All conditions in this area are favorable for the working of the clay.

II. In the Holly Springs formation outcrop area:

1. Salem Church community, 2 miles northwest of Chester, includes two north-south ridges between Little Bywy Creek and two of its tributaries. The chief outcrops are in road cuts in the valley walls east of the church (Sec. 33, T.18 N., R.10 E., SW. 1/4); in walls of a road cut in the slope to Little Bywy (Sec. 32, T.18 N., R.10 E., SE. 1/4), and in a tributary of Little Bywy (Sec. 32, S. 1/2). Several test holes were bored near this locality (K21, K119, and others). Very considerable thicknesses of clay were found: a 67-foot boring at the road intersection 1/3 mile north of the church, for example, logged 44 feet of clay, of which 39 feet in one body were described as "Clay, light-gray very plastic, with streaks of yellow iron rust." This hole started from the crest of the ridge, but not the highest part. Another, on the northwest slope of the same ridge, some 200 to 300 yards farther northwest, and 45.5 feet above a branch of Little Bywy, logged all material as clay under the uppermost intervals of 5 feet of soil and brown sand, to the bottom of the hole, 39.0 feet. These great thicknesses of clay possibly may be due in part to abnormally steep dips which in turn may have resulted from old landslips; the complicated bedding exposed along the road up the east wall of the valley, 1/2 mile east of Salem Church (Figure 11), suggests some such disturbance in this locality. In some cases, too, material which is logged as "sandy clay" may well be from a thick bed composed chiefly of clay-shale interlaminated with sand; such strata appear in the outcrops mentioned. Where the clay predominates, the ground-up material brought out by the auger would be designated "sandy clay," or if the sand seemed to be dominant, clayey or silty sand would be recorded. The weathered parts of these beds, appearing in outcrops, likewise may appropriately be called "sandy clay" or "clayey sand." In any event abundant clay exists in the vicinity of Salem Church, and in places topographic conditions are favorable for digging it out; the overburden is fairly heavy in general, but it is sand, easily removable. Test hole K119, on the same ridge a mile south of the church, penetrated 17.5 feet of clay and two thin beds of lignite; the overburden here was 13 feet, Test holes in the next ridge to the west, also penetrated abundant clay. Hole K21 (Sec. 5, T.17 N., R.10 E., NW. 1/4), on top of the ridge a little north of a road junction, passed through 15 feet of red and gray-streaked clay topped by the thin soil only, and at a depth of 29 feet encountered sandy gray clay which it

penetrated to the bottom of the 55-foot hole. The surface is almost level over several acres; the water-level, 25 feet (in the dry fall of the year); the drainage, good to valleys east and west; and the public road, right at hand. The road is not particularly good in bad weather. Another hole, on the slope of the ridge 0.5 mile northeast of K21, found 10 feet of brownish-yellow clay beneath only 3 feet of sand.

All these clays are sandy and silty, but appear to be suitable for various kinds of clay products. Results of tests of samples from K21 are given in the "Tests" part of this report.

2. Ackerman vicinity. Test hole K13, a little down the west slope from the summit of a high hill in the southwest corner of the corporate area of Ackerman, encountered 25 feet of gray and red-streaked clay, overlain by 4 feet of overburden and underlain by 24 feet of clayey and silty sand to the bottom of the 53-foot hole. This deposit is favorably situated. The overburden would be heavy towards the axis of the ridge, but if the body of clay is persistent, a large tonnage could be removed by contour workings. The water-level was 40 feet down, and the drainage is good. Another hole, 300 yards west of K13 and 40 feet lower in elevation, penetrated 27 feet of a mixture of sand and clay.

Test hole K69, a little north of the northwest corner of the Ackerman corporate area, between U. S. Highway 15 and the Gulf, Mobile, & Ohio Railroad, encountered blue clay at 16 feet and penetrated it an additional 16 feet. (Sec. 19, T.17 N., R.11 E.).

3. Boyd School vicinity. A dozen holes were bored in the northern part of the county, on both sides of the road extending west from Highway 9, 1 1/2 miles north of Big Bywy ditch, especially in the vicinity of Boyd School. Some good clay was found: test hole K84 penetrated 10 feet of sandy clay near the surface; another test hole, nearby, encountered 9 feet of clay under no overburden; and a third, 5 feet of clay just under the surface. K42, farther west, passed through 10 feet of clay, but it was deep. In general, although the shallow strata of this region include clay beds of considerable thickness under only slight overburden of sand, the clay is very sandy and silty and so generally associated with sand strata that it might not be of commercial value. Working conditions are only fair; the overburden is not great for the upper beds, but the water table is high, and the road becomes bad in wet weather.

4. Bywy School community (Secs. 7, 8, 9, 10, T.18 N., R.10 E.). Six holes in this area, all but one of them west of Highway 9 on the divide between Big Bywy and Middle Bywy, penetrated beds of sand, clay, and lignite.

K60 logged 10 feet of clay under 15 feet of sand; K28, 1 1/2 miles farther northwest, reached a depth of 29 feet, all through clay except for 7 feet of lignite. Another hole, 1/2 mile west of K28, encountered only sand and lignite. The farthest east of the 6 holes penetrated 7 feet of clay directly beneath the surface and 5 feet of lignite. From the records of these holes it appears that the uppermost strata in the Bywy School locality include clay beds of fair thickness, and that the overburden is not great. Highway 9, a good graveled road, is not far distant, but the east-west road is difficult to travel when muddy. The water table is relatively high through this part of the county, also.

5. Several outcrops in Highway 9 cuts, some 6 miles north by west of Ackerman, led to the drilling of five holes along 3 miles of the road north of Nebo Church and school (K20, K52, K53, K54, and one other). Thicknesses of 6.7, 7.5, 8.0, 10.0, and 14.0 feet of clay were encountered beneath light overburden. This area is favorably located for working the clays, being along a good graveled highway and having a rolling topography of moderate relief, but water might be troublesome at times.

6. The Panhandle. Twenty-seven to thirty test holes were bored in the Panhandle, most of them entirely or partly in the Holly Springs formation. Outcrops of the clays, sands, and lignites of this formation are fairly numerous in the western and southwestern parts of the Panhandle. The best outcrops are at K100 and K107, in the northwest wall of Briar Creek valley and in the southeast wall of Briar Creek valley (Secs. 28 and 33, T.15 N., R.10 E.); in the northeast corner of Section 20, same township and range; in the northwest quarter of Section 5, and in the southeast quarter of Section 7 (road cut and gully) where K110 was bored. Most of the holes passed through beds of clay, some of which were of notable thickness.

a. The Briar Creek region. K100 penetrated alternating beds of yellow, green, and gray sand and blue clay: an upper 5-foot bed of bluish red-streaked clay under only 4 feet of sand and soil, and a lower 10-foot bed of blue clay at a depth of 13 feet. The overburden is much greater a short distance to the east, because the hole is well towards the foot of a hill. The water level is about 21 feet. Test hole K107, 100 to 200 yards north of K100 and at a greater elevation, penetrated 28 feet of dark-gray sandy clay beneath 13 feet of sand, but the water level was 16.5 feet. K95, 1/2 mile north of K100, penetrated gray, blue, and yellow clay its entire depth, 28 feet; but here again the water table was high—12 feet. K98, 1/2 mile or a little more south of K100, logged 33 feet of gray, brown, and green clay in a total depth of 35 feet; a 1-foot bed of lignite was encountered at 17 feet, and water at about the same depth. A hole, 1/4 mile southeast of K98 and 5 feet lower, encountered 9 feet of gray and lignitic clay beneath only 3 feet of overburden, but water at 3 feet.

From the logs of the borings just discussed it appears that abundant clay underlies the surface in the Briar Creek district of the Panhandle (Secs. 20, 28, 29, 32, 33, T.15 N., R.10 E.), but that the water table is high. Although the region is hilly in general, several areas have only a few feet of sand and soil over the workable clay. It must be said, however, that the roads in this part of the county are difficult to travel after heavy rains.

b. Panhandle School and upper Wildcat Creek district (Secs. 7, 8, 9, 10, 15, 16, 17, 20, 21, 22, T.15 N., R.10 E.). Test hole K99, in the northeast quarter of Section 20, passed through nearly 22 feet of clay in a total depth of 33 feet; the water level was 15 feet. K101, 1/4 mile west of K99, penetrated clay under 15.5 feet of sand and passed through more than 17 feet of white, green, and black clay in one body; no water was encountered. A hole a little north of K101, at a considerably greater elevation, logged 29.5 feet of light-blue clay under 15.0 feet of sand; the bottom of the clay was not reached, but water was struck at 9.0 feet. Another boring 1/4 mile farther north (Sec. 17) reached a depth of 54 feet, passing through clay—light-gray, dark-gray, light-blue, and green—the entire depth except for 11.5 feet of sand and soil overburden; the water level was given as 28.0 feet, but water was encountered at the bottom of the overburden. K110, the most western of the borings, in the southeast quarter of Section 7, was one of the best of the region. It was started at the top of the north wall of a small valley above a conspicuous exposure of gray and lignitic clay, sand, and iron carbonate masses, and reached a depth of 40 feet, of which 26.5 feet were clay. A thickness of 21.0 feet of gray and black clay was passed through under the soil before any sand was encountered; the water level was 22.0 feet. Topographically this is a very favorable area for clay workings, and the overburden is light over many acres; but the local roads might be said to be dry-weather roads. K110 is little below the Holly Springs-Tallahatta contact.

c. Egg Creek headwaters vicinity. Test hole K117 reached clay at 5.5 feet and went through 13.5 feet of it. The area is favorable for working: at the intersection of two local roads, of which the east-west road is graveled and in fair condition; about 3/4 mile east of the main Weir-Panhandle road, which is a good graveled road; surface gently rolling.

7. The French Camp region.

The French Camp region may be said to include the western corner of Choctaw County, bounded on the south by Attala County and on the west by Montgomery; on the north it reaches to the divide north of Elkins Creek, and on the east to a little west of Dry Creek. Within this area the present survey bored about 35 holes, including K22-24, 34-37, 57, 58, 70, 71, 80, 81, 118, and 121. Several thick beds of clay were found, in most cases close to the surface. The findings of a few of these prospect holes are summarized herein, in east-west order: K121 (Sec. 36, T.17 N., R.8 E.) passed through gray clay 28.5 feet of its total depth of 36 feet. A 24-foot hole a little farther north-west at about the same level encountered 12.5 feet of gray clay under 12 feet of sand. K80, just east of the western edge of the French Camp village limits, reached a light-gray iron oxide-streaked clay at 7 feet and penetrated 10 feet of it; a 4-foot bed of dark-gray clay was encountered deeper under 11.5 feet of sand; thus a thickness of 14 feet of clay was passed through by this 33.5-foot hole. A boring just across the road south of K80 went through gray and black clay 19 feet of its depth of 28 feet. K34, 1/2 mile farther west, found 22 feet of clay under 18 feet of sand; K24 (Sec. 35, T.17 N., R.8 E.), about 1/4 mile west of K34, logged 23.5 feet of clay under 4.0 feet of over-burden; K22, about the same distance still farther west, showed 24 feet of clay under 5 feet of red sand; K35, 1/2 mile northwest of K22, passed through 23 feet of clay from the surface downward; K57 (Sec. 34, T.17 N., R.8 E.), 1/4 mile still farther northwest, pene-trated 14 feet of clay beneath 16 feet of sand; and K58 (Sec. 27, T.17 N., R.8 E.), 1/4 mile or more northwest of K57, passed through some 18 feet of clay. The records of these test holes, all west and southwest of French Camp, point to the existence of abundant clay in the region, but the road west from the village, known as the Poplar Creek road, becomes bad at times. The gently rolling topography is favorable for working of the beds, but the water table is relatively high.

The French Camp-Kilmichael road, extending northwest from French Camp, crosses the upper Holly Springs formation which includes many clay strata as in the Poplar Creek road belt west of French Camp. Ten holes were bored along this road, and a few others at short distances from it. A summary of the records of these holes follows:

Hole	Clay thickness	Overburden
K36	13 (feet)	Soil
K37	8.8	4.0
K81	11.0	Soil
K118	9.3	3.0
K23	11.0	Soil

Another hole, some 2 miles west by north of K23 and only 1/2 mile from the Montgomery County line, encountered 14.0 feet of good clay cropping out except for the soil.

8. The Sycamore School-Williams Spring area, in the northwestern corner of the county (T.18 N., R.8 E.) is underlain by many thick beds of clay under generally light overburden. A brief summary of findings follows:

K114 (Sec. 26), about 1/2 mile west of Sycamore school, encountered 13.0 feet of brown and gray clay, the top of which is immediately beneath the soil. K92, a mile farther west (Sec. 27), reached clay just under the soil and passed through 23 feet of it in three beds distinguished only by a lighter or darker gray color. K94a, 1/2 mile west of K92 and only 1/2 mile or less from the Montgomery County line, penetrated 17.0 feet of clay in a total depth of 23.5 feet, all material being clay below 5.0 feet of overburden except for 1.5 feet of sand. Test hole K96, 1/2 mile north by east of K94a, passed through six beds of clay, totaling a thickness of 18.5 feet, but all the beds were thin. Eight feet of the clay lay immediately under the soil.

From the summary of the thicknesses of clay beds found by test holes in these several localities, the magnitude of the proportion of clay in the formations of Choctaw County becomes evident. Commercial quantity is not wanting. The properties are sufficiently indicated in the "Tests" part of this report. Of course other factors which affect the problems of utilization vary greatly. So far as overburden is concerned, the most favorable localities are in the western part of the county, in the upper Holly Springs outcrop area.

No industrial plant using any mineral substance is operating in Choctaw County at present, but a brick plant was in operation at Ackerman many years ago. According to Logan[18] it used surface clays, made brick by the soft mud process, and burned it in scove kilns. Logan[18] states also that a body of clay suitable for the manufacture of brick lies just west of the Mobile, Jackson, and Kansas City Station in Ackerman [the present Gulf, Mobile, & Ohio Station]. He describes this clay as of a blue color and gives the thickness of the bed as about 15 feet. The best brick-making clays in this part of the country are in the second bottom deposits, says Logan, and he adds that some of the upland loams may be used in the soft mud process.

A phase of the Tallahatta (Basic) has been used as road metal in some parts of the state, especially in southwestern Lafayette County where a quarry was opened in 1939.[19]

LIGNITE

Lignite, a fuel known also as "brown coal," is composed of altered plant material, especially woody material (cellulose). The changes which it has undergone consisted in the main of escape of volatile constituents and relative increase of the proportion of fixed carbon. All evidence seems to point to the derivation of lignite from accumulations of plant debris in swamps or bogs, where conditions for atmospheric decay were unfavorable because of the partial or complete exclusion of the oxygen of the air. The chief features of the processes of the formation of lignite from plant waste may be briefly summarized.[13]

By far the greater part of the usable lignite was developed from plants which grew *in situ;* that is, where the lignite now is. The many evidences of this can not be reviewed here, but one or two which can be readily observed in Choctaw County should be mentioned. As a rule each bed of lignite is directly underlain by a bed of gray clay or clay-shale which commonly contains roots or root-impressions in the position of growth, strongly suggesting that the underlying bed was the soil in which the lignite-forming plants grew. A bed of silty sand, commonly lignitic, may be subjacent to the lignite. The purity of some beds of lignite, also, and the existence in some places of perfect leaf imprints in the lignite or associated clay, are accepted as evidences that the lignite accumulated *in situ*. In the swamp areas, in many cases surrounded by lands so low that drainage from them carried little or no sediment, the rate of accumulation of leaves, twigs, fruits, and other plant debris exceeded the rate of decay, with the result that a thick brown to black pulpy mass of this kind of material was built up. Most certainly much of this residuum of organic matter was submerged and thus shut away from the oxygen of the atmosphere, which promotes swift decay. Under such conditions slow decay takes place, or changes resembling slow decay. In the absence of air, the elements of the plant tissue unite with one another to a greater extent than they do in the atmosphere, forming marsh gas (methane, CH_4), carbon dioxide (CO_2), water (H_2O), and other compounds; but in whatever way these elements may combine, the result is always to increase the proportion of carbon remaining in the solid. Cellulose, or wood tissue, has, roughly, the composition expressed by the formula $C_{36}H_{54}O_{24}$; that is, 36 parts of carbon, 54 parts of hydrogen, and 24 parts of oxygen (by molecular weight). Under the conditions prevailing in swampy regions, as stated above, where the oxygen of the atmosphere is largely excluded by submerging swamp water, and where pressure is steadily increasing from the accumulating plant debris, and later from beds of sand or clay, the processes of slow decay drive off quantities of all three of the elements of the cellulose in the forms of the gases CH_4, CO_2, and H_2O, but the hydrogen and oxygen are lost much more rapidly than the carbon. Thus the relative proportion of carbon constantly increases. Through the removal of about 8 molecular weights of CO_2, 4 of CH_4, and 6 of H_2O, the woody mass is reduced to lignite, or brown coal, which has approximately the composition expressed by the formula $C_{24}H_{20}O_2$. Given sufficient time and continuing favorable conditions, the processes may create bituminous coal, or even anthracite. Of course a very considerable decrease of volume results from these processes.

Lignite is, then, immature coal. This fact may be made more apparent by the following table showing the composition (ultimate analyses) of the coal-forming plant mass at various stages:

	Carbon	Hydrogen	Oxygen	Nitrogen
1. Wood	49.66	6.21	43.03	1.10
2. Peat	59.5	5.5	33.0	2.0
3. Brown coal (Lignite)	68.7	5.5	25.0	0.8
4. Bituminous coal	81.2	5.5	12.5	0.8
5. Anthracite coal	95.0	2.5	2.5	0.0

Lignites vary widely in composition, and the proportions of the constituents recorded in the above table should be considered average only. Substances such as moisture and sulphur, common in all lignites, are not included, nor is the ash shown. As Clarke[14] states, lignites are "peculiarly hygroscopic," and commonly the moisture content is very high. The sulphur may be in the form of marcasite or pyrite concretions or grains or veins, or may be organic, or may be present in sulphates, such as gypsum, which is fairly abundant in the lignites and associated clays of Choctaw County, especially in the form of selenite. Resinoids and fossil hydrocarbons, disseminated and in masses, are abundant in lignite, also.

It should be remembered that the foregoing explanation of the origin of lignite takes into account only some of the leading features of the processes involved, and thus is likely to be a little misleading. Clarke[14] points out that all the various substances formed by the slow decay of vegetal matter under swamp conditions are "indefinite mixtures which vary in composition," and adds that "it is therefore impracticable to write chemical equations that shall properly represent their transformations." He calls attention to the facts that other important constituents besides cellulose enter into the complex coal-making processes, and that although cellulose loses CH_4, CO_2, and H_2O, "it also undergoes other changes which are difficult to measure." Further, "in every swamp or peat bog the waters are charged, more or less heavily, with soluble organic matter of which the written reactions take no account. This soluble matter is found in the waters of all bogs and streams, and it is just as much a factor in the real reactions as are the gaseous products or the solid carbonaceous residues."

Lignite is brown to black of color; its luster commonly is dull, but may be brighter; coherence may be strong, causing the material to be hard, compact, and firm, or may be weak, leaving the mass soft and unconsolidated. The initial woody texture may have been obliterated, or it may remain; some lignite shows readily identifiable parts of plants, including pieces of lignitized wood, or even wood only slightly altered. Lignite is lighter than coal but heavier than wood; its specific gravity is 1.2 to 1.5. The fuel value, expressed in British thermal units (B. T. U.), is greater than that of wood and peat but less than that of bituminous coal.* Commonly lignite burns with a yellow flame and gives off much smoke and a disagreeable odor, but some Choctaw County lignite was reported to burn devoid of smoke or soot. In few instances does lignite fuse or cake on burning; hence ordinarily it can not be used for making coke. Other physical characteristics are much the same as those of coal. In the bed or seam lignite may be blocked by vertical joints and by planes of cleavage parallel to the stratification planes; in the bed or out of it the fracture may be conchoidal or irregular, as the material is harder or softer. Of course, just as bituminous coal may vary in purity from the best grade of coal which has no shale or sandstone or other rock mixed with it, to the poorest grade, which has a large admixture of these impurities; so lignite may vary from the pure wood residue to a mixture of plant material with abundant sediment, and beyond this to lignitic clays and sands.[15]

Brown[15] gives the proximate analysis of a sample of lignite from the E. W. Oswalt land in Choctaw County: Fixed carbon, 42.47; volatile matter, 34.61; water, 11.61; ash, 11.31. The sulphur in this sample was determined as 2.66, and the calories as 5,595. The B. T. U. value is 10,071. Brown states that this sample was the only one which he found in the state which had more than 10,000 B. T. U. Other analyses records of Choctaw County lignites cited by the same writer are quoted below:

W. A. Collins property: Moisture, 11.44; volatile matter, 36.57; fixed carbon, 38.56; ash, 13.43; sulphur, 2.05; calories, 5,115; B. T. U., 9,207.

