MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph. D.
Director

BULLETIN 39

YAZOO COUNTY MINERAL RESOURCES

GEOLOGY
By
FREDERIC FRANCIS MELLEN, M. S.

TESTS
By
THOMAS EDWIN McCUTCHEON, B.S., CER. ENGR.

UNIVERSITY, MISSISSIPPI
1940

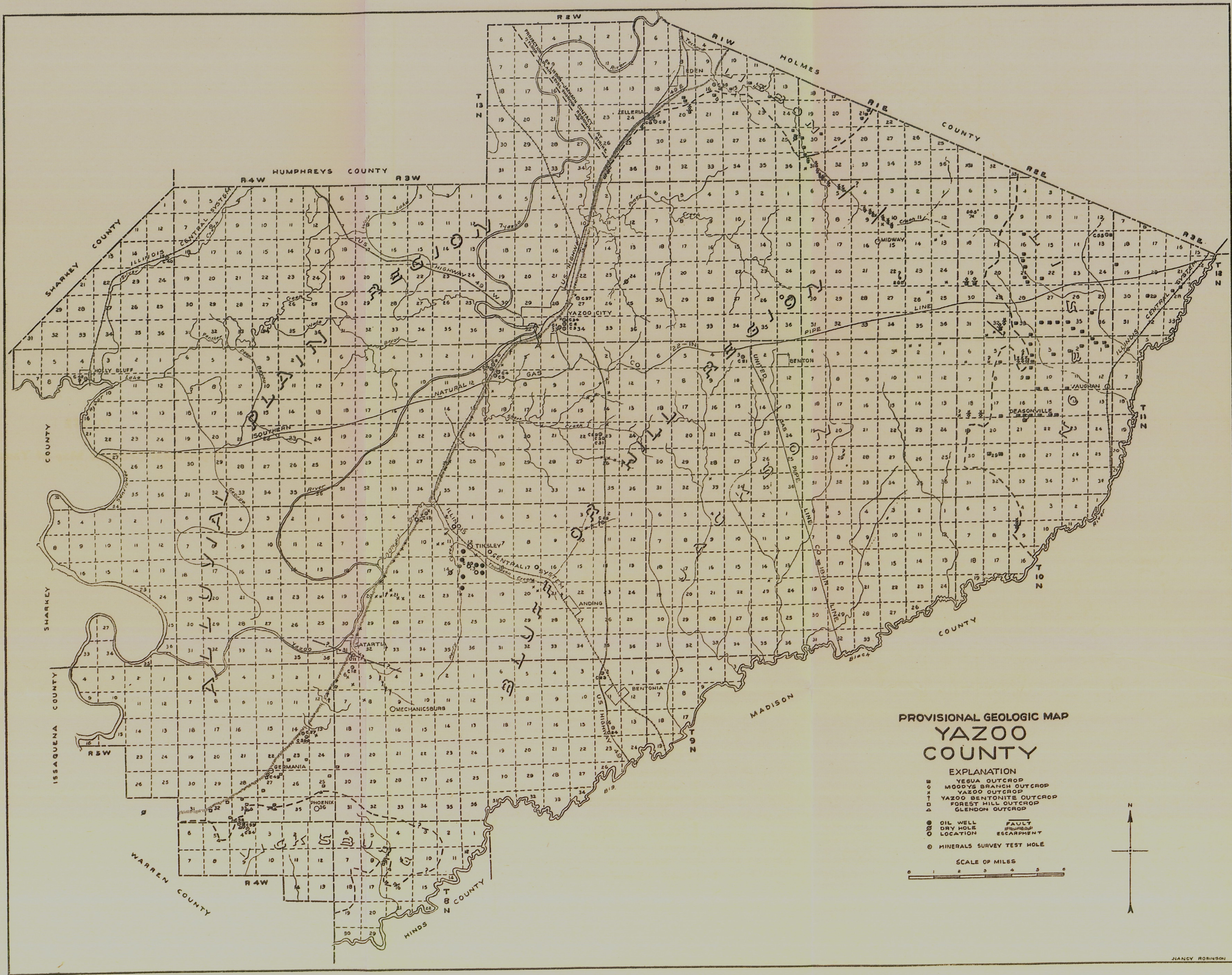

PLATE 1

Provisional Geologic Map of Yazoo County

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MISSISSIPPI GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

Office of the State Geological Survey
University, Mississippi
December 7, 1939

To His Excellency,
Governor Hugh White, Chairman, and
Members of the Geological Commission

Gentlemen:

Herewith is the manuscript of Bulletin 39, Yazoo County Mineral Resources: Geology by Frederic Francis Mellen, M. S., Assistant State Geologist; Tests by Thomas Edwin McCutcheon, B. S., Cer., Ceramic Engineer.

As heretofore, the tests have been made in the laboratories of the Mississippi Geological Survey at the University of Mississippi, the rooms for which have been most generously provided by the Department of Chemistry, to which in particular and the University in general the Survey expresses its gratitude.

The survey of the county and the tests of the minerals are possible only because of a Works Progress Administration project and grant, involving a survey of ten counties and a Federal fund of $106,193.00. To obtain this fund, the State Geological Survey, as sponsor, pledged $12,768.00, of which amount the State Legislature appropriated less than $4,000.00. Consequently, it has been necessary for the counties to act as cosponsors and to provide the balance of $9,000.00. With scarcely an exception the counties have so magnificently responded that the State Geological Survey's pledge has been fully paid.

Yazoo County, City, and Chamber of Commerce under the efficient direction of Secretary K. S. Foster, have loyally and financially supported the State Geological Survey. The Federal and State WPA officials have, at all times, shown the utmost interest in the survey. To them the Director has already acknowledged his obligation in his Seventeenth Biennial Report. To the State Industrial Commission, the State Advertising Commission, and the State Planning Commission, he is also under obligation.

During the routine work in October 1938, Assistant State Geologist Mellen noted that a thin bed of bentonite in the Yazoo clay member of the Jackson formation is approximately level throughout a distance of some ten miles. Then in February 1939, while checking the stratigraphy of Yazoo County, he discovered on Perry Creek near Tinsley a small exposure of the Moodys Branch marl at an elevation of 250 feet above its normal position—in short a dome favorable for oil and gas accumulation.

Emphasis must be placed on the fact that the discovery was made during a routine survey of all the minerals of the county—and, in this connection, the Director wishes to reiterate his conviction that the other non-metallic minerals of Mississippi in the long run will prove to be more valuable than oil and gas—for the State Legislature has not provided the State Geological Survey with sufficient funds to make exclusive oil and gas surveys. Rather the discovery was made because of Mr. Mellen's training in Physical, Historical, and Paleontological Geology, which the Director, as Professor of Geology, insisted that he, as well as all his other students, must have as fundamental courses.

The discovery of the Tinsley Dome, the direct result of pure science (Physical, Historical, and Paleontological Geology), has naturally led to an extensive economic development. In addition to the Union Producing Company G. C. Woodruff No. 1 well, the first commercial oil well in Mississippi, to date eight other wells have been drilled in the Tinsley Oil Field, seven of which are productive. Not only so, but practically the whole state is experiencing oil activity. Leases are being taken most every where; surface surveys and subsurface geo-physical surveys are being made by some 50 geologists and geo-physicists that have come to the state; test wells are being drilled; Yazoo City, Jackson, and Vicksburg are experiencing a decided increase in business—in short hundreds of thousands of dollars are coming to the state and are being spent in the search for oil and gas alone.

Respectfully submitted,

William Clifford Morse,
Director and State Geologist

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GEOLOGY

FREDERIC FRANCIS MELLEN, M. S.

INTRODUCTION

Yazoo County is in the west-central part of Mississippi, within the Mississippi-Yazoo Alluvial Plain region, the Thick Loess or Bluff Hill region, and the Thin Loess or Brown Loam region. It is the largest county in the state, having an area of 905 square miles. Its population (1930 census) was 37,262, of which 11,042 (29.63 percent) were white; the remainder, negro. Yazoo City, the county seat, having a population of 5,579, is built on the face of the bluff.

The 22-inch pipe line of the Southern Natural Gas Company, crossing the State from the Mississippi River, passes through Yazoo County almost east and west (Plate I). An 18-inch connecting line of the United Gas Pipe Line Company, branching from the main line near Benton, extends south out of Yazoo County a few miles east of Bentonia.

A 22 Kv. line of the Mississippi Power & Light Company extends northwest from Yazoo City across the alluvial valley. A 13 Kv. line extends north from Yazoo City to Eden, and another 13 Kv. line extends east from Yazoo City to Benton. These lines are supplied by the municipally owned gas-fired generating plant of Yazoo City. The settlements of Vaughan, Deasonville, and Bentonia are served by other lines of the Mississippi Power & Light Company conducting current which originates outside the county. The Rural Electrification Administration has recently been extending electric service over the county.

The county is crossed from north to south by several branches of the Illinois Central Railroad System (Plate I).

The Yazoo River, according to the District Engineer, U. S. Engineer Office, Vicksburg, Mississippi, is officially navigable throughout its entire length to Greenwood, Mississippi. The project depth is 4 feet; however, during low water season, the depth on some shoals is considerably less. The four-foot depth is not maintained since there is no commerce at present which demands it. Dredging equipment is available, and should commerce develop which would demand it, the four-foot depth could be maintained. The oscillation of the river is 40 feet at its head, 60 feet at its mouth.

Cotton farming is the chief occupation of the county, although corn, hog, and cattle farming is practiced along the bluff and in the hills. There are several lumber mills at Yazoo City, and one lumber mill at Bentonia; numerous portable lumber mills are now in operation over the county. A considerable quantity of timber is shipped by rail.

There has probably been as little mining activity in Yazoo County as in any county in the State. Gravel is used locally on the county roads, and was used in construction of the new concrete Highway 49. Most of the gravel used is dug or pumped from the bars in the larger streams of the Bluff region; but in one locality the loess was stripped off, and the Citronelle gravel was taken from below. The brick industry has operated intermittently, but at the present time there is no brick plant in the county.

STRATIGRAPHIC AND AREAL GEOLOGY

GENERAL

The range of geologic formations in Yazoo County is mid-Eocene to Recent. The bedrock, which underlies the hill or bluff region, consists, in ascending order, of the Lisbon formation (Yegua member), the Jackson formation, and the Vicksburg formation. Lying nonconformably over the two Eocene formations and the one Oligocene formation is a thick blanket of gravel referable to the Citronelle formation of Pliocene age (1, 2, 3). Wherever it is present, this formation, in turn, is overlain disconformably by the thick loessal silt, referred to in the past as the Bluff formation. In the western part of Yazoo County great erosive forces of the relatively recent past removed the bedrock formations and the Citronelle formation, scouring to depths reportedly as much as 100 feet below present sea level (4). This Mississippi-Yazoo alluvial plain has little to offer surface geology. The geologic summary below and the profile section of the bluff (Figure 4) show the geologic relationships of the several formations.

Areally, approximately 37 percent of Yazoo County lies within the alluvial plain of the Yazoo and Mississippi rivers. The remainder of the area of the county, approximately 63 percent, lies within the hill or bluff region.

As determined between two points (one a projection) on the conformable contact of the Moodys Branch and Yazoo members of the Jackson formation, the strike of the Eocene beds across northeastern Yazoo County is N. 34° W. The dip, however, seems to be variable from point to point over the county because of structual conditions, but as best determined the normal dip for most of Yazoo County is approximately 16.5 feet per mile S.56° W.

The general trend of the bluff through Yazoo County is N.33° E. Inasmuch as this is diagonal to the projected dip and strike of the bedrock formations of Yazoo County, a much greater outcrop face along the bluff is exposed than would be if the strike of the bluff were normal to the strike of the beds. For example, the Yazoo clay has a width of outcrop along the bluff in Yazoo County of 30 to 31 miles, the greatest width of outcrop of the belt of the Yazoo in the entire state, even including the Jackson-Canton area which has been flattened out by the Jackson Dome.

On the face of the bluff and on all the major and minor tributary streams flowing into the Yazoo River, to a greater extent in the outcrop of the Yazoo clay and to a lesser extent in the outcrop of the Yegua, Moodys Branch, and Vicksburg, the sides of the steep hills have for some centuries past been breaking and slumping over the plastic underlying materials. This slumping, the major phenomenon of the present day in the region, has been cited by Lowe (5) and carefully studied by Morse (6). As a result of this condition the loess and gravel beds have, in many places, been lowered obliquely through vertical intervals as great as 200 feet. This movement results also in strongly dipping beds, which, when observed, until proved otherwise, are to be regarded as land-slips.

SUMMARY OF EXPOSED ROCK FORMATIONS IN YAZOO COUNTY

System	Formation	Member	Character	Thickness (Feet)
Holocene			Alluvial deposits of gravel, sand, silt, clay, all more or less carbonaceous; dark brownish-gray; mostly cross-bedded and heterogeneous.	10 to 150
	Disconformity			
Pleistocene	"Loess"		Eolian or loessal silt: bluish-gray where un-oxidized, but everywhere in outcrop it is brownish-gray; abundant pulmonate gastropod shells throughout unleached portions; leached portions non-calcareous; homogeneous.	50 to 75
	Disconformity			
Pliocene	Citronelle		Diluvial terrace deposits of boulders, gravel, sand; local deposits of silt and silty clay; cross-bedded and heterogeneous.	25 to 50
	Nonconformity			
Oligocene	Vicksburg	Byram	Not positively identified in Yazoo County; in Warren County a succession of thin strata of glauconitic silty shell marl and calcareous silty montmorillonitic clays.	
		Glendon	Alternating strata of silty limestone and glauconitic, arenaceous, argillaceous marl; one or more beds of bentonite containing calcareous fossils; water falls common over basal limestones.	30 to 40
		(Mint Spring facies)	Glauconitic, argillaceous sand-marl; soft calcareous fossils abundant; few small scattered lignitic fragments; thin seams of montmorillonitic clay in lower part; homogeneous.	15 to 25
	Disconformity			
Eocene	Jackson	Forest Hill	Argillaceous, lignitic silt most abundant; thin argillaceous allocthonous lignite; lignitic leaf-bearing montmorillonitic clays; fine-grained cross-bedded sand; heterogeneous.	60 to 80
		Yazoo	Lower 350 feet, homogeneous silty fossiliferous montmorillonitic clay-marl; upper 150 feet contain several strata of very fine-grained montmorillonitic clay separated by siltier clays; thin bentonite 40 to 50 feet below top.	500
		Moody's Branch	Arenaceous, argillaceous, glauconitic marl; fossils abundant; water-bearing; locally indurated on exposure by oxidation of iron minerals and re-formation of lime; homogeneous.	30 to 45
	Disconformity			
	Lisbon	Yegua	About 100 feet of silty lignitic clays, argillaceous lignitic silts, and fine-grained argillaceous sands of non-marine or estuarine origin are exposed in northeastern Yazoo County; the base is not exposed.	100

LISBON FORMATION

GENERAL

According to the latest usage of the Mississippi Geological Survey (7) the Lisbon formation contains two divisions, the Kosciusko below and the Chickasawhay above. The name Chickasawhay, however, was pre-empted in 1934 by Blanpied, who used it for a marl of Vicksburg age (8). In Bulletin 30, Grim placed the Winona glauconitic sand-marl in the Tallahatta formation as the upper member. Other reports consider the Winona the basal member of the Lisbon formation (9, 10, 11). Recently, V. M. Foster and the writer, working separately, have agreed in their findings that the Winona is separated from the Tallahatta by a widespread unconformity and that the Winona properly constitutes the basal member of the Lisbon formation. It is generally agreed in the literature that the Yegua formation lies conformably on the Lisbon, a conclusion to which the writer, in his limited field work in that area, finds no evidence to the contrary. For the sake of consistency, therefore, in stratigraphic delimitation of formations, it is here proposed that the Yegua be regarded tentatively as the upper member of the Lisbon formation. The sequence of the Lisbon is, under this tentative revision: *

Lisbon formation

- Yegua member, lignitic clays, silts and fine sands
- Kosciusko member, quartzitic sandstone and sands
- Winona member, glauconitic and non-glauconitic sands

YEGUA MEMBER

The Yegua member of the Lisbon formation consists in Yazoo County of 100 feet or less of exposed non-marine or estuarine silts, silty clays, fine-grained sands, allocthonous lignite, and siderite concretions, the sedimentary materials being named in order of diminishing abundance. Lignitic wood is common, and well-preserved fossil leaves are not uncommon in the silty clays, as, for instance, at

* The tentative correlation of the Lisbon formation as given above has been found, by subsequent field work, to be inapplicable as the Winona sand is now determined by the writer to be the basal sand of another formation below the formation in which the Yegua is a member; and considerable confusion seems to be attached to the name "Kosciusko sand" especially as a wide-spread disconformity has been found through the section referred to as "Kosciusko." Therefore, it is with regrets that the stratigraphy of the Claiborne beds is left herein in such confusion. It is desirable to conduct stratigraphic studies of the Claiborne formations just as soon as possible. January 25, 1940.

the outcrop (Figure 1) just above the iron bridge over Techeva Creek (SE.1/4, NE.1/4, Sec. 16, T.13 N., R.1 W.) and in the deep wash at the home of Mrs. Bettie Deason (NW.1/4, Sec. 36, T.12 N., R.2 E.).

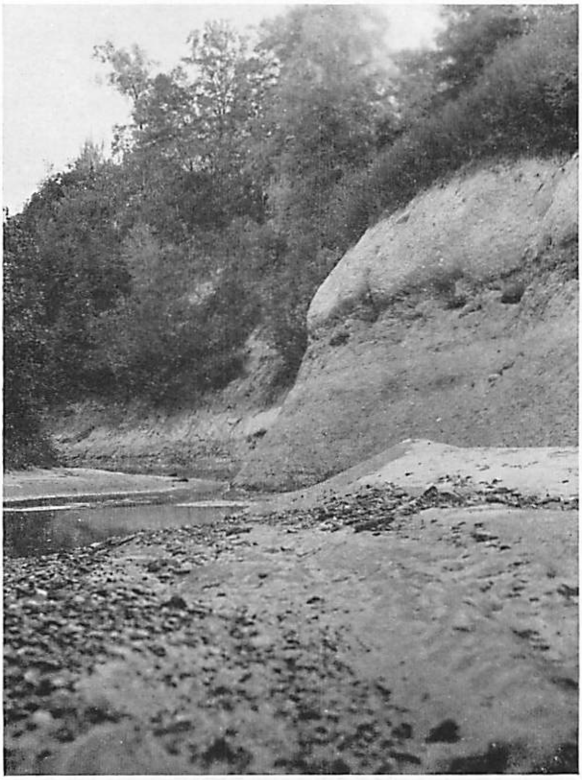

Figure 1.—Yegua member of the Lisbon formation, lignitic, argillaceous silts and lignitic silty clays above iron bridge over Techeva Creek (SE. 1/4, NE. 1/4, Sec. 16, T. 13 N., R. 1 W.). Two samples of test hole C35 were taken from the lower 18.0 feet, exposed at the right. September 15, 1938.

The contact of the Yegua member of the Lisbon formation with the Moodys Branch member of the Jackson formation is conspicuously disconformable. This contact is exposed (Figure 2) on the J. W. Tinnin property in a deep ravine (NW.1/4, NE.1/4, Sec. 20, T.13 N., R.1 W.) and in a roadside gully on the west side of Big Black bottom on property of W. H. Brister (NE.1/4, NW.1/4, Sec.9, T.10 N., R.2 E.). The upper part of the Yegua is a micaceous, argillaceous laminated silt, containing fragments of lignitic wood. On the Tinnin property, as at the Moodys Branch type locality, the top of the Yegua was riddled by borings of molluscs in the early Jackson epoch, and glauconitic sand and calcareous fossils are now found as foreign materials in these channels in the top 5.0 feet, more or less, of the beds of Yegua age.

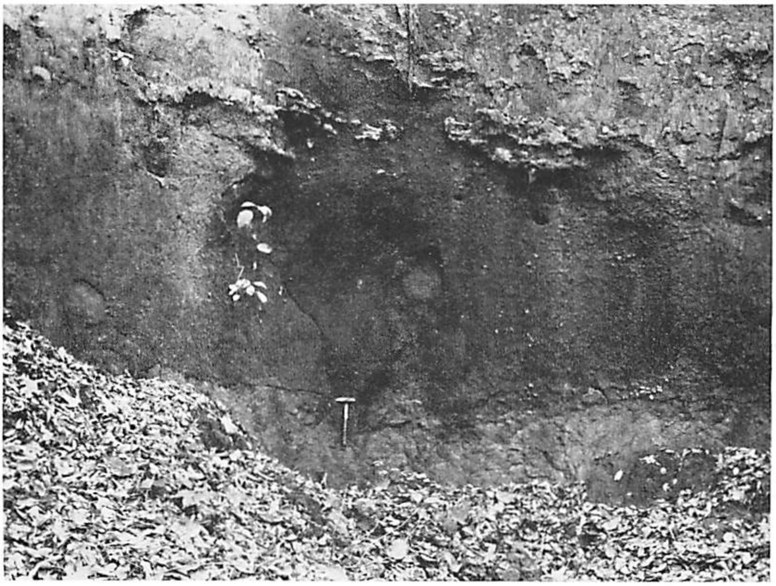

Figure 2.—Disconformable contact of the Yegua member of the Lisbon formation below and the Moodys Branch member of the Jackson formation above. Some of the finest exposures of these beds in Mississippi are in this ravine on the J. W. Tinnin property (NW.1/4, NE.1/4, Sec.20, T.13 N., R.1 W.). November 3, 1938.

A thin bed of bentonite in the Yegua member of the Lisbon formation is exposed for several hundred feet in a picturesque gorge on upper Hollowell (Kings) Creek about a mile above the uppermost road crossing in Yazoo County probably in (NE.1/4, Sec. 21, T.13 N., R.1 E.), Holmes County. The clay ranges in thickness from 0.2 to 0.3 foot. It is associated with lignitic silts and silty clays and lies 13.0 feet below weathered material taken to be the base of the Jackson formation. In a personal communication of November 20, 1939 P. G. Nutting writes in regard to a sample submitted to the U. S. Geological Survey: "After slaking in water and washing out the fines, the remaining chips are very translucent as in the purest bentonites. The acid leach is normal and the oil test gives 0.5 to 0.6 untreated and 2.0 to 3.4 after acid treatment, in line with the test of a fairly good activable bentonite." Careful search in the future may disclose the presence of this bed elsewhere in Mississippi.

JACKSON FORMATION

GENERAL

The Jackson formation is composed of three fairly well-defined members, the Moodys Branch, the Yazoo, and the Forest Hill, named in ascending order. The relationships are that of conformity. Although some geologists place the Forest Hill in the Vicksburg (12, 13), the writer's observation has been that the contact of the Yazoo and the Forest Hill is not only conformable, but gradational as well; and that the Forest Hill and Mint Spring contact is definitely unconformable in all exposures on the Yazoo-Mississippi bluff. There appears, then, to be no reason to alter the present usage by the Mississippi Geological Survey of the term Forest Hill (14). The Jackson formation, therefore, lies disconformably on the Lisbon formation, and is overlain disconformably by the Vicksburg formation.

MOODYS BRANCH MEMBER

The Moodys Branch glauconitic, argillaceous fossiliferous sand-marl rests disconformably on the Yegua member of the Lisbon formation. Partly because of the unconformable relationship, the thickness of the Moodys Branch is somewhat variable. On the W. H. Brister property on the Canton road (NE.1/4, NW.1/4, Sec.9, T.10 N., R.2 E.) the thickness is 31.0 feet. On the J. W. Tinnin property near Eden (NW.1/4, NE.1/4, Sec.20, T.13 N., R.1 W.) the thickness is 43.0 feet. Four hundred yards east of the grade crossing at Zelleria (N.1/2, SW.1/4, Sec. 19, T.13 N., R.1 W.) test hole C8 penetrated 37.0 feet before the rock bit broke off on a resistant seam. At Yazoo City (NE.1/4, NE.1/4, Sec.33, T.12 N., R.2 W.), test hole C34, after passing through the basal 57.4 feet of Yazoo clay-marl, was abandoned 23.4 feet in the sand-marl, because of water. These thicknesses, 31.0 and 43.0 feet, are commensurate with those recorded by other investigators in other parts of Mississippi.

SECTION BEGINNING ABOUT FLOOD-PLAIN LEVEL OF BIG BLACK RIVER ON THE NORTH SIDE OF THE CANTON-YAZOO CITY HIGHWAY ON THE W. H. BRISTER PROPERTY (NE.1/4, NW.1/4, SEC. 9, T. 10 N, R. 2 E.)

	Feet
Brown loam, variable	16.5
Brown loam and transitional material to the weathered Yazoo clay below; scattered chert and quartz pebbles near base of interval; black manganiferous "buck shot" near middle	
Yazoo clay (Jackson), variable	5.5
Clay, calcareous, silty fossiliferous glauconitic; lime nodules; thin stringers of bentonite; joints stained with iron and manganese precipitates	
Moodys Branch marl (Jackson)	31.0
Sand, yellowish-brown argillaceous, glauconitic; glauconite mostly changed to limonite; fossiliferous	
Disconformity, marked by an irregular band of thin hollow limonite concretions; elevation about 203 feet	
Yegua silt (Lisbon)	1.6
Silt, riddled by mollusc borings which are filled with sand from above; top part reddish to yellowish-brown; bottom part mottled gray and yellowish-brown	

Typical of many unconformities, there is a certain intimacy of materials of the beds below and above. It has been mentioned that the molluscan fauna of Jackson age bored into the surface of the beds of the Yegua, and that the glauconitic sands and the smaller marine shells sifted downward into the perforated upper few feet of the non-marine strata. Conversely, there are in the base of the Moodys Branch at many places scattered fragments of worn lignitic wood, evidently derived by erosion from the underlying Yegua.

The upper surface of the Moodys Branch marl is conformable with the lower part of the Yazoo clay (Figure 3). The contact is fairly definite at most points. On the Tinnin property the contact is about 203 feet above sea level, at Zelleria (C8) it is about 198, at the outcrop between Zelleria and Renshaw (SE.1/4, NW.1/4, Sec. 35, T.13 N., R.2 W.) it is about 140, and at the southeast corner of Glenwood Cemetery at Yazoo City (C34) the top of the Moodys Branch is about 60.0 feet above sea level. Though minor irregularities are suggested by these elevations, the dip as obtained from them is about 15.0 feet per mile S.31°W. The contact of the two members at the Brister property is 234 feet above sea level. From these elevations a general strike of N.34°W. is determined, and a dip S.56°W. The dip of 15.0 feet per mile, corrected to the determined normal direction (S.56°W.) becomes a dip of 16.5 feet per mile.

Figure 3.—Conformable contact of the Moodys Branch member below and the Yazoo member above, both of the Jackson formation on a county road at Zelleria (N.1/2, SW.1/4, Sec.19, T.13 N., R.1 W.). September 15, 1938.

The Moodys Branch is fossiliferous throughout its thickness and areal extent. Collections made at the type locality are the best known, but fossils are especially abundant at the Tinnin locality, one of the best exposures of the marl in the state. Good collections can also be made from the excellent exposures on Techeva Creek (NW.1/4, SW.1/4, Sec.10, T.12 N., R.1 E.; NE.1/4, Sec. 5, T.12 N., R.1 E.; SE.1/4, Sec.31, T.13 N., R.1 E.). *Ostrea trigonalis* Conrad (15), more abundant in the lower part of the Yazoo clay, is a persistent form in the Moodys Branch marl, and is diagnostic of the lower 200 or 300 feet of the Jackson formation in Yazoo County.

YAZOO MEMBER

The Yazoo clay conformably overlies the Moodys Branch marl and conformably underlies the Forest Hill sand. In Yazoo County it is roughly divisible into two facies.

The lower 350 feet, more or less, are remarkably uniform lithologically. This facies is a fairly homogeneous silty calcareous fossiliferous gummy, plastic montmorillonitic clay. It is well exposed at the type locality of the member, Yazoo City. In the ravines southeast of Glenwood Cemetery (Bob Whalen pasture) the outcrops and test holes C2, C3, and C34 show that there are at least 150 feet of relatively uniform material lying above the Moodys Branch marl. Likewise, on the south side of Yazoo City, where the Yazoo River touches the Bluff, measurements of numerous outcrops, coupled with calculations, show approximately 185 feet of the Yazoo clay

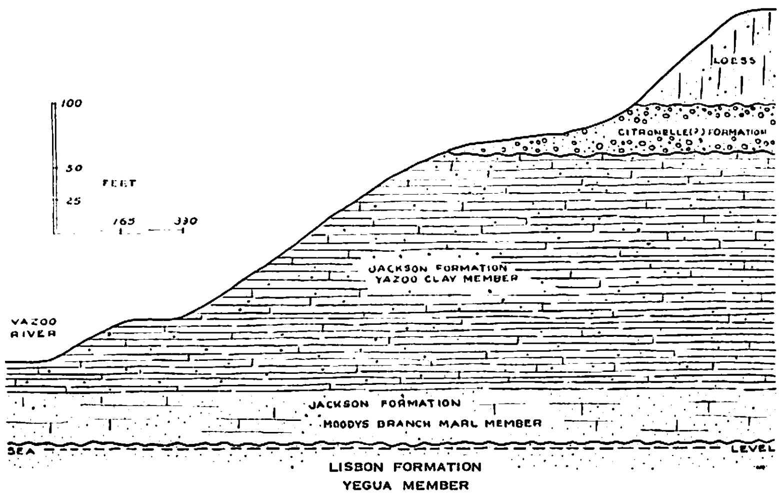

Figure 4.—Geologic section of the Bluff at the south side of Yazoo City, (A-A' on map).

(Figure 4). Of this thickness, 25.0 feet lie below river level; 60.0 feet, below flood plain level; and 125 feet lie above flood plain level. In the pasture of Ed Cooper (NE.1/4, NW.1/4 (?), Sec. 7, T. 11 N., R. 2 W.) test hole C4 penetrated 105.3 feet of this type of clay-marl; and test hole C5, 44.0 feet lower, penetrated 86.9 feet. The two holes show, therefore, 130.9 feet of material. Computations indicate 220 feet of material at this point, of which about 125 feet are above flood plain level. On the F. A. McGraw property (SE. 1/4, NE. 1/4, Sec. 3, T. 10 N., R. 3 W.) test hole C13 penetrated 42.8 feet of this type of clay-marl. At or near this point, the full thickness of the facies, 350 feet more or less, is present. The sub-bentonite of east Mississippi lies at the base of the Yazoo member (16).

The upper facies of the Yazoo clay, gradational with the lower, contains approximately 150 feet of material less homogeneous than the sub-jacent beds. The facies contains relatively pure beds of massive gummy non-calcareous montmorillonitic clay, beds of interlaminated silt and silty clay, a thin bed of bentonite, lentils of limestone and marl (SE. 1/4, NW. 1/4, Sec. 6, T. 9 N., R. 3 W.), and scattered large vertebrae of the *Zeuglodon* whale. The bed of bentonite indicates volcanic activity during the age of accumulation. The beds of interlaminated silt and silty clay indicate the transitional relationship with the Forest Hill member of the Jackson. The lentils of limestone and marl are also suggestive of the shoaling of the sea during the late Yazoo time.

Bay described the thin Yazoo bentonite from a few localities in Scott, Hinds, and Yazoo counties (17). Further work in Yazoo County showed that the bentonite bed is widespread, and that it varies from point to point, consistently ranging between about 0.4 and 1.0 foot in thickness. On the I. J. Hart property (SE.1/4, Sec. 31, T. 10 N., R. 3 W.), a test hole, drilled near the top of three or four successive steeply dipping outcrops of bentonite, revealed that there was only one seam of bentonite, and that the outcrops were on successive slumps. As a further check, test hole C11, high on the hill, was drilled to a depth of 111.4 feet. It penetrated only one bed of bentonite, 0.6 foot thick, at 54.6 feet. On the Mrs. F. P. Smith property (SE. 1/4, Sec. 14, T. 9 N., R. 4 W.) test hole C57 encountered 0.4 foot of the bentonite. On the Hart property the bentonite lies at least 54.6 feet below the Forest Hill; on the Smith property, at least 43.0 feet. As shown on the accompanying map, the outcrops of this bentonite are widely scattered in Yazoo County. The bed is an excellent stratigraphic marker. Care must be used, however, to determine what outcrops are in place and what outcrops are slumped (Figure 5).

