MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph. D.
Director

BULLETIN 42

TIPPAH COUNTY MINERAL RESOURCES

GEOLOGY
By
LOUIS COWLES CONANT, Ph. D.

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

UNIVERSITY, MISSISSIPPI
1941

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Prepared in cooperation with the Tippah citizens and the WPA as a report on O.P.465-63-3-275

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MISSISSIPPI GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

Office of the State Geological Survey
University, Mississippi
December 10, 1940

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

Gentlemen:

Herewith is Bulletin 42, Tippah County Mineral Resources—Geology by Louis Cowles Conant, Ph.D.; Tests by Thomas Edwin McCutcheon, B.S. Cer. Engr.—the fourth in a series of bulletins that the Mississippi Geological Survey as sponsor to WPA project 4847 pledged itself to publish.

The report is the fruit of the splendid cooperation on the part of the civic organizations of Ripley, the citizens of that city and of Tippah County with their State Geological Survey. Many citizens have contributed time and substance, for which the State Geologist is profoundly grateful—especially has Mr. Lee Cox, to mention only one of a number, labored for the success of the survey. The survey, of course, would not have been possible without the WPA grant.

The report reveals a number of valuable mineral deposits which await only commercial development to yield a substantial income. The tests show that the Porters Creek clay (middle phase) produces a porous material which, on crushing, forms one of the strongest light-weight aggregates for concrete known to the industry—a material not only light in weight but one which has excellent insulating qualities and one which should supply a great need.

Very sincerely yours,

William Clifford Morse,
State Geologist and Director

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TIPPAH COUNTY MINERAL RESOURCES

GEOLOGY

LOUIS COWLES CONANT, Ph.D.

INTRODUCTION

The field work on which this report is based was conducted from May to September, 1938, under the joint auspices of the Federal Works Progress Administration and the Mississippi Geological Survey, as one unit in a state-wide study of the mineral resources of Mississippi. This work was of two types: (1) prospecting of clays and other minerals and (2) geologic studies and mapping.

Laborers were employed to drill test holes and dig trenches and pits to determine the presence and extent of any material suspected to be of economic value, and to collect samples for laboratory examination. Clays, chiefly of the kaolinitic type, were extensively prospected by holes drilled with 4-inch post hole augers. From most of these holes samples weighing a few pounds were taken, and larger samples of promising material were taken with 6-inch, 8-inch or 9-inch augers, particular care being exercised to prevent the infall of foreign material, though a little contamination is probably present in all the samples.

In addition, the author made a general study of the geology of the county and prepared the geologic map (Pl. 1) which accompanies this report. This map was drawn on a highway and stream base map especially prepared for this survey by Mr. Andrew Brown from various sources. Though not accurate in all details, this map is far better than any previous map of the county and has been a satisfactory base for the present work. Outcrops and contacts were plotted in most instances by reference to such features as road intersections and stream crossings. Once located, a contact was projected by inspection of the topography and by use of an altimeter. With the altimeter it was possible to determine approximately where a contact might be found, even though no contacts were seen. In most places the altimeter evidence was supported by the presence of springs, changes in color or character of the soil, changes in vegetation, topographic differences, or the presence of landslips which are common at the upper boundary of clay formations. In a number of places these projected contacts were confirmed later by the discovery of outcrops.

Contacts are shown on the map by solid lines only where they were definitely observed, and outcrops are indicated only where the material can be unmistakably identified. Soils, topography, and other indirect evidences have not been used as a basis for indicating outcrops and known contacts, though in many cases such evidence is convincing to one familiar with the details of the region. Except for the divisions of the Ripley formation, most of the contacts so drawn on the map are probably accurate well within a quarter of a mile. When topographic maps are available it will be possible to map the contacts with much greater accuracy of detail.

GEOGRAPHY

COMMUNICATION

Tippah County, the location of which is shown in Figure 1, contains about 446 square miles. It is served by the Gulf, Mobile & Ohio Railroad, which runs north and south near the middle of the

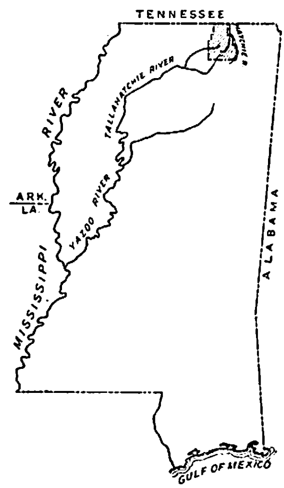

Figure 1.—Map showing the location of Tippah County.

county. Three main highways traverse the county: (1) U. S. 72, a hard surface road which crosses the northern part of the county through Walnut; (2) Mississippi 4, a gravel road which at present runs west from Ripley but is being extended east to Booneville; and (3) Mississippi 15, a hard surface road which parallels the railroad. The unimproved roads are for the most part all-weather roads where they are built on the Wilcox sands; but in other regions, notably those underlain by Porters Creek clay, the roads are almost or quite impassable in wet weather. Most of the early roads in the county, such as the old Saulsbury road and the old Pontotoc road, are ridge roads following old Indian trails. Even today most of the roads in the hill sections follow the ridges.

The county is served by a TVA power line which approximately parallels the railroad. Up to the present no extended branches of this line have been constructed. Only a few rural telephone lines have been built, and some of these have not been kept up. The county is well served by Rural Free Delivery routes.

POPULATION AND SCHOOLS

The 1940 census showed a population of 19,680 in Tippah County; the 1930 census showed 18,658. The proportion of colored population to the total in 1930 was about 16.9 percent, one of the lowest in the state; the 1940 proportion is not available as this is written.

Population figures for the towns and larger communities in 1940 were as follows:

Ripley	2,011
Blue Mountain	544
Walnut	516
Chalybeate	199

Ripley, Blue Mountain, Walnut, and Chalybeate have large consolidated schools in fairly new and up-to-date buildings, and many of the smaller communities have large grade schools and high schools. Blue Mountain is the home of Blue Mountain College for girls, a Baptist school of about 300 students.

AGRICULTURE

Aside from retail stores, cotton gins, and such other business activities as are normally present in a Southern rural community, the farm is the only important means of livelihood. In the past there has been much lumbering, but this has decreased in recent years through the cutting of the forest and through the purchase of land in the western part of the county by the Federal government for incorporation into the Holly Springs National Forest.

Owing in part to the prevalent system of tenant farming, much of the tillable land has been carelessly cultivated and allowed to erode, so that much of the soil is worn out and large areas are badly gullied.

Cotton, the chief crop, is raised largely for the cash income it affords though in recent years some diversification has been encouraged, and this, together with enforced cotton acreage reduction, has resulted in a somewhat greater variety of farm products.

LABOR

Owing to a combination of causes, a plentiful supply of unskilled labor is available for any industry that may require it. As the cost of living is low, this labor, both white and colored, is accustomed to low wages, though it is to be hoped that the wage scale will rise.

TOPOGRAPHY

Three well-defined topographic belts extend north and south the entire length of the county. These are the Pontotoc Hills, the Flatwoods, and the North Central Hills.