Chester: Moisture, 11.39; volatile matter, 39.79; fixed carbon, 38.72; ash, 10.10; sulphur, 2.83; calories, 5,236; B. T. U., 9,425.

Moses Bridges property: Moisture, 14.29; volatile matter, 38.90; fixed carbon, 37.71; ash, 9.10; sulphur, 0.86; calories, 5,018; B. T. U., 9,032.

Patrick Ray property: Moisture, 10.79; volatile matter, 41.59; fixed carbon, 36.54; ash, 11.08; sulphur, 1.18; calories, 5,311; B. T. U., 9,560.

Snow's field: Moisture, 11.07; volatile matter, 42.92; fixed carbon, 39.70; ash, 6.31; sulphur, 1.92; calories, 5,526; B. T. U., 9,947.

All analyses were on an air-dried basis. A comparison of these analyses with records of analyses of lignites from other states shows, according to Brown, that the better Mississippi lignites are the equal of the brown lignites of North Dakota and Texas, and are not greatly inferior to the black lignites of Colorado, Montana, and Wyoming.

*Note: A British thermal unit is essentially the quantity of heat required to raise the temperature of a pound of water from a temperature of 63° F. to a temperature of 64° F.

High-grade lignite is a good fuel; in fact, it can be used for all purposes for which bituminous coal is used, except perhaps for coking. Brown[15] states that some of the lignite from the E. W. Oswalt property was tried in the forge by the University of Mississippi shop, and gave a good weld. He states further that in North Dakota lignite has been used successfully in the burning of brick, an accomplishment which should be especially interesting to some Mississippi communities where excellent brick-making materials are in contact with or very near beds of lignite. It has been pointed out that in Choctaw County almost all beds of lignite are associated with clay. Lignite has been used under boilers, also, and proved to be a satisfactory fuel for that purpose; for example, it was said that at the old Mississippi Oil and Gas Co-operative Joint Stock Company's mine, lignite from the mine was burned under the boiler, producing neither soot nor smoke.[16] Indeed, the company reported that the lignite was smokeless, clinkerless, and sootless, and burned to a red ash; that the heat units were 11,400 B. T. U.; and the ash, from 6 percent to 7 percent.[16]

Lignite has been used in the manufacture of illuminating gas, but in some tests has not yielded a very good quality gas of this kind. In the manufacture of producer gas, however, the lignites tested by the Coal-testing Plant of the U. S. Geological Survey at St. Louis proved highly satisfactory. No Mississippi lignite was used, but according to Brown,[15] "The brown lignites tested came from North Dakota and Texas and are no better than many of the Mississippi lignites, and are inferior to some of them." The same writer quotes a summary of the results from the report of the committee in charge of the tests—a part of which is: "It has been shown that a gas of higher quality can be obtained from lignite than from high-grade bituminous coals, and that one ton of lignite used in a gas-producer plant will yield as much power as the best Pennsylvania or West Virginia bituminous coals used under boilers. It appears, in fact, that as coals decline in value when measured by their steam-raising power, they increase in value comparatively as a fuel for the gas producer. . . . the unexpectedly high power-producing qualities developed [by the lignites tested] in the gas producer and gas engine give promise of large future developments . . . . where extensive but almost untouched beds of lignite are known to exist."

The possibility of utilizing the lignite of Mississippi has been given some attention at various times and places. Probably the most sustained and serious attempt at development was that made by the Mississippi Oil and Gas Co-operative Joint Stock Company,[16] already referred to, who opened two or three mines in Choctaw County. The company continued operations for some time in spite of increasing difficulties both natural and economic, but finally was compelled to give up. The chief factors, aside from business difficulties, which led to its defeat, may be stated briefly.

The lignite seams exploited by the company, although of workable thickness, could not be depended on to retain a uniform thickness over wide areas, or, indeed over any considerable area; they appeared to be lens-shaped, and of very limited extent. Places are known where such lignite bodies thin from workable thickness to nothing in a few rods, or are even cut off abruptly.

Commonly the lignite is underlain by clay and overlain by clay or sand, which in general are not the best roof and floor material for mine tunnels, especially in a region of heavy rainfall. The sand or clay beds, where saturated with water, move easily in the direction of less resistance, as toward the mine openings, thus constituting a constant menace which must be guarded against by timbering almost every foot of the passages, at heavy expense. Moreover, timbers may be broken by the immense pressure, and sections of the entries filled, killing or trapping men, or at least necessitating costly repair work. It is pertinent to note here, however, that not in all cases are sands unsatisfactory as roofs for mine entries. In describing the old lignite mine 2 miles north-northwest of Louisville, Winston County, Mellen[4] states: "The roof of the mine has stood up through the decade or more of abandonment, and even though the timbers have rotted and fallen, the salt-and-pepper colored fine-grained slightly micaceous, argillaceous sand roof still bears the marks of tools throughout most of its 100-foot length; and in but few places has any of the roof caved. Because of its natural argillaceous bond, this unconsolidated sand makes a superb roof for a mine."

Mine waters are in some cases abundant and difficult to control. It should be noted in this connection, however, that the operating company reported that the slope mine east of Ackerman found no gas and very little water.[16]

The lignite itself commonly contains a very high percentage of water and may become saturated if it is subjacent to sand through which the water can readily percolate. Some springs in Choctaw County issue along the tops of beds of lignite, and instances are recorded of springs which flow from the lignite itself (Figure 15). Determination of the moisture content of fresh Mississippi lignites has shown an average of almost 35 percent.[15] Obviously so much

Figure 15.—Lignite Spring (Sec. 30, T.15 N., R.10 E.) in the southwestern part of the Panhandle.

water is a serious obstacle to mining and a source of great expense in handling. As Brown[15] puts it: "Thus it will be seen that the moisture in lignite is a serious consideration, especially in transportation, for a large part of the expense of transportation is for hauling useless water." Furthermore, the high moisture content tends to hasten disintegration of the lignite in the open air, through evaporation and absorption, freezing and thawing and their resultant expansion and contraction, tearing the fibers apart and multiplying openings for the entrance of water and air.

Lignite does not resist handling well; hence it does not ship well; and, as indicated above, it weathers rather easily, which causes it to deteriorate in storage.

The nearness of the bituminous coal mines of Alabama was a factor which affected adversely the effort to utilize the Choctaw County lignite. Bituminous coal is a better fuel than lignite for almost all purposes; and, inasmuch as it can be delivered in eastern Mississippi at a cost little, if any, above that of lignite, it is always preferred. Moreover, coal transports well and stores well. Also, mining problems in the Alabama coal fields, in firm, indurated rock strata, were more easily solved than the mining problems of the adjoining lignite area. Establishing a market for the Mississippi lignite, then, was found to be a serious problem.

Labor is not likely to be enticed by a job which involves working in mud and water much of the time, in rooms so low that they hardly permit an upright position, and under a roof through which water drips constantly at certain times, and which may crack at any time or place.

Problems not related to geology and geography, but little less troublesome, confronted the Mississippi Oil and Gas Co-operative Joint Stock Company. One of these, which had a direct bearing on the marketing of lignite, was the adaptation of furnaces to the burning of lignite. For example, locomotives which had been built to use bituminous coal could not use lignite at all, because the strong draft through the fuel bed, necessary for the efficient burning of coal, lifted the lignite particles and carried them over the arch and out of the stack, showering sparks on the countryside. To avoid this, lignite-burning engines were fitted with various special accessories and were constructed on a somewhat different plan than that of the coal-burning locomotives. A fine netting, commonly a 7 x 7 mesh, was used in the front end of the locomotive, and as this reduced the opening available for draft, the front end was made larger in order to provide a greater netting area. Other devices were: A table grate in the fire-box; restriction of the air opening into the ash-pan to about 7 percent of the total grate area; a baffle door; or air tubes cut through the side sheets about 6 inches above normal fire level. In short, inasmuch as lignite has fewer heat units than bituminous coal, either more of it must be burned per square foot of grate, or the grate area must be increased in proportion to the heating surface. The better of the two is an increase of the grate area, but this is impracticable in converting existing types of locomotives from bituminous coal to lignite burners.[16]

In a few words, commercial exploitation of the lignite of Choctaw County has been found to be impracticable because of (1) adverse geological factors, including the nature and extent of the lignite itself, its stratigraphic position, and the lithology of associated beds; and (2) its geographical position, within a relatively short distance of one of the major bituminous coal fields. The economic factors concerned are outgrowths of the limitations imposed by nature. It would seem, then, that any general use of the Choctaw County lignite, or, indeed, of the Mississippi lignite, as a fuel in the near future, is highly improbable. Utilization on a commercial scale, if accomplished at all, most likely will be through the medium of values other than those related to direct use as fuel, such, for examples, as in the manufacture of producer gas, and in the manufacture of lightweight aggregate for concrete from associated underclays.[4]

Choctaw County probably contains more lignite than any other county of the state. The present survey found lignite in about 72 holes of the 332, and thicknesses ranging from a mere showing up to 8 feet. The Ackerman formation is especially rich in lignite, and the Holly Springs formation also includes several seams of this "brown coal." At least two mines were operated in Choctaw County many years ago by the Mississippi Oil and Gas Co-operative Joint Stock Company: the larger was an underground mine opening on the Illinois Central Railroad right-of-way a little northeast of Blantons Gap and 1 1/2 miles northeast of Ackerman; the other consisted of strippings in the vicinity of Reform, one of the largest being some 1/2 mile south of the Gulf, Mobile, & Ohio Railroad station at Reform, and now about midway between the railroad track on the east and U. S. Highway 15 on the west. In the underground mine the bed of lignite mined lay 124 feet below the mouth of the slope by which it was reached, and measured 3.5 to 4.0 feet thick above a floor of fire-clay. Another bed, 6.0 feet in thickness, was said to have been discovered by the prospect drill 40 feet below the bed mined, and a 7.0-foot bed 40 feet still deeper. A thin bed of impure lignite, associated with gray clay, formerly cropped out a little below the mouth of the slope, in the railroad cut. At the time of the writer's visit while the mine was in operation, the workings extended back under the hills several hundred feet. It was reported that the 7-foot bed of lignite had a floor of rock which could be used for grindstones or other abrasives, and a roof of clay. This lignite seam was said to consist of 2.0 feet of black lignite at the base, and 5.0 feet of brown lignite above.[16]

The strip mine excavations at Reform have been largely filled by caving and slope wash, but the largest is now a depression occupied by water, forming a deep pool. The depth of this pit could not be measured conveniently, but test hole K65, about 100 feet south of the lake and 16 feet above it, found lignite at 21.5 feet and passed through 8.0 feet of it; the pit must, then, have been at least 25.0 to 30.0 feet deep originally. The water-level in the test hole was 22.0 feet. A 29.0-foot hole a little farther south, on higher ground, failed to find lignite, and a third hole 150 yards southwest of the lake and 31.0 feet above lake level reached lignite at 34.0 feet and penetrated 7.0 feet of it. A test hole, 1/2 mile northeast of this lake and probably at least 25.0 feet above it, encountered lignitic clay or impure lignite at 31.0 feet, and passed through 9.0 feet of it; the water level here was only 14.0 feet. In short, prospecting by the mining company in the past and prospecting by the present survey have proved the existence at and near Reform of a large body of lignite. It appears to be thick and under relatively light overburden, at least under a small area, but the water-table is high. It is very favorably situated for mining, between a railroad and a paved highway and near a railroad station.

The Blantons Gap mine was well located also with respect to transportation facilities, for the lignite was loaded direct into railroad cars from a tipple at the mouth of the mine which was a slope having an angle of perhaps 10 degrees. The room-and-pillar system, the pick and shovel and blasting powder methods were followed; haulage was by mule in the mine, by steam drawn cable in the slope.

At a few other places along the railroads or main highways of the county topographic, stratigraphic, and ground water conditions are reasonably favorable for opening of the underlying lignite seam or seams. Test hole K19 (Sec. 22, T.19 N., R.11 E.) on the J. P. Brooks property, about 40 yards east of U. S. Highway 15 and 100 to 150 yards west of the Gulf, Mobile, & Ohio Railroad, reached a depth of 43 feet, passing through 7 feet of lignite under 20 feet of overburden. The hole was located on the summit of a rise which slopes gently northwards and southwards. No other boring was made near by, and for this reason not much information is available on the areal extent of the lignite; but the smut of the bed shows in gullies across the highway perhaps 100 yards northwest of the hole. Test hole K18, 1/2 mile north of K19, penetrated no lignite in a depth of 35 feet; and K32, about 1/2 mile still farther north, reached a depth of 49 feet and encountered no lignite. The lignite in K19 is overlain by 9.5 feet of dark-gray clay and underlain by 5.0 feet of green clay. Water was encountered at 21.0 feet, but it was not excessive, and probably, the topography being what it is, could be drained off rather easily. A considerable area here has an elevation as great as that of the test hole (520 feet); the lignite bed probably underlies this area at a depth of 20 to 25 feet. The Brooks property is some 2 miles south of Mathiston and a mile north of Sherwood.

Test hole K68 (Sec. 7, T.17 N., R.11 E.) about 2 miles north of Ackerman, behind the E. M. McGovern house west of Highway 15 and east of the Gulf, Mobile, & Ohio Railroad, encountered lignite at 35 feet and passed through 5 feet of it. The site of this hole is too close to the McGovern house and to the highway for any working of the lignite, and the overburden is too great; but a short distance farther south are open fields on both sides of the highway, and the overburden is much less. This is a possible development site, in case the lignite bed maintains the test hole thickness under a sufficient area.

Lignite was found by several test holes along Highway 12 and the Illinois Central Railroad east and northeast of Ackerman. Test hole K4, a little more than a mile northeast of the town limits, passed through two beds of lignite and four beds of dark-gray and black lignitic clay. The upper lignite bed, 3.7 feet thick, was encountered at 14.3 feet; the lower, which was only 2.0 feet thick, at 27.0 feet. The upper bed might be worked here over a relatively small area. Other holes in the railroad and highway belt penetrated two or three seams of lignite, but in general these beds were thin. A hole 1/2 mile northwest of Fulcher, on the north side of Highway 12, passed through a 1.5-foot bed beneath 17.0 feet of overburden, and a 2.5-foot bed 17.5 feet deeper. A hole some 1/3 mile farther northwest at about the same elevation found 2.0 feet of lignite beneath 24.0 feet of sand and clay. A test hole on the south side of the railroad 200 to 300 yards east of Fulcher entered impure lignite at 21 feet and penetrated 8 feet of it. Test hole K94, on the north side of Highway 12 about a mile east of Fulcher, encountered 2.5 feet of lignite in two thin layers at depths of 12.5 and 22.5 feet; nearby holes (K1, K2) failed to encounter these seams.

Borings near the mouth of the old lignite mine (Sec. 21, T.17 N., R.11 E., NE. 1/4) penetrated low-grade lignite. Hole K6, a little south of the mine site, passed through a 5-foot bed encountered at 10 feet; Hole K48, about the same distance north of the mine site, penetrated two beds of brown to black lignitic clay. A hole 1/3 mile south of K6 encountered 2.3 feet of lignite, and another 1/2 mile north of K48 passed through only a 1.0-foot seam. From the data provided by these test holes it would seem that little if any mineable lignite lies within easy reach of the surface in this region.

At least three separate and distinct seams of lignite were discovered by test holes in the Lake Choctaw district (Secs. 2, 3, 10, 11, T.16 N., R.11 E.), including one seam of workable thickness. The data on lignite for this area are tabulated below:

Hole	Relative location	Lignite thickness	Overburden	Number seams
K7	3/4 mile east of Lake Choctaw	5.5	17.0	1
K8	3/4 mile east of Lake Choctaw	4.5	25.0	2
K9	3/4 mile east by south of Lake Choctaw	5.0	28.0	1
K10	250 yards south of Lake Choctaw	10.0	25.5	4
K11	South end of Lake Choctaw	9.5	15.0	3
K55	1/2 mile southeast of Lake Choctaw	8.5	33.0	2
K63	1/2 mile east of Lake Choctaw	7.5	18.5	2
K88	1/8 mile north of Lake Choctaw	6.5	8.5	3
K93	1/4 mile south of Lake Choctaw	4.0	32.0	2
K113	3/4 mile northwest of Lake Choctaw	5.0	7.5	1
B18	1/2 mile south of Lake Choctaw	0.5	22.5	1
Br13	2/10 mile south of Lake Choctaw	2.0	22.5	1
J1	1/2 mile northeast of Lake Choctaw	2.5	10.0	1
Mi3	200 yards south of gate to lake grounds	5.0	16.0	3
Mi32	1/2 mile south of Lake Choctaw	1.0	15.5	2

Lignite or lignite smut shows in many places in the Holly Springs outcrop area; a few of the more prominent may be mentioned. At Chester lignite crops out in a spring below the McWhirter house at the base of the wall of the deep valley of a tributary of Little Bywy. Brown[15] mentions lignite having a thickness of 20 to 22 inches in a spring just below the jail at Chester, which may be the same as that at the McWhirter place. He adds at least three other exposures in Chester. Six to 8 miles north by west of Ackerman, a little lignite shows in the walls of cuts for Highway 9; and in the western part of the Panhandle, in Lignite Spring (Figure 15). Of the numerous test holes in the Holly Springs area, 27 encountered lignite; several found two beds. The greatest thicknesses logged were 5 and 7 feet, but in three or four holes which recorded thicknesses of 3 feet or more the lignite possibly was Ackerman, and in the logs of some other holes no doubt some lignitic clay was described as lignite. In most cases thicknesses of 1.0 foot to 2.5 feet were found. The writer believes that the conclusion could safely be reached that few, if any, beds of lignite of workable thickness are likely to be found in the Holly Springs formation of Choctaw County.

Fantastic reports of great thicknesses of lignite in Choctaw County have been circulated from time to time. A typical story is that of the water well on the property of Mrs. Emma Tedder, which well was reported to have encountered lignite at 30 feet and to have been dug through 60 feet of good, dry lignite and abandoned, still in lignite. Needless to say, the existence of such great bodies of lignite in this region is very much open to question; the numerous test holes by the present survey failed to even suggest such a thickness, and the writer has heard of no well or drill-hole in the State of Mississippi which discovered such a huge deposit. It is likely that such stories originate from the discovery of considerable thicknesses of lignitic clay or impure lignite.

SAND AND SANDSTONE

That sand is very abundant in Choctaw County will be obvious to anyone who travels through the county or any part of it. Road cuts and railroad cuts, almost without exception, have exposed thicknesses of sand, commonly ferruginous, and erosion channels are in nearly all cases walled in large part by sand. Every formation which crops out contains abundant sand, aggregated in large and small units and disseminated through units composed predominantly of other kinds of materials. The fineness ranges from very coarse, approaching grit, to extremely fine, but fine to medium comprises the larger proportion. The sand of all formations is featured by a great diversity of color: White, reds, yellows, and browns, black, blue, green, pink, and purple, and several other subordinate colors. As stated in the discussion of stratigraphy, the Holly Springs formation includes the largest bodies of sand, but the basal members of the

Ackerman and the Meridian sand of the Tallahatta are important. During highway construction several pits were dug in the Holly Springs beds to obtain sand for use in paving. Pits are located here and there along the main highways, particularly along Highways 15 and 12. The largest pit in the county is in the eastern part of Section 4, Township 17 North, Range 10 East, 3/4 mile or so northwest of Chester, on the property of Mr. W. A. King; but another large pit is

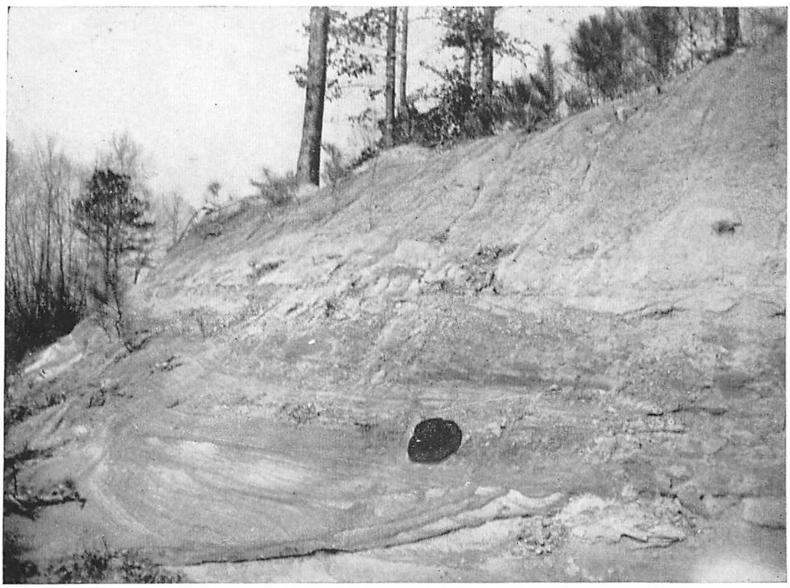

Figure 16.—Ackerman cross-laminated sand, pit in the east wall of the cut for Highway 15, 2 miles north of Reform. February 19, 1943.

on the west side of Highway 15 about 5 miles south of Ackerman, just across the highway from Five Mile Spring (SW. corner Sec. 15, T.16 N., R.11 E.), and a third on the east side of the highway a mile south of the second named. A fourth large pit is on the north side of Highway 12, 1/4 mile east of Fulcher, and another on the east side of Highway 15 about 2 miles north of Reform (Figure 16). The two pits last named are in the Ackerman formation. The pit on the King property is at least 60 feet deep, and except for a few pockets the sand is strongly colored by iron oxide. The highway department paid the owner a cent and a half per cubic yard by weight (approximately 2700 pounds) for this sand; and hauled it in dump trucks each of which was supposed to have a capacity of 4 cubic yards. (Mr. King said no truck ever carried less than its capacity.) The sand was transported to the mixing plant at Ackerman (Figure 17) where it was dumped within reach of a chain of buckets which lifted it into a large rotating steel cylinder heated to 350 degrees or more by a crude oil flame blown into it by a fan. For the lower course of pavement

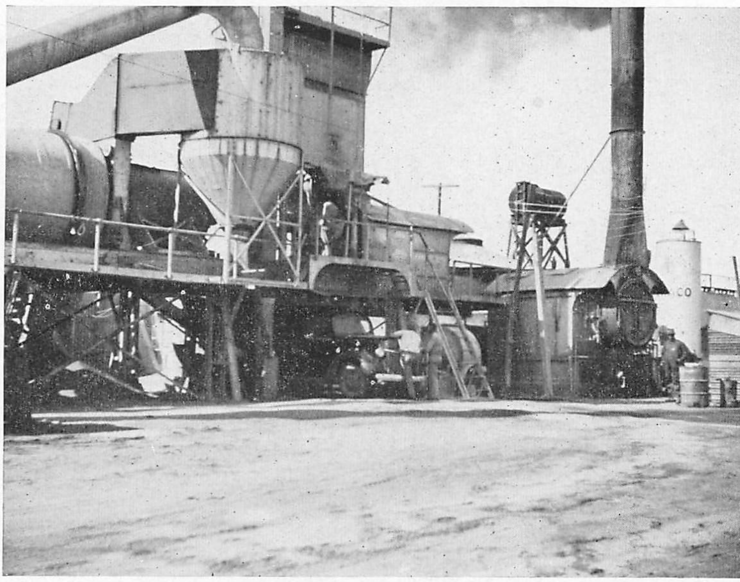

Figure 17.—Mississippi State Highway Department road metal mixing plant at Ackerman. October 19, 1940.

the sand and clay-lime-asphalt ratio was 2252-50-198; for the upper course, 2030-250-220. The sand was heated to 350 degrees and the asphalt to 300 degrees; the lime was added at air temperature.