The very fine-grained gummy bluish-gray montmorillonitic clays of the upper Yazoo clay lie in rather thick beds that appear to vary in freedom from silty impurities from point to point. On the Minnie McCorkle property (S. 1/2, SW. 1/4, Sec. 2, T. 10 N., R. 2 W.), test hole C25 penetrated 5.7 feet of this type clay lying directly on the bentonite. At Satartia and at the Mrs. F. P. Smith property (SE. 1/4, Sec. 14, T. 9 N., R. 4 W.), test holes C11 and C57, respectively, found siltier clay above the bentonite. At Germania and on the Mrs. F. P. Smith property very fine-grained plastic montmorillonitic clay was found at the top of the Yazoo member in test holes C49 and C59, respectively. Doubtless, this type material will be found on many of the other properties in the region.

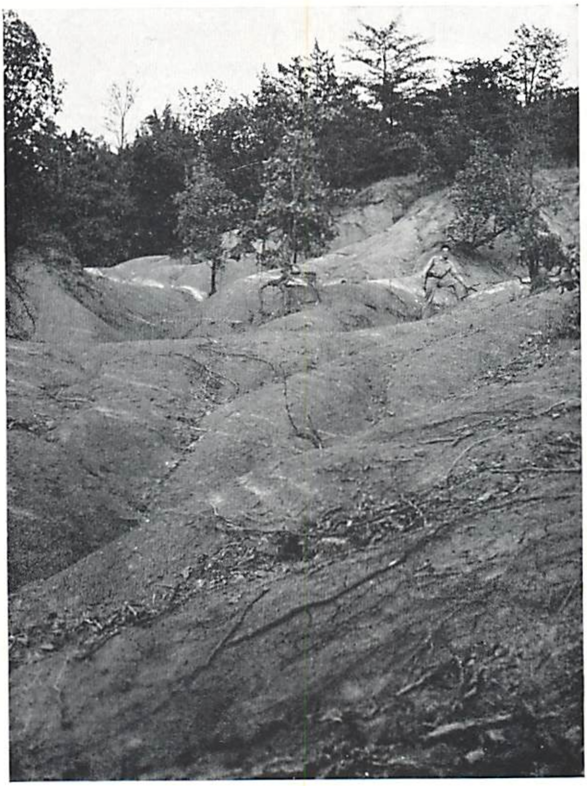

Figure 5.—Outcrop on the face of an enormous landslip (?) exposing the thin bed of bentonite in the upper facies of the Yazoo clay southeast of Satartia (SW.1/4, SE.1/4, Sec.31, T.10 N., R.3 W.). October 10, 1938.

Slumping and the development of gypsum are the two great surface phenomena of the Yazoo clay. Gypsum is abundant in the two arbitrary facies of the Yazoo. On the I. J. Hart place near Satartia, several hundred pounds of gypsum crystals were collected. Many of these were individual crystals, some several inches long and a half-inch or more in thickness; most, however, were rosettes. The larger crystals were most common in the siltier portions of the strata, being formed in a horizontal position, with the bedding. Most common, though, is the gypsum formed along the joints penetrating the calcareous clay (Figure 6). This gypsum is nearly all in small iron-stained crystals. Logs of test holes show that below the zone

Figure 6.—Outcrop of calcareous, gypsiferous Yazoo clay at Satartia (NE.1/4, SE.1/4, Sec.31, T.10 N., R.3 W.) showing slumped position of bedding and gypsum-lined joints. October 10, 1938.

of oxidation there is no gypsum; that in the zone of intense weathering the gypsum is, seemingly, missing. Conversely, pyrite is common in the unoxidized portions. It is suspected that most of the gypsum of the Yazoo clay-marl results from the effect of decomposing pyrite on the calcareous fossils. Perhaps some gypsum is derived from the action of connate iron sulphate on the lime, but too little is yet known about the quantity of original sulphate and sulphite minerals in the clays for any positive statement to be made.

FOREST HILL MEMBER

The Forest Hill member of the Jackson formation is probably 60 to 80 feet thick in Yazoo County. Measurements are difficult to make, because of the alternating beds of nonplastic permeable and plastic impermeable materials, a sequence which contributes greatly to the land-slip problem. The Forest Hill terrane represents the withdrawal of the Jackson sea. The sediments, argillaceous lignitic silt, thin argillaceous allocthonous lignite, lignitic leaf-bearing montmorillonitic clays, and fine-grained cross-bedded sand, are typical materials to be deposited at the close of a marine sedimentary cycle. The Forest Hill member is to the Jackson formation as the Yegua is to the Lisbon formation, and as the Naheola is to the Midway series (formation), a unit composed of the finer grained clastic rock and other materials deposited in heterogeneous manner, indicating withdrawal of the sea and emergence of the land prior to the erosion which follows such emergence. The lignite of the Forest Hill in Yazoo County is in but few places more than 1.5 or 2.0 feet in thickness, and is fissile, features which indicate its argillaceous and sedimentary nature; furthermore, it rarely lies on an underclay. On Coal Creek (NE. 1/4, Sec. 25, T. 9 N., R. 4 W., etc.) a highly sulphurous thin silty underclay is exposed in badly slumped outcrops, the quality of the clay suggesting very poor drainage conditions during its formation. Silicified and lignitized logs are not uncommon in the Forest Hill.

VICKSBURG FORMATION

GENERAL

As indicated in the summary of exposed rock formations of the county, it is proposed here to regard the Vicksburg as a formation rather than as a "Group", the rank assigned to the beds by the U. S. Geological Survey (18, 19) and formerly by the Mississippi Geological Survey (20). As the rank of the Jackson was reduced from "Group" to formation (21), likewise, on stratigraphic and lithologic grounds, it is proposed to treat the Vicksburg beds as of formational rank. The Forest Hill is overlain unconformably by the Glendon in the same manner as the Yegua is overlain by the Moodys Branch, the relations being similar even to the details of the marl-filled borings in the upper part of the non-marine beds and of the lignitic detritus in the lower part of the marine beds. The Vicksburg beds aggregate a much less thickness than the Jackson beds; also, because the more distinctive units of the Vicksburg are not separated by erosional or structural unconformities, it is believed proper to regard the lithologic units of the Vicksburg as stratigraphic members and facies rather than as stratigraphic formations and members.

In Yazoo County the Vicksburg formation is best exposed south of Satartia, near the heads of the streams flowing into the Yazoo River. Near the heads of these streams the lower limestones of the Glendon member form water-falls above the less resistant Mint Spring facies and the Forest Hill member (Jackson). At each of the water-falls, known as Thornell, Shop Hollow, Wildey, Wash Smith, and others, the exposures are very similar. The following section shows the characters and thicknesses of the beds.

SECTION AT THORNELL WATER-FALL (NW.¼, NE.¼, SEC. 4, T. 8 N., R. 4 W.)

	Feet	Feet
Glendon member (Vicksburg)		31.7
Clay, bentonitic (?) fossiliferous (covered by slump)		
Limestone, soft glauconitic, arenaceous, slightly argillaceous; marine fossils	1.4	
Marl, sand-, glauconitic, very calcareous, argillaceous; marine fossils abundant	3.1	
Clay, bentonitic, very fine-grained	0.1	
Marl, sand-, glauconitic, very calcareous, argillaceous; marine fossils abundant	3.0	
Limestone, very hard slightly glauconitic and arenaceous and argillaceous; marine fossils abundant	2.5	
Bentonite, high-grade; calcareous fossils (calcareous tufa deposited over this in stream channel)	1.5	
Limestone, hard slightly glauconitic and arenaceous and argillaceous; marine fossils abundant (This bed dips 2° N. 10° W.)	3.0	
Marl, sand-, glauconitic, very calcareous, argillaceous; marine fossils	4.9	
Limestone, hard slightly glauconitic and arenaceous and argillaceous; marine fossils abundant	1.3	
Marl, sand-, glauconitic, very calcareous, argillaceous; marine fossils abundant	2.2	
Limestone, soft glauconitic, arenaceous, slightly argillaceous; marine fossils abundant	2.2	
Marl, sand-, glauconitic, very calcareous, argillaceous; marine fossils abundant	3.3	
Limestone, hard glauconitic, arenaceous, slightly argillaceous; marine fossils abundant	1.5	
Limestone, soft glauconitic, arenaceous, argillaceous; marine fossils abundant	1.7	
Conformable contact		
Mint Spring facies of the Glendon (Vicksburg)		21.1
Marl, sand-, glauconitic, calcareous, argillaceous; marine fossils throughout but more abundant toward top	15.5	
Clay, bentonitic silty arenaceous; splotches of sand from mollusc borings	1.4	
Marl, sand-, glauconitic, calcareous, argillaceous; marine fossils; lignitic wood scattered throughout	4.2	
Covered interval (marked by slump)		2.5
Forest Hill member (Jackson)		3.0
Sand, silty laminated argillaceous fine-grained non-glauconitic non-calcareous; pieces of lignitized wood		3.0

The Vicksburg formation is exposed south of Phoenix in several of the streams flowing into the Big Black River. It crops out for a long distance on the hill slopes on the plantation of T. C. Guion (E. 1/2, Sec. 17; N. 1/2, SW. 1/4, Sec. 16, T. 8 N., R. 3 W.; etc.).

MINT SPRING FACIES

The Mint Spring receives its name from the outcrop of greensand marl below the water-fall on lower Mint Spring Bayou at the National Cemetery, Vicksburg (22). The thickness of the Mint Spring facies varies, due partly to the erosional unconformity on which it rests. The range is probably about 15.0 to 25.0 feet. The disconformity at its base is not exposed at many outcrops of the Mint Spring in Yazoo County. It shows north of Phoenix near the head of Coal Creek and west of Phoenix at a small waterfall just west of the Wildey waterfall. The best exposure of the contact known to the writer is at Haynes Bluff, Warren County (SE. 1/4, SW. 1/4, Sec. 23, T. 8 N., R.4 E.). The Mint Spring is merely a facies of the Glendon member, the whole member constituting a stratigraphic counterpart (basal sand) of the Clayton, Midway series (formation); of the Winona, Lisbon formation; and of the Moodys Branch, Jackson formation. The contact of the Mint Spring and the Glendon is gradational. For practical reasons the identity of the two units is preserved. Morse has placed, at the type locality, the contact at the base of the lowest indurated limestone and at the top of a semi-indurated marl stratum (23).

GLENDON MEMBER

The Glendon member of the Vicksburg formation consists of alternating beds of semi-crystalline limestone and marl, both materials being somewhat similar in composition, arenaceous, argillaceous, glauconitic and abundantly fossiliferous; the limestone contains the smaller percentage of clastic sediments.

The most interesting material of the Glendon, scientifically and commercially, is the bentonite which it contains. Near the Thornell Water-fall bentonite crops out at several places (Figure 7). In the measured section, the 1.5-foot bentonite lies 20.1 feet above the Mint Spring facies and 10.1 feet below the top of the highest exposed limestone bed. L. C. Conant and the writer, to further substantiate this position of the bentonite bed in the Glendon, were granted permission by C. M. Shaeffer, Manager of the Attapulgus Clay Company, to visit the company's pits near Polkville, Smith County. The bentonite was found to be lying on a pinnacled limestone surface approximately 12.2 feet below the top of the uppermost limestone bed. Two or three strata of limestone and several strata of marl are in the Glendon above the bentonite. These facts show clearly that at least three investigators have been misled by field conditions to report that the bentonite lies unconformably on the top of the Glendon limestone.

Figure 7.—Outcrop of a 1.7-foot bed of fossiliferous bentonite in the Glendon member of the Vicksburg formation in southwest Yazoo County (NW.1/4, NE.1/4, Sec.4, T.8 N., R.4 W.). November 27, 1938.

Measurements of the bentonite were taken in test hole C52 and in and near C53. The thickness varies considerably, the range probably being 0.7 foot to 1.8 feet. Samples of unweathered bentonite were obtained by digging through the overlying limestone and marl in the bed of the stream near test hole C53. The material when fresh is a peculiar light-gray waxy clay, which darkens on exposure to light. Other samples of incipiently oxidized and completely oxidized portions of the stratum were taken. The unoxidized and incipiently oxidized clay contain hard unleached fossils characteristic of the Vicksburg, and mollusc borings filled with marl. *Lepidocyclina mantelli* Morton and *Pecten poulsoni* Morton are most common. In contrast, the bentonite known from the outcrops in Smith County is mostly so thoroughly leached and oxidized that fossils are rare, and fossils that can be preserved in collections are negligible.

BYRAM MEMBER

The Byram member of the Vicksburg formation consists of evenly bedded silty montmorillonitic clay-marl and thin coquinas. Fossils are very abundant, and probably the best specimens of the Vicksburg are to be had from this member. No good exposures, however, were found in Yazoo County. Referable to the base of this member is the incipiently oxidized (mottled) bentonite (?) of test hole C54. To what extent this clay is the result of natural lixiviation, it is impossible to say. Even when the trench was run back 55.0 feet the clay was found to be incipiently oxidized, to be slightly glauconitic, and to be very dark at the base. The thin gravel and the slumped loess lie irregularly over the top of the bed. The maximum thickness of the Byram member in Yazoo County is not determinable, because of the slumping which develops on its surface.

CITRONELLE FORMATION

Information concerning the Citronelle formation of Yazoo County is extremely difficult to obtain. The most enlightening exposures have just recently been made by the Alabama Aggregate Company on the J. C. Alderman property (NE. 1/4, SW. 1/4, Sec. 23, T.11 N., R.2 W.). Twenty to 35.0 feet of loess were removed in order to mine 7.0 to 23.0 feet of gravel for use in the construction of concrete Highway 49. Three test channels, C29, C30 (Figure 8), C31, were cut in the exposed beds. The contact of the gravel and loess (Figure 9) is sharp and non-conformable.

The thickness of the Citronelle was nowhere adequately determined, because of incomplete exposures and because of the failure of augers to penetrate the gravelly portions. It is believed to range between 25.0 and 50.0 feet in Yazoo County.

The size of material in the Citronelle varies greatly. The range is from particles of silt size (C21) to boulders of several hundred pounds in weight.

Figure 8.—Citronelle gravel exposed in pits of the Alabama Aggregate Company (NE.1/4, SW.1/4, Sec.23, T.11 N., R.2 W.). Twenty-one feet of gravel (test C30) are exposed in this photograph. October 31, 1938.

The gravel represents a wide assortment of materials. All common types of quartz are abundant: oolitic, fossiliferous, and nonfossiliferous chert; quartzite of several origins and various colors; agate and chalcedony; rose, milky, and black quartz; sandstone; and silicified wood. No materials other than the quartzes were found despite careful searching of gravel bars, outcrops, and road cuts for a greater variety. Inasmuch as no igneous rocks were found, and as none of the stones examined showed glacial striation, a pre-Pleistocene age is assigned to the beds. Most of the chert and quartz sand grains are well-rounded. The largest boulders, those weighing perhaps 25.0 pounds and up, are only of chert, white sandstone, and silicified wood. The sandstone and silicified wood can be identified with sources less than 100 to 200 miles distant.

Some of the larger bodies of chert appear to be brecciated, and they contain dark earthy material lining irregular voids, suggestive of disintegration of sulphides, such as galena and sphalerite.

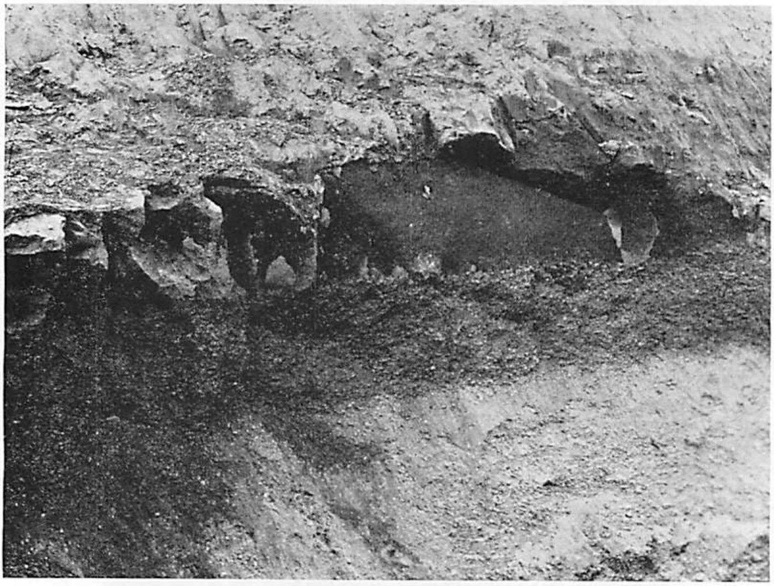

Figure 9.—Disconformable contact of the Citronelle gravel below and the Loess above in pits of the Alabama Aggregate Company (NE.1/4, SW.1/4, Sec.23, T.11 N., R.2 W.). October 31, 1938.

The Citronelle varies from point to point in character and thickness. Most of the gravel is very hard and tough, showing, as do the numerous surface bruises on most stones, that pounding and grinding during accumulation have eliminated the less resistant materials. There is considerable lateral variation, for within even a few hundred feet a rich bed of gravel may grade into a gravel-bearing sand. As an example of variation, the Citronelle of the Alderman property may be compared with the Citronelle of the I. J. Hart property (C12) where very little gravel was found in the upper 23.1 feet. In the eastern part of the county, the Citronelle, beneath the brown loam, ranges from a feather-edge to only a foot or less in thickness. Whether this is due to an original eastward thinning or to Pleistocene or Recent phenomena of degradation is debatable.

LOESS

That the loess and the underlying gravel are of different ages is further attested by the fact that there is found in the basal portion of the loess no interbedded sand or gravel, and in the upper portion of the gravel and sand there is found no interbedded loess. The only clear exceptions noted were obviously due to slumping or wash on steep slopes. Neither is there a gradation from one material to the other. One of the test holes, C21, shows a possible exception; it may, however, show one of several other phenomena and still be consistent with the theory. In test holes C1, C9, C12, C29, C30, C31, and others not here reported, the sharp contact exists.

Figure 10.—Oxidized calcareous loess in an old road on the Bluff south of Yazoo City (NW.1/4, NE.1/4, Sec.5, T.9 N., R.3 W.). November 27, 1938.

The loess is silt, remarkably uniform in texture through its thickness and extent (Figure 10). Its normal thickness range within

2.0 to 3.0 miles of the Bluff is probably 50.0 to 75.0 feet. The thickest material penetrated, however, was 57.0 feet in test hole C1, 63.7 feet in C9, 55.5 feet in C12, and probably 62.9 feet in C21. The loess thins eastward at a rate varying widely, but averaging perhaps between 2.0 and 3.0 feet per mile.

There is seemingly no difference between loess from the bottom of the stratum and loess from the top, except where the difference is plainly due to conditions of weathering. Near the bottom of test hole C1, 14.0 feet of unoxidized bluish-gray and incipiently oxidized olive-drab loess were penetrated. This phase represents a perched water-table from part of which the water is drained very rarely. Because of the underlying highly permeable gravel and sand and the narrowness of the ridges in most places, the loess is oxidized throughout. There are three definite zones of the loess. (1) The basal unoxidized portion is bluish-gray, and the shells contained in it are better preserved than in the overlying loess; it is seemingly identical with the rest of the loess. The zone is not distinct, as there are in most places gradational sub-zones of incipiently oxidized (olive-drab, etc.) material both below and above. (2) The next phase is the typical loess, well-oxidized but not thoroughly leached. It is commonly brownish-gray, and contains almost everywhere myriads of pulmonate gastropod shells and irregular lime nodules. This phase ranges from 1.0 foot to 60.0 feet in thickness. (3) The uppermost zone is the loess-material that has been both oxidized and leached. This material ranges from 1.0 foot to 10.0 feet in thickness on the escarpment, and to the eastward, where it is known as the brown loam, it ranges from 5.0 to 30.0 feet in thickness (Figure 11). It is much more nearly uniform in thickness in the eastern part of Yazoo County, especially where the topographic relief is slight.

From studies of the loess in Yazoo County the following conclusions concerning its genesis and history are reached: (1) The loess accumulated as a wind-blown silt on a grassy plain at an annual rate which did not exceed the ability of the vegetation to reestablish itself and did not fall short of the rate necessary to provide the minimum amount required for the burial and preservation of land snail shells and bones of various genera of *Mammalia*. (2) The bluish-gray loess possibly accumulated as oxidized or partly oxidized material and subsequently was reduced when the thickness of loess increased sufficiently to support a higher water-table. (3) The vertical jointing in the loess walls is probably due to diagonal strains produced by movement over subjacent plastic bedrock materials. (4) The rapid accumulation of loess probably continued until fairly recent times, and it is still evident that dust is being deposited in the area, though now the rate of erosion greatly exceeds the rate of deposition.

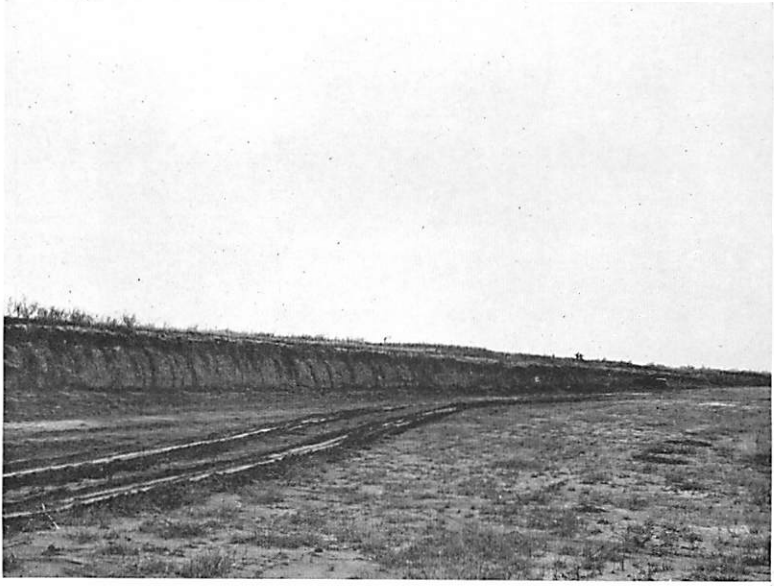

Figure 11.—Exposure of non-calcareous loess (test hole C24) in pit along highway 49 south of Bentonia (SE.1/4, Sec.14, T.9 N., R.2 W.). October 20, 1938.

Leighton, reporting on his examination of the test hole C1 samples, stated: "The samples are greatly similar to some of the loess found in Illinois, including as they do the non-calcareous loess at the surface, followed by an oxidized but unleached zone, below which occurs the fresh unleached and unoxidized or slightly oxidized loess" (24).

HOLOCENE OR RECENT DEPOSITS

The late geologic history of Yazoo County is probably the most confusing part. What happened during and after the glacial period is still obscure, and few clues have yet been found. It seems evident that there have been great epeirogenic changes produced in the area in recent times. The present deep incisement of the loess bluffs and the great thicknesses of the alluvial fill in the Mississippi

River valley are suggestive at once of both rejuvenation and subsequent subsidence, but many of the small streams from Vicksburg northward to Panola County show early stages of a new terracing cycle. The chronology of these events is not attempted here. It is sufficient for present purposes to call attention to some of the recent gradational processes.

Figure 12.—Partly carbonized log and other peaty material in alluvial section near head of Thompsons Creek (S.1/2, SW.1/4, Sec.2, T.10 N., R.2 W.). October 20, 1938.

It is not known whether the loess was deposited as an extensive wind-laid blanket and was subsequently cut through by the many small streams, or whether the development of the present streams continued throughout the deposition of the loess. Two things preclude this knowledge: (1) lack of abundant information about the surface upon which the loess was laid; and (2) the great degradational forces of erosion and land-slip, both of which are extremely active in the many drainage areas. There are phenomena which seem to support both hypotheses.

On the face of the bluff at several localities are deposits which seem to be remnants of alluvial terraces. This material is found above flood plain level north of Techeva Creek, at Valley, behind the M. F. Faulkner home at Germania, and in a deep gully along Highway 3 about 2.0 miles southwest of Germania (NE. 1/4, NE. 1/4, Sec. 32, T. 9 N., R. 4 W.). Because of the land-slip activity on the escarpment face, physiographic expression of terrace deposits would have only remote chances for preservation, and in Yazoo County where the bed-rock materials do not support strong topography, physiographic features of terraces younger than the Pliocene Citronelle were noted only along some of the larger stream valleys of the Bluff region.

Silicified wood is very abundant in the Citronelle gravels, but neither silicified nor carbonized wood was struck in any of the deep test holes, in loess, nor was either type seen in any outcrop of undoubted loess. However, many or all of the small streams of the loess region show peaty material and partly carbonized logs (Figure 12) at a definite position low in their alluvial profiles. In many stream valleys these buried trees lie as much as 20.0 to 30.0 feet below the present surface of the flood-plains. When did this forest flourish, during or after the active period of eolian deposition? Is it possible that the overlying laminated alluvial silt represents sedimentation after the advent of white men?

It is plainly written that in recent centuries the surface features of the hill region of Yazoo County have been in a state of instability. Nearly every outcrop shows signs of creep or of more rapid slipping. The vertical jointing of the loess, the steeply dipping laminae in outcrops of bedrock material, the slickensided surfaces, actual exposures of fracture planes (Figure 13), and typical landslip topography are startling proofs of this fact. The exposures made by cuts for the new Highway 49 between Yazoo City and Bentonia show many good examples of this condition.

The alluvial deposits of the smaller streams are of the same recent age as the alluvial deposits of the Mississippi-Yazoo valley. In the great valley, the upper 15.0 to 25.0 feet are variable in texture from very plastic silty clay to very silty semi-plastic clay or argillaceous silt. These materials grade downward within a few feet into arenaceous silts and fine-grained sand. Locally, the upper alluvial material is very similar in color and texture to the unoxidized loess.

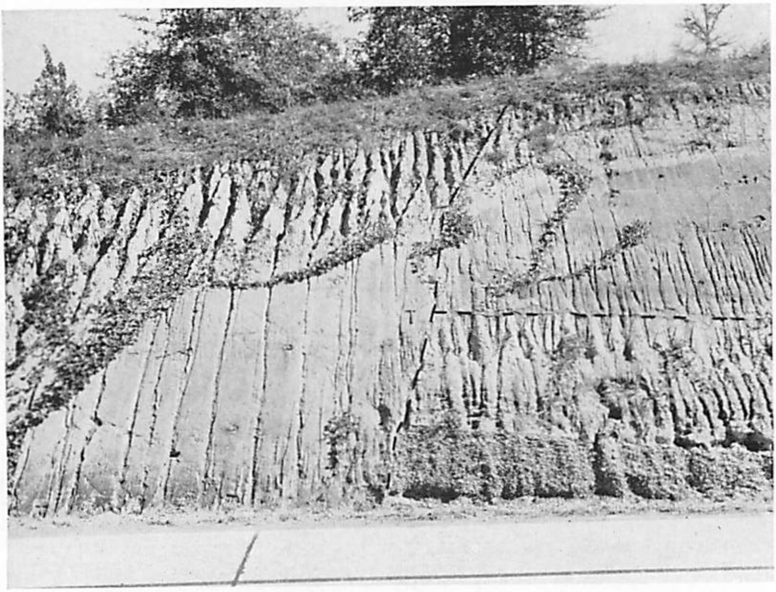

Figure 13.—An old landslip exposed by a cut for Highway 49, 3.5 miles southeast of Yazoo City. The beds involved are: Yazoo clay which crops out in the bed of a stream about 100 feet lower, vertically; Citronelle gravel; and Loess silt. All surface expression of this slip has been erased by natural agencies. October 19, 1938.

Unlike the loess, however, there is no uniformity throughout great thicknesses and wide extent of the alluvial materials. The loess is definitely to be described as homogeneous; the alluvial materials, as heterogeneous.

MINERAL RESOURCES

NON-FUELS

Most of the raw mineral substances that are found in commercial quantities in Yazoo County are those commonly thought of as having no economic value. The loess, for instance, is generally considered too calcareous and lacking too much in plasticity for ceramic use. The Yazoo clay-marl is a substance which usually would be considered too calcareous and too gypsiferous for use. The Yegua and Forest Hill silts and silty lignitic clays are impure materials and generally would be regarded as of no possible economic use. The Moodys Branch marl and the Glendon (Mint Spring) marly limestone are each probably too deficient in lime and too rich in clastic sediments to find ready acceptance in any major branch of the mineral industry. Materials of each of these stratigraphic units are found in unlimited quantities in Yazoo County. In composition, the various materials are surprisingly uniform. Because of the uniformity, the quantity, and the wide distribution and accessible locations of these deposits, samples were taken for experimental testing. The statistical summary, below, is a recapitulation of the prospecting work done in Yazoo County. Because descriptions of the various materials are given in the test hole records and in the sections on stratigraphic geology, it is thought unnecessary to attempt fuller descriptions.

The three beds of bentonite are, so far as these investigations show, too thin for commercial development. The Yegua bentonite ranges from 0.2 to 0.3 foot thick in the outcrop in the edge of Holmes County. The Yazoo bentonite ranges from 0.4 to 1.0 foot thick, and outcrops show that it is most commonly exposed in slumps. The Glendon bentonite ranges from 1.0 foot to 2.0 feet thick and is found between beds of indurated limestone without sufficient clearance to permit easy underground mining. Where prospected, the Glendon bentonite contains marl which fills numerous mollusc borings. It is, therefore, thought to be more calcareous than the weathered bentonite mined in Smith County.

Loessial clays have been used at various times in Yazoo County and Yazoo City for the manufacture of a uniformly textured, red-burning, common and face brick. Many of the present buildings of Yazoo City are constructed of locally manufactured brick. The fronts of these buildings have shown a good resistance to weathering forces and have retained their very pleasing uniform appearance. The raw material used was the weathered loess from the slopes of the hills near Yazoo City. On weathering, the alumina-silica ratio is thought to increase with the result that the loessial silt becomes more plastic. This workable zone is in most cases only a few feet thick. Logan reported that on the steeper slopes it rarely ever reached a thickness of 3.0 feet, and in the depressions a thickness of 8.0 feet was not uncommon (25). Only this most highly weathered part of the loessial profile was used in the manufacture of brick. The three common methods of brick-making, viz: soft mud, stiff mud, and dry-pressed processes, have been employed at various times in working up the loess clay.

Richard M. Quekemeyer collected the following information on the manufacture of brick in Yazoo City and County, obtaining most of his information from personal sources.

During the years 1892 to 1898 W. D. Pugh and G. H. Quekemeyer manufactured mud brick in the southeast part of Yazoo City. The clay used was taken from the hills near Brandon Street and Ridge Road. For three years the production was very slow because the brick were hand-made. In 1895 machinery was installed. This plant closed during 1898, due to exhaustion of proper clay. During the years 1899 to 1905 Quekemeyer and Gardner manufactured mud brick in the east section of Yazoo City at the east end of Canal Street, obtaining the clay from the slopes of the hills. This plant closed in 1905, due to financial conditions.

The Montgomery Land Company of Yazoo City, Mississippi, manufactured dry-pressed brick in the northeast section of Yazoo City for fifteen years, operating their plant from 1904 until 1919, at which time it closed, due to financial conditions.

From the year 1919 until 1927 no brick were manufactured in or near Yazoo City.

The Yazoo Brick Company was incorporated December 1, 1927. Mr. John Lear was president, Mr. J. B. Bennett, secretary and treasurer, and Mr. C. E. Mann, manager. The plant was located in the northeast part of Yazoo City near Grady Avenue. The Company manufactured dry-pressed brick from clay taken from the hill-slopes in the northeast part of the corporation. The plant operated three kilns, each holding approximately 250,000 brick. Gas burners were used in the process of firing. Fifteen days of firing were required for each kiln.

