MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.

Director

BULLETIN 64

ITAWAMBA COUNTY MINERAL RESOURCES

GEOLOGY

by

FRANKLIN EARL VESTAL, M. S.

TESTS

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HARRY J. KNOLLMAN

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LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
January 27, 1947

To His Excellency,
Governor Fielding L. Wright, Chairman, and
Members of the Geological Commission

Gentlemen:

Herewith is Bulletin 64, Itawamba County Mineral Resources, Geology, by Franklin Earl Vestal, Tests, by Harry J. Knollman.

Although the short title is Mineral Resources, as it is of the other county reports, nevertheless general geology is an important part of all these reports. In fact all mineral resources are based on general geology, particularly stratigraphic geology.

The report shows that Itawamba County is one of the richest counties in minerals other than fuels. In fact Bentonite for bleaching purposes is being produced on a large scale. Furthermore clays of the Tuscaloosa formation, only used in a small way for stone ware, if washed would prove, according to Ceramist Knollman, to be valuable for ceramic white wares, including electrical, chemical, and table porcelains, sanitary white ware, hotel china and dinner ware, ceramic floor and wall tile, dry pressed tile, pottery shapes, and art ware—uses not even started in the county.

As was true in all the other counties, the local citizens of Itawamba County cooperated by furnishing trucks for the transportation of laborers and by other similar means. For all such cooperation the Mississippi State Geological Survey is grateful.

Very truly yours,

William Clifford Morse,
Director and State Geologist

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ITAWAMBA COUNTY MINERAL RESOURCES

GEOLOGY

FRANKLIN EARL VESTAL, M. S.

INTRODUCTION

Itawamba County, northeastern Mississippi, is bounded on the north by Tishomingo and Prentiss Counties, on the west by Lee County, on the south by Monroe, and on the east by the State of Alabama (Figure 1). Inasmuch as all boundary lines are straight, except for a

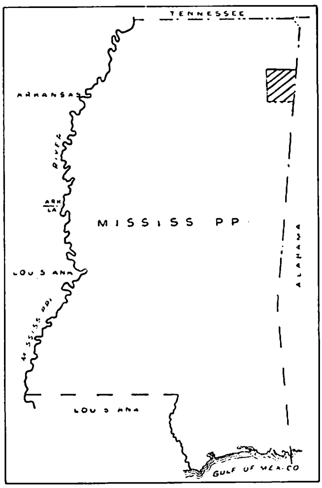


Figure 1.—Location of Itawamba County

slight irregularity of the western boundary, the shape of the county would be approximately rectangular but for the west of south trend of the Alabama-Mississippi state line. The northern boundary line is 21 3/4 miles long, the western, 25 3/4, the southern, 19 1/4, and the eastern, 26. The area of the county is 541 square miles.[1]

The population numbered 19,922 in 1940, an increase of 1,697 over the number in 1930.[1] It is classed as rural, inasmuch as Fulton, the county-seat and only town, had a 1940 population of only 1,154.[1] Villages and communities named on maps of Itawamba County are: Tremont, Mantachie, Dorsey, Evergreen, Tilden, Fairview, Greenwood, Oakland, Ballardsville, Carolina, Ratliff, Centerville, Kirkville, and perhaps another or two. Most of the villages are at road intersections. Communities which could hardly be accurately designated villages are centered about the church and school and perhaps the general store; for example, the New Salem community, the Van Buren community, the White Springs community, and others. In general the people are scattered unevenly over the region, the distribution pattern reflecting geographical conditions, especially the distribution of the arable land. The western half of the county is more densely populated than the eastern half, and east of the Tombigbee River the greater number of people live along State Highway 25, which, south of Fulton, roughly parallels the Tombigbee flood plain. In the more rugged hill districts people are fewest, and have their homes in or near the valleys.

The chief occupation is farming, but a considerable number of people are engaged in the sawmill and lumber industry. Although farming activities are carried on in all parts of the county, they are of course, more concentrated where agricultural conditions are most favorable—on the flood plains of the major streams, and in the region west of the Tombigbee. Cotton and corn are the leading crops, but truck and forage crops are given an appreciable acreage. Live stock raising is carried on on a small scale in connection with general farming. A large sawmill and lumber yard are located at Fulton, and portable sawmills operate here and there in the county, drawing their supply of timber from the forested hills and valleys, particularly from the belts of wooded lowlands along the larger streams.

Although most of the virgin forest which once covered the greater part of the region now within the boundaries of Itawamba County has been cut out or burned out, the saw still rings on the hills and in the dells, and its dismembered victims move as a long-drawn-out funeral procession with all speed along the byways and highways toward the mills, there to suffer further dismemberment. For a long time past the saw has been ringing the knell of Itawamba County and many other counties of Mississippi and other states. The knell is ringing now, but it will die away and be succeeded by fire and then silence. Where the stately pines crowned the hills and the oak, the hickory, the sycamore, the poplar, the cypress, the gum, beautified the valleys, the blackberry and the bamboo briar and the scrub oak will vex the land, and men will flee from it. Again it will be a wilderness, but without the glory of the first wilderness. The rains will descend and the floods come, and the soil which has taken ages to form, will then, undetained by the forest which it nourished, be seized and carried away by them. And the final state of the country will be utter desolation. It is time the rescue squads were stirring themselves, replanting trees, extinguishing their fires, withholding the ax, and banishing the saw. It is time many of the people should alter their thinking, which now holds the few dollars they may acquire by destroying the things which can not be replaced in a thousand years, of more value than their children's heritage.

The use of mineral products is confined to small potteries in the southeasternmost township, and to the mining of bentonite in the southern part of the county, as described in the text.

Except for a few hundred feet of the Illinois Central across the extreme northeastern corner, the only railroad in Itawamba County is the Mississippian, which extends from Amory, Monroe County, to Fulton, the right-of-way in Itawamba County being along the base of the east wall of the Tombigbee River Valley (Plate 1).

The road system consists of a few main highways and a network of local roads. The most prominent of the highways is U. S. Highway 78, also called the Bankhead Highway, which is laid across the county in a general east-west direction a little south of the central parallel. Other main highways are: Mississippi State Highway 25, reaching northeast-southwest from the northeastern corner of the county to Fulton, thence southeast and south parallel with the river; an unnumbered north-south state highway in the eastern part of the county, from the northeastern corner of the county to Tremont; and three unnumbered state highways west of the Tombigbee—one, the Booneville highway, north-south from Kirkville to Highway 78; another, northwest-southeast through Ratliff and Mantachie to Highway 78; and the third, northwest-southeast across the southwestern corner of the county via Evergreen and Carolina. U. S. Highway 78 is pavement; the other highways mentioned are graveled. The pavement of Highway 78 is narrow and rough from the top of the west wall of the valley of the Tombigbee River to the western boundary of the county. Several graveled roads are well traveled, leading to the farms and habitations of a considerable number of people, and these more used roads are joined by a net of local routes of travel, reaching to almost every section of the county. No definite system or pattern of routes of travel and transportation is evident, although, except for Highway 78, the north-south routes are most prominent, and the trunk roads tend to keep to the ridge summits in the most rugged part of the county.

A noticeable feature of the road pattern is that the valley of the Tombigbee River is almost without public roads. The Mississippi State Highway Department map of Itawamba County (Plate 1) shows only four roads crossing the river. Bull Mountain Creek is crossed by Highway 78 and by two roads south of the highway and two north of it.

A Tennessee Valley Authority transmission line roughly parallels Highway 25 from the northeastern corner of the county to Fulton, and U. S. Highway 78 from Fulton west to the Lee County line. Several villages and communities are served by lines of the Tombigbee Electric Power Association.

Itawamba County is not served by any gas pipe-lines.

PHYSIOGRAPHY

PROVINCES, TOPOGRAPHY, RELIEF

Except for a narrow strip along the western boundary, Itawamba County is part of the Tombigbee River Hills[2, 5] physiographic region of the Gulf Coast Plain.[2, 5] The narrow area in the western part of the county is included by the eastern border of the Black Prairie Belt.[2, 5] As Indicated by the name, the prominent features of the Tombigbee River Hills are hills of various shapes and elevations, ranging from rugged to rolling. The northeastern part of the county is most rugged, a stream-dissected plateau-like area reaching heights of some 500 to 550 feet or more above mean sea level and showing a maximum relief of at least 200 feet. Here are the steepest slopes, the narrowest valleys, and the narrowest ridge crests. The greatest elevations are some distance west of the eastern boundary of the county. Westwards and southwestwards the surface as a whole descends gradually and irregularly towards the Tombigbee River, which has cut a wide flat-bottomed valley north-south across the county. West of the river valley the surface rises more or less abruptly, but not to so great a height as that on the east. In fact, much of the territory west of the river could be accurately described as "rolling," especially in the southern part. As a whole, the topography is in the early maturity stage of development. The greatest elevation may be as much as 550 to 600 feet, and the least, on the Tombigbee where it is crossed by the southern boundary of the county, is about 200 feet at low water. The maximum relief of the county as a whole is, then, 350 to 400 feet.[7] A view, taking in the entire county, would show it cut into two prominent parts, an eastern two thirds and a western one third, by the Tombigbee River; a fourth of the eastern in turn, cut off by Bull Mountain Creek, and both eastern and western areas notched by smaller streams.

The hill country includes of course both elevations and depressions, the depressions being the valleys, along which flats and terraces have been developed from the mouths well up toward the sources. The flood plains of the Tombigbee River and Bull Mountain Creek are the most prominent lowlands, but some smaller stream plains are noticeable; those of Chubby, Gum, Twentymile, Mantachie, and Long Creeks, for examples. Terraces, or second and third bottoms, are conspicuous in places, as, for example, along the Tombigbee River and along Bull Mountain Creek, and particularly southwest of Oakland between Gum and Cypress Creeks.

DRAINAGE

Itawamba County is in the extreme northern part of the Tombigbee River drainage basin. The Tombigbee crosses the county from north to south, west of the central meridian, in a channel which is very crooked in detail. In fact, the main Tombigbee of Itawamba County and northern Monroe is more properly known as the East Fork of the Tombigbee River, a name applied above the mouth of Old Town Creek, which is designated the West Fork of the Tombigbee River. The East Fork, the main Tombigbee of Itawamba, is formed by the confluence of Mackeys Creek and Browns Creek about 2.5 miles south of the Prentiss-Itawamba county line. Numerous tributaries feed the Tombigbee, of which the chief are Bull Mountain Creek, Reeds Creek, Cummings Creek and Mud Creek from the northeast, and Donovan, Twentymile, Mantachie, and Long (Bogue Fala) Creeks from the northwest. Bull Mountain Creek, the largest of these streams, rises in Alabama, flows southwest in a somewhat sinuous course, and enters the Tombigbee less than a mile north of the southern boundary of Itawamba County. Its largest tributaries are Gum, Cypress, Johns and Jims Creeks. The west tributaries of the Tombigbee—Browns, Donovan, Twentymile, Mantachie, and Long Creeks —have been canalized (Plate 1).

The overall drainage pattern is dendritic, as is commonly the case with drainage courses in relatively homogeneous and horizontal or gently dipping beds; but in Itawamba County the dendritic pattern seems to be of the Lombardy poplar type—that is, the tributaries not only enter the main at a low angle, but through the greater part of their courses they flow at a low angle to their main.

Springs of small to moderate yield are numerous. Most of the larger water courses have perennial streams, fed by springs in part. The average annual rainfall of the region probably is about the same as that of Monroe County—47 inches—and a considerable percentage of it is absorbed by the sands, but much of that absorbed may return to the surface as springs, because of the interruption of its descent by outcropping clay beds, along the tops of which the water percolates through the sand and flows out at the outcrops.

STRATIGRAPHY

Generalized Section

The following summary indicates the names, geologic classification, relative ages, lithologic and structural characteristics, and approximate thicknesses of the rock units which crop out in Itawamba County:

	Feet
Psychozoic group	
Holocene system	
Recent series	
Recent formation	
Rock waste, residual or transported, consisting of soil, sub-soil, and underlying mantle rock; alluvium and colluvium. Estimated, 50 to	75
Unconformity	
Cenozoic group	
Pleistocene system	
———series	
Terrace deposits	
Gravel, sand, clay, and silt, disseminated, or aggregated in beds, lenses, or other units of irregular structure and relationships; old flood-plain deposits of Pleistocene time, remaining as stream terraces or deeply buried alluvium. Estimated, maximum	75

	Feet
Pliocene (?) system	
Some of the older terrace materials may have accumulated in their present position as long ago as Pliocene time.	
Great unconformity	
Mesozoic group	
Cretaceous system	
Gulf series	
Selma formation	
Coffee member, chiefly massive to cross-laminated fine glauconitic light-gray to brown sand and calcareous sandstone; subordinately laminae and laminated layers of dark sandy clay. Mooreville tongue, clayey chalk or chalky, shaly clay (marl)	100
Unconformity	
Eutaw formation	
Tombigbee member, massive fine glauconitic calcareous sand, gray to greenish-gray where fresh, oxidizing to shades of tan, yellow, and brown; some consolidated intervals and large concretions; locally fossiliferous. Lower Eutaw, irregularly bedded glauconitic gray to whitish sand which oxidizes to shades of tan, yellow, and brown, inter-stratified with laminated layers, thin laminae, or more massive layers of dark-gray to nearly black clay, and a little bentonite; some small chert gravel; sand locally cemented to ferruginous sandstone 300 to	350
Unconformity	
Tuscaloosa formation	
Sand, gravel, clay, silt, lignite, etc.: Sand fine, micaceous, light and vari-colored, irregularly bedded; in places consolidated. Gravel angular to subangular coarse chert and a little quartz, locally cemented to conglomerate; chiefly in the lower part of the formation. Clay lenses and laminae of various colors; considerable bentonite. Thin beds of sandy and clayey lignite. Irregularity of structure a feature. Estimated	200

THE TUSCALOOSA FORMATION

The Tuscaloosa formation,[2, 5] named for Tuscaloosa, Alabama, in the vicinity of which it is typically represented, is a body of rock, chiefly gravel, sand, and clay, which lies half encircling the southwest end of the exposed Paleozoic sedimentary and the pre-Paleozoic crystalline rocks of the southern Appalachian region. It is composed of debris which accumulated on the old hard rock as a result of long-continued weathering, and was carried to lower places by the various transporting agents, chiefly running water. A large part of this rock waste came to rest in the offshore shallow water of an advancing sea, or in bays, lagoons, and estuaries; some of it was dropped on the low coastal plain, taking the forms of wide alluvial fans and of lake, swamp, and delta deposits, which were later worked over by the waves. Much of it was shifted many times before it finally came to its present position, and inasmuch as deposition began far south of present Tuscaloosa exposures, by far the greater part of the formation is concealed by sediments of a later age. Being the oldest post-Paleozoic formation of the northeastern Mississippi region, except for the Little Bear Residuum, it lies on the Little Bear, or on the Paleozoic rocks where the Little Bear is not present. These old hard rocks were much eroded by streams prior to and during Tuscaloosa time, and the Tuscaloosa formation lies on the very rough surface so developed—that is, it is unconformable with the Paleozoic strata, and the contact is a surface of unconformity. In fact, the relief of the buried Paleozoic surface has been estimated to be at least 100 feet in Tishomingo County, and may be much more in places. The Tuscaloosa is not flat lying, either, but its beds normally slope (dip) away from where the shoreline was when they were formed. The dip of the formation as a whole ranges from south to northwest, at a rate varying from 20 feet or less to 30 to 35 feet to a mile (Plate 2). In places, too, where the strata have been disturbed since they were deposited, they have a still greater dip, which may be in a direction the reverse of the regional.

The great diversity of conditions under which transportation and deposition took place resulted in more or less nearly complete local sorting of the sediments and the forming of beds and lenses and other bodies of each of the main components. Thus, the formation includes beds or lenses composed of gravel only, or of sand, or of clay; but commonly a bed which is dominantly one type of material contains another type or other types. For examples, beds which are predominantly gravel commonly contain disseminated sand or lenses or lentils of sand, or even of clay, and many sand units are silty or clayey or gravelly, and clay bodies are almost invariably sandy or silty, and may contain grit or pebbles. Interlamination of clay with fine sand is common. Naturally, too, inasmuch as a large part of this rock material was originally deposited on low ground, in swamps or marshes or shallow lakes or lagoons where plants were abundant, lignitic clays and sands and lignitized wood are present in many places in the Tuscaloosa formation.

Gravel, most of which is angular to subangular coarse chert, comprises a considerable part of the basal 175 feet or less of the formation, and is present more or less sparingly at higher stratigraphic horizons.

Locally the gravel has been cemented to conglomerate by iron oxide or silica precipitated from solution in ground water, and much of it is ferruginous or otherwise colored. In a few places quartz pebbles are present. Great beds of gravel, of which some is very coarse, are included in the Tuscaloosa in widely separated localities, a few miles southeast of Iuka, for example.

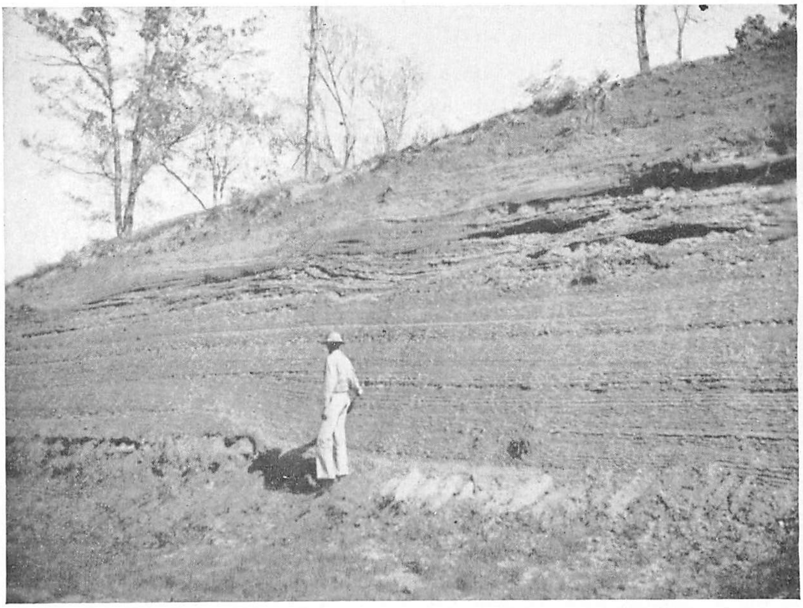


Figure 2.—Tuscaloosa beds, upper laminated sand, U. S. Highway 78 cut (NW. Cor., Sec. 6, T. 10 S., R. 10 E.), 7.0 miles east-southeast from Fulton. April 12, 1945.

The sands of the Tuscaloosa range from coarse to fine, but are for the most part fine and micaceous. Southward from about the latitude of Iuka the sands predominate, overlying the basal gravel. Color and degree of cementation vary somewhat widely, too. A large proportion of the sand has an olive-drab to dark-green or gray color, but much of it is of various shades of red or brown or yellow, or is banded or splotched with iron oxide and carbonaceous colors. Locally the sand has been cemented to sandstone, which may be in the forms of thin plates or sheets, or of thicker beds and lenses. Marcasite and carbonized or lignitized wood are mixed with the sand in places. The sand units—beds of considerable extent, or lenses or lentils—

may show various relationships to each other and to the other rock material. For example, numerous lenses of fine to coarse, current bedded, more or less micaceous sand, and subordinate layers of more or less sandy clay, are interbedded with gravel in places. Cross-bedding and cross-lamination of the sand are common; current bedding, curved or undulating, is prominent here and there, but much of the sand is evenly bedded, the beds and laminae being essentially horizontal (Figure 2).

Clay is present in the Tuscaloosa formation at almost all horizons. It may be in small quantities intimately mixed with the sand or gravel, or interlaminated with fine sand, or it may be aggregated in the form of conspicuous lenses or layers in the sand strata. These clays are of varying degrees of purity and of several colors, ranging from black through various shades of light blue, brown, and gray to red, yellow, pink, and white. Mottling is common. Beds of very compact, sandy clays might properly be called clay shale. Much of the upper clay is sufficiently pure for use in the manufacture of stoneware and pottery. The lignitic clays may contain leaf impressions. A little kaolin has been found, and bentonite persists near the top of the formation in Monroe and Itawamba Counties.

The lignite of the formation, chiefly near the top, at least in Mississippi, is not important, no bed being more than 2 to 3 feet thick. Lignitized wood is scattered through several beds.

The structure of the Tuscaloosa formation is notably irregular. In addition to cross-bedding contemporaneous erosion surfaces may be seen here and there; lateral gradation is a feature; consolidated sheets or seams may cut the mass of unconsolidated gravel or sand at almost any angle, and, as has been stated, locally the different units may have almost any sort of relation to each other.

Rock considered a part of the Tuscaloosa formation appears at the surface within the limits of a very irregular curving belt 8 to 40 miles wide reaching across south-central and western Alabama and the northeastern corner of Mississippi. In Mississippi it crops out in Lowndes, Monroe, Prentiss, Itawamba, and Tishomingo Counties, chiefly in the lower slopes of the larger valleys, but reaches the surface of the uplands in Itawamba and Tishomingo, where it was first studied by L. C. Johnson, in 1887. Johnson's definition of its areal extent there is still accepted with but few modifications.

The upper part only of the Tuscaloosa formation is represented in Mississippi.[2] The maximum thickness of the formation as a whole may exceed 1,000 feet, and in Mississippi it is 600 feet, more or less. In eastern Itawamba County the formation crops out as a belt 6 to 8 miles wide. Except for some Eutaw outliers in the southeastern corner of the county, the uppermost rock of the entire area east of Bull Mountain and Gum Creeks is Tuscaloosa. West of this upland region the Tuscaloosa beds crop out in the lower slopes of the walls of the deeper valleys, especially in the walls of Tombigbee River Valley. The western edge of the Tombigbee River

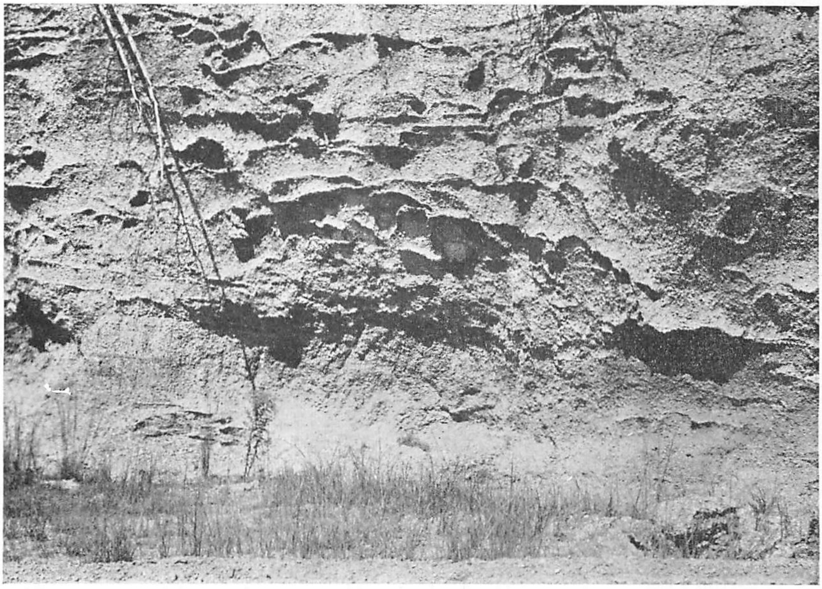


Figure 3.—Tuscaloosa formation, gravel wall of a pit (Sec. 14, T. 9 S., R. 10 E.) on the west side of the Red Bay road 5.5 miles northeast from U. S. Highway 78. After Stephenson and Monroe (Bull. 40, p. 55).

Valley belt of outcrop is 15 miles west of the Alabama-Mississippi boundary (Plate 1). The total area of outcrop in the county is close to one-half the area of the county. In the eastern part of the county the formation includes a considerable proportion of gravel, which is well exposed in numerous places, notably at six or seven places in the walls of cuts for the Tremont-Red Bay road. The most prominent of these is 5.5 miles northeast of U. S. Highway 78, the face of the wall of a large pit (Sec. 14, T. 9 S., R. 10 E.) on the west side of the road (Figure 3). The gravel here is chiefly chert, but includes a relatively few well-rounded quartz pebbles. It is featured also by numerous iron-cemented crusts, of which many are curving or pipe-shaped. The Tuscaloosa gravel beds can be distinguished from the beds of terrace gravel of the vicinity by the absence of orientation of their pebbles and the absence of stratification within the beds.

On the west side of the Tremont-Red Bay road some 4.5 miles from Highway 78 and half a mile north of the bridge over Bull Mountain Creek, the face of a cut exposes at least 40 feet of Tuscaloosa sand, comprising a basal member of 5 feet to 6 feet of laminated dark-bluish and gray silty and clayey lignitic sand below, overlain, along a very irregular contact, by a 4-foot to 5-foot interval of platy ferruginous sandstone, contorted ferruginous rock, gravel, iron carbonate concretions, and brown sand, and above this interval 15 feet or more of whitish sand, succeeded upwards by sand and platy sandstone.

A very good section of the Tuscaloosa beds is exposed by a gully along a farm road a mile northwest of Oakland and some 2 miles northwest of the outcrop described in the preceding paragraph:

SECTION OF THE SOUTH WALL OF A VALLEY (SE. COR., SEC. 16, T. 9 S., R. 10 E.) 4 MILES NORTH OF TREMONT AND 1 MILE NORTHWEST OF OAKLAND

	Feet	Feet
Eutaw formation		40
Sand, sandstone, and clay. The sand and sandstone are brown; the sand is irregularly laminated, and a sandstone ledge is included in the section 30 feet above the base. The clay is light gray, and aggregated as thin laminae, lentils, and stringers. To public road on the ridge	40	
Tuscaloosa formation		55
Clay, brown, black, light-gray and dull white; beds, distinguished by color, but all stiff, plastic clay, somewhat sandy. Due to weathering, the surface shows no sharp contacts between the intervals. Seams and veins of iron rust are numerous. In general, the succession is much like that of the clay section along U. S. Highway 78	40	
Covered by wash from above to the level of a farm house in the valley, but presumably Tuscaloosa	15	
Total section, 95 feet.		

A few good outcrops of the Tuscaloosa sands and clays may be seen in the vicinity of Oakland.

Warrens Bluff (Sec. 20, T. 7 S., R. 9 E.) is a wall of bedded sand reaching a height of more than 100 feet (115 to 120 feet in one place) above the flat of Mackeys Creek, through 60 to 70 feet of which it is practically vertical. The fresh sand, exposed by washes, is micaceous, whitish to various shades of brown and yellow, and contains clay laminae in places. Hilgard assigned this to the Eutaw, but it is now considered Tuscaloosa.

Along the State Line Road and the other local roads in the southeastern corner of the county, gravel and conglomerate of Tuscaloosa age show in several places.

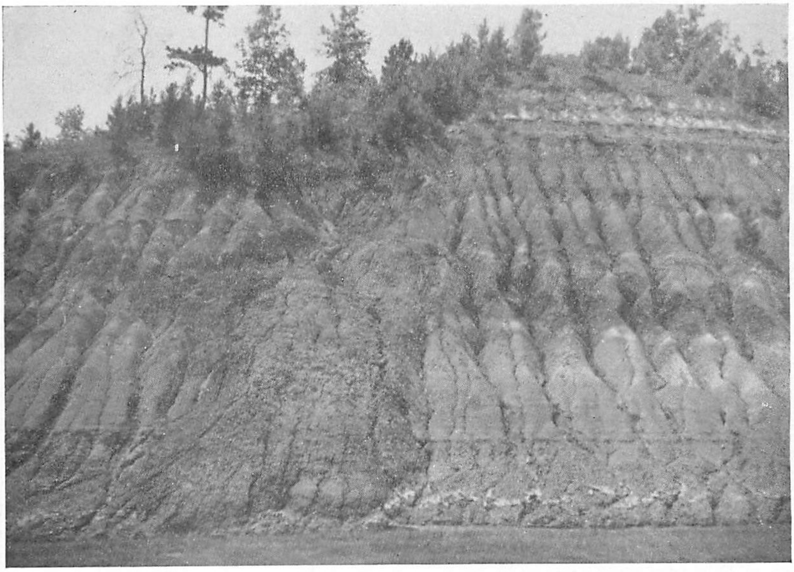


Figure 4.—Tuscaloosa clays exposed by U. S. Highway 78 cut (NE. 1/4, Sec. 6, T. 10 S., R. 10 E.) in the west wall of Gum Creek Valley 7.5 miles east-southeast from Fulton. September 7, 1945.

The section exposed by cuts for U. S. Highway 78 some 2 miles west of Tremont includes a greater stratigraphic range than any other section to be found in the county:

SECTION (SEC. 6, T. 10 S., R. 10 E., NORTHERN PART) OF WALLS OF U. S. HIGHWAY 78 CUTS AND OF THE SAND PIT ON THE NORTH SIDE OF THE HIGHWAY IN THE WEST WALL OF THE VALLEY OF GUM, CYPRESS, HICKORY, AND BULL MOUNTAIN CREEKS (Figure 4)

	Feet	Feet
Recent formation		1.5
Soil, subsoil, and mantle rock, to the top of the north wall of the sand pit	1.5	
Eutaw formation		30.5

	Feet	Feet
Sand, chiefly massive fine red-brown; lowermost 2 to 3 feet much streaked and mottled with gray, and roughly laminated	9.0	
Sand, yellow and brown, fine, interlaminated with thin gray silt or sand or clay; laminae sharply defined; some blood-red spots on the clay	8.0	
Sand, a massive lens, golden yellow, brown on the surface, fine, sparingly micaceous	3.0	
Sand rock, thin crusts, ferruginous, dark-brown to yellow, current figured on the surface, interlaminated with light-gray and yellow silt and clay and sand; some thicker ferruginous rock, especially towards the top; tubular sand rock; interval partly concealed	10.0	
Sand rock, ferruginous, yellow to dark-brown, very hard, irregular, but showing structure of underlying silt and sand; upper surface conspicuous by curved designs made by currents in the silt and sand which later hardened into rock; rock spotted in places, and much of it composed of very thin crusts	0.5	
Tuscaloosa formation		136.7
Silt and very fine sand, laminated, olive-drab to light tan or gray; laminae defined by iron rust where the material is fresh. In the wall of the highway cut the surface of this interval appears as very fine laminated gray sand and silt, but where the outermost loose material is removed and the fresh rock shows, it is closely jointed, gray to tan, blocky, each block laminated and laminae defined by iron rust. Chiefly silt, which contains some fine sand, and thin ferruginous sand rock or silt rock along the laminae and joint or fracture planes; 3 to 4 inches of ferruginous rock at the base of the interval	13.2	
Sand, silt, clay, and ferruginous rock, gray, light tan, and brown. Some thin intervals show conspicuous current bedding, diagonal, and some of the laminae toward the base dip westward at a steeper angle than the other laminae. This interval is in the north wall of the middle cut, some 200 yards southeast of the base of the sand pit. The material above it in this cut correlates in part with that underlying the highest Tuscaloosa interval in the uppermost cut, and some 15 feet at the base are included by the uppermost intervals of the lowest cut	33.0	
Sand, fine, somewhat micaceous, basically gray, but somewhat streaked and spotted and otherwise stained by yellow and brown iron oxide; bluish-gray towards the base, but lighter gray to dull white upwards; contains sufficient clay and silt to make it blocky, especially in the basal 1 foot or so, and in the top 1 foot or so which projects slightly	9.0	
Ferruginous rock, yellow, brown, and red-brown, platy; more regular than that in the subjacent interval	0.5	

	Feet	Feet
Clay, sandy, and sand, clayey; rust spotted, light-gray or olive-drab, contains much platy limonite which weathers out and lies on the surface of the slope below; oxidized masses of iron carbonate; the more clayey parts have shale-like structure and break out as flattish blocks	4.3	
Ferruginous rock: slabs, thin plates, and flattish ovoidal and discoidal lumps which were once iron carbonate (some iron carbonate cores remain), comprising an iron oxide-cemented bed (max.)	0.6	
Clay, light-gray, yellow limonite-mottled and seamed; platy limonitic material in fractures and joints	2.5	
Clay, lignitic, dark-brown to lighter brown to bluish-black, grading into darker color upwards, and almost tar-black at the top; some thin bands of impure brown lignite	3.6	
Clay, compact, indurated to a shale appearance; closely jointed and fractured; breaks out with hackly or rounded fracture in irregular blocks of various sizes; drying breaks it into smaller and smaller light-gray fragments; some limonite platy joints and seams; most of it light-brown to dark-brown to black, but light-gray towards the top	4.2	
Clay, light-gray, and mottled and seamed with yellow limonite; stiff, plastic; uppermost few inches indurated	3.0	
Clay, darker gray than that immediately below, and contains less limonitic material; jointed and fractured, as all the other intervals; some curved jointing and conchoidal lumps; limonitic platy seams	4.5	
Clay, light-gray, grading to darker gray towards the top; very stiff and plastic, and streaked and mottled with yellow limonite. Limonite-cemented material as plates in joints and fractures, and covers the surface as a broad yellow band; a mantle of this ferruginous material lies on the dull-white dry surface of the outcrop	3.5	
Ferruginous sandstone	0.6	
Clay, light-gray, stiff, plastic, shot through with seams of yellow limonite	2.0	
Clay, brown from iron rust, purplish-gray on the surface; much broken up; joint surfaces slickensided; interiors of lumps are light-gray or bluish, like the clay of the underlying interval; because of much iron oxide this interval forms a conspicuous broad brown band across the outcrop, which band is less prominent east of the middle of the face of the cut; the uppermost 1 foot is of darker color	6.6	
Clay, light-gray, like that of the sixth interval	1.2	
Clay, dark-gray to black	1.0	
Clay, light-gray to whitish, pure, heavy; breaks out in lumps which may have curved surfaces	4.5	

	Feet	Feet
Clay chiefly, but very sandy; dark-gray to nearly black, but dries light gray, and is very brittle, breaking into a multitude of small fragments on drying; fresh material much jointed, and can be dug out in large, firm blocks, some of which may have curved surfaces; yellowish coating on the faces of some of the blocks. The interval contains lignitized wood fragments and marcasite veins. Not shaly in the bed like the first interval	4.9	

Figure 5.—Tuscaloosa clay and sand in the northeast wall of a U. S. Highway 78 cut (SE. 1/4, Sec. 36, T. 9 S., R. 9 E.) 6.2 miles east-southeast from Fulton. September 23, 1942.

Sand chiefly, very fine gray to dark, laminated, silty, interlaminated with some dark-gray to black silty clay; laminae variously indurated. Rusty in places; contains marcasite and some lignitized wood, and, at the top, a marcasite layer	6.0	
Sand, clay, and silt, conspicuously laminated; weathered surface appears a succession of very knobby brown and gray bands, and has a yellowish-brown cast, because of oxidation of the abundant iron. Fresh material shows a rough banding of bluish-black silty gummy clay, fine sand, and thin ferruginous rock. The interval contains numerous marcasite lumps of irregular shape, rusty pockets, shaly ferruginous platy fragments of cemented laminae, and, near the base, some iron carbonate plates	7.0	

	Feet	Feet
Clay, blue, mottled with yellow iron rust where weathered; slightly sandy; contains numerous iron carbonate masses and marcasite concretions (north side of highway)	7.0	
Covered, but presumably included in the Tuscaloosa, to the water-level of Gum Creek, north of the highway, across the creek flat	14.0	

Total section, 168.7 feet.

Some of the clay strata and about 16 feet of the overlying sand of the Tuscaloosa are well exposed about half a mile northwest of the section just described, in the north wall of a cut (Figure 5, and Test hole R 5) for U. S. Highway 78.