The Pontotoc Hills occupy approximately the eastern two-thirds of the county, their western edge being close to the line of the Gulf, Mobile & Ohio Railroad. On the east, due to the presence of resistant upper Ripley ferruginous sandstone layers, they rise abruptly from the Prairie belt, which stands about 400 feet above sea level a short distance east of the Tippah-Prentiss county line, to elevations of almost 800 feet. This difference in elevation and the presence of the easily-eroded McNairy sand just below the sandstone layers have produced, in the region between the county line and the Hatchie, a deeply-dissected, mature topography known locally as the Hatchie hills. West of the Hatchie the hills are somewhat less rugged and the resistant Ripley and Clayton limestones cause the average elevations to follow the westward regional dip of about 30 feet to the mile until the hills merge with the Flatwoods at elevations of 400 to 500 feet.

The Flatwoods (Fig. 2) is a conspicuously level area which was popularly called by that name at least as early as 1860[1]. It is underlain by the Porters Creek clay, known locally by the apt though inaccurate name of "soapstone." The soil is heavy, cold, stiff, and difficult to cultivate. Few topographic irregularities appear in this region except in the northwest part of the county, where the Tippah sand member of the Porters Creek clay has produced a markedly rugged topography; and between Ripley and Falkner, and in the

Blue Mountain region, where hills between drainages have escaped destruction and are still capped with Wilcox sands. The Flatwoods belt in northern Tippah County is only 2 or 3 miles wide, but toward the south it widens to about 6 miles.

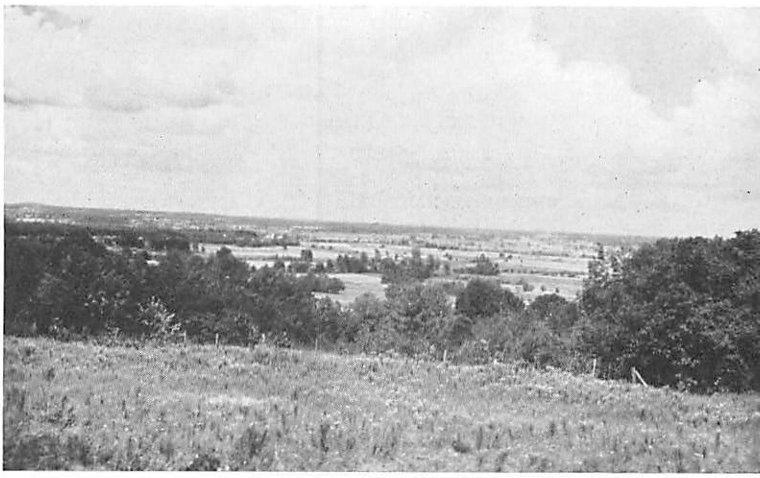

Figure 2.—View across the Flatwoods, looking north from the top of Blue Mountain. July 1939.

The North Central Hills, which are well developed in the northwestern part of the county, form a belt some 40 to 50 miles wide between the Flatwoods and the Mississippi River lowland. They have resulted from irregular dissection of the thick series of Wilcox sands and clays which overlie the Porters Creek clay and are responsible for a rugged topography with a relief of about 200 feet. Deforestation has led to much gullying and erosion in this area.

CLIMATE

According to a report of the Mississippi State Planning Commission[2], the average mean precipitation in Tippah County is about 54 inches, in general well distributed over the year with a slight preponderance in the winter and spring months. Summer rainfall is chiefly in the form of thunder showers of short duration. The maximum summer temperature is about 100°, while winter minima vary considerably from year to year, averaging about 15°.

DRAINAGE AND WATER RESOURCES

Tippah County is drained by three main stream systems: the Hatchie*, the Tallahatchie*, and Tippah Creek. The Hatchie and its tributaries, including Dry and Muddy Creeks and West Hatchie, drain most of the eastern and northern parts of the county north into Tennessee and eventually into the Mississippi River. The Tallahatchie and its tributaries drain the area west of Dumas and south of the Blue Mountain ridge, south and west into the Yazoo River. Tippah Creek and its tributaries drain the south-central and west-central portions west, eventually into the Tallahatchie.

Many of the streams have probably filled up appreciably within the last century because of the erosion of the hills following deforestation. All of the large stream beds and many of the smaller have been artificially channelled to insure more rapid run-off and thereby minimize the ever-present danger of flooded bottoms after heavy rains.

Little water power is now available, as the streams are mostly small with low gradients, though formerly water-mills were in use on all the main streams. As the water in the streams is unsuited for drinking and for most industrial uses owing to its mud content, water for such purposes is obtained from small springs, shallow wells, and artesian wells, the last named being the most reliable. Most of the artesian wells in the county are between 50 and 500 feet deep[3], the depth depending largely on the topographic and geographic location. Many wells in the valleys flow with a slight pressure, and the water has, in general, a low mineral content.

GENERAL GEOLOGY

Rocks formed during the three earliest eras of geologic time, the Archeozoic, Proterozoic, and Paleozoic, are not present at the surface in Tippah County. The oldest deposits in the county date from the last period of the Mesozoic era, the Cretaceous, and the youngest from the Eocene period of the Cenozoic era. Coastal plain deposits of these ages, consisting of unconsolidated sands, clays, marls, and subordinate layers of limestone and sandstone, underlie the county. The boundary between the Cretaceous and Cenozoic is the contact between the Owl Creek and Clayton formations.

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* Hatchie and Tallahatchie are said to be Chickasaw Indian names meaning, respectively, "River" and "Rocky River." Diary of the Rev. Sam Agnew, during the early days of the county, published about 1934 in the weekly Southern Sentinel, Ripley.

In late Mesozoic and early Cenozoic times the shoreline of the Gulf of Mexico was far inland from the present coast line, so that sediments of those ages are present over much of Georgia and Alabama, all of Mississippi except a small part of Tishomingo County, extend northward on both sides of the Mississippi River as far as Cairo, Illinois, and blanket considerable portions of Missouri, Arkansas, and Texas, and all of Louisiana. This extinct northern arm of the Gulf of Mexico is now referred to as the Mississippi Embayment. Streams flowing into this embayment brought quantities of sand, silt, and clay, the difference in the materials reflecting in large part the changing conditions in the drainage areas. Whenever the incoming streams brought little debris to a region, calcareous precipitates and the shells of dead animals made up the bulk of the sediment, forming limestone and marl. Inasmuch as the sea floor at this time was repeatedly sinking, materials originally deposited in shallow water were covered by younger sands and muds until deposits several thousand feet thick were formed. The sinking, however, was not continuous, but was interrupted by halts and even minor uplifts during which the sea water was drained off and the sediments exposed to erosion.

That the waters of the embayment teemed with life is shown by the abundance of marine fossils found throughout the area. Since the forms of animal life are continually changing with the disappearance of some species and the appearance of others, the presence of certain fossils in a sediment is to a geologist the most reliable indication of its geologic age. For example, sediments which contain shells of the large ribbed spiral-beaked oyster, *Exogyra costata,* found throughout eastern Tippah County, are known from this fact to be of Cretaceous age. Also, the great differences between the fossils of the Cretaceous period and those of the later periods indicate the intervention of a long period of time during which the land was out of water.