STATISTICAL SUMMARY OF PROSPECTING IN YAZOO COUNTY

Test hole No.	Total depth	Number of samples	Thickness of materials	Character of materials	Position
C1	58.4	6	57.0	Loess, calcareous oxidized and unoxidized	Loess
C2	62.0	9	57.0	Clay-marl	Yazoo
C3	71.0	11	71.0	Clay-marl	Yazoo
C4	105.3	13	103.6	Clay-marl	Yazoo
C5	86.9	9	85.7	Clay-marl	Yazoo
C6	29.5	3	27.5	Clay and silt, alluvial	Alluvium
C7	25.0	3	25.0	Clay and silt, alluvial	Alluvium
C8	67.6	3	21.8	Clay-marl	Yazoo
		4	35.5	Sand-marl	Moodys Br.
C9	64.2	8	63.2	Loess, calcareous oxidized	Loess
C11	111.4	12	110.0	Clay, Montmorillonitic silty; marly	Yazoo
		1	0.6	Bentonite	Yazoo
C12	78.6	4	49.3	Loess, calcareous oxidized	Loess
		3	21.1	Sand	Citronelle
C13	49.0	4	42.8	Clay-marl	Yazoo
C21	63.6	5	33.9	Loess, non-calcareous	Loess
		2	23.3	Clay, loessal	Loess
C23	18.6	3	18.3	Loess, non-calcareous	Loess
C24	15.6	2	15.3	Loess, non-calcareous	Loess
C25	19.0	1	5.7	Clay, montmorillonitic	Yazoo
		1	1.8	Bentonite, mixed with clay	Yazoo
		2	11.5	Clay, montmorillonitic silty	Yazoo
C29	46.0	2	7.0	Gravel and sand	Citronelle
C30	69.0	3	23.0	Gravel and sand	Citronelle
C31	53.0	3	18.0	Gravel and sand	Citronelle
C34	80.8		57.4	Clay-marl	Yazoo
			23.4	Sand-marl	Moodys Br.
C35	18.0	2	18.0	Silt, argillaceous	Yegua
C37	19.4	1	10.2	Loess, non-calcareous	Loess
C40	20.0	2	19.2	Clay and silt, alluvial	Alluvium
C43	20.2	2	20.2	Silt, argillaceous alluvial	Alluvium
C49	52.3		39.0	Sand, silty	Forest Hill
			13.3	Clay, montmorillonitic	Yazoo
C52	15.0	1	1.0	Bentonite, ochreous	Glendon
C53	1.8	1	1.8	Bentonite, incipiently oxidized	Glendon
C54	55.0	1	2.0	Bentonite (?), incipiently oxidized	Byram (?)
C55	38.5	2	8.3	Loess, non-calcareous	Loess
		4	24.9	Clay, silty and silt, argillaceous	Yegua
C57	45.0		38.0	Clay, montmorillonitic silty	Yazoo
			0.4	Bentonite	Yazoo
C59	43.1	1	13.0	Clay, montmorillonitic	Yazoo
		1	3.7	Clay, montmorillonitic silty	Yazoo
C60	35.9		12.5	Sand-marl	Moodys Br.
			23.4	Silt, argillaceous, lignitic	Yegua
33	1538.7	135	1158.4		

NOTE: This recapitulation is made from 33 logs selected as being representative and does not include all test holes drilled in Yazoo County.

The Yazoo Brick Company, Inc. sold the plant to Mr. W. H. Link, January 1930. Mr. Link operated it for two years. Since 1932 no brick have been manufactured in Yazoo City.

OIL AND GAS

DEVELOPMENT

Petroleum and natural gas were not known in Yazoo County prior to August 29, 1939, and commercial petroleum had not been discovered in Mississippi prior to that date, despite the facts that hundreds of test wells had been drilled in the state, and that two commercial gas fields had been exploited. This great number of test wells does not necessarily condemn the areas in which the wells were drilled, for it is known that many of the wells were located without any regard to favorable structures whatsoever, and that many of them were probably not drilled to sufficient depths.

Only two test wells had been drilled in Yazoo County prior to 1939: (1) The Free Run Oil Company's No. 2 on the I. S. Reed farm (SE. 1/4, NE. 1/4, Sec. 25, T.13 N., R.1 W.) which was abandoned August 10, 1926, at 2,721 feet, after reported showings of oil and gas; and (2) The Amerada Petroleum Corporation's Campbell No. 1 (SW. 1/4, Sec. 24, T.12 N., R.2 W.) which was completed March 23, 1930, as a dry hole at a depth of 5,198 feet.

In the progress of the field work of the present minerals survey structural data were secured which led the State Geological Survey to release the following memoranda on "The Tinsley Dome" and on "The Satartia Structure."

MISSISSIPPI STATE GEOLOGICAL SURVEY

IMMEDIATE RELEASE **University, Mississippi**

APRIL 12, 1939 MEMORANDUM FOR THE PRESS

The Tinsley Dome

A structural "High" in Yazoo County has been discovered by Frederic F. Mellen, supervising geologist of the W. P. A.-Mississippi State Geological Survey, in the minerals survey of the county, in which the Yazoo County Chamber of Commerce and Board of Supervisors are acting as co-sponsor.

The first indication of the structure was noted in October, 1938, when a thin bed of bentonite in the Yazoo clay member of the Jackson formation, a bed believed to be a reliable stratigraphic marker, was determined to lie at 250 feet above sea level six miles southeast of Yazoo City (Center of Sec. 26, T. 11 N., R. 2 W.); at 225 feet 2 1/2 miles farther south (SW.1/4, Sec. 2, T. 10 N., R. 2 W.); at 220 feet 9 1/2 miles southwest of the latter place (SE.1/4, NE.1/4, Sec. 32, T. 10 N., R. 3 W.); and at elevations of normal southwest dip at points farther south. Approximately the same elevation of the bentonite bed at two places 9 1/2 miles along the dip is the significant fact.

In checking his Yazoo County stratigraphy in February, 1939, Mr. Mellen discovered 12 feet of the Moodys Branch marl member of the Jackson formation on Perry Creek, a mile southwest of Tinsley (SW. Cor. NW.1/4, Sec. 13, T. 10 N., R. 3 W.), in an area where normally only younger Yazoo clays should have been exposed. Test hole C-60 revealed the base of the Moodys Branch marl 6 feet below water level; and 26 feet of the underlying silty, lignitic, pyritiferous, argillaceous beds of the Yegua. At this point the base of the Moodys Branch marl is 150 feet above sea level; in test C-34 in Yazoo City, ten miles northeast, it is 15 feet above sea level; in a small stream 1 1/2 miles south of Eden and about nine miles northeast of Yazoo City, it is 160 feet above sea level. The inlier of the Moodys Branch marl on Perry Creek at an elevation of 150 feet above sea level shows, therefore, the Tinsley structure to have a northward contour closure of at least 135 feet—a structure so favorable for oil and gas accumulation as to warrant further geologic study and seismographic exploration.

Although the existence of the Tinsley structure in a thickly loess-covered area is based largely on the evidence of a single outcrop of the Moodys Branch marl on Perry Creek, the structure of the higher bentonite bed tends to corroborate its presence; although all elevations are barometrically determined and are, consequently, not precise, and although the area was leased, seismologically surveyed, and surrendered, some ten years ago, nevertheless, the Tinsley structure should be further explored, especially with a seismograph, to determine whether or not the subsurface structure is sufficiently pronounced to warrant a commercial test well, and especially should it be further explored for the reason that it lies less than 35 miles northwest of the Jackson Gas Field.

Because of the great expense involved in oil and gas exploration and especially in deep drilling tests, this press notice is being released by William C. Morse, State Geologist, who spent a few days in the field, and by Frederic F. Mellen, the discoverer, only on the condition that this article be accepted in its entirety.

MISSISSIPPI STATE GEOLOGICAL SURVEY

FOR RELEASE ON
AUGUST 16, 1939

University, Mississippi

MEMORANDUM FOR THE PRESS

The Satartia Structure, Yazoo County

Satartia, Yazoo County, lies 15 miles south-southwest of Yazoo City and 5 miles southwest of the center of the Tinsley Dome, described in Mississippi Geological Survey Memorandum for the Press of April 12, 1939. In many places eastward and southward of Satartia, the hill slope gullies and the streams of the Bluff region expose the thin bentonite bed of the upper Yazoo clay. As early as November, 1938, members of the WPA-Mississippi Geological Survey Clay & Mineral Survey of Yazoo County suspected that the irregular elevations of the bentonite outcrops were due largely to structural conditions, although it was realized that slumping has taken place along the Bluff on an amazing scale. Subsequent to this date, the discovery of the Moodys Branch marl inlier near Tinsley confirmed the presence of the Tinsley Dome as it was suggested by various outcrops of the Yazoo bentonite; still later, the finding of pieces of bitumen near the center of Sec. 6, T. 9 N., R. 3 W., seemed further to establish the basis for the belief that the Satartia region is disturbed geologically.

The map and sketch accompanying this notice (Figure 14) show the distribution of the bentonite and elevations of the bentonite bed at points believed to be essential in situ. The position, trend, and even the presence of the fault is hypothetical, but, as in the case of the arch, the illustrations are designed to present what appears from field work to be the most reasonable structural condition.

Neither the varied elevations of the bentonite, nor the actual presence of the joint-filling bitumen, is sufficient evidence of a structure favorable to oil and gas accumulation. The extent to which slumping has developed on the Yazoo Bluff is not short of astounding, and although the key points were carefully chosen, all elevations are subject to correction. The several pieces of bitumen (the largest 2.0 x 3.0 x 0.5 inches) indicate the escape and evaporation of petroleum, but they do not indicate the source of the migration, nor the original quantity of oil.

The several evidences do not appear to warrant investment unless detailed geophysical work confirms the questionable surface indications of structure. With a recommendation for further study of the area, this release is made by William C. Morse, State Geologist, and is based on a report made to him by Frederic F. Mellen, Field Geologist, who supervised the field investigations.

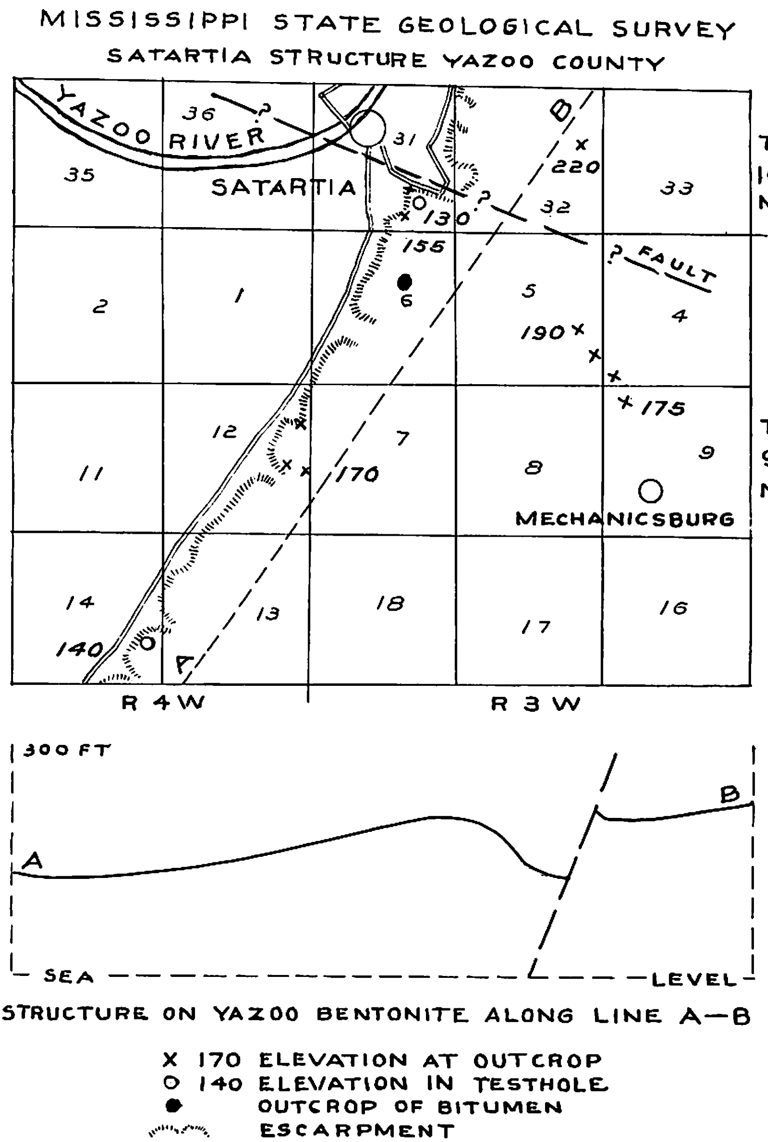

Figure 14.—Satartia structure Yazoo County. August 16, 1939.

Subsequent to the release of the memorandum of April 12, 1939, on the Tinsley Dome, the Union Producing Company leased much of the area, made a seismographic check of the structure, and on August 29, 1939 completed the G. C. Woodruff No. 1 well, the first commercial oil well in Mississippi, four and one-half months after the announcement - accounts of which appeared in the Robert L. Steffey Special Oil Scout Service, the Mississippi Mirror, the Oil Weekly, the Oil and Gas Journal, and the local, state, and national newspapers.

Figure 15.—Inlier of Moodys Branch marl, the surface indication of the Tinsley Dome. Discovered by Frederic F. Mellen, Geologist, WPA-Mississippi State Geological Survey-Yazoo City and County mineral survey in February 1939; announced April 12, 1939; proved August 1939. Photographed by William C. Morse September 22, 1939.

On December 7, 1939 seven wells had encountered productive oil sand, six of the seven were in production, and the seventh was waiting for casing concrete to set. Only one dry well, the Union Producing Company's Friley No. 1, had been drilled on the Tinsley Dome. The oil wells of this date were:

1. Union Producing Company's G. C. Woodruff No. 1;
2. Union Producing Company's Perry Estate No. 1;
3. Jones-O'Brien's Jennie Stevens No. 1;
4. Union Producing Company's Jennie Stevens No. 1;
5. Jones-O'Brien's Jennie Stevens No. 2;
6. Union Producing Company's G. C. Woodruff No. 2;
7. Jones-O'Brien's Jennie Stevens No. B-1.

The production of Union Producing Company's Stevens No. 1 and of Jones-O'Brien's Stevens No. B-1 comes from a lower sand, thought

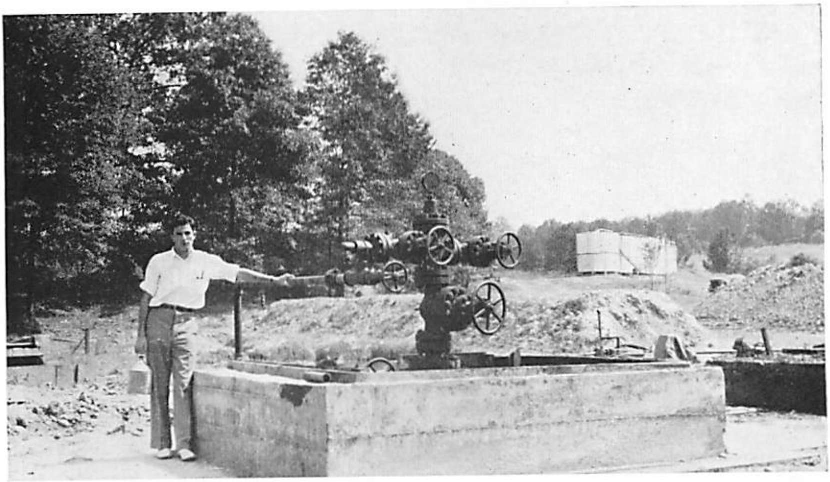

Figure 16.—Union Producing Company G. C. Woodruff No. 1, Mississippi's first commercial oil well. Tinsley Dome. Photographed by William C. Morse September 22, 1939.

to be in the Eutaw formation. Production from the other wells is from a sand some 400 feet higher, thought to be in the Selma formation. Although facilities for handling the oil are still so inadequate that the wells are not on production capacity, and although no official production reports are available, the Jones O'Brien's Stevens No. 1 well, for example, is reported in the daily press to be producing 1656 barrels daily through half-inch choke from sand between 4497 and 4520 feet under casing pressure of 295 pounds and tubing pressure of 210 pounds.

POSSIBILITIES - MIDWAY AREA

Certain structural features (Plate I) in the vicinity of Midway in northeastern Yazoo County suggest to the surface geologist the possible presence in that area of a structure favorable to oil and gas accumulation.

On the F. J. Pepper property (S. 1/2, Sec. 32, T.12 N., R.2 E.) the Yazoo clay is exposed at flood-plain level on the west side of the creek. A few hundred yards to the northeast on the east side of the creek the Yegua-Moodys Branch contact is exposed at a higher elevation, and weathered Moodys Branch is exposed to the top of the hill, facts suggesting an intervening fault of at least 40 feet displacement, downthrow to the west.

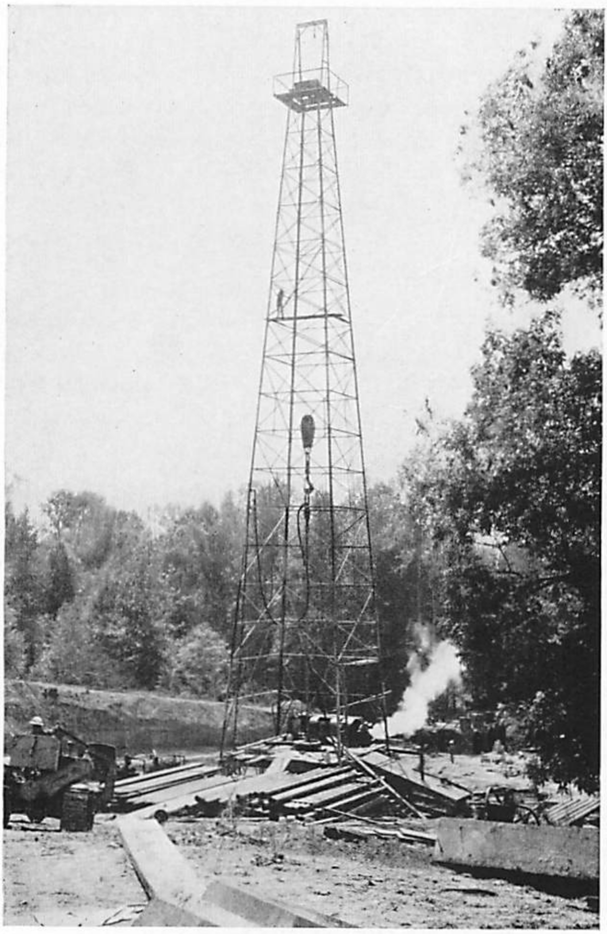

Figure 17.—Union Producing Company Perry Estate No. 1, Mississippi's second commercial oil well. Tinsley Oil Field. Photographed by William C. Morse September 22, 1939.

Two miles southeast of Midway on the J. G. Holmes property (SE. 1/4, Sec. 22, T.12 N., R.1 E.) red weathered Moodys Branch (?) crops out at one point at elevation 285 feet, or level with outcrops of Yazoo clay three miles to the northeast (Center, Sec 7, T.12 N., R.2 E.) This outcrop of Moodys Branch (?) is much higher than outcrops of the Moodys Branch-Yazoo contact north and northwest of Midway on Techeva Creek.

A mile north of Midway (about the center of the line between Secs. 9 and 10, T.12 N., R.1 E.) a fault of about 30 to 50 feet displacement crosses Techeva Creek. The plane and strike of the fault are not visible. Above the bridge over Techeva Creek the Moodys Branch-Yazoo contact is exposed about bridge level. Several hundred feet down stream from the bridge the Yazoo clay forms the bed of the stream, and the top of the Moodys Branch lies at an undetermined maximum depth below the stream bed. The contact is exposed downstream, rising in a westerly direction.

Another fault possibly cuts across Techeva Creek on the George Saxton property (NE. 1/4, SE. 1/4, Sec. 5, T.12 N., R.1 E.). Here, as at the last-mentioned location, Yazoo clay forms the bed of Techeva Creek, and the Moodys Branch-Yazoo contact rises toward the west.

A fault, possibly of displacement in excess of 50 feet, crosses Techeva Creek on the M. Reiman property (NE. 1/4, NW. 1/4, Sec. 31, T.13 N., R.1 E.). As at the other faults, the actual plane has been scoured out so that there is no exposure. However, within a few hundred feet are exposures of lignite and lignitic silts and clays, thought to be well down in the Yegua, and of the typical fossiliferous Moodys Branch marl. This fault differs from all the others in that its downthrow side is to the east. The exposure of Yegua just below the fault is the easternmost exposure of Yegua on Techeva Creek.

These faults, and probably numerous others which were not detected, are very likely secondary results of a localized structural uplift. The Tinsley Dome is possibly too far removed to be of importance in this connection. If the determination of Moodys Branch two miles southeast of Midway on the J. G. Holmes property be correct, it may reflect a structural uplift of sufficient magnitude to explain the faulting in this area.

In conclusion, it is recommended that further careful geological work be done in this area before drilling activity is begun.

TEST HOLE RECORDS

Jim Gibbs Property

Test Hole C1 Record

Location: T. 12 N., R. 2 W., Sec. 33, E.½, SW.¼, NE.¼; Lot 693, Yazoo City; Approx. 64 yds. NE. of the NE. corner of Rosie Wheeler's house Drilled: August 29, 1938

Elevation: 280 feet   Water level: 43 feet

No.	Depth	Thick.	Sample	Description of strata
1	0.4	0.4		Topsoil, very light-brown silty
2	12.5	12.1	C-1	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods
3	22.0	9.5	C-2	Silt, loessal light-brown almost non-plastic; contains very small nodules and shells of small pulmonate gastropods
4	31.4	9.4	C-3	Silt, loessal light-brown almost non-plastic; contains very small nodules and shells of small pulmonate gastropods
5	43.0	11.6	C-4	Silt, loessal light-brown almost non-plastic; contains very small nodules and shells of small pulmonate gastropods
6	50.4	7.4	C-5	Silt, loessal bluish-gray (unoxidized) almost non-plastic; contains shells of pulmonate gastropods; no lime nodules present
7	57.0	6.6	C-6	Silt, loessal brownish-gray and olive (incipient oxidation) almost non-plastic; contains very small lime nodules and shells of pulmonate gastropods
8	58.4	1.4		Sand and gravel, light-brown argillaceous; gravel most abundant at base of interval
	58.4	58.4	6	Total

Remarks: Hole abandoned on account of water causing walls to cave in; augers ineffectual in the gravel. Loess very pulverulent and of uniform grain size throughout the 57.0 feet. If usable, the lime nodules and shells might be removed easily by screening.

Bob Whalen Property

(PASTURE)

Test Hole C2 Record

Location: T. 12 N., R. 2 W., Sec. 33, SE.¼, NE.¼, (Lot 694, Yazoo City) Approx. 93 yds. S 50° E of confluence of two ravines at SW. cor. of Glenwood Cemetery near clump of 2 cedars and elm Drilled August 31, 1938

Elevation: 194.5 feet (approx.) Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	3.6	3.6	C-1	Silt, loessal yellow; very small lime nodules
2	5.0	1.4	C-2	Clay, semi-plastic arenaceous dark-tan; contains lime nodules and colluvial chert pebbles
3	19.5	14.5	C-3	Clay, semi-plastic silty calcareous grayish-brown with yellow iron-stained streaks; contains soft lime nodules and marine fossils
4	24.6	5.1	C-4	Clay, semi-plastic slightly silty calcareous gypsiferous grayish-brown with yellow iron-stained streaks; contains marine fossils
5	29.8	5.2	C-5	Clay, plastic silty calcareous gypsiferous marly brownish and bluish-gray; contains marine fossils
6	36.7	6.9	C-6	Clay, plastic silty calcareous bluish-gray; contains marine fossils (sample slightly contaminated)
7	42.0	5.3	C-7	Clay, plastic slightly silty calcareous marly bluish-gray; contains marine fossils
8	51.1	9.1	C-8	Clay, plastic silty calcareous marly bluish-gray; contains marine fossils (sample slightly contaminated)
9	62.0	10.9	C-9	Clay, plastic slightly silty calcareous bluish-gray; contains marine fossils
	62.0	62.0	9	Total

Remarks: Bottom of hole is 2.5 feet above level of confluence of the two ravines.

Bob Whalen Property

(PASTURE)

Test Hole C3 Record

Location: T. 12 N., R. 2 W., Sec 33, SE.¼, NE.¼ (Lot 694, Yazoo City)
Approx. 88 yds S. 28° E. of hole C2; between two persimmon trees
Drilled August 31, 1938

Elevation: 206.0 feet (approx.) Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	10.3	10.3	C-1	Clay, plastic silty gypsiferous (?) grayish-yellow with yellowish-red ironstained streaks
2	17.7	7.4	C-2	Clay, plastic silty light-gray with yellowish iron-stains; contains soft lime nodules
3	19.8	2.1	C-3	Clay, semi-plastic silty gypsiferous calcareous bluish-gray with yellow iron-stained streaks; contains marine fossils (sample slightly contaminated)
4	21.6	1.8	C-4	Clay, semi-plastic silty gypsiferous calcareous bluish-gray and grayish-brown with yellow iron-stain; contains marine fossils
5	31.2	9.6	C-5	Clay, plastic silty calcareous bluish-gray to dark-gray; contains streaks of iron-stained silt, and marine fossils
6	40.5	9.3	C-6	Clay, plastic silty calcareous dark-gray; contains streaks of light-gray silt, and marine fossils
7	42.9	2.4	C-7	Clay, plastic silty calcareous marly dark-gray; contains marine fossils
8	50.4	7.5	C-8	Clay, plastic fine-grained calcareous bluish-gray; contains marine fossils
9	59.7	9.3	C-9	Clay, plastic silty calcareous bluish-gray; contains marine fossils
10	69.5	9.8	C-10	Clay, plastic silty calcareous bluish-gray; contains marine fossils
11	71.0	1.5	C-11	Clay, semi-plastic silty calcareous light-gray; contains marine fossils
	71.0	71.0	11	Total

Remarks: Bottom of hole is 5.0 feet above confluence of the ravines.

Ed Cooper Property

Test Hole C4 Record

Location: T. 11 N., R. 2 W. Sec. 7; Probably NE.¼, NW.¼; 135 yards N 68° E. of hole C-5 Drilled: August 13, 1938

Elevation: 210 feet (approx.) Water level: Dry

No.	Depth	Thick.	Sample	Description of strata
1	1.7	1.7		Soil and subsoil, argillaceous silty dark-gray to yellow to light-brown semi-plastic
2	11.9	10.2	C-1	Clay, semi-plastic silty calcareous gypsiferous yellowish to light-brown; red iron-stained spots, contains a few marine fossils
3	23.1	11.2	C-2	Clay, silty, calcareous very gypsiferous gray to light-brown; yellow iron-stained streaks and pockets of red-iron-stained silt; contains marine fossils
4	34.6	11.5	C-3	Clay, plastic silty calcareous very gypsiferous yellowish to grayish to light-brown; blue spots at 28.2′; contains marine fossils
5	37.4	2.8	C-4	Clay, plastic tough silty calcareous non-gypsiferous bluish-gray; contains marine fossils
6	38.7	1.3	C-5	Clay, semi-plastic silty calcareous gypsiferous grayish to light-brown with blue spots; yellowish-red iron-stained streaks; incipiently weathered; contains marine fossils
7	48.7	10.0	C-6	Clay, plastic silty calcareous non-gypsiferous bluish-gray; upper 4.0′ incipiently weathered; lower 6.0′ unweathered; contact gradational; contains marine fossils
8	58.7	10.0	C-7	Clay, plastic tough calcareous non-gypsiferous; contains very little silt; contains marine fossils; upper 0.7′ lighter blue and siltier than middle 8.1′; lower 1.2′ siltier than middle 8.1′
9	67.7	9.0	C-8	Clay, semi-plastic very silty calcareous non-gypsiferous bluish-gray; contains marine fossils
10	77.7	10.0	C-9	Clay, plastic tough silty calcareous non-gypsiferous bluish-gray; contains marine fossils
11	87.7	10.0	C-10	Clay, plastic tough silty calcareous non-gypsiferous dark-bluish-gray; hard shell 81.4′; contains marine fossils
12	91.7	4.0	C-11	Clay, plastic tough very silty calcareous non-gypsiferous bluish-gray; contains marine fossils
13	101.7	10.0	C-12	Clay, semi-plastic very silty hard calcareous non-gypsiferous bluish-gray; contains marine fossils
14	105.3	3.6	C-13	Clay, semi-plastic very silty calcareous non-gypsiferous bluish-gray; contains marine fossils
	105.3	105.3	13	Total

Remarks: Hole abandoned at 105.3 feet; still in same type of clay.

Ed Cooper Property

Test Hole C5 Record

Location: T. 11 N., R. 2 W., Sec. 7, Probably in NE.¼, NW.¼; Roughly 150 yds. E. of R. R.; N. 59° E. of culvert on highway which is 0.3 mi. S. of C. L. White Home Drilled: September 13, 1938

Elevation: 166 feet Water level: Dry

No.	Depth	Thick.	Sample	Description of strata
1	1.2	1.2		Clay, semi-plastic silty dark-gray to yellow
2	11.4	10.2	C-1	Clay, semi-plastic silty calcareous, gypsiferous yellowish spotted with reddish-brown iron-stain; contains marine fossils sparingly
3	20.8	9.4	C-2	Clay, plastic silty calcareous, gypsiferous yellowish to grayish-brown to dark bluish-gray; contains marine fossils
4	29.0	8.2	C-3	Clay, plastic tough calcareous, non-gysiferous bluish-gray; contains very little silt in upper part; contains marine fossils
5	39.0	10.0	C-4	Clay, semi-plastic calcareous, non-gypsiferous very silty bluish-gray; thin stratum of plastic clay; contains marine fossils
6	49.0	10.0	C-5	Clay, semi-plastic very silty calcareous, non-gypsiferous bluish-gray; very small hard pyrite concretions at 42.3'; contains marine fossils
7	59.0	10.0	C-6	Clay, semi-plastic very silty calcareous, non-gypsiferous bluish-gray; contains marine fossils
8	69.0	10.0	C-7	Clay, semi-plastic very silty calcareous, non-gypsiferous bluish-gray; thin stratum of plastic clay; contains marine fossils
9	79.0	10.0	C-8	Clay, semi-plastic very silty calcareous, non-gypsiferous bluish-gray; upper half sample is a little more plastic than lower half; contains marine fossils
10	86.9	7.9	C-9	Clay, semi-plastic very silty calcareous, non-gypsiferous bluish-gray; contains marine fossils
	86.9	86.9	9	Total

Remarks: Abandoned at 86.9 feet in same type of clay.

Mrs. Ida Thomas Page Property

Test Hole Record C6

Location: T. 11 N., R. 2 W., Sec. 6, S.½, SW.¼; In field on flood-plain of Yazoo River approx. 150 yards W. of railroad; S. 65° W. of RR crossing at home of C. L. White Drilled: September 13, 1938

Elevation: 105 feet (Approx.) Water level: 20.0 feet

No.	Depth	Thick.	Sample	Description of strata
1	2.0	2.0		Topsoil, brownish and yellowish alluvium
2	11.0	9.0	C-1	Clay, very silty plastic yellowish to brownish
3	14.5	3.5	C-2	Clay, very silty plastic brownish-gray to yellowish
4	29.5	15.0	C-3	Silt, argillaceous slightly plastic brown to bluish-gray.
	29.5	29.5	3	Total

Remarks: Hole abandoned on account of water, and silt caving in on auger.

Mrs. Ida Thomas Page Property

Test Hole Record C7

Location: T. 11 N., R. 2 W., Sec. 6, S.½, SW.¼; 173 yds. S. 42° W. of hole No 6; almost due E. of southernmost of 3 tenant houses; approx. 150 yds. W. of RR Drilled: September 13, 1938

Elevation: 105 feet (Approx.) Water level: 20.0 feet

No.	Depth	Thick.	Sample	Description of strata
1	2.0	2.0		Topsoil, brownish-gray alluvial clay
2	8.0	6.0	C-1	Clay, bluish-gray to brownish plastic
3	13.6	5.6	C-2	Silt, argillaceous brownish-gray to yellowish slightly plastic; streaks of clay; 0.2′ of light-gray silt at 9.7′
4	25.0	11.4	C-3	Silt, coarser than above argillaceous brown to bluish-gray slightly plastic; streaks of silty clay
	25.0	25.0	3	Total

Remarks: Hole abandoned on account of water and silt flowing in on auger.