Filtrol Corporation's bentonite pits, and associated ravines, have exposed sections of Tuscaloosa and Eutaw strata:

SECTION AT FILTROL CORPORATION'S BENTONITE PITS (SE. 1/4, SEC. 24, T. 11 S., R. 9 E.)

	Feet	Feet
Recent formation		1.5
Soil, subsoil, and underlying mantle rock, to the top of the hill	1.5	
Eutaw formation		25.0
Sand, brown, micaceous, fine, containing ferruginous sand rock	25.0	
Tuscaloosa formation		85.6
Sand, silt, and clay, containing ferruginous rock plates and much marcasite and iron carbonate; of irregular structure—current bedding, horizontal and cross lamination, etc.	55.0	
Bentonite, blue and greenish to olive-drab; surface commonly rusty, and rust along the joint planes and fracture planes; much cracked up; thickness variable	10.5	
Sand chiefly, laminated micaceous light-blue to dark-blue and black, but the interval includes lentils and stringers of gray clay, lentils and stringers of grit and small gravel, and thin stringers and fragments of lignitized wood, besides numerous iron carbonate and marcasite nodules. The structure is irregular (see discussion of bentonite). The exact thickness was not readily determinable	6.5	
Covered; mixed material partly from pit dump—clay, ferruginous rock, rusty sand, and bentonite waste	3.5	
Clay, blue-black to jet-black; in places very gummy and stiff when wet, blocky when dry	2.0	
Clay, sandy, gray in general, but fresh exposure shows brownish-gray to bluish-gray or purplish-gray, and weathered surface shows dark or bluish to purplish spots and streaks. The bed shows evidences of slipping—it is much fractured and jointed, and has yellow limonite deposited along the cracks in a net-		

	Feet	Feet
like pattern, particularly in the lowermost 1 foot to 2 feet. The lower part is lighter of color and more sandy; the middle part darker, and the uppermost 1 foot or so lighter than the middle. The clay is hard and blocky when dry. May be two or three intervals, but can not be readily distinguished	5.0	
Sand or sandy silt, light-gray fine micaceous	0.9	
Sand chiefly, brown, yellow, and gray, interlaminated with clay and silt of the same colors; laminae strongly defined by iron oxide; sand very fine, silty, micaceous; to base of exposure	2.2	
Total section, 112.1 feet.		

Road cuts and gullies (Secs. 14 and 23, T. 11 S., R. 9 E.) in the south wall of Spring Creek a mile northwest of the Filtrol Corporation workings, expose a good section of the Tuscaloosa clays:

SECTION OF THE SOUTH WALL OF SPRING CREEK VALLEY

	Feet	Feet
Recent formation		1.5
Soil, subsoil, and mantle rock, to the top of the valley wall	1.5	
Terrace formation		33.5
Sand, ferruginous, containing some ferruginous sandstone, especially towards the base, and some gravel and conglomerate in the basal zone. Partly covered	33.5	
Tuscaloosa formation		62.0
Clay, gray, iron oxide stained and mottled, somewhat sandy, a clayey and silty sand towards the base; 10 feet of it exposed by a ravine east of the road, the remainder by ravines on the west side of the road. Clay, light-gray to dark-gray, with bands and patches of dull white clay and some lignitic clay; in places yellowed by limonite, especially along cracks	40.0	
Sand, gray and ferruginous, and ferruginous sand rock more abundant towards the top; well exposed in the ravine on the east side of the road, and poorly exposed in the ditch on the west side	7.0	
Clay, light-gray to darker gray, somewhat sandy, mottled and streaked with red, brown, and yellow iron oxide. Exposed here and there in the gully on the west side of the road	10.0	
Covered, but presumably Tuscaloosa, to base of section, flat of Spring Creek	5.0	
Total section. 97.0 feet.		

Mississippi State Highway 25 crosses the Tuscaloosa-Eutaw contact in several places south of Fulton, but exposes the beds most clearly some three quarters of a mile north of the Monroe County-Itawamba County line:

SECTION OF THE WEST WALL OF A CUT (SEC. 30, T. 11 S., R. 9 E., NE. 1/4) FOR MISSISSIPPI STATE HIGHWAY 25

	Feet	Feet
Recent formation		8.0
Soil, subsoil, and other mantle rock, to the top of the cut in front of and left of a farm house	8.0	
Eutaw formation		4.0
Sandstone, ferruginous, thick-bedded to thin-bedded	3.0	
Sand, brown, ferruginous sandstone, and small chert gravel, mixed, a loosely cemented conglomerate; silicified wood	1.0	
Tuscaloosa formation		12.6
Sand, coarse to medium, brown to black, cross-laminated; crusts of ferruginous sandstone along the laminae planes, loosely to firmly cemented	5.0	
Sand, medium to coarse, vivid bright blue where fresh, brown on weathered surface; more oxidized upwards, to black, brown, and olive-drab; cross-laminated on oxidized surface	3.7	
Siderite (iron carbonate, $FeCo_3$), silty, light-gray, crusted with iron oxide; broken; varies somewhat in thickness	0.5	
Shale, clay, blue, sandy, micaceous, finely laminated; fine gray sand along the lamination planes; slickensided; much like the first interval	1.0	
Sand, black and gray laminated, soft, flat flakes; very micaceous; contains nodules of marcasite	1.0	
Shale, clay, bluish-gray, micaceous, finely laminated; contains very fine gray sand along the lamination planes; breaks in flat blocks; somewhat stained by iron oxide; silty. To base of section, below the level of the highway	1.4	

Total section, 24.6 feet.

Tuscaloosa beds are exposed in many other places in the Tuscaloosa outcrop belt. Some of the more prominent of these outcrops may be mentioned specifically:

1) In the vicinity of the Truelove home crossroads (NW. 1/4, Sec. 4, and NE. 1/4, Sec. 5, T. 9 S., R. 10 E.) (Test hole R 86).

2) In the southeast wall of Jims Creek Valley at the site of old Sallis's Mill, Tuscaloosa clays and sands are well exposed by a ravine on the south side of the Sallis's Mill-Hopewell road (south edge, Sec. 12, T. 11 S., R. 9 E.). A short distance farther east bentonite crops out on the same side of the road.

3) On the north side of the Tilden-Academy road, a little more than a mile east of Bull Mountain Creek (Horns Crossing), is a large outcrop of Tuscaloosa clay (NW. 1/4, Sec. 31, T. 10 S., R. 10 E.)

(Test hole R 11). Several smaller outcrops may be seen farther east along the same road.

4) Cuts for Mississippi State Highway 25 in the south wall of the valley of Reeds Creek (NE. Cor., Sec. 20, T. 10 S., R. 9 E.) show several feet of Tuscaloosa beds, the Tuscaloosa-Eutaw contact, and a long section of Eutaw above to the top of the valley wall (Test hole R 44). The Tuscaloosa material here is much like that of the section on the same highway three quarters of a mile north of the Monroe County-Itawamba County line; bright sky-blue sand which turns greenish upon exposure to the air; sky-blue to light-gray sandy and silty bentonitic material; thin laminae and crusts of ferruginous sandstone or siltstone; lignitic clay and sand and a thin seam of lignite; iron carbonate masses; heavier ferruginous sandstone at the formatioal contact; irregular bedding, and so on.

5) On the N. Harrison farm (Sec. 34, T. 10 S., R. 9 E.) a small tributary of Bull Mountain Creek has exposed a fairly good section of the Tuscaloosa strata. A feature of the material exposed in a branch on the Burch land (Test holes R 37, 38, 39, 74, and 80), north of the Harrison farm, is a light-gray high-alumina clay. Dark-gray to black shaly clay shows farther up this stream, and some distance still farther up, the Tuscaloosa-Eutaw contact is exposed in a 15-foot vertical face of the right wall, where several feet of Tuscaloosa blue sand interlaminated with gray clay and containing marcasite, iron carbonate, and lignitized wood, crop out below the slightly irregular contact, and a few feet of laminated Eutaw sand above.

Stephenson and Monroe describe a Tuscaloosa-Eutaw section near New Salem church:

SECTION ON EASTWARD-FACING SLOPE OF BULL MOUNTAIN CREEK VALLEY ALONG ABANDONED ROAD EAST OF NEW SALEM CHURCH (SEC. 9, T. 11 S., R. 9 E.)

	Feet	Feet
Eutaw formation		12.0
Fine sandy clayey soil; bed of fine chert gravel at base. To top of hill	12.0	
Unconformity. (Not seen in section, but considerable chert gravel and fragments of silicified wood unconformably overlying the uppermost Tuscaloosa bed are exposed at approximately the same altitude in a shallow road cut 200 feet west.)		
Tuscaloosa formation		96.0
Stratified yellow sand and light-gray clay	11.0	

	Feet	Feet
Yellow very fine sand (may be in part slumped from overlying bed as these two upper beds are partly concealed by colluvium)	11.0	
Finely micaceous mealy very fine sand interlaminated with very fine sandy silty clay, tinted with green, purple, brown, and yellow; very finely glauconitic in some beds; sand beds are progressively thicker downward in section; thin corrugated beds of ferruginous sandstone are common	33.0	
Finely cross-bedded, highly micaceous (in small flakes), finely glauconitic (grains small and scarce) white, pink, green, buff, and yellow, very fine sand; weathered portion is highly micaceous light-red sand; much thin, corrugated ferruginous sandstone at base	17.0	
Bentonite, poorly exposed and thickness undetermined, but reported by local prospector, Mr. Lewis Moore, to be about 4 feet. Exposed part	1.0	
Concealed by colluvium	12.0	
Light-brown and gray micaceous fine sand containing many flakes and balls of clay; cut into breccia-like blocks by ferruginous sandstone; wad (MnO_2) common as coating on lumps of clay	5.0	
Concealed to flood plain of small branch	6.0	
Total section, 108 feet.		

The farthest west outcrop of Tuscaloosa observed by Stephenson and Monroe is on the Greenwood road (near NW. Cor., Sec. 25, T. 10 S., R. 8 E.), 1.5 miles southwest of Beans Ferry Bridge over the East Fork of Tombigbee River. The Tuscaloosa-Eutaw unconformity here is about 25 feet above the flood plain of the river. The contact extends southwards a little west of the river and is near the foot of the bluff at Shumpert's Fish Camp (abandoned), half a mile north of the Monroe County line (Sec. 26, T. 11 S., R. 8 E., central part). A small deposit of gray clay near the bottom of a valley at New Bethel probably is Tuscaloosa, as are some of the sands overlying it. The petrified logs here (Figure 7) probably are features of the Tuscaloosa-Eutaw contact. A fine flowing well at the old fish camp (Barrs Ferry Bridge) draws water from Tuscaloosa beds.

THE EUTAW FORMATION

The Eutaw formation[2, 5] as a whole is a body of dominantly fine to medium marine sand, glauconitic and micaceous, which lies on the Tuscaloosa and crops out in an irregular curving belt bordering the Tuscaloosa belt on the south, southwest, and west. The direction of trend (strike) of the outcrop belt is due to the low dip (Plate 2) of the beds towards the old Mississippi Embayment trough in which the Eutaw formation accumulated. The Eutaw belt of outcrop ranges in width from 3 to 15 miles in Alabama, and reaches a maximum of 20 or more in Mississippi. The eastern margin is very irregular because of stream dissection, which has uncovered the Tuscaloosa far down the valleys. The materials were derived from the Paleozoic and old crystalline rocks and from the Tuscaloosa, through weathering and erosion. The Eutaw is not conformable with the underlying Tuscaloosa, but lies on an uneven eroded surface. The trace of this surface of unconformity is exposed in a number of places. The contact zone in Mississippi is marked by a band of more or less lignitic and carbonaceous Tuscaloosa clay 15 to 20 feet thick, containing thin layers of glauconitic sand.

The Eutaw formation includes two units—the Eutaw proper (Lower Eutaw) and the Tombigbee sand member. The Lower Eutaw, 200 to 250 feet thick, is composed of irregularly bedded glauconitic sands interstratified with laminated layers, thin laminae, and some more massive layers of clay, most of which is dark gray to nearly black. Plant fragments and pieces of lignite are abundant in the clays. Small lenses and stringers of small pebbles are scattered through the sand, especially in the lower part of the formation, and a bed of small subangular chert gravel is a common feature of the basal zone. Almost everywhere the chert gravel is associated with cross-laminated glauconitic sand. Fresh sands of the Eutaw may be light gray to white, but commonly are darker gray to greenish gray; the weathered facies are deep reddish to brownish, due to the oxidation of the iron-bearing constituents, and in many places the oxidized sands are cemented into platy layers, sandy concretions, and even huge masses of ferruginous sandstone. Rain water has percolated through the sands, taking iron into solution, especially in the subsurface section of plant growth, and the dissolved iron has been precipitated from solution in the descending water, binding the sand grains together in the lower parts of the zone of weathering. Thus the sand at the base of the Eutaw is in many places cemented by limonite into hard tubular and corrugated sandstone.

The Tombigbee member of the Eutaw, averaging 100 feet in thickness, is massive, glauconitic, somewhat calcareous sand, of which some intervals, more strongly cemented, appear as rough layers of varying thickness; concretionary masses are present in places, also,

(Figure 9). The contact between the Eutaw proper and the Tombigbee sand is gradational, the transitional zone being cross-bedded and laminated clay. The upper part of the Tombigbee contains many fossils of marine invertebrates and vertebrates, but, so far as has been determined, a large part of the member is not fossiliferous. Some bentonite is included in the sand in Monroe and Itawamba Counties.

The Tombigbee sand is overlain unconformably by the Selma formation.

In Mississippi the area of outcrop of the Eutaw formation includes two-thirds of Itawamba County, the eastern half of Lowndes, the eastern three-fifths of Monroe, the eastern one-fourth of Prentiss, and the western three-fifths or more of Tishomingo. It appears as a roughly defined belt striking almost north-south, west of the outcrop belt of the Tuscaloosa formation and east of that of the Selma. The margins of the belt, especially the eastern margin, have been made notably irregular by stream action, which has exposed underlying formations far down the valleys on the east, and up the valleys on the west. Along the eastern margin some beds in the upper parts of the divides, isolated by erosion, remain as outliers of the main outcrop belt. In general, the Eutaw maintains a nearly uniform thickness and is an approximately synchronous band of deposits from Itawamba County southwards through Mississippi, but thins farther north.

The part of the Eutaw formation in Itawamba County is typical of the Eutaw as a whole: the Lower Eutaw is cross-bedded red glauconitic sand and subordinate thin-bedded sand and clay; the Tombigbee is massive glauconitic fine sand. It is at the surface or under a relatively thin covering of mantle rock in most of the western two-thirds of the county, except in the valley of the Tombigbee River (East Fork of the Tombigbee) and along the western boundary of the county. Eastward from Dorsey, which is some 2 miles east of Lee County and near the eastern edge of the Mooreville chalk, the cuts for U. S. Highway 78, and the nearby ravines, expose sections of the Eutaw to within 6 miles of the Alabama-Mississippi line. The hills along this route are composed chiefly of glauconitic sands and gray laminated marine clays. The Tuscaloosa beds crop out beneath the Eutaw in the lower slopes of the walls of the valley of the East Fork of the Tombigbee River, and appear in the north wall of the highway cut about 6 miles southeast of Fulton. The Tuscaloosa-Eutaw contact rises towards the east to the top of the west wall of Bull Mountain Creek Valley, east of which all the terrane is Tuscaloosa except outliers of Eutaw capping some hills and ridges in the southeastern corner of the county.

In the belt of Eutaw hills extending north-south through the central part of the county between the Tombigbee River and Bull Mountain Creek, are numerous outcrops of the Lower Eutaw materials, most of them exposing the dark-reddish and reddish-brown weathered phase. A feature of some of these outcrops is the presence of poorly preserved tubes of the fossil *Halymenites major* Lesquereux.

The Tuscaloosa-Eutaw contact and a section of the lowermost Eutaw are well exposed at the top of the long Highway 78 section of the west wall of Bull Mountain Creek Valley (Sec. 6, T. 10 S., R. 10 E.), described in the discussion of the Tuscaloosa formation. The uneven contact between the two formations is conspicuous in the south wall of the cut at the top of the ridge, where it is defined by several inches of ferruginous rock which is inclined at a low angle westwards. Above the contact the interval is weathered brown and yellow sand, retaining indistinct laminae except towards the top. On the south side of the highway is a large pit in the Eutaw sand; much of the floor of the pit is ferruginous sandstone just above the formational contact. Some 35 feet of Eutaw show here.

Although, as stated above, Eutaw beds crop out at many places in the county, few exposures of unweathered beds have been found. The general character of the material in the outcrops is indicated by the description of the Tuscaloosa-Eutaw sections in the discussion of the Tuscaloosa formation. Some good outcrops of the middle part of the Lower Eutaw may be seen along country roads north of U. S. Highway 78 and east of Mississippi State Highway 25. North of this region, the walls of a large cut (NE. 1/4, Sec. 16, T. 8 S., R. 9 E.), where a local road crosses Mud Creek, show silicified logs in the sands on the Tuscaloosa-Eutaw contact. North-northwest of this place some 3 miles, and 2 miles east of the East Fork of the Tombigbee, an exposure in the public road east of Spencer's store shows numerous stringers of small subangular chert pebbles in highly cross-bedded glauconitic sand which, stratigraphically, is less than 100 feet above the base of the Eutaw. Several outcrops in the hills east of Mackeys Creek in the northern part of the county reveal such stringers of chert pebbles in the glauconitic sands.

The walls of a valley which heads at Highway 25 about 10 miles south of the city limits of Fulton (SE. 1/4, Sec. 4, T. 11 S., R. 9 E.) and extends southeast to Bull Mountain Creek Valley, show a fairly good section of the basal part of the Lower Eutaw, and some upper Tuscaloosa. The weathered phase of the Eutaw is conspicuously ex-

Figure 6.—Eutaw laminated sand and clay, Highway 25 cut (SE. 1/4, Sec. 4, T. 11 S., R. 9 E.) 10 miles south by east from Fulton. Photo by F. F. Mellen, May 23, 1935.

posed by the gorge at the head of this valley. The Eutaw here consists of the usual sands and laminated sandy clays and clayey sands (Figure 6).

Eutaw sands and subordinate clays are shown in several places by headwater branches of Reeds Creek and Tuscaloosa beds in the lower slopes of the valley walls. At one place (NE. 1/4, Sec. 8, T. 10

S., R. 9 E.) a mile and a half east of Highway 25, the summit of the west wall of the valley is 126 feet above the creek. A long exposure of the red and brown sands may be seen along Highway 25 in the south wall of the valley above the Tuscaloosa beds already mentioned.

Half a mile or so north of White Springs the left wall of Tombigbee River Valley is a narrow ridge which reaches a height of 75 to 100

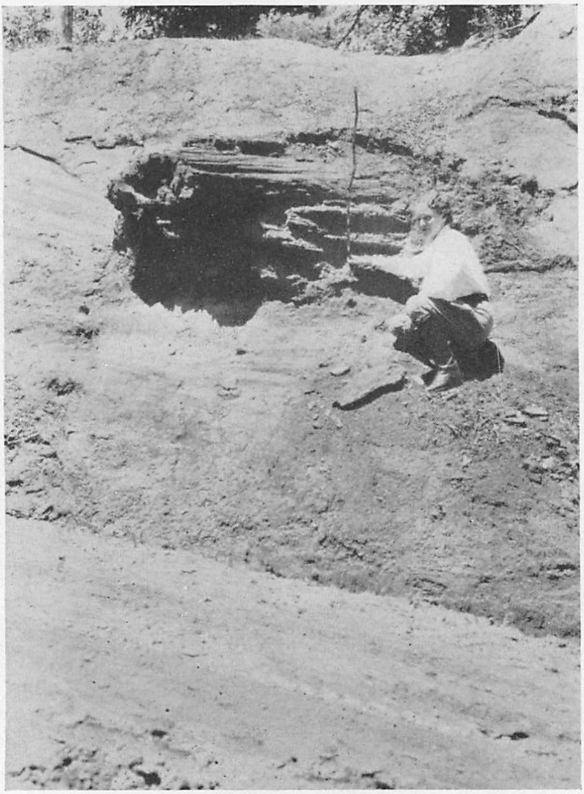


Figure 7.—Silicified log at Tuscaloosa-Eutaw contact in road cut (NE. 1/4, Sec. 23, T. 11 S., R. 8 E.) near New Bethel. Photo by F. F. Mellen, June 5, 1935.

feet above the river flat (SW. 1/4, Sec. 32, T. 10 S., R.9 E.). At this point the river is a very short distance from the foot of the bluff, and the Mississippian Railroad is between the river and the bluff some 15 feet above the flat. Three or four small railroad cuts at the base of the ridge expose sand and some brown loosely cemented sandstone, and ferruginous sandstone shows higher on the slope. The lowermost few feet of the wall here probably are Tuscaloosa material, the remainder, Eutaw.

The Tombigbee River bluff at the west end of Barrs Ferry Bridge, at the old fish camp (Central part, Sec. 26, T. 11 S., R. 8 E.) shows a good section of Lower Eutaw, and other good exposures are made by road cuts in the walls of a little valley at New Bethel, 1.5 miles farther north (Secs. 23 and 14, T. 11 S., R. 8 E.). Petrified logs are a feature of the beds at this place (Figure 7).

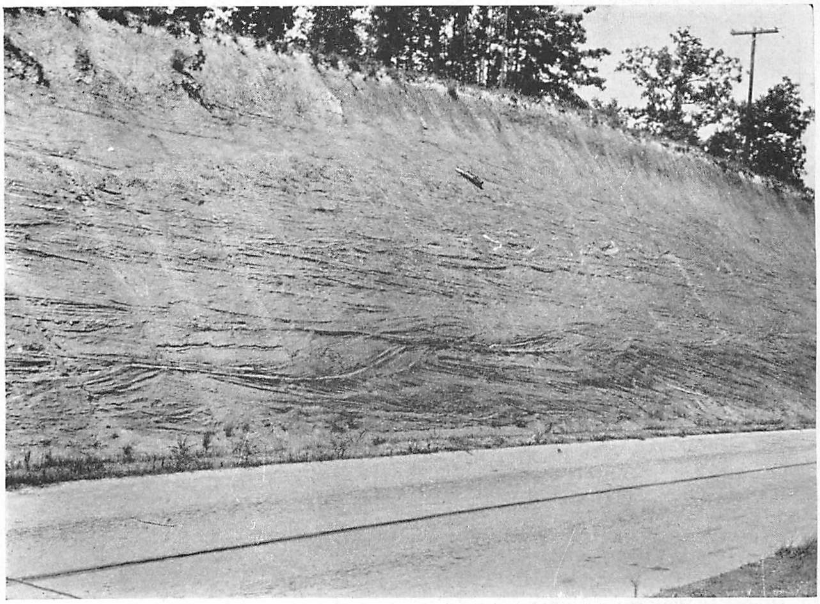


Figure 8.—Eutaw sand, irregularly bedded, not far below the base of the Tombigbee sand, U. S. Highway 78 cut (Sec. 34, T. 9 S., R. 8 E.) 3.0 miles west by south from Fulton. After Stephenson and Monroe (Bull. 40, p. 84.)

A good section of the upper part of the Lower Eutaw, not far below the base of the Tombigbee sand member, is shown by the walls of a cut for U. S. Highway 78 in the upper part of the west wall of the Tombigbee River Valley some 3 miles west by south of Fulton (Figure 8). The irregularly bedded red-brown glauconitic sand and thin-bedded sand and clay are well defined here.

The Lower Eutaw-Tombigbee sand contact trace is a very irregular line extending roughly north-south through the western part of the county. Tongues of the Lower Eutaw reach northward and northwestward along the valleys, and tongues of the Tombigbee sand extend southward and southeastward along the interstream ridges. The Tombigbee sand is at the surface in a narrow belt along the western boundary of the county, east of the Lee County line except for a few projections. It is well exposed in several places.

Figure 9.—Concretions in the Tombigbee sand, in a cut (SE. 1/4, Sec. 21, T. 9 S., R. 8 E.) for the U. S. Highway 78-Mantachie road, 2.5 miles west by north of Fulton. August 29, 1946.

On the northeast side of the Mantachie road about 3.0 miles southeast of Mantachie and 2.4 miles north of U. S. Highway 78 (SE. 1/4, Sec. 21, T. 9 S., R. 8 E.), seven large rounded concretions project from the Tombigbee sand (Figure 9). These masses, which seem to be fine micaceous bluish-green or greenish-blue sand cemented to an extremely tenacious sandstone, are scattered through the unconsolidated sand at different levels within a vertical interval of 10 feet or so. The largest observed is 4.5 feet in diameter; another is 3.5 feet in diameter and projects 2.5 feet above the sand matrix. The same concretion interval is exposed by a cut for a short east-west road a few rods farther north. The Mantachie road outcrop shows a continuous exposure of some 35 feet, entirely sand except for clay laminae toward the base, and may include the Lower Eutaw-Tombigbee contact, although no sharp contact is visible. The lower part of the exposure shows irregular bedding, whereas the Tombigbee member is in general massive.

Probably the interval containing the concretions is the same as that at Blue Bluff of the Tombigbee River north of Aberdeen, and that at the bridge some 6 to 8 miles south of Booneville, as well as at several other places, notably Bartons Bluff, Clay County.

The Lower Eutaw-Tombigbee sand contact, and intervals of both units, are exposed along a road 2.5 miles due east of Ratliff (NW. Cor., Sec. 18, T. 8 S., R. 8 E.):

SECTION ON EASTWARD-FACING SLOPE OF HILL 2.5 MILES EAST OF RATLIFF

	Feet	Feet
Eutaw formation (Tombigbee sand member)		27.0
Massive highly calcareous, glauconitic, micaceous sand; indurated ledge 17 feet above base; contains *Exogyra ponderosa* Roemer, and *Gryphaea* sp.	27.0	
Eutaw formation (typical beds)		28.0
Cross-bedded and thin-bedded glauconitic, micaceous sand and thin-bedded gray sandy clay	28.0	
Total section, 55 feet.		

At the junction of the Greenwood road with U. S. Highway 78 (SE. Cor., Sec. 31, T. 9 S., R. 8 E.), the highway cut exposes green and yellow Tombigbee sand containing oxidized pockets and lumps. Down hill a little west of the junction, the southwest wall of the cut shows a rather sharp Lower Eutaw-Tombigbee contact. The Lower Eutaw here is dark-gray to light-gray thin laminae and flakes of sandy clay or clay shale; the Tombigbee is massive green and blue and yellow sand immediately above the contact, but higher up it is brown to red brown because of the oxidation of contained iron. The contact can also be located approximately near the base of the west wall of the same valley. In front of a house the thinly laminated flaky clay, somewhat weathered, shows, and a little farther west the massive blue and green and yellow sand, oxidized to red brown near the surface. At the bottom of the west wall of the next valley westwards, is an exposure of 10 to 15 feet of sand and very sandy flaky clay. A yellowish-green to greenish-yellow micaceous sand, containing numerous borings, is overlain by some 10 feet of sandy shale-like clay, dark gray to dark bluish where fresh, but lighter gray to red and yellow mottled where weathered; flaky at the surface where the clay laminae have broken down under weathering and the fragments have dried. This interval is yellow limonitic and much iron stained, and contains some concretionary material. The sand-clay contact is marked by a crust of limonite-cemented clay.

A little bentonite within the Eutaw formation, probably all in the Lower Eutaw, has been found on the Carpenter, Bean, Myers, and Hall properties (see section on Economic Geology).

A short distance east of Kirkville a cut for the road leading to Spencer's store exposes about 15 feet of massive greenish-gray fine glauconitic sand containing a ferruginous layer which shows faint lamination about midway of the section. *Halymenites major* Lesquereux are numerous below the ferruginous layer. Some 25 feet of similar glauconitic sand containing *Halymenites major* Lesquereux shows a mile east of Kirkville a little below the top of the west wall of Meadow Creek. All these sands probably belong to the Tombigbee member of the Eutaw.

THE SELMA FORMATION

The Selma formation[2, 5] as a whole is a broad, irregularly tabular body of dominantly lime rock which lies on the Tombigbee member of the Eutaw from its eastern limit to south-central Lee County, and from there northwards includes the Coffee sand member, which is the equivalent of the lower 250 feet of the formation farther south. The Selma dips at a low angle (Plate 2) in directions ranging from south or slightly east of south at the eastern end, to west or a little north of west at the northern limit; thus its area of outcrop is an irregular roughly crescentic belt which borders the Eutaw outcrop belt on the west, southwest, and south, and extends from the southern part of western Tennessee to eastern Alabama. The maximum width of the Selma area of outcrop is 24 to 25 miles in eastern Mississippi and western Alabama; the belt is progressively narrower along the strike in both directions from there. The contact between the Selma and the Eutaw is marked by evidences of unconformity, such as a basal conglomerate composed of phosphatic molds of fossils, phosphatic nodules, and oyster shells, of which some were originally in the Tombigbee sand but have been reworked into the basal zone of the Selma. These features of the contact are said to have been traced from Lee County, Mississippi, through Alabama into Georgia.

Because its predominant material is unconsolidated limestone, or chalk, the Selma formation commonly is referred to as the Selma chalk. However, the formation includes very impure chalky clays and sands of which the $CaCO_3$ content is very low, and also strata which contain 98 percent or more of $CaCO_3$. The Coffee member is a slightly calcareous sand. Although no definite progressive variation of the quantity of lime in the Selma chalk, either vertically or laterally, has been discovered, the chalk is in general more sandy and clayey in northern Mississippi than it is farther south. The most nearly pure limestone of the formation is the very thin Arcola member, some 200 to 265 feet above the base. Fossil shells are an important part of the formation in places. Very minor components are concretionary nodules of marcasite, fresh or oxidized; phosphatic nodules and mollusk molds; gypsum veins and seams and joint fillings; calcite joint and fracture fillings; a little hydrated manganese dioxide (wad) and possibly small quantities of other substances.

Fresh chalk of the Selma is bluish gray or dark gray, but dries to light gray and white, and oxidation of the iron may alter the color to dull white or yellowish. Perhaps the most conspicuous features of the Selma outcrop belt are the glaring white "bald" spots where erosion has removed all weathered material, exposing the underlying chalk. In general the chalk is structureless, or massive, but in some outcrops distinct bedding is discernible, notably where the sand content is considerable, or where different degrees of consolidation are marked. Certain zones, also, contain substances of different composition and color from the containing rock, and for this reason appear as distinct beds—for examples, the layers of fossil shells and the phosphatic beds.

The Coffee sand member of the Selma is the age equivalent of the basal part of the typical Selma chalk, and although in northern Mississippi and in Tennessee it is not separated from the Eutaw formation by any stratigraphic break and is so similar in lithology to the typical Lower Eutaw as apparently to be indistinguishable from it, farther south in Mississippi the Tombigbee member of the Eutaw, readily identifiable, underlies the Coffee sand and thus fixes the stratigraphic position of the Coffee. The Coffee sand member in general crops out in a belt about 10 miles wide north of central Lee County. In central Lee County it intertongues and merges with the lower part of the Selma chalk. The outcrop area includes the northeastern quarter of Lee County, the middle third of Prentiss, the eastern third of Alcorn, and small adjacent areas in Itawamba and Tishomingo. The average thickness of the Coffee member is about 200 feet. The materials of which it is composed are sand and clay. The sand is glauconitic, fine to medium of texture, and thinly cross-bedded towards the north to more massive towards the south. The clay consists of thin laminae and laminated layers. Here and there the member contains comminuted plant fragments and scattered pieces of lignite.

The Selma formation as a body is classed as unconsolidated, but in some thicknesses the processes of consolidation (cementation for the most part) have proceeded much farther than in others, due to differences in lime content or freedom of water circulation or quantity and character of the aqueous solutions, or stratigraphic relations of beds of different permeability, or to other factors or combinations of factors. The Arcola limestone is strongly consolidated and very tenacious, and some thin layers of calcareous sand are strongly indurated.

The maximum thickness of the Selma formation is more than 900 feet in western Alabama, but the thickness is less in Mississippi, the formation thinning notably northwards.

In Itawamba County the Selma formation is represented by the eastern edge of the Mooreville tongue, and by a little of the Coffee sand member. The Mooreville tongue, named after Mooreville, Lee County, the type locality, is a tongue or wedge of clayey chalk or chalky shaly clay (marl) which projects northwards from the basal part of the main body of the Selma and loses its identity by gradation into the Coffee sand member in eastern Lee County and western Itawamba. Of its total thickness of some 200 feet, only a small part underlies the surface of Itawamba County, where the Mooreville outcrop area consists of a few small patches on the east side of the Lee County-Itawamba County line (Plate 1). The lesser relief of the Mooreville area as contrasted with the Tombigbee sand outcrop area which borders it on the east, is easily noticeable, as well as the difference in color and lithologic character of the two formations and their weathered phases. The Mooreville tongue is fossiliferous. Stephenson and Monroe mention that the Selma (Mooreville tongue)-Tombigbee sand contact is well exposed at several places in the vicinity of Dorsey, on U. S. Highway 78 in western Itawamba County.

They refer especially to an outcrop in a gully a tenth of a mile west of Dorsey, where 5 feet of very calcareous, glauconitic massive sand of the Tombigbee is overlain by 21 feet of very argillaceous and sandy chalk of the Mooreville containing fossils preserved either as shells or as phosphatic molds. These places were visited during the present survey, and some fossils, including vertebrae and teeth, were collected from an exposure a quarter of a mile east of Dorsey and 100 yards or so north of U. S. Highway 78.

About a quarter of a mile east of Dorsey, on the south side of U. S. Highway 78 at the head of a gully a little east of the McDaniels home, and 27 feet above the Tombigbee sand outcrop described in the discussion of the Eutaw, is an outcrop of very compact whitish fossiliferous sandy chalk or chalky sand. This material is at or very near the base of the Mooreville tongue of the Selma; the Tombigbee-Mooreville contact is concealed here, but is somewhere in the 27-foot interval referred to above. A little above the chalky outcrop, on the south side of the highway in front of the McDaniels home, the very resistant hard limy sand has been exposed by road work. The remains of a fossil turtle were found here.

The lower of these exposures is 65 feet higher than the Lower Eutaw-Tombigbee sand contact half a mile to the east.

Intervals of Mooreville not far above the base are well exposed by several outcrops in the vicinity of Dorsey north of Highway 78, but none east of Dorsey is more than 20 to 25 feet. Lime and limonite concretions are so thickly scattered about on the surface that in places they form an almost continuous mantle. The limonite nodules seem more characteristic of the top of the Tombigbee and the basal zone of the Mooreville, whereas the $CaCO_3$ concretions seem to be present in the residuum from weathering of the chalk of all outcrops. Fossil shells are abundant on the Mooreville exposures east and west of Dorsey: thousands of *Exogyrae* and *Ostreae* are conspicuous; smaller thin pelecypod shells are numerous also, and gastropods and vertebrate remains are sparingly represented. At the exposure a tenth of a mile west of Dorsey, already referred to, where gullies have been cut in the Mooreville, the authors of Bulletin 40 collected the pelecypods *Inoceramus* sp.; *Ostrea panda* Morton; *Exogyra ponderosa erraticostata* Stephenson, and *Trigonia* sp., and the gastropod *Xenophora leprosa* (Morton). Along Highway 78, 2 miles east of Mooreville, Lee County, and a short distance east of the Lee County-Itawamba County line, they found the following named fossils: Coral, *Micrabacia cribraria* Stephenson?; Vermes, *Hamulus onyx* Morton; Pelecypods, *Exogyra ponderosa* Roemer; *Anomia argentaria* Morton; *Cymella bella* Conrad?; *Veniella conradi* (Morton). Along the Mantachie road, 5 miles northeast of Mooreville, the fossils of which the names follow were collected: Vermes: *Hamulus major* Gabb; Pelecypods: *Ostrea plumosa* Morton; *Ostrea whitei* Stephenson; *Exogyra ponderosa* Roemer; *Exogyra ponderosa erraticostata* Stephenson.