Large areas appear to have stood, at times, only slightly above sea level, and to have been flooded by rivers which spread silt and sand over them. Such deposits contain no marine fossils, but do contain scattered leaf and petrified wood fragments.

Partly because of the greater down-warping in the center of the embayment and partly because of the original slope on which the materials were deposited, the older strata in Tippah County show a

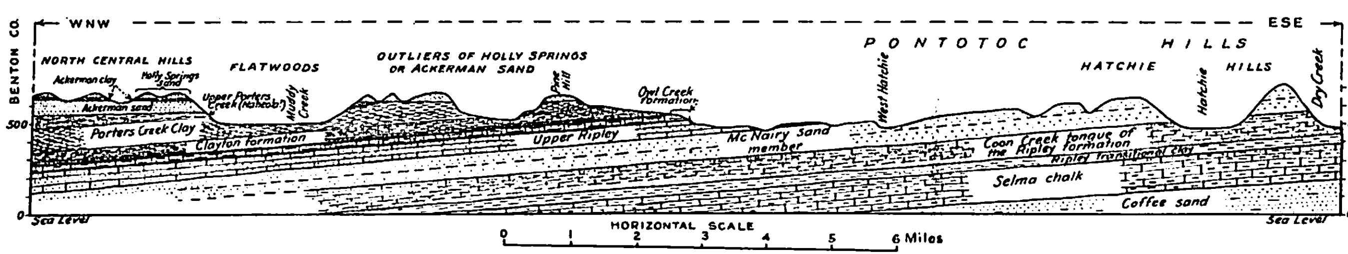

Figure 3.—Generalized east-west cross section of Tippah County showing the presumed arrangement of the strata below the surface. The surface relief and the dips are greatly exaggerated.

gentle inclination or regional dip to the west of about 30 feet to the mile. The younger beds, for reasons which are explained in the section on the Porters Creek clay, show a gentler dip, about 15 feet to the mile (Fig. 3).

The following table indicates the geologic formations found at the surface in Tippah County, and the geologic time in which each was formed. The names are arranged in order, the name of the youngest at the top:

GENERALIZED SECTION OF EXPOSED FORMATIONS IN TIPPAH COUNTY

Group	System and (Series)	Formation	Member or Phase	Character	Thickness (feet)
Cenozoic	Recent or Pleistocene	Colluvium		Sandy and silty material; reworked by rainwash, soil creep, landslips, etc.	0-25
	Pleistocene or Pliocene	Alluvium		Sand, silt, and clay deposited by present streams in their valleys; older deposits now partly removed to form terraces.	0-10
		Unconformity			
	Eocene (Wilcox)	Holly Springs (?) Sand		Red sand, locally coarse, with one or more beds of leaf-bearing pink and white laminated silty clay.	200±
		Ackerman formation	Upper clay member	Dark-gray laminated silty lignitic clays.	0-100±
			Basal sand member	Red sand, commonly cross-bedded; some clay-ball breccia; local siderite concretions; petrified wood fragments; a few boulders near base.	100±
			Basal clay member	White, gray lignitic, or bauxitic clays, commonly silty or sandy, found locally, probably a reworked kaolin or bauxite; the Fearn Springs formation of Mellen.	0-90
		Unconformity			
	Paleocene (Midway)	Porters Creek Clay	Bauxite-kaolin zone	Kaolin and bauxite found locally, probably weathered products of the Porters Creek clay into which they grade; the Betheden formation of Mellen.	0-70?
			Upper Phase	Laminated dark-gray or black silty clay with laminae of silt or sand; commonly highly micaceous; scattered siderite concretions; possible equivalent of the Naheola.	0-100±
			Typical phase (Including Tippah sand)	Dark-gray or black montmorillonitic clay; lamination nearly absent; conchoidal fracture. (Tippah sand probably a local development of this member; glauconitic sand, siltstone, and laminated clay).	100±
			Basal phase	Dark-green or black montmorillonitic clay, glauconitic, somewhat bentonitic; thin glauconitic siltstone layer at its base.	50±
		Clayton formation	Upper member	Dark laminated clays, marls, and sands; glauconitic throughout; shell and plant remains locally abundant; 1-2 foot limestone layer probably present in its lower portion.	50-60
			Basal member	Highly fossiliferous glauconitic sandy limestone and marl layers, limestone predominating.	15±
		Unconformity			
Mesozoic	Cretaceous (Gulf)	Owl Creek formation		Blue-black sandy glauconitic limy clayey beds (marl); nearly everywhere abounds in great variety of excellently preserved fossils.	30±
		Unconformity			
		Ripley formation	Upper (limestone) tongue	Limestone, marl, and subordinate sand and sandstone layers; limestone layers highly fossiliferous.	10-100±
			McNairy sand tongue	Cross-bedded micaceous marine sand, commonly ferruginous; locally irregularly indurated; contains at least one bed of light-colored laminated clay about 5 feet thick.	200±
			Coon Creek tongue	Blue-black impure marls, dark laminated clays, many laminae and scattered beds of yellow sand.	150±
			Transitional clay	Highly calcareous gray sandy clay, somewhat fossiliferous; distinguished by the presence of its sand from the underlying Selma chalk into which it grades.	50±
		Selma chalk		Consolidated impure chalk, locally highly fossiliferous; not actually found exposed in Tippah County, but probably close to surface in SE. corner of the county.	

STRATIGRAPHY—MESOZOIC GROUP

CRETACEOUS SYSTEM

The Gulf, or upper Cretaceous, series as exposed in Mississippi consists of seven formations: the Tuscaloosa, Eutaw, Coffee, Selma, Ripley, Prairie Bluff, and Owl Creek. Only the Ripley and Owl Creek formations have been recognized in Tippah County, though at one place the Selma chalk is not far below the surface.

SELMA CHALK

The Selma chalk, named for the town of Selma, Alabama, underlies the Black Prairie belt in northeast Mississippi. It is predominantly an impure chalk grading through gray clayey chalk which weathers to a heavy sticky joint clay, upward to the basal Ripley sandy clays. In places it is highly fossiliferous.

The Selma is a thick and important formation, but an extended discussion of it would be out of place here, because it has not been found to crop out anywhere in Tippah County, though it is probably only a few feet below the lowest points in the extreme southeastern corner of the county (Sec. 36, T.5 S., R.5 E.).

RIPLEY FORMATION

GENERAL FEATURES

The Ripley formation is the most widespread unit of the Upper Cretaceous (Gulf) series, extending under various names from Texas and Arkansas to southern Illinois, thence through Kentucky, Tennessee, Mississippi, Alabama, and Georgia, and northward east of the Appalachian Mountains as far as New Jersey. It was named in 1860 for the town of Ripley, Mississippi, by Hilgard[4], who included in the formation the Clayton limestone and the Owl Creek marl. Later Harris[5] found the Clayton to be of Eocene* age, and in 1937 Stephenson and Monroe[6] separated the Owl Creek from the Ripley and raised it to the rank of a formation. Consequently the Ripley formation as now defined is found nowhere closer than 3 miles to the town of Ripley, though the Owl Creek and Clayton are present within the corporate limits of the town.