SEWARD PROPERTY

TEST HOLE C8 RECORD

Location: T. 13 N., R. 1 W., Sec. 19, N.½, SW.¼ Drilled: September 14, 1938

Elevation: 230 feet Water level: 56.6 feet

No.	Depth	Thick.	Sample	Description of strata
1	0.4	0.4		Silt, loessal brown slightly plastic
2	6.0	5.6		Silt, loessal yellowish grading into light-gray at 2.5′; lime nodules at 3.8′; a few shells at 4.0′
3	8.8	2.8		Gravel and sand, red argillaceous
4	12.5	3.7	C-1	Clay, plastic calcareous iron-stained yellowish-gray; soft lime nodules
5	20.9	8.4	C-2	Clay, semi-plastic calcareous light grayish-yellow
6	21.7	0.8		Clay, semi-plastic calcareous light grayish-yellow; bluish silty calcareous clay below
7	30.6	8.9	C-3	Clay, semi-plastic light bluish-gray calcareous very silty; marine fossils
8	31.7	1.1	S-1	Sand; sand-marl, ferruginous yellowish-brown streaked with bluish-gray
9	32.1	0.4		Rock, hard arenaceous calcareous; shells
10	42.1	10.0	C-4	Sand; sand-marl, ferruginous, argillaceous, calcareous, gypsiferous packed tightly bright brownish-red; lime nodules and marine fossils
11	47.3	5.2	C-5	Sand; sand-marl, ferruginous, argillaceous calcareous bright brownish-red; marine fossils
12	57.3	10.0	C-6	Sand; sand-marl, medium-grained glauconitic, argillaceous, calcareous dark greenish-gray; marine fossils
13	67.6	10.3	C-7	Sand; sand-marl, fine-grained glauconitic, argillaceous, calcareous dark greenish-gray; marine fossils; darker color at 61.0′; small hard limerock at 64.5′; contaminated
	67.6	67.6	7	Total

Remarks: Rock, very hard (bit broken off on this). Approximately 400 yards east of grade crossing 23 yds. north of Zelleria station, along road; south of center of road 23 yds; by persimmon tree. This hole sampled basal Yazoo clay and both incipiently weathered and unweathered material of the Moodys Branch marl.

J. A. Bunner Property

Test Hole C9 Record

Location: T. 13 N., R. 1 W., Sec. 19, NE.¼, SW.¼ Drilled: September 15, 1938

Elevation: 340 feet Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	0.5	0.5		Topsoil, light-brown silty
2	10.2	9.7	C-1	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
3	19.0	8.8	C-2	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
4	28.0	9.0	C-3	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
5	36.0	8.0	C-4	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
6	42.2	6.2	C-5	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
7	47.3	5.1	C-6	Silt, loessal chocolate-brown almost non-plastic; contains shells of pulmonate gastropods and a few lime nodules
8	54.4	7.1	C-7	Silt, loessal reddish-brown semi-plastic; contains shells of pulmonate gastropods and a few lime nodules
9	63.7	9.3	C-8	Silt, loessal reddish-brown tough semi-plastic; contains shells of pulmonate gastropods and a few lime nodules; sand in lower part
10	64.2	0.5		Gravel; argillaceous sand
10	64.2	64.2	8	Total

Remarks: Along road 460 yds. E. of Test hole C8 to intersection of roads; thence north along road 168 yards; by locust tree; just north on crest of hill.

I. J. HART PROPERTY

TEST HOLE C11 RECORD

Location: T. 10 N., R. 3 W., Sec. 31, SE.¼; 12 yds. W. of center of Mechanicsburg road; 90 yds. S. 7° E. of test hole C10; by clump of locust trees
Drilled: October 2, 1938

Elevation: 180 feet Water level: 70.0 feet

No.	Depth	Thick.	Sample	Description of strata
1	0.8	0.8		Clay, plastic yellowish-brown; numerous live roots
2	16.0	15.2	C-1	Clay, plastic slightly silty calcareous, gypsiferous brownish-yellow to brownish-gray; contains soft lime nodules; contains a few small marine fossils
3	24.0	8.0	C-2	Clay, plastic very slightly silty calcareous, gypsiferous brownish-yellow to dark brownish-gray; contains a few small marine fossils
4	32.0	8.0	C-3	Clay, semi-plastic slightly silty calcareous, very gypsiferous brownish-gray to dark-gray
5	38.0	6.0	C-4	Clay, semi-plastic very silty calcareous, non-gypsiferous (?) laminated brown to to dark-gray; contains a few very small marine fossils
6	46.0	8.0	C-5	Clay, semi-plastic silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
7	54.6	8.6	C-6	Clay, semi-plastic silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
8	55.2	0.6	C-7	Clay, bentonite, non-plastic silty much lighter gray than material above and below
9	65.4	10.2	C-8	Clay, semi-plastic silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
10	77.0	11.6	C-9	Clay, plastic silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
11	87.0	10.0	C-10	Clay, plastic slightly silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
12	96.3	9.3	C-11	Clay, plastic slightly silty, slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
13	105.8	9.5	C-12	Clay, plastic slightly silty slightly calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
14	111.4	5.6	C-13	Clay, plastic silty calcareous, non-gypsiferous laminated bluish-gray; contains a few small marine fossils
	111.4	111.4	13	Total

Remarks: The hill on which C11 was bored has sufficient relief for outcrop of lower levels of the log. Cuts of samples C6—C12, inclusive sent to Nutting 10/17/38.

I. J. HART PROPERTY

TEST HOLE C12 RECORD

Location: T. 9 N., R. 3 W., Sec. 6, NE.¼; 835 yards S. of hole C11 along Mechanicsburg road; on bank 8 yards W. of road in pasture Drilled: October 3, 1938

Elevation: 315 feet Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	0.6	0.6		Topsoil, silty loessal; grass roots
2	15.3	14.7	C-1	Silt, loessal light-brown almost non-plastic; contains shells of pulmonate gastropods; small lime nodules
3	28.0	12.7	C-2	Silt, loessal light-brown almost non-plastic; shells of pulmonate gastropods; small lime nodules
4	40.0	12.0	C-3	Silt, loessal light-brown almost non-plastic; shells of pulmonate gastropods; small lime nodules
5	52.7	12.7	C-4	Silt, loessal light-brown almost non-plastic; shells of pulmonate gastropods; small lime nodules
6	55.5	2.8		Silt, loessal light-brown almost non-plastic grading to brown silt; arenaceous
7	60.0	4.5	C-5	Sand, fine-grained rounded argillaceous reddish-brown; a few small pebbles of quartz and chert
8	65.0	5.0	C-6	Sand, fine- to medium-grained rounded argillaceous bright-red
9	76.6	11.6	C-7	Sand, fine- to medium-grained rounded argillaceous brownish-red; small pockets of whitish sand; a few small pebbles of quartz and chert
10	78.4	1.8	S-1	Sand, medium- to coarse-grained rounded argillaceous reddish-brown; chert and quartz pebbles
11	78.6	0.2	S-2	Sand; gravel, reddish-brown argillaceous, sand, medium- to coarse-grained rounded; chert and quartz pebbles
	78.6	78.6	7	Total

Remarks: Abandoned at 78.6 feet because of caving of sand and gravel.

F. A. McGRAW PROPERTY

TEST HOLE RECORD C13

Location: T. 10 N., R. 3 W., Sec. 3, SE.¼, NE.¼; On hill slope about 200 ft. E. of Highway 3; 0.5 mile S. of Perry Creek bridge just S. of Valley
Drilled: October 7, 1938

Elevation: 150 feet Water level: Dry

No.	Depth	Thick.	Sample	Description of strata
1	4.4	4.4		Silt, loessal grayish-brown argillaceous
2	6.2	1.8		Sand; silt, yellowish-brown to reddish-brown argillaceous; a few chert pebbles
3	20.4	14.2	C-1	Clay, plastic silty calcareous, gypsiferous light-gray in upper part; lime nodules in upper part; marine fossils throughout; grades into bluish-gray at 12.6′
4	30.4	10.0	C-2	Clay, plastic, tough silty calcareous, non-gypsiferous bluish-gray; marine fossils
5	40.4	10.0	C-3	Clay, plastic, tough silty calcareous, non-gypsiferous bluish-gray; marine fossils
6	49.0	8.6	C-4	Clay, plastic, tough silty calcareous, non-gypsiferous bluish-gray; marine fossils
	49.0	49.0	4	Total

Remarks: Hole abandoned at 49.0 feet in same type of material.

H. E. TAYLOR PROPERTY

TEST HOLE RECORD C21

Location: T. 11 N., R. 1 W., Sec. 3, N.½, SE.¼; 165 yds. W. of Wilkerson Bros. Store; 16 yds. S. center of Yazoo City road; in edge of cedar grove
Drilled: October 17, 1938

Elevation: 385 feet — Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	0.3	0.3		Topsoil, silty loessal yellowish-brown; grass and tree roots
2	10.0	9.7	C-1	Silt, loessal light-brown almost non-plastic non-calcareous
3	19.7	9.7	C-2	Silt, loessal light-brown almost non-plastic non-calcareous
4	22.5	2.8	C-3	Silt, loessal brown almost non-plastic non-calcareous
5	24.2	1.7	C-4	Silt, loessal brown almost non-plastic non-calcareous; manganiferous pisolites (buckshot)
6	34.2	10.0	C-5	Silt, loessal light-brown to yellowish-brown argillaceous non-calcareous semi-plastic
7	35.2	1.0		Silt, loessal light-brown almost non-plastic non-calcareous
8	39.6	4.4		Silt, loessal argillaceous semi-plastic yellowish-brown
9	51.3	11.7	C-6	Clay, loessal silty yellowish-brown semi-plastic non-calcareous
10	62.9	11.6	C-7	Clay, loessal silty yellowish-brown plastic non-calcareous
11	63.6	0.7	S-1	Silt, alluvial light yellowish-brown argillaceous, arenaceous
	63.6	63.6	7	Total

Remarks: This section shows a high degree of weathering of the loessal material. It is the first section in Yazoo County to show alluvial silt beneath the loessal silt

C. F. Harris Property

Test Hole Record C23

Location: T. 9 N., R. 2 W., Sec. 2, NE.¼, SW.¼ Drilled: October 20, 1938
Elevation: 175 feet Water level: not det.

No.	Depth	Thick.	Sample	Description of strata
1	0.3	0.3		Soil, silty grayish-brown; grass roots
2	7.6	7.3	C-1	Clay, silty; silt, argillaceous; small manganiferous buckshot at top; grayish-brown to dark-brown, mottled ferruginous, non-calcareous; semi-plastic loessal material
3	13.1	5.5	C-2	Silt, loessal argillaceous dark-brown, slightly mottled ferruginous, non-calcareous semi-plastic
4	18.6	5.5	C-3	Silt, loessal argillaceous dark-brown, slightly mottled ferruginous; contains a few lime concretions, no shells, semi-plastic
	18.6	18.6	3	Total

Remarks: 110 yds. E. of right-of-way of Highway 49; 100 yards W. of railroad; S. 13.5° E. of center of overpass; N. 32.5° W. of Harris home; 15 feet inside NE. corner of pasture. This is an excellent location for a brickyard. Drainage is excellent.

State of Mississippi Property

Test Hole Record C24

Location: T. 9 N., R. 2 W., Sec. 14, SE.¼, SE.¼; On untouched portion of large borrow pit, 57 yds. S. 42° W. of NE. corner Drilled: October 20, 1938
Elevation: 150 feet Water level: not det.

No.	Depth	Thick.	Sample	Description of strata
1	0.3	0.3		Soil, grayish-brown very silty; grass roots
2	7.6	7.3	C-1	Silt, argillaceous yellowish-gray to brown semi-plastic
3	15.6	8.0	C-2	Silt, less argillaceous semi-plastic dark-brown
	15.6	15.6	2	Total

Remarks: Test hole is 259 feet from center of highway 49. Another hole drilled a few hundred yards S. showed remarkable uniformity of the material, which is weathered loess. The quantity under the expansive fields is unlimited. Drainage is excellent.

Mrs. Minnie McCorkle Property

Test Hole Record C25

Location: T. 10 N., R. 2 W., Sec. 2, S.½, SW.¼ Drilled: October 21, 1938
Elevation: 230 feet Water level: 1 foot

No.	Depth	Thick.	Sample	Description of strata
1	5.7	5.7	C-1	Clay, semi-plastic very slightly silty, slightly calcareous, bentonitic dark-gray; small marine fossils; small pyrite balls
2	7.5	1.8	C-2	Clay, semi-plastic very slightly silty, slightly calcareous dark-gray; contains 1.0 foot or less of bentonite, very slightly silty semi-plastic light-gray
3	15.0	7.5	C-3	Clay, plastic slightly silty bentonitic, slightly calcareous; small marine fossils; small pyrite balls
4	19.0	4.0	C-4	Clay, plastic silty bentonitic, slightly calcareous; small marine fossils; small pyrite balls
	19.0	19.0	4	Total

Remarks: The upper clay (C1) is, of course, the only that offers any development opportunities at this point; such development would certainly be limited to small output because of the relatively high overburden and lack of drainage. Hole drilled on south bank of stream about 50 feet above water gap at south end of meadow.

J. C. Alderman Property

Test Hole Record C29

Location: T. 11 N., R. 2 W., Sec. 23, NE.¼, SW.¼; top of hill just west of new Highway 49 Drilled: October 24, 1938
Elevation: Elevation 300 feet (top of gravel) Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	18-20	18-20		Silt, loessal light grayish-brown; material thrown back by shovel in stripping
2	39.0	20.0		Silt, loessal light grayish-brown
3	42.5	3.5	C-1	Gravel and sand
4	46.0	3.5	C-2	Gravel and sand
	46.0	46.0	2	Total

Remarks: This sampling was done in the north end of the pits operated during the construction of the new Highway 49 by the Alabama Aggregate Company.

J. C. ALDERMAN PROPERTY

TEST HOLE RECORD C30

Location: T. 11 N., R. 2 W., Sec. 23, NE.¼, SW.¼; top of hill just west of new Highway 49 Drilled: October 24, 1938

Elevation: 300 feet (top of gravel) Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	15.0	15.0		Silt, loessal light grayish-brown; material thrown back by shovel in stripping
2	45.0	30.0		Silt, loessal light grayish-brown; in situ
3	51.5	6.5	C-1	Gravel and sand
4	57.5	6.0	C-2	Gravel and sand, argillaceous
5	66.0	8.5	C-3	Gravel and sand
6	68.0	2.0		Sand, medium-grained reddish-yellow
7	69.0	1.0		Sand, medium-grained reddish-yellow; gravel
	69.0	69.0	3	Total

Remarks: This sampling was done in the center of the pits operated during the construction of the new Highway 49 by the Alabama Aggregate Company

J. C. ALDERMAN PROPERTY

TEST HOLE RECORD C31

Location: T. 11 N., R. 2 W., Sec. 23, NE.¼, SW.¼; top of hill just west of new Highway 49 Drilled: October 24, 1938

Elevation: 300 feet (top of gravel) Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	35.0	35.0		Silt, loessal light-grayish brown; in situ
2	41.0	6.0	C-1	Gravel and sand
3	47.0	6.0	C-2	Gravel and sand
4	53.0	6.0	C-3	Gravel and sand
	53.0	53.0	3	Total

Remarks: This sampling was done in the south end of the pits operated during the construction of the new Highway 49 by the Alabama Aggregate Company.

Bob Whalen Property

Test Hole Record C34

Location: T. 12 N., R. 2 W., Sec. 33, NE.¼, NE.¼; bed of branch S. of SE. corner of Glenwood Cemetery Drilled: November 1, 1938

Elevation: 115 feet Water level: 56.8 feet

No.	Depth	Thick.	Sample	Description of strata
1	10.0	10.0	S-1	Clay, bluish-gray calcareous plastic, tough; marine shells; silty
2	20.0	10.0	S-2	Clay, bluish-gray calcareous plastic, tough; marine shells; silty
3	30.0	10.0	S-3	Clay, bluish-gray calcareous plastic, tough; marine shells; very silty
4	40.0	10.0	S-4	Clay, greenish-blue calcareous plastic very hard, marine shells; very silty
5	50.0	10.0	S-5	Clay, greenish-blue calcareous plastic very hard, marine shells; very silty
6	57.4	7.4	S-6	Clay, greenish-blue calcareous plastic very hard, marine shells; very silty
7	72.4	15.0	S-7	Sand-marl, grayish-green glauconitic; marine shells
8	80.8	8.4	S-8	Sand-marl, dark grayish-green glauconitic very fine-grained argillaceous; marine shells (sample badly contaminated)
	80.8	80.8		Total

Remarks: Elevation from hole C34 to hole C2 is 66.0'. Top of Moodys Branch marl is about 57.6' above sea level.

16th Section Property

Test Hole Record C35

Location: T. 13 N., R. 1 W., Sec. 16, SE.¼, NE.¼; 50 yds. S. of iron bridge over Techeva Creek Drilled: November 3, 1938

Elevation: 1.15 (base of exposure)

No.	Depth	Thick.	Sample	Description of strata
1	9.0	9.0	C-1	Silt, gray lignitic; 0.2' lignitic wood thrown out at 6.0'
2	18.0	9.0	C-2	Silt, gray lignitic
	18.0	18.0	2	Total

Remarks: These samples are from the base of a 40-foot exposure of the Yegua beds and are of a typical material, though possibly not recoverable quantity at this point.

D. A. SWAYZE, EST. PROPERTY

TEST HOLE RECORD C37

Location: T. 12 N., R. 2 W., Sec. 27, SE.¼, NW.¼; 9 feet N. of pasture fence; 123 feet W. of power line Drilled: November 14, 1938

Elevation: 135 feet Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	2.2	2.2	C-1	Silt, loessal yellowish-gray non-calcareous
2	3.8	1.6		Silt, loessal bright yellowish-brown argillaceous non-calcareous
3	4.7	0.9		Silt, loessal dark grayish-brown argillaceous non-calcareous
4	8.0	3.3		Silt, loessal yellowish-brown non-calcareous
5	10.2	2.2		Silt, loessal yellowish-brown with gray patches non-calcareous
6	17.7	7.5		Silt, loessal yellowish-brown with gray streaks
7	19.4	1.7		Silt, loessal dark-gray manganiferous (?)
	19.4	19.4	1	Total

Remarks: The 10.2 feet of weathered loessal material composing this sample is regarded as typical of the material used in the past from adjoining property in the manufacture of brick.

J. W. CRAWFORD PROPERTY

TEST HOLE RECORD C40

Location: T. 12 N., R. 5 W., Sec. 13, NW.¼, SE.¼ Drilled: November 15, 1938

Elevation: 100 feet Water level: 1 foot, due to overflowing well nearby

No.	Depth	Thick.	Sample	Description of strata
1	0.8	0.8		Topsoil, dark loam
2	2.8	2.0	C-1	Silt, yellowish-brown to gray argillaceous semi-plastic
3	3.5	0.7		Silt, brownish-gray to light-gray argillaceous semi-plastic
4	6.8	3.3		Clay, grayish-brown silty very plastic tough
5	13.0	6.2		Clay, grayish-brown to yellowish-gray silty very plastic tough
6	20.0	7.0	C-2	Clay, very silty plastic brownish-gray
	20.0	20.0	2	Total

Remarks: Location: about 125 yds. N. 51° W. of NW. corner of J. W. Crawford home; 20 feet S. of center of Highway; 234 yds. SW. of Anguilla road two other holes bored a few hundred yards away in different directions show relative uniformity of this alluvial material.

F. W. SHARBROUGH, JR. PROPERTY

TEST HOLE RECORD C43

Location: T. 11 N., R. 5 W., Sec. 9, NE.¼ Drilled: November 15, 1938
Elevation: 95 feet Water level: 17 feet

No.	Depth	Thick.	Sample	Description of strata
1	10.0	10.0	C-1	Silt, grayish-brown argillaceous semi-plastic; grass roots in upper part
2	13.9	3.9	C-2	Silt, grayish-brown argillaceous semi-plastic
3	15.6	1.7		Silt, yellowish-brown to reddish-brown argillaceous semi-plastic
4	20.0	4.4		Silt, silty clay; bluish-black plastic; grades into fine-grained argillaceous sand below
5	20.2	0.2		Sand, bluish-gray fine-grained argillaceous
	20.2	20.2	2	Total

Remarks: Location: at Holly Bluff; 160 yds. W. of railroad underpass; about 100 yards N. of Sunflower River; 24 feet W. of 26-inch pecan tree. Four other holes bored in fields nearby showed similar materials.

M. F. FALKNER PROPERTY

TEST HOLE RECORD C49

Location: T. 9 N., R. 4 W., Sec. 27, NE.¼, NW.¼; 118 yards N. 88° E. of B. M. Y-41 Drilled: December 6, 1938
Elevation: 150 feet Water level: 18 feet

No.	Depth	Thick.	Sample	Description of strata
1	4.0	4.0		Sand, yellowish-brown, medium-fine grained
2	8.0	4.0		Sand, gray
3	9.0	1.0		Sand, grayish-yellow
4	10.7	1.7		Sand, light-blue
5	11.9	1.2	S-1	Lignite, brown, appears to be very earthy
6	12.6	.7		Lignitic earth, chocolate-brown clayey
7	20.5	7.9		Sand, brownish-yellow, fine-grained
8	30.0	9.5	S-2	Sand, blue, contaminated
9	39.0	9.0	S-3	Sand, brownish-blue
10	47.2	8.2	S-4	Clay, blue, no shells; Yazoo (?) plastic, contaminated from above
11	52.3	5.1		Clay, greenish-blue, plastic, contaminated
	52.3	52.3	4	Total

Remarks: Top of the Yazoo clay struck at 39.0 feet or approximately 111 feet above sea level. It is a very pure clay at the top but no samples could be taken because of silty water. Subsequently this clay has been sampled by hole C59.

W. E. & R. E. SELBY PROPERTY

TEST HOLE RECORD C52

Location: T. 8 N., R. 4 W., Sec. 4, about in NE.¼, NW.¼; 50 ft. above brink of 2nd fall on south side of valley below Thornell Waterfall Drilled: December 8, 1938

Elevation: About 180 feet

No.	Depth	Thick.	Sample	Description of strata
			P-1	Hole C52 is a trench dug from outcrop 15 feet into the hill. The stratum of bentonite is the same as near Thornell Waterfall and at C53, and is 12.5 feet above lowest hard ledge of limestone. The general level of the ridge tops is 130 feet above the bentonite. The thicknesses of the bentonite at different points in the trench are: 1.1, 0.7, 1.0, 1.0, 0.7, 0.8, 1.0. At the back of the trench there is 9 feet of gravel and sand. The bentonite is completely oxidized at all points, is a bright yellow fine-grained mealy clay, overlain and underlain by leached sandy bentonitic marl

Remarks: This material can be removed only by pick and shovel; there is, at most, only a few hundred cubic yards.

W. E. & R. E. SELBY PROPERTY

TEST HOLE RECORD C53

Location: T. 8 N., R. 4 W., Sec. 4, NW.¼, NE.¼; about 200 yards above brink of 1st waterfall on south side of valley below Thornell Waterfall Drilled: December 8, 1938

Elevation: 180 feet

No.	Depth	Thick.	Sample	Description of strata
			P-1	Hole C53 is a shallow vertical trench dug in the bentonite in the small pool where it crops out some 200 or 300 yards SW. of Thornell Waterfall. The bentonite, greenish-gray incipiently oxidized somewhat calcareous and fossiliferous and waxy is 1.7 to 1.8 feet thick. The bentonite is overlain by about 0.5 feet of whitish bentonitic marl or soft limestone beneath hard limestone, and is underlain by about an equal amount of bentonitic shell marl lying on hard limestone Sample C53-P1A was taken by digging through the bed of the stream about 50 yards SE. of C53; it is a totally unoxidized sample

Remarks: Only a few hundred tons at most could be removed without underground mining, and the low roof would discourage underground work. This bentonite is probably of no present commercial value.

W. E. & R. E. SELBY PROPERTY

TEST HOLE RECORD C54

Location: T. 8 N., R. 4 W., Sec. 4, NW.¼, NE.¼; about 400 yards ESE. of Thornell Waterfall at edge of stream Drilled: December 8, 1938

Elevation: 195 feet

No.	Depth	Thick.	Sample	Description of strata
			P-1	Trench dug from edge of stream back into hill 55.0 feet. Bentonite about 1 foot thick at outcrop; about 2.0 feet thick in middle, and about 1.8 feet thick at end. Nearly all bentonite incipiently oxidized and much-slickensided by pressure of over-lying gravel and loess. Sample C54-P1 taken at the end of trench. This bed overlies a very glauconitic marl over a ledge of limestone and is thought to be 15 to 20 feet above the bentonite of test-holes C52 and C53

Remarks: No economic value

F. H. DAVIS PROPERTY

TEST HOLE RECORD C55

Location: T. 12 N., R. 2 E., Sec. 13, NE.¼ NE.¼; 65 yds. NW. of home
Drilled: December 6, 1938
Water level: dry

No.	Depth	Thick.	Sample	Description of strata
1	3.7	3.7	C-1	Clay, silty (brown loam) plastic, uniformly brown at top; lower part mottled by white leached portions and darker manganiferous stains
2	8.3	4.6	C-2	Silt, loessal argillaceous semi-plastic; slightly mottled in upper portion by leaching and manganiferous residue; most of thickness uniformly brown
3	9.7	1.4		Sand and gravel, very argillaceous reddish-brown
4	11.3	1.6	C-3	Clay, arenaceous plastic mottled red and brown; small ferruginous sandrock at 11.0'
5	13.6	2.3		Sand, argillaceous brownish-red; chert and quartz pebbles
6	16.8	3.2	C-4 (6–8)	Clay, tough, plastic silty gray, mottled by red iron-stain
7	17.6	0.8	C-4 (6–8)	Clay, plastic silty gray
8	19.7	2.1	C-4 (6–8)	Clay, very silty semi-plastic gray, mottled by yellow and brown iron-stain
9	26.4	6.7	C-5	Silt, micaceous, argillaceous light-gray, slightly mottled by yellow almost non-plastic; few lumps of plastic clay
10	38.5	12.1	C-6	Silt, micaceous, argillaceous light-gray, slightly mottled by yellow almost non-plastic; few lumps of plastic clay; fine-grained sand in bottom of hole
	38.5	38.5	6	Total

Remarks: C1 is typical of the "brown loam"; C2 is highly weathered loess, non-calcareous; C1 grades into C2; C4, C5, C6 are Lisbon or Yegua material.

MRS. F. P. SMITH PROPERTY

TEST HOLE RECORD C57

Location: T. 9 N., R. 4 W., Sec. 14, SE.¼; 109 yds. from C57 to C58 N. 64° E. of Mrs. Frank P Smith residence Drilled: December 16, 1938
Elevation: 180 feet Water level: 36 feet

No.	Depth	Thick.	Sample	Description of strata
1	3.8	3.8		Loess, brown to yellow silty lime nodules
2	4.4	.6		Loess, yellowish hard lumps of red sand and gravelly lime rock
3	7.0	2.6		Sand and gravel, red
4	10.1	3.1		Silt, whitish yellow (Yazoo?)
5	14.6	4.5		Clay, gray yellow iron stain streaks very plastic; slightly contaminated
6	15.3	.7		Clay, mottled gray and blue mixed yellow iron-stain streaks; very plastic, tough
7	21.1	5.8		Clay, grayish-blue calcareous very plastic silty
8	40.0	18.9		Silt, greenish-gray argillaceous
9	40.5	.5		Clay, greenish-blue
10	42.7	2.2		Silt, greenish-gray
11	43.1	.4	S-1	Bentonite, light-gray very plastic slightly silty; slightly contaminated
12	45.0	1.9		Clay, greenish-blue silty plastic
	45.0	45.0	1	Total

Remarks: Hole abandoned at 45′. Top of bentonite 138′ above sea level.

MRS. F. P. SMITH PROPERTY

TEST HOLE RECORD C59

Location: T. 9 N., R. 4 W., Sec. 14, SE.¼; N. 84° E. of Mrs. Frank P. Smith home in pasture Drilled: December 16, 1938
Elevation: 194 feet Water level: 40.2 feet

No.	Depth	Thick.	Sample	Description of strata
1	4.8	4.8		Loess, brownish-yellow silty
2	15.2	10.4		Loess, yellow lime nodules, yellow iron stain at 11.2′ to reddish-brown
3	18.4	3.2		Clay, mottled yellowish red and gray very silty semi-plastic
4	18.7	.3		Sand and gravel red
5	31.7	13.0	P-1	Clay, greenish-blue non-calcareous (?) very fine-grained very slightly silty in lower part
6	35.4	3.7	C-1	Clay, shells greenish-blue slightly silty
7	43.1	7.7		Silt, light-bluish-gray very argillaceous
	43.1	43.1	2	Total

Remarks: Hole abandoned at depth of 43.1′. Top (?) of Yazoo clay is 175′ above sea level.

G. C. WOODRUFF PROPERTY

TEST HOLE RECORD C60

Location: T. 10 N., R. 3 W., Sec. 13; about 60 yards N. 56° E. of SW. corner NW.¼; about 4 feet above water level on E. bank of Perry Creek on outcrop Drilled: March 20, 1939

Elevation: 150 feet Water level: 4.0 feet

No.	Depth	Thick.	Sample	Description of strata
1	3.5	3.5		Sand-marl, very fossiliferous argillaceous, glauconitic, micaceous fine-grained, highly oxidized at top; incipiently oxidized below
2	12.5	9.0	S-1	Sand-marl, very fossiliferous argillaceous, glauconitic, micaceous fine-grained bluish-gray; grades to steel-gray below; bits of lignitic matter in places, especially near bottom of interval; toward bottom of interval material is laminated sparingly fossiliferous sparingly glauconitic, micaceous silt
3	22.1	9.6	S-2	Silt, very lignitic, micaceous, argillaceous, pyritiferous laminated
4	23.1	1.0	S-3 (4–5)	Lignite, soft brownish argillaceous
5	35.9	12.8		Silt, argillaceous and clay, silty, both laminated brownish-gray lignitic and pyritiferous
	35.9	35.9	3	Total

Remarks: About 9.0 feet of oxidized sand-marl are exposed in the bluff above the outcrop. Base of interval 2 is bored zone at top of Yegua showing a seeming gradation of materials. Intervals 3 - 5 are non-glauconitic and are the unbored portion of the Yegua. The base of the Moodys Branch marl lies about 8.0 feet below mouth of test hole.

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Through the persistent interest of Secretary K. S. Foster, the Yazoo County Chamber of Commerce made the final arrangements for the beginning, on August 13, 1938, of the Works Progress Administration-Mississippi Geological Survey's Clay and Minerals Survey of Yazoo County. The Yazoo County Board of Supervisors appropriated $307.00 for the purchase of tools and other items necessary for the work, and the Yazoo City Council provided office and storage space, heat, lights, and water for the duration of the work. Mrs. Sally Gwin, District Supervisor and Mrs. Laura Griffin, Area Supervisor, Division of Professional and Service Projects, WPA, and Mrs. Blanche Somerville, State Supervisor of WP 4847, supervised the official operation of the project very efficiently. Acknowledgments are due also Miss Margaret Grace McCorkle, recently appointed State Supervisor of WP 4847 and Miss Laura Cameron, Secretary of the Survey, both of whom aided in the preparation and in the proof-reading of the manuscript. State Geologist William C. Morse, and geologists L. C. Conant, V. M. Foster, and F. E. Vestal of the other county units of WP 4847 visited the writer in the field on several occasions and advised with him. Mr. Eron J. Chandler served efficiently as the crew supervisor and Mr. J. A. McCool as sample man. In addition to the original appropriation, the Yazoo County Board of Supervisors is continuing to assist magnanimously to defray the costs of final completion of the survey. The Southern Natural Gas Company has provided several hundred dollars worth of maps and pipe for use on the project. The Mississippi River Commission furnished several quadrangle maps, bench mark data, and information on the navigability of the Yazoo River. Mayor D. M. Love of Yazoo City and Mr. K. S. Foster were always cooperative and greatly facilitated the work of the survey. Under the direction of Miss Nannie Evans, Supervisor, the WPA Sewing Project made the hundreds of large sample bags needed.

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YAZOO COUNTY MINERAL RESOURCES

TESTS

THOMAS EDWIN McCUTCHEON, B. S., CER.

INTRODUCTION

In the geologic part of this report it is shown that deposits of several kinds of mineral materials are in great abundance, in fact inexhaustible supplies are available at locations that are readily accessible. Samples were secured by Mellen representing the different materials as to area and depth. The results of testing these samples show: (1) The general character of the materials, (2) The uniformity or non-uniformity of the deposits, (3) the properties of the individual C samples, and (4) possibilities for utilization of the deposits.

Inasmuch as the scope of the test work was limited mostly to standard routine tests, it was not possible to investigate thoroughly the numerous possibilities that exist; consequently, the most useful purposes this report can serve are to point out opportunities to commercial interests and to furnish them a guide in the proper selection of raw materials. The laboratory is making further studies on the several materials, the results of which, if important, will be announced by the Mississippi Geological Survey. The laboratory stands ready at all time to cooperate with commercial interest in working out particular problems concerning the mineral resources of Yazoo County.