A cut for the Kirkville-Ratliff road in the southwest wall of Twentymile Creek Valley (SE. 1/4, Sec. 2, T. 8 S., R. 7 E.) exposes a good section of Mooreville and a little of the uppermost Tombigbee sand. Some fossils were collected from the Mooreville beds near the base of the valley wall where a small tributary valley opens into the valley of Twentymile Creek. Hard phosphatic sandstone and phosphatic nodules show here. Less than 100 yards farther southwest, in the wall of a road cut in the hill slope, large phosphatic greensand concretions are prominent, and at the time the writer visited the place, several of these were lying alongside the road, where they had been left by the road-working machine. These are fossiliferous; one contained a large very well preserved ammonite, showing shell features, including the nacreous luster.

Only a little of the northwestern corner of Itawamba County north of Twentymile Creek, is underlain by the Coffee sand member of the Selma. The contact between the Coffee and the underlying Tombigbee sand is sharp and apparently conformable. The topography of the Coffee outcrop area here is hilly, and characterized by flat-topped ridges, and smoothly rounded hills, extending 70 to 80 feet above the flood plain of the Tombigbee River. It represents a mature stage of topographic development, and does not differ greatly from the topography of the Tombigbee sand; the rounded and more or less conical hills of the Tombigbee might serve in a measure to distinguish the two.

PLIOCENE?, PLEISTOCENE, AND RECENT

Rock materials, unconsolidated for the most part, which underlie the flood plains and compose the stream terraces of Itawamba County, have been accumulating during a period which extends back at least into Pleistocene time, and probably into Pliocene time.[2, 5]

At several places terraces border the stream valleys (Plate 1). One excellent example is the terrane betwen Gum and Cypress Creeks, 1.5 to 3.0 miles northwest of Tremont (Secs. 28, 29, 32, T. 9 S., R. 10 E.). Much of this terrace is gravel. Another prominent terrace is on both sides of Highway 78 half a mile northwest of Tremont, and still another is along the upper reaches of Bull Mountain Creek in the eastern part of the county. In fact, terraces have been developed rather generally along Bull Mountain Creek, especially on the east side. In the southern part of the county relatively extensive terraces containing a considerable percentage of gravel are a feature of the southeast wall of the valley of Bull Mountain Creek, notably of the area (Secs. 22, 23, 27, 28, T. 11 S., R. 9 E.) around Turon. Bluff Creek at a place (SW. Cor., Sec. 27, T. 11 S., R. 9 E.) less than a quarter of a mile upstream from the Smithville-Tremont road bridge, is 40 to 45 feet below the top of the terrace which borders it on the south. A slide here has exposed some 10 feet of rather coarse brown sand overlain by about 5 feet of evenly bedded gravel, and masses of conglomerate and ferruginous sandstone are lying on the slopes of the terrace face for considerable distances. A few pits in this vicinity have exposed the gravel and sand of the terraces.

Terraces have been developed in many places along the East Fork of the Tombigbee River. A good example (Sec. 3, T. 9 S., R. 8 E.) is the west wall of the river valley some 6 miles north from Highway 78 and about 4 miles by a straight line northwest of Fulton. The top of the terrace here is 20 to 22 feet above the flood plain. Equally well defined terraces exist in several other localities along the river valley north of Highway 78. South of Highway 78, also, the west wall of the river valley is terraced along much of its length. Terraces are conspicuous at the site of old Van Buren (SW. 1/4, Sec. 24, T. 10 S., R. 8 E.) and north of it to a point beyond the mouth of Mantachie Creek. The terrace top is 25 to 30 feet above the river flat.

Stephenson and Monroe describe a section (NW. 1/4, Sec. 4, T. 10 S., R. 10 E.) of one wall of a cut for the Red Bay road, eight-tenths of a mile north of Tremont:[5]

SECTION ON RED BAY ROAD, 0.8 MILE NORTH OF TREMONT

	Feet	Feet
Pliocene or Pleistocene terrace deposit		15.0
Cross-bedded gravel composed of subangular to well-rounded pebbles, mostly chert, in a matrix of red sand; a bed of ironstone at base	15.0	
Unconformity		
Tuscaloosa formation		17.0
Light-and dark-gray, some pinkish, very fine sandy clay; ironstone at base	9.0	
Harsh white micaceous sand	8.0	
Total section, 32 feet.		

A large part of the area of Itawamba County is flood plain. The East Fork of the Tombigbee River winds about in a flat which at Fulton is a mile and a half wide, and at Walkers Bridge crossing (Secs. 35 and 36, T. 7 S., R. 8 E.), 2.5 miles south of the northern boundary of the county, is 1.3 miles in width. The flood plain of Bull Mountain Creek is almost as wide in the stream's lower course, and its larger tributaries have relatively extensive flats. Likewise, the larger tributaries of the East Fork of the Tombigbee, which enter from the west, have relatively wide flood plains. The alluvia underlying the stream plains consist, almost entirely, of sand, gravel, silt, and clay, and various combinations of these.

As part of the survey for the proposed Tennessee River-Tombigbee River waterway, the U. S. Engineers, in January to May, 1938,[8] made numerous 3-inch borings along the East Fork of the Tombigbee, all located on the flood plain or on adjacent terraces or other ground slightly higher than the flood plain. Forty-five of these holes were in Itawamba County. The deepest was 61.5 feet, the shallowest 25.0 feet; 3 holes were 60.5 feet each, 1 hole 60.0 feet, and 1 hole 58.0 feet; others ranged from 25.0 to 32.3, most of them being 25.0 or 30.0 feet. The areal distribution of the borings was fairly uniform, 18 holes being north of the latitude of Fulton, and 27 south of it. Altitudes ranged from 340.3 feet near the northern boundary to 233.3 feet near the southern. The logs of these auger-holes show that the rock materials encountered were almost entirely silt, sand, clay, and gravel. Sandy silt and silty fine sand were especially abundant. The percentage of silt was large; of gravel, small. Colors were brown, tan, and gray, and a little blue. Several holes, notably Nos. 112, 113, and 114 a little southeast of Ironwood Bluff bridge, passed through considerable thicknesses of stiff gray clay. All holes found water at slight depths.

Logs of three of these borings, one (201) on the northern boundary of the county; a second (189) in the central part, and a third (113) in the southern part, are given herewith.

HOLE 201

Date drilled: April 22, 1938
Location: On the Itawamba County-Prentiss County line, west of the NE. Cor. Sec. 21, T. 7 S., R. 9 E., on the north side of the road, in the valley of Mackeys Creek.

Elevation: 330.6 — Datum: Mean sea level

Elevations of contacts	Description of rock material
330.0	Fine gray sand
327.5	Fine tan silty sand; water
323.1	Fine tan sand
321.6	Fine tan sandy silt
315.5	Fine tan silty sand
305.0	Fine gray clayey silt
302.5	Gray silty clay
300.0	Fine gray clayey silt

HOLE 189

Date drilled: April 14, 1938
Location: On the line between Secs. 13 and 14, a little south of the center, T. 9 S., R. 8 E., 1.5 miles north by west of Fulton, in the valley of the East Fork of the Tombigbee River.

Elevation: 268.3 — Datum: Mean sea level

Elevations of contacts	Description of rock material
265.8	Fine brown sand; water
259.8	Fine tan silty sand
250.3	Tan sandy silt
245.3	Blue sandy silt
242.8	Fine gray silty sand
237.8	Fine gray sand

HOLE 113

Date drilled: February 4, 1938
Location: Center, Sec. 18, T. 11 S., R. 9 E., about a quarter of a mile southeast of Ironwood Bluff bridge over the East Fork of the Tombigbee River, on the south side of the road, a little northwest of the Mississippian Railroad.

Elevation: 251.5 — Datum: Mean sea level

Elevations of contacts	Description of rock material
249.5	Tan sandy silt; water about 250.8
235.5	Fine tan silty sand
230.5	Stiff gray clayey silt
205.5	Stiff gray clay
200.5	Stiff gray silty clay
195.5	Compact gray silt
190.0	Compact gray sandy silt

The thickness of the alluvium of the river valley may be estimated from the logs of these borings. All logs have numerous intervals, implying that no great thickness of any one kind of material was encountered. Probably the assumption is warranted, then, that none of the holes reached entirely through the alluvium, and that the alluvium is 60 feet thick at least.

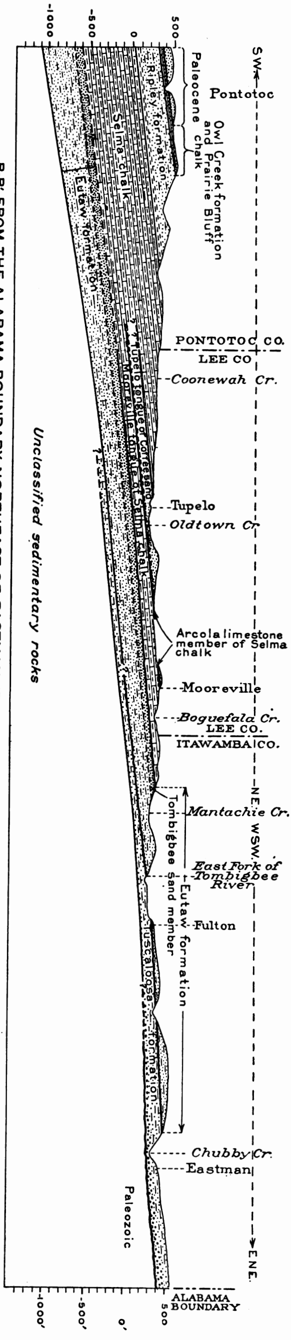
No doubt the alluvium of the valley of Bull Mountain Creek is of the same general character and of comparable thickness towards the lower end of the valley. Burdine No. 1 oil prospect well, located on the flat 3.5 to 4.0 miles northeast of the creek's mouth, found the base of the gravel at a depth of 185 feet, according to the log,[14] but at least some of this material probably was part of the Tuscaloosa formation. The very considerable width of the valley flat implies that the underlying alluvial material is of notable thickness. Such a statement would be true of other valleys of the county, also.

STRUCTURE

The observed structural features of the Cretaceous strata which underlie Itawamba County are bedding, dip, unconformities, joints, cross-bedding and cross-lamination, contemporaneous erosion surfaces, irregular bedding of various types, and perhaps other structures. Of these, the regional dip, the bedding, and the interformational unconformities, may be considered major structural features, the others minor.

The general regional dip varies somewhat, but averages about 30 feet to the mile[5] almost west (Plate 2), the strike in this latitude being north-south. The unconformities are the Tuscaloosa-Eutaw and the Eutaw-Selma contacts, but only the Tuscaloosa-Eutaw contact shows a noticeable erosional unconformity.[5] Bedding is present to a greater or smaller degree throughout the Cretaceous formations, conspicuous in the Tuscaloosa and the Lower Eutaw (Figures 2, 4, 6, 8), not so prominent in the Tombigbee sand and the Selma. The minor structural features listed above are distributed widely through the formations, one or more of them being present at almost every outcrop.

Certain investigations of stratigraphic and structural conditions in Itawamba County are reported to have revealed the existence of low folds or domes suitable for oil and gas traps. Easton reported



B-B' FROM THE ALABAMA BOUNDARY NORTHEAST OF EASTMAN, ITAWAMBA CO., VIA FULTON TO PONTOTOC, PONTOTOC CO.

Plate 2.—Geologic cross-section from the Alabama boundary through Itawamba, Lee, and Pontotoc Counties, to Pontotoc. After Stephenson and Monroe (Bull. 40, Plate 2, B-B')

the discovery in Monroe County of a north-south fold of which the axis extends into southern Itawamba County.[6] The Grasty No. 1 well in the southeastern part of the county was said to have been located on a definite structure, and Stephenson and Monroe mention a small anticline.[5]

The structure of the underlying Paleozoic can be inferred only, from outcrops in Tishomingo County and in northwestern Alabama. Only three or four wells in Itawamba County, of which the Grasty is deepest, have reached the Paleozoic. According to the log, the Grasty well reached the hard rock at about 172 to 179 feet. The Cowart No. 1 well, in northern Monroe County, found the Paleozoic at 193 feet.[5, 6] The various depths of the Paleozoic beds below the present surface, as determined by wells in Monroe and other counties, and the general appearance of the outcrop area in adjacent Alabama, when considered along with the elevations of the present surface, suggest that the upper surface of the Paleozoic rock underlying Itawamba County is irregular and as a whole has considerable relief. Also, the Paleozoic structural features discovered from outcrops and wells elsewhere suggest that similar structures or extensions of the same structures are present in Itawamba County. For examples: In Franklin County, Alabama, which borders the northern half of Itawamba County on the east, gentle northwest-southeast folds have been found, including, according to Semmes, "one of the most pronounced and persistent folds in the whole of northwest Alabama, and the most favorable for testing."[6] In Marion County, Alabama, which adjoins Itawamba County south of Franklin, similar structures have been found.[6] Minor northwest-southeast fault systems have been reported along this same part of the Mississippi-Alabama line; Easton stated that he had found four such fault lines, and believed that production could be obtained along them. The faults appear to be near the north edges of the folds mentioned above.[6]

The axis of the Cincinnati Arch or Cincinnati Anticline strikes in general northeast-southwest, and its continuation extends through Itawamba County. However, the great anticline, so pronounced in Ohio, Kentucky, and Tennessee, and famous as an oil and gas trap, may not be developed in Itawamba County to a degree sufficient to be of economic importance. Minor northwest-southeast structures, as described above, are more likely to have affected any possible oil and gas accumulation than is any one regional structure[4].*

PALEOGEOGRAPHY AND GEOLOGIC HISTORY[5]

At the beginning of Late Cretaceous time the area which is now Itawamba County was part of a broad low-lying plain of slight relief. Drainage from the north and east followed winding courses across the plain to a bay reaching northwards from the Cretaceous ocean. Relatively early in Late Cretaceous time crustal deformation brought about a tilting of this plain "in such a manner as to cause a downwarp south of the axis of movement and an uplift north of it." The effect was to rejuvenate the streams and at the same time to admit the sea to a large region which had been lowland. The steepened gradient increased the velocity of the runoff from the higher land at the north; their greater velocity in turn gave the streams greater capacity to erode and transport, and the result was that huge quantities of gravel, sand, clay, and silt were carried from the newly uplifted region southward to the narrowing coastal plain and the advancing gulf. This rock debris built flood plains, alluvial fans, lake and swamp deposits, and deltas; worked over by the waves, it was fashioned into bars and other transient depositional features of the shore of a shallow sea. In general, the gravel, being coarsest and heaviest, was deposited nearest the shore and tended to remain in the shoreward phase of the basal part of the new formation; the sand was carried farther seaward, and the silt still farther. As the shallow water crept northwards it rearranged the deposits, spreading them more widely along the shore line. Apparently the downwarping was prolonged, because the marine area continued to grow until almost all the territory now included in the Mississippi Embayment was covered. During this time deposition was sufficiently rapid to keep the advancing waters shallow. The encroachment of the Tuscaloosa sea was finally halted some distance west and southwest of the landward edge of the present Tuscaloosa formation. The bentonite deposits seem to be evidence of some vulcanism in nearby territory about this time.

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*The geology of northeast Mississippi and northwest Alabama, with especial reference to oil and gas reservoirs and structures, is discussed at length by the writer in Miss. State Geol. Survey Bull. 57, Monroe County Mineral Resources.

The next episode was a withdrawal of the sea from the region, exposing the newly deposited sediments to weathering and erosion for a very long time. The Tuscaloosa age ended when this retreat of the shore line was halted.

The Eutaw age was initiated by the beginning of a second Late Cretaceous incursion of marine waters. The Eutaw gulf transgressed the roughened plant-clad surface of the Tuscaloosa terrane, advancing far to the north, in places beyond the limits reached by the preceding sea, all the while receiving sand and clay and a little gravel from the adjacent land. The effects of the waves, tides, and currents can be read in the irregular bedding of the Eutaw sands. The waters remained widespread in this area through the remainder of Late Cretaceous time, during which sediment from the land, and lime from organisms, built on the bottom beds of sand, clay, and chalky mud or impure chalk totaling 1400 to 1500 feet in thickness. Through Early Eutaw time subsidence of the sea bottom seems to have been uniform, but it appears to have become more rapid late in Eutaw time, and the sand was deposited in deeper water, where movement was not sufficient to produce bedding. The Eutaw age was brought to a close by a general shallowing of the sea and emergence of wide areas of sea bottom, but the new land, a low-lying plain, was submerged again in a relatively short time, geologically speaking.

The initiation of this submergence began the Selma age. Streams brought a little fine sediment from the low shores, and the waves re-worked some of the Tombigbee sand into the younger deposits; but lime from the abundant marine organisms came to compose a larger and larger part of the accumulations on the sea bottom. Chalky muds came to predominate toward the south, but farther north deposition of sand continued, inasmuch as drainage from the land on the east was largely towards the northwest.

Evidence (unconformities) exists of a general retreat of the sea following the deposition of the Selma sediments, and a long period of erosion of the new land. Another advance of the waters succeeded the erosion interval, before the Mesozoic era closed with crustal movements which raised all northeastern Mississippi and central Alabama relative to sea level. The margin of the old gulf was drawn far southwards, from where it crawled slowly back again as the recently elevated land crumbled under the attack of the agents of degradation and was returned bit by bit to the waves. The Paleocene time had begun. The sea spread widely over the worn down land, bringing with it a greatly changed and largely new assemblage of marine life, composed partly of immigrants and partly of new species descended from the Cretaceous forms which had previously inhabited the area. This Paleocene (Midway) submergence was the last marine inundation to reach northeastern Mississippi. Possibly it did not extend over the territory now included by Itawamba County; if it did, the sediments which it received were eroded away entirely after its final retirement. The region has been land, then, since early Tertiary time, subject to weathering and erosion as well as to geologic changes which take place far below the surface. Its history since early Tertiary time is the story of land conditions only, not both land and marine as was its Cretaceous history.

Not all the events of the immensely long time from the beginning of the Tuscaloosa age to the present are recorded by the Upper Cretaceous and later formations. What happened during the periods when the Itawamba County area was land must be inferred from the information we have about land conditions elsewhere at the same time, together with the little geological evidence which still exists in the county itself. The unconformities within the Cretaceous terrane are evidence that the regions where they are present were land at various periods, and the irregularities of the old surfaces were made by subaerial erosion; but the rock waste removed was shifted far to the south and covered by younger material. It can not be studied, unless on a small scale from well samples; but the characteristics of the formations in the county tell something of the conditions on adjacent lands which no doubt were very similar to those existent in the county when it was land.

Such evidence as we have implies that the Cretaceous lands of the Gulf region had a subtropical climate not unlike that of today: Relatively high temperatures most of the year, moderate to heavy rainfall, light prevailing winds, and occasional violent storms. The coarse material of the non-marine part of the Tuscaloosa formation suggests abundant water and strong currents; the fine material, less volume and weaker currents. Without doubt most of the land was covered with trees or other plants, as indicated by the beds of lignitic clay containing leaf impressions, the silicified wood, and the fragments of lignitized wood. It is equally certain that animal life was well represented on the Cretaceous lands, although few fossils of land animals have been found. As mentioned in the text, some fossil remains were brought to light by the mining of bentonite.

The most noteworthy post-Cretaceous events were crustal disturbances which brought about relative changes of level and consequent acceleration or retardation of gradational processes. In late Miocene or early Pliocene time the region which is now northern Mississippi was part of a great plain having an altitude about 100 feet higher than that of the present Pontotoc Hills. Later uplifts caused the quickened streams to cut deeper and deeper valleys in the plain, leaving successive terraces. During the Pleistocene period (ice age) great rivers flowed southward from the melting glaciers, transporting immense quantities of rock debris, particularly silt, to build up the flood plains.

ECONOMIC GEOLOGY

SOILS

The mineral content of the soil of Itawamba County is derived for the most part from the rock formations which crop out or have cropped out, in the county. Necessarily this is true of the residual soils, because they originated *in situ*—that is, in the place where they now are—through weathering of rock that once occupied the same position. Also the rock material of the flood-plain soils of streams which are entirely inside the county is derived from the county bed rock, inasmuch as it is one-time residual soil and loosened rock washed from the valley walls and spread over the stream flats. However, the transported soils of the flood plains of the East Fork of the Tombigbee River and of Bull Mountain Creek, which have their sources outside the county, contain at least a relatively small percentage of rock debris from Paleozoic sandstones and shale of Tishomingo County, Mississippi, and of Alabama.

Insofar as soil minerals are concerned, then, the Itawamba County soils reflect the lithologic character of the bed rock. The residual soil of any part of the Tuscaloosa outcrop area is dominantly sandy, gravelly, or clayey, according as the part of the parent formation at that place was dominantly sand or gravel or clay. The residual soils of the Eutaw area are sandy loams or clay loams, the red sandy Orangeburg type prevailing, especially in the Tombigbee sand outcrop belt.[9]

The U. S. Department of Agriculture Bureau of Soils, in cooperation with the Mississippi State Geological Survey, completed a detailed soil survey of Monroe County in 1910, and of Lee County in 1916, but no such study of the soils of Itawamba County was made. However, the soils of the Tuscaloosa and Eutaw areas of Itawamba are almost idential with those of Monroe, and the soils of the small tracts of the Mooreville and Coffee members of the Selma formation in the extreme western part of Itawamba County are very similar to those of the same members in Lee County. In fact, the soil maps of Monroe and Lee Counties indicate that several soil types of those counties extend into Itawamba. The most extensive soil type of the Lower Eutaw region, east of the Tombigbee River, is the Orangeburg fine sandy loam, an upland soil, of which the results of mechanical analyses are recorded below, in percentages:[8]

Soil: Fine gravel, 0.4; coarse sand, 3.6; medium sand, 4.2; fine sand, 52.2; very fine sand, 8.7; silt, 24.4; clay, 6.1.

Subsoil: Fine gravel, 0.1; coarse sand, 2.1; medium sand, 3.3; fine sand, 37.1; very fine sand, 6.4; silt, 17.7; clay, 33.4.

Thus the mechanical analyses show that the Orangeburg fine sandy loam consists of some 69 percent sand, 24 percent silt, and only 6 percent clay, whereas the subsoil runs 49 percent sand and fine gravel, 17.7 percent silt, and 33.4 percent clay. The higher clay content of the subsoil probably is due chiefly to the carrying of the clay particles from the soil into the subsoil by descending water.

The Orangeburg soil is a gray sandy loam which ranges in thickness from 8 to 14 inches; the subsoil is a red to brownish sandy clay 22 to 28 inches thick. Both soil and subsoil are types which would normally develop from a formation such as the Eutaw.

In the plateau region of the eastern and northeastern parts of the county, especially between Bull Mountain Creek and the Tombigbee River, notable areas remain of the Brown Loam or high terrace type of soil.[9]

The Cahaba silt loam commonly is a terrace soil. The largest areas are in the terraced belt along the East Fork of the Tombigbee River and along Bull Mountain Creek and tributaries. It is a gray silt loam averaging 8 inches thick; the subsoil is a yellowish clay loam to an average depth of 18 inches, where it grades into a yellowish sandy clay. The mechanical analyses record is:

Soil: Fine gravel, 0.2; coarse sand, 0.8; medium sand, 2.2; fine sand, 13.9; very fine sand, 5.4; silt, 67.0; clay, 10.6.

Subsoil: Fine gravel, 0.3; coarse sand, 0.4; medium sand, 2.4; fine sand, 16.0; very fine sand, 9.8; silt, 49.8; clay, 20.9.[6, 9]

Areas of several different soil types extend into western Itawamba County from Lee. The most prominent of these are the Pheba fine sandy loam, the Pheba silt loam, the Oktibbeha clay, the Oktibbeha clay, shallow phase, the Catalpa silty clay loam, the Catalpa silt loam, and the Catalpa fine sandy loam. As the descriptive terms indicate, loam is a mixture of sand, silt, and clay, and the types are differentiated on the basis of the relative proportions of these components. All the soil types named above, and many others, are briefly described in Bulletin 63 of the Mississippi State Geological Survey, and some of the data are pertinent in this discussion. The two types of the Pheba series are upland soils, occupying the Coffee sand area. The Pheba fine sandy loam is best developed on slopes and in places of pronounced relief. The Pheba silt loam is the dominant soil on the undulating to rolling topography, especially on the wide interstream divides. The record of the results of mechanical analyses of the Pheba silt loam is given below, in percentages:

Soil: Fine gravel, 0.1; coarse sand, 1.0; medium sand, 1.8; fine sand, 7.5; very fine sand, 10.8; silt, 70.3; clay, 8.5.

Subsoil: Fine gravel, 0.1; coarse sand, 0.6; medium sand, 1.0; fine sand, 3.9; very fine sand, 6.5; silt, 60.5; clay, 27.2

Lower subsoil: Fine gravel, 0.3; coarse sand, 1.5; medium sand, 1.8; fine sand, 8.1; very fine sand, 12.8; silt, 56.0; clay, 19.3.

The surface soil and subsoil are acid, and the soil is deficient in lime and in organic matter.[10]

The Oktibbeha series is developed in outcrop areas of the Mooreville tongue of the Selma formation. The Oktibbeha clay is the chief type, but its shallow phase occupies a much larger area. The soil and subsoil are typically brown to red brown. The surface soil commonly is acid, as is the subsoil, but they grade downward into limy material.[10]

The Catalpa series are lowland soils. The silty clay loam, the most extensive of the series, is the chief soil of the large creek bottoms, being especially well represented in the flood plain of Twentymile Creek. It is neutral or acid except where lime has been added by wash from calcareous upland soils, and the subsoil is acid. One Lee County sample, from the surface to a depth of 8 inches, contained 2.12 percent of CaO; another sample, from the 8-inch to 24-inch depth, 0.72; and a third, from 24 to 36 inches down, 0.78. The mechanical analyses record follows:

Soil: Fine gravel, 0.1; coarse sand, 0.6; medium sand, 1.6; fine sand, 13.2; very fine sand, 8.6; silt, 49.8; clay, 25.8.

Subsoil: Fine gravel, 0.2; coarse sand, 0.6; medium sand, 0.8; fine sand, 11.8; very fine sand, 7.6; silt, 45.8; clay, 33.0.

Lower subsoil: Fine gravel, 0.0; coarse sand, 0.2; medium sand, 0.5; fine sand, 13.5; very fine sand, 8.8; silt, 41.9; clay, 35.2.[10]

The Catalpa silt loam is present along some of the smaller streams of the western and southwestern parts of the county, and to some extent in the larger valleys. The results of mechanical analyses are:

Soil: Fine gravel, 0.2; coarse sand, 0.6; medium sand, 0.9; fine sand, 4.2; very fine sand, 18.0; silt, 63.5; clay, 12.5.

Subsoil: Fine gravel, 0.0; coarse sand, 0.8; medium sand, 1.4; fine sand, 8.4; very fine sand, 18.6; silt, 43.1; clay, 27.5.[10]

The Catalpa fine sandy loam is the predominant type along the small streams of the Coffee sand areas. Both soil and subsoil are decidedly acid. The results of mechanical analyses are recorded below:

Soil: Fine gravel, 0.0; coarse sand, 0.1; medium sand, 0.2; fine sand, 33.2; very fine sand, 34.6; silt, 23.8; clay, 7.8.

Subsoil: Fine gravel, 0.0; coarse sand, 0.4; medium sand, 0.5; fine sand, 26.4; very fine sand, 26.4; silt, 30.0; clay, 16.2.

Lower subsoil: Fine gravel, 0.0; coarse sand, 0.2; medium sand, 0.5; fine sand, 26.8; very fine sand, 25.8; silt, 28.6; clay, 17.8.[10]

Lowe[9] states that along the border of the Black Prairie region in western Itawamba County is an area of the Guin fine sandy loam, developed on rolling topography. This soil, derived from the Eutaw beds, is 8 to 10 inches thick and rests on a brownish-red clay loam subsoil. The mechanical analyses results are as follow:

Soil: Fine gravel, 0.2; coarse sand, 2.0; medium sand, 3.0; fine sand, 23.1; very fine sand, 4.9; silt, 58.7; clay, 7.6.

Subsoil: Fine gravel, 0.1; coarse sand, 1.2; medium sand, 2.0; fine sand, 24.4; very fine sand, 3.7; silt, 49.5; clay, 18.8.

The larger streams of the Tombigbee River Hills region in Itawamba County have wide flood plains, of which the soils are generally fertile. East Fork of the Tombigbee River, and Bull Mountain Creek, are bordered by broad bottom lands. The East Fork bottom soils are said to be less fertile in general than the soils of the flood plain of Bull Mountain Creek. However, the large quantity of black gravel and iron concretions in the soils of Bull Mountain Creek bottom and Hurricane Creek bottom indicates poor drainage. Nevertheless, on the whole the soils of the Tombigbee River Hills are well drained. The steep slopes and the sandy soils and the underlying sands of the hills facilitate drainage, and most of the bottom lands drain satisfactorily because of their sand and gravel content.[9]

Lowe[9] summarizes the relative percentages and the number of pounds of phosphorus, potassium, and lime in thirteen samples of soil and subsoil from different parts of the uplands and bottom lands of the Tombigbee River Hills region, of which Itawamba County occupies the central part. The equivalents of the phosphorus and potassium as phosphoric acid and potash (K_2O) are given. This estimated fertility is based on 2,000,000 pounds of soil to the acre, or the soil to a depth of about 7 inches. The estimates are made in pounds of mineral plant food per acre, both water soluble and acid soluble, but not including the insoluble.

Upland soils: Phosphorus, 0.038 percent, equivalent to 616 pounds per acre; as phosphoric acid, 1,412 pounds per acre; potassium, 0.1031 percent, equivalent to 2,062 pounds per acre; as potash, 2,946 pounds per acre; lime (CaO), 0.15 percent, equivalent to 3,000 pounds per acre.

Upland subsoils: Phosphorus, 0.024 percent, equivalent to 480 pounds per acre; potassium, 0.12 percent, equivalent to 2,860 pounds per acre; lime (CaO), 0.12 percent, equivalent to 2,400 pounds per acre.

Bottom land soils: Phosphorus, 0.078 percent, equivalent to 1,560 pounds per acre; as phosphoric acid, 3,580 pounds per acre; potassium, 0.16 percent, equivalent to 3,200 pounds per acre; as potash, 3,860 pounds per acre; lime (CaO), 0.385 percent, equivalent to 7,700 pounds per acre.

Bottom land subsoils: Phosphorus, 0.029 percent, equivalent to 589 pounds per acre; potassium, 0.132 percent, equivalent to 2,640 pounds per acre; lime (CaO), 0.17 percent, equivalent to 3,400 pounds per acre.

WATER

Itawamba County is well watered.[2] Not only is the rainfall heavy, but the lithology and structure of the underlying rock favor the storing up of water for longer or shorter periods and the yielding of it at a moderate rate. Outcropping interbedded sand and clay condition numerous springs and streams, and deeper, the dipping beds are reservoirs from which abundant pure water may flow or be drawn through wells. Few deep wells have been drilled, however, because springs and shallow wells have provided an adequate supply. Probably artesian flows from Tuscaloosa beds could be obtained by wells 200 to 400 feet deep in the lower areas of the western part of the county—the flood plain of the East Fork of the Tombigbee River and the downstream reaches of the flood plains of the larger tributaries of the river. Most of the shallow wells are not more than 40 to 50 feet deep. Two wells at or near Ratliff are 200 and 222 feet deep and obtain water from the Eutaw formation. Until recently Fulton drew its water supply from shallow wells in the Lower Eutaw sand and possibly the Upper Tuscaloosa; but now a well 188 feet to 200 feet deep, tapping water-bearing gravel in the Tuscaloosa, provides a flow of 175 gallons a minute. The well is said to have passed through 140 to 150 feet of clay, silt, and lignite chiefly, much of it blue to black and containing iron sulphide. Sand was subordinate above the 150-foot depth, but a little below 150 feet a 10-foot bed of sand was penetrated, and below it a 25-foot bed of small white gravel containing abundant water. The water, which has much iron in solution, is pumped from the well into a tank, from which it flows by gravity through a filter, and is then pumped into the town tank or reservoir, for distribution.

BENTONITE*

Bentonite is a clay-like mineral substance of somewhat uncertain origin, although most recent and efficient studies have tended to show that it is chiefly volcanic dust altered in water. It is widely used in many types of industry; probably it is utilized for more different purposes than is any other mineral substance. One of its chief uses is as a bleaching agent for oils of all kinds, and it is used for many other purposes in connection with petroleum production and refining. Perhaps its second most important general use is in foundry work, as a bond for molding sands, and as an ingredient in core-washes to keep carbonaceous material in suspension.

Bentonite and bentonitic clays have been found in Itawamba County at the places and on the properties specified below:

East of the Tombigbee River:

South of U. S. Highway 78 and east of Bull Mountain Creek

1) Filtrol Corporation workings, formerly the S. Cole property (Sec. 24, T. 11 S., R. 9 E.)
2) J. T. Stuckey, W. B. Sallis, and J. H. Sallis properties (Sec. 13, T. 11 S., R. 9 E.)
3) J. S. Welch Estate property (Sec. 18, T. 11 S., R. 10 E.)
4) E. S. Christian and Mrs. Della Patterson properties (Sec. 1, T. 11 S., R. 9 E.)
5) M. S. Falls and J. M. Plunkett properties (Sec. 36, T. 10 S., R. 9 E.)
6) C. C. Cody and Charles Seaton properties (Sec. 9, T. 11 S., R. 10 E.)
7) E. P. Kennedy property (Sec. 4, T. 11 S., R. 10 E.)

South of U. S. Highway 78 and west of Bull Mountain Creek

8) Properties of Mrs. L. E. Wheeler, I. J. Evans, John E. Evans, P. A. Evans, the Clifton Estate, Curtis Mattox, Earl Mattox, A. J. Mattox, D. S. Perkins, J. M. Kennedy, the Bank of Amory, and W. M. Pearce. Property of J. R. Johnson is referred to in old descriptions of bentonite deposits. (New Salem Community, Secs. 3, 4, 5, 8, 9, 10, T. 11 S., R. 9 E.)

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*For a brief discussion of the composition, properties, and uses of bentonite, see Mississippi State Geological Survey Bulletin 57, Monroe County Mineral Resources, pp. 90-94.

North of U. S. Highway 78
9) J. A. West (Sec. 14, T. 9 S., R. 9 E.) and Bogan Warren (Sec. 14, T. 9 S., R. 9 E.)
10) Troy Hall (Sec. 16, T. 8 S., R. 10 E.)
11) Governor Williamson (Sec. 15, T. 8 S., R. 10 E.)
12) W. A. Beasley and J. M. Gibbs (Sec. 25, T. 8 S., R. 8 E.)

West of the Tombigbee River
13) F. M. Carpenter (Sec. 33, T. 8 S., R. 8 E.)
14) J. I. Bean (Sec. 4, T. 9 S., R. 8 E.)
15) Joe Myers (Sec. 7, T. 11 S., R. 8 E.)
16) W. R. Hall (Sec. 6, T. 11 S., R. 8 E.)