The Ripley formation in Tippah County is about 400 feet thick, Despite its thickness and the great relief over most of the region of its outcrop, good exposures, especially of the uppermost member, are

* The Clayton has recently been assigned by the U. S. Geological Survey to a newly established division, the Paleocene.

few. Hilgard[7] noted this fact in including this member in his "Orange sand." A reasonable explanation of the poor exposures is that the rugged topography causes the permanent ground water level to be far below the surface, and the sandy materials permit the ground water to penetrate deeply, so that erosion gullies 20 or more feet deep commonly expose only a red sandy clay difficult to identify. In many places near the top of the formation, however, the weathered material contains light-colored splotches which here and there preserve the outlines of fossils sufficiently clearly to indicate the forms from which they were derived. Such material is well shown three-quarters of a mile south of Dumas where, on the west side of a narrow ridge, there are interrupted exposures of about 175 feet of unaltered limestone, marl, and sand, whereas only a few hundred feet away deep erosion gullies on the east side of the ridge at the same elevation show deeply weathered strata which contain many light-colored splotches. Some of these clearly represent fossils but others may be worm or root borings.

Four distinct units make up the Ripley formation in Tippah County: (1) a transitional sandy calcareous gray clay, (2) the Coon Creek tongue, (3) the McNairy sand tongue, and (4) the upper limestone, marl, sand tongue. As it was not decided to differentiate these units until most of the field work was completed, they were mapped only in a general way on the basis of a few widely scattered outcrops and the broad topographic conditions.

TRANSITIONAL GRAY CLAY

A gray calcareous, sandy clay, probably about 50 feet thick, forms a transitional zone between the underlying impure Selma chalk and the overlying, dominantly sandy, Ripley formation. The gradation is so perfect that it is difficult to place the contact, but Monroe[8] has suggested that the contact be considered that level where the sandy constituents become noticeable. The clay is present in Tippah County only in the extreme southeast corner (Sec. 36, T.5 S., R.5 E.) where only about the upper 25 feet is present.

COON CREEK TONGUE

The Coon Creek tongue, named for Coon Creek, Tennessee[9], consists of blue-black laminated sandy micaceous marls and clays with partings and beds of fine sand. The thickness of this unit is difficult to determine as its contacts with the overlying and underlying beds are poorly exposed. At its northernmost exposure in Tippah County, near the junction of Dry Creek and the Hatchie, it is exposed for about 50 feet up the valley walls and may extend higher. Separated exposures of the top and bottom of the tongue in the southeast corner of the county (Secs. 35 and 36, T.5 S., R.5 E.) on the east slope of the Hatchie-Tombigbee divide indicate that the Coon Creek is here about 150 feet thick.

Certain marl layers in the Coon Creek tongue abound in well-preserved fossils, notably univalves. Good exposures of this fossiliferous marl may be seen (1) on the property of E. C. Jones in a road cut at the base of the east wall of a tributary of the Tallahatchie (Sec. 34, T.5 S., R.4 E.) and (2) in small bluffs on the north side of a stream south of the J. W. O'Kelly house about 2 1/2 miles south of Dumas (NW. 1/4, Sec. 35, T.5 S., R.4 E.). A few miles to the south much better exposures have been found in Union County, and to the north Wade[9] has made the type locality at Coon Creek, Tennessee, famous for its assortment of well-preserved shells.

As the beds are exposed only in the stream valleys in the eastern part of the county, and as the contact with the overlying beds is on the steep hillsides some 75 to 100 feet above the flood plains, the outcrop areas are only a little wider than the stream bottoms themselves.

MCNAIRY SAND TONGUE

The McNairy sand tongue[10] lies above the Coon Creek tongue and includes the greatest thickness of the Ripley formation in northern Tippah County, where Stephenson[11] estimated the McNairy to be about 200 feet or more thick. The present observations in the rugged hills in the eastern part of the county confirm this estimate. To the south the tongue becomes thinner and disappears a few miles south of the Tippah-Union county line. It consists of coarse cross-bedded micaceous sand, commonly unfossiliferous, and somewhat ferruginous. It is typically exposed as loose sand, but at many places has been consolidated into ferruginous sandstones of tubular, corrugated, or otherwise irregular forms which are readily recognizable as belonging to this tongue.

A bed of gray sandy clay which crops out in many places appears to be a fairly persistent layer within the McNairy sand. It is well exposed (1) about three-quarters of a mile east of Peoples (Sec. 36, T.3 S., R.4 E.), where the road descends the west wall of West Hatchie; (2) in a deep erosion ditch on the land of W. M. Medford, north of, and about 90 feet below, the road (near the SW. cor. Sec. 29, T.3 S., R.5 E.); (3) on the north wall of Clear Creek about 1 mile north of Dumas, on the Ripley road. In these places the clay is about 4 feet thick, and McNairy sands lie above and below. It appears to be about 75 to 100 feet below the top of the Ripley formation.

The McNairy sand is well exposed on the high ridge east of Dry Creek in the southeastern part of the county, on the ridge between Dry Creek and the Hatchie, on the east slope of the hills west of the Hatchie and its tributaries, and on the valley slopes on both sides of the Tallahatchie.

UPPER TONGUE

The upper tongue of the Ripley formation consists of a series of beds of sandy limestone interbedded with other materials, normally sand toward the north and marl toward the south. The limestone is highly fossiliferous, containing large number of *Exogyra costata,* various species of *Cardium,* many smaller bivalves and univalves, and hemispherical echinoids (sea-urchins) whose five radiating markings have given them the local name of "star-rocks." This tongue is thin or possibly absent at the Tennessee line, but thickens progressively toward the south as the underlying McNairy sand thins. The steep road on the east side of Muddy Creek (NW. 1/4, Sec. 26, T.1 S., R.4 E.) shows about 10 feet of the material at the base of the hill, and a road cut on the south side of a small creek (SE. 1/4, Sec. 2, T.2 S., R.4 E.) shows about 5 feet of it in contact with the McNairy sand below and the Owl Creek marl above.

The best outcrop of this tongue found in Tippah County, showing about 85 feet of it, is three-quarters of a mile south of Dumas in a deep ravine heading at the west side of the ridge at a road fork (Sec. 23, T.5 S., R.4 E.). This ravine shows the following section:

SECTION IN A RAVINE THREE-QUARTERS OF A MILE SOUTH OF DUMAS

	Feet	Feet
Owl Creek formation, about		15
Ripley formation, about		161
Limestone, fossiliferous, containing many Cardia, about	1	
Covered interval, about	20	
Marl, blue-black fossiliferous, about	5	
Limestone, poorly exposed, about	2	
Covered interval, about	42	
Limestone	1	
Covered interval, about	10	
Limestone, containing echinoids, about	5	
Covered interval, probably chiefly sand like that below, about	45	
Sand, scattered exposures, cross-bedded, containing ferruginous concretions (McNairy sand), about	30	

A more accessible exposure of limestone is near the foot of Yancy Hill, 3 miles east of Ripley on the Corinth road (near NE. cor. Sec. 17, T.4 S., R.4 E.). Here the new road on the south bluff of Owl Creek has been cut through the limestone, many boulders of which have been dumped into the ditch. Other exposures are at L. T. Bradock's, north of Walnut Creek (SE. 1/4, Sec. 16, T.3 S., R.4 E.), and on the land of Erastus Blackwell, formerly known as the Booker Pate or Sam Alexander place, on the south bluff of White Oak Creek (E. 1/2, SW. 1/4, Sec. 33, T.3 S., R.4 E.). Wherever this limestone is exposed it abounds in a variety of fossils. The area of outcrop of this tongue is bounded by that of the McNairy sand on the east and that of the Owl Creek formation on the west.