Sand for all the common uses, such as for building and paving, is available in unlimited quantities in Choctaw County.

Lowe[6] states, referring to the Holly Springs formation: "The sand of this formation furnishes excellent building material along most of the outcrop, the coarse sand especially being admirably adapted to the making of mortar and concrete. In some localities the sand is useful in road making. In many places where it contains a proper admixture of clay and iron it makes an excellent molding sand," but no sand was discovered which would be suitable for the manufacture of high-grade glass; the percentages of iron oxide and carbonaceous matter and mica are too high. The quantity of white sand relatively is small, and even that which appears white no doubt contains a considerable percentage of unoxidized iron; moreover, nearly all of it is micaceous or clayey or both. In the western part of the county white sand is exposed in some places, notably in the walls of cuts for the Natchez Trace, and several holes penetrated strata of white sand. Test hole K114 (Sec. 26, T.18 N., R.8 E.) penetrated 21 feet into a body of "white sand with yellow streaks," encountered at 14 feet; but did not reach the bottom of it; K118 (Sec. 1, T.17 N., R.8 E.), about 4 miles south by east of K114, also logged 21 feet of white sand, the top of which was reached at 12 feet, but did not pass entirely through it; and a test hole some 2 1/2 miles south by east of K118 (Sec. 30, T.17 N., R.9 E.) encountered at 5 feet a body of "white, yellow, and pink sand" which the auger penetrated 19 feet but did not pass entirely through. Still another test hole, less than 1/4 mile north of the last mentioned, penetrated from the surface 26 feet of "pink and yellow streaked sand," of which it failed to reach the bottom.

The white sand referred to above may belong to the Meridian sand member of the Tallahatta formation, as may also a large quartzite bowlder found a short distance from the southernmost of the test holes, which is about 1/2 mile northeast of French Camp.

Sand is very noticeable along the water-courses, where in places large quantities have been accumulated. Commonly the alluvial sand has been leached of the iron oxide or carbonaceous stain and is light-gray to white of color, but is micaceous in varying degrees. This channel or flood-plain sand has fewer impurities than the sand direct from the formations, but no doubt would require further washing before use for any purpose except possibly for building or paving. No test holes were bored in any of the stream flats, but in view of sand accumulations in the channels and the nature of the processes of alluvial deposition, large bodies of relatively pure sand could be expected to be beneath the flood-plains.

The sandstone of Choctaw County is almost entirely ferruginous and was formed by local cementation of sand in the original sand bodies. Field evidence indicates that the cementation was effected by water carrying mineral matter, especially iron and silica, in solution percolating downwards and laterally and in some cases upwards through the sand, wherever openings were available. Variation of conditions, such as evaporation or temperature or pressure or velocity or mingling of solutions of different chemical character, caused a precipitation of some of the mineral matter from solution and a filling of the interstices between the grains of sand. A common stratigraphic position is directly above the contact of a sand bed with underlying clay, because here the descent of the aqueous solutions is checked by impervious material. The sandstone units, as would be anticipated from their mode of origin, are of very irregular shapes and divers sizes, and exhibit considerable diversity of orientation with relation to structural features although in general cementation follows bedding and lamination planes. Very large masses lie near the base of the Holly Springs formation at the top of the Blantons Gap section; also in the Ackerman sands, especially in the Illinois Central Railroad cuts west of Fulcher, where heavy slabs of this type of rock project from the face of the exposure or lie where they have fallen at its base. Accumulations of ferruginous sandstone retard erosion and lead to the development of very high hills by protecting underlying material and determining the direction of drainage. Most of the notable elevations of the county are capped by this sandstone: Williams Hill and others of the Noxubee Hills are outstanding examples in the eastern part of the county, and the Ironstone Hills in the western part of the Panhandle owe their name to their content of ferruginous rock. In short, ferruginous sandstone, ranging in thickness from very thin plates to masses several feet thick, is very abundant in Choctaw County. It has little economic value, but could have more if it were used to the fullest extent possible. At present its uses are confined to building of chimneys, foundations, well curbs, walks, retaining walls, etc. (Figure 18), on a small scale, and to metaling of stretches of local road. Although it is not an ideal building stone, because of its extreme irregularity of surface and shape of the individual masses and its lack of uniformity of cementation, this rock could be utilized for the construction of entire buildings just as well as for the building of chimneys, provided a really good mortar were used rather than the kind of material which in too many cases is made to serve on chimneys in the rural communities. The ferruginous sandstone and clay ironstone are hard to shape, but inasmuch as many present-day stone buildings are put together of pieces of various shapes and sizes, difficulty of working would not seem to bar the sand rock in question as building material. It is not a particularly attractive rock per se, either, but it fits in well with rural scenery, especially in a region of brown, red, and yellow sands; besides, certain advantages it possesses offset, at least in part, its lack of beauty. It is durable, fire-proof, requires no treatment to protect it from the weather or from insects, shuts out both cold and heat more efficiently than wood does, and needs little or no repairs. The observation may be made here, very pertinently, too, in connection with the subject of living quarters in Choctaw and many other counties of Mississippi,

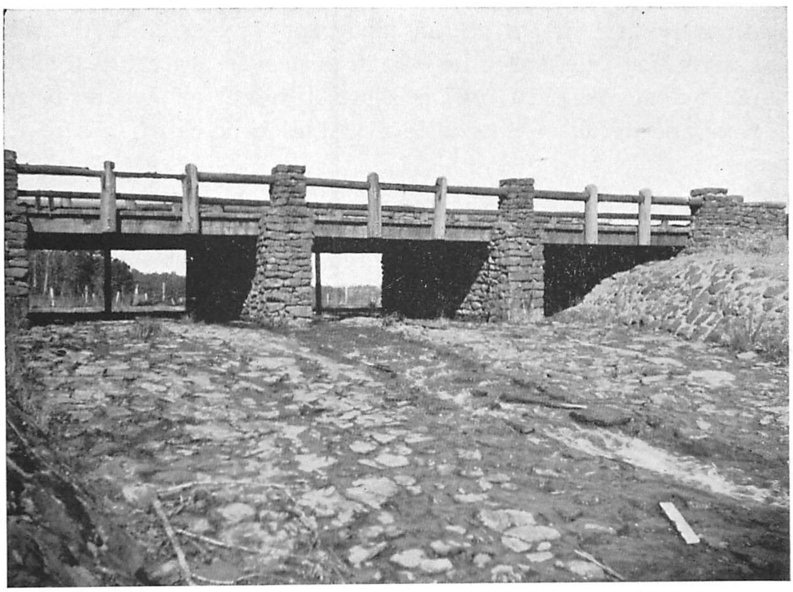

Figure 18.—Highway bridge and spillway at the southeast end of Lake Choctaw; native rock used for bridge piers and spillway floor. February 12, 1943.

that almost any other sort of structure would be more attractive than that now serving as home for thousands of people. In any event, the main building and pavement and stairways at Lake Choctaw are excellent examples of what may be done with this local rock. No one will refuse to admit that the impression is very pleasing. A fact which thrusts itself upon the attention of any observing person who enters Choctaw County (and the same could be truthfully said of many other counties of Mississippi) is, that the forests, which in years past have provided fuel and housing and numerous other necessities for the people, have been depleted almost to the point of utter destruction. Of necessity, then, some substitute must be found soon. To the problem of building material, natural rock, brick, tile, and concrete are the logical answers, and these should be drawn from the concerned community itself, as far as possible. As stated elsewhere, Choctaw County has abundant clays suitable for the manufacture of brick and tile. The natural rock is not ideal, but can be used to advantage on a much larger scale than at present. Certain obstacles will have to be overcome, of course: Obstacles created by the characteristics of the rock itself, as already mentioned; the remoteness of much of the rock from main routes of travel and transportation; the roughness of the topography where it is, and the relatively great elevation of most of it. However, a great deal of this sandrock could be used within short distances of where it was quarried, and because of its wide distribution much of it is readily accessible.

OIL AND GAS

Choctaw County has been explored more or less thoroughly by oil men, but no drilling has been done. On January 3, 1940, the Joe G. Strahan Ballard No. 1 (Sec. 8, T.18 N., R.10 E., SE. 1/4, SE. 1/4) was spudded in on a 10,000-acre block, but shut down almost immediately.

The structure as indicated by surface evidence has been discussed in this paper, as has the stratigraphy above the Midway-Wilcox contact. At greater depths the Eutaw and Tuscaloosa formations are possible oil and gas reservoirs, and even the Paleozoic, provided a suitable structure is present. The writer believes that an intensive study of the Choctaw County region, more especially the eastern part, should be made, with a view to determine, if possible, whether or not conditions favorable for the accumulation of oil and gas exist. Also, a known structure in Montgomery County may extend beneath the western part of Choctaw. An instrumental survey of the whole of Choctaw should supplement the surface work. No recommendation of a drilling-site can be made intelligently unless and until much more field work has been done and a larger body of data accumulated.

WATER

Choctaw County has an abundant water supply, most of which for domestic use is drawn from wells of relatively shallow depth—less than 100 feet. Although sufficient water for farm use is obtained from wells in all parts of the county, the Holly Springs sand yields the best water and the most copious flow. Conditions are favorable for flowing wells in the northwestern part of the area, but no flowing well has been reported. Springs are numerous, also, especially in the Holly Springs outcrop belt; most of them have a small to moderate flow of 2 to 4 gallons a minute. Williams Spring, Lignite Spring, and Five Mile Spring which have been mentioned (Figures 6, 15) are typical. Much of the water, especially from the Ackerman formation, is highly mineralized, and, for this reason, has been thought to have medicinal properties. Red Springs, in the northwestern part of the county, is a good example; at one time it was developed as a local resort, and the "mineral water" was bottled and sold.[8] No doubt its odor and taste were sufficiently unpleasant to establish its efficacy as a medicine and insure at least a limited sale.

The water supply of the towns and villages is obtained from wells, although many years ago Ackerman was supplied by a group of springs. Attempts to get adequate water by deep wells were at first unsuccessful: the first well reached a depth of 300 to 400 feet; the second was abandoned at 1106 feet. Another, drilled to a depth of 375 feet, filled with water to within 12 feet of the surface. It is improbable that any aquifer capable of providing an adequate water supply for the town underlies this region above the Eutaw formation, which might be reached at 1,600 to 1,800 feet.[8]

In the following table, analysis No. 3 is that of water from the 375-foot well, probably from the Porters Creek. Analysis No. 1 shows the mineral matter in water from a spring on the property of T. L. Griffin at Reform; No. 2, from one of the springs which formerly furnished the water for Ackerman:

MINERAL ANALYSES OF GROUND WATERS FROM CHOCTAW COUNTY[8]
(PARTS PER MILLION)

	1	2	3
Silica (SiO_2)	38.0	11.0	29.0
Iron (Fe)	3.8	0.9	14.0a
Calcium (Ca)	13.0	5.2	11.0
Magnesium (Mg)	5.2	0.9	8.1
Sodium and Potassium (Na plus K)	14.0	4.5	Na 32.0
			K 4.9
Carbonate radicle (CO_3)	0.0	0.0	0.0
Bicarbonate radicle (HCO_3)	62.0	20.0	154.0

Sulphate radicle (SO_4)	21.0	3.1	2.3
Chloride radicle (Cl)	7.0	6.0	6.1
Nitrate radicle (NO_3)	0.7	0.0	-------
Phosphate radicle (PO_4)	-------	-------	0.9
Total dissolved solids at 180° C	129.0	39.0	184.0b
Total hardness as $CaCO_3$ (calculated)	54.0	17.0	61.0
Date of collection	April, 1914	May, 1914	-------

a Iron and aluminum oxides (Fe_2O_3 plus Al_2O_3). b Calculated.

Analysts: 1. Mississippi State Chemical Laboratory; 2. W. F. Hand, Mississippi State Chemical Laboratory; 3. W. R. Perkins, Mississippi State Chemical Laboratory.

SOIL

The average soil is a mixture of mineral substances chiefly and organic substances secondarily. Obviously the mineral matter is derived from pre-existing country rock, in situ, if the soil is residual, or from rock in the same region or a more or less distant region, if the soil is transported. It might reasonably be expected, then, that the mineral composition of any soil would correspond more or less closely with the mineral content of the rock type or types from which the soil was derived; but the degree of closeness of this correspondence is intimately related not only to the character of the parent rock but to the history of the soil. That is, if the soil originated by mechanical weathering chiefly, its minerals should be almost identical with those of the parent rock; but if chemical weathering were the leading process and had operated over a considerable period, the soil minerals commonly would be fewer, and possibly some of them of different identity, than those of the source rock. The same would be true of the chemical constituents: the soluble substances would be entirely or almost leached out, and the final product, the soil, would be composed in the main of the insoluble or difficultly soluble mineral matter. Due to such processes, all soils tend to become very much alike both mineralogically and chemically in course of time.

The mineral part of the soils of Choctaw County unquestionably was derived from country rock similar to that which now underlies the surface. As has been stated, the country rock is sand, silt, and clay almost entirely. All the soils, likewise, are mixtures of sand, clay, and silt. The report of the U. S. Department of Agriculture Bureau of Soils Soil Survey of Choctaw County[2] lists sixteen soil types, including fine sand, fine sandy loam, very fine sandy loam, silt loam, silty clay loam, and clay. The map which accompanies the report shows that these types are scattered widely over the area in a jigsaw puzzle pattern as small patches of very irregular outline; no one type appears to be restricted to any certain part of the county, even in a general way; but the largest continuous tracts of any one type are Collins silt loam and silty clay loam, alluvial soils blanketing the flood-plain belts of the main streams. The very complex pattern of soil areas is largely due, no doubt, to the considerable shifting about of the materials, resulting from hilly topography in a region of heavy rainfall. From the map no system of areal grouping of soil types is obvious, but the writers of the report recognize "three well-defined soil divisions: (1) Upland, or old sedimentary and loessial soils; (2) old stream alluvium, the terrace or second bottom soils lying above normal overflow; (3) recent stream alluvium or bottoms subject to overflow."[2] That is, the areal grouping of the soil types is topographic rather than geographic.

The Brown Loam soil, derived from the thin eastward extension of the Pleistocene Loess, which is well developed along the east wall of the Mississippi River trench, covers about one-fifth of Choctaw County, where it is represented by the Pheba silt loam. It is said to give "marked variability to the soils of the county," and to be one of the most extensive soil types and "the most important agricultural soil of the county." This Pheba silt loam is one of the four leading soil types which occupy two-thirds to three-fourths of the area of the county.

In Choctaw County, as in most, if not all, of the other counties of the state, the soil continues to be the most valuable mineral resource, because it yields direct the fundamental necessity of life-food. Furthermore, its value can be made available at less expense and in a shorter period than that of any other mineral resource; its exploitation requires no special technology or specialized machinery, although these are of very material assistance; and some kind of return can in most cases be counted on. For all that, soil minerals can be destroyed and lost through unintelligent working of the soil and absence of a plan for conservation; in many places they have been lost, and there we may see what utter desolation looks like. No abandoned mining districts and their "ghost towns," melancholy as they may be, can impress us with such a feeling of irreparable loss as can a once prosperous agricultural region now denuded of its soil.

IRON ORE

The description of the strata includes statements concerning masses of limonite and siderite of various shapes but most commonly flatish ellipsoidal or discoidal or lenticular, which are enclosed by the beds or laminae of clay or silt. These flat-lying masses are aggregated as discontinuous layers; that is, although each individual mass is separated from the others, all in a series or bed are strung along the same stratigraphic level. Most of them were originally siderite but have been oxidized almost completely to silty limonite. A bed of this ore may lens out in a short distance or may be fairly persistent. A number of such beds are included in the Porters Creek, Ackerman, and Holly Springs formations; in general the individual masses are small, but some measure 3.0 feet in length, and 1.0 to 1.5 feet in diameter. Several outcrops of this iron ore were located in the discussion of the stratigraphy; the most prominent ore (a) east of Reform about 2 miles, in the east wall of the valley of King Creek (Sec. 15, T.18 N., R.11 E.); (b) in the walls of Blantons Gap (Sec. 21, T.17 N., R.11 E.); (c) in a shallow cut for the Weir-French Camp road a mile or more east of French Camp (Figure 12), (Sec. 32, T.17 N., R.9 E.); (d) in a roadside gully at the north end of the Ironstone Hills, in the western part of the Panhandle (Sec. 7, T.15 N., R.10 E.). That the ore is concretionary appears proved by the relationships of the individual masses to the enclosing beds, and by the behavior of the masses under weathering. In some cases the laminae of the containing beds were seen to be bent around the ore body, as if the latter had grown in its present position by successive additions; and weathered masses had broken down into a heap of shells. Moreover, when one of these partly oxidized lumps was broken with the hammer, commonly it separated into concentric shells. Some of the masses had a little siderite in their centers, and some had very resistant cores. The breaking down into shells probably is a process of exfoliation, caused by differential expansion and contraction induced by unequal temperature changes and wetting and drying.

Although this iron ore is somewhat silty, much of it is of good quality, and the total tonnage is considerable. The major beds are so thin, however, so far apart stratigraphically and geographically, and in many places under such heavy overburden, that mining them is impracticable. Here, too, as with the lignite and the Alabama coal, the proximity of the thick hematite beds of Alabama would severely handicap any effort at development, unless a demand could be established for the Mississippi ore for mixing with the Alabama ore. Many years ago a little of the ore from Benton County, almost identical with the Choctaw County ore, was used with the red hematite at Birmingham and was said to have improved the grade of steel.[17] The slight manganese content of iron carbonate suggests that the carbonate ore would be of value for the manufacture of high-grade steel. Another possible use is for the preparation of paint pigment. The George S. Mephan Company, of East St. Louis, has used large quantities of the Benton County ore for this purpose.[4]

No analyses of the Choctaw County ore are at hand, but the Benton and Marshall County ores of the same type contained 45 percent to 50 percent of metallic iron, and some samples contained a considerable percentage of manganese. In general they ran high in silica and low in phosphorus.