As far as prospecting has determined, the deposit named first on the list, now being worked by Filtrol Corporation, is the largest in the county, and possibly the largest in the state. The area of the workings is perhaps 15 to 20 acres, and prospect holes have indicated a much greater extent for the body of bentonite. The overburden of Tuscaloosa and Eutaw sand, ferruginous sandstone, and subordinate clay varies in thickness, of course, with the surface relief and the irregularity of the upper surface of the bentonite; the maximum may be 75 feet at least. In general the overburden is easily removed. That the body of bentonite is of irregular shape is indicated by a range of thickness from 14 feet or more down to a few inches within the limits of the workings, and from 10.5 to 11.0 feet down to 3.0 feet within 200 to 300 yards. The face of bentonite exposed by the excavation at the place where digging was going on at the end of June, 1945, measured 10.5 feet in height (Figure 10), but 100 yards to the west the bed appears to be cut off abruptly: its upper contact can be traced diagonally across the walls of a ravine from the top to the bottom, descending westwards. Still farther westwards the bentonite is much thinner. The face where work is going on shows also that the basal contact of the bentonite is irregular in detail: from the ravine on the west it rises eastwards 10 to 11 feet in 100 yards or less, and from this highest point descends eastwards less steeply. Numerous exploration holes, drilled for the purpose of defining the bentonite body and determining its thickness, discovered that its top and bottom draw together northwards; that is, the greatest thickness is towards the southern end, and near the southern end is a definite sag or syncline. In short, the body of bentonite appears to be roughly wedge-shaped, or lens-shaped, but very irregular. It dips slightly westwards along with the other strata.

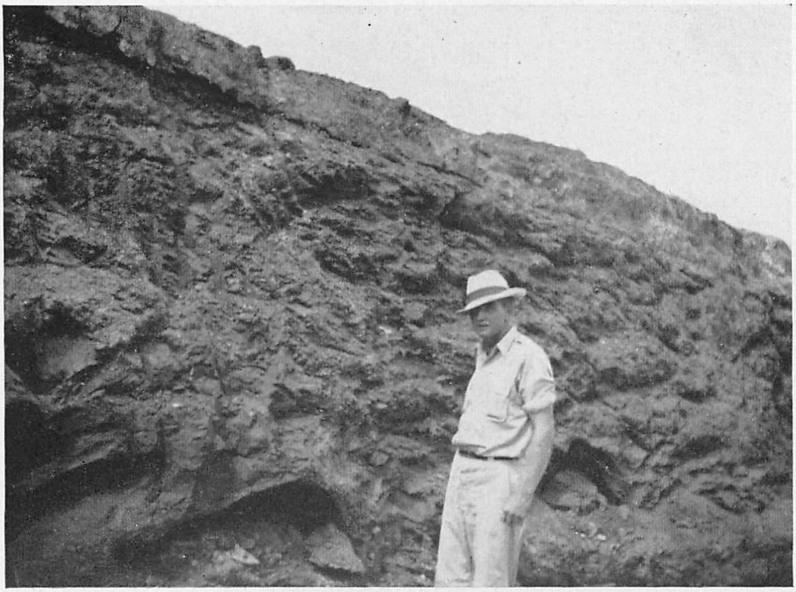

Figure 10.—Face of bentonite bed, Filtrol Corporation pit (SE. 1/4, Sec. 24, T. 11 S., R. 9 E.). June 29, 1945.

As exposed in place, the bentonite is massive, and breaks in irregular blocks, many of which have curved surfaces, among a complex of joints and fractures (Figure 10). The fresh material is light blue, but when exposed to the air undergoes a rather rapid change of color to greenish gray, olive green, or olive drab, due to the oxidation of the iron. Exposure over a protracted period to weathering agencies brings about still further change of color, through shades of brown and yellow to a pale yellow or dull white. This light-colored bentonite, then, is considered the weathered phase of the blue. Both colors are present in many deposits, and in some deposits only the lighter color is present. The face of the exposure in the Filtrol pit is greenish gray to brown, and brown iron rust has accumulated along the joint-planes and fracture-planes. A single block of bentonite may be blue near the center, and the remainder greenish or light yellow, obviously indicating that the change in color was caused by weathering agencies operating from without. Scattered through the bed are hard nodules of discoidal or roughly spherical shape, which appear to be indurated bentonite. Slickensided surfaces are numerous. No marine fossils have been found in the bentonite bed, but some fossil bones of land animals seem to indicate that the material did not accumulate in the sea. Furthermore, the bentonite is underlain by dark-blue to black micaceous sand containing laminae and lentils of dark clay, lentils and stringers of grit and small gravel, iron carbonate nodules, stringers and fragments of lignitized wood, and much marcasite disseminated as coatings, replacements, or nodules. All these conditions seem to be strong evidence that the bentonite accumulated in a swamp or marsh, possibly on the flood plain of a stream, or in a lake.

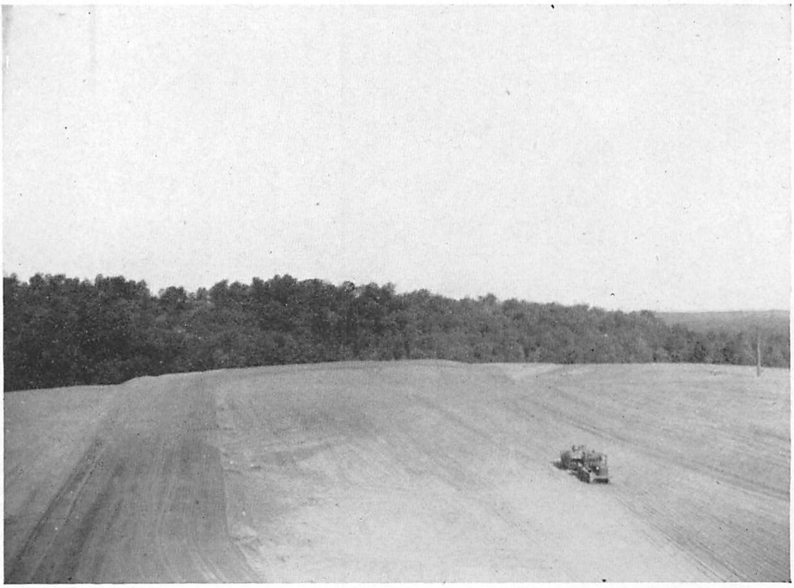

Figure 11.—Stripped area, Filtrol Corporation bentonite workings (SE. 1/4, Sec. 24, T. 11 S., R. 9 E.). June 29, 1945.

Filtrol Corporation has mined bentonite here for several years and has taken out many thousands of tons. The strip method of mining is used: First, the forest cover is removed from an area underlain by bentonite; next, the overburden is stripped off by bulldozers, beginning commonly along the walls of a valley where the bottom of the bentonite deposit is exposed and the debris may be dumped on ground below the bentonite level. Mining of the clay is begun by the removal of the narrow section of the bed thus uncovered along the slope, and as this contour mining proceeds, additional overburden is taken away and shifted to the space once occupied by bentonite; thus the stripped area is progressively increased. Were it not for the great thickness of the bentonite body, the expense of removing the very heavy overburden (60 to 75 feet or more) would make development unprofitable except perhaps along the outcrop, including a few feet or a few yards back from the outcrop. However, Filtrol Corporation has cut away entire hills down to the bentonite bed (Figure 11), and piled the debris in valleys or worked out areas,

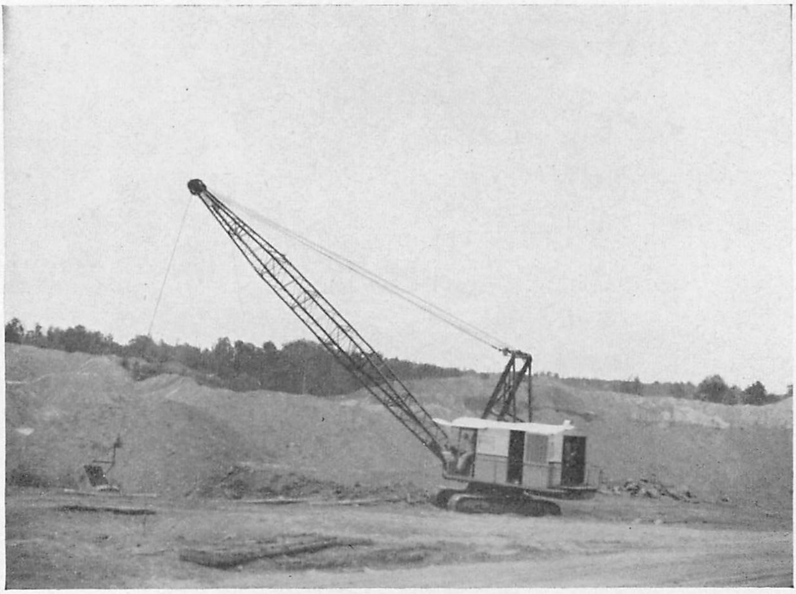

Figure 12.—Worked out area, and dragline in operation, Filtrol Corporation bentonite pit (SE. 1/4, Sec. 24, T. 11 S., R. 9 E.). June 29, 1945.

where it appears like a group of miniature mountains (Figure 12). Such large-scale stripping has been favored by the topography—deep valleys and tributary ravines—as well as by the character of the overburden—unconsolidated or only slightly consolidated sand chiefly.

The bentonite is dug from the deposit by a drag-line (Figure 12), and dumped into trucks, each of which has a capacity of 4 to 5 tons, the average being about 4 1/2 tons. These trucks transport the clay to Amory, where it is loaded on railroad cars for hauling to the big plant in Jackson, Mississippi. The distance from the pits to the railroad yards in Amory is about 17 miles, over a graveled road except for some 5 miles of black top from Amory toward Smithville. Although the graveled road is rough, largely because of the hard wear it receives, and has received for years, from the speeding clay trucks, it traverses essentially level terrace top, and consists of straight stretches except for the two or three miles of road closest to the pits. The number of trucks used varies: at the end of June, 1945, eight were in use, but at times in the past twice or three times that number have been employed. Nineteen men were employed on the date mentioned, but of course the number of employees has varied from time to time.

No reliable estimate of the original tonnage of this deposit, or of the quantity of clay already removed, is available; but 2,200 tons per acre-foot have been used as a basis for estimates. Taking into account the very considerable extent and notable thickness of the deposit, an estimate of 500,000 tons seems conservative.

A chemical analysis of a fresh sample from the bentonite bed showed:

CHEMICAL ANALYSIS

	Percent
Ignition loss	12.40
Silica (SiO_2)	54.00
Alumina (Al_2O_3)	22.01
Iron (Fe_2O_3)	7.40
Titania (TiO_2)	0.95
Lime (CaO)	2.32
Magnesia (MgO)	Trace
Miscellaneous	0.92

Analyst, H. S. Emigh.

The bentonite underlying the S. Cole farm was discovered some time before 1935. In May of that year, the writer of the present report visited the place, and found an open pit in the slope of a flat-topped ridge or terrace. The pit exposed 5 feet of greenish-white somewhat sandy bentonite, characterized by close jointing or fracture, and also conchoidal fracture. An auger hole, started on the lowest part of the crest of the ridge about 20 yards east of the pit, passed through 8 feet of overburden and 9 feet of bentonite, but did not reach the bottom of the deposit. A hole bored in the bottom of the pit reached the bottom of the bentonite bed at a depth of 2.5 feet, thus proving a thickness of 7.5 feet where the pit was dug. A third hole, on the northwest side of the ridge and some 13 feet below the ridge top, reached the bottom of the bentonite at a depth of about 6.5 feet. Two small outcrops showed greenish-gray much jointed and fractured somewhat sandy bentonite, containing a black substance along the openings.

By April, 1937, two large test pits had been dug by the Attapulgus Clay Company (Filtrol), and a considerable number of borings made. The pits were about 5 feet in diameter; one was approximately 15 feet deep, and the other possibly 25 to 30. The shallower pit, on the slope of a ridge, found 10.5 to 11.0 feet of bentonite; the deeper pit, on the opposite slope of the same ridge, begun on almost flat ground 10 feet above the mouth of the shallower, passed through a few feet of bentonite near the bottom.

A bentonite deposit which has long been known is that on the J. T. Stuckey property, the W. B. Sallis property, and perhaps other land adjacent, chiefly in Section 13, Township 11 South, Range 9 East. This was discovered from an outcrop on the south side of the Sallis's Mill-Hopewell road almost on the northern boundary of the section, or possibly in the extreme southern part of Section 12. The outcrop material is greenish gray to light yellow, and the extent of the exposure seems to indicate a thickness of 6 feet or so under overburden ranging from 10 feet to 28 feet of sand and a little clay. At least one other outcrop is known—in an old road perhaps a quarter of a mile southeast of the larger outcrop mentioned above.

Filtrol Corporation has bought or leased the Stuckey property. Figures on the extent and thickness of the bentonite are not available.

The J. H. Sallis land, adjoining the W. B. Sallis and J. T. Stuckey properties, contains some bentonite, but not enough prospecting has been done on it to provide a basis for an estimate of the quantity. A relatively small area has an elevation sufficiently high to include the bentonite interval. A test hole begun on the crest of a flat-topped ridge (NW. 1/4, Sec. 13, T. 11 S., R. 9 E.) above Sallis's Mill east of the Smithville-Tremont road encountered very sandy light-blue to dark-blue bentonite, almost a bentonitic sand, at a depth of 25 feet. The blue material proved to be very thick, but contained little pure bentonite, so far as determined by the test hole. The overburden is sand.

On the J. S. Welch Estate, or Quilla Welch land, near the eastern border, test holes passed through a thin bed of bentonite of good quality. The overburden in this area, including much ferruginous sandstone, is light to heavy.

On the E. S. Christian land (SW. 1/4, Sec. 1, T. 11 S., R. 9 E.), a few prospect holes passed through a thin bed of good quality bentonite, of whitish, blue, and greenish color. The maximum thickness did not exceed 1.5 to 2.0 feet, and the sand overburden is medium to heavy. Probably this is only a small deposit. Also, outcrops have been found on the Della Patterson property in the same section, but nothing further is known about the deposit there.

Some years ago a deposit of bright sky-blue bentonite was found on the Marvin Falls land, by an exposure at the head of a ravine (NW. 1/4, SE. 1/4, Sec. 36, T. 10 S., R. 9 E.). The bed is 4.0 to 4.5 feet thick. However, three holes, located 60 to 75 yards from the outcrop and several feet above it, were carried to a level well below it, but found no bentonite. Later a second outcrop was found a quarter of a mile northwest of the first. The bentonite which shows on the J. M. Plunkett property, a quarter of a mile southeast of the Falls outcrop, near the bottom of a deep ravine (SE. 1/4, Sec. 36, T. 10 S., R. 9 E.), probably is part of a body of clay which at one time included the Falls material also.

Some light-yellow bentonite has been found on the C. C. ("Cull") Cody farm (NE. 1/4, NW. 1/4, Sec. 9, T. 11 S., R. 10 E.). A hole immediately above and a little back from the one outcrop passed through 6 feet of good bentonite, but other borings were disappointing. A very few borings in this ridge and nearby territory found some bentonite, but no thickness greater than 3 feet was reported, and several holes found no clay at all. On the E. P. Kennedy farm adjoining the Cody property, a small outcrop (SE. 1/4, SW. 1/4, Sec. 4, T. 11 S., R. 10 E.) in a gully, led to the drilling of several prospect holes. One of these, only a few yards up slope from the outcrop, found 2.5 feet of bentonite under 3 feet of sand; other borings found nothing. The greater part of the bentonite of the Cody and Kennedy properties seems to be in a short spur ridge west of a small tributary of Splunge Creek. Prospecting on the Charles Seaton land, where a small outcrop (NW. 1/4, Sec. 9, T. 11 S., R. 10 E.) suggested the presence of a sizeable body of bentonite, proved fruitless. Holes only a few feet from the outcrop passed through about a foot of bentonite, and holes at a greater distance found none. The 1-foot to 2-foot bed shown by the outcrop appears to plunge at a high angle, as if it had been involved in a land slip.

On the northwest side of Highway 25 about half a mile southwest of the junction of the White Springs road with the highway, the Clifton and Graham and the Mrs. B. E. Evans (John E. Evans) properties (Sec. 8, T. 11 S., R. 9 E.) are underlain by a bed of bentonite of variable thickness. This region is a series of spur ridges and intervening narrow valleys extending northwest and southwest from the main plateau at the highway. The bentonite underlies sand, silt, and silty clay in most places. The sand is fine and micaceous, and locally bentonitic or glauconitic, or both; in a place or two small chert gravel was found in it. The silt commonly is laminated medium gray micaceous, and may be clayey and grade into laminated micaceous silty clay. One or two holes found the clay dark gray to black lignitic, grading downwards into dark, tough, sandy clay. The beds which immediately underlie the bentonite are pretty much the same as those above it; sand, silt, and clay in different relationships, containing a little gravel here and there. The logs copied below, of test holes on the Clifton property, describe the rock material associated with the bentonite. It will be seen that the bentonite bed in the first hole is 12.2 feet below the surface, and in the second, 42.8 feet. The difference, 30.6 feet, represents roughly the difference in elevation, although the strata in the second hole may have been lowered a little by slipping. The dip is negligible in the 400 feet or so separating the holes. Roughly, then, the two holes have passed through a continuous section of 59.1 feet.

TEST HOLE 1

Depth	Thick.	Description of materials
12.2	12.2	Sand, silt, and silty clay; thin ironstone at intervals
14.4	2.2	Bentonite, tan, oxidized throughout; high-grade
16.7	2.3	Silt and sand, bentonitic; chert pebbles in bentonitic sand about 1 foot below the bentonite
16.8	0.1	Rock, ferruginous
22.5	5.7	Silt, bentonitic, very ferruginous at the top; laminated silty clay below; at 18.0 feet a streak of argillaceous slightly glauconitic sand; oxidized bentonitic (?) silt below the sand; at 21.5 feet to 22.5 feet is glauconitic and bentonitic (?) sand containing a small quantity of water and a few large chert grains
22.9	0.4	Silt, medium-gray micaceous, grading into black silty clay; streaks of coarse sand and gravel near the base of the interval

25.1	2.2	Clay, dark-gray tough silty laminated lignitic, containing thin streaks of fine sand
26.9	1.8	Silt, medium-gray lignitic, containing streaks of clay; at 25.5 feet, pyritized lignitic wood, and at 26.0 feet, streaks of lignitic siderite; interval most lignitic towards the base

In Test Hole 1 no water was encountered above 20 feet, and all the material above that depth was oxidized. The black ball clay was not reached.

TEST HOLE 2

Depth	Thick.	Description of materials
24.3	24.3	Sand, fine more or less ferruginous
24.5	0.2	Rock, ferruginous
28.7	4.2	Silt, argillaceous very micaceous laminated
28.8	0.1	Rock ferruginous
31.3	2.5	Silt, more argillaceous than that above, micaceous and lignitic; only slightly oxidized at the top; water seepage
31.4	0.1	Rock, hard ferruginous
42.8	11.4	Sand, fine, glauconitic (?), silt, and dark lignitic clay, laminated, all unoxidized; grades downwards into dark tough sandy clay
46.6	3.8	Bentonite, pure, unoxidized, high-grade; has a very strong fetid taste which is weaker below the top, and a light bluish-gray color which changes to apple green (by oxidation) in about 15 minutes
46.9	0.3	Silt, dark-gray argillaceous

Many years ago a narrow prospect trench was dug in the northwest flank of the westernmost ridge of the Mrs. B. E. Evans property, 150 yards or so from the southwest end of the ridge. In late May, 1935, the trench was 8 feet deep at the uphill end, and the walls showed 3 feet of grayish to greenish-gray and some light-yellow bentonite under 5 feet of sand. Leveling showed the thickness of the overburden to the crest of the ridge to be 15 feet, but the maximum overburden is 25 feet. The location of this ridge, only 300 to 400 yards east of the Mississippian Railroad, bordering the flood plain of the Tombigbee River, and about half a mile west of Highway 25, seems to make it a good place to begin digging operations. It is about 12 miles from Fulton and perhaps 13 miles from Amory.

Stratigraphic relations seem to indicate that all the bentonite in the county east of the Tombigbee River is of Tuscaloosa age, interstratified with silts and silty clays and sands near the top of the Tuscaloosa formation. The lignitic zone near the top of the Tuscaloosa, and small gravel associated with the Tuscaloosa-Eutaw contact, have been found subjacent to or only a few feet under the bentonite, in both outcrops and prospect holes. In fact, the irregular thickness of the bentonite bed probably is due in part to post-Tuscaloosa, pre-Eutaw, errosion. Blue bentonite and light-yellow bentonite are present, the light-yellow being a weathered, or naturally activated phase of the blue, probably produced by the oxidation of the iron which in the blue material is in the protoxide state. The blue color changes to apple green within a few minutes on exposure to the air. The light-yellowish phase is developed where weathering has been active, either recently or in the distant past. Commonly, then, the yellowish bentonite constitutes a fringing deposit of the main body of blue bentonite underlying a hill or ridge, or a layer overlying a layer of blue bentonite. The relative thicknesses of the two phases of the bed could be expected to vary slowly but steadily as weathering proceeded, until the entire bed was yellow. Many of the prospect holes passed through yellowish bentonite only; a few found blue or light bluish-gray only, and the remainder encountered both colors. In general the holes started on the crests of the ridges, where the overburden is thickest, penetrated blue bentonite, apparently the undisturbed bed. Obviously the hills have been breaking away, and the lower slopes in places are a series of slips; much of the slope bentonite (the fringing deposit) is highly oxidized and otherwise weathered, and mixed with clay, sand, and silt; and the thicknesses are controlled by the angles of rest of the beds involved in the movements.

Conditions, both physical and economic, which affect the recovery and use of bentonite, are more favorable in the New Salem community than in any other district of Itawamba County. The topographic position of the bentonite in the Clifton-Evans terrane, well above the bottoms of the valleys in most places, will permit easy shifting of the overburden to the lower slopes and into the valleys, and also favors good drainage. The bentonite which is now below the position of the main bed, due to landslips, and is in the flanks of the ridges, could be recovered by opening cuts along the slopes. The overburden ranges in thickness from a foot or less to 45 feet, but by far the greater part of the clay is under 25 feet or less of overburden. The overburden is, as already stated, largely loose sand and silt, easily removable.

The Clifton and Evans hill properties are bordered on the east by Highway 25, and the Evans land reaches west to the valley of the

Tombigbee River. No part of either property is more than three quarters of a mile east of the Mississippian Railroad, and the westernmost ridge is only 200 to 300 yards from the railroad. The Tombigbee River Valley is at the foot of the westernmost ridge. If the Tombigbee River Waterway is opened, it will be available for the transportation of the bentonite.

On the old J. R. Johnson place, about a quarter of a mile south of the Highway 25-White Springs Road junction, and west of the highway, the 3-foot bed of tan to light-yellow bentonite shows in a farm road west of the house, and farther towards the river it crops out in the foothills. Also, reports were to the effect that three prospect holes on the property found bentonite (SW. 1/4, Sec. 9, T. 11 S., R. 9 E., and SE. 1/4, Sec. 8, T. 11 S., R. 9 E.).

On the north side of Highway 25 for a distance of a quarter of a mile or more east of the junction of the White Springs Road with the highway, (SW. 1/4, NW. 1/4, Sec. 9, T. 11 S., R. 9 E.), deep ravines and small valleys have exposed sections of the strata, including the bentonite. Three or four outcrops of bentonite here may be the first discovered in the New Salem community. The westernmost of the bentonite showings, and the most prominent, is near the base of the wall of a deep ravine 50 to 53 feet below the highway at the old Wheeler or Christian store building, only a few rods northeast of the road junction. The section includes 9 feet of bentonite, much stained and streaked with iron rust (limonite) deposited from solution in the water which constantly seeps out along the contact of the bentonite with the overlying sand. The bed consists of the blue phase below and the tan or yellowish phase above, but the exposure has been so discolored by iron that the relative thicknesses of the two are not easy to determine. Bay[11] describes the section here, from the bottom of a prospect hole at the base of the valley wall, to the top of the valley wall, as follows:

SECTION OF THE WHEELER EXPOSURE AT CHRISTIAN'S STORE

	Feet
Sand, oxidized brownish to red argillaceous medium to fine-grained friable, and a few indurated layers and bands of small ferruginous concretions	75
Bentonite, light tan soft waxy, which breaks with conchoidal fracture and is essentially free of grit	4
Bentonite, dark blue waxy hard and brittle slightly arenaceous; contains lignitic fragments	5
Sand, glauconitic bluish gray, and a little admixed bentonite	2
Sand, green medium to fine-grained highly glauconitic	---

As stated above, the highway is only 50 to 53 feet above the bentonite at the store building, but the top of the area on the south side of the highway is a few feet still higher.

The bentonite bed can be traced eastwards along the valley wall by its topographic expression—shoulders or small benches about on a level with the bed. It shows in a ravine some 350 yards east of the Christian store outcrop, and west of New Salem church, where 22 inches of the tan bentonite are exposed.[11] Also, the bed of bentonite is said to have been found by drilling in the valley beyond the hilltop to the southeast (See also section in the description of the Tuscaloosa formation). Towards the west from the road junction it has been drilled through in several places on the I. J. Evans farm north of the White Springs road, where thicknesses from 2 to 6 feet are said to have been found (SE. 1/4, NE. 1/4, Sec. 8, and SW. 1/4, NW. 1/4, Sec. 9, T. 11 S., R. 9 E.). Farther west about a quarter of a mile is a small outcrop near the western end and a little below the crest of a ridge which is part of land owned by the Bank of Amory. This is a few rods east of the White Springs road (SW. 1/4, NE. 1/4, Sec. 8). A hole started on the crest of the ridge about 100 yards southeast of the outcrop and 26 feet above it, and bored to a depth of 31.5 feet, found 2.5 feet of much weathered, rusty, pale-green to very light yellow bentonite under 26.5 feet of brown sand containing some sandstone towards the bottom. The bentonite was underlain by a foot of red-brown sand, beneath which was an interval of 1.5 feet of bentonitic sand and clay, containing black inclusions. The conclusion seems justified that the body of bentonite in this area is thickest in the vicinity of the road junction, and thins westwards and southwards (compare thicknesses on Clifton and Evans properties).

Two small outcrops of bentonite (NW. 1/4, Sec. 10, T. 11 S., R. 9 E.), near a local road three quarters of a mile or a little more northeast of New Salem school, suggest the presence of a large body of bentonite, but much auger prospecting by different parties has failed to find any considerable quantity. One of these outcrops, in a spring in the wall of Bull Mountain Creek Valley, shows light-blue bentonite. Prospect hole R 83 a few yards north of the spring and 8 feet above it, was drilled to a depth of 25 feet, but did not pass through any bentonite. Hole R 84, about the same distance south from the spring and 5 feet above it, reached a depth of 11 feet, and found much-weathered bentonite, plenty of water, and a hard rusty clay difficult to penetrate. The second outcrop is in the left wall of a ravine 200 to 300 yards west of the spring outcrop and on the east side of a local road leading from Highway 25 to Bull Mountain Creek Valley.

Some two years ago the discovery of a bentonite deposit about 1.5 miles north of the White Springs area, on the west side of Highway 25, was reported.

On the J. A. West and Bogan Warren farms (Sec. 14, T. 9 S., R. 9 E.), dense, light-blue, somewhat sandy bentonite crops out in two or three places in ravines. The thickness may be 3 to 4 feet, and the sand overburden ranges from light to heavy.

The bentonite on the Troy Hall land (SE. 1/4, Sec. 16, T. 8 S., R. 10 E.) in the northeastern part of the county 2 miles west of the Tremont-Red Bay road, crops out in a spring which issues from the base of a gravel and conglomerate bed, about 15 feet above the bottom of the small valley, beside an old farm road and a few yards from a branch of Chubby Creek. The thickness was not definitely determinable at the outcrop, but a face of 15 to 18 inches was exposed by digging under the gravel. Numerous joints and fractures have broken the bentonite into blocks of various shapes and sizes, most of which are coated by iron rust. The fresh material is light sky blue, grit free, dense, extremely fine grained, has a soapy feel, and is non plastic or only moderately plastic. No other outcrop could be found in the immediate vicinity. The overburden is of light to medium thickness, but very difficult to contend with. So far as has been determined, the deposit is small. About a mile southeast of the Hall outcrop, some bentonite, reported to be 4 feet thick, on the Governor Williamson property (Sec. 15, T. 8 S., R. 10 E.), probably was originally a part of the Hall deposit.

Some 5.5 miles north of Fulton, and about 8 miles by the graveled road, bentonite crops out in a few places well up toward the tops of the highest hills of this district, on the W. A. Beasley and J. M. Gibbs farms (NE. 1/4 and SE. 1/4, Sec. 25, T. 8 S., R. 8 E.). This area is on the east bluff of the wide valley of the Tombigbee River and Mud Creek. The outcrops show a bed of light-yellow to cream-colored bentonite some 2 to 3 feet thick, and eight test holes found thicknesses ranging from a half foot up to 6 feet or more. However, the greater thicknesses were in holes on the slopes, and probably were measurements of slumped material; most of the bentonite from these holes was contaminated. One hole from the crest of the ridge passed through a 3-foot bed, which probably represents about the average thickness of the bentonite at this locality. The area of the deposit is only a few acres, the surrounding country being below the general bentonite level. Overburden is nearly all red and brown sand, and as measured in the test holes, ranged from less than 3 to more than 20 feet thick. Four holes found no bentonite at all, or only a trace of it.

The results of a chemical analysis of a sample from the Gibbs property are stated below:

CHEMICAL ANALYSIS

	Percent
Ignition loss	28.19
Silica (SiO_2)	45.54
Alumina (Al_2O_3)	16.08
Iron (Fe_2O_3)	4.85
Titania (TiO_2)	0.90
Lime (CaO)	0.66
Magnesia (MgO)	Trace
Miscellaneous	3.78

Analyst, H. S. Emigh.

A thin bed of light-yellow bentonite lies a few feet below the surface on the F. M. Carpenter farm (SE. 1/4, Sec. 33, T. 8 S., R. 8 E.), a little north of Tombigbee church, some 5 miles northwest of Fulton. No thickness greater than 2 feet has been found, and although the area of the deposit has not been accurately determined, the prospecting that has been done indicates that it is not more than a relatively few acres. The combination of gentle slopes, relatively light overburden, and thin bed, has probably permitted a rather advanced stage of weathering of the bentonite. Another showing of bentonite in the vicinity, on the J. I. Bean property about 2 miles northeast of Mantachie, is closely connected with the Carpenter deposit, and may have been at one time a part of it. At a place (NE. 1/4, Sec. 4, T. 9 S., R. 8 E.) in a gully along the highway, is a poor outcrop of badly weathered material. A test hole on the low slope 100 to 150 yards from the road found only a few inches of weathered bentonitic material; another, farther up the slope, went through sand and a dark-blue sandy clay, but no bentonite. Probably only a very thin lens exists in this area.

A small deposit of bentonite was found a few years ago in the vicinity of Evergreen, in the southwestern part of the county. On the W. R. Hall land (SE. Cor., Sec. 6, T. 11 S., R. 8 E.) the authors of "The Upper Cretaceous Deposits" measured the section described below:[5]

SECTION ON EASTWARD-FACING SLOPE OF BOGUEFALA CREEK VALLEY ON LAND OF W. R. HALL

	Feet
Eutaw formation (Tombigbee sand member?)	
Red sand containing highly weathered tubes which may be *Halymenites major* Lesquereux	8
White and cream-colored silty bentonite	1
Massive glauconitic sand containing *Halymenites major* Lesquereux	26
Concealed to valley	30
Total section, 65 feet.	

The survey on which the present report is based bored several test holes along the road from about a mile to 2 miles southeast of Evergreen, near outcrops of bentonite exposed by road cuts. The distance between the northernmost outcrop observed, and the southernmost, is about half a mile. Hole R 53 (NE. 1/4, Sec. 7, T. 11 S., R. 8 E.), on the Joe Myers land about a quarter of a mile northwest of the Myers home, on the west side of the road near an outcrop, found 2 feet of light-yellow bentonite mixed with sand, under 5 feet of red sand. The record of the chemical analysis of the sample from the Myers outcrop is:

CHEMICAL ANALYSIS

	Percent
Ignition loss	28.30
Silica (SiO_2)	47.00
Alumina (Al_2O_3)	17.85
Iron (Fe_2O_3)	4.30
Titania (TiO_2)	0.85
Lime (CaO)	0.20
Magnesia (MgO)	Trace
Miscellaneous	2.50

Analyst, H. S. Emigh.

Hole R 54 (SE. 1/4, Sec. 6, T. 11 S., R. 8 E.), about a quarter of a mile farther north, east of the road, on the W. R. Hall farm, passed through 2 feet of good light-yellow to whitish or cream-colored bentonite under 6 feet of soil and yellowish-brown sand. Four other holes along this Evergreen-Carolina highway, ranging in depth from 15 feet to 40, found no bentonite. The information provided by outcrops and by drilling, then, seems to indicate that the deposit southeast of Evergreen is a relatively small lens, or perhaps two or more thin bodies of bentonite.

The writers referred to above state that the Hall bentonite is "near the contact between the typical beds of the Eutaw and the overlying Tombigbee sand member," and "may belong with the former." They express the opinion that the deposit is at about the same stratigraphic position as the lower bentonite bed on Panther Creek south of Aberdeen, Monroe County.[5]

The preceding summary of the information about bentonite in Itawamba County indicates that several deposits, large and small, have been found, but is not intended to convey the idea that all the bentonite of the county has been discovered, although the prospecting has extended over the entire region and has been carried on through a period of at least seventeen years. Probably all the deposits of any considerable size have been found. However, prospecting for bentonite is more or less a gamble, due to the difficulties involved. One of the chief handicaps is the fewness of outcrops. In most places the hills are heavily wooded or covered with undergrowth which effectively conceals the bed rock. Even in an outcrop of strata including bentonite, the bentonite bed may be obscured, because of its habit of weathering easily far back into the hill, allowing the associated sand and clay to wash or creep down over it. Besides, the terrane is in general so cut up by erosion, and consists so largely of sand, that weathering of the bentonite has been active everywhere. The result has been that apparently the good quality bentonite has been left in relatively small pockets and lenses or beds, which grade into very sandy and silty material both vertically and laterally. The dark-blue bentonitic sand and clay are of considerable thickness and extent, and may contain accumulations of good bentonite of variable size at different levels within their vertical and areal range, the positions of these good deposits depending on the direction of the weathering, and their size on the intensity of the weathering. Thus the prospector has in many localities no infallible way to determine whether or not bentonite is present except to bore holes, locating them sufficiently far above and back from the place where the bentonite should crop out to insure finding it if it is there. And even in this method he must be cautious, because of the prevalence of landslips, by which the strata may be displaced many feet from their original positions. Moreover, in view of the "spotty" pattern of the deposits, the prospector has no assurance that because, for example, one boring may find 6 feet of bentonite, another of the same depth a few rods distant will find an equal thickness, or even any at all.

It would seem, then, that the location and magnitude of the deposits can be determined only by the drilling of numerous holes, which must be located on undisturbed strata and carried to a depth sufficient to reach below the general bentonite level of the region, or if located on beds which have slipped, they must be deep enough to reach the bentonite at the lower level.

The conditions briefly stated above have an important bearing, also, on estimates of the quantity of bentonite in a deposit. To obtain a reasonably accurate theoretical estimate of the tonnage of ore of any sort in place, the data must include (1) the area of the ore body; (2) the thickness of the ore body, meaning the average thickness in case the thickness is not uniform; (3) the weight per unit, as an acre-foot, a cubic yard, or a cubic foot. Of course, the topographic position of the bottom of the ore body, in this case the bentonite, must be determined accurately, in order that the area may be calculated, and corrections must be made for irregularities of the bed, such as result from erosion and weathering. The extent of lateral gradation from high-grade bentonite into impure bentonite, bentonitic sand and clay, and ordinary sand, clay, and silt—and such gradation is more or less the rule—can not be successfully estimated. It tends to reduce the tonnage of good bentonite. The thickness of the bed can be ascertained by test holes, which should be distributed over the area in such a way as to test all main parts of it.