LABORATORY TESTS OF THE YAZOO CLAY-MARL

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Physical Properties in the Unburned State, Hole No. C2

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	14.34	*	*	Fine, open	Brown
C2	21.41	*	*	Fine, open	Brown
C3	21.82	*	*	Fine, open	Brown
C4	36.47	43.62	17.43	Fine, dense	Brown
C5	36.83	48.43	19.84	Fine, dense	Dark brown
C6	31.71	34.01	12.98	Fine, dense	Grey
C7	34.87	39.77	15.56	Fine, dense	Grey
C8	43.10	56.08	24.00	Fine, dense	Grey
C9	41.50	49.23	20.26	Fine, dense	Grey

*Data not determined due to lack of natural plasticity of material necessitating use of artificial binder to form test pieces.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C3

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	30.96	37.32	14.46	Fine, dense	Lt. brown
C2	34.64	45.07	18.12	Fine, dense	Lt. brown
C3	35.36	45.38	18.27	Fine, dense	Lt. brown
C4	36.54	41.37	16.32	Fine, dense	Lt. grey
C5	38.44	47.82	19.53	Fine, dense	Grey
C6	40.85	55.62	23.77	Fine, dense	Dark grey
C7	33.17	33.73	12.85	Fine, dense	Lt. grey
C8	36.33	46.53	18.87	Fine, dense	Grey
C9	43.02	54.72	23.26	Fine, dense	Grey
C10	41.68	51.53	21.49	Fine, dense	Grey
C11	35.10	39.87	15.61	Fine, dense	Lt. grey

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C4

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	32.66	42.04	16.65	Fine, dense	Brown
C2	33.04	44.10	17.62	Fine, dense	Brown
C3	34.57	42.08	16.65	Fine, dense	Brown
C4	34.56	41.68	16.46	Fine, dense	Lt. grey
C5	29.52	30.81	11.59	Fine, dense	Brown
C6	37.55	48.97	20.10	Fine, dense	Grey
C7	43.80	62.32	27.83	Fine, dense	Dark grey
C8	35.88	31.88	11.68	Fine, dense	Grey
C9	39.72	53.63	22.64	Fine, dense	Dark grey
C10	39.04	50.02	20.68	Fine, dense	Grey
C11	39.50	50.76	21.06	Fine, dense	Grey
C12	35.13	41.58	16.41	Fine, dense	Grey
C13	38.27	43.12	17.18	Fine, dense	Grey

Modulus of rupture:

Composite of C1, C2, C3; 530 lbs. per sq. inch.
Composite of C6, C7, C8; 611 lbs. per sq. inch.
Composite of C9, C10, C11, C12; 607 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C5

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	32.63	42.08	16.65	Fine, dense	Brown
C2	38.49	47.77	19.48	Fine, dense	Dark brown
C3	42.02	58.32	25.35	Fine, dense	Dark grey
C4	37.10	44.37	17.77	Fine, dense	Lt. grey
C5	41.10	48.98	20.10	Fine, dense	Grey
C6	42.72	54.58	23.14	Fine, dense	Grey
C7	42.82	56.88	24.46	Fine, dense	Grey
C8	37.95	42.38	16.80	Fine, dense	Grey
C9	35.96	38.09	14.78	Fine, dense	Grey

Modulus of rupture:

Composite of C1, C2, C3, C4; 649 lbs. per sq. inch.
Composite of C5, C6, C7, C8; 555 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C8

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	39.39	60.92	26.94	Fine, dense	Brown
C2	38.22	44.67	17.92	Fine, dense	Lt. brown
C3	33.05	36.28	13.96	Fine, dense	Lt. grey
C4	21.44	7.14	2.46	Open, sandy	Brown
C5	17.91	6.86	2.36	Open, sandy	Brown
C6	17.20	2.13	.74	Open, sandy	Dark grey
C7	25.34	13.73	4.83	Open, sandy	Dark grey

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C13

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	35.85	42.74	16.99	Fine, dense	Brown
C2	39.73	37.67	14.59	Fine, dense	Dark grey
C3	37.02	40.34	15.84	Fine, dense	Dark grey
C4	40.55	47.37	19.28	Fine, dense	Dark grey

SCREEN ANALYSES

Screen Analyses, Hole No. C2

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.60	9.02	4.78	2.28	3.28	1.64	78.40
C2	1.31	6.27	8.90	2.06	3.21	4.86	73.39
C3	0.17	0.73	0.99	0.70	0.85	2.23	94.33
C4	1.20	2.86	1.95	3.10	4.12	3.54	83.23
C5	0.21	1.53	3.96	2.64	5.38	2.50	83.78
C6	0.11	2.90	3.39	3.23	5.15	1.74	83.48
C7	0.19	1.58	3.48	2.23	5.31	3.05	84.16
C8	0.03	2.77	4.78	1.57	8.60	2.85	79.40
C9	0.02	1.43	3.30	7.88	8.15	2.67	76.55

Character of residue.

Sample C1. Abundance of limonitic sand nodules; small amounts of quartz and carbonaceous material; trace of muscovite.

Sample C2. Abundance of quartz and limonitic nodules; considerable quantity of calcareous clay.

Sample C3. Abundance of calcite; considerable quantities of fossils, clay nodules and limonite; small amounts of quartz, gypsum and ferruginous material; trace of muscovite.

Sample C4. Abundance of calcareous arenaceous nodules; considerable quantities of fossils, quartz and gypsum; small amounts of muscovite and ferruginous material.

Sample C5. Abundance of clay nodules and gypsum; considerable quantity of limonite; small amounts of pyrite, fossils and quartz; trace of muscovite.

Sample C6. Abundance of limonitic nodules and clay lumps; considerable quantities of fossils and quartz; small amounts of muscovite, glauconite and biotite.

Sample C7. Abundance of calcareous nodules; considerable quantity of fossils; small amounts of calcite, muscovite and biotite.

Sample C8. Abundance of calcareous nodules; considerable quantity of fossils; small amounts of pyrite, muscovite and quartz.

Sample C9. Abundance of calcareous clay nodules; small amounts of fossils and muscovite; traces of pyrite and lignite.

SCREEN ANALYSES, HOLE NO. C3

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.09	0.40	1.51	0.65	1.85	4.74	90.96
C2	0.16	1.16	1.57	1.50	2.39	2.19	91.03
C3	0.17	0.80	1.35	0.85	1.83	5.07	89.93
C4	0.08	1.12	1.50	0.99	0.75	1.62	93.94
C5	0.31	2.76	4.56	2.49	2.54	5.56	81.78
C6	0.09	0.23	3.50	2.94	9.48	3.20	80.56
C7	0.18	0.95	4.79	1.85	5.00	3.52	83.71
C8	0.26	2.25	3.23	1.35	3.45	1.89	86.57
C9	0.01	1.00	1.65	1.05	1.62	1.73	92.94
C10	0.02	1.56	2.89	3.05	8.03	2.52	81.93
C11	0.08	2.26	6.00	5.64	7.04	4.63	74.35

Character of residue.

Sample C1. Abundance of calcareous material; considerable quantities of fossils, limonite and muscovite; small amounts of plant fragments and ferruginous material.

Sample C2. Abundance of calcareous earthy nodules and limonitic nodules; considerable quantity of fossils; small amounts of quartz gypsum and muscovite.

Sample C3. Abundance of calcareous arenaceous nodules and fossils; considerable quantities of limonitic nodules and ferruginous material; small amounts of gypsum and muscovite.

Sample C4. Abundance of fossils and gypsum; considerable quantity of grey clay; small amounts of limonite and muscovite.

Sample C5. Abundance of calcareous arenaceous material and calcareous clay nodules; small amounts of fossils and quartz; traces of muscovite and pyrite.

Sample C6. Abundance of calcareous clay nodules; considerable quantities of fossils and shell fragments; small amounts of quartz, muscovite, pyrite and gypsum.

Sample C7. Abundance of calcareous clay nodules; considerable quantities of fossils; small amounts of muscovite, pyrite and quartz; trace of carbonaceous material.

Sample C8. Abundance of calcareous material; considerable quantity of fossils; small amounts of quartz, muscovite and pyrite; trace of carbonaceous material.

Sample C9. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of quartz, pyrite and muscovite.

Sample C10. Abundance of calcareous clay nodules; considerable quantity of fossils; traces of muscovite and macasite.

Sample C11. Abundance of calcareous material; considerable quantity of fossils; traces of muscovite and pyrite.

SCREEN ANALYSES, HOLE NO. C4

Sample No.	Percent residue through 20 mesh retained on screens Nos. 30	60	100	150	200	250	Pan
C1	0.23	1.11	1.15	1.00	1.23	2.03	93.25
C2	0.99	3.46	2.07	1.48	2.11	6.06	83.83
C3	0.20	1.01	3.19	1.00	2.45	5.60	86.55
C4	0.04	1.03	8.24	6.27	7.73	3.83	72.86
C5	0.40	1.12	2.17	2.32	4.00	5.21	84.78
C6	0.34	2.24	3.22	2.00	3.82	8.51	79.87
C7	0.15	1.26	2.65	1.80	4.55	2.91	86.68
C8	0.35	1.27	3.59	2.90	5.06	2.75	84.08
C9	0.03	1.95	3.70	1.04	3.18	8.67	81.43
C10	0.09	4.00	4.64	2.87	4.09	5.73	78.58
C11	0.02	0.57	1.10	1.67	1.56	3.89	91.19
C12	0.04	0.50	1.28	1.32	1.99	3.95	90.92
C13	0.03	0.30	1.25	3.00	4.11	5.91	85.40

Character of residue.

Sample C1. Abundance of limonitic clay nodules and white clay nodules; considerable quantities of gypsum and muscovite; small amounts of fossils, ferruginous material, glauconite and quartz; trace of plant fragments.

Sample C2. Abundance of gypsum and clay; considerable quantities of limonitic nodules and grey clay nodules; small amounts of muscovite, fossils, ferruginous material and quartz; trace of magnetite.

Sample C3. Abundance of clay nodules; considerable quantities of gypsum, fossils, limonite and muscovite.

Sample C4. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of pyrite, quartz and gypsum; trace of muscovite.

Sample C5. Abundance of fossils and gypsum; considerable quantity of calcareous clay nodules; small amounts of limonite and quartz; trace of muscovite.

Sample C6. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of muscovite, pyrite and quartz.

Sample C7. Abundance of calcareous clay nodules; considerable quantities of shell fragments and pyrite; small amounts of fossils and quartz; trace of muscovite.

Sample C8. Abundance of clay nodules and fossils; small amounts of muscovite and aragonite.

Sample C9. Abundance of calcareous clay nodules; considerable quantity of fossils; small amount of pyrite; trace of muscovite.

Sample C10. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of quartz and muscovite.

Sample C11. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of quartz, muscovite and pyrite.

Sample C12. Abundance of calcareous clay nodules and fossils; traces of pyrite and muscovite.

Sample C13. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of pyrite and muscovite; trace of ferruginous material.

SCREEN ANALYSES, HOLE NO. C5

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.19	0.90	1.70	0.67	1.93	5.60	89.01
C2	0.35	1.50	2.52	0.60	2.35	7.05	85.63
C3	0.07	1.46	1.50	1.81	2.68	4.83	87.65
C4	0.21	0.41	3.35	1.81	1.83	2.49	89.90
C5	0.04	0.55	2.55	1.24	1.47	2.55	91.60
C6	0.06	0.95	2.83	1.67	2.35	6.73	85.41
C7	0.10	1.93	3.51	1.95	1.50	4.34	86.67
C8	0.06	0.55	1.12	1.08	2.03	5.08	90.08
C9	0.07	0.87	2.07	2.40	4.30	9.11	81.18

Character of residue.

Sample C1. Abundance of limonitic clay, gypsum and fossils; small amounts of ferruginous material, muscovite, plant fragments and quartz.

Sample C2. Abundance of gypsum and limonitic clay nodules; small amounts of shell fragments, muscovite and pyrite; trace of glauconite.

Sample C3. Abundance of grey clay and fossils; small amounts of shell fragments, pyrite and muscovite.

Sample C4. Abundance of calcareous material and fossils; small amounts of quartz, muscovite, calcite and plant fragments.

Sample C5. Abundance of fossils and clay nodules; considerable quantity of pyrite; small amounts of quartz, muscovite, calcite and shell fragments.

Sample C6. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of muscovite and quartz.

Sample C7. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of ferruginous material, muscovite and quartz; traces of pyrite and plant fragments.

Sample C8. Abundance of calcareous material; considerable quantity of fossils; small amounts of pyrite, quartz, muscovite and limonitic material.

Sample C9. Abundance of calcareous material; considerable quantity of fossils; small amounts of glauconite, limonitic material and muscovite.

SCREEN ANALYSES, HOLE NO. C8

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.90	1.97	1.11	0.70	1.07	2.09	92.16
C2	0.17	1.55	1.04	1.37	2.95	5.79	87.13
C3	0.32	7.36	6.48	2.84	6.30	2.66	74.04
C4	1.80	30.90	31.15	3.22	1.37	1.42	30.14
C5	1.55	25.13	39.97	4.93	2.58	2.55	23.29
C6	0.98	16.84	46.65	11.22	2.98	2.40	18.93
C7	0.52	4.61	29.37	23.54	8.57	6.15	27.24

Character of residue.

Sample C1. Abundance of calcitic material; considerable quantities of fossils and limonitic nodules; small amounts of ferruginous material and muscovite; traces of fossils, carbonaceous material and quartz.

Sample C2. Abundance of calcareous clay nodules; considerable quantities of calcitic nodules, limonitic nodules and fossils; small amounts of quartz, muscovite and ferruginous material; trace of magnetite.

Sample C3. Abundance of calcareous clay nodules; small amounts of fossils and muscovite; traces of marcasite and ferruginous material.

Sample C4. Abundance of quartz and clay nodules; considerable quantities of ferruginous rock and phosphate nodules; small amounts of fossils, muscovite, shell fragments and free quartz.

Sample C5. Abundance of quartz, shell fragments, limonitic clay and grey-green clay; small amount of phosphate nodules; trace of glauconite.

Sample C6. Abundance of quartz and shell fragments; considerable quantities of phosphate nodules and argillaceous arenaceous material; trace of magnetite.

Sample C7. Abundance of quartz and shell fragments; considerable quantities of phosphate nodules and grey-green clay; small amounts of pyrite, ferruginous material and magnetite; trace of muscovite.

SCREEN ANALYSES, HOLE NO. C13

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.32	1.06	1.66	0.99	1.93	4.11	89.93
C2	0.01	0.43	1.83	1.91	2.58	5.07	88.17
C3	0.09	1.55	1.78	1.42	2.70	6.32	86.14
C4	0.03	0.24	2.97	1.95	2.80	6.44	85.57

Character of residue.

Sample C1. Abundance of gypsum and fossils; considerable quantities of calcareous clay nodules and limonitic clay; small amounts of ferruginous material, muscovite, marcasite and quartz.

Sample C2. Abundance of calcareous clay nodules; considerable quantity of fossils; small amounts of ferruginous material, muscovite and marcasite.

Sample C3. Abundance of calcareous clay nodules and fossils; considerable quantity of quartz; small amounts of marcasite, calcite and muscovite.

Sample C4. Abundance of calcareous clay; considerable quantity of fossils; small amounts of muscovite, ferruginous material; traces of quartz and calcite.

CHEMICAL ANALYSES

CHEMICAL ANALYSIS, HOLE NO. C2

SAMPLE, COMPOSITE OF C3, C4, C5, C6, C7, C8, C9.

Ignition loss	17.17	Lime, CaO	18.03
Silica, SiO_2	41.58	Magnesia, MgO	0.60
Alumina, Al_2O_3	14.92	Potash, K_2O	0.03
Iron Oxide, Fe_2O_3	7.15	Soda, Na_2O	0.31
Titania, TiO_2	0.75		

Sulfur, SO_3 2.10 percent

CHEMICAL ANALYSIS, HOLE NO. C4

SAMPLE, COMPOSITE OF C1, C2, C3.

Ignition loss	13.25	Lime, CaO	10.84
Silica, SiO_2	48.99	Magnesia, MgO	0.62
Alumina, Al_2O_3	17.50	Potash, K_2O	0.24
Iron Oxide, Fe_2O_3	7.70	Soda, Na_2O	0.20
Titania, TiO_2	0.80		

Sulfur, SO_3 3.32 percent

CHEMICAL ANALYSIS, HOLE NO. C13

SAMPLE, COMPOSITE OF C1, C2, C3, C4.

Ignition loss	19.57	Lime, CaO	17.76
Silica, SiO_2	39.56	Magnesia, MgO	0.14
Alumina, Al_2O_3	16.08	Potash, K_2O	Trace
Iron Oxide, Fe_2O_3	7.15	Soda, Na_2O	0.09
Titania, TiO_2	0.20		

Sulfur, SO_3 1.95 percent

PYRO-PHYSICAL PROPERTIES

Pyro-physical Properties, Hole No. C2

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
C1	04	32.70	18.42	1.78	2.64	.62	.24	Lt. Red Not St. H.
C1	01	30.89	16.93	1.83	2.64	1.54	.54	Lt. Red Not St. H.
C1	2	22.56	11.30	2.00	2.58	10.89	3.77	Red Not St. H.
C1	4	17.54	8.48	2.06	2.51	14.93	5.27	Red St. H.
C1	6	15.35	7.21	2.13	2.52	16.92	6.02	Dark Red St. H.
C1	8	7.52	3.31	2.27	2.47	23.41	8.54	Brownish Red St. H.
C1	10	4.28	2.27	1.88	1.92	4.28	1.46	Gunmetal Bl., St. H.
C2	04	*	*	*	*	*	*	Salmon Cr., Not St. H.
C3	04	32.56	19.81	1.65	2.44	2.39	.81	Salmon Cr., Not St. H.
C3	01	31.35	19.18	1.64	2.38	-.81	-.30	Salmon Cr., Not St. H.
C3	2	31.27	19.54	1.60	2.33	-.22	-.10	Grey-Buff Cr., Not St. H.
C3	4	*	*	*	*	*	*	Grey-Buff Bl., Not St. H.
C4	04	*	*	*	*	*	*	Salmon Cr., Rpt., St. H.
C5	04	*	*	*	*	*	*	Lt. Dull Red Cr., Bl., Rpt., St. H.
C6	04	37.35	23.30	1.60	2.56	5.25	1.80	Grey-Buff St. H.
C6	01	30.69	18.69	1.64	2.37	6.20	2.11	Grey-Buff St. H.
C6	2	28.44	16.38	1.74	2.43	11.78	4.10	Greenish Buff Cr., St. H.
C6	4	27.78	15.96	1.79	2.40	15.94	5.65	Greenish Buff St. H.
C7	04	37.81	24.12	1.57	2.52	4.71	1.63	Greenish Buff Not St. H.
C7	01	36.50	23.80	1.54	2.42	3.65	1.25	Greenish Buff Not St. H.
C7	2	33.78	22.28	1.52	2.29	2.25	.77	Greenish Buff Not St. H.
C7	4	32.37	21.05	1.54	2.28	2.90	.98	Greenish Buff Not St. H.
C7	6	32.64	20.71	1.58	2.34	6.39	2.18	Greenish Buff Not St. H.
C8	04	*	*	*	*	*	*	Dull Salmon Cr., Bl., St. H.
C9	04	32.13	21.17	1.52	2.24	4.93	1.70	Grey-Buff Cr., Not St. H.
C9	01	30.19	20.94	1.49	2.17	1.39	.47	Grey-Buff Cr., Not St. H.
C9	2	25.35	16.04	1.58	2.12	7.39	2.53	Greenish Grey Cr., Not St. H.
C9	4	21.62	13.73	1.58	2.01	8.12	2.81	Greenish Grey Cr., St. H.

* Data unreliable due to condition of test pieces.
Abbreviations: St. H., steel hard; Bl., bloated; Cr., cracked; Rpt., ruptured.

PYRO-PHYSICAL PROPERTIES, HOLE No. C3

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk Specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
C1	04	24.22	14.74	1.65	2.17	2.67	.91	Salmon-Grey Cr., Not St. H.
C1	01	22.91	14.01	1.64	2.13	1.90	.64	Salmon-Grey Cr., Not St. H.
C1	2	21.68	12.99	1.67	2.13	4.12	1.42	Greenish Grey Cr., Not St. H.
C1	4	*	*	*	*	*	*	Greenish Grey Cr., Bl., St. H.
C2	04	31.45	20.40	1.55	2.25	2.76	.94	Salmon-Grey Not St. H.
C2	01	28.09	17.69	1.68	2.22	5.36	1.83	Grey-Buff Cr., St. H.
C2	2	26.52	16.22	1.64	2.22	7.23	2.50	Greenish Grey St. H.
C2	4	24.93	14.90	1.68	2.23	9.07	3.13	Greenish Grey St. H.
C2	6	5.62	3.66	1.54	1.63	2.74	.94	Greenish Grey Bl., St. H.
C3	04	34.71	22.95	1.51	2.32	1.62	.57	Salmon Not St. H.
C3	01	33.05	21.63	1.53	2.28	4.26	1.46	Salmon Not St. H.
C3	2	32.50	22.24	1.53	2.27	4.41	1.52	Grey-Buff Not St. H.
C3	4	35.11	22.94	1.53	2.36	4.39	1.49	Greenish Grey Not St. H.
C3	6	35.05	21.88	1.61	2.38	7.68	2.64	Greenish Grey Not St. H.
C4	04	35.18	21.20	1.66	2.56	13.21	4.65	Grey-Buff St. H.
C4	01	35.40	23.42	1.51	2.34	1.94	.67	Grey-Buff St. H.
C4	2	31.18	19.45	1.60	2.31	9.08	3.13	Grey-Buff St. H.
C4	4	32.99	20.60	1.60	2.39	11.41	3.99	Grey-Buff St. H.
C4	6	24.29	14.45	1.69	2.32	13.80	4.83	Greenish Buff St. H.
C5	04	27.26	16.64	1.64	2.25	4.25	1.46	Greyish Salmon Cr., Not St. H.
C5	01	25.73	15.65	1.65	2.23	5.54	1.90	Greyish Salmon Cr., Not St. H.
C5	2	21.88	13.06	1.68	2.15	7.40	2.53	Greenish Grey Cr., St. H.
C5	4	*	*	*	*	*	*	Greenish Grey Cr., Bl., St. H.
C6	04	*	*	*	*	*	*	Dull Salmon Cr., Bl., St. H.
C7	04	36.83	24.11	1.53	2.42	6.00	2.04	Grey-Buff Not St. H.
C7	01	35.22	23.54	1.58	2.32	3.46	1.18	Grey-Buff Not St. H.
C7	2	35.48	23.57	1.50	2.31	5.30	1.80	Grey-Buff Not St. H.
C7	4	30.59	19.43	1.58	2.27	9.41	3.27	Grey-Buff Not St. H.
C7	6	32.46	19.68	1.65	2.44	14.83	5.24	Grey-Buff St. H.
C8	04	32.06	20.19	1.58	2.33	3.92	1.35	Salmon-Grey Cr., St. H.
C8	01	24.90	14.86	1.68	2.24	7.95	2.74	Grey-Buff Cr., St. H.
C8	2	23.77	14.05	1.70	2.22	8.81	3.06	Greenish Grey Cr., St. H.
C8	4	25.27	19.67	1.29	1.73	-18.79	-6.71	Greyish Green Cr., Bl., St. H.
C9	04	28.46	18.27	1.56	2.18	-3.32	-1.15	Greyish Salmon Cr., Not St.H.
C9	01	27.92	17.82	1.57	2.18	.47	.17	Greyish Salmon Cr., Not St.H.
C9	2	22.69	14.30	1.58	2.05	-.42	-.17	Greenish Grey Cr., Not St.H.
C9	4	*	*	*	*	*	*	Greenish Grey Cr., Bl., St. H.
C10	04	32.47	20.72	1.57	2.32	5.02	1.73	Grey-Buff Cr., Not St. H.
C10	01	28.54	17.95	1.59	2.24	8.43	2.92	Grey-Buff Cr., Not St. H.
C10	2	27.47	16.87	1.63	2.23	10.41	3.63	Greenish Grey Cr., Not St.H.
C10	4	25.11	17.42	1.44	1.93	-.27	-.10	Greenish Grey Cr., Bl., St. H.
C11	04	40.68	26.98	1.51	2.44	4.31	1.49	Grey-Buff Not St. H.
C11	01	38.78	27.04	1.43	2.34	1.32	.47	Grey-Buff Not St. H.
C11	2	36.09	24.66	1.47	2.38	3.72	1.28	Grey-Buff Not St. H.
C11	4	40.32	27.45	1.47	2.47	5.27	1.80	Grey-Buff Not St. H.
C11	6	38.75	25.00	1.55	2.53	10.50	3.63	Grey-Buff St. H.

*Data unreliable due to condition of test pieces.

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

PYRO-PHYSICAL PROPERTIES, HOLE NO. C4

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk Specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	*	*	*	*	*	*	Salmon	Cr., Bl., St. H.
C2	04	*	*	*	*	*	*	Salmon	Cr., Bl., St. H.
C3	04	*	*	*	*	*	*	Salmon	Cr., Bl., St. H.
C4	04	34.39	21.13	1.63	2.46	8.94	3.01	Grey-Buff	St. H.
C4	01	28.74	17.07	1.69	2.36	13.19	4.61	Grey-Buff	St. H.
C4	2	33.06	21.50	1.54	2.29	4.77	1.63	Grey-Buff	St. H.
C4	4	36.46	23.02	1.58	2.49	6.72	2.32	Grey-Buff	St. H.
C5	04	35.69	22.95	1.56	2.42	2.75	.94	Salmon-Buff	Not St. H.
C5	01	32.13	19.81	1.62	2.39	5.94	2.04	Grey-Buff	Not St. H.
C5	2	33.09	21.73	1.52	2.28	1.10	.37	Grey-Buff	Not St. H.
C5	4	31.90	19.70	1.62	2.38	7.77	2.67	Grey-Buff	Not St. H.
C6	04	34.83	22.16	1.57	2.41	2.89	.98	Salmon-Buff	Not St. H.
C6	01	33.03	20.97	1.58	2.36	4.93	1.70	Salmon-Buff	Not St. H.
C6	2	26.25	17.39	1.51	2.05	-1.98	-.67	Grey-Buff	Not St. H.
C6	4	29.59	17.32	1.71	2.41	13.18	4.61	Grey-Buff	Not St. H.
C7	04	*	*	*	*	*	*	Lt. Red	St. H.
C8	04	35.12	23.32	1.51	2.32	2.09	.70	Grey-Buff	Not St. H.
C8	01	32.41	20.69	1.57	2.32	8.17	2.81	Grey-Buff	Not St. H.
C8	2	33.07	22.26	1.49	2.22	2.47	.84	Grey-Buff	Not St. H.
C8	4	33.24	20.75	1.60	2.41	11.57	4.03	Grey-Buff	Not St. H.
C9	04	*	*	*	*	*	*	Lt. Red	Cr., Bl., St. H.
C10	04	29.11	18.63	1.57	2.21	4.02	1.39	Grey-Buff	Cr., Not St. H.
C10	01	22.11	13.57	1.62	2.08	10.98	3.81	Greenish Grey	Cr., Not St. H.
C10	2	26.51	16.80	1.58	2.16	5.89	2.01	Greenish Grey	Cr., Not St. H.
C10	4	23.53	14.98	1.57	2.05	6.45	2.22	Greenish Grey	Cr., St. H.
C11	04	38.50	25.94	1.49	2.41	1.90	.64	Grey-Buff	Cr., Not St. H.
C11	01	36.31	24.68	1.47	2.32	.97	.33	Grey-Buff	Cr., St. H.
C11	2	22.85	14.42	1.71	2.21	14.41	5.09	Grey-Buff	Cr., St. H.
C11	4	23.57	14.41	1.64	2.14	12.23	4.28	Grey-Buff	Cr., St. H.
C12	04	38.92	25.44	1.53	2.49	4.82	1.66	Grey-Buff	Cr., Not St. H.
C12	01	37.67	24.57	1.53	2.46	2.34	.81	Grey-Buff	Cr., Not St. H.
C12	2	32.24	19.88	1.63	2.40	10.57	3.67	Grey-Buff	Cr., Not St. H.
C12	4	35.65	22.55	1.58	2.45	8.40	2.88	Grey-Buff	Cr., Not St. H.
C13	04	36.75	23.32	1.58	2.49	6.34	2.18	Grey-Buff	Cr., Not St. H.
C13	01	35.42	23.16	1.53	2.37	3.48	1.18	Grey-Buff	Cr., St. H.
C13	2	27.20	16.15	1.69	2.32	13.53	4.76	Grey-Buff	Cr., St. H.
C13	4	26.16	15.14	1.74	2.38	15.82	5.61	Grey-Buff	Cr., St. H.

*Data unreliable due to condition of test pieces.

Abbreviations: St.H., steel hard; Bl., Bloated; Cr., cracked.

Note: Modulus of rupture was determined at cone 04 of composite of samples C1, C2, C3; C6, C7, C8; and C9, C10, C11, C12. Due to warpage, cracks and bloating data are unreliable. Tests were discontinued after cone 04.

PYRO-PHYSICAL PROPERTIES, HOLE NO. C5

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk Specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	31.80	19.90	1.60	2.34	3.85	1.32	Salmon-Grey	Not St. H.
C1	01	26.19	15.85	1.66	2.24	5.71	1.97	Greenish Buff	St. H.
C1	2	29.96	18.57	1.61	2.31	5.73	1.97	Greenish Buff	St. H.
C1	4	26.39	15.97	1.65	2.24	8.66	2.99	Greenish Buff	St. H.
C2	04	*	*	*	*	*	*	Dull Red	Cr., Bl., Rpt., St. H.
C3	04	*	*	*	*	*	*	Salmon-Grey	Cr., Bl.,Rpt.,St.H.
C4	04	39.65	27.02	1.47	2.43	2.36	.81	Grey-Buff	Not St. H.
C4	01	36.87	24.54	1.50	2.38	6.17	2.11	Grey-Buff	Not St. H.
C4	2	35.57	24.26	1.47	2.28	3.99	1.35	Grey-Buff	Not St. H.
C4	4	40.15	26.52	1.45	2.42	2.74	.94	Grey-Buff	Not St. H.
C5	04	31.55	18.68	1.69	2.47	14.13	4.98	Grey-Buff	St. H.
C5	01	29.20	17.80	1.64	2.33	13.20	4.61	Grey-Buff	St. H.
C5	2	28.30	16.55	1.71	2.39	16.12	5.72	Grey-Buff	St. H.
C5	4	30.49	18.42	1.66	2.38	14.20	4.98	Grey-Buff	St. H.
C6	04	38.20	25.22	1.52	2.45	4.73	1.63	Grey-Buff	Not St. H.
C6	01	26.20	15.46	1.71	2.31	17.41	6.21	Grey-Buff	Not St. H.
C6	2	36.38	24.32	1.50	2.35	5.20	1.76	Grey-Buff	Not St. H.
C6	4	39.80	26.17	1.52	2.54	6.42	2.22	Grey-Buff	Not St. H.
C6	6	29.78	18.12	1.64	2.34	14.78	5.20	Grey-Buff	Bl., St. H.
C7	04	32.18	19.97	1.63	2.40	10.29	3.56	Grey-Buff	Cr., Not St. H.
C7	01	23.11	13.73	1.69	2.19	13.84	4.87	Grey-Buff	Cr., St. H.
C7	2	32.87	21.16	1.56	2.32	6.11	2.11	Grey-Buff	Cr., St. H.
C7	4	24.36	14.33	1.70	2.25	15.00	5.27	Grey-Buff	Cr., St. H.
C8	04	34.58	22.99	1.51	2.31	4.34	1.49	Grey-Buff	Cr., Not St. H.
C8	01	30.35	19.16	1.59	2.28	9.27	3.20	Grey-Buff	Cr., Not St. H.
C8	2	34.34	23.12	1.49	2.18	4.80	1.63	Grey-Buff	Cr., St. H.
C8	4	32.85	20.78	1.58	2.35	9.86	3.42	Grey-Buff	Cr., St. H.
C9	04	42.80	30.20	1.45	2.48	3.10	1.04	Grey-Buff	Not St. H.
C9	01	41.05	28.07	1.47	2.49	8.07	2.78	Grey-Buff	Cr., Not St. H.
C9	2	39.68	28.57	1.39	2.30	3.68	1.25	Grey-Buff	Cr., Not St. H.
C9	4	43.05	31.57	1.37	2.42	3.14	1.08	Grey-Buff	Not St. H.
C9	6	39.62	26.08	1.52	2.51	12.72	4.46	Grey-Buff	Not St. H.

*Data unreliable due to condition of test pieces.

Abbreviations: Cr., cracked; Bl., bloated; Rpt., ruptured; St. H., steel hard.

Note: Modulus of rupture was determined at cone 04 of composites of samples C1, C2, C3, C4; C5, C6, C7, C8. Due to warpage, cracks and bloating, data are unreliable. Tests were discontinued after cone 04.