MISCELLANEOUS MINERALS

Small quantities of several mineral species are disseminated through the strata: calcite, selenite, marcasite, pyrite, glauconite, hematite, and perhaps others. Selenite is a form of glassy crystallized gypsum ($CaSO_4.2H_2O$) which in some places is abundant in the gray clays of the Ackerman formation. Marcasite, associated with a little pyrite, is very common in the lignitic clays and lignites, appearing as concretions, veins, coatings and replacements, or disseminated as small grains. Marcasite and pyrite have been referred to as "fool's silver" and "fool's gold," because of their superficial resemblance to silver and gold, and because they have deceived many people into mistaking them for those precious metals. Glauconite is a hydrous silicate of potash and iron which is scattered through some sands, silts, and clays, chiefly as small grains. Hematite, the ferric oxide, colors the rock materials red in many places, but is present only in relatively small quantities. In fact, none of the minerals named above is of any value in Choctaw County.

TEST HOLE RECORDS

Charles Stacey Property

Test Hole K1

Location: T.17 N., R.11 E., Sec. 14, eastern part; 30 ft. north of Highway 12. 0.3 mile southwest of the Charles Stacey house, 500 ft. north of Illinois Central Railroad

Drilled: January 3, 4, 1941

Elevation: About 430 ft. Water level: 42 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	4.0	4.0	Clay, brown and gray sandy; Sample 1
2	16.0	12.0	Clay, yellow and gray; contains fine sand; Sample 2
3	25.5	9.5	Sand, gray very fine; silty or argillaceous
4	34.0	8.5	Clay, light-gray, with some fine sand; Sample 3
5	44.0	10.0	Sand, yellow very fine micaceous; contains some thin iron-cemented fragments; sand grains angular

Ted Hunt Property

Test Hole K4

Location: T.17 N., R.11 E., Sec. 16, central part; 250 yds. northeast of the Ted Hunt house, 50 ft. on north side of Highway 12

Drilled: November 6, 7, 8, 9, 12, 1940

Elevation: About 475 ft. Water level: 14 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
0	0.5	0.5	Soil
			Ackerman formation
1	7.0	6.5	Sand, brown
2	11.5	4.5	Sand, yellow
3	12.5	1.0	Clay, gray very plastic
4	14.3	1.8	Clay, lignitic very sandy
5	18.0	3.7	Lignite
6	23.7	5.7	Clay, dark-gray; dries light-gray; contains a little very fine sand; Sample 1
7	27.0	3.3	Sand, light-gray, with clay
8	29.0	2.0	Lignite
9	38.0	9.0	Clay, dark-gray; dries light-gray; contains fine sand; about same as 5.7 interval above; Sample 2
10	41.0	3.0	Clay-shale, dark-gray

ILLINOIS CENTRAL RAILROAD COMPANY PROPERTY

TEST HOLE K6

Location: T.17 N., R.11 E., Sec. 21, NE.1/4; 100 ft. east of railroad, 500 ft. south of lignite pit

Drilled:

Elevation: 530 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	7.2	7.2	Clay, red; Sample 1
2	10.0	2.8	Sand, gray, with some clay; silty
3	15.0	5.0	Lignite, clayey; Sample 2
4	18.5	3.5	Clay, light-gray
5	28.0	9.5	Sand, yellow

U. S. GOVERNMENT PROPERTY

TEST HOLE K7

Location: T.16 N., R.11 E., Sec. 2, NE. 1/4; Webster road on east side, 20 yds. from Ida Jackson house Drilled: November 16, 18, 1940

Elevation: ± 575 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Ackerman formation
2	3.5	2.5	Clay, brown
3	10.5	7.0	Sand, light-gray very fine rust-spotted; Sample 1
4	17.0	6.5	Clay, dark-gray; dries light-gray; silty; Sample 2
5	22.5	5.5	Lignite, silty sandy
6	30.7	8.2	Clay, dark-gray; iron carbonate seams; Sample 3
7	35.9	5.2	Clay, light-gray
8	40.9	5.0	Clay, green, with sand; chiefly clayey sand; Sample 4

U. S. GOVERNMENT LAKE CHOCTAW PROPERTY

TEST HOLE K11

Location: T.16 N., R.11 E., Sec. 11, NW. 1/4; 100 yds. south of east end of lake (spillway), west side of road

Drilled: December 2, 3, 4, 1940

Elevation: ± 564 ft.

Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	3.0	3.0	Sand, light-brown silty micaceous very fine
2	6.7	3.7	Clay, light-gray micaceous yellow rust-spotted silty
3	12.0	5.3	Sand, yellow to brown micaceous very fine; contains rust-cemented lumps
4	15.0	3.0	Clay, light-gray to light-brown somewhat rusty; contains very fine sand
5	18.0	3.0	Lignite
6	30.5	12.5	Clay, very light-gray; Sample 1
7	34.0	3.5	Lignite
8	38.0	4.0	Clay, light-gray lignitic; contains very fine sand; Sample 2
9	41.0	3.0	Lignite
10	57.0	16.0	Clay, gray very sandy; sand very fine; Sample 3

U. S. GOVERNMENT LAKE CHOCTAW PROPERTY

TEST HOLE K12

Location: T.16 N., R.11 E., Sec. 4, SE. 1/4; 375 feet east of new Highway 15, 75 ft. east of old Highway 15 at Lake Choctaw and old Highway 15 road junction

Drilled: December 6, 11, 1940

Elevation: 620 ft. ?

Water level: 30 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	13.0	13.0	Sand, red-brown medium non-micaceous
2	20.3	7.3	Sand, light-yellow to light-brown fine micaceous
3	26.0	5.7	Sand, yellow and light-gray very fine; Sample 1
			Ackerman formation
4	40.0	14.0	Clay, gray rusty; mixed with fine sand; Sample 2

R. E. NASON PROPERTY

TEST HOLE K13

Location: T.17 N., R.11 E., Sec. 30, SE. 1/4; in Ackerman, 0.75 mile west of Court House, 200 ft. south of McGee and Thompson road; southwest of R. E. Nason rent house

Drilled: November 13, 1940

Elevation: 592 ft. Water level: 40 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	4.0	4.0	Sand, red-brown fine to medium non-micaceous; Sample 1
2	29.0	25.0	Pipe clay, gray and red streaked; contains a little fine sand; Sample 2
3	48.5	19.5	Sand, fine light-gray somewhat rusty silty
4	53.0	4.5	Sand, light-gray very fine somewhat rusty

W. E. KILPATRICK PROPERTY

TEST HOLE K16

Location: T.17 N., R.11 E., Sec. 7, NE. 1/4; 0.1 mile northeast of the Kilpatrick house, 50 ft. north of Highway 15; west of culvert

Drilled: December 16, 17, 1940

Elevation: ± 575 ft. Water level: 35 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	4.0	4.0	Clay, red streaked sandy; Sample 1
2	12.5	8.5	Clay, light-brownish gray; contains fine sand; Sample 2
3	27.0	14.5	Sand, light-yellow to light-brown, a little rusty, very fine
4	29.0	2.0	Lignite, dark-brown to black
5	36.0	7.0	Clay, light-gray; Sample 3
6	38.0	2.0	Sand, green; water

EDGAR PIERCE PROPERTY

TEST HOLE K18

Location: T.19 N., R.11 E., Sec. 15, southern part; 100 ft. west of Gulf, Mobile, & Ohio Railroad at mile post 253; 500 ft. east of U. S. Highway 15

Drilled: December 26, 1940

Elevation: 496 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	9.0	9.0	Clay, brown and gray streaked; contains fine sand; Sample 1
2	18.5	9.5	Clay, gray
3	35.0	16.5	Sand, light-gray very fine shaly; Sample 2

W. H. McINTYRE PROPERTY

TEST HOLE K21

Location: T.17 N., R.10 E., Sec. 5, NW. 1/4; 0.2 mile south of the W. H. McIntyre house, 150 ft. west of road near road junction

Drilled: October 18, 1940

Elevation: Water level: 25 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	15.0	15.0	Clay, brown and gray streaked; contains abundance of fine sand; Sample 1
2	18.0	3.0	Sand, yellow
3	29.0	11.0	Sand, brown medium angular silty
4	55.0	26.0	Clay, gray sandy; sand fine to medium; Sample 2

C. Busby Property

Test Hole K26

Location: T.18 N., R.10 E., Sec. 13, NW. 1/4; on west side of Reform and Webster road, 3.4 miles west of Highway 15

Drilled: January 22, 23, 1941

Elevation: ± 470 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Holly Springs formation
2	4.0	3.0	Sand, brown and gray silty
3	14.0	10.0	Clay, light-gray somewhat rusty; contains fine sand; Sample 1
4	17.0	3.0	Sand, gray to light-brown, with iron streaks and clay; very fine
5	19.0	2.0	Clay, light-gray to light-brown rusty
			Ackerman formation?
6	23.7	4.7	Clay, dark-brown lignitic shaly
7	29.0	5.3	Clay, dark-gray with sand; dries light-gray
8	32.0	3.0	Sand, dark-brown silty

Buck Clark Estate Property

Test Hole K33

Location: T.17 N., R.11 E., Sec. 14, west-central part; 50 ft. north of old Highway 12, on top of hill 0.25 mile southeast of the Clark house

Drilled: December 31, 1940

Elevation: ± 460 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Ackerman formation
1	8.0	8.0	Clay, gray and rusty brown sandy; Sample 1
2	25.0	17.0	Clay, light-gray sandy; Sample 2

BEDFORD HUFFMAN PROPERTY

TEST HOLE K34

Location: T.17 N., R.8 E., Sec. 36, SW. 1/4; 240 ft. south of Poplar Creek and French Camp road, in front of the D. A. Edwards house and 500 ft. south of it

Drilled: January 6, 1941

Elevation: Water level: 36 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Tallahatta formation, Meridian member
1	9.0	9.0	Sand, yellow to brown very micaceous; contains lumps of rust-cemented sand; evidences of laminae
2	17.8	8.8	Sand, brown, with some clay; very micaceous
			Holly Springs formation
3	21.0	3.2	Clay, brownish-gray; contains much fine sand; Sample 1
4	32.0	11.0	Clay, light-gray, changing to dark-brown; sandy; sand very fine; Sample 2
5	40.0	8.0	Clay, dark-gray, with some sand

MRS. LUCY DRAIN ESTATE PROPERTY

TEST HOLE K36

Location: T.17 N., R.8 E., Sec. 25, NE. 1/4; 0.1 mile west of the R. M. Downing house, 900 ft. south of the J. B. Ward house, 10 ft. west of highway

Drilled: January 10, 1941

Elevation: Water level: 41 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Tallahatta formation, Meridian member
1	13.0	13.0	Sand, dull white clayey fine, rust-stained; Sample 1
2	31.5	18.5	Sand, brownish-gray clayey
3	41.0	9.5	Sand, light-gray silty; Sample 2
4	45.0	4.0	Sand, white; water

D. V. PARTRIDGE PROPERTY

TEST HOLE K37

Location: T.17 N., R.8 E., Sec. 24, western part; 500 ft. west of dwelling, 100 ft. west of Poplar Creek road, southeast of Elkins Creek

Drilled: January 14, 1941

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Tallahatta formation, Meridian member
1	4.0	4.0	Sand, rust-brown, and some gray
2	12.8	8.8	Clay, light-gray rust streaked; Sample 1
3	25.0	12.2	Sand, light-brown rusty somewhat micaceous

A. D. MCADAMS PROPERTY

TEST HOLE K40

Location: T.18 N., R.11 E., Sec. 18, NW. 1/4; 500 ft. southwest of dwelling, 800 ft. east of Meek Busby house, 300 ft. south of Reform and Antioch road

Drilled: January 22, 1941

Elevation: ± 460 ft.

Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	12.0	12.0	Clay, gray, with some sand; Sample 1
2	17.2	5.2	Sand, yellow; many rusty lumps
			Ackerman formation
3	28.0	10.8	Sand, brown lignitic clayey
4	29.5	1.5	Lignite
5	40.0	10.5	Sand, gray clayey or silty; Sample 2

R. V. HUNT PROPERTY

TEST HOLE K54

Location: T.18 N., R.10 E., Sec. 22, northern part; on west side of Highway 9, about 10 ft. from highway, 100 yds. northwest of house on opposite side of highway Drilled: November 20, 29, 30, 1940

Elevation: Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	3.8	3.8	Sand, red-brown clayey
2	6.0	2.2	Clay, light-gray sandy, mottled with some brown
3	14.0	8.0	Clay, dark-gray, brown streaks, very sandy; Sample 1
4	32.0	18.0	Sand, gray and brown very fine

GULF, MOBILE, & OHIO RAILROAD PROPERTY

TEST HOLE K56

Location: T.18 N., R.11 E., Sec. 29, SW. 1/4; 50 yds. above new overpass on Williams Hill, Gulf, Mobile, and Ohio and Highway 15 crossing, about 50 ft. west of track Drilled: December 17, 18, 1940

Elevation: 609 ft. Water level: 21 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent colluvium from Holly Springs sand
1	1.0	1.0	Sand, red
			Ackerman formation
2	4.5	3.5	Clay, sandy light-gray
3	13.0	8.5	Clay, blue-gray, mixed with sand; Sample 1
4	14.0	1.0	Clay, lignitic dark-brown sandy
5	21.0	7.0	Sand, hard packed light-gray very fine
6	35.0	14.0	Sand, hard packed green clayey; dries greenish-yellow

M. TAYLOR PROPERTY

TEST HOLE K58

Location: T.17 N., R.8 E., Sec. 27, SE. 1/4; 175 yds. north of the Taylor residence, 18 yds. south of French Camp and Poplar Creek road

Drilled: January 8, 9, 1941

Elevation:

Water level: 33 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Tallahatta formation, Meridian member
1	5.0	5.0	Sand, brown and yellow
			Holly Springs formation
2	10.0	5.0	Clay, light-gray sandy, mottled with yellow and brown; Sample 1
3	15.5	5.5	Clay, red, yellow, and gray sandy; Sample 2
4	17.5	2.0	Sand, light-gray rust-specked fine
5	21.0	3.5	Clay, sandy light-gray
6	21.3	0.3	Lignite, brown clayey
7	25.0	3.7	Clay, gray, with pinkish to purplish tint
8	26.0	1.0	Clay, brown lignitic
9	27.5	1.5	Lignite, brown to black impure
10	40.0	12.5	Sand, blue-gray very fine micaceous

U. S. GOVERNMENT PROPERTY

TEST HOLE K63

Location: T.16 N., R.11 E., Sec. 2, north-central part; 30 ft. east of road, 0.5 mile northeast of Choctaw Lake

Drilled: December 3, 1940

Elevation: About 607 ft.

Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Top soil
			Ackerman formation
2	5.0	4.0	Sand, clayey, or clay, very sandy light-gray rust-flecked
3	12.0	7.0	Sand, brown and gray clayey or silty
4	13.0	1.0	Lignite and lignitic clay, black
5	18.5	5.5	Clay, gray; Sample 1
6	22.0	3.5	Lignite, brown to black
7	28.0	6.0	Clay, gray, with very fine sand
8	32.0	4.0	Lignite, brown clayey
9	36.0	4.0	Clay, light-gray; contains fine sand; Sample 2
10	39.0	3.0	Clay, light-gray, with very fine sand or silt
11	48.0	9.0	Clay, greenish-gray sandy; Sample 3
12	55.0	7.0	Sand, gray, with little clay

U. S. Government Property

Test Hole K64

Location: T.16 N., R.11 E., Sec. 3, SW. 1/4; 15 ft. north of Lake Choctaw road, 0.5 mile west of Water Tower Drilled: December 12, 1940

Elevation: $\pm$ 600 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Soil
2	2.5	2.0	Sand, iron-brown; probably colluvium from Holly Springs sand
			Ackerman formation
3	5.5	3.0	Clay, gray brown-stained sandy
4	12.0	6.5	Clay, gray sandy; Sample 1
5	13.5	1.5	Clay, chocolate-brown and gray sandy
6	22.0	8.5	?

Ben Head Property

Test Hole K71

Location: T.17 N., R.9 E., Sec. 32, eastern part; 1.5 miles east of French Camp, 12 yds. northeast of the Head home, 125 yds. north of French Camp-Weir road Drilled: January 8, 9, 1941

Elevation: $\pm$ 500 ft. Water level: 26 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Surface soil
			Holly Springs formation
2	11.0	10.0	Clay, mottled rust-brown and gray sandy; Sample 1
3	16.0	5.0	Sand, light-brown very fine clayey or silty
4	26.0	10.0	Clay, light-gray shaly sandy
5	40.0	14.0	Sand; blue when wet, but dries greenish-gray; very fine

T. C. KITE PROPERTY

TEST HOLE K72

Location: T.17 N., R.9 E., Sec. 22, SE. 1/4; 1.5 miles north of Weir-French Camp road, 15 yds. east of Kenago road in front of Miller (colored) School Drilled: January 15, 1941

Elevation: ± 560 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Surface soil
			Holly Springs formation
2	10.0	9.5	Clay, yellow and gray sandy; or clayey sand
3	27.5	17.5	Clay, light-chocolate-brown, with a little sand; Sample 1
4	32.0	4.5	Sand, light-gray micaceous

EDWIN STEADMAN PROPERTY

TEST HOLE K74

Location: T.18 N., R.11 E., Sec. 18, NW. 1/4; 200 yds. west of Antioch Church, 15 yds. north of Reform and Antioch road, 1.7 miles west of Highway 15

Drilled: January 22, 23, 1941

Elevation: ± 460 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Surface soil
			Ackerman formation
2	4.5	4.0	Clay, light-gray, with a little sand
3	10.0	5.5	Silt, light-gray
4	17.0	7.0	Clay, greenish-gray, with sand; Sample 1
5	27.0	10.0	Sand, light-gray very fine micaceous
6	29.5	2.5	Lignite, impure
7	39.0	9.5	Sand, dark-blue to gray silty; Sample 2
8	42.0	3.0	Lignite, black

MORRIS ELLINGTON PROPERTY

TEST HOLE K75

Location: T.18 N., R.11 E., Sec. 34, SW. 1/4; 15 yds. north of Spring Hill and Dido road, about 200 yds. north of the Ellington house

Drilled: February 5, 6, 7, 1941

Elevation: About 550 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Surface soil
			Ackerman formation
2	3.0	2.5	Clay, yellowish-gray rust-spotted; contains fine sand
3	13.5	10.5	Clay, light-gray pure to silty; Sample 1
4	25.5	12.0	Clay, gray and yellow sandy rusty
5	27.5	2.0	Silt, bluish-gray sandy
6	31.0	3.5	Sand, iron-brown and gray micaceous
7	32.0	1.0	Clay, dark-bluish-gray; contains fine sand
8	33.0	1.0	Lignite, impure
9	45.0	12.0	Sand, bluish-gray fine silty micaceous
10	48.0	3.0	Lignite; Sample 2

CLYDE CARTLEDGE PROPERTY

TEST HOLE K80

Location: T.17 N., R.8 E., Sec. 36, NW. 1/4; north of French Camp and Poplar Creek road, 150 yds. northeast of French Camp Cemetery

Drilled: January 8, 1941

Elevation: Watel level: 20 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Top soil
			Tallahatta formation, Meridian member
1	7.0	7.0	Sand, brown; contains silt
			Holly Springs formation
2	13.0	6.0	Clay, light-gray, with iron streaks; Sample 1
3	17.0	4.0	Clay, dark-gray; dries lighter gray
4	21.5	4.5	Sand, light-gray very fine, almost a silt
5	28.5	7.0	Sand, dark-gray; dries light-gray
6	32.5	4.0	Clay, dark-gray; dries light-gray; contains much fine sand and silt
7	33.5	1.0	Lignite

U. S. GOVERNMENT PROPERTY

TEST HOLE K82

Location: T.16 N., R.11 E., Sec. 23, SW. 1/4; 33 yds. north of Betheden Highway, 8 yds. east of local road Drilled: January 20, 1941

Elevation: About 550 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Top soil
			Ackerman formation
1	4.0	4.0	Clay, dark-rust-brown very sandy
2	23.5	19.5	Clay, light-gray; little sand; Sample 1
3	26.0	2.5	Lignite, dark-brown
4	32.0	6.0	Clay, dark-gray silty

E. D. JONES PROPERTY

TEST HOLE K83

Location: T.18 N., R.10 E., Sec. 13, NW. 1/4; 48 ft. south of Reform and Greensboro road, 12 ft. east of local road running south

Drilled: January 22, 1941

Elevation: $\pm$ 475 ft. Water level: 36 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Holly Springs formation
1	2.0	2.0	Clay, brown
2	14.0	12.0	Clay, light-gray, with sand streaks; Sample 1
3	17.0	3.0	Clay, chocolate-brown, with sand
4	43.0	26.0	Sand, light-gray, with brown streaks
			Ackerman formation
5	46.0	3.0	Lignite, brown to black
6	48.0	2.0	Clay, dark-gray

E. L. REED PROPERTY

TEST HOLE K87

Location: T.18 N., R.9 E., Sec. 31, northern part; 45 ft. north of Huntsville road, 80 yds. west of dwelling Drilled: February 19, 1941

Elevation: ± 500 ft. Water level: 24 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Holly Springs formation
2	9.0	8.0	Clay, gray, yellow streaks; Sample 1
3	11.5	2.5	Sand, light-gray clayey or silty
4	13.5	2.0	Lignite, brown
5	23.0	9.5	Sand, gray iron-streaked fine
6	28.0	5.0	Lignite
7	31.0	3.0	Clay, dark-gray
8	39.0	8.0	Sand, yellow

K. A. DENDY PROPERTY

TEST HOLE K92

Location: T.18 N., R.8 E., Sec. 27, east-central part; 75 ft. north of Huntsville and Bankston road Drilled: February 19, 24, 1941

Elevation: About 450 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Top soil
			Holly Springs formation
2	8.0	7.0	Clay, gray; Sample 1
3	21.0	13.0	Clay, dark-gray, with sand; Sample 2
4	24.0	3.0	Clay, light-gray sandy
5	27.0	3.0	Sand, gray
6	36.0	9.0	Clay, dark-gray, with sand

TRAVIS AUSTIN PROPERTY

TEST HOLE K94A

Location: T.18 N., R.8 E., Sec. 27, NW. 1/4; 10 yds. north of Winona road and 250 yds. west of cross roads of Winona, Stewart, and Huntsville roads

Drilled: March 11, 1941

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Soil
2	5.0	4.5	Sand, yellowish-red, rusty; probably colluvium from Meridian sand
			Holly Springs formation
3	7.5	2.5	Clay, yellowish-gray sandy
4	14.5	7.0	Clay, reddish-light-gray sandy; Sample 1
5	20.0	5.5	Clay, yellowish-gray, with sand
6	21.5	1.5	Sand, yellow silty
7	22.5	1.0	Clay, blue sandy; dries light-gray
8	23.5	1.0	Clay, chocolate-brown sandy

K. W. HUTCHINSON PROPERTY

TEST HOLE K95

Location: T.15 N., R.10 E., Sec. 20, SE. corner; 15 yds. southwest of McCool road

Drilled: March 19, 20, 1941

Elevation: About 500 ft.