CERAMIC CLAYS

As stated in the description of the stratigraphy, the Tuscaloosa formation contains beds or lenses of clay of varying purity and of several colors—black, light blue, gray, brown, yellow, pink, white, and mottled. Much lignitic clay is included, of which a bed of jet-black clay is a feature. The logs of the test holes indicate the characteristics of the clays in the areas prospected with the auger. A discussion of specific localities where clay beds crop out or have been penetrated by the auger follows:

THE NEW SALEM-WHITE SPRINGS AREA

Some 10 miles by highway southeast of Fulton, near the base of the west wall of Bull Mountain Creek Valley, gray and lignitic clay crops out in several places along a local road (SW. 1/4, Sec. 3, T. 11 S., R. 9 E.); also northwards along the bluff from there. Test hole R

25 found 26 feet of gray and lignitic clay, and R 85 penetrated gray clay at a depth of 5 feet. These places are little more than a quarter of a mile from Highway 25, a good graveled road, but are far down a steep slope. Overburden is very heavy, too.

A little north of White Springs a cut for the Tilden-White Springs road exposes clay and sand (northern part, Sec. 5, T. 11 S., R. 9 E.). Test hole R 45 found some 10 feet of good gray lignitic clay here. The place is close to the Mississippian Railroad. A mile or more farther south, clay crops out in the northeast wall of a cut for the White Springs-New Salem road (NE. 1/4, Sec. 8, T. 11 S., R. 9 E.) less than half a mile east of the Mississippian Railroad. Test hole R 51 found only a few feet of clay here.

Both the outcrops mentioned are near the base of the east wall of the Tombigbee River Valley.

THE TILDEN AREA

In an area (Secs. 27 and 34, T. 10 S., R. 9 E.) a mile to a mile and a half southeast of Tilden, Test holes R 22, R 37, R 38, R 39, and R 80 were bored near the bottom of the valleys of two small tributaries of Bull Mountain Creek, on the N. Harrison, B. Thomas (Dora Burch), and perhaps other properties. Light-gray and dark lignitic clay crops out in the two creeks a few yards from the holes. Some time before the auger prospecting here, samples (R95OC) of the light-gray clay were taken from the creek bottom and banks for analysis in a search for high-alumina clay. The test holes showed several clay beds interbedded with sand—thicknesses of 16.5 to 26.0 feet of clay were passed through, but all is deeply buried except under a relatively small area. The locality is half to three-quarters of a mile east of Highway 25, but can be reached by local roads only, which are bad in rainy weather.

THE REEDS CREEK AREA

Clays from Reeds Creek Valley were described by Logan,[7] who gives an analysis and tests of a "white Tuscaloosa clay" suitable for the manufacture of stoneware and fireproof wares, from the farm of Mr. William Reed half a mile east of old Reedville, which was along Reed Creek west of Highway 25. Results of Logan's analyses and tests are:[7]

Chemical Analysis of Reed Clay

	Percent
Moisture (H_2O)	3.03
Volatile matter (carbon dioxide, CO_2, etc.)	6.66
Silicon dioxide (silica, SiO_2)	66.70
Aluminum oxide (alumina, Al_2O_3)	18.22
Ferric oxide (Fe_2O_3)	3.60
Calcium oxide (CaO)	0.57
Magnesium oxide (MgO)	0.47
Sulphur trioxide (SO_3)	0.22
Total	99.47

Rational Analysis

Clay substance	46.17
Free silica	38.75
Fluxing impurities	4.14

Tests

Specific gravity, 2.10

Water required for plasticity, 30 percent

Fusion temperature: Clay unfused at Cone 20, but vitrified and had no absorption.

Logan[7] describes also a "plastic blue clay" from the W. H. Palmer farm, 4 miles south of Fulton. This clay, which was said to form a bed 12 feet thick, was used by the old W. M. Cheney pottery for the manufacture of stoneware, according to reports. As nearly as could be determined, the Cheney pottery was located on Highway 25 in the northeast quarter of Section 18, or thereabouts. A reconnaissance by the present writer and party in 1935 found the W. H. Palmer farm (NE 1/4, Sec. 17, T. 10 S., R. 9 E.) in the valley of Reeds Creek, and located outcrops showing a mottled red and gray clay above, grading into stiff, plastic, whitish, clay within a depth of 1 to 2 feet. The bed of whitish or light-gray clay was reported to be 10 to 12 feet thick, and if it is, and the thickness is uniform, the clay extends under a small valley where the overburden is light unless slope wash in the past has carried more material into the valley than appears to be the case. Also, the slope above is gentle and the hill low, which means that the overburden in this direction probably is not prohibitive (Test holes R 2 and R 4).

The 1942-43 survey bored ten test holes in the valley of Reeds Creek. All except R 3 and R 49 passed through several beds of clay, totaling a considerable thickness. R 1 reached, under an overburden of 10 feet of interbedded sand and clay, the top of a bed of clay which the auger penetrated 25.6 feet but did not reach the bottom. This is only a few yards from Highway 25. Hole R 2, on the Palmer land, found 21.5 feet of light-gray and dark-gray clay under only 3.5 feet of sandy overburden, and broken by only one bed, 4.2 feet thick, of sand. It did not reach the bottom of the lowermost clay bed encountered. Hole R 4, on the same property, passed through 32.7 feet of clay under only 7.3 feet of overburden; R 42 found 11 feet of clay and only one thin bed of sand; R 43 passed through clay its entire depth of 10.3 feet; R 44 found 17 feet of clay; R 48 passed through 14 feet of clay under only 5 feet of overburden, and R 91 was bored through 17.8 feet of clay split by two thin beds of sand.

The data reviewed above indicate clearly that in the lower parts of the walls of this small valley are very considerable thicknesses of clay, part of which, at least, has been proved to be suitable for stoneware and perhaps other clay products. Further, the conditions for removing the clay probably are more favorable here than at any other place in the county with the exception of the outcrops along U. S. Highway 78. None of the test holes referred to is more than 2 miles from Highway 25 via a local road along the valley, and the holes which found the thickest and best clay are, except R 91, within less than a half a mile of the highway. The Mississippian Railroad is only a half mile from the area via Highway 25. The topography also is favorable, in general, especially in the part of the valley for a distance of half a mile northeast of the highway—slopes are low and the relief small. The overburden is light in many places, and the water-table not too high. The road along the valley would have to be improved before it could be used in all kinds of weather.

THE U. S. HIGHWAY 78 AND THE BOOKOUT OR OTIS ROAD AREA

The Bookout road, or the Otis road, named from the J. L. Bookout home at old Otis, extends along the west wall of Bull Mountain Creek Valley from U. S. Highway 78 to the Tilden road a little west of Horns Crossing. Tuscaloosa clays crop out in a few places along this 5-mile to 6-mile stretch of road. A quarter of a mile or less northwest of the junction of this road with Highway 78, on the north side of the highway, is the conspicuous outcrop of Tuscaloosa clay and sand mentioned in the discussion of stratigraphy (Figure 5), and a mile or less southeast of the junction is the still larger outcrop described as a section under stratigraphy (Figure 4). Twelve test holes were bored in this region—five along or near the highway, six along Bookout road, and one just north of the Tilden-Horns Crossing road and a half mile west of the junction of the two roads. Test hole R 5, started just above the Highway 78 outcrop first referred to above (SE. 1/4, Sec. 36, T. 9 S., R. 9 E.), reached a depth of 37 feet, passing through 20 feet of light-gray to dark-gray and black clay split by a thin seam of lignite, under 15.8 feet of sand overburden. The hole did not reach the bottom of the clay. Hole R23, three-tenths of a mile farther west and perhaps 20 feet lower than R 5, penetrated 18.8 feet of clay under 6.0 feet of overburden. Hole R 6, located above the face of the north wall of the Highway 78 cut just northwest of Gum Creek (NW. 1/4, NE. 1/4, Sec. 6, T. 10 S., R. 10 E.), found 22.6 feet of lignitic clay under 11 feet of sand overburden and interbedded with two thin sand strata. The thickness of the clay strata here, however, is much better indicated by the description of the section (see Stratigraphy), which includes 52.8 feet of clay with very little sand. Hole R 7, started on a bench well up towards the top of the west wall of Gum Creek Valley about half a mile south of R 6, reached a depth of 33.6 feet, of which 28.9 feet were clay. A section exposed by ravines here (SE. 1/4, Sec. 6, T. 10 S., R. 10 E.) was measured and described as follows:

SECTION OF CLAY EXPOSURE IN THE WEST WALL OF GUM CREEK VALLEY ON THE COOPER PLACE, HALF A MILE SOUTH OF U. S. HIGHWAY 78

Tuscaloosa formation	Feet
Clay, blue, stiff, very plastic when wet; somewhat streaked and spotted with yellow iron oxide; thin seams of sand at the top, and above this a zone of weathered sandy clay, to top of the clay outcrop	2.3
Clay, whitish or very light-gray, very stiff and plastic; weathers almost white; has yellow iron oxide streaks, more numerous toward the bottom of the bed	4.0
Clay, lignitic, light chocolate-brown; hard, lumpy when dry, stiff and plastic when wet; darker towards the top, and greater iron content; to top of bed of sand, 40 feet above the water-level of Gum Creek	7.0
Total section, 13.3 feet.	

The light-gray clay of the second interval is called "lime" and "chalk" by the people of the vicinity, who have used it for whitewash. The Smithville Pottery Company found that it was good ceramic clay, albeit a little too "tight," owing to insufficient sand, for the making of ware.

This is the old Bowan Carding Mill clay, discussed by Logan,[7] who seems to include the entire clay body of the section above in his 15 feet of "white plastic clay." He states that it may be used in the manufacture of stoneware and low or medium grade fireproof wares. The results of his tests are:[7]

TESTS OF BOWAN CARDING MILL CLAY

Water required for plasticity, 19 percent
Air shinkage, 8 per cent
Rate of slaking, very rapid
At Cone 17 in the muffle, burned to a light pink and vitrified without cracking
In the flame at Cone 17, turned slate color, vitrified and cracked
At Cone 20, vitrifies, turns white, and shows no absorption
Loss of weight in burning, 5.5 percent.

The two outcrops along Highway 78, and Test holes R 5, R 23, R 6, and R 7, demonstrate that great thicknesses of clay underlie this area, but conditions for removing it are not too favorable. Overburden is heavy, and although a main pavement highway is right at hand, the nearest railroad is at Fulton, 6 to 8 miles distant. The best prospect here is the small hill on which R 6 was located; it is the north end of a spur of the main ridge which shows the big Highway 78 exposure and the Cooper place outcrop, and was cut off from the main ridge by the highway. This hill is almost all clay except for the 11 feet or so of sand at the top.

Test holes R 15 and R 16, on the east side of the Bookout road, found good thickness of clay, but R 76, two miles farther south, and at a greater elevation, passed through sand only. Holes R 77 and R 78 passed through clay to their total depths except for 2.0 to 2.5 feet of sandy and gravelly soil and subsoil. Gray, somewhat iron-stained clay crops out in two or three places near the J. L. Bookout home (Eastern part, Sec. 13, T. 10 S., R. 9 E.). The thickness shown is 5 to 6 feet, and the overburden 6 to 10 feet up to 20 feet. Logan[7] refers to an outcrop of "white plastic clay" in the feed lot a few rods west of the Bookout home, gives the thickness of the exposure as 5 feet, and says that the clay is suitable for stoneware. R 26, on the north side of the Tilden-Horns Crossing road a quarter of a mile west of the junction of this road and the Bookout road, found 10 feet of gray and dark clay under 9 feet of overburden. It would seem, then, that the Tuscaloosa terrane exposed in the west wall of the valley of Bull Mountain Creek from Highway 78 south to the Tilden-Horns Crossing road consists in considerable part of clay. In fact, the outcrops and test holes of the Tilden, Reeds Creek, and New Salem areas prove that the region west of Bull Mountain Creek Valley is underlain by large bodies of clay almost to the southern border of the county.

AREA EAST OF BULL MOUNTAIN CREEK.

The southeastern corner of Itawamba County, east of Bull Mountain Creek, is particularly rich in clays. Tuscaloosa clays crop out in many places, and the survey of 1942-43 bored nineteen auger holes in the central and northern parts of the area, chiefly along the Horns Crossing-Academy road, the Tremont-Academy road, and the Harbour's Store-Academy road. A few of the more prominent outcrops are discussed in the following paragraphs:

A road cut and roadside ditch (Secs. 11 and 12, T. 10 S., R. 10 E.) about four-tenths of a mile north of Harbour's Store, which is 3 miles southeast of Tremont on Highway 78, expose light-gray iron-stained sandy clay, containing pockets of platy limonitic material. A nearby pit, dug by the pottery men, showed 2 to 3 feet of the clay above the water. The potters found the clay very good for making ware, and favorably located, being at the top of a hill near a main highway, and under light overburden. However, two test holes (R 9, R 40) found a maximum of only 4.5 feet of good clay. Possibly other holes, scattered over the relatively large area of the hilltop, might find greater thicknesses. About three-tenths of a mile farther north, near the base of the same ridge and a few feet above the flat of Johns Creek Valley, clay is exposed in the road cut, a roadside gully, and in nearby ravines (about on the line between Secs. 11 and 12, T. 10 S., R. 10 E.). It is light gray to bluish white, laminated, the laminae defined by iron oxide, and contains disseminated fine white sand and thin lenses of ferruginous sand. The exposure has a maximum thickness of 6 to 7 feet, but suggests that the deposit is irregular. A small pit at the base of the slope between two hollows was dug by the pottery people, who found the clay excellent for their purposes. Overburden is great except in a narrow belt along the slope.

About a quarter of a mile south of Harbour's Store, clay of variegated colors is exposed by a cut (NE. 1/4, Sec. 14, T. 10 S., R. 10 E.) for the Academy road, and by roadside gullies. A thickness of 5 to 6 feet shows under 7 to 10 feet or more of overburden. Test hole R 82 at this place found 10.9 feet of red-streaked gray clay under 8.9 feet of soil and red-brown sand with some gravel. The location is favorable as concerns accessibility.

Another easily accessible location is the south wall of the valley of Johns Creek a mile south of Tremont. A cut here (SW. 1/4, Sec. 9, T. 10 S., R. 10 E.) for the Tremont-Academy road has exposed some 10 feet of clay. The J. B. Young pottery is said to have used some clay from this outcrop and found it very satisfactory. Test hole R 8 at the top of the west wall of the cut reached a depth of 47.5 feet, all clay except for half a foot of soil and 1.3 feet of impure lignite. The site is on a good gravel road a mile or less south of Highway 78 at Tremont.

Raper Springs road extends along the base of the east wall of the valley of Bull Mountain Creek from its junction with the Tremont-Academy road a mile and a half south of Tremont, to the Tilden-Academy road just east of Horns Crossing. The highlands east of the road are heavily wooded in most places, but outcrops here and there imply that much of the terrane is clay. Perhaps the most conspicuous outcrop along this stretch of road is on the slope a little south of the site of the old Raper Springs Hotel (NE. 1/4, Sec. 19, T. 10 S., R. 10 E.), where gray clay, mottled and streaked by ferric oxide, shows from near road level to at least 25 to 30 feet higher. Test hole R 10, started some 35 to 40 feet above the road, reached a depth of 42.3 feet, all except 3.1 feet of which was gray, brown, and yellow clay. Raper Springs issue from the top of this body of clay. Test hole R 18 (NW. 1/4, Sec. 30, T. 10 S., R. 10 E.), on the east side of Raper Springs road three quarters of a mile north of its junction with the Tilden-Academy road, found 13 feet of gray clay in two beds separated by a 2.8-foot bed of sand.

The same clay terrane is represented by several prominent outcrops along the west-east Tilden-Academy road, just north of the valley of Jims Creek. The largest (NW. 1/4, Sec. 31, T. 10 S., R. 10 E.), in the west wall of the valley of a small tributary of Jims Creek about half a mile east of the Raper Springs road, reaches a height of 35 to 40 feet above the valley bottom. Test hole R 11, started just above this exposure, passed through 34 feet of clay, except for a little sand rock and lignite. Other test holes along this road found notable thicknesses of clay: R 12, 35.8 feet in a depth of 42.4 feet; R 13, 15.8 feet of 32.9 feet; R 14, 26.9 feet of 28.0 feet; R 17, 11.4 feet; R 19, 25.9 feet in a total depth of 31.9 feet.

The Academy-Tremont road and the Academy-Harbours Store road likewise traverse this region of abundant clay, as indicated by outcrops, although the few test holes were not particularly successful, largely because of rock and water. However, Test hole R 21, on the Harbours Store road about a mile northeast of Academy church, found 20.6 feet of red-brown and gray clay, and R 41 and R 92, some 2.5 miles farther northeast on the same road, above an outcrop of gray and lignitic clay, passed through clay to their entire depths of 15.2 and 25.1 feet, respectively, except for about 5 feet of sand and soil overburden.

In the southeastern corner of the county, south of the Tilden-Academy road, are many showings of Tuscaloosa clay, including several deposits of light-gray to white clay.

On the Harris farm, 3.5 miles south of Highway 78 and a mile west of the Alabama line, a thickness of 10 to 15 feet of gray and lignitic clay is exposed towards the base of a slope 100 yards or so northwest of the Harris home (NE. 1/4, Sec. 35, T. 10 S., R. 10 E.). Light-gray iron oxide-streaked clay from a 4-foot bed at this place has been used by two or three potteries and pronounced excellent potters clay (R 94OC). It weathers almost white, contains some fine sand, and is very plastic. No doubt the deposit is very extensive, too, probably being part of the general clay interval of the upper Tuscaloosa. However, the site can be reached only by the hilly graveled State Line road and a bad farm road; the overburden is much too great for large-scale working, and water would be troublesome.

Another place from which the potters obtained clay is the Creel place, or S. W. Harris farm (SW. 1/4, Sec. 35, T. 10 S., R. 10 E., or NW. 1/4, Sec. 2, T. 11 S., R. 10 E.). Light-gray iron oxide-streaked clay which dried nearly white was dug from the upper slope of a ridge. Some 200 yards to the northeast a cut for the old Kentucky Lumber Company railroad exposed about 10 feet of gray slightly lignitic clay, containing seams and nodules of iron oxide.

The section of the south wall of Spring Creek Valley (SE. 1/4, Sec. 14, and NE. 1/4, Sec. 23, T. 11 S., R. 9 E.) has been described in the discussion of stratigraphy. Logan[7] described a 47-foot section here, including a 6-foot bed of blue clay at the base, and a 4-foot bed of blue clay 12 feet higher. The results of his tests of the lower clay, which he classes as a stoneware clay are:

TEST OF SPRING CREEK VALLEY CLAY

Specific gravity, 2.47
Water required for plasticity, 32 percent
Slakes slowly to coarse grain
Air shrinkage, 7.0 percent
Average tensile strength of air-dried briquettes, 113 pounds; maximum strength, 120 pounds
Vitrified but unfused at cone 13
Shrinkage in burning, 2.0 percent; total shrinkage 9.0 percent.

A few years ago the face of a small gravel pit (SW. 1/4, Sec. 13, T. 10 S., R. 10 E.) on the east side of the State Line road about a mile south of Highway 78, exposed as the uppermost interval 2 to 3 feet of sand, clay, and soil; subjacent to this a foot or so of brown sand, under which were 2.5 feet of mixed sand and gravel, and a basal interval of about 2.0 feet of very light-gray to whitish stiff plastic clay somewhat mottled with maroon and purple and red, and containing fine disseminated sand, also sandy lumps and pockets and a few small pebbles. The auger proved an additional 2 feet of clay here.

The black clay which persists in the upper part of the Tuscaloosa is well exposed on the Charles Cody farm (NE. 1/4, Sec. 7, T. 11 S., R. 10 E.) near the Cody home. At this place gullying has exposed a section consisting of 5 feet of black material, overlain by 2 feet to 3 feet of light-gray clay which probably would make good stoneware. In most places the overburden is heavy.

REGION NORTH OF HIGHWAY 78 AND BULL MOUNTAIN CREEK

Much of the upper Tuscaloosa of eastern Itawamba County north of Highway 78 is clay, also, as indicated by numerous clay outcrops in road cuts, ravines, and valley walls. The thickest exposure seen (SE. Cor., Sec. 16, T. 9 S., R. 10 E.), 1 mile northwest of Oakland, has been described in the discussion of stratigraphy. Other outcrops of some prominence may be referred to briefly:

Logan[7] states that white plastic Tuscaloosa clays were found on the N. Funderburke land, also on the W. W. Hall and Dr. W. T. Cullom farms, 7.5 to 9.0 miles west of Red Bay, Alabama. The Funderburke clay shows in a road cut and gully (NE. 1/4, Sec. 20, T. 8 S., R. 10 E.) near the base of the west wall of Panther Creek Valley a little northwest of the junction of Panther and Chubby Creeks, 3 miles east of Highway 25. Some years ago about 2 feet of this clay were exposed in the gully, and boring showed that it extended 2 feet deeper, grading downwards into yellowish-brown and cream-colored sand. The clay is pure white to dull white or light gray, only slightly sandy, extremely plastic and tenacious; deeper, it contains streaks and pockets of red iron oxide. The bed is capped by a thin layer of ferruginous sandstone. The overburden is moderate; the deposit is on a graveled road. The old Smithville Pottery tried samples of the Funderburke clay, and found that they made good ware, but lacked sand.

In front of the Truelove home (NE. Cor., Sec. 5, T. 9 S., R. 10 E.) dark slaty-gray iron oxide-stained clay is exposed in the roadside gully and the hill slope above, to a height of 12 to 13 feet above the road. This is near the base of the west wall of the valley of Gum Creek, a few rods southwest of the road forks. For some distance back from the exposure the overburden is not great.

About 3 miles south of the Truelove place, where the local road crosses Little Briar Creek (SW. 1/4, Sec. 17, T. 9 S., R. 10 E.), gullying of the slope on the east side of the road has exposed dark-gray iron-stained clay through a 15-foot interval. The whitened weathered surface is strewn with ferruginous platy ironstone fragments of the iron oxide-cemented clayey and sandy material which has formed in the cracks in the clay body. The clay is somewhat sandy and very plastic.

A few small clay outcrops show farther south along this Gum Creek road. Some thin beds of kaolin, interbedded with clay, sand, and sand rock, show on the Gordon Holly place (Sec. 10? T. 9 S., R. 10 E.).

The westernmost exposure of Tuscaloosa clay in the county is near New Bethel, west of the East Fork of the Tombigbee River, where the Enon-New Bethel road crosses a small valley (NE. 1/4, Sec. 23, T. 11 S., R. 8 E.). The clay is bluish gray, somewhat uniformly spotted with red iron oxide, contains fine sand, and, near the surface at least, is much slickensided (Test hole R 52). Probably this deposit, and other clay deposits near the bases of the hills in this vicinity, belong to the upper (lignitic) part of the Tuscaloosa, and the outcrops may be due to structural conditions.

REGION WEST OF THE TOMBIGBEE RIVER

The surface formations of Itawamba County west of the East Fork of the Tombigbee are the Eutaw, including a little of the Lower Eutaw and the entire width of the Tombigbee member outcrop belt, and the Selma, including a narrow strip of the eastern border zone of the Mooreville tongue and the Coffee sand. The region is almost entirely sand, but in small part shaly clay interlaminated with the sand. The clay of the Eutaw, the Mooreville, and the Coffee possibly could be used locally for making brick, but it is not very good brick clay. Both the fresh Mooreville and the residuum from weathering contain too much lime, sulphur, and organic matter to be good ceramic material. A sample of the Coffee clay of Lee County was subjected to laboratory tests. The raw clay was gray to black, contained considerable silt and sand and carbonaceous matter, and broke out of the deposit in lumps, many of which were rounded and showed conchoidal fracture. Like the Porters Creek clay, which it resembled, it had some of the characteristics of bentonite, and probably was bentonitic. When ground fine, the clay took up so much water that it could not be molded satisfactorily. It could not be molded except by being ground coarse and handled quickly, that is, by methods which resulted in a rough product. On the basis of the tests, this Coffee clay could be said to be one of the least desirable clays for brick making, although possibly it could be used for making poor or medium quality brick by the plastic or stiff-mud process, or dry press brick (8 percent to 10 percent moisture). Its weight was a crucial factor: not low enough for light-weight brick, nor high enough for dense brick. Probably the Coffee clay would be suitable for light-weight aggregate, or for mixing with lime in the manufacture of cement.[10]

THE POTTERIES

The southeastern corner of the county was known locally some years ago as "the jug-shop district," because of the several small potteries operated there at one time or another. At least seven such "jug-shops" were in operation in the summer of 1935, and several others had been active before that time. Most of the pottery industry was, and is, a side-line to farming—that is, the making of ware was engaged in by farmers as a supplemental source of income when the business of farming was not so pressing. The ware consisted of churns, jars, jugs, crocks, flower-pots, charcoal burners, chimney thimbles, and such like utensils. One or two potteries made tombstones in addition, but few, if any, attempted any art objects. Naturally the output was small and the market local.

The mode of operation of these shops varied little from one to another. Commonly the clay was dug with pick and shovel from a deposit as near as practicable to the pottery, hauled to the pottery building by wagon or truck, and dumped on the ground or thrown into an open log bin or pit. Much of it was used just as taken from the deposit, but large quantities were "weathered" before being used, either by exposure to the natural elements for varying periods, or by storage in covered bins and watering from time to time. "Weathering not only renders the clay more plastic, but also causes the oxidation of deleterious substances, such, for instance, as iron pyrites." In these small potteries which made stoneware and earthenware almost exclusively, the manufacturing process commonly began with the pug mill, which cut and mixed the clay and extruded it at the lower end of the mill chamber through an opening circular or square of cross-section. As the column or ribbon of clay issued it was cut by wire into sections each about 18 inches long, and these sections or blocks were placed in a bin and kept covered with wet canvas pending wedging. The pug mill was powered by a mule or by a motor.

Wedging, commonly done by hand in the small shops, consisted of a kneading for the purpose of removing air bubbles. The ball or block of clay was cut across a wire placed over a plaster or cloth surface on a table; the pieces then were united, and the process repeated several times. Shaping by throwing or turning on the potters wheel followed. A mass of clay of weight sufficient for the making of the piece of ware was placed in the center of the wheel, and the turner shaped it by hand and simple hand tools as it revolved with the wheel, adding water as needed. Most of the wheels were "kick" wheels, powered by the potter's foot applied to a lever, but a few wheels were driven by motor. Objects such as jug handles might be molded by pressing the clay by hand into molds, or shaping it by hand without molds.

The shaping and finishing completed, the piece of ware was cut from the disc by passing a wire across the disc while it was in motion. The ware was then placed on shelves to dry. Relatively uniform conditions for drying had to be maintained, in order to prevent cracking. Commonly, if the weather was fair and the relative humidity low, the ware dried in a week or less. The air drying might be permitted to continue only long enough to remove a considerable part of the moisture, after which the objects were placed in a dry room or greenware room and subjected to heat[6] from steam coils or from ovens which dried it more rapidly. The glaze was then added to the dry ware. The glaze was mixed with water in a large barrel or tub to a watery paste or slip; this was strained through a finely woven cloth into another container, in order to remove all sand or other impurities which might roughen the glaze on the ware. Each piece of ware was immersed and rolled around in the thin slip until it was evenly coated all over, then set aside to dry, which it did in a few minutes. Albany slip clay, which produces a brown glaze, was a common glaze used. Its composition is indicated by the following analysis:[7]

ANALYSIS OF ALBANY SLIP CLAY

	Percent
Moisture (water, H_2O)	0.37
Volatile matter (carbon dioxide, CO_2, etc.)	8.87
Silicon dioxide (silica, SiO_2)	56.75
Aluminum oxide (Alumina, Al_2O_3)	15.47
Ferric oxide (Iron, Fe_2O_3)	5.73
Calcium oxide, (lime, CaO)	5.78
Magnesium oxide (magnesia, MgO)	3.32
Potassium oxide and sodium oxide (potash and soda, K_2O, Na_2O)	3.25
Total	99.54

Burning followed the glazing. The kilns, built of brick, commonly were oblong of shape, and of capacity varying from 400 gallons or less to 3,000 gallons or more. Wood or coal was used as fuel. The temperature was raised gradually to the degree indicated by cone 6 to cone 9, and the length of time required for the burning ranged from 12 hours to 48 to 60 hours.

The story of the making of stoneware by these small potteries can be told most briefly and clearly by describing the process step by step from the pit to the finished product through the W. C. Davis & Son's pottery (Sec. 26, T. 11 S., R. 9 E.), about a fifth of a mile south of the Smithville-Tremont road. The Davis pottery is the only shop operating continuously at present, and probably the largest and most nearly up to date which ever made ware in Itawamba County.

The clay used by the Davis pottery is obtained from a terrace deposit (SE. 1/4, Sec. 27, T. 11 S., R. 9 E.) in the north wall of the valley of Bluff Creek, half a mile southwest of the plant (Figure 13). It is dark gray when damp or wet, but dries light gray, is somewhat sandy and lignitic, and slightly stained by iron oxide. The 6-foot bed is overlain by gravel and underlain by sand. The pottery has obtained clay from this deposit for more than 20 years. The clay is hauled by wagon or truck to the pottery, dumped in a pile, and as needed is taken from the pile and packed into a soaking vat of dimensions about 10 x 3 x 3 feet, where it is covered with water (about 60 gallons if the clay is entirely dry) and soaked over night, or for several hours at least. After soaking, the clay is run through a grinder powered by a gasoline engine, and the ground clay, extruded near the bottom of the grinder through an aperture some 8 or 10 x 4 inches, is next fed into the screener, where it is forced through a screen by a piston. All gravel is screened out. From the screen it is cut by wire into blocks, each of which contains enough clay for the piece of ware to be made from it, and wedged. The next step takes it to the potter's wheel, where it is shaped by the potter as it revolves with the wheel. The potter turns by hand, adding water as needed. The two wheels are powered by electricity. The completed ware is set on a drying rack, where it remains until it is dry, commonly a week or less if the weather is fair and the air relatively dry. The glaze is applied to the dried ware. The glaze is mixed with water in

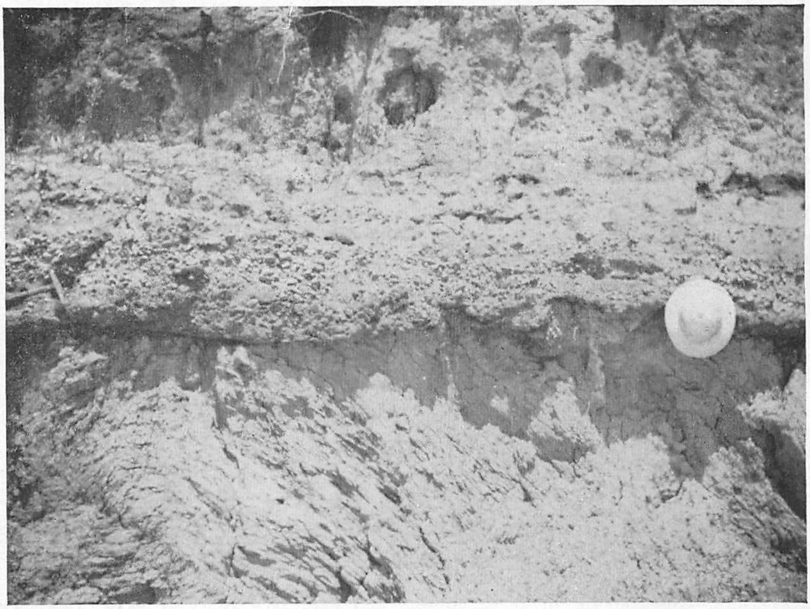

Figure 13.—Pottery clay, Davis Pottery pit (SE. 1/4, Sec. 27, T. 11 S., R. 9 E.) in the north wall of Bluff Creek Valley a mile southwest of Turon. June 21, 1945.

a large container to a watery paste; this is strained through a finely woven cloth in order to take out all sand and other impurities. The piece of ware is immersed in the glaze, then set aside to dry, which it does in a few minutes. The ware is then stacked in the kiln to be burned. The kiln is a downdraft, beehive type, holding about 3,000 gallons of ware, and heated by burning coal. The heat is regulated as well as possible. No device is now used to indicate just what degree of heat is reached at any particular time and place, although Seger cones were formerly used. In the early stages of firing, the heat is kept down, fuel being added no oftener than at 1-hour intervals; during the next 12 hours fuel is added at half hour intervals, and finally, to the completion of the burning, it is added at 20-minute intervals. Burning may require from 48 to 60 hours. Michigan slip glaze is used, and the ware is brown in color as it comes from the kiln. During the war the light white or bluish or cream-colored glaze could not be obtained, probably because zinc oxide was not available.

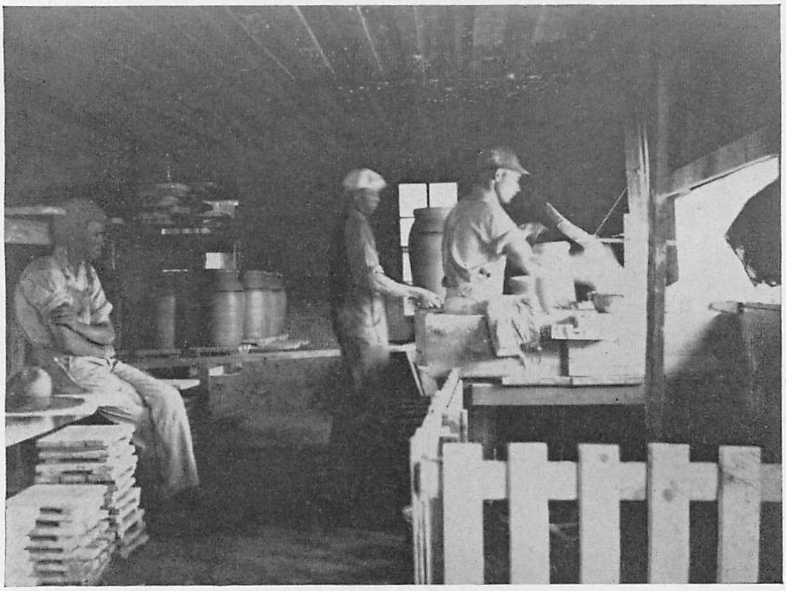

Figure 13a.—Interior of the D. E. Summerford Pottery (NE. 1/4, NW. 1/4, Sec. 36, T. 10 S., R. 10 E.), State Line road. Photo by F. F. Mellen, May 27, 1935.

The Davis pottery has in the past made a variety of ware, but at present makes churns chiefly, of two or three sizes. If both wheels were in operation, the output would average 800 gallons in an 8-hour day. As a rule the ware is peddled out, but in June, 1945, the Spruce Pine Pottery, at Spruce Pine, Franklin County, Alabama, was taking the entire output.

Few of these small potteries operated continuously for any considerable time. The custom was to make a few hundred gallons of ware, and then peddle it out before resuming operations, or else to work until an order was filled. The output was relatively small, not only because of the irregularity of the periods of operation, but because of the small capacity of each shop. The State Line Pottery, which was active in the spring of 1935 on the northeast side of Highway 78 about 100 yards east of the Mississippi-Alabama line, using clay from southeastern Itawamba County, had a capacity of about 800 gallons a week from its one wheel. The D. E. Summerford pottery

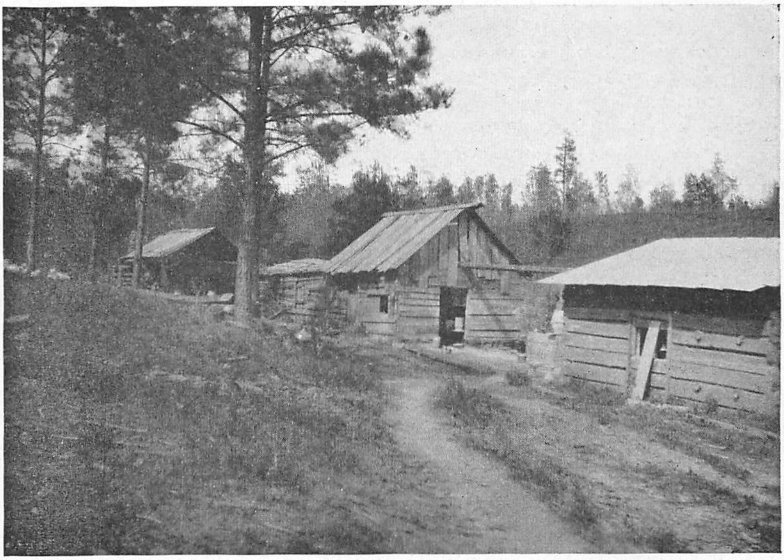

Figure 14.—Buildings of the J. B. Young Pottery (NE. 1/4, Sec. 6, T. 11 S., R. 10 E.), on the Smithville-Tremont road. Typical of "jug shops" of Itawamba County. April 25, 1935.