Figure 4.—Type locality of the Owl Creek formation, near Ripley. The boys are standing at edge of the creek bed and at the Owl Creek-Clayton contact. July 1938.

OWL CREEK FORMATION[12]

The Owl Creek formation is named from an excellent outcrop (Fig. 4) on the south bluff of Owl Creek about 2 1/2 miles northeast of Ripley (Sec. 7, T.4 S., R.4 E.), which has been a classic collecting ground for geologists since 1856, when it was first visited by Hilgard[13]. Its fossils, which are plentiful, varied, and exceptionally well preserved, were first described by Conrad[14] in 1858.

Formerly known as the Owl Creek tongue of the Ripley formation, it was separated from the Ripley by Stephenson and Monroe[15] and raised to the rank of a formation because of the presence of a widespread unconformity at its base which indicates a time of emergence between the periods of deposition of the two formations. It has, therefore, been mapped as a distinct unit for this report.

The formation consists of a bluish highly fossiliferous glauconitic, micaceous sand. Its thickness is described by earlier writers as 20 feet, but one bluff at the type locality shows 27 feet, and the actual thickness probably varies between 20 and 30 feet, and may be even greater in places. Good outcrops, though not numerous, are fairly well scattered over the county so that by the use of the altimeter it has been possible to map the outcrop of the formation with a fair degree of accuracy.

Abundant well-preserved fossils characterize the material at almost all of its outcrops. Good fossils may be obtained not only from the famous type locality 2 1/2 miles northeast of Ripley, but from Owl Creek outcrops at the following localities: (1) in a road cut about 1 mile north of Providence School (Sec. 27, T.2 S., R.4 E.); (2) in road cuts on the two sides of Walnut Creek on the L. T. Braddock place (near the SE. cor. Sec. 16, T.3 S., R.4 E., and the NE. cor. Sec. 21, T.3 S., R.4 E.); (3) on the south bluff of White Oak Creek on the land of Erastus Blackwell, formerly referred to as the Booker Pate or Sam Alexander place (E. 1/2, SW. 1/4, Sec. 33, T.3 S., R.4 E.); and (4) from a small outlier traversed by the road at the top of a hill about three-quarters of a mile south of Dumas (near W. edge Sec. 24, T.5 S., R.4 E.). The Dumas outlier is distinctly more chalky and may represent a northward extension of the Prairie Bluff formation to which the Owl Creek gives way farther south in Union County.

The following section at the L. T. Braddock place, where the Owl Creek beds are in contact with the underlying Ripley and the overlying Clayton beds, is taken from a publication by Stephenson and Monroe[15]:

SECTION AT THE L. T. BRADDOCK PLACE, NORTH OF WALNUT CREEK

	Feet	Feet
Clayton formation (Midway)		24.0
Fine to medium glauconitic, ferruginous sand; line of pebbles made up of the underlying light-brown very fine sand at the base	24.0	

Unconformity		
Owl Creek formation		25.5
Light-brown very fine micaceous sand	5.0	
Light blue-gray calcareous, micaceous, argillaceous sand, rich in fossils	9.0	
Yellow sandy, calcareous clay	1.5	
Limestone	0.5	
Yellow sandy, calcareous clay	0.5	
Blue-gray calcareous, argillaceous very fine sand containing abundant fossil shells; basal foot contains numerous pebbles of concretionary origin that appear to be waterworn	9.0	
Unconformity		
Ripley formation		8.0
Hard nodular ferruginous, calcareous sandstone, containing echinoids	2.0	
Fine to coarse reddish-brown sand containing small brown pellets and abundant tubes of *Halymenites major*	6.0	

The Owl Creek formation weathers to a fertile red soil similar to, but slightly more clayey and lighter in color than, the typical adjacent Ripley and Clayton soils.

The Owl Creek is the uppermost formation of the Cretaceous system and of the entire Mesozoic group in Mississippi. It is separated from the younger beds by one of the most widespread unconformities in the Atlantic and Gulf Coastal Plain province.

STRATIGRAPHY—CENOZOIC GROUP

PALEOCENE SYSTEM—MIDWAY SERIES

The Midway series, named for Midway landing on the Alabama River in Alabama, is the oldest series of Cenozoic strata exposed in Mississippi. Heretofore the Midway has been considered the basal portion of the Eocene system in the Eastern Gulf Coastal Plain, but with the recent adoption of the term Paleocene by the U. S. Geological Survey[8] it is now included in that division. In Tippah County the Midway consists of the Clayton formation and the overlying Porters Creek clay.

CLAYTON FORMATION

GENERAL FEATURES

The Clayton formation, named for the town of Clayton, Alabama, is between 50 and 75 feet thick in Tippah County and comprises two distinct members: (1) a basal limestone and marl member, and (2) an upper marl, clay, and sand member. In 1860 Hilgard[16] placed the limestone member in the Mesozoic (Cretaceous), but it is now known to be of Cenozoic (Paleocene) age[17].

No complete section of the Clayton is known in Tippah County. At Chalybeate Springs, in a ravine north of old U. S. Highway 72, the following section from the lower contact to the top of the hill shows it to be at least 65 feet thick, and as some of the nearby points of land are several feet higher and show typical Clayton soil, it is probable that the formation is at least 10 or 15 feet thicker.

SECTION IN RAVINE AT CHALYBEATE SPRINGS

	Feet	Feet
Clayton formation, about		65.5
Yellowish sandy clayey material, which weathers to a red soil, about	38.0	
Yellow sandy material; probably a weathered blue marl, about	5.5	
Blue marl, sandy	2.5	
Covered interval, probably blue marl	3.0	
Blue sandy marl, fossiliferous	5.5	
Limestone, containing Turritellas and other fossils	0.5	
Blue marl	5.5	
Sandy limestone, fossiliferous	0.5	
Blue marl, fossiliferous	2.0	
Sandy limestone, containing Turritellas and other fossils	2.5	
Owl Creek marl, blue, fossiliferous		4.0

Commencing about three-quarters of a mile east of Tiplersville on the road to Chalybeate nearly continuous exposures show about 72 feet of the Clayton formation, 30 feet of Porters Creek clay, and 25 feet of Wilcox sand.