Water level: 12 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Holly Springs formation
2	12.0	11.0	Clay, light-gray
3	16.0	4.0	Sand, clayey light-gray and iron-brown; Sample 1
4	21.0	5.0	Clay, blue; Sample 2
5	28.0	7.0	Clay, yellow with gray streaks

H. D. KERR PROPERTY

TEST HOLE K98

Location: T.15 N., R.10 E., Sec. 33, NW. corner; 10 yds. north of McCool and Plattsburg road, 0.13 mile east of Hopewell Church

Drilled: March 20, 22, 24, 1941

Elevation: Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Holly Springs formation
2	6.0	5.0	Sand, light-brown to yellowish
3	10.0	4.0	Clay, dark-gray; Sample 1
4	15.0	5.0	Clay, light-gray sandy slightly rust-spotted
5	17.0	2.0	Clay, brown
6	18.0	1.0	Lignite
7	22.0	4.0	Clay, dark-gray
8	28.0	6.0	Clay, green, with sand
9	35.0	7.0	Clay, dark-brown
10			Clay, dark-gray

K. W. HUTCHINSON PROPERTY

TEST HOLE K100

Location: T.15 N., R.10 E., Sec. 29, eastern part; 400 ft. southeast of the Hutchinson dwelling, 35 ft. east of McCool road

Drilled: March 19, 20, 1941

Elevation: ± 490 ft. Water level: 21 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Soil
			Holly Springs formation
2	4.0	3.5	Sand, yellow to brown silty
3	9.0	5.0	Clay, bluish, with red streaks; dries light-gray; Sample 1
4	13.3	4.3	Sand; three colors
5	23.3	10.0	Clay, blue; Sample 2
6	33.5	10.2	Sand, green, with some clay; Sample 3
7	36.5	3.0	Sand, light-bluish-gray

EMMETT PICKLE PROPERTY

TEST HOLE K101

Location: T.15 N., R.10 E., Sec. 20, NE. 1/4; 0.3 mile west of the R. C. Stevens house, 75 ft. west of McCool road, 300 ft. west of bridge at intersection of roads Drilled: March 26, 1941

Elevation: ± 500 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.5	0.5	Soil
			Tallahatta formation, Meridian member?
2	9.5	9.0	Sand, yellow and light-gray fine
			Holly Springs formation
3	15.5	6.0	Clay, white and yellow sandy and silty
4	21.2	5.7	Clay, white; Sample 1
5	25.2	4.0	Clay, green; Sample 2
6	32.9	7.7	Clay, black; Sample 3
7	44.9	12.0	Sand, green fine micaceous

JIM HARDEN PROPERTY

TEST HOLE K112

Location: T.15 N., R.10 E., Sec. 9, NW. 1/4; 14 yds. west of Weir and Panhandle road; 0.3 mile north of the Harden house

Drilled: March 14, 1941

Elevation: ± 500 ft. Water level: 22 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Tallahatta formation, Meridian member?
2	7.0	6.0	Sand, brown to yellow clayey
3	12.5	5.5	Sand, light-gray and yellow clayey
			Holly Springs formation
4	17.5	5.0	Clay, brown, with iron streaks; Sample 1
5	22.0	4.5	Clay, dark-gray; Sample 2
6	27.0	5.0	Sand, dark-gray; wet; caving

O. A. RAY PROPERTY

TEST HOLE K115

Location: Almost on Choctaw-Winston County line, but probably in Winston County, on north side of High Point road, 0.7 mile west of Highway 15 and 0.6 mile east of Gulf, Mobile, & Ohio Railroad

Drilled: April 23, 1941

Elevation: ± 560 ft. Water level: 8 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
			Holly Springs formation
2	4.0	3.0	Sand, brown clayey
3	10.0	6.0	Clay, gray, with pink streaks and splotches; sandy; Sample 1
4	18.0	8.0	Sand, gray, with clay
			Ackerman formation
5	25.0	7.0	Clay, brown sandy
6	32.0	7.0	Clay, green
7	34.0	2.0	Clay, dark-gray
8			Sand, green; touched

W. G. WOMACK PROPERTY

TEST HOLE K120

Location: T.19 N., R.10 E., Sec. 13, extreme eastern part; on south side of LaGrange road and west side of local road 100 ft. from junction; 4 miles west of Highway 15, 3 miles east of Highway 9 Drilled: June 27, 1941

Elevation: ± 520 ft. Water level: Dry

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	0.9	0.9	Soil, light-gray sandy loam
			Ackerman formation
2	3.4	2.5	Sand, light-brown silty, grading into brown clay
3	6.0	2.6	Clay, brown, with iron streaks
4	12.5	6.5	Clay, gray; Sample 1
5	18.0	5.5	Sand, gray clayey
6	29.0	11.0	Clay, dark-gray sandy, with iron streaks
7	32.0	3.0	Sand, brown
8	38.5	6.5	Clay, dark-gray, containing brown sand
9			Sand, light-brown; touched

FRENCH CAMP SCHOOL OR SHADY GROVE CHURCH PROPERTY

TEST HOLE K121

Location: T.17 N., R.8 E., Sec. 36, near southern section line; 65 yds. west of French Camp road, 20 yds. east of Shady Grove (Negro) Church

Drilled: June 26, 1941

Elevation: About 475 ft. Water level: 21 ft.

No.	Depth	Thick.	Description of strata and designations of samples.
	0	0	Surface
			Recent formation
1	1.0	1.0	Soil
2	5.0	4.0	Sand, brown, possibly some of it residual from Meridian sand
			Holly Springs formation
3	10.0	5.0	Clay, gray, with yellow sand
4	16.5	6.5	Clay, gray, with pink streaks of sand
5	19.0	2.5	Sand, gray clayey
6	21.0	2.0	Clay, dark-gray; wet
7	29.0	8.0	Clay, light-gray; Sample 1
8	32.0	3.0	Clay, dark-gray
9	36.0	4.0	Clay, gray

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REFERENCES

1. U. S. Department of Commerce, Bureau of the Census: 16th Census of the United States, 1940. First Series, Number of Inhabitants, Mississippi, pp. 3, 4, 1941.

2. U. S. Department of Agriculture, Soil Survey of Choctaw County, Mississippi, by A. C. Anderson, E. Malcolm Jones and Thomas Jabine, pp. 249, 250, 252, 253, 254-262, 263, 264, 265, 276, 1923.

3. Foster, V. M., Outline Physiographic Description of Mississippi: Mississippi State Planning Commission, Jackson, Mississippi, pp. 14-17, and map between pages 6 and 7, October 11, 1937.

4. Mellen, Fredric Francis, Winston County Mineral Resources: Mississippi State Geol. Survey Bull. 38, pp. 21, 22, 23, 26, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 40 et seq., 44, 45, 48, 80, 81, 147, 160, 1939.

5. Lowe, E. N., Mississippi, Its Geology, Geography, Soil and Mineral Resources: Mississippi State Geol. Survey Bull. No. 14, pp. 67, 68, 69, 70, 315, 1919.

6. Lowe, E. N., Coastal Plain Stratigraphy of Mississippi, Midway and Wilcox Groups: Mississippi State Geol. Survey Bull. No. 25, pp. 21, 25, 35, 36, 38, 60, 61, 63, 64, 65, 67, 68, 73, 74, 1933.

7. Grim, Ralph Early, The Eocene Sediments of Mississippi: Mississippi State Geol. Survey Bull. 30, pp. 32, 122, 123, 1936.

8. Stephenson, Lloyd W., Logan, William N., and Waring, Gerald A., The Ground-Water Resources of Mississippi: U. S. Geol. Survey Water-Supply Paper 576, pp. 44, 45, 46, 47, 50, 51, 110-112, and map, Plate 2, 1928.

9. Foster, V. M., Lauderdale County Mineral Resources: Mississippi State Geol. Survey Bull. 41, pp. 68 et seq., 71, 1940.

10. Thomas, Emil Paul, The Claiborne: Mississippi State Geol. Survey Bull. 48, pp. 14, 16, 20, 21, 22, 24, 25, 26, 28, also Letter of Transmittal, and Plate 1, 1942.

11. Lowe, E. N., Oil and Gas Prospecting in Mississippi: Mississippi State Geol. Survey Bull. No. 15, pp. 35-36, 1919.

12. Lowe, E. N., Petroleum prospecting in Mississippi: Section 2, Ninth Biennial Report of the Director of the State Geological Survey, p. 64, 1921-23.

13. Chamberlin, T. C., and Salisbury, R. D., Geology, Volume II, Earth History, pp. 564 et seq., Henry Holt, 1905.

14. Clarke, F. W., The Data of Geochemistry: U. S. Geol. Survey Bull. 770, p. 756, 1924.

15. Brown, Calvin S., The Lignite of Mississippi: Mississippi State Geol. Survey Bull. No. 3, pp. 10, 12, 23, 39, 51, 52, 54, 55, 63, 65, 1907.

16. Mississippi Oil and Gas Co-operative Joint Stock Company Papers, Aug. 27, 1919, Feb. 14, 1921, May 12, 1925, etc.

17. Lowe, E. N., Preliminary Report on Iron Ores of Mississippi: Mississippi State Geol. Survey Bull. No. 10, p. 47, 1913.

18. Logan, William N., The Clays of Mississippi, Part I, Brick Clays and Clay Industry of Northern Mississippi: Mississippi State Geol. Survey Bull. No. 2, pp. 182, 183, 1907.

19. A New Mineral Paving Industry: Mississippi State Geol. Survey Press Release, May 25, 1939.

CHOCTAW COUNTY MINERAL RESOURCES

TESTS

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INTRODUCTION

In the geologic part of this report Vestal states that the clays are found in the Hatchetigbee, Holly Springs, Ackerman, Fearn Springs, and Porters Creek formations. In the laboratory an attempt was made to classify the clays according to the formations from which they were sampled. This classification indicated that clays having similar physical, chemical, and pyrometric properties were common to several formations, and, consequently, there appeared to be no distinguishing characteristics between clays from different formations with the exception of those from the Porters Creek. A classification of samples according to formations would lead to overlapping and confusion. In order to evaluate the clays of Choctaw County they have been classified in this part of the report according to their economic uses which groups together clays having similar characteristics and similar economic uses, and in this instance the classification is without respect to formation.

Three general types of clay are represented in the samples tested. The first type is the clear burning buff and salmon group and is classified as Pottery, Brick, and Tile Clays. These clays are suitable for a variety of uses and are probably the most important in the county.

The second type of clay is classified as Brick and Tile Clays—Red Burning. The title suggests the general characteristics of the clays. Some samples are better suited for specific purposes, and these are enumerated under Possibilities for Utilization. Common clays such as are represented under this classification prove valuable through utilization.

The third type of clay has undesirable ceramic properties and is thus limited in its application. Some of the samples are suitable for use in other fields and should not be overlooked. These materials are classified as Miscellaneous Clays.

POTTERY, BRICK, AND TILE CLAYS

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Water of plasticity in percent	Drying shrinkage		Modulus of rupture in pounds per sq. inch	Color
			Volume in percent	Linear in percent		
K4	1	37.36	30.56	11.46	280	Gray
K11	1	28.75	35.62	13.69	682	Gray
K12	2	36.17	32.42	12.28	268	Lt. gray
K34	1-2	30.96	27.44	10.16	288	Lt. gray
K63	1	39.29	46.67	18.92	476	Gray
K71	1	30.44	43.02	17.14	654	Lt. gray
K72	1	28.05	25.91	9.55	312	Reddish gray
K75	1	35.00	37.15	14.36	365	Lt. gray
K82	1	32.19	41.33	16.32	599	Lt. gray
K95	1	31.68	39.89	15.61	474	Reddish gray
K100	2	31.23	36.07	13.87	375	Gray
K101	1	32.53	40.17	15.75	498	Lt. gray
K115	1	35.92	49.69	20.47	758	Reddish gray
K120	1	35.78	49.67	20.47	581	Lt. gray
K121	1	31.82	36.88	14.23	353	Lt. gray

SCREEN ANALYSES

SAMPLE K4-1

Retained on screen	Percent	Character of residue
60	29.16	Abundance of lignitic, arenaceous clay nodules; traces of pyrite and free lignite.
100	10.82	Abundance of arenaceous clay nodules; considerable quantity of lignitic nodules; trace of pyrite.
250	13.16	Abundance of clay nodules; considerable quantity of lignitic nodules; small amount of quartz.
Cloth	46.86	Clay substance including residue from above.

SAMPLE K11-1

Retained on screen	Percent	Character of residue
60	1.23	Abundance of lignitic clay nodules; small amounts of lignite and white clay nodules.
100	.76	Abundance of lignitic clay nodules; small amounts of lignite and white clay nodules.
250	3.86	Abundance of quartz; considerable quantity of gray clay nodules; small amounts of muscovite and lignite.
Cloth	94.15	Clay substance including residue from above.

SAMPLE K12-2

Retained on screen	Percent	Character of residue
60	19.16	Abundance of arenaceous, lignitic clay nodules; considerable quantity of quartz; small amount of pyrite.
100	11.33	Abundance of arenaceous clay nodules; considerable quantity of quartz; small amount of muscovite; trace of ferruginous material.
250	17.23	Abundance of clay nodules; considerable quantity of quartz; small amount of muscovite.
Cloth	52.28	Clay substance including residue from above.

SAMPLE K63-1

Retained on screen	Percent	Character of residue
60	3.49	Abundance of lignitic clay nodules; considerable quantity of lignite; small amounts of limonite and plant fragments.
100	1.75	Abundance of gray clay nodules; small amounts of lignite, limonite, and quartz.
250	6.36	Abundance of gray clay nodules; small amount of lignite; traces of limonite, muscovite, and quartz.
Cloth	88.40	Clay substance including residue from above.

SAMPLE K72-1

Retained on screen	Percent	Character of residue
60	3.11	Abundance of micaceous, arenaceous, limonitic nodules.
100	5.30	Abundance of micaceous, arenaceous, limonitic nodules.
250	6.89	Abundance of limonitic nodules; traces of quartz and muscovite.
Cloth	84.70	Clay substance including residue from above.

SAMPLE K75-1

Retained on screen	Percent	Character of residue
60	1.16	Abundance of limonitic nodules; considerable quantity of gypsum; small amount of gray clay nodules; trace of plant fragments.
100	.55	Abundance of limonitic clay nodules; small amounts of gray clay nodules, gypsum, plant fragments, and quartz.
250	.39	Abundance of limonitic clay nodules; considerable quantities of muscovite and gray clay nodules.
Cloth	97.90	Clay substance including residue from above.

SAMPLE K82-1

Retained on screen	Percent	Character of residue
60	.84	Abundance of gray clay nodules; considerable quantities of lignitic clay nodules and gypsum; small amounts of plant fragments and ferruginous material.
100	1.10	Abundance of gray clay nodules; small amount of lignitic clay nodules; traces of gypsum, limonitic nodules, and quartz.
250	1.58	Abundance of gray clay nodules; small amounts of quartz, muscovite, and limonite.
Cloth	96.48	Clay substance including residue from above.

SAMPLE K100-2

Retained on screen	Percent	Character of residue
60	3.79	Abundance of lignitic clay nodules; small amounts of pyrite, lignite, and limonite.
100	3.21	Abundance of lignitic clay nodules; considerable quantity of gray clay nodules; small amounts of quartz and limonitic nodules.
250	7.29	Abundance of lignitic clay nodules; considerable quantity of quartz; small amount of limonite.
Cloth	85.71	Clay substance including residue from above.

SAMPLE K101-1

Retained on screen	Percent	Character of residue
60	1.72	Abundance of arenaceous gray clay nodules; small amount of lignite; traces of pyrite and quartz.
100	3.11	Abundance of gray clay nodules; small amounts of quartz and lignite.
250	2.88	Abundance of quartz; considerable quantity of gray clay nodules; small amount of lignite.
Cloth	92.29	Clay substance including residue from above.

SAMPLE K120-1

Retained on screen	Percent	Character of residue
60	4.04	Abundance of gray clay nodules; considerable quantity of gypsum; trace of limonite.
100	4.56	Abundance of gray clay nodules; considerable quantity of white clay nodules; traces of lignite, limonite, and muscovite.
250	4.72	Abundance of gray clay nodules; considerable quantity of white clay nodules; small amounts of quartz and muscovite.
Cloth	86.68	Clay substance including residue from above.

SAMPLE K121-1

Retained on screen	Percent	Character of residue
60	.56	Abundance of gray clay nodules; considerable quantities of quartz and marcasite; small amount of limonitic-stained clay nodules; trace of carbonaceous material.
100	.66	Abundance of gray clay nodules; considerable quantity of quartz; small amounts of limonitic-stained clay nodules, marcasite, and quartz.
250	.72	Abundance of quartz; considerable quantity of gray clay nodules; small amounts of marcasite, limonitic nodules, and muscovite.
Cloth	98.06	Clay substance including residue from above.

Alta Ray Gault, laboratory geologist.

CHEMICAL ANALYSES*

SAMPLE K4-1

Ignition loss	7.96
Silica, SiO_2	65.88
Alumina, Al_2O_3	19.06
Iron oxide, Fe_2O_3	2.97
Titania, TiO_2	1.09
Lime, CaO	0.55
Magnesia, MgO	0.66
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.35
Sulfur, SO_3	0.91

SAMPLE K11-1

Ignition loss	7.67
Silica, SiO_2	66.85
Alumina, Al_2O_3	20.73
Iron oxide, Fe_2O_3	2.05
Titania, TiO_2	1.25
Lime, CaO	0.73
Magnesia, MgO	0.38
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.38

SAMPLE K12-2

Ignition loss	7.03
Silica, SiO_2	65.88
Alumina, Al_2O_3	19.19
Iron oxide, Fe_2O_3	3.64
Titania, TiO_2	0.68
Lime, CaO	0.29
Magnesia, MgO	0.53
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.40
Sulfur, SO_3	1.74

SAMPLE K63-1

Ignition loss	6.12
Silica, SiO_2	67.61
Alumina, Al_2O_3	16.78
Iron oxide, Fe_2O_3	5.42
Titania, TiO_2	0.69
Lime, CaO	0.81
Magnesia, MgO	1.10
Manganese, MnO_2	Trace
Alkalies, (K_2O, Na_2O)	0.26

SAMPLE K72-1

Ignition loss	6.13
Silica, SiO_2	74.38
Alumina, Al_2O_3	14.88
Iron oxide, Fe_2O_3	1.70
Titania, TiO_2	0.89
Lime, CaO	None
Magnesia, MgO	1.07
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.45

SAMPLE K75-1

Ignition loss	10.57
Silica, SiO_2	56.00
Alumina, Al_2O_3	27.01
Iron oxide, Fe_2O_3	2.53
Titania, TiO_2	1.22
Lime, CaO	0.78
Magnesia, MgO	1.14
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.44

SAMPLE K82-1

Ignition loss	7.18
Silica, SiO_2	64.64
Alumina, Al_2O_3	21.76
Iron oxide, Fe_2O_3	2.36
Titania, TiO_2	1.28
Lime, CaO	0.36
Magnesia, MgO	0.87
Manganese, MnO_2	None
Alkalies, (K_2O, Na_2O)	0.39

SAMPLE K100-2

Ignition loss 6.00
Silica, SiO_2 .... 69.39
Alumina, Al_2O_3 .... 19.26
Iron oxide, Fe_2O_3 .. 2.21
Titania, TiO_2 .... 1.16
Lime, CaO .... None
Magnesia, MgO 1.19
Manganese, MnO_2 None
Alkalies, (K_2O, Na_2O) 0.19

SAMPLE K101-1

Ignition loss 6.24
Silica, SiO_2 .... 69.31
Alumina, Al_2O_3 .... 19.04
Iron oxide, Fe_2O_3 ... 2.17
Titania, TiO_2 .... 0.98
Lime, CaO .... None
Magnesia, MgO 1.23
Manganese, MnO_2 None
Alkalies, (K_2O, Na_2O) 0.22

SAMPLE K120-1

Ignition loss 6.76
Silica, SiO_2 .... 67.01
Alumina, Al_2O_3 .... 20.61
Iron oxide, Fe_2O_3 . 2.95
Titania, TiO_2 .... 0.87
Lime, CaO 0.29
Magnesia, MgO 0.94
Manganese, MnO_2 ... 0.09
Alkalies, (K_2O, Na_2O) 0.40
Sulfur, SO_3 .... 0.15

SAMPLE K121-1

Ignition loss 7.04
Silica, SiO_2 .... 67.36
Alumina, Al_2O_3 .... 21.10
Iron oxide, Fe_2O_3 .. 2.60
Titania, TiO_2 .... 1.25
Lime, CaO .... None
Magnesia, MgO 0.32
Manganese, MnO_2 None
Alkalies, (K_2O, Na_2O) 0.33

* Samples ground to pass 100-mesh screen.