(Figure 13a) (NE. 1/4, NW. 1/4, Sec. 36, T. 10 S., R. 10 E.), on the west side of the State Line Road 3.8 miles south from Highway 78, probably never exceeded 200 gallons a day under the kick-wheel system, but may have produced more after the installation of a motor to run one of the wheels. The Plunkett and Ford pottery (near the center, Sec. 35, T. 10 S., R. 10 E.), on a local road a mile southwest of the D. E. Summerford shop, had a capacity of only about 100 gallons a day. Its predecessor, the old John Plunkett pottery, averaged about 2,000 gallons of stoneware annually, according to Logan.[7] The J. B. Young shop (NE. 1/4, Sec. 6, T. 11 S., R. 10 E.) (Figure 14), a little east of the Smithville-Tremont road in the valley of a branch of Jims Creek, could turn out possibly 100 gallons a day. Some light-gray mottled clay used was dug near the pottery. It was said to be very resistant to heat and to burn almost white to brick red. The old E. P. Kennedy pottery (SE. 1/4, Sec. 4, T. 11 S., R. 10 E.), on the Hopewell-Academy road a mile or so northeast of Hopewell, was reported by Logan[7] to have had a capacity of 7,000 to 8,000 gallons a year, made from a nearby 4-foot to 5-foot bed of mottled clay, white predominating. The results of Logan's studies of the Kennedy clay may be summarized:

TESTS OF KENNEDY CLAY

Physical Properties:

Tensile strength, 120 pounds (maximum) per square inch
Plasticity, 30 percent water required
Air shrinkage, 8 percent
Specific gravity, 2.5

Firing tests:

Color, pyrometric cone 20, dark gray
Hardness, Cone 20, vitrified
Absorption, Cone 20, none

Rational analysis, percent:

Clay substance, 36.64
Free silica, 49.35
Fluxing impurities, 5.31

Chemical analysis, percent:

Moisture (water, H_2O)	2.71
Volatile matter (carbon dioxide, Co_2, etc)	5.91
Silicon dioxide (silica, SiO_2)	71.53
Ferric oxide (iron, Fe_2O_3)	4.14
Aluminum oxide (alumina, Al_2O_3)	14.46
Calcium oxide (lime, CaO)	0.62
Magnesium oxide (magnesia, MgO)	0.55
Sulphur trioxide (SO_3)	----
Total	99.92

The old W. A. Summerford pottery (SW. 1/4, Sec. 11, T. 11 S., R. 10 E.), also mentioned by Logan,[7] was reported to have had a yearly output of about 5,000 gallons. Logan states that the clay deposit here was about 6 feet thick, and that the clay was white to yellowish white with streaks of blue. His study of samples yielded the results described below:

TESTS OF SUMMERFORD CLAY

Physical properties:

Rate of slaking, rapid; very slow in one puddled sample
Particle size, less than .05 percent retained on a 150-mesh screen
Tensile strength, 111 pounds per square inch
Plasticity, 20 percent of water required
Air shrinkage, 8 percent

Firing tests:

Color, pyrometric cone 01, white; Cone 9, yellow; Cone 17, light pink; Cone 19, yellowish gray; Cone 20, gray
Hardness, Cone 01, soft; Cones 9, 19, 20, steel hard; Cones 17, 19, 20, vitrified
Shrinkage, percent, Cone 01,—; Cone 9, 5; Cone 17, 5; Cone 19, 5
Absorption, percent, Cone 01, 25; Cones 9, 19, —; Cone 20, 0.
Other effects, loss of weight in burning, 3 percent; takes both artificial glaze and slip glaze without cracking

Rational analysis, percent:

Clay substance, 69.89
Free silica, 20.27
Fluxing impurities, 1.97

Chemical analysis,	Percent
Moisture (water, H_2O)	0.77
Volatile matter (carbon dioxide, CO_2, etc.)	6.77
Silicon dioxide (silica, SiO_2)	62.58
Ferric oxide (iron, Fe_2O_3)	1.57
Aluminum oxide (alumina, Al_2O_3)	27.58
Calcium oxide (lime, CaO)	0.40
Magnesium oxide (magnesia, MgO)	Trace
Sulphur trioxide (SO_3)	Trace
Total	99.67

The old James Davidson pottery (Eastern part, Sec. 29, T. 10 S., R. 10 E.), was located in the village of Academy (known also as Whitney, Jims Creek, and Asbury). Logan[7] states that the clay was dug from a 6-foot bed under an overburden of "thinly bedded sands and clays containing attenuated layers of ironstone," from near the public road west of the village. It was mottled red and pink in the bed, and cream colored when reduced to powder. A short distance west of the site of the old pottery, a somewhat sandy gray clay containing patches of yellow and red has been exposed by gullying in the east wall of a creek valley, and shows also in the nearby road cut. The Davidson pottery used two kilns, each of which had a capacity of 650 gallons. The usual kinds of ware were made, but in addition the shop was well known locally for its tombstones. The tombstone manufactured by the Davidson pottery was 3 to 4 feet long and 2 feet wide, and was lettered in relief.

The results of Logan's study of the clay used by the Davidson pottery may be summarized:

TESTS OF DAVIDSON CLAY

Physical properties:

- Particle size, 10 percent retained on a 150-mesh screen
- Tensile strength, 80 pounds per square inch, average
- Plasticity, 25 percent of water required
- Air shrinkage, 8 percent

Firing tests:

- Color, pyrometric cone 12, cream; Cone 20, reddish yellow
- Hardness, Cone 12, hard; Cone 20, vitrified
- Shrinkage, Cone 20, 7 percent
- Other effects; remarks, qualities of slip and artificial glaze good on raw clay

Rational analysis, percent:

- Clay substance, 69.54
- Free silica, 17.02
- Fluxing impurities, 5.01

Chemical analysis,	Percent
Moisture (water, H_2O)	0.54
Volatile matter (carbon dioxide, CO_2, etc.)	7.40
Silicon dioxide (silica, SiO_2)	59.12
Ferric oxide (iron, Fe_2O_3)	4.39
Aluminum oxide (alumina, Al_2O_3)	27.44
Calcium oxide (lime, CaO)	0.34
Magnesium oxide (magnesia, MgO)	-------
Sulphur trioxide (sulphur) (SO_3)	Trace
Total	99.23

The R. J. ("Bud") Middleton pottery (NW. 1/4, SE. 1/4, Sec. 11, T. 11 S., R. 10 E.) was on the west side of the State Line Road about 6 miles from Highway 78 and a mile west of the Alabama line. It obtained clay from various places, but especially from a 6-foot bed of gray, iron-stained clay in the west wall of Splunge Creek Valley. The leading items of equipment were a mule-power grinder, two "kick" wheels, and a 1200-gallon kiln.

SAND AND GRAVEL

As pointed out in the discussion of stratigraphy, the surface formations in Itawamba County are dominantly sand, but contain some gravel and clay, disseminated or as bodies. Sand is abundant everywhere, almost all of it silty or clayey, or both silty and clayey, and stained yellow, brown, and red brown by iron oxide. That considerable quantities of it have been used locally on roads, is attested by a few large and many small sand pits scattered over the county. One of the largest of the pits is in the basal Eutaw formation at the top of the west wall of the valley of Gum Creek, some 6.5 miles southeast of Fulton, on the north side of Highway 78 (NW. 1/4, Sec. 6, T. 10 S., R. 10 E.). Sand and sand rock removed from here were used in the building of the highway fill across the wide valley, and the enormous quantities of sand removed in opening the big cut south of the pit were used for the same purpose. At many places along Highway 78, material, chiefly sand, has been excavated in making cuts for the highway, and used in fills across the small valleys. Much of the material for the Tombigbee River Valley fill came from the west bluff of the valley, as shown by the large cut 2.5 to 3.0 miles southwest of Fulton (Figure 8). Cuts along almost every road in the county expose beds of sand.

The drainage courses of Itawamba County have been developed in the Tuscaloosa and Eutaw sand, clay, and gravel, except the upper reaches of the larger tributaries from the west, which are in Selma territory. The East Fork of the Tombigbee River, the trunk stream, rises in the same formations farther north, and Bull Mountain Creek, its largest tributary, has its sources in the sand and gravel of western Alabama. Because the streams of the county flow almost entirely in a terrane which is so largely sand and gravel, their flood plains are underlain by sand and gravel chiefly, and their channels are all but choked by the same kinds of materials. The stream terraces, too, conspicuous in several localities, are mainly sand and gravel.

The gravel deposits of the original formations (Tuscaloosa and terraces) are in the eastern part of the county. The gravel has been used locally to some extent for road metal. Several small pits have been opened; one of the largest on the west side of the Tremont-Red Bay road 5.5 miles northeast of Tremont (Figure 3),[5] and others along the same road. The gravel is chiefly medium size chert pebbles, some of it cemented to conglomerate, and iron-cemented bands of irregular shape.

A few small pits have been dug in the terrace gravel deposits, also. One is about half a mile west of Tremont, on the north side of Highway 78 a few rods east of the bridge over Bull Mountain Creek

(Sec. 5, T. 10 S., R. 10 E.); another on the northeast side of the old highway a short distance northeast of Highway 78 and some three quarters of a mile west of the Alabama line (NE. 1/4, Sec. 13, T. 10 S., R. 10 E.) (Figure 15); a third, half a mile or so south of Highway 78 and about 2 miles southeast of Tremont (NE. 1/4, Sec. 15, T. 10 S., R. 10 E.); another in the left bank of Splunge Creek in the south-

Figure 15.—Terrace gravel pit (NE. 1/4, Sec. 13, T. 10 S., R. 10 E.) in the northeast wall of old Highway 78 three-quarters of a mile west of the Alabama line. September 23, 1942.

eastern corner of the county (NW. 1/4, SW. 1/4, Sec. 23, T. 11 S., R. 10 E.), and still another about 2.5 miles east of Oakland and on the east side of a graveled highway a little west of Bull Mountain Creek (NW. 1/4, Sec. 19, T. 9 S., R. 11 E.), less than a mile west of the Alabama line. The locations of these pits and others are indicated on the map (Plate 1).

As stated, gravel is abundant in the channels and beneath the flood plains of Bull Mountain Creek and the East Fork of the Tombigbee River. In many places it constitutes bars which cause rapids. Burdine No. 1 well, drilled for oil or gas, located on the flood plain of Bull Mountain Creek, is said to have penetrated 185 feet of sand and gravel before reaching Paleozoic rock.

By way of summation, it may be said that the county has abundant supplies of sand which can be used in concrete, mortar, and plaster, although in its natural state most of it is not ideal for such purposes, because of impurities, especially clay, organic matter, and iron sulphide.[10]* However, in several industries which use sand, specifications commonly are not very rigid, but are adjusted to fit supplies available in the locality concerned.[12] This is particularly true of structural sand. Except locally, and on a relatively small scale, chiefly in road construction, the sand of the county has not been used. Gravel has been used somewhat extensively on the roads. All the main routes of travel, except U. S. Highway 78, which is pavement, have been graveled. In fact, Highway 78 from the Lee County line to about 3 miles southwest of Fulton, is graveled on both sides of a narrow central pavement. Highway 25 is graveled throughout its length in Itawamba County except for a mile or two in Fulton, and the Tremont-Red Bay road, the Highway 78-Mantachie road, the Highway 78-Greenwood-Evergreen road, and another or two, are prominent graveled roads.

Ferruginous sandstone, formed by the cementation of sand by iron oxide and silica precipitated from solution in descending subsurface water, is prominent in some parts of the county, especially in the Eutaw formation. Besides places referred to in the foregoing text, other specific localities are: At Raper Springs (NE. 1/4, Sec. 19, T. 10 S., R. 10 E.); and in an isolated ridge (NE. 1/4, Sec. 31, T. 10 S., R. 10 E.) a short distance south of the Horns Crossing-Academy road. In both places springs issue from beneath the sandstone at its contact with underlying clay. The sandstone has been used locally for such purposes as building well curbs, retaining walls, walks, chimneys, and foundations for buildings. It could be used more extensively for such things, and even as building material for entire dwellings. However, it is not sufficiently abundant for general use as a building stone; commonly it is in places which are difficult of access; it is not uniformly cemented, and the masses are very irregular of shape. Blocks of conglomerate, also found in the gravel beds, have been used to some extent for building material, but they are so very difficult to shape that if used at all they must almost necessarily be used as taken from the pit.

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*A summary of the classification, properties, and uses of sand is given in Mississippi State Geological Survey Bulletin 63, Lee County Mineral Resources, pp. 122-125.

All in all, Itawamba County contains no natural building stone of consequence.

OIL AND GAS

No commercial production of oil or gas has been obtained in Itawamba County, although four or five prospect wells have been drilled and reconnaissance surveys having as their objective the discovery of any favorable structures which may exist, have been carried on sporadically for many years. Possibly the first well drilled for oil or gas was located in the southeast quarter of Section 7, Township 10 South, Range 9 East, between Highway 25 and the Mississippian Railroad, some 4 miles south of Fulton. Little information is available about this well. Reports were to the effect that it was drilled in 1921 by Missouri men, the name of the company unknown, with a small gasoline drilling machine; that hard rock (possibly Paleozoic) was encountered at 220 feet, and that a depth of 396 feet had been reached by October 29, 1921. The well was still in hard rock when abandoned. A show of oil was reported at 324 feet; also, asphalt was said to have been found.[13]

Late in 1926 or early in 1927 (February, 1927, according to one report) a local company, the Itawamba Oil and Gas Company, erected a derrick (Sec. 16, T. 10 S., R. 9 E.) some 5 miles south of Fulton, on a 5,000-acre block, but did no drilling. The projected well was to be known as the No. 1 Evans.

The Kentucky Lumber Company No. 1 well, more commonly known as the Grasty well, was begun October 21, 1939, by the Red Iron Drilling Company, of Shreveport, Louisiana, contractor, at the direction of Gordon C. Grasty and the United East and West Oil Company, operators. The location (West center, NE. 1/4, SE. 1/4 Sec. 7, T. 10 S., R. 10 E., 660 feet south of the north line and 1280 feet west of the east line of the southeast quarter of the section) was selected after a surface survey of the region by H. D. Easton. It is in the flood plain a little north of the junction of Bull Mountain and Gum Creeks, at an elevation determined by the barometer as 362 feet. At a depth of 96 feet the bit was twisted off and left in the hole, and the drillers skidded the rig over 24 feet and began again. On the morning of October 24, 10 3/4-inch surface casing was set at 169 feet 9 inches. Drilling was discontinued on June 7, 1940, at a depth of 3,530 feet. This well, the deepest in Itawamba County and one of the deepest in the northeastern Mississippi-northwestern Alabama region, began in Recent alluvium and passed through some

Cretaceous (Tuscaloosa) and more than 3,000 feet of Paleozoic strata, including Mississippian, Devonian, Silurian, and Ordovician. Possibly it reached the Knox dolomite (Cambro-Ordovician) as suggested by the samples of dolomitic limestone from near the bottom of the hole. However, Easton expressed the opinion that the Knox was not reached, and that the well should have gone deeper. The section drilled through showed several interesting features. In the first place, no Pennsylvanian strata were recognized, although thick Pennsylvanian (Pottsville) conglomerate, sandstone, and shale, including thin coal beds, crop out in Alabama a few miles east of the Grasty well. In the second place, the Pennington formation, uppermost Mississippian, is assigned a thickness of 377 feet, although its maximum thickness at the outcrop in Alabama is only 200 feet. In the third place, some Chester formations which crop out in Tishomingo County a few miles to the north were not recognized in the Grasty well section; the part of the Chester which underlies the Bangor appears to have thinned to about half its outcrop thickness. In the fourth place, the black shale at the top of the Devonian in the outcrop section is missing from the well section. The Silurian strata were easily recognized by the included red and pink beds, and the Ordovician by gray and brown sandy limestones and a few thin sandstones.

The Grasty well found a little live oil and definite evidences of the former presence of oil. The paleontologist of the Shell Oil Company listed the showings: Asphalt, 490 feet to 500 feet, and 518 feet to 530 feet; distillate, 530 feet to 549 feet; oil, 549 to 570; oil, 1150 to 1240; asphalt, 1330 to 1340, and 1350 to 1362. The note is made that asphalt, distillate stain, and oil, showed continuously from a depth of 490 feet to 570 feet. All these showings were from the Chester series of the Mississippian system. The driller's log, however, records the depths of the petroliferous beds as follow: 553 to 567, and 567 to 575, oil; 2998 to 3010, rainbow of oil and some salt water; 3133 feet, a little gas; 3170 feet, "A little very live, green oil shows with the water while bailing." It was claimed that the shallow (560-570 feet) oil showing indicated that possibly sufficient oil was present for a commercial well if acid had been applied, but no attempt at acid treatment was made when the drill was at that depth. After the well had reached its total depth, an attempt was made to test two shallow zones. The 7-inch casing was pulled up from 2515 feet to 1368 feet and cemented, the plug being set at 1321 feet, and the casing between 1165 and 1210 feet was perforated by 100 shots. Efforts to force acid into the rock failed. The rock occupying the

560-foot to 570-foot interval, which was counted on to produce sufficient oil for a small pumper, could not be tested because no cement had been placed in the well outside the casing that high up, and a squeeze job of re-cementing could not be resorted to because of exhaustion of funds. Hence no test of this shallow zone was made. Easton expressed the opinion that other wells should be drilled to 560 to 570 feet, and could be counted on to make at least small pumpers. Probably acting on this suggestion, certain parties set up a rig some time later a quarter of a mile or so north of the site of the original well, but apparently abandoned the project before any hole was completed to the depth mentioned.

The "tops" in the Grasty well were determined as stated below:

	Feet
Top of Paleozoic (Mississippian, Chester),	160
Top of the Bangor formation	549
Top of the Tuscumbia formation	1362
Top of the Devonian (possibly)	1625
Top of the Silurian	2197
Top of the Ordovician	2237

The most recent drilling in Itawamba County was by the Gregg-Tex Gasoline Corporation, of Longview, Texas. R. L. Burdine No. 1 well (NW. 1/4, NE. 1/4, SE. 1/4, Sec. 16, T. 11 S., R. 9 E.) (Figure 16) was begun on October 10, 1944, and completed to 1511 feet on November 10, 1945.[14] The location, on the flood plain of Bull Mountain Creek, on the R. L. Burdine farm a mile or so south of New Salem school and church, was selected on the basis of reported studies and observations by several geologists and others at different times during several years. Mr. Lewis Moore, of Itawamba County, interested himself particularly in the search for a favorable structure, taking advantage of his intimate acquaintance with the territory acquired through long residence and through many years as field man for Filtrol Corporation. As stated in the part of this report which relates to structure, geological conditions in places in Marion County, Alabama, and in Monroe County, Mississippi, suggest the presence of structural conditions in Itawamba County favorable for the accumulation of oil and gas. However, the most definite statement on the subject is made by Stephenson and Monroe,[5] of the U. S. Geological Survey. Following the description (quoted in the discussion of stratigraphy in the present report) of a section east of New

Salem church (Sec. 9, T. 11 S., R. 9 E.), they say: "This exposure is at the crest of a small anticline. The bentonite bed is only 16 feet lower (barometer) here than at the Silas Mill locality. As the two localities are 3 miles apart, the bed should be from 60 to 90 feet lower at New Salem than at Silas Mill." This place "on the crest of a small anticline" is only a mile or a little more north of Burdine No. 1 well.

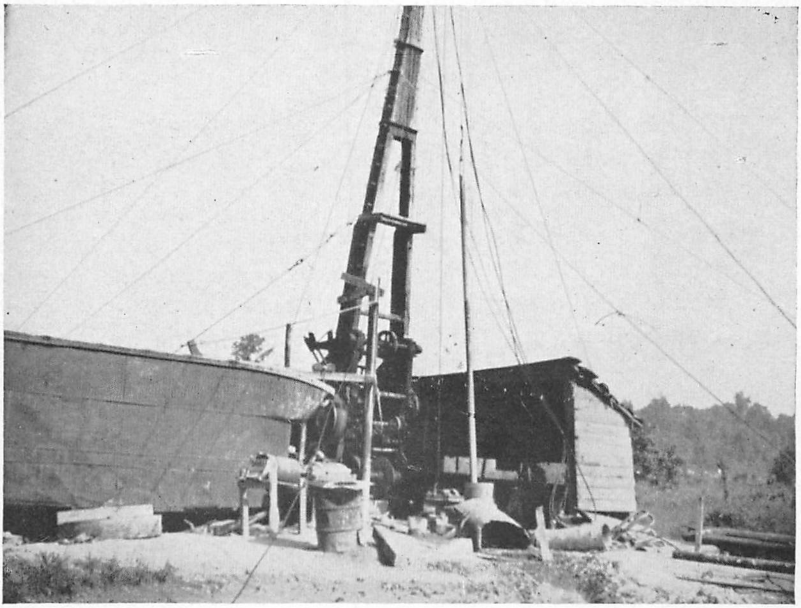

Figure 16.—Rig at R. L. Burdine No. 1 well (NW. 1/4, NE. 1/4, SE. 1/4, Sec. 16, T. 11 S., R. 9 E.), a mile south of New Salem School. June 27, 1945.

The Burdine well found small quantities of greenish oil and a notable thickness of asphaltic limestone, but failed to get commercial production. Positions of the "tops" in the rock section penetrated were not definitely determined. It was believed by the operators that the beds were running much higher than in the Grasty well; in fact, the top of the Tuscumbia (Iuka of Tishomingo County) was said to have been reached at 1192 feet, as against 1362 in the Grasty well. Later study, however, tended to show that the Tuscumbia had not been reached at the depth named, and that the formations were running lower than in the Grasty well, as would normally be true, inasmuch as the Burdine well is about 8 miles southwest of (down dip from) the Grasty.

Persistent rumors that Paleozoic rock outcrops had been seen in the county were investigated, but no such outcrops were found. One place mentioned was the bed of Bull Mountain Creek near the old Jones bridge west of Sallis's Mill. No Paleozoic rock was found in this area except erratic bowlders, chiefly sandstone, similar to bowlders found at several other places in the county. Terrace gravel and conglomerate and ferruginous sandstone are conspicuous at the Bull Mountain Creek locality.

SUMMARY

The mineral substances of Itawamba County which are sufficient in quantity to make development economically feasible are ceramic clays, bentonite, sand, and gravel.

The ceramic clays are confined to the Tuscaloosa formation, in the eastern part of the county, where they are exposed in many places within the limits of a wide belt. Several outcrops show excellent clay sections, and the Highway 78 cut in the west wall of Gum Creek Valley exposes more than 50 feet of clay. Of 70 or more test holes scattered widely over the Tuscaloosa outcrop, fewer than 10 failed to encounter clay, and most passed through two or three beds of clay. A few encountered clay only, throughout their depth. The evidence provided by outcrops and test holes, then, is conclusive that the Itawamba County Tuscaloosa contains immense quantities of clay which the present laboratory tests have proved to be suitable for use in the manufacture of many types of ceramic ware. In fact, one type of these clays is so nearly pure that Ceramist Knollman recommends further purification by washing, a treatment given all high-grade kaolins before they are placed on the market:

"... The clays of this group [Group 1, kaolinitic clays] are in general of such purity in their natural state that it appears to be well worth while to wash them. One of the clays (R 6-1) especially, gives promise that the purified washed clay would rank with the better grades of kaolins. Other clays (R 6-2, R 8-2, R 86, R 93, R 94 and R 95) also look promising as good grades of kaolin, if given the washing treatment. Such clays would then be suitable for use in bodies of ceramic white wares."

The kaolinitic clays are interbedded with other types of clays or grade into them laterally, and seem to be distributed widely in the

Tuscaloosa formation. Test hole R 6 is on Highway 78; R 8 is half a mile north of the highway, and several other test holes which discovered clay of the kaolinitic type are on gravel roads. A few outcrops of the same kind of material are favorably located.

Several deposits of the other two types of clay, also, are favorably situated with relation to highways, notably the thick beds along Highway 78, referred to above. Probably the best location with relation to both highway and railroad is the Reeds Creek area some 6 miles by Highway 25 south from Fulton.

Itawamba is one of the six counties of the state which contain bentonite deposits of commercial size. At present the Filtrol Corporation workings in southern Itawamba County are the largest bentonite mine in the state. To date bentonite is known to exist on 30 to 35 other properties in the county, some of which have been prospected intensively. The data available are insufficient to serve as an adequate basis for an estimate of the total tonnage, but it can hardly be less than 1,000,000 tons of good material, perhaps much more. The quantity of inferior grades of bentonite could well be equally great. All important deposits are near graveled roads, and the New Salem community bentonite, the second largest deposit of the county, is only a short distance from the Mississippian Railroad. Properties which are known to contain large accumulations of good bentonite are, without exception, under lease or have been purchased by private corporations. All in all, prospecting through many years by national and state surveys and by private parties, has proved that bentonite is the most important mineral resource of Itawamba County, at least under present conditions.

Sand is very abundant, but has no economic value except locally. It has been used to a considerable extent in road construction, and on a small scale in building. Gravel, prominent in the Tuscaloosa formation, in river terraces, and in flood-plain deposits, has been used as road metal and as concrete aggregate.

No oil or gas in commercial quantities has been found in the county, although favorable structures have been reported, and at least three wildcat wells have been drilled. However, the exploration and the drilling have not been sufficient to warrant condemnation of the territory as a possible oil or gas field.

The soils are sands, sandy loams, silt loams, and clay loams for the most part. All are in general acid or neutral, deficient in lime.

The soils of the small lime areas may be slightly less acid than the others. Farming is general over the county, but is more extensive on the bottom lands, which are most fertile and otherwise best adapted to agriculture. Water is so abundant that there is no lack of it for domestic purposes; shallow wells can reach adequate supplies of good water in most parts of the county, and deep wells obtain a strong flow.

TEST HOLE RECORDS

Rufe Palmer Property

Test Hole R 4

Location: T. 10 S., R. 9 E., Sec. 17, NW. 1/4, SE. 1/4; about 0.4-mile northeast of Hwy. 25, on the northwest side of the Reeds Creek road some 60 yds. southwest of house owned by R. Palmer Drilled: Sept. 21, 22, 1942

Elevation: 10 feet above bridge over Reeds Creek east of hole Water level: 21 ft.

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Tuscaloosa formation
1	7.3	7.3	Sand, brown, containing a little small gravel
2	14.3	7.0	Clay, gray, containing iron rust
3	18.1	3.8	Clay, light-gray, mixed with rusty clay
4	21.9	3.8	Clay, blue gummy
5	23.4	1.5	Clay, black shiny gummy, containing a few nodules of marcasite
6	40.0	16.6	Clay, gray dark to light

Marshall Chamblee Property

Test Hole R 5

Location T. 9 S., R. 9 E., Sec. 36, SE. 1/4; north side of Hwy. 78 about 250 yds. northwest of Chamblee's store (Three Way Station), above high face of highway cut Drilled: Sept. 23, 24, 1942

Elevation: 41 feet above Hwy. 78 Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Tuscaloosa formation
1	15.8	15.8	Sand, red-brown and gray, containing a little small gravel, thin sand rock, some light-brown sand, and thin streaks of gray clay
2	18.6	2.8	Clay, light-gray sandy
3	28.3	9.7	Clay, interbedded black and gray gummy; Sample 1
4	29.5	1.2	Lignite, impure; contains marcasite concretions and some clay
5	34.2	4.7	Clay, black to gray; iron carbonate masses; clay lighter in color below the iron carbonate; sample d
6	37.0	2.8	Clay, bluish-gray

D. JACKSON PROPERTY

TEST HOLE R 6

Location: T. 10 S., R. 10 E., Sec. 6, NE. 1/4 near center; top of face of cut on north side of Hwy. 78, 150 to 200 yds. west of bridge over Gum Creek

Elevation: 56 feet above Gum Creek under highway bridge

Drilled: Sept. 25, 29, 1942
Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.4	0.4	Soil, dark, and sand, silty light-brown
			Tuscaloosa formation
2	11.1	10.7	Sand, clayey and silty brown; sand rock at base
3	17.0	5.9	Clay, bluish-gray, containing a little sand and gravel; Sample 1
4	28.9	11.9	Clay, brown sandy lignitic; yellow iron rust; Sample 2
5	33.7	4.8	Clay, black lignitic somewhat sandy; Sample 3
6	36.4	2.7	Sand, gray

WHITEHEAD PROPERTY

TEST HOLE R 8

Location: T. 10 S., R. 10 E., Sec. 9, SW. 1/4, near center; three quarters of a mile south of Tremont, on the west side of the Tremont-Smithville road

Drilled: Oct. 1, 2, 5, 1942
Water level: dry

Elevation: 10 feet above road

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.5	0.5	Soil, light-brown sandy loam
			Tuscaloosa formation
2	1.0	0.5	Clay, light-brown sandy
3	17.7	16.7	Clay, dark bluish-gray streaked with red-brown and some yellow grading into light-gray sandy; Sample 1
4	22.0	4.3	Clay, bluish-gray grading into darker gray some yellow streaks; slightly sandy; Sample 2
5	23.3	1.3	Lignitic material, dark bluish-gray
6	24.3	1.0	Clay, lignitic brown crumbly, spotted with yellow
7	32.8	8.5	Clay, light-gray somewhat sandy, to dark-gray shaly; Sample 3
8	44.0	11.2	Clay, light-gray slightly sandy; Sample 4
9	47.5	3.5	Clay, as above; rock at bottom

Cantrell Property

Test Hole R 10

Location: T. 10 S., R. 10 E., Sec. 19, NE. 1/4; east side of Raper Springs road 3.3 miles south of Tremont, under a whiteoak tree 100 yds. from the road

Drilled: Oct. 6, 7, 8, 1942

Elevation: 35 feet above road — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.9	0.9	Soil, light-brown sandy loam
			Tuscaloosa formation
2	6.9	6.0	Clay, light-brown hard yellow iron rusted
3	9.5	2.6	Clay, brown and yellow, as above; Sample 1
4	24.3	14.8	Clay, gray iron-stained gummy
5	40.1	15.8	Clay, bright bluish-gray grading downwards into lignitic with some yellow and dark-gray and some brown iron oxide; slightly sandy; Sample 2
6	42.3	2.2	Sand, somewhat clayey

John Horn Property

Test Hole R 11

Location: T. 10 S., R. 10 E., Sec. 31, NE. 1/4, NW. 1/4; about half a mile east of the Raper Springs road and 200 yds. north of the Tilden-Academy road, near abandoned house above a large clay outcrop — Drilled: Oct. 8, 1942

Elevation: 20 feet above road — Water level: 18 ft.

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	1.3	1.3	Soil and subsoil, light-brown sandy rocky
			Tuscaloosa formation
2	8.1	6.8	Clay, bluish-brown and gray to black lignitic
3	15.0	6.9	Clay, reddish-brown, and sand rock
4	16.3	1.3	Clay, light-gray slightly sandy, streaked with yellow iron rust; Sample 1
5	35.4	19.1	Clay, gray to black gummy; very light-gray somewhat sandy; Sample 2

Terry Horn Property

Test Hole R 12

Location: T. 10 S., R. 9 E., Sec. 25, SE. Cor.; south side of Tilden-Academy road about 100 yds. southeast of the Raper Springs road

Drilled: Oct 12, 13, 1942

Elevation: 5 feet above road — Water level: 35 ft.

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	6.6	6.6	Soil, subsoil, and underlying mantle rock, red gravelly sand, slightly clayey
			Tuscaloosa formation
2	12.2	5.6	Clay, light-gray to dark lignitic, containing pink and yellow iron rust; Sample 1
3	23.1	10.9	Clay, very dark lignitic; Sample 2
4	26.9	3.8	Clay, light-blue, bentonitic?; Sample 3
5	30.5	3.6	Clay, dark-gray to dark-blue stiff
6	38.8	8.3	Clay, like Interval 5; Sample 4
7	42.4	3.6	Clay, as in Intervals 5 and 6

C. P. Horn Property

Test Hole R 14

Location: T. 10 S., R. 10 E., Sec. 31, NW. 1/4, NE. 1/4; Horns Crossing-Academy road, half a mile east of Hole R 11, a quarter of a mile east of the C. P. Horn home, and 40 feet north of the road — Drilled: Oct. 19, 1942

Elevation: 15 feet above the road — Water level: 12 ft.