SECTION ON THE CHALYBEATE ROAD COMMENCING ABOUT THREE-QUARTERS OF A MILE EAST OF TIPLERSVILLE

	Feet	Feet
Wilcox, about		25
Red sand, stratified, some white layers; used for highway topping; contact not seen; about	25	
Porters Creek clay, about		30
Laminated black clay and yellow sand, probably Tippah sand member; exposures poor, about	5	
Hard glauconitic rock layer, forms slight terrace in road	1	
Laminated black clay and sand with a 3-inch glauconitic rock layer near the middle; probably Tippah sand member, about	10	
Hard glauconitic rock layer, about	1	
Clay, typical Porters Creek near top, more silty and glauconitic near base	12	
Hard glauconitic rock layer, about	1	

Clayton formation, about		72
Sand, glauconitic, gray-green, weathering to brown; lower part more clayey	27	
Sand, light blue-gray, highly micaceous, fine-grained, sparingly glauconitic	10	
Badly weathered interval	10	
Sandy weathered material, micaceous and clayey with some badly weathered fossils; probably the limestone member	25	

Near Ripley where the contacts of the Clayton formation with the underlying Owl Creek marl and the overlying Porters Creek clay are exposed within half a mile of each other (Sec. 24, T.4 S., R.3 E.) the Clayton has an apparent thickness of only about 50 or 55 feet.

The fertile red soil derived from the Clayton has been described by older writers as being of an Indian red color. Actually only the marl member gives this typical shade, the limestone weathering to a dirty straw or ocher color. In most road cuts this difference in color is conspicuous, though near the surface, where weathering has been more intense, it is in many places difficult to distinguish one from the other.

Except in the Blue Mountain region the Gulf, Mobile, & Ohio Railroad follows closely the western edge of the Clayton outcrop through Tippah County. The geologic map shows a width of Clayton which appears out of all proportion to the relative thinness of the formation, but this apparent discrepancy is caused by the topography of the region, which in turn reflects the resistance to erosion of the materials composing the Clayton. Throughout the Clayton outcrop area the surface rises toward the east about 20 to 30 feet to the mile, the rise corresponding in general to the dip of the underlying strata, until it is broken by the escarpments west of the West Hatchie and its tributaries in the northern part of the county, and the Tallahatchie in the southern part. In the latter region the north-south ridges between the tributaries of the Tallahatchie show Clayton material at the top. The Clayton formation is therefore largely responsible for that part of the Pontotoc Hills which lies west of the West Hatchie and its tributaries.

BASAL LIMESTONE AND MARL MEMBER

The thickness of the basal limestone and marl member varies widely at its none too numerous outcrops. Thus, at Chalybeate Springs three thin limestone layers are separated and overlain by strata of blue marl, whereas in a gulch north of the road near Moses Chapel, about 2 1/2 miles east of Ripley on the Corinth road, the limestone is at least 10 feet thick, and the bottom of the stratum is not exposed. In a sinkhole about half a mile east by south of Ripley (NE. 1/4, NW. 1/4, Sec. 24, T.4 S., R.3 E.) a thickness of 10 feet is well exposed, and large pieces of the limestone can be seen at the top of the hill at least 20 feet above the outcrop. Lowe[18] reports 18 feet of Clayton limestone above the Owl Creek marl at the type locality of the Owl Creek formation.

The fresh limestone is light-gray in color, typically stained yellowish-brown in places by the weathering of its glauconite grains. Hard, crystalline, and highly fossiliferous, it can generally be identified by the presence of great numbers of the conical high-spiraled snail, *Turritella mortoni,* from which is derived its common name of "Turritella rock." Commonly only the external impressions and corkscrew-like internal molds of the *Turritella* are preserved; but in the exposure at Chalybeate Springs, and in a group of slabs near the road on the steep east wall of Muddy Creek (Sec. 26, T.1 S., R.4 E.), entire shells are present. The slabs near Muddy Creek, which may have been hauled there, since no outcrops could be found, contain also many phosphatic nodules.

Among the other places in Tippah County where fossils may be found in this member are the following: (1) in the road cut at the L. T. Braddock place (near SE. cor. Sec. 16, T.3 S., R.4 E.); (2) in the ravine 2 1/2 miles east of Ripley on the north side of the Corinth road, just west of Moses Chapel (Sec. 17, T.4 S., R.4 E.); (3) at the type locality of the Owl Creek formation 2 1/2 miles northeast of Ripley (Sec. 7, T.4 S., R.4 E.); (4) at the southeast corner of the Ripley corporation on the east wall of King Creek (NW. 1/4, Sec. 24, T.4 S., R.3 E.); (5) at the road corner 1 mile due south of the Ripley courthouse (E. edge Sec. 23, T.4 S., R.3 E.) and (6) at the road corner on Eddings Hill, 2 miles south of Ripley (SW. 1/4, Sec. 25, T.4 S., R.3 E.).

In most places the freshly-broken surfaces of the limestone show an abundance of glassy-looking quartz grains. As the marl interbedded with the limestone is also sandy, the weathering of this member yields a bed of ocher-colored sand. Such sand is well exposed at the base of the hill on the Chalybeate road three-quarters of a mile east of Tiplersville, and at Eddings Hill. Hilgard[10] reports that the limestone at Chalybeate Springs had been made into millstones, a use probably made possible by their sandy character and by the thinness of the layers at that place.

On the ridge east of King Creek, near Ripley, a number of sinkholes have been produced by the solution of the limestone and the collapse of the overlying material. The most accessible of these sinkholes are north of the cross-roads about 1 1/2 miles east of Ripley.

At the Eddings Hill exposure recent WPA roadside improvements have afforded a good exposure of small faults (Fig. 5) which probably represent subsidence due to solution of the calcareous constituents in the underlying basal member of the Clayton. The 1 1/2-foot limestone layer there exposed is about 28 feet above the limestone outcrops at the base of the hill, and probably represents the highest limestone layer in the Clayton formation.

Figure 5.—Small scale faulting in the Clayton formation at the road corner on Eddings Hill, 2 miles south of Ripley. February 1939.

UPPER MEMBER

The upper, so-called "marl," member of the Clayton, which is about 40 to 60 feet in thickness, varies considerably from bottom to top and from place to place. At Chalybeate Springs the lower portion is a blue sandy somewhat fossiliferous marl (see previously described section) whereas the road cut just west of the ravine near Moses Chapel, previously referred to, exposes material which is more finely laminated and clayey.

In most places the material is poor in fossils, but locally it is highly fossiliferous. A road cut 1 1/2 miles east of Falkner shows a 1-foot layer of highly phosphatic material, containing shark teeth and abundant other fossil remains. Residents of this neighborhood report that similar beds 2 or 3 feet thick have been found near by and used for fertilizer. A search failed to reveal more exposures, however, and it is probable that this phosphate-rich bed does not persist for any great distance.