B. F. Mandlebaum, analyst.

PYRO-PHYSICAL PROPERTIES

TEST HOLES K4, K11, K12, K34, K63, K71

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and rémarks
K4 1	02	28.70	16.47	1.74	2.45	11.59	4.03	2037	Lt. buff** St. H.
	1	15.48	7.90	2.02	2.45	22.96	8.34	3038	Buff**
	3	14.59	7.37	1.96	2.26	21.39	11.81	3085	Buff**
	5	13.98	6.74	2.03	2.32	21.40	11.81	4124	Buff**
	7	9.72	4.73	2.05	2.27	24.75	9.06	3771	Buff**
	9	8.37	3.90	2.15	2.29	28.02	10.41	3368	Gray**
	11	3.43	1.95	1.76	1.82	12.73	4.46	N.D.*	Gray** Bl.
K11 1	02	15.38	7.66	2.08	2.37	10.43	3.63	3662	Cream St. H.
	1	12.45	6.04	2.06	2.35	13.03	4.57	4144	Cream
	3	13.17	6.46	2.38	2.35	11.76	4.10	4358	Buff
	5	8.80	4.16	2.11	2.32	14.89	5.24	4358	Buff
	7	7.87	3.72	2.11	2.30	15.19	5.35	4077	Buff
	9	5.77	2.71	2.14	2.26	15.93	5.65	4700	Grayish buff
	11	9.93	5.01	1.98	2.20	9.61	3.34	3224	Gray
K12 2	02	30.92	18.09	1.71	2.47	6.27	2.15	2218	Lt. buff**
	1	28.07	15.56	1.80	2.51	11.58	4.03	2141	Dk. buff** St. H.
	3	25.86	14.03	1.85	2.49	13.26	4.65	2641	Dk. buff**
	5	21.39	11.07	1.98	2.43	19.10	6.82	2561	Dk. buff**
	7	18.67	9.44	1.93	2.46	17.02	6.06	2717	Dk. buff**
	9	15.22	7.64	1.99	2.35	19.90	7.13	2436	Grayish buff**
	11	13.38	6.62	2.02	2.34	21.20	7.63	3102	Grayish buff**
K34 1-2	02	28.10	16.00	1.76	2.45	5.73	1.97	1741	Buff**
	1	25.04	13.61	1.79	2.46	9.14	3.17	1875	Buff** St. H.
	3	24.98	12.91	1.93	2.58	14.45	5.09	2615	Buff**
	5	19.64	10.81	1.93	2.40	14.27	5.01	2766	Grayish buff**
	7	20.67	10.80	1.91	2.41	13.62	4.79	2402	Grayish buff**
	9	17.86	8.85	2.02	2.46	18.04	6.44	2695	Grayish buff**
	11	8.41	4.50	1.87	2.04	11.73	5.10	2289	Brown** Bl.
K63 1	02	17.85	9.40	2.04	2.41	18.14	6.48	2241	Buff St. H.
	1	6.11	2.97	2.07	2.21	22.34	8.11	2394	Buff
	3	5.83	2.82	2.08	2.20	23.53	8.58	2396	Buff
	5	3.57	1.85	2.04	2.11	22.53	8.18	2599	Buff
	7	5.96	3.08	1.95	2.08	18.64	6.67	2024	Buff Bl.
K71 1	02	20.59	10.77	1.91	2.41	6.09	2.08	2783	Salmon** St. H.
	1	16.39	8.18	2.00	2.40	7.90	2.71	N.D.	Salmon**
	3	17.11	8.55	2.00	2.42	9.92	3.38	2800	Lt. red**
	5	14.43	7.09	2.04	2.38	11.17	3.88	3230	Dk. buff**
	7	12.58	6.10	2.06	2.36	11.72	4.06	3326	Dk. buff**
	9	12.97	6.15	2.11	2.42	14.04	4.94	N.D.	Dk. buff**
	11	7.49	4.34	1.72	1.83	–4.44	–1.52	N.D.	Brown** Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

* Cracked.

** Stained with calcium salts.

TEST HOLES K72, K75, K82, K95, K100, K101

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks	
K72 1	02	29.55	16.79	1.76	2.50	3.70	1.25	1463	Cream	St. H.
	1	26.63	11.42	1.80	2.46	8.01	2.78	N.D.	Cream	
	3	24.63	13.31	1.85	2.45	8.83	3.02	2114	Cream	
	5	25.89	14.21	1.82	2.46	7.58	2.60	2790	Cream	
	7	21.36	11.40	1.90	2.47	11.41	3.95	2468	Cream	
	9	12.96	6.19	2.10	2.42	19.50	6.98	N.D.	Cream	
	11	6.46	3.03	2.13	2.28	20.67	7.44	N.D.	Gray	
K75 1	02	16.24	8.00	2.04	2.44	20.83	7.48	3222	Lt. buff**	St. H.
	1	14.94	7.19	2.07	2.44	22.16	8.03	3080	Lt. buff**	
	3	6.20	2.86	2.17	2.32	25.63	9.39	3515	Lt. buff**	
	5	14.02	6.70	2.09	2.43	22.71	8.22	3449	Lt. buff**	
	7	0.78	0.35	2.22	2.24	27.07	10.00	1012*	Grayish buff**	
	9	0.13	0.07	2.24	2.25	28.21	10.50	7288	Grayish buff**	
	11	3.80	2.01	1.89	1.98	15.52	5.50	N.D.*	Grayish buff**	Bl.
K82 1	02	17.89	9.04	1.98	2.41	11.20	3.88	3468	Lt. buff	St. H.
	1	11.96	5.71	2.09	2.38	14.81	5.24	3710	Lt. buff	
	3	11.48	5.49	2.09	2.36	15.73	5.57	4228	Lt. buff	
	5	11.89	5.67	2.10	2.38	16.18	5.72	4420	Lt. buff	
	7	5.15	2.39	2.16	2.31	18.80	6.71	4095	Grayish buff	
	9	2.24	1.03	2.12	2.23	19.72	7.09	3101	Grayish buff	
K95 1	02	19.28	9.97	1.94	2.40	8.08	2.78	2892	Salmon buff**	St. H.
	1	13.56	6.65	2.04	2.36	13.77	4.83	2528	Salmon buff**	
	3	12.64	6.23	2.03	2.32	13.43	4.72	2670	Salmon buff**	
	5	10.28	4.96	2.07	2.31	15.62	5.53	2557	Grayish buff**	
	7	8.06	4.03	2.08	2.28	15.81	5.61	2558	Grayish buff**	
	9	11.48	5.44	2.11	2.38	17.40	6.17	3669	Grayish buff**	
	11	6.04	2.73	2.04	2.17	14.74	5.20	4196	Brown**	
K100 2	02	22.76	12.35	1.85	2.39	4.94	1.70	2544	Buff	St. H.
	1	17.39	8.89	2.03	2.34	13.05	4.57	2654	Buff	
	3	15.11	7.59	1.95	2.37	10.08	3.49	2800	Buff	
	5	13.10	6.43	1.99	2.35	12.03	4.21	3720	Buff	
	7	12.22	5.92	2.04	2.32	14.37	5.05	3826	Buff	
	9	6.92	3.16	2.18	2.35	19.76	7.09	4407	Grayish buff	
	11	6.45	3.09	2.08	2.23	16.16	5.72	4466	Brown	
K101 1	02	15.74	7.84	2.03	2.38	10.50	3.63	4391	Lt. buff	St. H.
	1	12.67	6.09	2.07	2.37	12.52	4.39	N.D.	Lt. buff	
	3	10.24	4.84	2.11	2.35	15.16	5.35	4271	Buff	
	5	7.51	3.47	2.16	2.34	16.88	5.98	6154	Buff	
	7	5.16	2.39	2.15	2.27	16.80	5.95	5110	Buff	
	9	1.40	0.55	2.21	2.23	18.64	6.67	4550	Gray	
	11	8.65	4.27	1.98	2.13	9.57	3.31	N.D.	Gray	Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

* Cracked.

** Stained with calcium salts.

TEST HOLES K115, K120, K121

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
K115 1	02	20.10	10.54	1.91	2.39	4.24	1.46	2165	Buff** St. H.
	1	17.73	9.07	1.96	2.38	5.26	1.80	2316	Buff**
	3	18.34	9.33	1.97	2.41	7.21	2.50	3644	Buff**
	5	18.27	9.26	1.97	2.42	7.48	2.57	3307	Buff**
	7	15.03	7.48	2.01	2.36	9.23	3.20	4045	Buff**
	9	14.49	6.99	2.07	2.08	12.15	4.24	2883*	Grayish buff**
	11	7.87	3.73	2.10	2.28	11.70	4.10	4928	Brown**
K120 1	02	17.00	8.57	1.98	2.39	10.18	3.52	2707	Dk. buff** St. H.
	1	12.17	5.95	2.07	2.30	14.33	5.05	2645	Dk. buff**
	3	10.17	4.97	2.04	2.28	12.96	4.54	3299	Dk. buff**
	5	10.11	4.88	2.05	2.34	13.35	4.68	3735	Dk. buff**
	7	7.38	3.54	2.08	2.25	14.70	5.16	1135*	Gray**
	9	5.78	2.72	2.13	2.26	16.63	5.91	4060	Gray**
	11	10.69	5.56	1.92	2.15	7.76	2.67	N.D.*	Brown**
K121 1	02	20.59	10.76	1.92	2.41	8.91	3.09	3488	Buff St. H.
	1	20.59	7.23	2.04	2.40	14.55	5.12	3961	Buff
	3	16.14	8.02	2.02	2.53	13.55	4.76	4209	Buff
	5	16.62	8.31	2.00	2.40	13.02	4.57	4651	Buff
	7	11.77	5.58	2.08	2.36	16.82	5.98	4423	Buff
	9	2.89	1.29	2.24	2.31	22.17	8.03	4913	Gray
	11	7.20	3.47	2.07	2.23	16.18	5.72	4406	Brown Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

* Cracked.

** Stained with calcium salts.

POSSIBILITIES FOR UTILIZATION

The materials classified as Pottery, Brick, and Tile Clays may further be divided into three groups. This secondary division is for the purpose of pointing out some differences in quality which affect the utilization of the clays.

Group 1 consists of clays represented by samples K11-1, K63-1, K72-1, K75-1, K82-1, and K121-1. These clays burn to clear even shades of cream and buff at low to medium-high temperatures and to gray at and above vitrification temperatures. Samples K75-1 and K82-1 are slightly contaminated with gypsum.

Group 2 consists of clays represented by samples K34—1-2, K100-2, and K101-1. These clays are similar to the group 1 variety except that the general color is slightly darker. Sample K34—1-2 is slightly contaminated with gypsum.

Group 3 consists of clays represented by samples K4-1, K12-2, K71-1, K95-1, K115-1, and K120-1. The general character of these clays is similar to those in groups 1 and 2 except that they burn to considerably darker colors and all contain soluble calcium salts.

The plastic properties of all clays in the three groups are excellent. The linear drying shrinkage ranges from medium to high but is not excessive considering the type of clay. Dry strength or modulus of rupture ranges from medium to high for the several clays. A number of these clays are definitely bond clays.

On burning, the clays become steel hard at low temperatures. Above cone 3 porosity and absorption values decrease very slowly. The firing shrinkage is low and fairly constant within the burning range of several cones. Some of the clays begin to bloat at cone 11, probably due to the decomposition of gypsum; however, the clays are not overburned at this temperature. Clays highest in silica have medium to high modulus of rupture values in the burned state. Clays highest in alumina have unusually high burned strength. Modulus of rupture values of 3,000 to 4,000 pounds per square inch are common, and some samples at certain temperatures are in the range of 6,000 to 7,000 pounds per square inch.

Those clays in group 1 free from gypsum and those in which the calcium salts may be rendered insoluble by addition of barium salts are suited for making various kinds of pottery such as art pottery, yellow ware, and kitchen ware. They are suitable for use in stone ware, and as the major ingredient in chemical stone ware. The clays highest in alumina and free from gypsum are suited for use as a medium-duty refractory bond clay for use in retorts, crucibles, and saggers.

Clays high in silica and free of gypsum are suited for the manufacture of wall tile and natural, salt glazed, and enameled facing tile and brick. Flower pots and garden pottery are possibilities.

Clays in groups 2 and 3 being of the same general variety as those in group 1 could normally be used for the same purpose; however, the burned colors are generally darker and staining by calcium salts is more prevalent. These clays are of lower grade and are less likely to be used as long as higher grade clays are available.

BRICK AND TILE CLAYS—RED BURNING

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Water of plasticity in percent	Drying shrinkage		Modulus of rupture in pounds per sq. inch	Color
			Volume in percent	Linear in percent		
K1	1–2	37.80	50.52	20.95	808	Brownish gray
K6	1	45.88	64.70	29.33	609	Reddish brown
K7	1	32.51	30.62	11.51	392	Brownish gray
K16	1–2	36.59	43.72	17.48	470	Brownish gray
K16	3	40.80	43.45	17.33	370	Lt. gray
K18	1	31.48	33.55	12.76	563	Yellowish brown
K21	1	37.42	39.79	15.56	316	Brownish gray
K21	2	31.17	30.08	11.25	350	Brownish gray
K33	1	37.89	42.70	16.94	469	Brownish gray
K33	2	46.62	54.41	23.09	641	Lt. gray
K36	1	33.43	46.37	18.77	650	Brownish gray
K37	1	37.13	53.33	22.47	636	Yellowish gray
K56	1	40.00	23.31	8.50	187	Lt. gray
K58	1–2	32.41	42.97	17.09	421	Brownish gray
K74	1	30.31	32.93	12.50	350	Yellowish gray
K80	1	28.87	35.89	13.78	542	Lt. gray
K83	1	39.70	59.07	25.77	704	Brownish gray
K94A	1	33.85	46.86	19.02	556	Reddish gray
K95	2	29.97	41.26	16.27	515	Brownish gray
K98	1	36.78	53.86	22.75	589	Reddish gray
K100	1	38.71	50.15	20.74	574	Reddish gray
K100	3	36.25	47.33	19.28	521	Gray
K101	2–3	34.04	29.95	11.21	316	Lt. gray

SCREEN ANALYSES

Sample K18-1

Retained on screen	Percent	Character of residue
60	4.97	Abundance of limonitic, arenaceous clay nodules; small amount of carbonaceous material.
100	2.90	Abundance of limonitic, arenaceous clay nodules, some not stained; considerable quantity of carbonaceous material; small amounts of quartz and muscovite.
250	7.54	Abundance of limonitic clay nodules; considerable quantity of quartz.
Cloth	84.59	Clay substance including residue from above.

Sample K21-2

Retained on screen	Percent	Character of residue
60	20.66	Abundance of lignitic, arenaceous clay nodules; small amounts of limonitic nodules and quartz; trace of plant fragments.
100	12.41	Abundance of gray clay nodules; considerable quantity of limonitic nodules; small amounts of white clay nodules and quartz; trace of ferruginous material.
250	10.80	Abundance of quartz; considerable quantity of clay nodules, some stained with limonite; small amount of ferruginous material.
Cloth	56.13	Clay substance including residue from above.

Sample K36-1

Retained on screen	Percent	Character of residue
60	3.82	Abundance of limonitic, arenaceous clay nodules; considerable quantity of plant fragments; small amounts of lignite and gray clay nodules; trace of gypsum.
100	5.46	Abundance of limonitic, arenaceous clay nodules; considerable quantity of white clay nodules; small amount of quartz.
250	13.66	Abundance of quartz; considerable quantities of limonitic-stained clay nodules and white clay nodules.
Cloth	77.06	Clay substance including residue from above.

SAMPLE K94A-1

Retained on screen	Percent	Character of residue
60	1.01	Abundance of gray clay nodules; considerable quantity of limonitic clay nodules.
100	.84	Abundance of quartz; considerable quantity of limonitic nodules; small amounts of lignite and muscovite.
250	3.88	Abundance of quartz; considerable quantity of limonitic clay nodules; small amount of muscovite.
Cloth	94.27	Clay substance including residue from above.

SAMPLE K100-1

Retained on screen	Percent	Character of residue
60	3.20	Abundance of gray clay nodules; considerable quantity of earthy hematite; small amount of quartz.
100	5.57	Abundance of quartz; considerable quantity of gray clay nodules; small amounts of earthy hematite and lignitic clay nodules.
250	5.50	Abundance of quartz; considerable quantities of hematite and gray clay nodules.
Cloth	85.73	Clay substance including residue from above.

SAMPLE K100-3

Retained on screen	Percent	Character of residue
60	8.13	Abundance of arenaceous gray clay nodules; small amounts of pyrite and lignite.
100	6.41	Abundance of arenaceous gray clay nodules; small amounts of quartz and pyrite.
250	15.87	Abundance of gray clay nodules; small amount of quartz.
Cloth	69.59	Clay substance including residue from above.

Alta Ray Gault, laboratory geologist.

CHEMICAL ANALYSES*

Sample K18-1

Ignition loss 5.52	Iron oxide, Fe_2O_3 ... 6.38	Magnesia, MgO 0.86
Silica, SiO_2 .... 67.08	Titania, TiO_2 .... 0.77	Manganese, MnO_2 ... 0.11
Alumina, Al_2O_3 ...... 17.92	Lime, CaO 0.22	Alkalies, (K_2O, Na_2O) 0.20

Sample K21-2

Ignition loss 4.63	Titania, TiO_2 .... 0.77	Manganese, MnO_2 ... 0.07
Silica, SiO_2 .... 70.85	Lime, CaO 0.68	Alkalies, (K_2O, Na_2O) 0.42
Alumina, Al_2O_3 ...... 16.76	Magnesia, MgO 0.93	Sulfur, SO_3 .... 0.24
Iron oxide, Fe_2O_3 .. 5.12		

Sample K36-1

Ignition loss 5.60	Iron oxide, Fe_2O_3 ... 4.79	Magnesia, MgO 1.00
Silica, SiO_2 .... 67.48	Titania, TiO_2 .... 0.69	Manganese, MnO_2 None
Alumina, Al_2O_3 ...... 19.97	Lime, CaO .... None	Alkalies, (K_2O, Na_2O) 0.17

Sample K94A-1

Ignition loss 6.47	Titania, TiO_2 .... 0.73	Manganese, MnO_2 None
Silica, SiO_2 .... 67.82	Lime, CaO 0.22	Alkalies, (K_2O, Na_2O) 0.55
Alumina, Al_2O_3 ...... 17.48	Magnesia, MgO 1.65	Sulfur, SO_3 .... 0.78
Iron oxide, Fe_2O_3 ... 4.20		

Sample K100-1

Ignition loss 6.60	Iron oxide, Fe_2O_3 ... 5.70	Magnesia, MgO 0.77
Silica, SiO_2 .... 65.35	Titania, TiO_2 .... 0.83	Manganese, MnO_2 None
Alumina, Al_2O_3 ..... 20.03	Lime, CaO .... None	Alkalies, (K_2O, Na_2O) 0.28

Sample K100-3

Ignition loss 5.57	Iron oxide, Fe_2O_3 ... 4.66	Magnesia, MgO 1.39
Silica, SiO_2 .... 69.80	Titania, TiO_2 .... 0.73	Manganese, MnO_2 None
Alumina, Al_2O_3 ...... 17.07	Lime, CaO 0.49	Alkalies, (K_2O, Na_2O) 0.37

* Samples ground to pass 250-mesh screen.