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	1.1	1.1	Soil, dark-gray sandy loam with some gravel
			Tuscaloosa formation
2	6.1	5.0	Clay, dark-gray sticky, spotted with yellow iron rust; some rocks near the base, where the clay is more sandy
3	12.5	6.4	Clay, blue gummy and rusty; water at top; Sample 1
4	28.0	15.5	Clay, dark lignitic grading downwards into light-gray to whitish; caving from above

W. L. Dickinson Property

Test Hole R 19

Location: T. 10 S., R. 10 E., Sec. 31, NE. Cor.; Horns Crossing-Academy road a mile or more east of Raper Springs road, a little west of the Dickinson home under a red oak tree north of the road in front of a tenant house

Drilled: Oct. 27, 28, 1942
Elevation: 3 feet above road
Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.9	0.9	Soil, sand, grayish-brown
			Tuscaloosa formation
2	6.0	5.1	Sand, brown, somewhat clayey
3	13.2	7.2	Clay, bluish to grayish red-streaked, containing yellow iron rust
4	17.0	3.8	Clay, gray lignitic tough; Sample 1
5	31.9	14.9	Clay, light-gray sandy

Mrs. Charles Chamblee Property

Test Hole R 23

Location: T. 9 S., R. 9 E., Sec. 36, NW. 1/4, SE. 1/4; 6 miles east-southeast of Fulton, on the north side of Hwy. 78 half a mile northwest of Chamblee's store, a few yards north of old highway

Drilled: Nov. 5, 1942
Elevation: 10-15 feet above road
Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	6.0	6.0	Soil, brown sandy, and brown clayey sand
			Tuscaloosa formation
2	17.0	11.0	Clay, brown iron rust streaked, dark-gray to lignitic; Sample 1
3	24.8	7.8	Clay, yellowish-brown, light-blue, and gray, to dark lignitic; somewhat sandy; Sample 2

O. A. Christian Property

Test Hole R 25

Location: T. 11 S., R. 9 E., Sec. 3, SW. 1/4, SW. 1/4; about 10 miles south of Fulton, a quarter of a mile east of Hwy. 25, across a local road about 100 yds. west of the Christian home — Drilled: Nov. 11, 1942

Elevation: About 10 feet above road — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	6.4	6.4	Soil and red sand
			Tuscaloosa formation
2	10.9	4.5	Clay, gray sandy, somewhat stained with yellow iron rust; tough and gummy
3	22.5	11.6	Clay, blue gray to bright gray somewhat lignitic; contains iron rust; gummy; Sample 1
4	32.4	9.9	Clay, somewhat sandy, grading downwards into clayey sand

Henry Stephens Property

Test Hole R 26

Location: T. 10 S., R. 9 E., Sec. 26, SW. 1/4, NW. 1/4; 1.5 miles east by south of Tilden, 40 yds. north of the Tilden-Horns Crossing road, near the W. M. Stone home — Drilled: Nov. 12, 1942

Elevation: About 10 feet above road — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.5	0.5	Soil, brown sandy and gravelly loam
			Terrace formation
2	9.0	8.5	Sand and gravel, brown
3	14.1	5.1	Clay, gray slightly sandy, grading downwards into clay, rusty yellow and darker
4	18.0	3.9	Clay, dark gummy slightly rusty; Sample 1
5	21.0	3.0	Sand, brownish, clayey

Hall and Ensley Property

Test Hole R 45

Location: T. 11 S., R. 9 E., Sec. 5, northern part; east side of Tilden-White Springs road a quarter of a mile north of Will Cannon's home at White Springs Drilled: Jan. 12, 1943

Elevation: 30 feet above the flat of the East Fork of the Tombigbee River Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Tuscaloosa formation
1	11.0	11.0	Sand, reddish-brown, mixed with clay, gray, grading downwards into sticky gray clay
2	13.3	2.3	Clay, gray sandy iron stained
3	16.3	3.0	Clay, bright gray with yellow streaks, somewhat lignitic
4	23.1	6.8	Clay, very dark gray lignitic; Sample 1
5	26.2	3.1	Clay and rock

Bob Yielding Property

Test Hole R 46

Location: T. 9 S., R. 10 E., Sec. 28, NE. 1/4; 3 miles north of Tremont and Hwy. 78, and a mile southwest of Oakland; 350 yds. east of a road junction

Elevation: 75 feet above road bridge south of the Yielding home Drilled: Jan, 13, 1943 Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	8.1	8.1	Soil and subsoil, and underlying mantle rock consisting of reddish brown sand and a little sand rock
			Tuscaloosa formation
2	11.0	2.9	Clay and some sand
3	14.5	3.5	Clay, very dark lignitic tough
4	20.0	5.5	Clay, gray tough sandy; Sample 1
5	25.8	5.8	Clay, light-gray; Sample 2
6	32.0	6.2	Clay, light-gray; Sample 3

Bob Yielding Property

Test Hole R 47

Location: T. 9 S., R. 10 E., Sec. 28, NW. 1/4, NE. 1/4; 3 miles north of Tremont and Hwy. 78, and a mile southwest of Oakland; 50 feet south of the road and 200 yds. southwest of Test Hole R 46 Drilled: Jan. 14, 15, 1943

Elevation: 40 feet above road bridge south of the Yielding home Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	2.6	2.6	Soil, brown sandy loam, and subsoil, reddish-brown clay
			Tuscaloosa formation
2	5.4	2.8	Clay, light-gray slightly sandy; Sample 1
3	8.5	3.1	Clay, dark-gray and yellow shaly
4	12.0	3.5	Clay, gray very sandy
5	19.0	7.0	Clay, very rusty; almost all yellow rust
6	22.3	3.3	Clay, light-gray to reddish-gray; Sample 2
7	24.5	2.2	Clay, with some gray sand
8	25.5	1.0	Clay, gray with pinkish tint
9	33.2	7.7	Clay, light-gray to brownish and pink tinted; Sample 3
10	35.2	2.0	Clay, reddish tough

Bank of Amory Property

Test Hole R 51

Location: T. 11 S., R. 9 E., Sec. 8, NE. 1/4; east side of the New Salem-White Springs road, half a mile west of its junction with Hwy. 25, and a mile south by east of White Springs Drilled: Jan. 29, 1943

Elevation: 30 feet above the flat of the East Fork of the Tombigbee River Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	1.3	1.3	Soil and subsoil
			Tuscaloosa formation
2	9.3	8.0	Sand, yellow
3	13.7	4.4	Sand, yellow, black, gray, and other colors, with a little clay and shaly iron sandstone
4	20.6	6.9	Clay, dark bluish-gray to very dark lignitic; iron carbonate near the base; Sample 1
5	23.3	2.7	Clay, reddish sandy, with iron rust; some dark-gray clay and sand rocks

E. C. Sloan Property

Test Hole R 52

Location: T. 11 S., R. 8 E., Sec. 23, NE. 1/4; west side of Barrs Ferry bridge road a little north of New Bethel, in a small valley on an outcrop north of the Sloan home — Drilled: Feb. 1, 1943

Elevation: 5 feet above road level — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	4.6	4.6	Soil and brown sand
			Tuscaloosa formation
2	11.0	6.4	Clay, gray sandy
3	14.2	3.2	Clay, dark-gray grading into lignitic; somewhat sandy; Sample 1

Mrs. Elmer Brown Property

Test Hole R 75

Location: T. 9 S., R. 10 E., Sec. 16, SE. Cor.; about a mile northwest of Oakland and 4 miles north of Tremont — Drilled: Mar. 2, 1943

Elevation: — Water level: 28 ft.

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	3.5	3.5	Soil, brown sandy loam, and subsoil, red-brown and gray clay
			Tuscaloosa formation
2	6.5	3.0	Clay, light-gray, with some red iron rust
3	21.5	15.0	Clay, dark-gray to black lignitic; Sample 1
4	23.0	1.5	Clay, yellowish rusty
5	24.5	1.5	Clay, light-gray
6	27.0	2.5	Clay, yellow rusty
7	28.0	1.0	Clay, light-gray, grading into darker clay downwards, and into sand and water

John Dill Property

Test Hole R 77

Location: T. 10 S., R. 9 E., Sec. 26, NW. 1/4, NE. 1/4; half a mile north of Horns Crossing road and 100 yds. west of the Bookout road; 75 feet southeast of a gravel pit — Drilled: Oct. 22, 23, 1942

Elevation: 10 feet above road at mail box — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent and *Terrace formations*
1	0.5	0.5	Soil, light-gray sandy and gravelly loam
2	2.5	2.0	Sand, brown silty and gravelly
			Tuscaloosa formation
3	18.0	15.5	Clay, blue, gray, and brown, somewhat sandy and streaked with yellow iron rust; Sample 1
4	33.0	15.0	Clay, blue and gray, with red sand streaks and a little gravel; Sample 2

G. C. Maxcey Property

Test Hole R 86

Location: T. 9 S., R. 10 E., Sec. 4, or T. 8 S., R. 10 E., Sec. 32, NW. 1/4 Sec. 4 or SE. Cor. Sec. 32; southeast side of Maxcey's Mill road a quarter of a mile southwest of the Eastman road, on a hillside a few rods northeast of a house — Drilled: Nov. 13, 1942

Elevation: 27 feet above the floor of a ravine under a bridge 150 feet north of the hole — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	1.4	1.4	Soil and subsoil and other mantle rock
			Tuscaloosa formation
2	8.4	7.0	Sand, red
3	21.0	12.6	Clay, very dark-gray to light-gray tough; somewhat rusty in spots, and contains fine sand; Sample 1

Davis? Property

Test Hole R 93 OC (pit)

Location: T. 11 S., R. 9 E., Sec. 27, SE. 1/4; north wall of the valley of Bluff Creek half a mile southwest of the Davis Pottery, and a quarter of a mile south of the Turon road — Measured: June 21, 1945

Elevation: 5 feet above branch south of pit — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Terrace formation
1	7.0	7.0	Sand, brown clayey, containing scattered small gravel
2	12.0	5.0	Gravel and conglomerate and sand: Gravel bed cemented at bottom into conglomerate; gravel unevenly distributed through the interval, and mixed with sand, roughly sorted, and indistinctly bedded and laminated; some streaks of sand almost free of gravel
3	18.0	6.0	Clay, dark-gray and somewhat lignitic where fresh, dries light-gray; considerable sand content, sufficient to show lamination on dry surface; many drying cracks; sand laminae; micaceous, fine flakes; sparingly pyritiferous; Sample 1
4	19.0	1.0	Sand, brown impure; thin ferruginous sandstone at the top
5	23.0	4.0	Covered, to water level of the branch

Harris Property

Test Hole R 94 OC

Location: T. 10 S., R. 10 E., Sec. 35, NE. 1/4; north of the Harris home 75 to 100 yds., from the wall of a gully — Measured: Sept. 26, 1945

Elevation: 10 feet above bottom of valley — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	1.0	1.0	Soil and subsoil, clay loam and clay, sandy
			Tuscaloosa formation
2	3.0	2.0	Clay, light-gray on exposed surface, darker gray where damp; sandy, and somewhat mottled with iron oxide; breaks out in lumps; Sample 1

Rogers Property

Test Hole R 91

Location: T. 10 S., R. 9 E., Sec. 16, SW. 1/4, NW. 1/4; a mile northeast of Hwy. 25, on the south side of a farm road at road forks, 100 feet southeast of Reeds Creek — Drilled: Dec. 18, 21, 1942

Elevation: 17.5 feet above Reeds Creek — Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface

			Recent formation
1	8.5	8.5	Soil, sandy loam, subsoil, and underlying sand and red clay mantle
			Tuscaloosa formation
2	11.0	2.5	Clay, blue, with iron rust
3	13.2	2.2	Sand, gray, very yellow with rust
4	21.0	7.8	Clay, gray and blue rusty; tough, slightly sandy; Sample 1
5	26.3	5.3	Clay, very dark lignitic, grading into gray; Sample 2
6	29.3	3.0	Sand, light-gray
7	31.5	2.2	Clay, very dark-gray to black, somewhat sandy; interval not complete

Walter Jones or State of Mississippi Property

Test Hole R 92

Location: T. 10 S., R. 10 E., Sec. 23; west side of Academy-Harbours Store road, 2.6 miles north of the road junction half a mile or less north of Academy church; 2.0 miles south of Harbours Store, which is on Hwy. 78

Drilled: Dec. 24, 1942

Elevation: 7 feet above the road Water level: dry

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Recent formation
1	0.2	0.2	Soil, gray sandy loam
			Tuscaloosa formation
2	1.2	1.0	Sand, gray somewhat clayey
3	5.2	4.0	Sand, clayey reddish-brown, grading downwards into lighter brown containing some sand rock
4	8.5	3.3	Clay, dark-gray somewhat mottled with red and yellow spots; light greenish-yellow towards the bottom only slightly sandy; Sample 1
5	11.0	2.5	Clay, light-gray stiff, mixed with golden-brown rusty material
6	15.2	4.2	Clay, light-gray to dark-gray to nearly black, with red spots and rusty material; Sample 2

Dora Burch or B. Thomas Property

Test Hole R 95 OC

Location: T. 10 S., R. 9 E., Sec. 34, NE. 1/4; bed of tributary of Bull Mountain Creek 200 to 300 yds. west of old house place and gravel pit

Elevation: Water level: at surface

No.	Depth	Thick.	Description of strata and designations of samples
	0.0	0.0	Surface
			Tuscaloosa formation
1	6.0	6.0	Clay, light-gray to white; Sample 1 dug from the bed of the creek channel through a distance of 50 to 75 yds. and a vertical interval of about 6 feet

ACKNOWLEDGMENTS

Data for the present report on the geology and mineral resources of Itawamba County have been obtained chiefly by a field survey made in 1942-43, but also from reconnaissance field work by the writer and his associates at various times during the years 1934-37 and 1945-46, as well as from the published records of the results of investigations by other interested parties, including a few geologists. The 1942-43 work was sponsored by the Mississippi State Geological Survey, and carried forward in cooperation with the county, and with the Federal Government through the Work Projects Administration, up to the date of the closing of that agency, March 6, 1943. Acknowledgment of assistance given during the period of cooperative activity is due especially to Mr. Spearman, Chairman of the Board of Supervisors of Itawamba County at that time, and Mr. Wilburn, a member of the Board. Each of these gentlemen provided a truck for a few weeks, for the purpose of transporting the drilling crews, the tools, and the samples. The late Mr. Louis Sheffield is entitled to special mention, too, for his general encouragement of the project, and the very material assistance he rendered by making available a satisfactory store room and office. Mr. E. D. Phillips contributed much to the prospecting by giving the geologist in charge the benefit of his intimate knowledge of the county and of the locations of mineral deposits. Mr. Lang, superintendent of mining operations for Filtrol, gave the writer permission to study the bentonite and associated beds exposed by the pits, and to collect samples; and the drillers of R. L. Burdine No. 1 oil test well kindly provided information about drilling progress and the rock encountered, and shared their well cuttings. Other citizens helped in one way or another. Nor must the writer omit expression of appreciation of the work of his associate, Mr. Frederic F. Mellen, in 1934, 1935, and 1937, and of his associate, Mr. W. T. Lovelace, in 1935.

For information drawn from publications by several writers, acknowledgment is made in the list of references and at places in the text.

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TESTS

HARRY J. KNOLLMAN, Cer. Engr.

INTRODUCTION

The clays of northeastern Mississippi, which include those of Itawamba County, have been referred to by several geological writers in publications of the Mississippi Geological Survey. Information relative to these clays, prior to the surveys of the last twelve years, has been of a rather general nature, with conclusions drawn from data obtained from incomplete tests of random samples from a few localities. The samples may or may not have been representative of the deposits or strata under consideration. Such earlier information regarding the few deposits in Itawamba County that have been tested does not generally take into consideration the stratigraphic position of the beds, differences in characteristics and properties of the beds at different localities, and the economic possibilities of individual strata and groups of strata at the various localities.

In the present study, all the samples tested are representative of the upper part of the Tuscaloosa formation. They were selected as representative of different parts of the county. Different depths and stratigraphic positions were also taken into consideration when selecting the samples to be tested. Although clays from the separate localities are in a general sense very similar within their stratigraphic positions, the sequence of beds may not be consistent. Certain clay bed types may be, and often are, thicker in one region than in another, or may be missing entirely in places. Some beds of similar clay may be easily accessible in one region, but covered with an excessive overburden in another. Consequently, possibilities for commercial development of certain clays may be much more promising in one locality than in another.

CLASSIFICATION OF THE CLAYS

A correlation of the clays from the several regions has been made by classifying the clays tested according to their general types and their uses. In reading this report, frequent reference should be made to the test-hole records. Three distinct types of clays are represented by the twenty-five clay samples tested in this study. They are (1) kaolinitic clays, generally burning to a white or cream color; (2) pottery or ball clays, generally burning to a buff or gray color; and (3) brick and heavy clay products clays, generally red or brown burning. The last named are abundant everywhere.

These distinct types appear to be available in very pure deposits, in deposits that seem to be gradational, and, although not definitely determined in this study, in deposits contaminated with silt, sand, lignite, sandstone, gypsum, mica, and ferromanganese minerals. These minerals and rocks may appear alone or in combination, and in traces to large quantities. In any case, the clays in this study are, in their chief physical properties in the unburned state and in their pyrophysical characteristics, similar to clays in other counties of northeastern Mississippi, Tippah and Monroe Counties, for example, where the above accessory minerals were found in greater or less abundance in the clays.

It is, therefore, clear that a great number of clays not only exhibit properties common to their distinct types, but also exhibit properties influenced by the kinds and amounts of accessory minerals present. The above classification is an attempt to systematize the wide variety of clays available. Thus, there is no sharp distinction between the first two classes. Whereas the clays of the kaolinitic type tend to burn white or cream and are open-burning throughout their best apparent firing range, many of them exhibit the high plasticity and stickiness of the ball clays. Some of the pottery clays, on the other hand, possess the high porosity and absorption generally characteristic of kaolins. The gradational character is further indicated by the fact that nearly all the red-burning clays studied tend to be open burning over a long firing range, and do not, in general, develop the deep red color almost invariably associated with common brick, drain tile, and similar heavy clay products. It would appear that these red-burning clays are contaminated with variable quantities of kaolins or ball clays, or possibly with traces of the Porters Creek type of clays. Possibly the fact that they are all representative of the upper part of the Tuscaloosa formation may explain their characteristics.

Contamination within narrow limits is not necessarily detrimental; in fact, the usefulness of a clay with respect to heavy clay products such as brick, sewer pipe, structural tile, and hollow block, is dependent on the amount and kind of accessory impurities present. The working properties of the clay during manufacture, the texture and color of the burned product, as well as the length of the maturing range and the degree of the finishing temperature all are governed by the relative quantity and the nature of the accessory minerals present. Such minerals may even determine the economies of operation in some instances. On the other hand, the higher grades of ceramic wares, such as refractories, white wares, abrasive wheel bonds, paper filler, fine pottery ware, and pigments, must not be contaminated with these accessory minerals to any extent, especially with the iron-bearing types.

It appears probable that one of the reasons why many of the clays in this study seem to a degree to be a mixture of the three classes is, that some of the samples represent holes of considerable depth. Nine of the 25 samples were obtained from depths of more than 10 feet, the maximum depth being 19.1 feet. If a clay bed is made up of one of the higher types of clay, the kaolins and pottery clays, it may contain at least thin strata of impure clays or minerals, which go to make up the composite sample. Typical red-burning clays likewise may be mixed with some of the higher grade, whiter clays in the composite sample, thus altering the properties of both types. Furthermore, the tests in this study show that of the seven holes represented by more than one sample, four have clays of the same character and class throughout their depths, while three passed through clays of different classes. Thus Holes R 8 and R 23 were found to contain both the kaolin and red-burning types; Hole R 12, the pottery and heavy clay products types.

It appears advisable to pay closer attention to overlying and underlying beds, and to the differences in characteristics and properties of the clay beds at different depths of the same hole, than was done in this general survey, whenever the commercial possibilities and utilization of the clays from this county shall be seriously considered. Provided the overburden is not excessive, the higher types of clay should be sampled at five-foot intervals in order that sufficient representative material may be available for study to determine their essential properties and suitable uses.

GENERAL CHARACTERISTICS

As a group, the clays of this study are essentially open burning over a wide temperature range. They require temperatures higher than Cone 11 before starting to overfire, most of them requiring much higher temperatures than Cone 11 to become dense or to swell from overfire. This holds generally true, even for most of the red-burning clays. Other characteristics of most of the samples are, high density or apparent specific gravity, and generally high absorption and porosity over a wide firing range. Both their raw and fired transverse strength or modulus of rupture is comparatively low. This is not detrimental in itself, except where heavy clay products are to be produced. Shrinkages, in general, tend to be high.

In the unburned state, the clays of this study have a fine-grained, approximately uniform texture, generally high plasticity, and a tendency to excessive stickiness, especially on the addition of a slight excess of water. They have, also, a tendency to laminate badly when run through the die.

LABORATORY TESTS

The essential physical properties of the clays studied, and the results of tests, are given in the following tables. Detailed locations of the test holes are included in the test hole drilling records.

ABBREVIATIONS

COLOR

Black	Bla
Brownish black	BrBla
Brown	Br
Dark brown	DkBr
Light brown	LtBr
Mottled brown	MotBr
Pinkish brown	PBr
Reddish brown	RBr
Buff	B
Dark buff	DkB
Light buff	LtB
Medium buff	MB
Mottled buff	MotB
Reddish buff	RB
Varied buff	VaB
Chocolate	Ch
Cream	C
Dark cream	DkC
Light cream	LtC
Mottled cream	MotC
Gray	G
Blackish gray	BlaG
Brownish gray	BrG
Dark gray	DkG
Gunmetal gray	GM
Light gray	LtG
Medium gray	MG
Pink	P
Brownish pink	BrP
Red	R
Brownish red	BrR
Chocolate red	ChR
Pinkish red	PR
Salmon red	SR
Tan	T
Grayish tan	GT
White	W
Creamy white	CW

HARDNESS

Hard	H
Medium hard	MH
Very hard	VH
Soft	S
Very soft	VS

MISCELLANEOUS

Bloated	Bl
Cracked, badly	Vck
Cracked, slightly cracked	Ck
Iron spotted	I
Outcrop	OC
Pounds per square inch	lbs./sq. in.
Reducing burn at Cone 5	5R
Specific gravity	Sp. gr.
Warped	W

KAOLINITIC CLAYS

CHEMICAL ANALYSES

SAMPLE R 6 1

Ignition loss	9.15
Silica, SiO_2	68.34
Alumina, Al_2O_3	19.34
Iron oxide, Fe_2O_3	3.03
Titania, TiO_2	0.55
Lime, CaO	Trace
Miscellaneous	Trace

SAMPLE R 6 2

Ignition loss	6.40
Silica, SiO_2	76.30
Alumina, Al_2O_3	10.37
Iron oxide, Fe_2O_3	1.93
Titania, TiO_2	0.50
Lime, CaO	Trace
Miscellaneous	4.50

SAMPLE R 6 3

Ignition loss	7.76
Silica, SiO_2	72.26
Alumina, Al_2O_3	15.39
Iron oxide, Fe_2O_3	2.15
Titania, TiO_2	0.50
Lime, CaO	Trace
Miscellaneous	1.94

SAMPLE R 8 2

Ignition loss	6.56
Silica, SiO_2	75.00
Alumina, Al_3O_2	15.59
Iron oxide, Fe_2O_3	1.88
Titania, TiO_2	0.45
Lime, CaO	Trace
Miscellaneous	0.52

SAMPLE R 23 1

Ignition loss	6.86
Silica, SiO_2	67.24
Alumina, Al_2O_3	19.09
Iron oxide, Fe_2O_3	2.89
Titania, TiO_2	1.00
Lime, CaO	0.20
Miscellaneous	2.72

SAMPLE R 86 1

Ignition loss	6.90
Silica, SiO_2	71.22
Alumina, Al_2O_3	19.19
Iron oxide, Fe_2O_3	1.95
Titania, TiO_2	0.50
Lime, CaO	Trace
Miscellaneous	0.24

SAMPLE R 93 OC

Ignition loss	6.26
Silica, SiO_2	74.30
Alumina, Al_2O_3	16.21
Iron oxide, Fe_2O_3	3.21
Titania, TiO_2	0.45
Lime, CaO	Trace
Miscellaneous	Trace

SAMPLE R 94 OC

Ignition loss	6.12
Silica, SiO_2	75.50
Alumina, Al_2O_3	15.20
Iron oxide, Fe_2O_3	2.48
Titania, TiO_2	0.60
Lime, CaO	Trace
Miscellaneous	0.10

SAMPLE R 95 OC

Ignition loss	7.06
Silica, SiO_2	71.40
Alumina, Al_2O_3	18.21
Iron oxide, Fe_2O_3	2.81
Titania, TiO_2	0.70
Lime, CaO	Trace
Miscellaneous	Trace

Herbert S. Emigh, Analyst.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole	Sample	Color	Water of plasticity, percent	Degree of lamination	Drying shrinkage, volume, percent	Drying shrinkage, linear, percent	Modulus of rupture, lbs./sq. in.	Working properties
R 6	1	DkG	34.21	Strong	33.15	10.01	59	Very plastic, sticky, feather edges
R 6	2	DkG	19.12	None	12.06	4.15	327	Moderately plastic, some weak, sandy
R 6	3	DkG	26.25	Slight	27.28	8.63	199	Very plastic, sticky
R 8	2	DkG	26.60	None	23.22	7.21	262	Very plastic, sticky
R 23	1	MG	23.83	Strong	28.54	8.44	122	Very plastic, sticky, feather edges
R 86	1	BrG	23.68	Slight	22.28	6.93	205	Very plastic, good
R 93	OC	G	18.35	None	15.87	5.03	395	Very plastic, good
R 94	OC	BrP	18.03	None	12.11	3.88	305	Moderately plastic, good
R 95	OC	LtG	25.63	Some	23.93	7.41	73	Very plastic, very tough

PYRO-PHYSICAL PROPERTIES

TEST HOLES R 6 AND R 8

Hole	Sample	Cone	Porosity, percent	Absorption, percent	Bulk sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage, percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color, other data		
R 6	1	05	32.10	17.61	1.83	2.69	7.62	1.21	11.82	664	MH	W	
		02	31.88	16.66	1.88	2.73	8.20	2.16	12.77	565	MH	CW	Ck
		1	30.43	15.48	1.89	2.72	9.11	3.49	14.10	495	MH	CW	Ck
		3	27.93	13.44	1.98	2.72	14.39	3.93	14.54	607	MH	W-LtC	Ck
		5	23.66	12.08	1.99	2.68	14.82	4.56	15.17	465	H	W-C	Ck
		7	22.98	11.23	2.02	2.62	16.30	4.65	15.26	661	H	LtC	Vck
		9	11.67	5.98	2.06	2.37	18.64	5.51	16.12	795	VH	C	
		11	10.42	5.12	2.05	2.41	19.59	4.66	15.27	605	VH	C	
		5R	19.53	9.57	2.04	2.46	18.05	5.59	16.20	838	H	DkC	Ck
R 6	2	05	32.15	17.75	1.81	2.67	-0.32	-0.89	4.82	546	VS	W-LtC	Ck
		02	32.14	17.70	1.80	2.66	-0.29	0.25	5.96	573	VS	LtC	Vck
		1	31.74	17.39	1.82	2.67	-0.20	0.15	5.86	622	S	LtC	Vck
		3	31.71	17.11	1.83	2.68	-0.14	-0.22	5.49	683	S	LtC	Vck
		5	30.46	16.52	1.84	2.65	0.32	-0.30	5.41	830	S	C	Vck
		7	29.71	16.17	1.84	2.60	0.84	0.44	6.15	865	S	C	Vck
		9	27.88	15.05	1.86	2.57	1.32	0.33	6.04	1005	S	C	Vck
		11	26.95	14.58	1.85	2.53	2.16	0.00	5.71	1371	S	C	Ck
		5R	27.96	15.47	1.86	2.58	1.61	0.33	6.04	794	S	LtB	Ck
R 6	3	05	29.12	15.36	1.90	2.67	4.47	0.61	9.73	887	S	DkC	
		02	26.78	14.07	1.91	2.61	6.00	2.22	11.34	1329	MH	DkC	
		1	26.27	13.64	1.93	2.61	6.77	2.12	11.24	1309	MH	DkC	
		3	25.65	13.08	1.95	2.62	8.68	2.21	11.33	1317	MH	DkC	
		5	17.79	8.80	2.02	2.49	10.51	2.46	11.58	1474	MH	DkC	
		7	16.16	7.95	2.03	2.47	11.37	2.64	11.76	1435	MH	DkC	
		9	14.63	7.12	2.04	2.41	12.02	3.15	12.27	1826	MH-H	Dkc	Ck
		11	14.03	6.89	2.04	2.34	12.75	2.67	11.79	1039	MH-H	DkC	Ck
		5R	17.80	8.80	2.02	2.46	12.97	3.36	12.48	1413	MH	LtB	
R 8	2	05	26.34	14.36	1.86	2.56	1.89	0.19	7.72	1498	VS	W-LtC	
		02	25.79	13.56	1.90	2.56	3.59	1.20	8.73	1968	S	C	
		1	25.82	13.52	1.91	2.57	4.25	1.37	8.90	1925	MH	C	
		3	23.48	12.80	1.93	2.49	5.23	1.71	9.24	2345	MH	C	
		5	21.53	11.06	1.95	2.48	6.45	2.09	9.62	2482	H	C	
		7	20.63	10.51	1.96	2.47	6.99	2.14	9.67	2683	H	C	
		9	18.39	9.18	1.99	2.43	8.18	2.13	9.66	3127	H	C	
		11	17.45	9.09	1.99	2.40	7.46	1.37	8.90	2798	H	C	
		5R	19.64	9.93	1.97	2.45	7.11	2.59	10.12	2898	H	DkC	

*In unburned state and after firing

TEST HOLES R 23, R 86, R 93 OC, R 94 OC, R 95 OC

Hole	Sample	Cone	Porosity, percent	Absorption, percent	Bulk sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage, percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color, other data		
R 23	1	05	24.97	13.63	1.98	2.65	6.02	1.33	10.43	358	MH	LtC	Ck
		02	23.42	12.12	2.01	2.63	7.64	3.14	12.24	376	MH	C	Ck
		1	23.77	11.73	2.03	2.65	9.89	4.18	13.28	501	H	C	Ck
		3	22.09	10.72	2.06	2.65	11.10	3.93	13.03	525	H	C	Vck
		5	13.60	6.57	2.09	2.43	12.14	4.10	13.20	643	H-VH	C	Vck
		7	9.10	4.28	2.13	2.35	12.71	4.20	13.30	995	H-VH	C	Ck
		9	5.97	2.79	2.14	2.28	12.50	4.20	13.30	1035	VH	MotB	Ck
		11	4.47	2.09	2.14	2.23	12.76	4.32	13.42	940	VH	MotB	Ck
		5R	10.05	4.75	2.12	2.36	14.20	4.62	13.72	1059	H-VH	DkC	Ck
R 86	1	05	26.35	13.98	1.96	2.66	3.03	0.41	8.36	1337	H	W-LtC	Ck
		02	24.97	12.67	1.98	2.63	6.49	2.05	10.00	1401	H	CW-C	Ck
		1	24.42	12.31	1.99	2.62	7.66	2.17	10.12	2036	H	CW-C	Ck
		3	24.36	12.02	2.01	2.58	8.15	2.23	10.18	1935	H	C	Ck
		5	21.38	9.73	2.03	2.54	8.43	2.55	10.50	1909	H	C	Ck
		7	18.64	9.12	2.05	2.51	9.00	2.71	10.66	2859	H	C	Ck
		9	13.59	6.52	2.08	2.41	10.27	3.52	11.47	3094	VH	C	Ck
		11	12.85	6.17	2.09	2.39	11.82	-0.36	7.59	1928	VH	C	Ck
		5R	15.85	8.37	2.06	2.44	10.85	3.71	11.69	2678	H	DkC	Ck
R 93	OC	05	25.55	13.00	1.96	2.64	2.77	None	None	None	S	LtC	
		02	22.12	10.94	2.02	2.58	5.40	1.84	6.75	2340	MH	LtC	
		1	21.55	10.59	2.04	2.57	5.88	None	None	None	MH	LtC	
		3	20.84	10.46	2.06	2.64	6.42	2.46	7.59	1765	MH	C	
		5	15.59	7.44	2.11	2.52	7.85	None	None	None	MH	C	
		7	14.55	7.09	2.13	2.49	10.82	3.06	7.97	3340	MH	C	
		9	9.48	4.30	2.21	2.44	14.28	4.30	9.82	3090	H	C	
		11	7.96	3.62	2.23	2.39	14.73	3.68	9.20	1240	VH	C	
		5R	12.75	5.85	2.18	2.50	11.65	None	None	None	H	MB	
R 94	OC	05	27.34	14.51	1.95	2.68	0.32	0.05	5.91	1285	S	Wt-LtC	
		02	27.77	14.39	1.94	2.67	3.00	1.24	7.10	1093	S	C	Ck
		1	27.68	14.31	1.94	2.67	3.63	1.70	7.56	1300	S	C	Ck
		3	27.57	14.23	1.94	2.66	3.65	1.47	7.33	1585	MH	C	Ck
		5	23.23	11.01	2.02	2.61	5.40	None	None	None	MH	C	
		7	23.34	11.80	2.00	2.56	6.10	1.63	7.49	1583	H	C	Ck
		9	20.31	10.10	2.01	2.52	6.28	1.77	7.63	1973	H	C	
		11	19.48	9.74	2.00	2.48	6.85	1.02	6.88	1748	VH	C	
		5R	22.58	10.97	2.00	2.55	5.82	1.37	7.23	1548	MH	LtB	
R 95	OC	05	29.21	15.47	1.89	2.66	4.39	1.28	10.12	306	MH	W-LtC	Vck
		02	25.52	12.91	1.93	2.66	8.91	2.83	11.67	573	MH	W-LtC	Vck
		1	25.38	12.78	1.99	2.67	9.32	3.40	12.24	748	MH	C	Vck
		3	23.99	11.80	2.03	2.67	11.24	3.28	12.12	456	MH	C	Vck
		5	19.87	9.99	2.04	2.55	12.56	3.66	12.50	655	H	C	Ck
		7	17.03	8.24	2.07	2.49	13.19	3.50	12.34	671	H	C	Vck
		9	9.52	4.22	2.12	2.34	15.89	4.66	13.50	1398	VH	C	Vck
		11	4.30	1.99	2.16	2.26	15.95	4.28	13.12	1718	VH	C	
		5R	12.47	5.92	2.15	2.40	13.83	4.24	13.08	1174	MH	LtB	Ck

*In unburned state and after firing

UTILIZATION POSSIBILITIES

The clays in this group are characterized by their comparatively low strength and low shrinkage in the green or unburned state, their tendency to check and form numerous minute cracks during burning and cooling, their comparatively high porosity at high temperatures, and their low maximum burned strength or modulus of rupture.

The typical average properties of the clays in this group are: Water of plasticity, 24.0 percent; linear drying shrinkage, 5.75 percent; green modulus of rupture, 175 pounds per square inch; porosity at Cone 9, 15.7 percent; total linear shrinkage at Cone 9, 12.3 percent; and fired modulus of rupture, 1925 pounds per square inch. Most of the clays checked or crackled during the burning and cooling. Checking affects the modulus of rupture very considerably, making for erratic and generally low values.

The tendency to crack during burning and cooling is not unusual with kaolins and ball clays, and is not necessarily detrimental to them. Cracking would be detrimental and would prevent general use of the clay alone, but when this type of clay is used in conjunction with clays of other types, or in whiteware bodies, the tendency to crack is largely eliminated. More important is the degree of purity of these clays, especially as a consideration for white ware use.

All clays in this group burned to a white or cream color, with a tendency to burn to a darker shade at the higher temperatures. Also the high temperature tests revealed occasional to rare dark iron or manganese spots. The chemical analyses of the group showed the iron oxide (Fe_2O_3) to vary from 1.88 to 3.21 percent. Oddly enough, the two clays (R 6-1 and R 93) which had the highest iron content were among the whitest burning in the group, but showed a few dark spots, especially at the higher temperature burns, which probably accounts for this seeming contradiction.

High-grade kaolins commonly are washed before being placed on the market. The Itawamba County clays of this group are in general of such purity in their natural state that it appears to be well worth while to wash them. One of these clays (R 6-1), especially, gives promise that the purified washed clay would rank with the better grades of kaolins. Other clays (R 6-2, R 8-2, R 86, R 93, R 94, and R 95) also look promising as good grades of kaolin, if given the washing treatment. Such clays would then be suitable for use in bodies of ceramic white wares that include electrical, chemical, and table porcelains, sanitary white ware, hotel china and dinner ware, ceramic floor and wall tile, dry pressed tile, pottery shapes, and art ware. Provided the clays remain sufficiently uniform, their generally high plasticity would make them useful as a bond for certain types of abrasive grinding wheels. Such clays would also be well suited for use in compounding glazes and enamels. Outside of the ceramic field, the purified clays would be well suited for a filler in paper, rubber, oil cloth, and other items, and as a paint pigment.

Clay R 23-1, which tends to burn to a mottled buff at Cone 9 and higher, would be desirable for making high-grade buff-colored and speckled face brick, if used with a low maturing clay of the pottery type given in the next class.

The pyrometric cone equivalent or fusion point of the clays in this study was not determined in the time available, therefore nothing definite can be stated as to the suitability of the clay for use as refractories. However, their pyrophysical behavior at the higher temperatures of Cones 9 and 11, and their comparatively high alumina content, as seen from the chemical analyses, indicate that most of the clays would be very suitable for use in the manufacture of fire brick, refractory shapes, refractory grog, and for saggers. Calcining the clay between Cones 9 and 15 should produce a refractory grog suitable for high-grade refractories. The detrimental factor is the high iron content in some of the clays.

The unpurified clays also appear suitable for use in high-grade white to cream face brick, especially when blended with clays of the pottery type. Glazed tile and terra cotta shapes could also be made from such clay mixtures. Low-grade pottery ware and stoneware can also be made from some of these clays, using them just as they are in nature.