Other places where fossils abound are as follows: (1) in the creek bed under the railroad trestle 1 1/2 miles north of Walnut (Sec. 29, T.1 S., R.4 E.); (2) at Chalybeate Springs (Sec. 3, T.2 S., R.4 E.); (3) about 1 mile southwest of Tiplersville a few hundred feet west of the junction of old and new Highways 15, at the base of a 50-foot bluff on the south wall of Bluff Creek (NE. 1/4, Sec. 30, T.2 S., R.4 E.); (4) about 1 mile northeast of the Ripley courthouse along the Moore's Mill road (N. edge Sec. 13, T.4 S., R.3 E.); (5) about 4 miles north of Ripley in a ditch on the west side of the railroad track (NW. 1/4, Sec. 31, T.3 S., R.4 E.); and (6) about 1 1/2 miles north of Cotton Plant in a ditch beside old Highway 15, just south of its junction with the new highway (Sec. 29, T.5 S., R.3 E.). It is quite possible that all of these except (2) represent one heretofore unrecognized layer near the top of the formation.

Excellent exposures of the upper Clayton in contact with Porters Creek clay can be seen about 1 1/4 and 1 1/2 miles northeast of Ripley on the Moore's Mill road leading to the type locality of the Owl Creek formation, both in road cuts and in an abandoned portion of the road immediately south of its present location. The following section is a composite of two exposures:

COMPOSITE SECTION OF THE UPPER CLAYTON ON MOORE'S MILL ROAD, ABOUT 1 1/4 AND 1 1/2 MILES NORTHEAST OF RIPLEY

	Feet	Feet
Soil to top of hill, about		6.0
Porters Creek formation, about		3.0
Clay, about	2.5	
Hard glauconitic rock layer, about	0.5	
Clayton formation, about		25.0
Glauconitic sand with thin laminae of glauconitic clay	2.0	
Hard glauconitic rock layer	0.2	
Glauconitic sand, somewhat clayey, more so at the base	11.8	
Blue marl, highly micaceous and silty, with many fossil-rich phosphatic lenses about 2 feet above the base, about	11.0	

The uppermost Clayton contains numerous glauconitic sand beds, the thickness of which seems to vary from place to place.

PORTERS CREEK CLAY

GENERAL FEATURES

The Porters Creek clay is named for Porters Creek[20] which, in the vicinity of Middleton, Tennessee, shows many good outcrops of the clay along its course.

The formation has a probable maximum thickness in Tippah County of 200 to 250 feet, the best evidence being shown by a well drilled about 1915 on the property of Mr. John Shappley (Sec. 27, T.2 S., R.3 E.). Mr. Shappley reports that the well is 258 feet deep, and from his description it appears that it penetrates about 150 feet of Porters Creek clay, all of the Clayton and Owl Creek formations, and strikes water in the Ripley sands. As the mouth of the well is about 75 feet below a well-exposed Porters Creek-Wilcox contact a few hundred yards to the west, the total thickness here appears to be about 225 feet.

Both at Middleton and throughout Tippah County the contact between the Clayton formation and the Porters Creek clay is marked by a light-gray glauconitic hard sandstone layer ranging from a few inches to a foot or more in thickness. This stratum is well exposed at many places in the county: (1) in the railroad cut near Brownfield, about half a mile south of the Tennessee State line; (2) on the Chalybeate road about 1 mile northeast of Tiplersville; (3) on the east side of the road cut on old Highway 15 half a mile north of the Ripley courthouse; (4) in road ditches in the western part of Ripley; (5) in the yard of the Terry Morton place, about three-quarters of a mile east of the Ripley courthouse; (6) near the top of a small hill on the Cotton Gin road about 1 mile southeast of Ripley (near the center Sec. 24, T.4 S., R.3 E.); and (7) at the McAlister place on the Union County line about 2 miles west of Cotton Plant.

Because this layer has resisted erosion better than the materials above and below, it tends to control the topography and even to support comparatively large outliers of Porters Creek clay. The geologic map (Pl. 1) shows seven such outliers east of the main Porters Creek outcrop belt, and six of these are attributable to the resistance of the sandstone layer. The seventh and largest outlier, Pine Hill, about 5 miles northeast of Ripley, seems to owe its isolated situation to its accidental separation from the unusually high east-west ridge which lies between the Hatchie and Tippah drainages, but even here the effect of the contact layer is seen in the broad Porters

Creek platform on the north and south sides of the hill. This hill shows 60 to 70 feet of Porters Creek clay overlying the Clayton formation and in turn overlain by Wilcox sands.

Another two-formation outlier, about 1 mile northeast of Tiplersville at the locality previously described under the heading "Clayton formation," shows an interesting section through most of the Clayton formation, all of the Porters Creek clay (here only about 30 feet thick), and 25 feet of Wilcox sand. This section is particularly instructive because it shows three other hard layers similar to the contact layer, but clearly within the Porters Creek clay, and apparently representing that part of the formation known as the Tippah sand member.

In Tippah County the dip of the Porters Creek clay is probably similar to that of the underlying formations, about 30 feet to the mile. The dip of its contact with the overlying Wilcox sands, as well as the dip of the Wilcox strata, could not be determined reliably, because of many irregularities, but such observations as have been made suggest a westward dip of about 15 feet a mile. Seemingly the unconformity which separates the Porters Creek clay from the overlying Wilcox strata bevels the Porters Creek clay which thus lies below it in the form of a great wedge, thin at the east and progressively thicker toward the west (Fig. 3). This condition accounts for the fact that the total thickness of the formation is only 30 feet on the hill 1 mile northeast of Tiplersville, whereas it is 60 to 70 feet thick at Pine Hill, 200 or more feet thick farther west, and as much as 800 feet thick where encountered in wells much farther to the southwest[21].

Though casual inspection of the Porters Creek clay in its various outcrops suggests that the material is nearly uniform throughout both its vertical and horizontal extent, careful observations show that it is composed of three distinct phases.

BASAL PHASE

In Tippah County the basal 50 to 75 feet of the Porters Creek clay is silty, glauconitic, bentonitic, and somewhat harder than the typical material. In recent years Mr. W. D. Shelton, a resident of the county, has discovered bentonitic layers a few inches in thickness, the material having a green waxy appearance.

Because of its glauconitic content the basal Porters Creek clay weathers to a red soil much like that derived from the Clayton, thus making it difficult to separate the two materials by their soils. This is particularly true in the vicinity of Cotton Plant in the southern part of the county and near Tiplersville in the northern part.

TYPICAL PHASE

Overlying the basal phase is a massive clay composed in large part of the clay mineral montmorillonite[22]. This, the typical phase of the formation, is dark-gray when wet, light-gray when dry, and contains relatively little silt and mica. It shows little or no stratification but exhibits a conchoidal fracture which causes it to break out in lumps from 1 to 4 inches in diameter. Its texture when cut

Figure 6.—Fifty-foot bluff of Porters Creek clay on the Kate Davis place. July 1938.

with a knife is much like that of soap, the freshly cut surfaces normally showing thin yellow streaks which are probably fine glauconitic silt. Its plasticity is demonstrated by the slippery roads it produces. When dry it cracks and scales, yielding readily to erosion until a level surface is formed. Though for the most part devoid of megascopic fossils, it does contain microscopic foraminifera[23]. Local deposits of bentonitic clays seem to belong to this phase (test holes A 212 and A 216).