PYRO-PHYSICAL PROPERTIES, HOLE NO. C8

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk Specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
C1	04	*	*	*	*	*	*	Lt. Red Cr., Rpt., St. H.
C2	04	43.45	31.12	1.40	2.47	2.39	.81	Grey-Buff Not St. H.
C2	01	43.63	31.34	1.39	2.47	.93	.33	Grey-Buff Cr., Not St. H.
C2	2	39.25	27.39	1.43	2.36	9.17	3.17	Grey-Buff Cr., Not St. H.
C2	4	42.95	29.67	1.45	2.53	9.49	3.27	Grey-Buff Cr., Not St. H.
C2	6	40.17	25.58	1.57	2.63	15.15	5.35	Greenish Buff St. H.
C3	04	47.75	32.80	1.46	2.78	3.31	1.15	Grey-Buff Cr., Not St. H.
C3	01	44.94	31.12	1.45	2.63	3.21	1.11	Grey-Buff Cr., Not St. H.
C3	2	43.40	30.26	1.44	2.54	2.14	.74	Grey-Buff Cr., Not St. H.
C3	4	47.25	32.99	1.43	2.69	1.96	.67	Grey-Buff Not St. H.
C3	6	44.20	29.06	1.52	2.73	9.20	3.20	Greenish Buff Not St. H.
C4	04	42.97	26.63	1.61	2.82	-2.92	-1.01	Dull Red Not St. H.
C4	01	40.35	25.43	1.61	2.66	-4.08	-1.39	Dull Red Not St. H.
C4	2	32.53	18.23	1.78	2.64	7.11	2.46	Brown Not St. H.
C4	4	38.87	23.22	1.67	2.74	1.97	.67	Brown Not St. H.
C4	6	29.87	16.17	1.84	2.63	10.14	3.52	Greyish Brown Not St. H.
C5	04	†	†	†	†	†	†	Dull Red Not St. H.
C5	01	†	†	†	†	†	†	Dull Red Not St. H.
C5	2	36.48	21.56	1.69	2.67	1.65	.57	Greyish Brown Not St. H.
C5	4	40.28	24.56	1.65	2.76	-2.12	-.74	Greyish Brown Not St. H.
C5	6	32.60	18.60	1.75	2.60	4.59	1.56	Greyish Brown Not St. H.
C6	04	†	†	†	†	†	†	Dull Red Not St. H.
C6	01	†	†	†	†	†	†	Dull Red Not St. H.
C6	2	38.35	23.25	1.65	2.67	-3.49	-1.18	Greyish Brown Not St. H.
C6	4	42.20	26.75	1.58	2.73	-8.43	-2.92	Greyish Brown Not St. H.
C6	6	33.71	19.88	1.70	2.56	1.39	.47	Greyish Brown Not St. H.
C7	04	39.92	24.23	1.65	2.74	-2.59	-.87	Dull Red Not St. H.
C7	01	36.91	22.63	1.63	2.58	-1.77	-.60	Dull Red Not St. H.
C7	2	28.60	16.17	1.77	2.48	8.31	2.88	Dull Red Not St. H.
C7	4	36.70	22.12	1.66	2.62	.88	.30	Dull Red Not St. H.
C7	6	27.08	16.86	1.61	2.18	-.76	-.27	Dull Red Not St. H.

*Data unreliable due to condition of test pieces.

†Test pieces disintegrated in water.

Abbreviations: Cr., cracked; Rpt., ruptured; St. H., steel hard.

PYRO-PHYSICAL PROPERTIES, HOLE NO. C13

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk Specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	25.40	15.60	1.63	2.18	5.11	1.76	Salmon	Cr., St. H.
C1	01	21.57	13.15	1.64	2.10	5.63	1.94	Grey-Buff	Cr., St. H.
C1	2	19.56	11.87	1.65	2.05	7.84	2.71	Grey-Green	Cr., St. H.
C1	4	21.87	15.01	1.46	1.87	-4.42	-1.52	Grey-Green	Cr., Bl., St. H.
C1	6	24.06	15.88	1.52	1.99	-.99	-.33	Grey-Green	Cr., Bl., St. H.
C2	04	37.50	21.39	1.53	2.26	4.09	1.39	Salmon	Cr., Not St. H.
C2	01	24.90	15.41	1.62	2.15	6.89	2.36	Grey-Buff	Cr., St. H.
C2	2	21.46	12.75	1.67	2.15	11.98	4.17	Grey-Green	Cr., St. H.
C2	4	26.55	10.52	1.33	1.82	-10.58	-3.67	Grey-Green	Cr., Bl., St H.
C2	6	*	*	*	*	*	*	Grey-Green	Cr., Bl., St H.
C3	04	33.00	19.85	1.67	2.48	12.26	4.28	Grey-Buff	Cr., St. H.
C3	01	33.60	21.44	1.54	2.36	6.85	2.36	Grey-Buff	Cr., St. H.
C3	2	27.03	15.72	1.72	2.36	17.30	6.14	Grey-Buff	Cr., St. H.
C3	4	39.35	25.28	1.55	2.57	7.08	2.42	Grey-Buff	Cr., St. H.
C3	6	36.85	22.83	1.61	2.56	9.42	3.27	Grey-Buff	Cr., St. H.
C4	04	31.65	19.88	1.59	2.33	7.47	2.57	Grey-Buff	Cr., St. H.
C4	01	32.41	20.66	1.58	2.33	8.15	2.81	Grey-Buff	Cr., St. H.
C4	2	27.95	17.14	1.63	2.27	11.06	3.85	Grey-Buff	Cr., St. H.
C4	4	26.57	16.31	1.63	2.22	10.33	3.59	Grey-Buff	Cr., St. H.
C4	6	26.65	17.86	1.51	2.05	2.24	.77	Grey-Green	Cr., Bl., St H.

*Data unreliable due to condition of test pieces.

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

SUMMARY OF RESULTS

GENERAL

The Yazoo clay-marl is represented by material from test holes C2, C3, C4, C5, C8, and C13. The upper part of test hole C2 includes calcareous loess and the lower part of test hole C8 includes the Moodys Branch marl. Test data for the included loess and Moodys Branch marl are recorded in this part of the report; however, the discussion of these data is in the parts treating more fully on these materials.

Mellen estimates that the clay-marl has a maximum thickness of 350 feet and an average thickness of 175 feet (1). Test hole C4 penetrated the clay 100 feet and was abandoned in the same type of material. Samples for testing were taken at approximately 10 foot intervals (C samples) except where there was a noticeable change in the character of the material. Each C sample was tested in the same manner and under similar conditions; consequently, the results are indicative of the variation in chemical and physical properties between C samples. The general characteristics of the clay from interval to interval and from test hole to test hole are comparable; and composite samples representing thicknesses of 30 feet or more are remarkably uniform; however, specific properties of individual C samples indicate that there is a rather definite variation in the lime content of certain C samples and that there is no regular sequence of repetition, nor is there a definite sequence as to thickness. Further, the presence of lime in lesser and greater amounts seems to be abruptly gradational which accounts for the two seemingly distinct phases of the clay-marl.

The clay substance in the marl is probably montmorillonitic; it is fine grain, silty, and plastic. Calcareous material is present as fossils, gypsum, calcite, and as finely divided carbonate throughout the clay. Quartz, muscovite, pyrite, and limonite are minor constituents of the clay-marl. It is noted from the screen analyses that gypsum is present in the upper samples from all test holes except test hole C8 where it is absent. The gypsum is prevalent in the upper 20 to 40 feet of the marl and is not found at greater depths. Coincidentally, pyrite is absent in the upper strata where gypsum is present but is found in the lower strata where gypsum is absent, except in transitional or overlapping C samples. This condition seems to substantiate the theory concerning the formation of gypsum in calcareous clays through the oxidation of pyrite liberating sulphuric acid which combines with calcium forming calcium-sulphate. The presence or absence of gypsum does not appear to affect the total calcium content of the different C samples.

The physical properties of the clay-marl in the unburned state are not conducive to successful manufacture of clay products. The volume and linear shrinkage of all C samples from all test holes are too high to permit manufacture of ware free from cracks and warpage without the addition of some non-plastic material. Notwithstanding the high shrinkage of the clay, small test pieces were dried in the laboratory fairly successfully but not sufficiently so to recommend the clay-marl as the sole constituent for use in ordinary clay products.

The variations in water of plasticity between C samples and subsequent drying shrinkage are a fair indication of the variation in the clay substance between C samples. Samples having the highest water of plasticity are highest in clay substance, and those lowest in water of plasticity contain increased amount of silt or lime or both. The relation between clay content and lime content is borne out in the pyro-physical properties of the samples.

Ries, quoting from the work of Rieke, states that clay containing lime carbonate up to 10 per cent may burn to a dense body below its fusion point, and that a higher percentage of lime causes the points of vitrification and viscosity to draw closer together (2). Lovejoy concludes that, as the lime content increases, a serious fluxing difficulty is experienced, but when it becomes excessive it acts as a refractory and carries the burning over the fluxing range, thus making it impossible to obtain a low fusing mixture with an excess of lime. He further states that a clay containing sufficient iron to burn red will, when impregnated with lime, burn to a buff, changing at higher temperatures to a yellow green and finally to a decided green. At very low temperatures before the lime enters into the fusible mixture, the color of the ware is red which is due to iron but disappears when the iron begins to combine with lime and silica as a lime-iron-silicate producing the final green color (3). The above citations are given as they so clearly picture the conditions that exist in the burning of the clay-marl as shown in the accompanying tables of pyro-physical properties.

Though it would be possible to burn below cone 04 fairly dense ware made from the phase of the clay-marl containing the lesser amounts of lime, such as sample C1, C2, and C3 from test hole C4, and at higher temperatures a fairly dense ware from the clay-marls containing a greater amount of lime, such as samples C1, C2, C3, and C4 from test hole C13, and a very open bodied ware from certain other C samples, the risk involved is too great to justify a clay products operation if using the clay-marl alone, especially in view of excessive shrinkage of the clay in the unburned state.

An outstanding characteristic of the clay-marl is its high flexual strength in the unburned state which, of the samples tested, averages nearly 600 pounds per square inch. This property suggests the possibility of adding relatively non-plastic material such as loess or the siliceous clay from the Yegua to reduce drying shrinkage and improve burning characteristics, making it possible to produce clay products such as common brick, fireproofing, and farm drain tile.

ROCK WOOL

The feasibility of producing rock wool from the clay marl has been investigated insofar as testing facilities permitted. The work remaining to be done is the actual production of the wool and an investigation of the quality of wool produced. It is hoped that equipment and facilities will be available in the near future so that the investigation can be completed. The study so far has covered the survey of the raw materials by Mellen, and an examination of the raw materials by the writer as to quality, uniformity, and suitability.

The chemical analysis of the material from test hole C2 is that of a composite sample representing 57 feet of typical clay-marl. The analysis of material from test hole C13 is of 42.8 feet of the clay located approximately ten miles from test hole C2. The chemical analysis of the material from test hole C4 is not representative of the typical clay-marl as the sample included too much clay substance. The analyses, as given on a previous page, when recalculated to exclude volatile substances would be representative of analyses of wool produced from the material. They are as follows:

TEST HOLE C2

COMPOSITE SAMPLES C3 TO C9 INCLUSIVE

Silica,	SiO_2	50.00	Lime, CaO	21.60
Alumina,	Al_2O_3	17.90	Miscellaneous	2.02
Iron Oxide,	Fe_2O_3	8.58		

TEST HOLE C13

COMPOSITE SAMPLES C1 TO C4 INCLUSIVE

Silica,	SiO_2	48.80	Lime,	CaO	21.90
Alumina,	Al_2O_3	19.75	Miscellaneous		.53
Iron Oxide,	Fe_2O_3	8.84			

Chemical analyses of commercial mineral wool from Bulletin No. 61 of the Illinois State Geological Survey, are as follows:

No.	Type of Material	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Misc.
1	Rock wool	40.1	18.6	1.7	28.1	11.1	0.4
2	Rock wool	36.9	19.5	1.4	33.8	7.8	0.6
3	Rock wool	37.1	11.9	1.2	33.4	15.6	0.8
4	Rock wool	34.5	16.1	0.7	29.8	18.2	0.7
5	Mineral wool	38.0	15.3	6.8	17.9	19.8	2.2
6	Rock wool	41.8	13.2	0.7	25.5	18.2	0.6
7	Rock wool	44.0	10.3	1.9	41.8	0.6	1.4
8	Slag wool	39.5	37.6		15.1	7.0	0.8
9	Mineral wool	36.3	13.1	20.4	27.2	2.4	0.6

From a comparison of analyses of the Yazoo clay-marl with the analyses of commercial mineral wool, it is seen that the composition of the clay-marl is not within the commercial range of mineral wool. However, with the addition of lime to the clay-marl a suitable mixture could be obtained. The Glendon limestone which crops out in the southern edge of Yazoo County and which is more abundant in Warren County has been analyzed by commercial interests and appears to be entirely suitable as a source of lime.

The investigation so far indicates that the production of mineral wool in Yazoo county is feasible but will require further study to determine the proper proportions of clay-marl and limestone that will produce the best quality of wool. The influence of gypsum, iron, and pyrite on the quality of the wool is a matter for further study. The possibility of using the siliceous clay from the Yegua in combination with the Glendon limestone is worthy of further investigation.

LABORATORY TESTS OF THE YAZOO CLAY

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Physical Properties in the Unburned State, Hole No. C11

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	41.27	59.50	26.01	Fine, dense	Brown
C2	49.40	72.38	34.89	Fine, dense	Dark grey
C3	43.23	56.85	24.46	Fine, dense	Dark brown
C4	34.35	36.39	14.00	Fine, dense	Dark grey
C5	50.53	69.88	32.98	Fine, dense	Grey
C6	50.33	69.72	32.91	Fine, dense	Dark grey
C8	43.25	60.57	26.69	Fine, dense	Grey
C9	37.77	53.40	22.47	Fine, dense	Grey
C10	42.92	61.97	27.57	Fine, dense	Grey
C11	42.35	60.30	26.50	Fine, dense	Grey
C12	46.55	65.18	29.66	Fine, dense	Grey
C13	46.95	66.73	30.76	Fine, dense	Grey

Modulus of rupture:

Composite of C4, C5; 776 lbs. per sq. inch.

Physical Properties in the Unburned State, Hole No. C25

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	47.80	65.78	30.07	Fine, dense	Dark grey
C2	50.80	79.35	40.94	Fine, dense	Grey
C3	49.85	68.92	32.32	Fine, dense	Dark grey
C4	47.60	65.57	29.93	Fine, dense	Dark grey

Physical Properties in the Unburned State, Hole No. C59

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
P1	29.57	27.80	10.29	Fine, dense	Dark grey
C1	22.22	12.49	4.35	Fine, dense	Grey

Modulus of rupture:

Sample P1; 275 lbs. per sq. inch.

SCREEN ANALYSES

Screen Analyses, Hole No. C11

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.91	2.13	3.63	0.79	2.33	2.53	87.68
C2	0.53	2.40	1.61	1.56	1.85	4.14	87.91
C3	0.24	3.99	7.35	2.36	4.28	6.78	75.00
C4	0.32	1.88	3.45	4.40	3.77	6.07	80.11
C5	0.14	2.60	5.88	3.36	5.37	5.88	76.77
C6	0.07	2.98	5.42	3.55	3.20	4.31	80.47
C7	0.12	6.67	9.00	5.48	7.53	8.59	62.61
C8	0.01	1.19	3.44	3.40	3.60	2.99	85.37
C9	0.09	2.43	4.05	3.07	0.72	1.71	87.93
C10	0.03	0.55	1.55	1.45	1.20	3.97	91.25
C11	0.10	3.05	4.66	4.17	2.84	4.57	80.61
C12	0.11	0.74	1.05	0.82	0.61	3.17	93.50
C13	0.13	2.60	7.04	9.43	6.43	6.53	67.84

Character of residue.

Sample C1. Abundance of gypsum and limonitic clay nodules; small amounts of fossils and muscovite; trace of ferruginous material.

Sample C2. Abundance of limonitic and grey clay nodules; considerable quantity of gypsum; traces of fossils, muscovite and ferruginous material.

Sample C3. Abundance of grey clay nodules; considerable quantity of ferruginous material; small amounts of muscovite, limonitic clay and gypsum.

Sample C4. Abundance of grey clay nodules; considerable quantity of limeonitic arenaceous nodules; traces of quartz and muscovite.

Sample C5. Abundance of grey clay nodules; small amounts of quartz, calcareous material and muscovite.

Sample C6. Abundance of grey clay nodules; considerable quantity of pyrite; small amounts of fossils and ferruginous material; traces of gypsum and muscovite.

Sample C7. Abundance of calcareous clay nodules; traces of quartz and biotite.

Sample C8. Abundance of grey clay nodules; small amounts of pyrite and shell fragments; traces of quartz and muscovite.

Sample C9. Abundance of grey clay nodules; small amounts of pyrite, shell fragments, muscovite and quartz.

Sample C10. Abundance of grey clay nodules; small amounts of shell fragments and fossils.

Sample C11. Abundance of calcareous clay nodules; small amounts of fossils and muscovite.

Sample C12. Abundance of calcareous clay nodules; small amounts of shell fragments, fossils, muscovite and pyrite; trace of quartz.

Sample C13. Abundance of calcareous clay nodules; small amounts of quartz and fossils; traces of plant fragments, pyrite and muscovite.

SCREEN ANALYSES, HOLE NO. C25

Sample No.	Percent residue through 20 mesh retained on screens Nos. 30	60	100	150	200	250	Pan
C1	0.08	4.55	5.23	7.05	5.67	3.75	73.67
C2	0.04	2.07	6.75	0.60	6.24	4.95	79.35
C3	0.03	2.90	6.63	4.28	3.82	3.98	78.36
C4	0.03	1.78	4.03	3.12	3.50	2.52	85.02

Character of residue.

Sample C1. Abundance of grey clay nodules; small amounts of pyrite and lignite.

Sample C2. Abundance of calcareous clay; considerable quantity of grey clay; small amounts of pyrite and quartz; trace of shell fragments.

Sample C3. Abundance of calcareous clay nodules; small amount of pyrite; traces of quartz, limonite and muscovite.

Sample C4. Abundance of grey clay nodules; small amounts of pyrite, muscovite and quartz.

SCREEN ANALYSES, HOLE NO. C59

Sample No.	Percent residue through 20 mesh retained on screens Nos. 30	60	100	150	200	250	Pan
P1	0.05	1.63	3.32	1.81	2.94	5.07	85.18
C1	0.10	5.30	5.15	4.16	7.55	6.08	71.66

Character of residue.

Sample P1. Abundance of grey clay nodules; small amount of pyrite; trace of muscovite.

Sample C1. Abundance of grey clay nodules; considerable quantity of quartz and muscovite.

CHEMICAL ANALYSIS

CHEMICAL ANALYSIS, HOLE NO. C59

COMPOSITE OF SAMPLE P1

Ignition loss	9.79	Lime, CaO	7.03
Silica, SiO_2	56.84	Magnesia, MgO	None
Alumina, Al_2O_3	20.00	Potash, K_2O	Trace
Iron Oxide, Fe_2O_3	6.70	Soda, Na_2O	0.19
Titania, TiO_2	0.65		

Moisture at 100°C, 7.51 Sulfur, SO_3, 3.57 Soluble salts, SO_4, 0.80

SUMMARY OF RESULTS

The Yazoo clay is represented by material from test holes C11, C25, and C59. Clays from test holes C11 and C25 are comparable, but sample P1 from test hole C59 is not comparable to the other samples in its physical properties. The water of plasticity of the clays from test hole C25 averaged about 58 percent, and from test hole C11, about 46 percent; whereas that of sample P1 from test hole C59 is 29.37 percent. Likewise, the volume shrinkage of clays from test hole C25 averages about 66 percent; and from test hole C11, about 62 percent. The volume shrinkage of sample P1 from test hole C59 is only 27.8 percent. Further, the modulus of rupture of composite samples C4 and C5 from test hole C11 is 776 pounds per square inch, and that of sample P1 from test hole C59 is only 275 pounds per square inch. The cause of the wide difference in properties of materials from what is supposed to be the same bed of clay is unaccountable. Chemical analyses and dehydration curves of several samples would no doubt be enlightening, but time allotted for testing these materials permitted only one chemical analysis. Screen analyses of the samples show no significant variation in accessory minerals.

The Yazoo clay differs very little from the Yazoo clay-marl and contains, as would be expected, more clay substance and less calcium in the form of gypsum and fossils. The water of plasticity and drying shrinkage are higher than those of the typical clay-marl, and the modulus of rupture of composite samples C4 and C5 from test hole C11 exceeds the high average of the clay-marl by 176 pounds per square inch. The warpage of the typical clay during drying is excessive. Clay bars, seven inches long and one inch square, formed from a composite of samples C1, C2, and C3 from test hole C11, cracked to such an extent during drying that they were unfit for further testing.

The principal clay mineral in sample P1 from test hole C59 appears to be montmorillonite. The alumina to silica ratio is 1 to 4.85 or 26 percent alumina to 74 percent silica. The alumina to silica ratio of the clay-marl from test hole C2 is 1 to 4.71 or 26.5 percent alumina to 73.5 percent silica. For test hole C4 of the clay-marl the alumina to silica ratio is 1 to 4.58 or 26.3 percent alumina to 73.7 percent silica. The close agreement of the ratios of alumina to silica of the clay-marl and the Yazoo clay, together with comparable physical properties, point to the similarity of the clay substance in the Yazoo clay and the Yazoo clay-marl.

The pyro-physical properties of the Yazoo clay are not given in tabular form, because of the burning behavior of all samples at Cone 04, the first firing. All test pieces from all C samples from test holes C11, C25, and C59 were either bloated, cracked, or ruptured to such an extent at Cone 04 that the alteration during burning could not be accurately measured. There was no attempt to fire the test pieces to a higher temperature. The behavior of the Yazoo clay under heat treatment differs little if any from that of the less calcareous phase of the clay-marl.

Due to the excessively high shrinkage in the unburned state and the unfavorable burning behavior, the Yazoo clay is of no commercial importance for ceramic purposes.

The non-ceramic uses of the Yazoo clay appear to be of considerable importance. Though the clay may not be the best of its kind for certain uses, the deposit is of such magnitude that it seems worthwhile to devise methods of beneficiation and apply known methods in order to utilize the clay. The particular uses considered favorable are: (1) as a bleaching clay, (2) as a bond in molding sand, (3) as a drilling mud, (4) as a raw material for the manufacture of light weight aggregate for concrete, and (5) as a beneficial filler in fertilizer.

The bleaching action of the Yazoo clay toward mineral oil was determined by P. G. Nutting of the United States Geological Survey from samples furnished by F. F. Mellen. The summary given in the following table is the bleach rating and is the ratio of the volume of filtered oil by colors to the volume of clay filtering it.

Hole	Sample	Untreated				Acid Treated				Soluble			Organic
		Gr.	Yel.	Red	Bl.	Gr.	Yel.	Red	Bl.	Fe:	Al:	Ca:	
C11	C6	0.2	0.3	0.3	0.3	1.2	1.5	1.7	2.1	3	6	1	Much
C11	C7	0.2	0.3	0.3	0.3	1.3	1.6	1.7	2.1	2	7	1	Much
C11	C8	0.1	0.2	0.2	0.2	0.9	1.2	1.4	1.8	4	6	Tr	None
C11	C9	0.2	0.3	0.3	0.3	0.4	1.2	1.4	1.7	2	6	2	Much
C11	C10	0.2	0.3	0.3	0.3	1.2	1.4	1.6	2.1	2	6	2	Much
C11	C11	0.2	0.3	0.3	0.3	1.1	1.3	1.4	1.8	2	6	2	Much
C11	C12	0.3	0.4	0.4	0.4	0.9	1.1	1.3	1.6	2	6	2	Much
C25	C1	0.2	0.3	0.3	0.3	1.0	1.5	1.8	2.1	4	6	0	None
C25	C1*	0.2	0.3	0.3	0.3	1.1	1.6	1.9	2.2	3	6	1	Much

* Weathered

Concerning the above tests, Nutting states in his letter to Mellen, October 27, 1938, "In oil absorption, these samples differ surprisingly little from each other—. The fraction of absorbent clay in the silt appears to vary little not only with depth (0, 55, and 100 feet) but with wide variation in calcium, fossil, and organic contents."

The untreated clay is too inefficient to be of value as a bleach. The acid treated clay compares with naturally active domestic fullers earth and imported English earth but is not equal to the better grades of activated bentonite. Methods of beneficiation of the Yazoo clay supplementing acid treatment appear worth investigating in view of the large deposits of material and the probable shortage of English earth during war times.

The colloidal character of the Yazoo clay suggests its use as a green bond in molding sand. The high dry strength of the clay would be beneficial in preserving mold structure during the pouring of molten metals.

The physical properties of the clay are characteristic of drilling mud. The nearness of this clay to the Yazoo oil field and to the Louisiana and Texas oil fields makes further investigations advisable.

The manufacture of light weight aggregate for concrete from the Yazoo clay is a possibility. The burning characteristics of the clay are favorable and the availability of fuel oil and water transportation in Yazoo County point to economical manufacture and distribution. The scope of the light weight aggregate industry is described in Bulletin No. 38 of the Mississippi Geological Survey. The trend toward permanent insulated construction, made possible by light weight aggregate, makes the aggregate increasingly important.

The filler in commercial fertilizer is usually some inert material such as sand, the purpose of which is to facilitate the spreading of active ingredients in proportions not harmful to plant life and to weight the active ingredients so they will not be blown away by wind. The Yazoo clay appears to be suitable as a filler, serving the usual purposes and providing less weight per unit of bulk concentration. The clay should tend to lessen dustiness by providing a medium for absorbing fine ingredients of the active fertilizer. Further, the calcium and iron content of the clay filler would increase the value of the fertilizer as these two ingredients are not usually included.

LABORATORY TESTS OF THE GLENDON BENTONITE

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Physical Properties in the Unburned State, Hole No. C52

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
P1	36.05	35.92	13.42	Dense, grainy	Brown

Physical Properties in the Unburned State, Hole No. C53

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
P1	35.06	33.82	12.89	Dense, Grainy	Bluish Grey

Physical Properties in the Unburned State, Hole No. C54

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	24.49	15.64	5.53	Open, Grainy	Brown

SCREEN ANALYSES

Screen Analysis, Hole No. C52

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
P1	0.15	1.05	1.52	1.88	3.03	4.38	87.99

Character of residue.

Sample P1. Abundance of bentonitic clay nodules; considerable quantity of limonitic clay; traces of muscovite, ferruginous rock and quartz.

Screen Analysis, Hole No. C53

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
P1	0.08	0.35	6.64	8.07	9.72	6.55	68.59

Character of residue.

Sample P1. Abundance of bentonitic clay nodules; small amount of ferruginous rock; trace of fossils.

SCREEN ANALYSIS, HOLE No. C54

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.15	2.64	6.89	4.35	6.47	10.65	68.85

Character of residue.

Sample C1. Abundance of clay nodules; considerable quantity of limonitic material; small amounts of quartz and muscovite.

CHEMICAL ANALYSIS

CHEMICAL ANALYSIS, HOLE No. C53

COMPOSITE OF SAMPLE P1

Ignition loss	10.60	Lime, CaO	0.65
Silica, SiO_2	57.89	Magnesia, MgO	Trace
Alumina, Al_2O_3	24.97	Potash, K_2O	None
Iron Oxide, Fe_2O_3	5.15	Soda, Na_2O	0.05
Titania, TiO_2	0.50		

Moisture at 100°C, 12.82 Sulfur, SO_3, 0.36 Soluble salts, SO_4, 0.50

Alumina to Silica ratio, 1:3.9

PYRO-PHYSICAL PROPERTIES

PYRO-PHYSICAL PROPERTIES, HOLE No. C52

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
P1	04	18.43	9.51	1.94	2.88	22.10	7.99	Red	Not St. H.
P1	01	16.97	8.26	2.05	2.47	24.19	8.82	Red	Not St. H.
P1	2	*	*	*	*	*	*	Brownish Grey	Rpt., St. H.

*Data unreliable due to condition of test pieces.

Abbreviations: Rpt., ruptured; St.H., steel hard.

PYRO-PHYSICAL PROPERTIES, HOLE No. C53

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
P1	04	17.74	10.17	1.74	2.12	18.11	6.48	Brownish Grey	Ch., Not St. H.
P1	01	15.64	8.70	1.80	2.13	21.80	7.87	Brownish Grey	Ch., St. H.
P1	2	*	*	*	*	*	*	Salmon	Rpt., St. H.

*Data unreliable due to condition of test pieces.

Abbreviations: Ch., checked; Rpt., ruptured; St.H., steel hard.

PYRO-PHYSICAL PROPERTIES, HOLE NO. C54

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	26.90	14.10	1.91	2.61	26.11	9.63	Red	Ch., Not St. H.
C1	01	30.17	14.86	2.02	2.91	30.47	11.42	Red	Ch., Not St. H.
C1	2	*	*	*	*	*	*	Brown	Rpt., Not St. H.

*Data unreliable due to condition of test pieces.
Abbreviations: Ch., checked; Rpt., ruptured; St.H., steel hard.

SUMMARY OF RESULTS

The bentonites of Yazoo County, represented by samples from test holes C52, C53, and C54, range in thickness from 1 to 2 feet. They are inaccessible and could not be mined profitably; consequently they are of little economic value. The samples were tested as an ordinary clay, and the results are given here as a matter of record.

P. G. Nutting of the United States Geological Survey tested the bleaching properties of sample P1 from test hole C53 and states in his letter to Mellen of March 9, 1939: "My tests show your sample entirely lacking in bleaching power when untreated by acid but to have a high activity (1.8-2.5-2.9-3.8) after the removal of about 22 percent (by weight) with acid. In this respect it behaves like the Vicksburg bentonite of Smith County. However its behavior toward acid is so different that a different age or ash fall is indicated to my mind."

LABORATORY TESTS OF THE LOESS SILT

PHYSICAL PROPERTIES IN THE UNBURNED STATE

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C1

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	17.20	*	*	Fine, open	Brown
C2	13.82	*	*	Fine, open	Lt. Brown
C3	16.26	*	*	Fine, open	Lt. Brown
C4	15.58	*	*	Fine, open	Lt. Grey
C5	13.57	*	*	Fine, open	Dark Grey
C6	14.99	*	*	Fine, open	Greyish Brown

*Data not determined due to lack of natural plasticity of material necessitating use of artificial binder to form test pieces.

Modulus of rupture:

Composite of C1 C2, C3; 111 lbs. per sq. inch.
Composite of C4, C5, C6; 153 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C9

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	19.98	*	*	Fine, open	Brown
C2	17.89	*	*	Fine, open	Brown
C3	14.20	*	*	Fine, open	Brown
C4	16.41	*	*	Fine, open	Brown
C5	17.69	*	*	Fine, open	Brown
C6	10.99	*	*	Fine, open	Brown
C7	13.15	*	*	Fine, open	Reddish Brown
C8	12.53	*	*	Fine, open	Reddish Brown

*Data not determined due to lack of natural plasticity of material necessitating use of artificial binder to form test pieces.
Modulus of rupture:
Composite of C1, C2, C3, C4; 99 lbs. per sq. inch.
Composite of C5, C6, C7, C8; 152 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C12

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	15.65	*	*	Fine, open	Brown
C2	15.23	*	*	Fine, open	Brown
C3	14.30	*	*	Fine, open	Brown
C4	16.38	*	*	Fine, open	Brown

*Data not determined due to lack of natural plasticity of material necessitating use of artificial binder to form test pieces.
Modulus of rupture:
Composite of C1, C2; 149 lbs. per sq. inch.
Composite of C3, C4; 94 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C21

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	14.33	*	*	Fine, open	Brown
C2	15.79	*	*	Fine, open	Brown
C3	10.87	*	*	Fine, open	Brown
C4	12.28	*	*	Fine, open	Brown
C5	15.83	*	*	Fine, open	Lt. Brown
C6	13.38	.77	.27	Fine, open	Lt. Brown
C7	12.81	1.67	.57	Fine, open	Lt. Brown

*Data not determined due to lack of natural plasticity of material necessitating use of artificial binder to form test pieces.
Modulus of rupture:
Composite of C1, C2; 165 lbs. per sq. inch.
Composite of C1, C2, C5; 202 lbs. per sq. inch.
Composite of C6, C7; 296 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C23

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	17.75	2.84	.98	Fine, open	Brown
C2	14.01	.97	.33	Fine, open	Brown
C3	13.10	1.66	.57	Fine, open	Lt. Brown

Modulus of rupture:
Composite of C1, C2, C3; 188 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C24

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	15.52	.77	.27	Fine, open	Brown
C2	12.34	.66	.24	Fine, open	Brown

Modulus of rupture:
Composite of C1, C2; 200 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C37

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	15.36	1.50	.50	Fine, open	Brown

Modulus of rupture:
Sample C1; 425 lbs. per sq. inch.
Note—Artificial binder used in Sample C1.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C55

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	15.39	1.95	.67	Fine, open	Brown
C2	11.79	2.61	.91	Fine, open	Brown
C3	19.45	11.42	3.99	Fine, dense	Red
C4	25.24	40.34	15.84	Fine, dense	Brown
C5	19.90	2.08	.70	Silty, open	Grey
C6	15.23	2.47	.84	Silty, open	Grey

Modulus of rupture:
Composite of C1, C2, C4; 405 lbs. per sq. inch.