POTTERY CLAYS

CHEMICAL ANALYSES

SAMPLE R 5 1

Ignition loss	9.20
Silica, SiO_2	63.26
Alumina, Al_2O_3	22.99
Iron oxide, Fe_2O_3	3.35
Titania, TiO_2	1.10
Lime, CaO	0.49
Miscellaneous	Trace

SAMPLE R 5 d

Ignition loss	8.00
Silica, SiO_2	68.48
Alumina, Al_2O_3	18.72
Iron oxide, Fe_2O_3	3.70
Titania, TiO_2	0.55
Lime, CaO	Trace
Miscellaneous	0.55

SAMPLE R 11 1

Ignition loss	11.96
Silica, SiO_2	57.80
Alumina, Al_2O_3	22.83
Iron oxide, Fe_2O_3	4.90
Titania, TiO_2	0.80
Lime, CaO	Trace
Miscellaneous	1.71

SAMPLE R 11 2

Ignition loss	11.98
Silica, Sio_2	64.10
Alumina, Al_2O_3	18.27
Iron oxide, Fe_2O_3	2.75
Titania, TiO_2	0.40
Lime, CaO	Trace
Miscellaneous	2.50

SAMPLE R 12 2

Ignition loss	12.08
Silica, SiO_2	62.66
Alumina, Al_2O_3	19.83
Iron oxide, Fe_2O_3	3.63
Titania, TiO_2	0.65
Lime, CaO	Trace
Miscellaneous	1.15

SAMPLE R 12 4

Ignition loss	10.02
Silica, SiO_2	66.53
Alumina, Al_2O_3	16.60
Iron oxide, Fe_2O_3	3.95
Titania, TiO_2	0.65
Lime, CaO	Trace
Miscellaneous	2.25

SAMPLE R 91 1

Ignition loss	7.78
Silica, SiO_2	66.82
Alumina, Al_2O_3	17.38
Iron oxide, Fe_2O_3	5.57
Titania, TiO_2	0.75
Lime, CaO	0.30
Miscellaneous	1.40

SAMPLE R 91 2

Ignition loss	8.99
Silica, SiO_2	64.08
Alumina, Al_2O_3	21.48
Iron oxide, Fe_2O_3	3.60
Titania, TiO_2	0.50
Lime, CaO	0.40
Miscellaneous	0.95

Herbert S. Emigh, Analyst

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole	Sample	Color	Water of plasticity, percent	Degree of lamination	Drying shrinkage, volume percent	Drying shrinkage, linear, percent	Modulus of rupture, lbs./sq. in.	Working properties
R 5	1	DkG	32.31	Strong	36.29	10.87	146	Very plastic, very sticky
R 5	d	G	17.80	None	21.19	6.61	......	Very plastic, very sticky
R 11	1	BrG	31.09	Strong	27.71	8.49	166	Very plastic, sticky, feather edges
R 11	2	BlaG	29.70	Strong	31.88	9.66	60	Very plastic, sticky, feather edges
R 12	2	GT	27.01	Strong	31.80	9.64	153	Very plastic, very sticky
R 12	4	DkG	23.08	None	18.97	5.96	367	Very plastic, good
R 91	1	LtG	21.65	Slight	25.45	7.85	227	Very plastic, sticky
R 91	2	DkG	27.61	Strong	30.38	9.22	42	Very plastic, sticky, feather edges

PYRO-PHYSICAL PROPERTIES

TEST HOLES R 5, R 11

Hole Sample	Cone	Porosity, percent	Absorption, percent	Bulk sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage, percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color, other data		
R 5 1	05	27.73	14.44	1.93	2.69	9.61	2.41	13.56	473	MH-H	W-LtC	Ck
	02	26.94	14.11	1.95	2.66	11.43	3.69	14.84	424	MH-H	LtC	Ck
	1	25.23	12.66	1.99	2.66	13.60	5.01	16.16	428	MH-H	LtC	Ck
	3	19.04	9.31	2.05	2.53	14.52	5.02	16.17	713	MH-H	C-LtB	Ck
	5	17.01	8.36	2.06	2.48	15.11	4.22	15.37	674	H	C-LtB	Vck
	7	16.60	7.76	2.05	2.46	15.57	4.85	16.00	760	H	C-LtB	Ck
	9	8.60	4.14	2.07	2.27	15.73	4.95	16.10	1217	VH	MotC-B	Ck I
	11	6.49	2.07	2.08	2.23	16.11	4.91	16.06	2844	VH	MotC-B	Ck I
	5R	13.71	6.59	2.07	2.41	15.49	4.69	15.84	528	VH	MotB	Ck
R 5 d	05	20.50	9.96	2.10	2.58	8.51	None	None	None	H	DkC	
	02	16.33	7.63	2.14	2.56	11.15	4.00	10.30	1665	H	DkC	
	1	15.54	7.23	2.18	2.55	12.23	None	None	None	VH	DkC	
	3	6.15	2.80	2.20	2.48	13.38	None	None	None	VH	DkC	
	5	1.51	0.68	2.22	2.25	14.49	None	None	None	VH	B	
	7	1.59	0.38	2.21	2.25	13.84	4.70	11.00	1980	VH	DkB	
	9	6.61	3.28	2.08	2.17	7.32	3.70	10.00	3625	VH	DkB	I
	11	8.74	4.35	2.02	2.20	5.02	1.80	8.10	885	VH	DkB	I
	5R	2.38	0.91	2.23	2.27	14.35	None	None	None	VH	Ch	Ck
R 11 1	05	29.94	15.76	1.91	2.72	11.23	3.43	12.17	1333	MH-H	DkC	
	02	24.02	12.41	1.94	2.68	16.21	3.74	12.48	1282	MH-H	DkC-B	
	1	19.96	9.42	2.10	2.66	19.75	3.51	12.25	1328	MH-H	B	Ck
	3	12.45	5.64	2.21	2.49	23.25	8.36	17.10	1215	H-VH	B	
	5	8.14	3.72	2.21	2.41	25.09	7.41	16.15	2222	VH	RB	I
	7	4.93	2.01	2.28	2.39	26.12	7.64	16.38	2052	VH	B-GM	I
	9	2.76	1.42	2.03	2.08	16.78	4.06	12.80	2279	VH	GM	I
	11	3.62	1.72	2.01	2.04	16.66	6.64	15.40	2043	VH	GM	Ck I
	5R	2.70	1.44	2.27	2.43	28.52	8.94	17.68	2836	VH	DkG	
R 11 2	05	26.80	13.76	1.95	2.67	5.98	2.14	12.61	1205	H	W-C	Ck
	02	24.98	13.56	2.00	2.67	11.44	4.19	14.66	1021	H	C	Ck
	1	23.13	11.65	2.05	2.67	13.91	4.37	14.84	709	H	C	Ck
	3	22.39	13.02	2.11	2.67	14.99	4.82	15.29	565	H	C	Vck
	5	15.52	9.36	2.12	2.53	16.21	5.08	15.55	688	VH	MotB	Ck
	7	14.65	7.44	2.12	2.48	16.44	5.13	15.60	764	VH	MotB	Ck
	9	3.37	1.54	2.18	2.26	19.38	5.69	16.16	2393	VH	MotB	Ck
	11	4.48	2.05	2.16	2.29	19.86	5.43	15.90	2832	VH	MotB	
	5R	11.62	4.81	2.15	2.47	17.75	5.19	15.66	919	VH	DkG	Ck

*In unburned state and after firing

Test Holes R 12, R 91

Hole Sample	Cone	Porosity, percent	Absorption, percent	Bulk sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage, percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color other data			
R 12 2	05	24.51	11.67	1.98	2.64	8.97	2.37	12.65	754	H	PR,B		
	02	21.73	9.01	2.07	2.60	13.05	3.75	14.03	507	H	B		
	1	17.67	8.27	2.14	2.59	15.09	4.60	14.88	1390	H	B		
	3	8.92	4.14	2.15	2.37	15.35	5.08	15.36	1275	VH	VaB	Ck	
	5	6.13	2.95	2.18	2.32	15.87	4.73	15.01	1142	VH	VaB	Ck	
	7	6.02	2.74	2.20	2.31	16.96	4.73	15.01	1048	VH	VaB	w	
	9	5.04	2.11	2.22	2.27	17.32	4.45	14.73	2480	VH	Ch	Ck	
	11	4.66	1.18	2.23	2.26	16.81	3.43	13.71	1637	VH	GM		
	5R	6.93	3.12	2.22	2.37	18.49	4.90	15.18	441	VH	DkG	Ck	
R 12 4	05	25.52	13.50	1.89	2.54	7.38	1.50	9.50	960	MH	None		
	02	24.30	12.72	1.92	2.53	8.92	2.33	10.33	1377	MH	B**		I
	1	22.97	11.81	1.95	2.52	11.43	4.27	12.27	1585	MH	DkB**	Ck	
	3	22.77	11.72	1.98	2.48	12.92	4.67	12.67	2083	H	DkB**		
	5	18.84	9.38	2.04	2.48	12.93	None	None	None	H	None		
	7	15.59	7.62	1.92	2.43	14.06	3.96	11.96	2318	VH	DkBr		I
	9	18.33	10.36	1.86	2.32	10.29	1.20	9.20	1758	VH	DkBr		I
	11	18.14	9.81	2.07	2.26	6.93	–0.50	7.50	1698	VH	Br	Ck	I
	5R	14.20	6.83	2.01	2.42	14.47	4.77	12.77	2787	VH	DkB		I
R 91 1	05	22.67	11.18	2.03	2.63	7.14	1.70	10.18	1796	H	LtB		
	02	22.03	10.01	2.05	2.63	9.75	3.56	12.04	2110	H	LtB		
	1	20.92	9.66	2.07	2.62	9.98	3.84	12.32	2133	H	LtB		
	3	18.65	8.83	2.12	2.60	12.32	4.01	12.49	2255	H-VH	LtB		
	5	13.34	6.20	2.13	2.47	12.84	4.03	12.51	2268	VH	VaB		I
	7	12.79	5.89	2.15	2.46	17.01	3.99	12.47	2198	VH	VaB	Ck	
	9	11.64	5.68	2.05	2.24	8.68	3.17	11.65	2713	VH	VaB		I
	11	6.90	3.37	2.05	2.19	7.59	2.48	10.96	2553	VH	VaB		I
	5R	9.53	4.40	2.16	2.39	16.30	4.64	13.12	3452	VH	DkBr	Vck	
R 91 2	05	19.99	9.61	2.13	2.62	12.64	4.82	13.65	435	H	C**	Ck	
	02	18.51	9.11	2.14	2.57	19.39	5.92	14.75	527	H	DkC**		
	1	16.52	8.23	2.14	2.55	21.66	6.16	14.99	678	H	DkC	Ck	
	3	11.89	5.53	2.15	2.45	22.65	6.32	15.15	1061	VH	LtB		
	5	8.25	4.46	2.28	2.36	22.63	6.53	15.36	708	VH	VaB	Ck	I
	7	6.96	3.19	2.20	2.36	24.98	7.02	15.85	1118	VH	VaB		I
	9	5.05	2.36	2.18	2.29	26.78	6.74	15.57	1599	VH	DkB		I
	11	2.45	1.08	2.29	2.33	29.19	6.45	15.28	1563	VH	DkB	Ck	I
	5R	10.30	4.61	2.23	2.46	25.31	7.78	16.61	1017	VH	B		I

*In unburned state and after firing

**Scummed or stained with calcium salts

UTILIZATION POSSIBILITIES

The clays in this group exhibit considerable variations in their properties, but owing to their very high iron content, they burn to a buff or gray color at their maturing temperatures. This is their chief characteristic and classifies them as the pottery clays.

Some of the clays have the low strength and shrinkage in the green state that is typical of kaolins, but the analogy ends there, since their low porosity, high shrinkage and comparatively high fired strength at their maturing temperatures are more nearly the properties of bond or ball clays. Clays R 11 - 2 and R 91 - 2 are examples of this type. Clay R 12 - 4, on the other hand, has the open-burning characteristics even at high temperatures typical of kaolins, but its other properties, including its dark buff to brown color, are those of the bond clays. The clays of this group, therefore, exhibit some properties common to all, and are consequently suitable for many products without the addition of other clays and ceramic materials commonly used in white ware and pottery bodies. Some of them can be used by blending with other clays which lack the properties that they possess. Some could be used as an ingredient in ivory earthenware bodies.

The typical average properties of these pottery clays are: Water of plasticity, 26.3 percent; linear drying shrinkage, 8.5 percent; green modulus of rupture, 165 pounds per square inch, but very variable, varying from 42 pounds per square inch to 367 pounds per square inch; porosity at Cone 9, 7.65 percent; total linear shrinkage at Cone 9, 13.3 percent, and fired strength, 2260 pounds per square inch.

It is probable that some of the whiter burning clays in this group would be so greatly aided by beneficiation that they could be used in the whitewares industry for the manufacture of the products mentioned under the kaolinitic type of clays. Clays R 5 - 1, R 5 - d, and R 11 - 2 appear to be in this class. They are suitable as the sole constituent of bodies for art ware, pottery ware, kitchen ware, stoneware, some grades of sanitary ware, and faience.

All of the clays in this group appear to be suited, either alone or in a mixture with lighter-burning clays, for use in making stoneware, conduit and hollow tile, terra cotta, faience, enameled face brick, glazed tile, garden pottery, statuary, art ware and a wide variety of light-colored face brick. At the high temperatures, some of the clays would make a variety of mottled and speckled face brick. Plain or speckled cream, buff, or gray face brick in a wide variety can be made from many of these clays.

HEAVY CLAY PRODUCTS CLAYS

CHEMICAL ANALYSES

SAMPLE R 8 1

Ignition loss	6.80
Silica, SiO_2	73.18
Alumina, Al_2O_3	13.47
Iron oxide, Fe_2O_3	5.23
Titania, TiO_2	1.10
Lime, CaO	Trace
Miscellaneous	0.22

SAMPLE R 8 3

Ignition loss	9.34
Silica, SiO_2	65.52
Alumina, Al_2O_3	16.20
Iron oxide, Fe_2O_3	4.58
Titania, TiO_2	0.85
Lime, CaO	0.26
Miscellaneous	3.25

SAMPLE R 8 4

Ignition loss	8.14
Silica, SiO_2	70.16
Alumina, Al_2O_3	15.35
Iron oxide, Fe_2O_3	4.26
Titania, TiO_2	0.85
Lime, CaO	0.22
Miscellaneous	1.02

SAMPLE R 12 1

Ignition loss	8.66
Silica, SiO_2	72.60
Alumina, Al_2O_3	13.48
Iron oxide, Fe_2O_3	2.78
Titania, TiO_2	0.80
Lime, CaO	Trace
Miscellaneous	1.68

SAMPLE R 12 3

Ignition loss	7.44
Silica, SiO_2	72.41
Alumina, Al_2O_3	13.52
Iron oxide, Fe_2O_3	5.30
Titania, TiO_2	0.70
Lime, CaO	Trace
Miscellaneous	0.63

SAMPLE R 23 2

Ignition loss	6.76
Silica, SiO_2	66.63
Alumina, Al_2O_3	17.41
Iron oxide, Fe_2O_3	4.03
Titania, TiO_2	1.00
Lime, CaO	1.10
Miscellaneous	3.07

SAMPLE R 25 1

Ignition loss	7.22
Silica, SiO_2	71.36
Alumina, Al_2O_3	17.18
Iron oxide, Fe_2O_3	4.04
Titania, TiO_2	0.55
Lime, CaO	Trace
Miscellaneous	Trace

SAMPLE R 52 1

Ignition loss	7.50
Silica, SiO_2	70.88
Alumina, Al_2O_3	13.81
Iron oxide, Fe_2O_3	5.35
Titania, TiO_2	0.80
Lime, CaO	0.22
Miscellaneous	2.44

Herbert S. Emigh, Analyst

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole	Sample	Color	Water of plasticity, percent	Degree of lamination	Drying shrinkage, volume, percent	Drying, shrinkage, linear percent	Modulus of rupture, lbs./sq. in.	Working properties
R 8	1	LtBr	22.47	None	19.94	6.24	349	Plastic, satisfactory
R 8	3	BrBla	22.57	Some	20.91	6.55	155	Plastic, satisfactory
R 8	4	DkG	21.87	None	18.41	5.78	260	Very plastic, satisfactory
R 12	1	GT	29.98	None	33.14	10.08	554	Very plastic, satisfactory
R 12	3	MG	26.08	None	13.65	4.34	338	Very plastic, satisfactory
R 23	2	DkG	17.33	Slight	14.78	4.69	356	Very plastic, satisfactory
R 25	1	DkG	24.72	Slight	26.15	8.05	464	Very plastic, satisfactory
R 52	1	DkG	26.72	Slight	35.15	10.56	450	Very plastic, satisfactory

PYRO-PHYSICAL PROPERTIES

TEST HOLES R 8 AND R 12

Hole Sample	Cone	Porosity, percent	Absorption, percent	Bulk, sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color, other data			
	05	27.71	14.17	1.93	2.70	2.34	0.25	7.18	1492	MH	PR		
	02	27.17	14.10	1.93	2.69	3.19	1.35	8.28	2036	MH	PR		
	1	26.83	13.56	1.95	2.65	3.88	1.28	8.21	1973	MH	PR**		
	3	26.48	13.59	1.95	2.64	4.56	1.17	8.10	2152	MH	PR		
R 8-1	5	23.40	11.72	1.96	2.53	5.09	1.18	8.11	2719	H	PR	I	
	7	22.57	11.59	1.95	2.52	6.35	1.37	8.30	2494	H	PR	I	
	9	19.83	10.10	1.96	2.45	7.08	1.20	8.13	3027	H-VH	PR	I	
	11	14.38	7.22	2.03	2.33	5.57	0.82	7.75	3218	H-VH	PR	I	
	5R	22.11	11.26	1.96	2.47	5.57	1.50	8.43	2901	H	RBr	I	
	05	22.33	11.24	1.99	2.56	7.94	1.52	9.12	2035	H	RBr**		
	02	19.36	10.10	1.98	2.54	10.71	3.60	11.20	1895	H	RBr	I	
	1	18.71	9.27	1.99	2.39	10.95	3.50	11.10	1865	H	PR**		
	3	14.93	7.42	2.01	2.37	12.18	3.42	11.02	1710	H	PR**		Ck
R 8-3	5	11.86	5.98	2.01	2.27	11.98	3.32	10.92	2480	VH	RBr**	I	
	7	12.46	6.11	2.01	2.27	11.76	4.24	11.84	2784	VH	RBr	I	
	9	15.81	8.63	1.83	2.17	3.90	0.68	8.28	2210	VH	Ch	I	
	11	20.35	11.30	1.83	2.30	2.80	0.20	7.80	1990	VH	Ch	I	
	5R	14.01	6.86	2.01	2.36	10.53	4.16	11.76	2090	VH	DkBr	I	w-Vck
	05	23.61	11.91	2.00	2.60	8.03	2.00	9.27	None	H	LtBr**		
	02	21.68	10.98	1.98	2.55	8.06	2.70	9.97	1412	H	LtBr	I	
	1	18.65	9.41	2.01	2.48	9.23	2.76	10.03	810	H	PR**		Ck
	3	20.12	9.96	2.02	2.48	9.44	3.30	10.57	2385	VH	PR	I	Ck
R 8-4	5	15.06	6.64	2.02	2.36	10.20	None	None	None	VH	None		
	7	14.27	6.70	2.03	2.35	10.84	3.30	10.57	1255	VH	PR**	I	Ck
	9	14.01	6.55	1.96	2.26	4.27	2.13	9.40	3267	VH	BrR	I	
	11	15.14	7.76	1.96	2.29	3.32	1.73	9.00	2575	VH	Ch	I	
	5R	13.10	6.35	2.05	2.37	11.37	3.60	10.87	2420	VH	MotBr	I	
	05	28.83	15.72	1.83	2.58	0.67	1.00	8.37	903	VS	PR-B		
	02	27.98	16.31	1.86	2.59	1.21	0.42	9.79	922	VS-S	B		
	1	27.08	14.40	1.89	2.58	1.60	0.64	10.01	963	S	B-SR		
	3	27.23	14.48	1.88	2.58	1.60	0.55	9.92	1080	S	B-PR		
R 12-1	5	26.28	13.87	1.88	2.57	1.89	0.32	9.69	1208	S	PR-B		
	7	26.08	13.71	1.89	2.56	2.18	0.15	9.52	1112	S	PR-T		
	9	24.93	13.02	1.91	2.55	3.63	0.97	10.34	1223	S	PR-T	I	
	11	23.66	12.29	1.92	2.52	3.89	0.62	9.99	1359	MH	T	I	
	5R	25.24	13.16	1.91	2.56	2.54	0.65	10.02	1214	MH	B		

*In unburned state and after firing

**Scummed or stained with calcium salts

TEST HOLES R 12, R 23, R 25, AND R 52

Hole Sample	Cone	Porosity, percent	Absorption, percent	Bulk, sp. gr.	Apparent sp. gr.	Volume shrinkage, percent	Linear shrinkage percent	Total linear shrinkage, percent*	Modulus of rupture, lbs./sq. in.	Hardness, color, other data			
R 12, 3	05	36.63	22.02	1.68	2.69	1.81	0.25	6.12	627	VS	BrR		Ck
	02	36.42	21.35	1.69	2.67	5.45	1.58	7.45	658	VS	BrR		
	1	36.08	21.09	1.71	2.68	6.38	1.59	7.46	670	S	BrR**		
	3	35.33	19.76	1.75	2.66	7.78	2.26	8.13	1230	S	BrR**		
	5	31.00	17.47	1.79	2.62	7.92	2.80	8.67	1510	S	PR		
	7	28.40	15.30	1.86	2.60	11.91	3.26	9.13	1547	MH	MotBr	I	
	9	None	None	None	None	None	3.70	9.57	1167	MH	GM	I	
	11	13.92	7.89	1.77	2.06	6.36	4.63	10.50	1400	MH	GM		
	5R	28.60	9.18	1.96	2.49	10.27	3.11	8.98	1820	MH	MotBr	I	w
R 23, 2	05	23.50	11.86	2.00	2.58	5.43	0.72	6.61	1494	MH	B**		
	02	22.61	11.52	1.95	2.54	6.92	2.33	8.22	1698	MH	SR**		
	1	22.05	11.17	1.97	2.52	8.74	2.77	8.66	1887	H	SR**		
	3	22.12	10.81	2.03	2.63	10.20	3.13	9.02	2444	VH-H	SR**	I	
	5	14.17	6.18	2.09	2.38	11.16	3.17	9.06	2609	VH	PR**	I	
	7	13.44	6.09	2.08	2.43	12.10	3.70	9.59	2911	VH	PR	I	
	9	13.40	6.84	2.01	2.30	3.55	2.76	8.65	2318	VH	RBr	I	
	11	16.84	8.56	1.91	2.23	2.11	0.58	6.47	2124	VH	RBr	I	
	5R	14.40	6.74	2.14	2.48	17.56	4.05	9.94	2628	VH	DkB	I	
R 25, 1	05	24.13	12.57	1.92	2.53	4.46	1.28	9.74	1758	MH	PBrR		
	02	22.02	11.42	1.96	2.50	5.93	2.58	11.04	2017	MH	SR-B	I	
	1	22.04	11.31	1.97	2.51	7.05	2.66	11.12	2036	MH	SR-B	I	
	3	19.19	9.59	2.00	2.48	8.21	2.99	11.45	2188	H	SR-B	I	
	5	17.82	8.89	2.01	2.44	9.22	3.37	11.83	2566	VH	PR-Br**	I	
	7	16.07	8.00	2.03	2.40	10.20	3.84	12.30	2900	VH	SR-B**	I	
	9	14.76	7.41	2.03	2.33	10.02	2.29	10.75	2571	VH	RBr	I	
	11	13.83	6.88	2.02	2.30	9.14	2.04	10.50	2523	VH	Br	I	
	5R	17.56	8.54	2.06	2.49	11.13	4.00	12.46	3022	VH	DkBr	I	
R 52, 1	05	25.68	14.25	1.80	2.43	1.48	0.67	9.66	1270	MH	PR		
	02	19.11	10.81	1.77	2.18	1.86	1.51	10.50	1841	MH	BrR	Bl	
	1	20.86	11.36	1.85	2.32	3.07	2.13	11.12	1533	MH	ChR	Bl	
	3	26.91	15.79	1.71	2.32	–5.42	0.04	9.03	1760	MH	BrR	Bl	
	5	27.12	24.18	1.51	2.38	–16.60	–2.15	6.84	1068	H	BrR**	Bl	
	7	36.47	12.42	1.78	2.21	0.75	1.49	10.48	1596	VH	Ch	Bl	w
	9	22.21	31.80	1.41	2.54	–26.48	–7.08	1.91	771	S	Ch	I Bl	
	11	44.68	19.26	1.60	2.27	–10.91	–2.37	6.62	1030	S	Ch	I Bl	w
	5R	30.42	16.00	1.70	2.33	2.51	0.73	9.72	1459	VH	Ch	I Bl	

*In unburned state and after firing

**Scummed or stained with scluble salts

UTILIZATION POSSIBILITIES

The clays of this group are characterized by their rather low strength in both the green and burned state, when their use in the heavy clay products industry is considered. Their strengths are below those usually desired for most products of this kind, although in most cases, the deficiency is not serious. They are also outstanding in their high porosity and absorption at high temperatures, a rather unusual property for clays of this nature. In addition, the deep red color usually associated with common brick, drain tile, and like products, is not attained in this group. They therefore appear to be admixtures to some extent with the two preceding groups of clay.

As is to be expected, the chemical analyses reveal that the silica and iron contents in this group are appreciably higher than in the preceding groups, whereas the alumina content is lower. The balance of the constituents do not vary appreciably from the other two groups of clay.

The typical average properties of this group are: Water of plasticity, 24.0 percent; dry linear shrinkage, 7.0 percent; green modulus of rupture, 366 pounds per square inch; porosity at Cone 9, 17.9 percent; absorption at Cone 9, 9.0 percent; total linear shrinkage at Cone 9, 8.4 percent, and fired modulus of rupture at Cone 9, 2255 pounds per square inch.

Clay R 52 was consistently bloated in all of the burns, and the fractured structure showed the typical dark grayish black, porous structure found in clays of this nature when the carbon is not fully burned out of the clay during the early stages of the firing. The standard firing schedule adopted for all these burns proved to be too rapid for this particular clay, resulting in the swelling of the test pieces to a greater or less degree. As a consequence, the pyrophysical properties of Clay R 52 are very variable and erratic from one cone to the next. They do not represent the true values that would have been obtained had all the carbon been burned out prior to the maturing stage of the clay. This clay was the sole member of the group acting in this manner. It gives every evidence of being capable of making a good quality haydite or light-weight burned clay aggregate for concrete use.

This group of clays offer a wide range of material suitable for numerous varieties of face brick, common brick, structural tile, fireproofing, flue lining, drain tile, sewer pipe, hollow block and hollow facing tile. All the clays have a long maturing range, possess very satisfactory plasticity, do not laminate to any extent in running through a die, and in general have suitable to excellent fired properties. At high temperatures, some of these clays are capable of making a wide variety of speckled and mottled brick of various shades and hues. Since it is likely that most of these clays are closely associated with other types, as is the case with clays from some of the holes in this study, their properties may be readily altered to meet any special requirements by the addition of such other clays.

LABORATORY PROCEDURE

PREPARATION

The various clay samples that had been collected in the field were stored in a steam-heated laboratory several months prior to testing, so that preliminary drying of the clays was unnecessary. 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. The 10-pound sample was reserved for screen analysis, chemical analysis, and for making pyrometric cones. Approximately 75 pounds of clay from the remainder were 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 homogeneous 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. A few of the longer bars were made by pressing the plastic clay to the final size by hand in a hardwood mold of the plunger type. Most of them were made on a hand operated machine by feeding the plastic mass through a die situated directly in front of the two disked wheels that did the feeding. 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 or else the upper and lower depths of cut, 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. Where there was sufficient clay on hand 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 long 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 determined using a double beam balance. All the test pieces were allowed to air-dry for a time on slatted wooden pallets and then oven-dried by gradually increasing the temperature of the oven from room temperature to 100° C. and maintaining the oven temperature between 100° C. and 110° C. for several hours. After drying, and cooling to room temperature, the short bars were reweighed, and their dry volume was determined as above described. Five or six long bars were broken on a Fairbanks cross-breaking machine to determine modulus of rupture. This machine was of the tensile strength determination type in which the section holding the tensile strength briquettes was replaced by a suitable cross-breaking device with knife edges, and also provided with an automatic shut-off for the shot.

The raw color and the workability of the clay were observed during the grinding, wedging, and forming of the various test pieces. The following properties of the dried unburned test pieces were then determined and calculated by the standard methods outlined in Volume 11, 1928 Journal of the American Ceramic Society.

The water of plasticity was calculated as a percentage of the weight of the dry test piece, by the following formula:

$$T = \frac{Wp - Wd}{Wd} \times 100,$$

in which T = percent water of plasticity, Wp = weight of the plastic test piece, and Wd = weight of the dry test piece. The average of three test pieces is taken as the percent water of plasticity.

The dry volume shrinkage was calculated by the following formula:

$$b = \frac{Vp - Vd}{Vd} \times 100,$$

in which b = percent volume shrinkage, Vp = plastic volume, and Vd = dry volume. The plastic volume and the dry volume were determined in a mercury volumeter, as already mentioned.

The linear shrinkage was calculated from the volume shrinkage and is based on the dry volume, according to the formula:

$$a = 100 \left[\sqrt[3]{1 + \frac{b}{100}} - 1 \right],$$

in which a = percent linear shrinkage, and b = as above.

The modulus of rupture was calculated by the formula:

$$M = \frac{3\ Pl}{2\ bd^2},$$

where M = modulus of rupture in pounds per square inch, P = breaking of load in pounds (to nearest 0.01 pound), 1 = distance between knife edges in inches, b = breadth of bar in inches, and d = depth of bar in inches. The average modulus of rupture is reported, in which a variation of plus or minus 15 percent from the average is allowed; wider variations were discarded.

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. Except for one Cone 5 burn that was reducing, 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 generally 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. Pyrometric cones were used above 2,100° F., and they were also used to determine the finishing point of each burn. From three to six long bars were burned and tested for each clay at each cone temperature indicated in the table of pyrophysical properties. Three short bars were fired as test pieces for each clay at each cone temperature.

On completing the firing of the long and short test pieces the kiln was cooled gradually to the point where the test pieces could be withdrawn from the kiln. The short bars were then weighed on a double beam balance to determine the dry weight. The volumes of the fired test pieces were determined in a mercury volumeter, in the same manner as for the unburned test pieces. After weighing, the bars were placed in water which was then heated to the boiling point and was kept boiling for five hours. They were allowed to cool in the water to room temperature and were reweighed as before mentioned, which gave the saturated weights. The long bars were broken on the Fairbanks testing machine already mentioned to determine modulus of rupture. The following properties were then calculated by the standard methods and formulae outlined in Volume 11, 1928, of the Journal of the American Ceramic Society.

The apparent porosity was calculated by means of the following formula:

$$P = \frac{Sf - Wf}{Vf} \times 100,$$

in which P = the percent apparent porosity, Sf = weight of saturated fired test piece in grams, Wf = weight of the fired test piece in grams, Vf = volume of the fired test piece in cubic centimeters.

The volume change or volume shrinkage was determined by the relation,

$$b_1 = \frac{Vd - Vf}{Vd} \times 100,$$

in which b_1 = percent volume change, Vd = volume of the dry test piece in cubic centimeters.

The apparent specific gravity was determined by the formula:

$$G = \frac{Wf}{Vf - (Sf - Wf)},$$

in which G = the apparent specific gravity.

The bulk specific gravity was calculated by the formula:

$$Gb = \frac{Wf}{Vf},$$

in which Gb = the bulk specific gravity.

The absorption was obtained by the formula:

$$A = \frac{Sf - Wf}{Wf} \times 100,$$

in which A is the absorption and represents the percentage weight of water absorbed by the dry piece.

Changes in the hardness were determined by cutting the test pieces with a knife blade and noting their relative hardness compared with steel. The color of the test pieces was noted at the same time.

The modulus of rupture was obtained by the same formula and methods outlined for the raw, unburned bars.

CONVERSION TABLE

Cones to Temperatures

Cone	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	2,039
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	When heated at 100° C. per hour			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	3,400
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.

CHEMICAL ANALYSES

Grinding: The samples which were completely analyzed were ground to pass a 100-mesh sieve. Some of the samples were washed through a 250-mesh sieve; the portion that passed through was dried, ground, and analyzed.

Moisture: Moisture determinations were run on all samples received: i.e., in an air dried condition. An oven temperature of 110° C. was maintained on each sample for one hour.

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

Silica: Ignited samples were fused with 8 to 10 times their weight of anhydrous sodium carbonate, and the fusion dissolved in dilute hydrochloric acid. Double dehydrations of the silica with hydrochloric acid were carried out in all cases. The resulting silica was filtered off, ignited, weighed, volatilized by hydrofluoric acid, and the crucible reweighed. SiO_2 was found by difference.

Alumina: Alumina, iron, and titania were precipitated together by ammonium hydroxide in the presence of ammonium chloride. Macerated filter paper was added to give a fine-grain precipitate. Double precipitations were found necessary to remove all manganese, calcium, and magnesium. The mixed hydroxides were filtered off, washed free of chlorides, ignited, and weighed. The weight represents the total of alumina, iron oxide, and titania. The mixed oxides were fused with sodium bisulfate to which a little sodium sulfate had been added to reduce sputtering. The fusion was dissolved in dilute sulfuric acid. In a few cases small amounts of silica were recovered here by filtration, ignition, and volatilization with hydrofluoric acid; accordingly, this was added to silica and deducted from alumina.

Iron oxide: An aliquot of the solution of the bisulfate fusion was reduced with test lead, and titrated with potassium dichromate with diphenylamine indicator. The dichromate was standardized so that the percentage of ferric oxide in the original sample was equal to the number of cc. of solution used.

Titania: Another aliquot of the bisulfate fusion solution was placed in a colorimeter tube, and hydrogen peroxide added. The colorimeter was of the Schreiner type: i.e., a tube within a tube. The standard titania solution was diluted so that the height of the standard column divided by the height of the unknown column gave the percentage of TiO_2 in the original sample. The total of titania and iron oxide was subtracted from the weight of the combined precipitate of alumina, iron oxide, and titania, leaving alumina.

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

Miscellaneous: All substances present in the samples other than those mentioned above.

Recent and Quaternary (Pleistocene) flood plain material

Tertiary (Pliocene?) and Quaternary (Pleistocene) material, chiefly terrace deposits.

Great unconformity

Cretaceous system, Selma formation: Ks, undifferentiated Selma; Ksc, Coffee member, chiefly light-gray cross-bedded glauconitic sand, a few ledges of calcareous sandstone, and some sandy clay; Ksm, Mooreville member or tongue, clayey and sandy chalk or chalky clay.

Unconformity

Cretaceous system, Eutaw formation: Ket, Tombigbee member, massive fine gray to greenish-gray glauconitic sand; Ke Lower Eutaw member, more or less cross-bedded and thinly laminated glauconitic sand and clay.

Unconformity

Cretaceous system, Tuscaloosa formation, Kt: light and varicolored irregularly bedded sand, clay, and gravel; gravel mostly in the lower portion.

⊗ Prominent outcrops, locations of stratigraphic sections described in the text
X Other prominent outcrops
(B) Bentonite areas
R4 ⊙ Ceramic clay test holes
⚒ Gravel and sand pits
□ Potteries, past and present
ϕ Oil test wells, dry

GEOLOGIC MAP
OF
ITAWAMBA COUNTY
MISSISSIPPI
by Franklin Earl Vestal

SCALE OF MILES
1 ½ 0 1 2 3