B. F. Mandlebaum, analyst.

PYRO-PHYSICAL PROPERTIES

Test Holes K1, K6, K7, K16, K18

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
K1 1-2	02	17.71	9.15	1.94	2.35	8.74	3.02	2496	Dull red** St. H.
	1	10.21	4.87	2.09	2.34	14.10	4.94	N.D.	Dull red**
	3	11.38	5.58	2.04	2.66	13.76	4.83	N.D.	Dull red**
	5	9.19	4.37	2.11	2.31	15.99	5.65	N.D.	Dull red**
	7	5.40	3.07	2.06	2.17	14.40	5.45	N.D.	Dull red**
	9	6.62	3.12	2.12	2.27	16.58	5.87	N.D.	Dull red**
K6 1	02	22.61	12.19	1.88	2.54	7.65	2.64	1750	Lt. red Ch.
	1	21.85	10.93	2.00	2.56	10.52	3.67	N.D.	Lt. red Ch.
	3	21.53	10.97	1.96	2.49	10.38	3.59	3003	Lt. red Ch., St. H.
	5	20.60	10.09	2.03	2.57	14.96	5.27	3403*	Red Ch.
	7	20.11	9.84	2.02	2.52	13.67	4.79	2523*	Red Ch.
	9	15.65	7.31	2.14	2.47	18.82	6.74	2653*	Reddish brown Ch.
	11	7.15	3.75	1.91	2.05	13.76	4.83	N.D.	Reddish brown Ch.
K7 1	02	32.84	18.68	1.75	2.59	2.54	0.87	1206	Lt. red
	1	31.19	17.24	1.81	2.63	5.00	1.70	N.D.	Lt. red
	3	32.19	18.36	1.78	2.63	4.62	1.59	1414	Red
	5	27.37	14.67	1.87	2.65	4.68	1.59	1306	Red St. H.
	7	29.11	15.42	1.87	2.81	8.74	3.02	1455	Red
	9	19.46	9.65	2.02	2.50	15.84	5.61	1526	Brown
	11	15.81	7.75	2.06	2.46	17.66	6.29	2115	Brown
K16 1-2	02	26.86	14.21	1.89	2.48	7.89	2.74	1154	Lt. red
	1	26.20	13.82	1.90	2.57	5.98	2.04	N.D.	Lt. red
	3	25.09	13.26	1.88	2.53	7.71	2.67	2497	Red
	5	16.94	8.24	2.57	2.48	15.52	5.50	2574	Red St. H.
	7	15.00	7.00	1.95	2.49	10.91	3.81	2655	Red
	9	15.03	7.10	2.12	2.43	17.63	6.32	2979	Reddish brown
	11	5.71	2.70	2.11	2.29	17.67	6.29	N.D.	Brown
K16 3	02	28.20	15.50	1.82	2.53	8.68	2.99	1770	Salmon St. H.
	1	22.83	11.80	1.93	2.51	15.33	5.42	N.D.	Salmon
	3	19.49	10.24	1.90	2.35	12.26	4.28	2110	Red
	5	19.25	9.86	1.95	2.42	15.13	5.35	1983*	Red
	7	17.42	8.77	2.01	2.41	16.78	5.95	779*	Brown
	9	20.22	10.76	1.72	2.15	3.29	1.11	1755*	Brown
	11	6.68	3.87	1.73	1.85	3.65	1.25	N.D.	Brown Bl.
K18 1	02	24.52	12.91	1.94	2.56	9.70	3.34	1635	Red
	1	21.36	10.73	2.01	2.56	12.56	4.39	2355	Red St. H.
	3	22.67	11.48	1.98	2.55	11.78	4.10	2444	Red
	5	21.88	11.01	1.99	2.54	12.48	4.35	2135	Red
	7	16.64	8.18	2.05	2.46	14.89	5.24	3230	Red
	9	12.47	5.77	2.16	2.47	19.42	6.98	3708	Brown
	11	3.69	1.72	2.15	2.23	18.79	6.71	N.D.*	Brown Bl.

Abbreviations: Ch., checked; Bl., bloated; St. H., steel hard.

* Cracked.

** Stained with calcium salts.

TEST HOLES K21, K33, K36, K37, K56

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
K21 1	02	33.15	11.97	1.78	2,66	3.23	1.11	1022	Lt. red
	1	34.98	14.54	1.84	3.38	7.53	2.60	1124	Lt. red
	3	29.50	15.91	1.85	2.63	7.60	2.60	1082	Red St. H.
	5	27.07	10.86	1.91	2.62	10.48	3.63	1270	Red
	7	25.89	10.10	1.88	3.01	8.82	3.06	1275	Red
	9	23.25	11.69	1.99	2.59	13.89	4.87	1584	Brown
	11	20.43	9.99	2.05	2.57	16.11	5.72	1972	Brown
K21 2	02	31.30	17.18	1.82	2.65	4.36	1.49	1014	Salmon
	1	26.44	14.88	1.85	2.22	5.82	2.01	N.D.	Salmon St. H.
	3	26.63	14.37	1.85	2.53	6.39	2.18	1116	Red
	5	21.49	10.82	2.04	2.54	13.02	4.57	1284	Red
	7	25.84	13.48	1.94	2.62	10.38	3.59	1450	Red
	9	12.43	6.08	2.05	2.34	15.54	5.50	1548	Brown
K33 1	02	31.17	16.82	1.86	2.70	9.97	3.45	1836	Salmon St. H.
	1	30.21	16.06	1.91	2.62	14.76	5.20	1669	Salmon
	3	32.20	17.49	1.84	2.73	9.68	3.34	1758	Lt. red
	5	27.46	14.12	1.95	2.79	14.05	4.94	1774	Lt. red
	7	28.73	14.87	1.93	2.75	14.64	5.16	1908	Lt. red
	9	23.36	11.58	2.02	2.63	17.10	6.06	2010	Red
	11	25.00	11.85	2.02	2.66	17.50	6.21	2909	Red
K33 2	02	22.44	11.87	1.88	2.43	30.62	11.51	2664	Lt. red** St. H.
	1	18.63	8.97	2.08	2.59	31.58	11.89	1196	Lt. red**
	3	15.38	8.03	1.98	2.36	29.02	10.83	1129	Lt. red**
	5	9.77	4.66	2.09	2.32	24.99	9.14	1268	Reddish brown**
	7	9.45	4.49	2.11	2.33	25.03	9.18	2277	Reddish brown**
	9	9.85	4.57	2.15	2.39	27.21	10.08	4254	Reddish brown**
	11	7.00	3.57	1.96	2.12	20.14	7.25	N.D.*	Brown**
K36 1	02	20.21	10.58	1.94	2.43	5.89	2.01	2340	Salmon St. H.
	1	23.08	11.43	2.02	2.67	3.52	1.21	3130	Salmon
	3	18.04	8.99	2.00	2.45	9.15	3.17	2791	Red
	5	15.90	7.81	2.04	2.42	10.70	3.70	2741	Red
	7	14.18	6.71	2.11	2.46	13.79	4.79	4359	Red
	9	12.73	5.94	2.14	2.46	15.00	5.27	3613	Brown
	11	5.78	2.94	1.97	2.09	7.96	2.74	N.D.*	Brown Bl.
K37 1	02	3.92	1.85	2.19	2.28	18.56	6.63	3654	Salmon St. H.
	1	1.48	0.67	2.22	2.25	18.99	6.78	N.D.	Salmon
	3	2.90	1.34	2.16	2.28	17.18	6.10	4418	Salmon
	5	1.05	0.50	2.25	2.27	20.52	7.30	3265	Reddish brown
	7	0.27	0.22	2.21	2.21	18.92	6.78	6499	Reddish brown
K56 1	02	35.45	21.25	1.67	2.87	12.93	4.54	850	Salmon**
	1	28.01	15.04	1.86	2.58	22.72	8.26	1193	Salmon** St. H.
	3	23.93	12.31	1.61	2.55	25.34	9.31	2142	Reddish brown**
	5	21.92	11.18	1.63	2.51	25.88	9.51	1602	Reddish brown**
	7	14.33	6.74	2.13	2.46	31.84	12.02	2062	Brown**
	9	11.08	5.73	1.93	2.18	25.00	9.14	2849	Brown**

Abbreviations: Bl., bloated; St. H., steel hard.

* Cracked.

** Stained with calcium salts.

TEST HOLES K58, K74, K80, K83, K94A, K95

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks	
K58 1-2	02	14.04	6.65	2.11	2.46	14.58	5.12	2801	Lt. red**	St. H.
	1	9.27	4.29	2.23	2.41	19.34	6.94	3313	Lt. red**	
	3	7.63	3.43	2.16	2.38	16.44	5.83	4177	Lt. red**	
	5	6.74	2.87	2.23	2.39	18.99	6.78	4352	Dk. red**	
	7	1.86	0.86	2.17	2.22	17.25	6.14	5202	Reddish brown**	
	9	0.61	0.27	2.26	2.28	20.23	7.28	5801	Reddish brown**	
K74 1	02	27.53	14.75	1.87	2.58	5.84	2.01	1422	Red	St. H.
	1	25.47	13.20	1.93	2.53	8.49	2.92	N.D.	Red	
	3	24.75	12.97	1.91	2.54	8.23	2.81	1841	Red	
	5	25.24	13.24	2.07	2.55	7.83	2.67	1849	Dk. red	
	7	20.87	10.46	2.99	2.52	12.85	4.50	2553	Dk. red	
	9	13.65	6.64	2.06	2.38	15.10	5.31	N.D.	Brown	
K80 1	02	15.74	7.78	2.02	2.40	10.42	3.59	3180	Salmon	St. H.
	1	11.08	5.25	2.11	2.33	14.59	5.12	N.D.	Salmon	
	3	8.99	4.24	2.12	2.33	14.96	5.27	4999	Lt. red	
	5	9.45	4.40	2.15	2.37	16.00	5.65	N.D.	Lt. red	
	7	4.22	2.03	2.09	2.18	13.74	4.79	N.D.	Brown	Bl.
K83 1	02	19.93	10.62	1.87	2.34	5.66	1.94	1771	Salmon	St. H.
	1	17.53	8.94	1.96	2.38	8.19	2.81	N.D.	Salmon	
	3	17.97	9.24	1.94	2.26	8.41	2.92	2739	Buff	
	5	19.15	9.90	1.94	2.39	8.41	2.92	4099	Buff	
	7	14.52	7.27	2.00	2.34	11.44	3.99	N.D.	Buff	
	9	14.89	7.31	2.03	2.39	12.87	4.50	N.D.	Grayish buff	
	11	8.42	4.11	2.07	2.26	14.38	5.05	N.D.	Grayish buff	
K94A 1	02	18.85	9.60	1.96	2.42	7.37	2.53	3271	Salmon**	St. H.
	1	15.19	7.49	2.03	2.36	9.65	3.34	3815	Salmon**	
	3	14.84	7.39	2.01	2.36	9.78	3.38	3360	Salmon**	
	5	16.24	8.06	2.02	2.40	10.03	3.49	3317	Salmon**	
	7	8.84	4.17	2.11	2.32	14.41	5.09	2912	Grayish brown**	
	9	5.84	2.56	2.14	2.27	15.58	5.50	3370	Brown**	
K95 2	02	17.32	8.66	2.00	2.42	9.04	3.13	2417	Salmon	St. H.
	1	16.54	7.95	2.05	2.11	10.66	3.70	2544	Lt. red	
	3	12.21	5.76	2.07	2.36	12.08	4.21	2746	Lt. red	
	5	9.97	4.76	2.09	2.33	12.92	4.54	2748	Lt. red	
	7	8.29	3.92	2.12	2.31	13.95	4.90	3268	Red	
	9	10.83	5.02	2.15	2.37	15.60	5.50	4689	Brown	
	11	5.94	2.91	2.04	2.17	11.23	3.92	3312	Brown	

Abbreviations: Bl., bloated; St. H., steel hard.

** Stained with calcium salts.

TEST HOLES K98, K100, K101

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks	
K98 1	02	15.21	7.49	2.03	2.33	11.87	4.14	2700	Salmon**	St. H.
	1	7.18	3.34	2.15	2.31	15.11	5.35	2255	Lt. red**	
	3	7.36	3.51	2.10	2.23	14.22	5.01	2328	Lt. red**	
	5	6.76	3.15	2.15	2.30	16.26	5.76	3103	Dk. red**	
	7	5.59	2.60	2.15	2.28	16.30	5.76	3712	Dk. red**	
	9	6.06	2.75	2.21	2.35	17.94	6.40	4834	Brown**	
K100 1	02	19.27	9.69	1.98	2.46	11.77	4.10	3439	Salmon	St. H.
	1	15.46	7.59	2.12	2.41	15.17	5.35	4365	Salmon	
	3	12.15	5.76	2.04	2.41	14.00	4.90	3015	Salmon	
	5	9.09	4.20	2.16	2.37	19.18	6.86	2862	Red	
	7	5.99	2.75	2.18	2.32	19.93	7.17	3379	Red	
	9	7.63	3.46	2.20	2.39	20.96	7.56	4844	Brown	
	11	6.61	3.32	2.00	2.14	12.94	4.54	4532	Brown	
K100 3	02	25.43	13.30	1.88	2.51	3.11	1.08	2129	Salmon	
	1	22.63	11.73	1.93	2.49	4.76	1.63	2644	Lt. red	
	3	21.57	11.22	1.92	2.45	5.26	1.80	2807	Lt. red	
	5	20.90	10.80	1.94	2.45	6.07	2.08	3062	Red	St. H.
	7	20.47	10.48	1.95	2.46	6.37	2.18	3300	Red	
	9	19.58	10.90	1.80	2.24	–1.63	–.57	2241	Reddish brown	
	11	12.31	6.52	1.87	2.14	3.92	2.39	2324	Brown	
K101 2-3	02	28.50	16.90	1.77	2.53	7.71	2.67	1932	Buff	St. H.
	1	29.97	12.27	1.88	2.45	11.86	4.14	N.D.	Buff	
	3	23.74	12.65	1.88	2.48	12.58	4.39	3350	Salmon	
	5	23.18	11.92	1.92	2.48	11.34	3.95	3624	Salmon buff	
	7	18.91	9.56	1.98	2.44	17.17	6.17	2626	Salmon buff	
	9	12.85	6.29	2.04	2.34	19.76	7.09	N.D.	Grayish buff	
	11	9.51	5.38	1.77	1.96	7.78	2.67	N.D.	Brown	Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

** Stained with calcium salts.

POSSIBILITIES FOR UTILIZATION

The samples classified as Brick and Tile Clays—Red Burning represent a variety of clays of variable quality. Sample K6-1 cracks on burning, and sample K33-2 has a rather high total shrinkage, and neither are considered as being of economic value. All other samples have commercial possibilities and may be grouped into three qualities based on linear drying shrinkage. The linear drying shrinkage may be decreased in commercial practice by coarse grinding and limiting the water used to develop plasticity to the minimum. Thus, clays which have a high drying shrinkage and a normal to low burning shrinkage may be successfully utilized in making various kinds of brick and tile. Samples having normal drying and burning shrinkages are as follows: K7-1, K18-1, K21-2, K56-1, K74-1, K80-1, and K101—2-3. These clays are well suited for the manufacture of face brick and common brick, hollow tile, partition tile, drain tile, and possibly sewer pipe. They burn steel hard at low temperatures and do not overburn below cone 11. The firing shrinkage is low and changes only slightly over a firing range of several cones. The fired colors are somewhat dull and some of the samples are stained with calcium salts.

The second quality group has a higher average drying shrinkage but may be utilized by controlling the grinding and water content. These clays are generally suitable for the same products as mentioned above. The clays in this group are: K16—1-2, K16-3, K21-1, K33-1, K58—1-2, and K95-2.

The third quality group has a high average drying shrinkage and could better be used after a pre-heating treatment to reduce drying shrinkage or by adding non-plastic material such as sand or grog. The firing shrinkage is generally low, and the firing range is more than adequate for most heavy clay products. The clays in this group are: K1—1-2, K6-1, K36-1, K37-1, K83-1, K94A-1, K98-1, K100-1, and K100-3.

MISCELLANEOUS CLAYS

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Water of plasticity in percent	Drying shrinkage		Modulus of rupture in pounds per sq. inch	Color
			Volume in percent	Linear in percent		
K1	3	39.05	33.84	12.89	493	Gray
K4	2	37.66	43.57	17.38	430	Gray
K7	2	34.16	26.35	9.71	413	Gray
K7	3	34.64	39.21	15.33	589	Gray
K11	2	34.83	31.14	11.72	506	Gray
K11	3	32.95	34.54	13.20	630	Gray
K13	2	43.03	61.17	27.06	475	Lt. gray
K18	2	40.70	60.02	26.38	570	Lt. gray
K26	1	38.94	53.97	22.81	798	Lt. gray
K40	1	41.72	60.98	26.94	874	Brownish gray
K54	1	41.37	61.55	27.31	639	Lt. gray
K63	2	38.49	47.48	19.33	745	Gray
K63	3	35.30	49.71	20.52	552	Gray
K64	1	33.69	44.53	17.87	674	Lt. gray
K74	2	41.25	46.74	18.97	720	Gray
K87	1	35.29	49.88	20.57	643	Lt. gray
K92	1–2	36.89	45.41	18.32	586	Lt. gray
K112	2	42.88	44.28	17.72	630	Gray
K112	1	41.01	54.57	23.14	662	Yellowish brown

SCREEN ANALYSES

SAMPLE K11-2

Retained on screen	Percent	Character of residue
60	4.93	Abundance of micaceous, lignitic clay nodules; traces of lignite and limonite.
100	5.13	Abundance of micaceous, lignitic clay nodules; trace of limonite.
250	6.47	Abundance of gray clay nodules; small amounts of quartz and limonite.
Cloth	83.47	Clay substance including residue from above.

SAMPLE K26-1

Retained on screen	Percent	Character of residue
60	3.99	Abundance of white clay and gray clay nodules; considerable quantity of pyrite; small amounts of lignitic and ferruginous material.
100	3.28	Abundance of white clay and gray clay nodules; considerable quantity of quartz; small amounts of lignite and ferruginous material; trace of pyrite.
250	3.96	Abundance of clay nodules; considerable quantity of quartz; small amounts of lignite, muscovite, and ferruginous material.
Cloth	88.77	Clay substance including residue from above.

SAMPLE K64-1

Retained on screen	Percent	Character of residue
60	4.74	Abundance of gray clay nodules; considerable quantity of gypsum; small amount of plant fragments; trace of limonite.
100	1.74	Abundance of gray clay nodules; small amount of limonitic-stained nodules; traces of limonite, quartz, and ferruginous material.
250	2.02	Abundance of clay nodules; small amount of ferruginous material; trace of muscovite.
Cloth	91.50	Clay substance including residue from above.

Alta Ray Gault, laboratory geologist.

CHEMICAL ANALYSES*

Sample K11-2

Ignition loss 6.55
Silica, SiO_2 .... 67.00
Alumina, Al_2O_3 .... 17.24
Iron oxide, Fe_2O_3 ... 4.87
Titania, TiO_2 .... 0.75
Lime, CaO 1.91
Magnesia, MgO 0.78
Manganese, MnO_2 .... 0.18
Alkalies, (K_2O, Na_2O) 0.31

Sample K26-1

Ignition loss 7.32
Silica, SiO_2 .... 65.46
Alumina, Al_2O_3 .... 18.99
Iron oxide, Fe_2O_3 .. 4.36
Titania, TiO_2 .... 0.81
Lime, CaO 0.73
Magnesia, MgO 1.09
Manganese, MnO_2 None
Alkalies, (K_2O, Na_2O) 0.40
Sulfur, SO_3 .... 0.28

Sample K64-1

Ignition loss 6.04
Silica, SiO_2 .... 63.38
Alumina, Al_2O_3 .... 19.97
Iron oxide, Fe_2O_3 .. 5.04
Titania, TiO_2 .... 0.63
Lime, CaO 0.88
Magnesia, MgO 1.07
Manganese, MnO_2 ... 0.25
Alkalies, (K_2O, Na_2O) 0.66
Sulfur, SO_3 .... 1.34

* Samples ground to pass 250-mesh screen.