SCREEN ANALYSES

SCREEN ANALYSES, HOLE NO. C1

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.07	1.28	0.92	0.55	1.10	1.43	94.65
C2	0.87	2.21	0.57	0.49	0.79	0.67	94.40
C3	0.88	1.55	0.40	0.20	0.19	0.20	96.58
C4	0.19	0.98	0.22	0.24	0.19	0.53	97.65
C5	0.27	1.48	0.75	0.96	0.92	0.26	95.36
C6	0.32	2.45	1.32	0.43	0.49	0.19	94.80

Character of residue.

Sample C1. Abundance of limonitic sand concretions; considerable quantity of ferruginous material; small amounts of carbonaceous material, muscovite and quartz; trace of biotite.

Sample C2. Abundance of limonitic calcareous arenaceous nodules; considerable quantity of ferruginous material; small amounts of calcitic material, shell fragments and quartz; trace of muscovite.

Sample C3. Abundance of calcareous material; considerable quantity of limonitic arenaceous nodules; small amounts of shell fragments and quartz; traces of ferruginous rock, muscovite and phlogopite.

Sample C4. Abundance of calcareous arenaceous materials; small amounts of ferruginous rock, shell fragments, quartz and muscovite.

Sample C5. Abundance of calcareous arenaceous material; considerable quantities of shell fragments, quartz and muscovite; small amount of pyrite.

Sample C6. Abundance of quartz and arenaceous material; small amounts of limonite and shell fragments; traces of ferruginous material and muscovite.

SCREEN ANALYSES, HOLE NO. C9

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.12	0.43	0.30	0.13	0.38	0.58	98.06
C2	0.34	1.45	0.50	0.35	0.27	0.57	96.52
C3	0.67	1.95	0.66	0.39	0.37	0.48	95.48
C4	0.38	1.13	0.40	0.18	0.18	0.32	97.41
C5	0.30	0.74	0.25	0.11	0.12	0.23	98.25
C6	0.23	0.80	0.31	0.17	0.14	0.24	98.11
C7	0.43	1.30	0.56	0.28	0.19	0.24	97.00
C8	0.13	0.76	0.60	0.40	0.99	1.91	95.21

Character of residue.

Sample C1. Abundance of calcareous arenaceous tubes and nodules; considerable quantity of ferruginous material; traces of plant fragments and muscovite.

Sample C2. Abundance of calcareous arenaceous tubes and nodules; small amount of ferruginous material and muscovite.

Sample C3. Abundance of calcareous arenaceous tubes and nodules; small amounts of ferruginous material, muscovite and fossils.

Sample C4. Abundance of calcareous arenaceous tubes and nodules; small amounts of muscovite and ferruginous material.

Sample C5. Abundance of calcareous arenaceous tubes and nodules; small amounts of fossils and muscovite.

Sample C6. Abundance of calcareous arenaceous tubes and nodules; small quantities of ferruginous material and muscovite.

Sample C7. Abundance of calcareous arenaceous tubes and nodules; considerable quantity of shell fragments; small amounts of ferruginous material and muscovite.

Sample C8. Abundance of calcareous arenaceous tubes and nodules; considerable quantity of ferruginous material; small amount of muscovite.

SCREEN ANALYSES, HOLE NO. C12

ample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.40	1.27	0.75	0.80	0.77	1.35	94.66
C2	0.61	1.54	0.52	0.40	0.39	0.39	96.15
C3	0.22	0.53	0.18	0.12	0.13	0.27	98.55
C4	0.29	0.76	0.28	0.18	0.16	0.33	98.00
C5	0.24	23.70	41.04	4.94	1.10	0.90	28.08
C6	0.13	31.00	44.28	3.05	0.72	0.45	20.37
C7	6.68	70.94	14.76	1.17	0.42	0.23	5.80

Character of residue.

Sample C1. Abundance of calcareous arenaceous material; small amount of ferruginous material; traces of muscovite and free quartz.

Sample C2. Abundance of calcareous arenaceous nodules; small amounts of ferruginous material and muscovite.

Sample C3. Abundance of calcareous arenaceous nodules; trace of muscovite.

Sample C4. Abundance of calcareous arenaceous nodules; small amount of muscovite.

Sample C5. Abundance of quartz; considerable quantity of calcareous material; traces of limonite and hematite.

Sample C6. Abundance of quartz; traces of hematite, limonite, magnetite and tourmaline.

Sample C7. Abundance of quartz; small amounts of feldspar, limonite, hematite, magnetite and muscovite.

SCREEN ANALYSES, HOLE NO. C21

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.02	0.30	0.33	0.50	0.72	0.96	97.17
C2	0.01	0.04	0.05	0.04	0.15	0.12	99.59
C3	0.36	2.79	2.59	1.05	2.50	4.59	86.12
C4	1.64	5.31	1.79	1.54	1.09	2.25	86.38
C5	0.10	1.36	1.03	0.31	0.49	0.43	96.28
C6	0.08	0.40	0.40	0.31	0.33	0.49	97.99
C7	0.03	0.21	0.83	1.08	0.95	0.67	96.23

Character of residue.

Sample C1. Abundance of arenaceous nodules; small amount of plant fragments.

Sample C2. Abundance of arenaceous material; considerable quantity of plant fragments; traces of carbon and muscovite.

Sample C3. Abundance of arenaceous nodules; considerable quantity of manganiferous material (probably psilomelane); small amount of limonite; trace of magnetite.

Sample C4. Abundance of limonitic arenaceous nodules; considerable quantity of manganiferous nodules.

Sample C5. Abundance of limonitic arenaceous nodules; small amounts of limonitic clay nodules and manganiferous grains.

Sample C6. Abundance of limonitic clay nodules; considerable quantity of manganiferous material; small amounts of free quartz and magnetite.

Sample C7. Abundance of limonitic clay nodules and free quartz; considerable quantity of manganiferous nodules; trace of plant fragments.

SCREEN ANALYSES, HOLE NO. C23

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.25	2.38	1.44	0.76	0.83	0.45	93.89
C2	0.04	0.08	0.07	0.06	0.07	0.09	99.59
C3	0.06	0.10	0.03	0.06	0.05	0.10	99.60

Character of residue.

Sample C1. Abundance of limonitic arenaceous material; small amounts of ferruginous material and plant fragments; traces of muscovite and quartz.

Sample C2. Abundance of arenaceous material; considerable quantity of ferruginous material; small amounts of quartz and muscovite.

Sample C3. Abundance of calcareous arenaceous material; small amounts of fossils, ferruginous material, quartz and muscovite.

SCREEN ANALYSES, HOLE NO. C24

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.03	0.22	0.33	0.33	0.95	0.66	97.48
C2	0.02	0.01	0.03	0.02	0.03	0.08	99.81

Character of residue.

Sample C1. Abundance of arenaceous nodules; small amounts of plant fragments, fossils and ferruginous material; traces of pyrite and muscovite.

Sample C2. Abundance of limonitic arenaceous nodules; considerable quantity of clay nodules; small amount of ferruginous material; traces of muscovite, ilmenite and magnetite.

SCREEN ANALYSIS, HOLE No. C37

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.03	0.27	0.57	0.67	0.73	0.82	96.91

Character of residue.

Sample C1. Abundance of arenaceous nodules; considerable quantity of argillaceous material; small amounts of ferruginous material and muscovite.

SCREEN ANALYSES, HOLE No. C55

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.45	3.91	3.62	2.19	2.95	2.28	84.60
C2	0.27	1.90	1.05	0.92	0.95	0.66	94.25
C3	0.42	4.95	7.31	10.72	15.75	4.82	56.03
C4	0.08	0.54	0.93	1.40	4.18	7.84	85.03
C5	0.03	0.44	1.60	9.40	25.38	13.02	50.13
C6	0.03	0.50	1.35	12.60	24.92	14.45	46.15

Character of residue.

Sample C1. Abundance of limonitic arenaceous material; small amounts of free quartz, ferruginous material and plant fragments.

Sample C2. Abundance of calcareous arenaceous nodules; considerable quantity of ferruginous material.

Sample C3. Abundance of free quartz; considerable quantity of ferruginous material; small amount of limonite; traces of muscovite and magnetite.

Sample C4. Abundance of limonitic arenaceous nodules; considerable quantity of clay nodules; small amounts of hematite and muscovite.

Sample C5. Abundance of limonitic arenaceous nodules; considerable quantity of clay nodules; small amount of muscovite.

Sample C6. Abundance of limonitic arenaceous nodules and quartz; considerable quantity of clay nodules; traces of muscovite, hematite, ferruginous material and biotite.

CHEMICAL ANALYSES

Chemical Analysis, Hole No. C1

Composite of Sample: C1, C2, C3.

Ignition loss	7.53	Lime, CaO	4.08
Silica, SiO_2	67.62	Magnesia, MgO	Trace
Alumina, Al_2O_3	16.05	Potash, K_2O	0.04
Iron Oxide, Fe_2O_3	3.37	Soda, Na_2O	0.05
Titania, TiO_2	0.60		

Moisture at 100°C, 1.61 Sulfur, SO_3, 0.45 Soluble salts, SO_4, 0.50

Chemical Analysis, Hole No. C9

Composite of Samples C1, C2, C3, C4, C5, C6, C7, C8.

Ignition loss	8.10	Lime, CaO	4.61
Silica, SiO_2	66.27	Magnesia, MgO	None
Alumina, Al_2O_3	16.20	Potash, K_2O	0.05
Iron Oxide, Fe_2O_3	3.35	Soda, Na_2O	0.25
Titania, TiO_2	0.75		

Moisture at 100°C, 1.56 Sulfur, SO_3, 1.23 Soluble salts, SO_4 0.75

Chemical Analysis, Hole No. C23

Composite of Samples C1, C2 and C3.

Ignition loss	4.08	Lime, CaO	3.35
Silica, SiO_2	73.05	Magnesia, MgO	None
Alumina, Al_2O_3	14.66	Potash, K_2O	0.06
Iron Oxide, Fe_2O_3	4.25	Soda, Na_2O	0.29
Titania, TiO_2	0.85		

Moisture at 100°C, 1.76 Sulfur, SO_3, 0.41 Soluble salts, SO_4, 0.35

Chemical Analysis, Hole No. C24

Composite of Samples C1 and C2.

Ignition loss	2.85	Lime, CaO	4.71
Silica, SiO_2	74.78	Magnesia, MgO	None
Alumina, Al_2O_3	12.40	Potash, K_2O	Trace
Iron Oxide, Fe_2O_3	4.58	Soda, Na_2O	0.26
Titania, TiO_2	0.90		

Moisture at 100°C, 1.54 Sulfur, SO_3, 0.75 Soluble Salts, SO_4, 0.50

PYRO-PHYSICAL PROPERTIES

Pyro-physical Properties, Hole No. C1

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	36.54	21.60	1.69	2.67	1.38	.47	Lt. Red	Not St. H.
C1	01	36.30	21.60	1.68	2.64	.84	.30	Lt. Red	Not St. H.
C1	2	25.28	13.32	1.93	2.58	13.67	4.79	Red	Not St. H.
C1	4	23.25	11.96	1.94	2.53	13.89	4.87	Red	St. H.
C1	6	17.79	8.66	2.06	2.50	17.74	6.32	Red	St. H.
C2	04	47.08	32.05	1.46	2.74	-1.06	-.37	Salmon	Not St. H.
C2	01	46.25	31.77	1.46	2.71	-.16	-.07	Salmon	Not St. H.
C2	2	43.62	28.78	1.52	2.69	1.18	.40	Grey-Buff	Not St. H.
C2	4	40.20	25.21	1.59	2.67	7.48	2.57	Grey-Buff	Not St. H.
C2	6	30.42	16.79	1.81	2.61	15.15	5.35	Grey-Buff	Not St. H.
C3	04	46.48	31.48	1.47	2.76	-1.42	-.50	Salmon	Not St. H.
C3	01	45.88	30.78	1.49	2.75	-2.18	-.74	Grey-Buff	Not St. H.
C3	2	44.58	30.50	1.51	2.72	-.41	-.13	Grey-Buff	Not St. H.
C3	4	40.20	25.01	1.61	2.69	8.42	2.92	Grey-Buff	Not St. H.
C3	6	32.66	18.52	1.76	2.62	16.18	5.72	Grey-Buff	Not St. H.
C4	04	47.22	32.27	1.46	2.77	-2.56	-.83	Salmon	Not St. H.
C4	01	44.56	30.42	1.47	2.65	-1.97	-.67	Grey-Buff	Not St. H.
C4	2	44.32	29.35	1.51	2.72	1.89	.64	Grey-Buff	Not St. H.
C4	4	41.35	26.17	1.58	2.69	3.15	1.08	Grey-Buff	Not St. H.
C4	6	24.40	12.60	1.93	2.56	23.50	8.56	Greenish Grey	St. H.
C5	04	41.30	25.72	1.61	2.73	-1.87	-.64	Salmon	Not St. H.
C5	01	40.72	25.20	1.60	2.70	-3.03	-1.04	Salmon	Not St. H.
C5	2	38.17	22.96	1.67	2.69	2.42	.84	Grey-Buff	Not St. H.
C5	4	28.89	16.04	1.80	2.53	7.21	2.50	Grey-Buff	Not St. H.
C5	6	21.90	11.04	1.98	2.54	17.64	6.29	Grey-Buff	St. H.
C6	04	33.25	18.89	1.79	2.70	.34	.13	Salmon	Not St. H.
C6	01	31.95	17.63	1.81	2.70	.66	.24	Salmon	Not St. H.
C6	2	22.54	11.25	2.00	2.59	8.82	3.06	Red	Not St. H.
C6	4	18.56	9.03	2.06	2.52	12.65	4.43	Red	St. H.
C6	6	9.41	4.21	2.24	2.47	19.95	7.17	Dark Red	St. H.

Abbreviations: St. H., steel hard.

Modulus of Rupture

Composite of C1, C2, C3

At cone	04	01	2	4	6
Lbs./sq. inch	243	285	594	552	544

Composite of C4, C5, C6

At cone	04	01	2	4	6
Lbs./sq. inch	307	359	461	378	511

Pyro-physical Properties, Hole No. C9

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	39.87	24.72	1.62	2.68	-1.02	-.37	Lt. Red	Not St. H.
C1	01	34.70	20.42	1.70	2.60	1.99	.67	Lt. Red	Not St. H.
C1	2	21.91	11.31	1.94	2.48	14.75	5.20	Red	Not St. H.
C1	4	21.47	11.32	1.97	2.53	14.20	4.98	Red	St. H.
C1	6	25.24	13.37	1.89	2.53	14.14	4.98	Red	St. H.
C1	8	15.17	7.13	2.13	2.51	23.52	8.58	Dark Red	St. H.
C1	10	2.22	1.18	1.88	1.93	12.41	4.35	Gunmetal	St. H.
C2	04	44.00	28.85	1.53	2.76	-1.97	-.67	Salmon-Buff	Not St. H.
C2	01	43.12	28.31	1.52	2.67	.31	.13	Salmon-Buff	Not St. H.
C2	2	38.20	23.49	1.62	2.63	6.08	2.08	Grey-Buff	Not St. H.
C2	4	34.96	20.42	1.70	2.63	12.16	4.39	Grey-Buff	Not St. H.
C2	6	32.17	18.92	1.69	2.50	10.14	3.52	Grey-Buff	Not St. H.
C2	8	8.42	3.94	2.15	2.36	29.32	10.96	Grey-Green	St. H., Glazed
C3	04	44.50	29.27	1.52	2.74	-4.97	-1.70	Salmon-Buff	Not St. H.
C3	01	44.30	29.06	1.53	2.74	-2.51	-.83	Salmon-Buff	Not St. H.
C3	2	39.75	24.93	1.59	2.65	1.42	.50	Grey-Buff	Not St. H.
C3	4	41.25	26.00	1.59	2.70	3.98	1.35	Grey-Buff	Not St. H.
C3	6	35.67	21.16	1.69	2.63	6.78	2.32	Grey-Buff	Not St. H.
C3	8	.47	.21	2.23	2.24	30.78	11.55	Grey-Green	St. H., Glazed
C4	04	46.35	31.32	1.48	2.76	-1.49	-.50	Salmon-Buff	Not St. H.
C4	01	47.30	32.67	1.45	2.74	-2.12	-.74	Salmon-Buff	Not St. H.
C4	2	40.37	25.65	1.55	2.64	3.70	1.25	Grey-Buff	Not St. H.
C4	4	45.45	30.46	1.49	2.73	-.33	-.13	Grey-Buff	Not St. H.
C4	6	38.88	24.15	1.61	2.63	7.80	2.67	Grey-Buff	Not St. H.
C4	8	4.96	2.21	2.26	2.38	34.94	13.38	Grey-Green	St. H., Glazed
C5	04	49.00	33.57	1.44	2.78	-2.08	-.70	Salmon-Buff	Not St. H.
C5	01	46.40	32.02	1.46	2.70	-.99	-.33	Salmon-Buff	Not St. H.
C5	2	43.05	28.54	1.50	2.65	4.04	1.39	Grey-Buff	Not St. H.
C5	4	43.40	28.55	1.52	2.70	5.02	1.73	Grey-Buff	Not St. H.
C5	6	44.55	30.57	1.46	2.63	3.61	1.25	Grey-Buff	Not St. H.
C5	8	8.24	3.69	2.29	2.48	35.50	13.59	Grey-Green	St. H., Glazed
C6	04	47.32	32.20	1.47	2.79	-1.67	-.57	Salmon-Buff	Not St. H.
C6	01	42.47	27.60	1.54	2.68	3.43	1.18	Salmon-Buff	Not St. H.
C6	2	39.83	25.18	1.59	2.63	6.79	2.32	Grey-Buff	Not St. H.
C6	4	37.25	22.24	1.67	2.67	12.75	4.46	Grey-Buff	Not St. H.
C6	6	43.50	28.60	1.52	2.69	.51	.20	Grey-Buff	Not St. H.
C6	8	5.38	2.38	2.30	2.44	34.96	13.38	Grey-Green	St. H., Glazed
C7	04	38.67	23.24	1.66	2.70	-2.44	-.84	Salmon	Not St. H.
C7	01	33.02	18.85	1.75	2.62	2.14	.74	Salmon-Grey	Not St. H.
C7	2	22.45	11.42	1.97	2.54	11.17	3.88	Salmon-Grey	Not St. H.
C7	4	28.10	14.97	1.88	2.61	7.21	2.50	Salmon-Grey	Not St. H.
C7	6	31.25	17.43	1.80	2.61	3.17	1.08	Salmon-Grey	Not St. H.
C7	8	1.39	.61	2.25	2.28	21.65	7.83	Grey-Green	St. H., Glazed
C8	04	33.90	19.38	1.75	2.65	-.32	-.13	Salmon	Not St. H.
C8	01	31.92	18.06	1.77	2.60	1.25	.44	Lt. Red	Not St. H.
C8	2	16.01	7.70	2.09	2.48	15.72	5.57	Red	Not St. H.
C8	4	19.43	9.57	2.03	2.52	12.57	4.39	Red	Not St. H.
C8	6	28.07	15.21	1.85	2.57	6.04	2.08	Red	Not St. H.
C8	8	10.23	4.31	2.26	2.50	22.90	8.30	Dark Red	Not St. H.
C8	10	3.82	1.88	2.04	2.12	13.19	4.61	Gunmetal	St. H.

Abbreviations: St. H., steel hard.

Modulus of Rupture
Composite of C1, C2, C3, C4

At cone	04	01	2	4	6	8
Lbs./sq. inch	187	211	255	470	459	3638

Composite of C5, C6, C7, C8

At cone	04	01	2	4	6	8
Lbs./sq. inch	246	261	314	341	511	2894

PYRO-PHYSICAL PROPERTIES, HOLE NO. C12

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	38.36	23.61	1.63	2.64	1.91	.67	Red	Not St. H.
C1	01	32.52	18.72	1.74	2.62	8.83	4.06	Red	Not St. H.
C1	2	22.33	11.37	1.97	2.53	20.40	7.32	Red	Not St. H.
C1	4	26.35	13.97	1.89	2.57	16.17	5.72	Dark Red	Not St. H.
C1	6	26.20	14.07	1.88	2.55	15.30	5.38	Dark Red	Not St. H.
C1	8	7.72	3.55	2.21	2.42	27.72	10.29	Reddish Brown	St. H.
C2	04	46.10	31.36	1.47	2.73	-1.52	-.54	Salmon	Not St. H.
C2	01	44.00	29.25	1.51	2.69	2.24	.77	Salmon-Buff	Not St. H.
C2	2	36.57	21.56	1.68	2.62	11.71	4.10	Grey-Buff	Not St. H.
C2	4	35.70	21.01	1.69	2.64	14.09	4.94	Grey-Buff	Not St. H.
C2	6	39.85	25.04	1.59	2.64	7.17	2.46	Grey-Buff	Not St. H.
C2	8	20.82	10.00	2.08	2.62	28.85	10.75	Greenish Grey	St. H.
C3	04	49.20	35.51	1.39	2.73	-.36	-.13	Salmon	Not St. H.
C3	01	47.70	33.91	1.41	2.69	1.52	.54	Grey-Buff	Not St. H.
C3	2	42.75	28.04	1.52	2.66	6.71	2.32	Grey-Buff	Not St. H.
C3	4	42.20	27.32	1.54	2.67	8.93	3.09	Grey-Buff	Not St. H.
C3	6	47.15	33.30	1.42	2.68	1.31	.47	Grey-Buff	Not St. H.
C3	8	35.16	20.20	1.74	2.68	20.57	7.40	Greenish Grey	St. H.
C4	04	45.45	30.50	1.49	2.73	-1.95	-.67	Salmon	Not St. H.
C4	01	46.00	31.01	1.49	2.75	-1.14	.40	Salmon	Not St. H.
C4	2	40.80	26.28	1.58	2.67	5.26	1.80	Grey-Buff	Not St. H.
C4	4	39.07	23.95	1.63	2.68	7.22	2.50	Grey-Buff	Not St. H.
C4	6	43.60	28.76	1.52	2.68	2.25	.77	Grey-Buff	Not St. H.
C4	8	.97	.41	2.35	2.37	36.02	13.87	Greenish Grey	St. H.

Abbreviations: St. H., steel hard.

MODULUS OF RUPTURE
COMPOSITE OF C1, C2.

At cone	04	01	2	4	6	8
Lbs./sq. inch	290	287	502	549	531	2259

COMPOSITE OF C3, C4

At cone	04	01	2	4	6	8
Lbs./sq. inch	173	178	301	404	1162	5948

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
C1	04	31.87	17.95	1.78	2.61	2.20	.74	Red Not St. H.
C1	01	32.72	18.61	1.76	2.62	3.19	1.08	Red Not St. H.
C1	2	21.00	10.70	1.96	2.49	17.64	6.29	Red Not St. H.
C1	4	28.76	15.66	1.84	2.58	4.30	1.46	Red Not St. H.
C1	6	22.70	13.11	1.96	2.54	11.61	4.06	Dark Red St. H.
C1	8	10.18	4.59	2.22	2.47	19.99	7.13	Dark Red St. H.
C1	10	1.66	.83	2.06	2.09	15.47	5.46	Reddish Brown St. H.
C2	04	37.61	22.64	1.66	2.66	1.96	.67	Red Not St. H.
C2	01	35.05	20.54	1.71	2.62	3.49	1.18	Red Not St. H.
C2	2	14.31	6.80	2.12	2.46	21.63	7.83	Red Not St. H.
C2	4	30.14	16.61	1.81	2.59	8.34	2.88	Red Not St. H.
C2	6	21.76	12.23	2.01	2.57	15.77	5.57	Dark Red St. H.
C2	8	4.19	1.84	2.26	2.42	26.64	9.84	Dark Red St. H.
C2	10	.90	.42	2.23	2.25	24.66	9.01	Gunmetal St. H.
C3	04	34.12	19.28	1.77	2.68	3.15	1.08	Red Not St. H.
C3	01	33.24	18.97	1.75	2.62	2.15	.74	Red Not St. H.
C3	2	19.30	9.87	1.99	2.48	13.36	4.68	Red Not St. H.
C3	4	22.55	12.86	1.97	2.54	12.05	4.21	Dark Red St. H.
C3	6	25.76	13.78	1.91	2.57	8.53	2.95	Dark Red St. H.
C3	8	3.69	1.62	2.27	2.36	25.08	9.18	Reddish Brown St. H.
C4	04	35.05	19.93	1.76	2.71	-3.27	-1.11	Yellow Buff Not St.H., Specked
C4	01	31.18	17.25	1.81	2.63	1.22	.44	Yellow Buff Not St.H., Specked
C4	2	27.82	15.11	1.84	2.54	2.24	.77	Reddish Buff Not St.H.,Specked
C4	4	29.18	15.74	1.85	2.62	1.20	.40	Reddish Buff Not St.H.,Specked
C4	6	31.55	17.19	1.84	2.68	.71	.23	Reddish Buff Not St.H.,Specked
C4	8	33.11	18.68	1.77	2.64	2.69	.91	Reddish Buff Not St.H.,Specked
C4	10	27.52	14.81	1.85	2.55	2.01	.70	Brownish Buff St.,H. Specked
C5	04	33.32	18.72	1.79	2.68	-1.12	-.40	Lt. Red Not St. H.
C5	01	30.94	16.97	1.82	2.64	2.65	.91	Lt. Red Not St. H.
C5	2	27.25	14.50	1.88	2.58	4.07	1.39	Red Not St. H.
C5	4	27.55	14.59	1.89	2.61	4.35	1.49	Red Not St. H.
C5	6	28.27	15.12	1.87	2.61	1.75	.60	Red Not St. H.
C6	04	30.34	16.30	1.86	2.68	-.50	-.17	Lt. Red Not St. H.
C6	01	27.66	14.50	1.91	2.64	1.57	.54	Lt. Red Not St. H.
C6	2	25.04	12.94	1.93	2.58	2.48	.84	Red Not St. H.
C6	4	28.01	14.78	1.90	2.63	1.73	.60	Red Not St. H.
C6	6	25.25	13.03	1.94	2.59	6.20	2.11	Red Not St. H.
C6	8	26.55	13.78	1.93	2.63	-.48	-.17	Red Not St. H.
C6	10	20.85	10.38	2.01	2.54	6.71	2.32	Reddish Buff St. H.
C7	04	30.36	16.47	1.85	2.65	-1.08	-.37	Lt. Red Not St. H.
C7	01	32.35	18.05	1.79	2.65	2.48	.48	Lt. Red Not St. H.
C7	2	27.86	14.91	1.87	2.59	4.47	1.52	Red Not St. H.
C7	4	27.72	14.15	1.89	2.62	3.00	1.01	Red Not St. H.
C7	6	28.34	15.20	1.87	2.61	3.22	1.11	Red Not St. H.
C7	8	26.56	13.25	1.93	2.59	6.08	2.08	Red St. H.
C7	10	15.96	7.55	2.12	2.52	13.58	4.76	Mottled Reddish Brown St.H.

Abbreviations: St.H., steel hard.

MODULUS OF RUPTURE

COMPOSITE OF C1, C2.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	351	610	884	1342	1930	2047	2274

COMPOSITE OF C1, C2, C5.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	582	619	1099	1200	2046	2675	3213

COMPOSITE OF C6, C7.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	829	930	980	1137	1500	1859	2695

PYRO-PHYSICAL PROPERTIES, HOLE NO. C23

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	29.32	16.05	1.82	2.58	3.46	1.18	Red	Not St. H.
C1	01	31.00	17.20	1.80	2.57	3.19	1.08	Red	Not St. H.
C1	2	15.87	7.72	2.06	2.45	16.65	5.91	Red, Flashed,	Not St. H.
C1	4	27.60	14.79	1.87	2.57	6.30	2.15	Red	Not St. H.
C1	6	18.24	8.99	2.03	2.49	13.82	4.87	Red	St. H.
C1	8	9.05	4.15	2.19	2.41	20.74	7.48	Dark Red	St. H.
C1	10	5.97	3.27	1.83	1.95	5.86	2.01	Brown	St. H.
C2	04	32.61	18.46	1.77	2.62	4.11	1.42	Lt. Red	Not St. H.
C2	01	33.57	19.28	1.74	2.62	2.11	.74	Lt. Red	Not St. H.
C2	2	23.43	12.18	1.92	2.51	13.03	4.57	Red, Flashed,	Not St. H.
C2	4	25.53	13.42	1.90	2.56	11.32	3.95	Red	St. H.
C2	6	9.34	4.29	2.18	2.41	23.34	8.50	Dark Red	St. H.
C2	8	4.01	1.78	2.26	2.36	25.80	9.47	Reddish Brown	St. H.
C2	10	2.59	1.32	1.95	2.01	11.09	3.85	Dark Brown	St. H.
C3	04	41.83	26.90	1.58	2.68	-.51	-.20	Dull Red	Not St. H.
C3	01	41.25	26.20	1.58	2.68	-.15	-.07	Salmon Buff	Not St. H.
C3	2	33.11	19.00	1.74	2.61	7.88	.71	Grey-Buff	Not St. H.
C3	4	33.84	19.54	1.73	2.62	8.56	2.95	Reddish Buff	Not St. H.
C3	6	17.72	8.56	2.07	2.52	24.35	8.90	Reddish Buff	Not St. H.
C3	8	.44	.20	2.22	2.23	27.90	10.33	Brownish Green	St.H., Glazed

Abbreviations: St.H., steel hard.

MODULUS OF RUPTURE
COMPOSITE OF C1, C2, C3.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	514	638	929	1745	2362	2665	3576

PYRO-PHYSICAL PROPERTIES, HOLE NO. C24

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	36.00	20.91	1.72	2.69	-.50	-.17	Salmon	Not St. H.
C1	01	28.93	15.90	1.82	2.56	3.81	1.32	Red	Not St. H.
C1	2	16.48	7.97	2.07	2.48	16.13	5.72	Red, Flashed,	Not St. H.
C1	4	26.82	10.91	2.00	2.56	12.21	4.28	Red	St. H.
C1	6	20.28	10.01	2.02	2.54	12.34	4.32	Dark Red	St. H.
C1	8	7.66	3.38	2.26	2.45	21.80	7.87	Brownish Red	St. H.
C1	10	4.44	2.05	2.17	2.27	18.28	6.52	Brown	St. H.
C2	04	30.06	22.19	1.74	2.67	-.43	-.17	Salmon	Not St. H.
C2	01	28.67	15.80	1.83	2.57	7.21	2.50	Red	Not St. H.
C2	2	7.95	3.59	2.22	2.42	23.52	8.58	Red, Flashed,	Not St. H.
C2	4	22.14	11.22	1.97	2.53	13.88	4.83	Red	St. H.
C2	6	24.98	13.05	1.92	2.55	9.11	3.17	Red	St. H.
C2	8	5.71	2.52	2.27	2.41	24.39	8.90	Reddish Brown	St. H.
C2	10	1.92	.97	2.00	2.03	13.81	4.87	Reddish Brown	Bl.,St.H.,Glazed

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

MODULUS OF RUPTURE
COMPOSITE OF C1, C2.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	489	967	1753	1923	2408	2502	2863

PYRO-PHYSICAL PROPERTIES, HOLE NO. C37

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	31.34	17.43	1.80	2.62	4.47	1.52	Lt. Red	Not St. H.
C1	01	32.71	18.57	1.76	2.61	1.03	.37	Lt. Red	Not St. H.
C1	2	22.29	11.51	1.94	2.49	11.10	3.85	Red	Not St. H.
C1	4	22.80	11.67	1.95	2.53	9.24	3.20	Red	St. H.
C1	6	18.63	9.25	2.03	2.50	12.22	4.28	Red	St. H.
C1	8	12.07	5.50	2.18	2.47	18.52	6.63	Dark Red	St. H.
C1	10	2.94	1.46	2.01	2.07	10.08	3.49	Brown	St. H.

Abbreviations: St.H., steel hard.

MODULUS OF RUPTURE

Sample	At cone	04	01	2	4	6	8	10
C1	Lbs./sq. inch	616	695	1278	1525	1692	1785	2918

PYRO-PHYSICAL PROPERTIES, HOLE No. C55

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	30.73	16.86	1.83	2.64	2.07	.70	Lt. Red	Not St. H.
C1	01	30.40	16.52	1.84	2.65	3.15	1.08	Lt. Red	Not St. H.
C1	2	13.67	6.41	2.14	2.48	17.52	6.25	Red, Flashed,	Not St. H.
C1	4	24.15	12.35	1.96	2.58	7.30	2.50	Red	St. H.
C1	6	22.36	11.22	1.99	2.57	11.00	3.81	Red	St. H.
C1	8	11.82	5.40	2.22	2.48	19.49	6.98	Dark Red	St. H.
C1	10	3.22	1.47	2.18	2.25	18.33	6.55	Brown	St. H.
C2	04	25.71	13.41	1.91	2.58	3.89	1.32	Lt. Red	Not St. H.
C2	01	26.60	13.97	1.91	2.62	3.14	1.08	Lt. Red	Not St. H.
C2	2	20.28	9.40	2.20	2.75	14.20	4.98	Red	Not St. H.
C2	4	15.23	7.19	2.13	2.50	12.36	4.32	Red	St. H.
C2	6	10.05	4.61	2.20	2.49	15.75	5.57	Dark Red	St. H.
C2	8	5.36	2.33	2.31	2.43	20.07	7.21	Dark Red	St. H.
C2	10	5.28	2.66	1.99	2.11	6.29	2.15	Brown	St. H.
C3	04	29.35	15.81	1.86	2.63	.17	.07	Salmon	Not St. H.
C3	01	28.67	15.43	1.86	2.61	.35	.13	Salmon	Not St. H.
C3	2	27.10	14.81	1.87	2.58	.90	.30	Lt. Red	Not St. H.
C3	4	28.65	15.31	1.87	2.62	.90	.30	Lt. Red	Not St. H.
C3	6	28.11	15.07	1.87	2.59	.00	.00	Lt. Red	Not St. H.
C3	8	30.33	16.41	1.86	2.67	.71	.27	Red	Not St. H.
C3	10	30.75	16.49	1.87	2.70	1.24	.44	Red	Not St. H.
C4	04	*	*	*	*	*	*	Salmon	Cr., Rpt., Not St.H.
C5	04	34.20	20.15	1.70	2.58	-1.22	.44	Buff	Not St. H.
C5	01	33.52	19.52	1.72	2.58	-.68	.24	Buff	Not St. H.
C5	2	33.52	19.58	1.71	2.57	1.01	.37	Buff	Not St. H.
C5	4	33.66	19.63	1.72	2.59	.00	.00	Buff	Not St. H.
C5	6	32.73	18.89	1.73	2.58	2.25	.77	Buff	Not St. H.
C5	8	32.70	18.81	1.74	2.58	.32	.13	Grey-Buff	Not St. H.
C5	10	32.14	18.37	1.75	2.53	2.58	.87	Grey-Buff	Not St. H.
C6	04	34.13	20.13	1.70	2.57	-8.65	-2.99	Buff	Not St. H.
C6	01	34.84	20.62	1.69	2.59	-2.65	-.91	Buff	Not St. H.
C6	2	31.99	18.61	1.72	2.53	-2.29	-.77	Buff	Not St. H.
C6	4	33.25	19.23	1.73	2.59	-1.95	-.67	Buff	Not St. H.
C6	6	32.05	18.53	1.73	2.55	-.34	-.13	Buff	Not St. H.
C6	8	31.95	18.19	1.76	2.58	1.59	.54	Grey-Buff	Not St. H.
C6	10	30.77	17.37	1.77	2.56	3.05	1.04	Grey-Buff	Not St. H.

*Data unreliable due to condition of test pieces.

Abbreviations: Cr. cracked; Rpt., ruptured; St.H., steel hard.

MODULUS OF RUPTURE
COMPOSITE OF C1, C2, C4.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	1362	1753	1968	2160	2607	2710	3533

SUMMARY OF RESULTS

The loess is represented by material from test holes C1, C9, C12, C21, C23, C24, C37, and the upper parts of test holes C55 and C2. The material is void of natural plasticity and in other respects is similar to the alluvium described elsewhere in this report. The loess is unsuited for the usual ceramic purposes but can be made into face brick using the semi-dry press process.

LABORATORY TESTS OF THE ALLUVIUM SILT

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Physical Properties in the Unburned State, Hole No. C6

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	27.12	28.21	10.50	Fine, open	Lt. grey
C2	20.81	8.95	3.09	Fine, open	Lt. grey
C3	21.27	8.12	2.81	Fine, open	Lt. grey

Modulus of rupture:
Composite of C1, C2, C3; 334 lbs. per sq. inch.

Physical Properties in the Unburned State, Hole No. C7

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	40.20	56.97	24.52	Fine, dense	Dark grey
C2	25.80	31.03	11.68	Fine, open	Lt. grey
C3	22.20	19.25	6.90	Fine, open	Lt. grey

Modulus of rupture:
Composite of C1, C2, C3; 476 lbs. per sq. inch.

Physical Properties in the Unburned State, Hole No. C40

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	23.23	19.48	6.98	Fine, open	Brown
C2	27.49	34.10	12.98	Fine, open	Brown

Modulus of rupture:
Composite of C1, C2; 447 lbs. per sq. inch.

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE NO. C43

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	12.86	3.55	1.21	Fine, open	Grey
C2	12.97	1.24	.44	Fine, open	Grey

Modulus of rupture:

Sample C1; 263 lbs. per sq. inch.
Sample C2; 285 lbs. per sq. inch.

SCREEN ANALYSES

SCREEN ANALYSES, HOLE NO. C6

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.29	0.80	1.74	1.15	5.56	12.55	77.91
C2	0.10	0.60	0.45	3.55	12.10	14.34	68.86
C3	0.02	0.12	0.31	2.73	8.95	12.26	75.61

Character of residue.

Sample C1. Abundance of limonitic ferruginous arenaceous material; considerable quantity of grey clay; small amount of common sand minerals.

Sample C2. Abundance of ferruginous rock grains; considerable quantity of limonitic clay nodules; small amounts of muscovite and common sand minerals.

Sample C3. Abundance of ferruginous material; considerable quantity of limonitic clay nodules; small amounts of muscovite, common sand minerals and plant fragments.

SCREEN ANALYSES, HOLE NO. C7

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.10	4.05	3.41	2.02	2.91	1.04	86.47
C2	0.12	0.93	1.23	1.02	1.34	1.95	93.41
C3	0.10	0.92	1.13	3.55	6.22	6.96	81.12

Character of residue.

Sample C1. Abundance of calcareous clay; considerable quantity of limonitic clay nodules; small amounts of ferruginous material and calcite.

Sample C2. Abundance of grey clay; considerable quantity of limonitic nodules; small amounts of ferruginous material and muscovite.

Sample C3. Abundance of arenaceous clay nodules; considerable quantity of quartz; small amounts of ferruginous material and muscovite; trace of calcareous material.

SCREEN ANALYSES, HOLE NO. C40

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.03	0.55	1.25	1.03	4.06	5.28	87.53
C2	0.03	0.51	0.66	1.28	0.95	1.89	94.68

Character of residue.

Sample C1. Abundance of ferruginous arenaceous nodules; considerable quantity of grey clay nodules; small amount of limonitic material; traces of muscovite and biotite.

Sample C2. Abundance of grey clay; considerable quantity of ferruginous material; small amounts of quartz and limonite; traces of carbonaceous material, plant fragments and muscovite.

SCREEN ANALYSES, HOLE NO. C43

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.12	1.96	3.99	5.98	9.25	10.95	67.75
C2	0.21	5.42	4.28	3.77	5.90	6.53	73.89

Character of residue.

Sample C1. Abundance of limonitic arenaceous clay nodules; considerable quantity of quartz; small amount of ferruginous material; traces of muscovite, limonite, magnetite and clay.

Sample C2. Abundance of rounded quartz grains; considerable quantity of limonitic arenaceous material; small amounts of dark minerals common to sand and clay nodules.

CHEMICAL ANALYSES

CHEMICAL ANALYSIS, HOLE NO. C6

COMPOSITE OF SAMPLES C1, C2, C3.

Ignition loss	3.65	Lime, CaO	3.14
Silica, SiO_2	73.01	Magnesia, MgO	Trace
Alumina, Al_2O_3	14.73	Potash, K_2O	0.04
Iron Oxide, Fe_2O_3	3.60	Soda, Na_2O	0.09
Titania, TiO_2	0.55		

Moisture at 100°C, 2.90 Sulfur, SO_3, 0.23 Soluble salts, SO_4, 0.55

CHEMICAL ANALYSIS, HOLE NO. C43

COMPOSITE OF SAMPLES C1 AND C2.

Ignition loss	2.81	Lime, CaO	4.96
Silica, SiO_2	76.35	Magnesia, MgO	None
Alumina, Al_2O_3	12.57	Potash, K_2O	Trace
Iron Oxide, Fe_2O_3	3.12	Soda, Na_2O	0.07
Titania, TiO_2	0.60		

Moisture at 100°C, 2.32 Sulfur, SO_3, 1.04 Soluble salts, SO_4, 0.75

PYRO-PHYSICAL PROPERTIES

Pyro-physical Properties, Hole No. C6

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	*	*	*	*	*	*	Lt. Red	Bl., Not St. H.
C2	04	33.67	19.46	1.73	2.61	.66	.24	Salmon	Not St. H.
C2	01	21.87	11.60	1.89	2.41	7.37	2.53	Lt. Red	Not St. H.
C2	2	26.44	14.79	1.79	2.44	3.68	1.25	Red	Not St. H.
C2	4	25.98	14.56	1.83	2.50	5.62	1.94	Red	Not St. H.
C2	6	21.15	10.66	1.99	2.52	11.60	4.03	Red	St. H.
C2	8	15.14	7.28	2.08	2.45	16.60	5.87	Brownish Red	St. H.
C2	10	5.04	2.79	1.80	1.90	2.94	1.01	Reddish Brown	Bl., St. H.
C3	04	32.52	18.54	1.76	2.60	.85	.30	Salmon	Not St. H.
C3	01	28.04	15.77	1.78	2.47	2.33	.81	Lt. Red	Not St. H.
C3	2	22.18	11.63	1.90	2.44	9.07	3.13	Red	Not St. H.
C3	4	21.71	11.17	1.94	2.48	11.67	4.06	Red	Not St. H.
C3	6	23.05	11.94	1.94	2.50	10.25	3.56	Red	Not St. H.
C3	8	19.05	9.36	2.04	2.51	13.90	4.83	Brownish Red	St. H.
C3	10	5.40	3.03	1.79	1.89	3.49	1.18	Reddish Brown	Bl., St. H.

*Data unreliable due to condition of test pieces.

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

Modulus of Rupture
Composite of C1, C2, C3.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	880	1094	1114	1306	1581	2093	1761

Pyro-physical Properties, Hole No. C7

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	*	*	*	*	*	*	Salmon	Cr. Bl. St. H.
C2	04	22.69	11.71	1.94	2.51	5.51	1.90	Salmon	Not St. H.
C2	01	16.73	8.39	2.01	2.41	10.92	3.81	Lt. Red	Not St. H.
C2	2	*	*	*	*	*	*	Dark Brown	Bl., St. H.
C3	04	29.08	15.90	1.82	2.57	1.64	.57	Lt. Red	Not St. H.
C3	01	19.60	10.00	1.96	2.44	7.83	2.71	Red	Not St. H.
C3	2	*	*	*	*	*	*	Dark Brown	Bl., St. H.

*Data unreliable due to condition of test pieces.

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

Modulus of Rupture
Composite of C1, C2, C3.

At cone	04	01	2	4	6
Lbs./sq. inch	1687	2345	2362	2763	3045

PYRO-PHYSICAL PROPERTIES, HOLE NO. C40

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	*	*	*	*	*	*	Lt. Red	Bl., St. H.
C2	04	*	*	*	*	*	*	Lt. Red	Bl., St. H.

*Data unreliable due to condition of test pieces.
Abbreviations: Bl., bloated; St. H., steel hard.

MODULUS OF RUFTURE
COMFOSITE OF C1, C2.

At cone	04	01	2	4	6
Lbs./sq. inch	1670	2164	2490	3366	3830

PYRO-PHYSICAL PROPERTIES, HOLE NO. C43

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	31.70	17.44	1.81	2.66	-4.13	-1.42	Lt. Red	Not St. H.
C1	01	28.80	15.24	1.89	2.65	-1.63	-.57	Lt. Red	Not St. H.
C1	2	21.50	10.99	1.95	2.49	2.38	.89	Red, Flashed,	Not St. H.
C1	4	26.78	13.97	1.89	2.56	.02	.01	Red	Not St. H.
C1	6	22.90	11.83	1.94	2.51	3.97	1.35	Red	Not St. H.
C1	8	20.89	10.41	2.01	2.56	6.76	2.32	Dark Red	St. H.
C1	10	3.93	1.92	2.04	2.12	5.82	2.01	Brown	St. H.
C2	04	27.41	14.48	1.89	2.60	-.01	.00	Lt. Red	Not St. H.
C2	01	27.57	14.80	1.87	2.59	.50	.17	Lt. Red	Not St. H.
C2	2	18.62	9.42	1.98	2.43	5.04	1.73	Red, Flashed,	Not St. H.
C2	4	23.74	12.24	1.94	2.55	3.18	1.08	Red	Not St. H.
C2	6	15.36	7.39	2.08	2.45	9.25	3.20	Dark Red	St. H.
C2	8	11.21	5.24	2.14	2.40	11.04	3.85	Dark Red	St. H.
C2	10	5.78	3.27	1.77	1.88	-6.17	-2.11	Brown	Bl., St. H.

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

MODULUS OF RUFTURE

Sample	At cone	04	01	2	4	6	8	10
C1	Lbs./sq. in.	378	461	633	816	993	1114	1639
C2	Lbs./sq. in.	724	765	1146	1228	1408	1881	1400

SUMMARY OF RESULTS

The alluvium, as represented by samples from test holes C6, C7, C40, and C43 is evidently a weathered phase of the loess containing more colloidal matter and fine sand. The material is composed essentially of fine grains of silica and alumino silicates whose surfaces are coated with hydrated colloidal iron. It cannot be considered a clay even though it contains some clay substance, possesses certain plastic properties, and burns to a dense body.

The alluvium is more plastic than the loess and is stronger in the dry state; however, it is doubtful that it contains more clay substance. As pointed out in the part of this report relating to the loess, its plastic properties or lack of them is due to the absence of appreciable amounts of clay substance, and that the little plasticity it does have is attributed to the fineness of grain and the presence of hydrated iron. The increased plasticity of the alluvium is probably due to a more nearly complete hydration of its iron content made possible by favorable ground water conditions.

The formation of hydrated iron, its deposition and bonding power on sand grains, was studied by Brown, who states that magnetite and hematite are readily dissolved in water containing organic acid and as the water percolates through sand the iron is precipitated as hydrated iron, limonite, on the sand grains. He is of the opinion that the iron is in a colloidal condition and when deposited on the surface of the sand grains becomes an important factor in developing a bond. He states that most high grade molding sands are thickly coated with limonite in a colloidal condition (4). Littlefield states that clay does not adhere to the smooth surfaces of quartz grains, but if the quartz grains are coated with a film of limonite, clay will adhere more tightly to them than to the clay body (5).

The alluvium may appear to be fairly uniform; however, physical properties of the different C samples show considerable variation. The water of plasticity ranges between 13 percent and 40 percent, the typical average being 25 percent. The normal linear shrinkage is 6 percent to 12 percent but varies between 0.44 percent and 24.52 percent as extremes. The lowest modulus of rupture is 263 pounds per square inch and the highest is 476 pounds per square inch. Though there is a maximum variation of 213 pounds the minimum value is ample for heavy clay products.

The alluvium may be burned satisfactorily under oxidizing conditions. It is very sensitive to reducing kiln atmosphere and will fail at lower temperatures than expected if not properly oxidized during burning. Calcium in small amounts, as in this alluvium, is a very active flux and is the principal fluxing constitutent when the burning is done under oxidizing conditions. Iron, as present in this alluvium, is not a fluxing agent within the burning range of the alluvium and under oxidizing burning conditions; however, under reducing conditions, ferric oxide, Fe_2O_3, is converted to ferrous oxide, FeO, which is an active flux and readily combines with lime and silica forming an iron-lime-silicate that softens at lower temperatures, causing failure of the ware. This same condition is true of the loess; however, the loess is not as sensitive to reducing kiln atmosphere, because it is more open bodied than the alluvium, thus making it possible for oxygen to enter the loess body more readily than the tighter bodied alluvium. Samples C1 and C2 from test holes C43 and samples C2 and C3 from test holes C6 contain less organic and colloidal matter; they are more open bodied and would be preferred for burning in commercial kilns, because they are less sensitive to reducing kiln atmosphere resulting from periodic firing.

Though every effort was made to maintain an ideal oxidizing kiln atmosphere when firing the test pieces in the laboratory, some of the small test pieces that were nearer the flame failed at a lower temperature than the long bars made of the same material that were farther away from the flame. The location of test pieces in the kiln will account for a small difference in temperature, but it will not account for the failure at Cone 04 of small test pieces of samples C1 and C2 from test hole C40 and the successful firing through Cone 6 of long bars. The same applies to material from test hole C7 which failed at Cones 04-2 when near the flame but was satisfactory through Cone 6 when partly protected.

The more open bodied alluvium has a burning range from Cone 2 through Cone 8 but should not be fired above Cone 6 in commercial kilns. Slight change in the porosity and shrinkage of the alluvium within its burning range points to the production of a uniform product. Continuous kilns permit better control of temperature and kiln atmosphere and would be more satisfactory for burning the alluvium than periodic kilns.

Due to the lack of natural plasticity the alluvium is limited in its uses. It is suited for the production of an excellent quality red face brick when using the semi-drypress process and for the production of machine made flower pots. It would be difficult to find a better material for flower pot manufacture.

LABORATORY TESTS OF THE YEGUA SILT

PHYSICAL PROPERTIES IN THE UNBURNED STATE

PHYSICAL PROPERTIES IN THE UNBURNED STATE, HOLE No. C35

Sample No.	Water of plasticity in percent	Drying shrinkage		Texture	Color
		Volume in percent	Linear in percent		
C1	12.29	1.40	.47	Silty, open	Grey
C2	15.67	1.39	.47	Silty, open	Grey

Modulus of rupture:

Composite of C1, C2; 190 lbs. per sq. inch.

SCREEN ANALYSES

SCREEN ANALYSES, HOLE No. C35

Sample No.	Percent residue through 20 mesh retained on screens Nos.						
	30	60	100	150	200	250	Pan
C1	0.01	0.25	2.15	9.18	12.07	9.55	66.79
C2	0.02	0.22	2.77	6.17	7.86	11.53	71.43

Character of residue.

Sample C1. Abundance of grey clay nodules; considerable quantity of quartz; small amount of carbonaceous material; trace of magnetite.

Sample C2. Abundance of quartz; considerable quantities of carbonaceous material and grey clay nodules; small amounts of muscovite and magnetite.

CHEMICAL ANALYSIS

CHEMICAL ANALYSIS, HOLE No. C35

COMPOSITE OF SAMPLES C1 AND C2.

Ignition loss	3.01	Lime, CaO	3.08
Silica, SiO_2	83.40	Magnesia, MgO	None
Alumina, Al_2O_3	8.33	Potash, K_2O	Trace
Iron Oxide, Fe_2O_3	1.15	Soda, Na_2O	0.11
Titania, TiO_2	0.85		

Moisture at 100°C, 1.32 Sulfur, SO_3, 0.29 Soluble salts, SO_4, 0.50

PYRO-PHYSICAL PROPERTIES

Pyro-physical Properties, Hole No. C35

Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
C1	04	31.21	17.38	1.80	2.61	-1.47	-.50	Buff	Not St. H.
C1	01	31.37	17.47	1.80	2.61	-3.51	-1.21	Buff	Not St. H.
C1	2	28.77	15.75	1.83	2.56	-4.15	-1.42	Buff	Not St. H.
C1	4	29.34	16.10	1.82	2.58	-.17	-.07	Lt. Grey - Buff	Not St. H.
C1	6	28.24	15.39	1.84	2.55	-.17	-.07	Lt. Grey - Buff	Not St. H.
C1	8	25.80	13.63	1.90	2.55	2.08	.70	Grey - Buff	Not St. H.
C1	10	23.66	12.20	1.94	2.54	3.53	1.21	Grey - Buff	St. H.
C2	04	35.89	21.65	1.65	2.58	-2.84	-.98	Buff	Not St. H.
C2	01	35.91	21.72	1.65	2.58	-2.35	-.81	Buff	Not St. H.
C2	2	35.79	21.51	1.63	2.53	-1.75	-.60	Buff	Not St. H.
C2	4	34.59	20.95	1.65	2.57	-1.14	-.40	Buff	Not St. H.
C2	6	35.45	21.66	1.64	2.53	-1.61	-.57	Buff	Not St. H.
C2	8	33.57	19.58	1.72	2.58	1.25	.44	Grey - Buff	Not St. H.
C2	10	31.15	17.86	1.75	2.54	5.65	1.94	Grey - Buff	St. H.

Abbreviations: St. H., steel hard.

Modulus of Rufture

Comfosite of C1, C2.

At cone	04	01	2	4	6	8	10
Lbs./sq. inch	206	254	419	293	510	527	923

SUMMARY OF RESULTS

The argillaceous silt from the Yegua is represented by material from test hole C35 and from the lower part of test hole C55. The material possesses little plasticity and is not steel hard when burned below Cone 10. The fired modulus of rupture up to and including Cone 10 is too low to permit the use of the silt as the sole constituent of clay products.

LABORATORY TESTS OF THE MOODYS BRANCH MARL

CHEMICAL ANALYSIS

Chemical Analysis, Hole No. C8

Comfosite of Samples C6 and C7.

Ignition loss	7.35	Lime, CaO	3.85
Silica, SiO_2	71.91	Magnesia, MgO	None
Alumina, Al_2O_3	10.03	Potash, K_2O	None
Iron Oxide, Fe_2O_3	7.43	Soda, Na_2O	0.04
Titania, TiO_2	0.40		

Moisture at 100°C, 2.42 Sulfur, SO_3, 3.37 Soluble salts, SO_4, 0.80

SUMMARY OF RESULTS

The properties of the Moodys Branch marl from test hole C8 are given in this report under the title, Yazoo clay-marl. The material does not appear to have any commercial possibilities.

LABORATORY TESTS OF THE CITRONELLE GRAVEL

SCREEN ANALYSES

SCREEN ANALYSES OF GRAVEL, COMPOSITE SAMPLE

Test Hole	Sample No.	Percent residue on screens						
		1¼ inch	1 inch	¾ inch	½ inch	3/8 inch	10 mesh	Pan
C29	C1, C2	5.39	13.55	17.28	12.06	14.97	7.61	29.18
C30	C1, C2, C3	8.04	17.02	17.10	12.27	11.22	6.20	28.18
C31	C1, C2, C3	7.69	11.77	14.00	12.64	12.24	7.22	34.53

SUMMARY OF RESULTS

The gravel of Yazoo County is represented by samples from test holes C29, C30, and C31. Screen analyses indicate that the size-graduation in the different samples is fairly uniform. The material is used extensively as a topping for clay-sand roads and as an aggregate in concrete.

LABORATORY PROCEDURE

PREPARATION

Preliminary drying of the clays was unnecessary, for they had been collected from the field and stored in a steam-heated room several months prior to testing. Primary samples of about 200 pounds were crushed in a No. 2 jaw crusher. The crushed material was screened through a No. 20-mesh Tyler standard screen; the residue coarser than 20-mesh was ground in a burr mill until it passed the 20-mesh screen. The final bit of residue remaining on the 20-mesh screen was collected for examination, the description of which appears in the tables of screen analyses under the designation "Residue retained on screen No. 20." The clay which had passed 20-mesh screen was thoroughly mixed and reduced to a 10-pound sample by coning and quartering. This operation was accomplished in a metal lined tray approximately 4 feet square and 8 inches deep. The 10-pound sample was reserved for screen analysis, thermal 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 three sizes: cubes, 1 inch square; short bars, 1 inch square by 2 inches long; long bars, 1 inch square by 7 inches long. The test pieces were made by wire-cutting bars of approximate size from the plastic mass and then pressing them in molds to the final size. The long bars were pressed by hand in a hardwood mold of the plunger type. The short bars were formed in a Patterson screw press fitted with a steel die. The 1 inch cubes were cut from short bars. Each test piece was identified as to test hole number, sample number, and individual piece number. The identification was made by stamping the necessary letters and numerals on the test pieces. A shrinkage mark of 10 centimeters was stamped on the long bars. Sixty long bars, 100 short bars, and 4 cubes were made from each primary clay sample. Certain C samples were not large enough to make the full number of test pieces.

PLASTIC, DRY, AND WORKING PROPERTIES

Immediately on forming the short bars their plastic volume was determined in an overflow volunteer of the Schurecht type, using kerosene as the liquid. The plastic weight was measured to .01 gram using a triple beam balance. All of the test pieces were allowed to air-dry several days on slatted wooden pallets and then were oven-dried by gradually increasing the temperature of the oven from room temperature to 100°C. in 4 hours and maintaining the oven temperature between 100°C. and 110°C. for an additional hour. After drying, the short bars and cubes were placed in dessicators, and on cooling to room temperature they were reweighed and placed in kerosene to soak 24 hours, after which, their volumes were taken as above described. The 1 inch cubes were slaked in water in accordance with the procedure outlined by the American Ceramic Society. Ten long bars were broken on a Fairbanks cross-breaking machine to determine modulus of rupture.

The workability of the clay was observed during grinding, wedging, and the forming of the test pieces. Clays having a suitable plasticity were formed into pottery shapes by throwing on a potters wheel. Where the quantity of clay permitted, standard size brick were made in a hand mold for the purpose of observing drying characteristics of thick bodies. The water of plasticity, modulus of rupture, and volume of shrinkage, were calculated by methods outlined by the American Ceramic Society. The linear shrinkage was calculated from the volume of shrinkage and checked against the linear shrinkage measured from the long bars.

FIRED PROPERTIES

The long and short bars were burned in a downdraft surface combustion kiln especially designed for the purpose, using Butane gas for fuel. Oxidizing conditions were maintained in the kiln during the entire period of firing. The test pieces were stacked criss-cross in the kiln to permit complete circulation of gasses. The kiln was fired at the rate of 200°F. per hour up to 200°F. below the optimum temperature. The last 200°F. rise was accomplished in two to three hours. The rate of firing was measured by means of a Chromel-Alumel thermocouple up to 2100°F., at which point the couple was withdrawn from the kiln and pyrometric cones alone were used.

The fusion point of pyrometric cone equivalent of the several clays was determined in accordance with the standard procedure outlined by the American Ceramic Society, by using double tangent burners in a furnace especially designed for the purpose.

After the firing of the long and short test pieces the kiln was cooled gradually in twenty-four to thirty-six hours, after which the short bars were immediately placed in dessicators and weighed to an accuracy of .01 gram on a triple beam balance. After weighing, the bars were placed in water which was then heated to the boiling point and was kept boiling for four hours. They were allowed to cool in the water to room temperature and were reweighed as before mentioned. Immediately thereafter the volumes of the test pieces were determined in a Schurecht volumeter using water as the liquid. Volume shrinkage, porosity, absorption, bulk specific gravity, and apparent specific gravity were calculated in accordance with methods outlined by the American Ceramic Society. The long bars were broken on a Fairbanks testing machine to determine modulus of rupture. Five long bars were burned and tested for each clay at each cone temperature indicated in the table of pyro-physical properties. Three short bars were fired as test pieces and six additional short bars were fired as check pieces for each clay and at each cone.

CONVERSION TABLE

CONES TO TEMPERATURES

Cone No.	When fired slowly, 20°C. per hour		When fired rapidly, 150°C. per hour	
	°C.	°F.	°C.	°F.
010	890	1,634	895	1,643
09	930	1,706	930	1,706
08	945	1,733	950	1,742
07	975	1,787	990	1,814
06	1,005	1,841	1,015	1,859
05	1,030	1,886	1,040	1,904
04	1,050	1,922	1,060	1,940
03	1,080	1,976	1,115	2,039
02	1,095	2,003	1,125	2,057
01	1,110	2,030	1,145	2,093
1	1,125	2,057	1,160	2,120
2	1,135	2,075	1,165	2,129
3	1,145	2,093	1,170	2,138
4	1,165	2,129	1,190	2,174
5	1,180	2,156	1,205	2,201
6	1,190	2,174	1,230	2,246
7	1,210	2,210	1,250	2,282
8	1,225	2,237	1,260	2,300
9	1,250	2,282	1,285	2,345
10	1,260	2,300	1,305	2,381
11	1,235	2,345	1,325	2,417
12	1,310	2,390	1,335	2,435
13	1,350	2,462	1,350	2,462
14	1,390	2,534	1,400	2,552
15	1,410	2,570	1,435	2,615
16	1,450	2,642	1,465	2,669
17	1,465	2,669	1,475	2,687
18	1,485	2,705	1,490	2,714
19	1,515	2,759	1,520	2,768
20	1,520	2,768	1,530	2,786

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

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

SCREEN ANALYSIS

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

The disintegrated clay in slip form was poured through a nest of Tyler standard screens, the sizes being 30, 60, 100, 150, 200, and 250-mesh. The material passing through the 250-mesh screen was caught on a cloth in a plaster vat. After a fair sample was caught on the cloth, the screens, still in nest, were washed with a stream of water until no further material passed through the screens.

The screens were dried at 110°C., after which, the residue from each screen was weighed and collected in glass vials for further study.

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

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

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

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

CHEMICAL ANALYSIS

Grinding: All samples were ground to pass a 100-mesh sieve.

Moisture: Moisture determinations were run on all samples as 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. Double precipitations was found necessary to remove all chlorides. The mixed hydroxides were filtered off, washed free from chlorides, ignited, and weighed. This weight represents the total of alumina, iron, and titania. The mixed oxides were fused with potassium bisulfate, and dissolved in water. 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 as determined and subtracted from alumina.

Iron: An aliquot of the solution of the bisulfate fusion was run through a Jones reductor and titrated with standard permanganate solution made up so that 1cc. is equivalent to 0.001 gram ferric oxide.

Titania: Another aliquot of the solution of the bisulfate fusion was placed in a nessler tube with a few drops of hydrogen peroxide and the color of the tube compared to standard color tubes.

The total of iron and titania was subtracted from the total of alumina, iron, and titania to leave the alumina.

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

Magnesia: Magnesia was determined in the lime filtrate by precipitation as the mixed ammonium phosphate. It was ignited and weighed as $Mg_2P_2O_7$.

Alkalies: Alkalies were determined by the J. Lawrence Smith method as outlined in Scott "Standard Methods of Chemical Analysis." The hydrofluoric acid method of decomposition was used because it was found to be more practical with the apparatus at hand.

Sulfur: Sulfur was determined in a separate sample by a carbonate fusion, solution in dilute hydrochloric acid, oxidation to SO_4 with bromine and precipitation with 10 percent barium chloride solution. Precipitate was weighed as barium sulfate. Ignition losses were corrected for SO_3 before totaling the analyses.

Duplicate analyses were made on each clay and the average was reported.

Soluble salts: Ten grams of each clay were accurately weighed and boiled in 100 cc. of water to which 10 cc. of HCl were added. The precipitates were allowed to settle and 10 cc. portions of $BaCl_2$ solution (1 cc. equivalent to .001 gram SO_4) were run in. After each addition the solutions were stirred, allowed to settle, and one drop added to a drop of dilute H_2SO_4 on a spot plate. As soon as a white precipitate formed in one spot the percent of soluble salts was taken as the number of cc. run in divided by 100.

LABORATORY STAFF

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Alta Ray Gault, B. A., M. S. .... Mineralogist
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PLATE 2

Map of Gravity Meter Survey of Tinsley Oil Field by Petty Gravity Surveys, Inc. Courtesy of the firm and of Mr. W. Harlan Taylor.