B. F. Mandlebaum, analyst.

PYRO-PHYSICAL PROPERTIES

TEST HOLES K1, K4, K7, K11, K13, K18, K26, K40, K54, K63

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks	
K1 3	02	22.05	11.55	1.89	2.44	16.45	5.83	2894	Dull red	St. H.
	1	10.47	5.61	1.88	2.10	8.42	2.92	N.D.	Dull red	Bl.
	3	10.64	8.82	1.20	1.52	-31.45	-11.85	N.D.	Dull red	Bl.
K4 2	02	12.40	6.18	2.11	2.36	17.29	6.14	2961	Dull red	St. H.
	1	4.24	2.15	2.06	2.05	15.52	5.50	N.D.	Dull red	Bl.
	3	7.29	3.59	2.19	2.16	17.13	6.10	4543	Dull red	Bl.
K7 2	02	14.80	7.57	1.96	2.27	19.22	6.90	3391	Dull red*	
K7 3	02	9.97	4.86	2.72	2.30	18.92	6.78	5295	Dull red	St. H.
	1	10.28	6.15	1.68	1.87	-2.34	-.81	N.D.	Dull red	Bl.
	3	15.72	9.75	1.62	1.94	-3.38	-1.15	3684	Dull red	Bl.
K11 2	02	10.94	5.03	2.18	2.44	26.10	9.59	3383	Dull red	St. H.
	1	6.28	3.93	1.61	1.71	3.74	1.28	N.D.	Dull red	Bl.
	3	9.43	5.92	1.61	1.78	1.01	0.37	3694	Dull red	Bl.
K11 3	02	18.24	9.18	2.05	2.43	14.69	5.16	3053	Dull red	St. H.
	1	12.60	7.06	1.79	2.05	5.12	1.72	N.D.	Dull red	Bl.
	3	14.46	11.59	1.24	1.45	-36.62	-14.09	1628	Dull red	Bl.
K13 2	02	9.68	4.56	2.14	2.35	17.47	6.21	2078	Dull red**	St. H.
	1	4.67	2.04	2.12	2.21	16.58	5.87	N.D.	Dull red**	Bl.
	3	7.38	3.94	1.88	2.03	7.77	2.67	1111	Dull red**	Bl.
K18 2	02	11.97	5.66	2.12	2.40	15.97	5.65	2077	Dull red**	St. H.
	1	5.73	2.83	2.02	2.11	11.83	4.14	N.D.	Dull red**	Bl.
	3	21.78	12.93	1.61	2.03	-11.18	-3.88	3136	Dull red**	Bl.
K26 1	02	12.22	5.88	2.07	2.36	14.73	5.20	2545	Dull red**	St. H.
	1	6.79	3.31	2.02	2.18	13.64	4.79	N.D.	Dull red**	Bl.
	3	12.55	7.44	1.69	1.93	-4.16	-1.42	Bl.	Dull red**	Bl.
K40 1	02	9.68	4.69	2.05	2.52	14.62	5.16	3913	Dull red	St. H.
	1	6.11	3.55	1.78	2.01	-.90	-3.09	N.D.	Dull red	Bl.
	3	18.66	15.82	1.19	1.46	-47.47	-19.33	N.D.	Dull red	Bl.
K54 1	02	15.55	7.83	1.98	2.35	7.67	2.64	2681	Buff**	.St. H
	1	11.92	5.88	2.06	2.34	9.36	6.94	N.D.	Buff**	
	3	8.49	3.94	2.05	2.29	11.81	4.14	3836	Buff**	
K63 2	02	10.52	5.06	2.08	2.32	14.34	5.05	4827	Buff	St. H.
	1	1.06	0.63	2.02	2.15	11.97	4.17	N.D.	Buff	
	3	10.24	5.45	1.87	2.18	7.39	2.53	3936	Buff	Bl.
K63 3	02	21.92	11.34	1.93	2.47	8.41	2.88	1443	Dull red	St. H.
	1	22.16	11.92	1.24	2.37	0.62	0.24	N.D.	Dull red	
	3	29.60	23.62	1.24	1.76	-41.93	-16.60	N.D.	Dull red	Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

* Iron pops.

** Stained with calcium salts.

TEST HOLES K64, K74, K87, K92, K112

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
K64 1	02	14.37	7.16	2.15	2.35	12.57	4.39	3316	Dull red** St. H.
	1	6.81	3.75	1.17	1.94	7.24	2.50	N.D.	Dull red** Bl.
	3	13.55	11.54	1.17	1.32	-42.78	-16.99	N.D.	Dull red** Bl.
K74 2	02	19.70	12.66	1.56	1.94	-8.28	-2.85	1858	Dull red Bl., St. H.
K87 1	02	10.05	5.24	2.70	2.30	13.43	4.72	3729	Dull red** St. H.
	1	8.75	4.30	2.04	2.18	11.34	3.95	N.D.	Dull red** Bl.
	3	10.14	5.40	1.88	2.09	4.93	1.70	3927	Dull red** Bl.
K92 1-2	02	15.02	7.55	1.99	2.35	11.47	3.99	2558	Dull red** St. H.
	1	12.12	5.78	2.09	2.39	16.50	5.83	N.D.	Dull red**
	3	5.61	2.60	2.16	2.28	18.27	6.52	3819	Dull red**
K112 1	02	11.17	5.20	2.15	2.42	20.13	7.25	1330	Dull red St. H.
	1	2.38	1.21	2.24	2.29	23.23	8.46	N.D.	Dull red
	3	5.71	2.79	2.05	2.17	16.45	5.83	3486	Dull red
K112 2	02	15.95	8.09	1.97	2.31	19.54	7.01	3385	Dull red St. H.
	1	4.56	2.16	2.12	2.19	26.97	9.99	N.D.	Dull red
	3	9.91	6.84	1.48	1.65	-7.46	-2.57	N.D.	Dull red Bl.

Abbreviations: Bl., bloated; St. H., steel hard.

** Stained with calcium salts.

POSSIBILITIES FOR UTILIZATION

The samples classified as Miscellaneous Clays are characterized by their high drying shrinkage and their high modulus of rupture values in the unburned state. The clays are steel hard at cone 02 and have a very short firing range. The modulus of rupture values in the burned state are high for samples that could be tested. Most of the test pieces either cracked or bloated and could not be tested.

The clays are limited in their application for ceramic products. They could serve as a bonding material in less plastic clays and as a flux in refractory clays. Samples K1-3, K11-2, K11-3, K40-1, K63-3, K64-1, and K112-2 bloat at low temperatures forming a light-weight vesicular mass. These clays when burned under conditions most favorable to the development of the vesicular structure could be later crushed for use as a vitrified light-weight aggregate in concrete.

LABORATORY PROCEDURE

PREPARATION

Preliminary drying of the clays was unnecessary, for they had been collected in the field and stored in a steam-heated laboratory several months prior to testing. Primary samples of about 200 pounds were crushed in a No. 2 jaw crusher. The crushed material was screened through a No. 20-mesh Tyler standard screen; residue coarser than 20-mesh was ground in a burr mill until it passed the 20-mesh screen. The clay which had passed 20-mesh screen was thoroughly mixed and reduced to a 10-pound sample by coning and quartering. This operation was accomplished in a metal lined tray approximately 4 feet square and 8 inches deep. The 10-pound sample was reserved for screen analysis, chemical analysis, and for making pyrometric cones. Approximately 75 pounds of clay from the remainder was mixed with water and kneaded by hand to a plastic consistency. The plastic mass was divided into small portions and thoroughly wedged to remove entrapped air and to develop a homogenous plastic body. The small portions were recombined in the same manner and stored in a metal lined damp box until used for making test pieces.

FORMING OF TEST PIECES

Test pieces were of two sizes: short bars, 1 inch square by 2 inches long, and long bars, 1 inch square by 7 inches long. The test pieces were made by wire-cutting bars of approximate size from the plastic mass and pressing in molds to the final size. The long bars were pressed by hand in a hardwood mold of the plunger type. The short bars were formed in a Patterson screw press fitted with a steel die. Each test piece was identified as to test hole number, sample number, and individual piece number. The identification was made by stamping the necessary letters and numerals on the test pieces. A shrinkage mark of 10 centimeters was stamped on the long bars. Sixty long bars and thirty short bars were made from each primary clay sample. Certain samples were not large enough to make the full number of test pieces.

PLASTIC, DRY, AND WORKING PROPERTIES

Immediately on forming the short bars their plastic volume was determined in a mercury volumeter. The plastic weight was measured to 0.01 gram using a triple beam balance. All of the test pieces were allowed to air-dry several days cn slatted wooden pallets and then oven-dry by gradually increasing the temperature of the oven from room temperature to 100°C. in 4 hours and maintaining the oven temperature between 100°C. and 110°C. for an additional hour. After drying, the short bars were placed in descicators, and on cooling to room temperature they were reweighed, and the volume was determined as above described. Five long bars were broken on a Fairbanks cross-breaking machine to determine modulus of rupture.

The workability of the clay was observed during grinding, wedging. and the forming of the test pieces. The water of plasticity, modulus of rupture, and volume shrinkage were calculated by methods outlined by the American Ceramic Society. The linear shrinkage was calculated from the volume shrinkage and is based on the dry volume.

FIRED PROPERTIES

The long and short bars were burned in a down-draft surface combustion kiln especially designed for the purpose. Butane gas was used for fuel. Oxidizing conditions were maintained in the kiln during the entire period of firing. The test pieces were stacked criss-cross in the kiln to permit complete circulation of gases. The kiln was fired at the rate of 200°F. per hour to within 200°F. of the maximum temperature. The last 200°F. rise was accomplished in two to three hours. The rate of firing was measured by means of a Chromel-Alumel thermocouple up to 2,100°F., at which point the couple was withdrawn from the kiln; and, by means of pyrometric cones above 2,100°F.

On completing the firing of the long and short test pieces the kiln was cooled gradually in twenty-four to thirty-six hours, after which the short bars were immediately placed in descicators and weighed to an accuracy of 0.01 gram on a triple beam balance. After weighing, the bars were placed in water which was then heated to the boiling point and was kept boiling for four hours. They were allowed to cool in the water to room temperature and were reweighed as before mentioned. Immediately thereafter the volumes of the test pieces were determined in a mercury volumeter. Volume shrinkage, porosity, absorption, bulk specific gravity, and apparent specific gravity were calculated in accordance with methods outlined by the American Ceramic Society. The long bars were broken on a Fairbanks testing machine to determine modulus of rupture. Five long bars were burned and tested for each clay at each cone temperature indicated in the table of pyro-physical properties. Three short bars were fired as test pieces for each clay at each cone temperature.

CONVERSION TABLE

CONES TO TEMPERATURES

Cone No.	When fired slowly, 20°C per hour		When fired rapidly, 150°C. per hour	
	°C	°F	°C	°F
010	890	1,634	895	1,643
09	930	1,706	930	1,706
08	945	1,733	950	1,742
07	975	1,787	990	1,814
06	1,005	1,841	1,015	1,859
05	1,030	1,886	1,040	1,904
04	1,050	1,922	1,060	1,940
03	1,080	1,976	1,115	2,039
02	1,095	2,003	1,125	2,057
01	1,110	2,030	1,145	2,093
1	1,125	2,057	1,160	2,120
2	1,135	2,075	1,165	2,129
3	1,145	2,093	1,170	2,138
4	1,165	2,129	1,190	2,174
5	1,180	2,156	1,205	2,201
6	1,190	2,174	1,230	2,246
7	1,210	2,210	1,250	2,282
8	1,225	2,237	1,260	2,300
9	1,250	2,282	1,285	2,345
10	1,260	2,300	1,305	2,381
11	1,285	2,345	1,325	2,417
12	1,310	2,390	1,335	2,435
13	1,350	2,462	1,350	2,462
14	1,390	2,534	1,400	2,552
15	1,410	2,570	1,435	2,615
16	1,450	2,642	1,465	2,669
17	1,465	2,669	1,475	2,687
18	1,485	2,705	1,490	2,714
19	1,515	2,759	1,520	2,768
20	1,520	2,768	1,530	2,786

Cone No.	When heated at 100°C per hour		Cone No.	When heated at 100°C per hour	
	°C	°F		°C	°F
23	1,580	2,876	32	1,700	3,092
26	1,595	2,903	33	1,745	3,173
27	1,605	2,921	34	1,760	3,200
28	1,615	2,939	35	1,785	3,245
29	1,640	2,984	36	1,810	3,290
30	1,650	3,002	37	1,820	3,308
31	1,680	3,056	38	1,835	3,335

The properties and uses of pyrometric cones: The Standard Pyrometric Cone Company, Columbus, Ohio.

SCREEN ANALYSES

A quantity of clay from each quartered sample was dried at 110°C.-constant-weight, after which exactly 100 grams were blunged in approximately two liters of water by pouring the slip back and forth until all the substance apparently disintegrated.

The disintegrated clay in slip form was poured through a nest of Tyler standard screens, the sizes being 60, 100, and 250. The material passing through the 250-mesh screen was caught on a cloth in a plaster vat. After a fair sample was caught on the cloth, the screens, still in nest, were then washed with a stream of water until no further material passed through the screens. The screens were dried at 110°C., after which the residue from each screen was weighed and collected in glass vials for further study.

It is evident that the above treatment would not completely disintegrate all of the clay nodules; and, though this could have been accomplished by blunging with rubber balls, it was not the purpose of this screen analysis to break the clay down to a finer state of division than would ordinarily occur in usual commercial blunging procedure; consequently, the screen analysis will show residue as "clay nodules" which indicates that a very thorough blunging will be necessary to disintegrate completely the clay in commercial use.

The residue from each screen was examined carefully under a binocular microscope. The finer material was examined under a petrographic microscope. Determinations were made from the physical appearance of mineral grain and crystal form corroborated by use of physical properties test, magnetized needle, reactions to wet reagents; and, where grain size permitted, blow pipe analyses were made.

Undoubtedly there were minerals present in the clays that could not be distinguished under the microscope, because of their fine state of division. However, those that have been recorded have been definitely identified.

Terms used in the tables of screen analyses for describing quantity of residue are: "abundance," meaning one-half or more of residue on screen; "considerable quantity," between one-fourth and one-half; "small amount," less than one-fourth; and "trace," few grains scattered throughout residue.

CHEMICAL ANALYSES

Grinding: Samples were ground to pass a 100-mesh screen.

Ignition loss: One gram of each sample was heated in a platinum crucible at full heat of a blast burner for one hour.

Silica: Ignited samples were fused with 6 to 8 times their weight of anhydrous sodium carbonate, and the fusion dissolved in dilute of hydrochloric acid. The samples were double dehydrated with hydrochloric acid. The silica was filtered off, washed, ignited, weighed, volatilized by hydrofluoric acid, and the crucible reweighed. SiO_2 was found by loss in weight. Any residue after evaporation was fused with sodium carbonate and dissolved in the original filtrate for alumina determination.

Alumina: Alumina, iron, and titania were precipitated together by ammonium hydroxide in the presence of ammonium chloride. Double precipitations were necessary to remove all the chlorides. The mixed hydroxides were filtered off, washed free of chlorides, ignited, and weighed. The weight represents the total of alumina, iron, and titania. The mixed oxides were fused with potassium bisulphate and dissolved in dilute sulphuric acid. In some cases a small amount of silica was recovered by filtration, ignition, and volatilization with hydrofluoric acid. This amount was added to silica and deducted from alumina.

Iron: An aliquot of the solution of bisulfate solution was reduced with aluminum dust in sulphuric acid solution and titrated with standard potassium permanganate solution. The iron was calculated as Fe_2O_3.

Titania: Another aliquot of the bisulfate solution was placed in a Schreiner type colorimeter tube and a few drops of hydrogen peroxide added. This solution was compared in color with a standard titania solution. The total of iron and titania was subtracted from the mixed precipitate of alumina, iron, and titania, leaving alumina.

Manganese: Manganese was removed from the sample used for the ultimate analysis, but discarded, and the determination was made on a separate larger sample. The sample was treated with hydrofluoric acid and sulfuric acid, twice evaporated, and the insoluble residue removed by filtering. Manganese was determined colorimetrically using potassium periodate as the color reagent, and matching against a standard color sample.

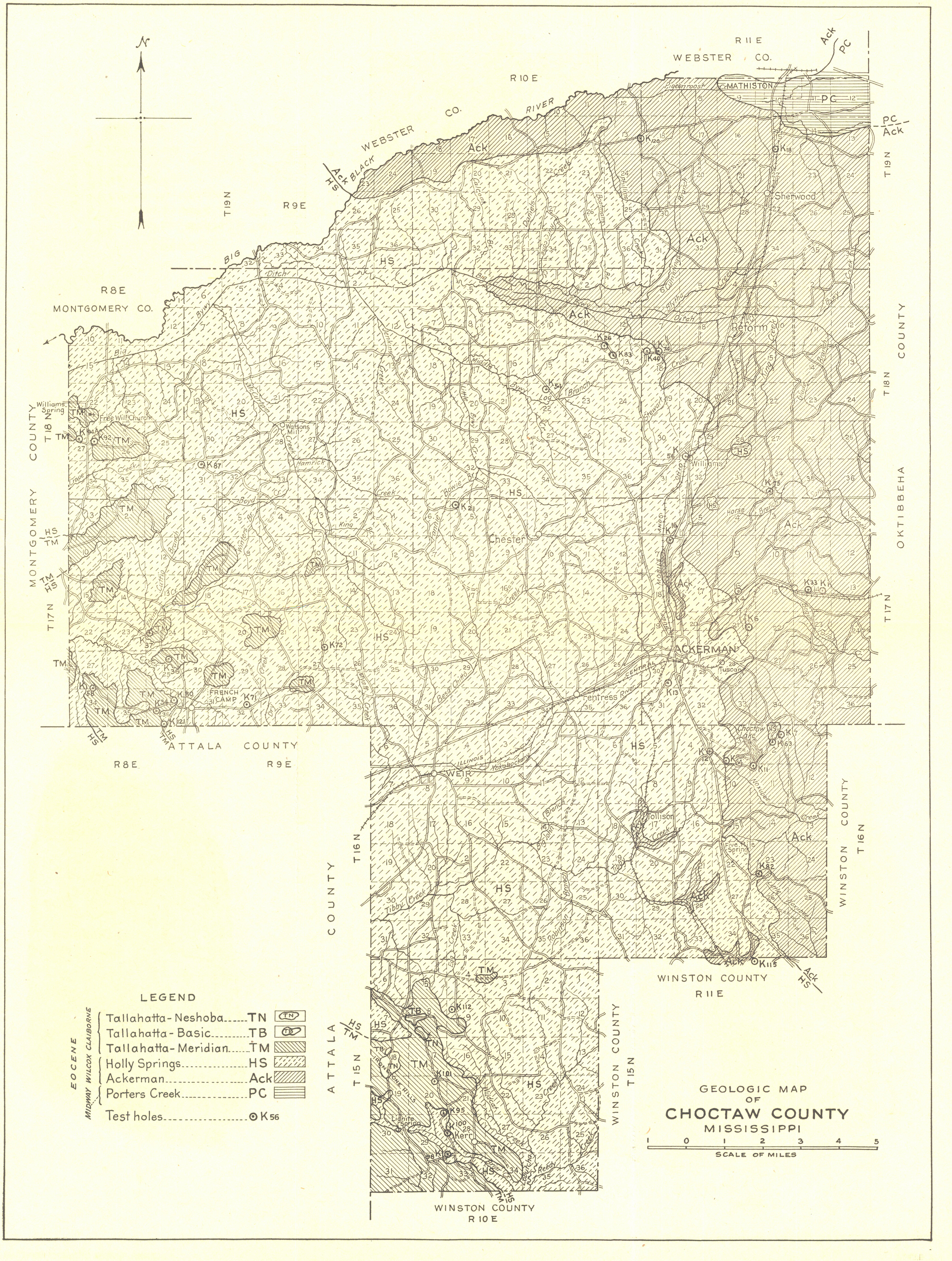
Lime: Lime was determined from the filtrate of the manganese determination by precipitation as the oxalate in the presence of ammonium acetate in alkaline solution. It was weighed as CaO.

Magnesia: Magnesia was determined from the lime filtrate by precipitation as mixed ammonium phosphate in alkaline solution. It was ignited and weighed as $Mg_2P_2O_7$, and calculated to MgO.

Alkalies: Alkalies were determined by the J. Lawrence Smith method as outlined in Scott "Standard Methods of Chemical Analysis." Sodium and potassium were not separated but reported as combined oxides.

Sulfur: Sulfur was determined in a separate sample by a carbonate fusion, solution in dilute hydrochloric acid, oxidation to SO_4 with bromine and precipitation with 10 percent barium chloride solution. Precipitate was weighed as barium sulfate, and reported as SO_3.

Duplicates were made on all samples and the average was reported.


GEOLOGIC MAP
OF
CHOCTAW COUNTY
MISSISSIPPI
SCALE OF MILES
1 0 1 2 3 4 5
LEGEND
EOCENE
MIDWAY WILCOX CLAIBORNE
Tallahatta-Neshoba......TN
Tallahatta-Basic..........TB
Tallahatta-Meridian.......TM
Holly Springs...............HS
Ackerman.....................Ack
Porters Creek...............PC
Test holes.....................K 56
WEBSTER CO.
MONTGOMERY CO.
MONTGOMERY COUNTY
ATTALA COUNTY
WINSTON COUNTY
OKTIBBEHA COUNTY
R8E
R9E
R10E
R11E
T19N
T18N
T17N
T16N
T15N
MATHISTON
Sherwood
Reform
Williams
Chester
ACKERMAN
Tuscan
FRENCH CAMP
WEIR
Tollison
Kerr
Choctaw Lake
Williams Spring
Free Will Church
Watsons Mill
Lignite Spring
Five Mile Spring
BIG BLACK RIVER
ILLINOIS CENTRAL