This middle phase of the clay is probably about 100 feet thick in Tippah County, though it has not been found in contact with both the overlying and underlying materials. Excellent exposures 50 to 85 feet thick can be seen at the following places: (1) at the Kate Davis place (Fig. 6), where the clay has been dug commercially, at times, from a 50-foot bluff (SW. 1/4, SW. 1/4, Sec. 4, T.4 S., R.3 E.); (2) about 1 mile northwest of Doxey School (NE. 1/4, Sec. 9, T.4 S., R.3 E.); (3) in the roads on the long hills about half a mile southeast of Manning School (near SE. cor. Sec. 8, T.4 S., R.3 E.); (4) on Highway 4 about 4 1/2 miles west of Ripley, where the road descends abruptly to the flood plain of North Tippah Creek; and (5) east of Highway 15 in Blue Mountain, on the steep slopes of Main and Mill streets.

LAMINATED UPPER PHASE

The upper part of the Porters Creek clay exhibits a blue-black color, contains much silt and mica, and is distinctly laminated, with a few thin layers of the more typical material. In many places it contains concretions of siderite, "paint rock," an iron carbonate formed by leaching and precipitation of the iron content of the clay[21]. Many of these are well exposed in a U-shaped ditch about 8 feet deep and a quarter of a mile long on the property of S. W. Jackson south of Flat Rock Church in Benton County, half a mile west of the Tippah-Benton county line (Sec. 16, T.5 S., R.2 E.). Similar exposures are found in other scattered localities, notably on the land of W. D. Shelton (Sec. 17, T.3 S., R.3 E.), where fine-grained siderite concretions about an inch thick and several inches in diameter are found in abundance at the surface.

A jet-black structureless clay makes up the upper part of the Porters Creek formation at the J. D. Ketcham place (near SE. cor. Sec. 14, T.3 S., R.3 E.) and at the Ollie Hines place (Sec. 13, T.2 S., R.3 E.). A section of the contact at the Ketcham place follows:

SECTION OF THE MIDWAY-WILCOX CONTACT ON THE J. D. KETCHAM PLACE

	Feet	Feet
Wilcox		12.2
Soil and subsoil, red and sandy	6.0	
Bauxite, white sandy, interbedded with cross-bedded sand containing clay balls	6.0	
Massive limonite 0.1 to	0.2	
Porters Creek clay		5.0
Ocher zone; massive yellow plastic clay with many blue streaks (deoxidation?)	3.5	
Clay, jet-black massive	1.5	
Similar massive black clay extends down the creek for a long distance, but is not well exposed.		

The laminated upper phase of the Porters Creek clay is of varying thickness and in many places is not present. Its absence may be due to the somewhat irregular upper surface of the formation, which in turn probably resulted from erosion during the long period of time between the deposition of the Porters Creek clay and the Wilcox sediments. During this interval the Porters Creek clay was evidently worn down to a nearly sea level plain with local irregularities. This laminated upper phase may well be a northward extension of the Naheola formation, which also belongs to the Midway series, and which overlies the Porters Creek (Sucarnoochee) clay in Alabama and in Lauderdale County, Mississippi[25].

TIPPAH SAND MEMBER

A sand and sandstone phase of the Porters Creek clay which Lowe[26] at one time designated the Tippah sandstone formation appears in Tippah County, notably in the northern part. Later Lowe[27] classified it as a local phase developed within the Porters Creek clay. Both Grim[28] in Mississippi and Whitlatch[29] in Tennessee consider it a series of lenticular deposits within the clay, an interpretation with which the present writer is in accord. The material has been variously referred to as Tippah sandstone, Tippah sand, or merely Tippah, but as most of the material is sand, or a sandy phase of the Porters Creek formation, the term Tippah sand seems preferable.

Hilgard[30] noted the presence of the sandstone layers of this member in northern Tippah County. Lowe[31] in a generalized section shows reddish and yellowish sands, white sands, sandstones, and laminated clays, and estimates the thickness of the member at 100 feet. It is best exposed along a dirt road leading west off Highway 15 about 1 1/2 miles north of Tiplersville. About half a mile west of the highway, on the land of W. R. Pitner (SE. 1/4, Sec. 7, T.2 S., R.4 E.), the Porters Creek clay is exposed about 35 feet below the sands and sandstones, showing clearly that these belong to the Porters Creek and not to the underlying Clayton formation which they somewhat resemble. In front of the old John Wright house (near center Sec. 7, T.2 S., R.4 E.) referred to by Lowe[32], three sandstone layers are exposed in the road, while about a quarter of a mile west, on the land of George W. Wright, the washed-out bed of an old road shows 15 feet of yellow sand overlain by 24 feet of laminated Porters Creek clay. On the land of Herman Keith (Sec. 12, T.2 S., R.3 E.) the steep south wall of Hurricane Creek shows the following section:

SECTION OF TIPPAH SAND AT THE HERMAN KEITH PLACE

	Feet	Feet
Wilcox sand, about		10
Porters Creek clay, about		50
Clay, upper part contains scattered spheroidal limonite concretions about 12-18 inches in diameter, about	50	
Tippah sand member, about		60
Hard glauconitic sandstone layer, fossiliferous, forming a distinct terrace on the hillside, about	4	
Yellow micaceous sand containing scattered thin distinct laminae of Porters Creek clay	33	
Thinly laminated yellow micaceous sand and Porters Creek clay	23	

Figure 7.—Exposure of Tippah sand in recent culvert excavation showing, from bottom up, about 3 feet of yellow micaceous cross-bedded sand, a few inches of ferruginous sandstone, 2 to 3 feet of hard glauconitic siltstone, and 1 to 2 feet of Porters Creek clay. South side of old U. S. Highway 72, about 2 1/2 miles west of Walnut. June 1939.

It is possible that the three sandstone layers seen throughout this region may be correlated with the three rock layers 2 miles southeast, in the road 1 mile northeast of Tiplersville, although the latter may be lower in the Porters Creek clay than are the layers at the Wright and Keith places. Three sandstone layers have also been observed in this member in Tennessee[33].

Other good exposures of the Tippah sand are present at the following places: (1) in the cut on old U. S. Highway 72 about 1 mile west of Walnut where about 20 feet of this sand lies between the

Porters Creek clay and the overlying Wilcox; (2) on the same highway about 2 1/2 miles west of Walnut near the middle of Sec. 36, T.1 S., R.3 E. (Fig. 7) where it has been well exposed by recent culvert construction; (3) on a country road across the northern part of Sec. 31, T.1 S., R.4 E. where both the sandstone and the sand are found, the sandstone forming a pronounced ledge in the road; and (4) on the Tippah-Union county line about 2 miles west of Cotton Plant where a country road crosses a similar ledge. At several places, notably on Highway 15 about 3 miles north of Ripley, and on the hills east of Highway 15 in Blue Mountain, a distinctly glauconitic layer in the Porters Creek clay is a possible equivalent of the Tippah sand.

A probable contact between the Tippah sand and the overlying Wilcox sand is present in a small sand pit beside old Highway 15, at the top of a small hill south of Turkey Creek, and about 2 1/2 miles north of Falkner.

It has been suggested that the Tippah sand may be an equivalent of the Naheola formation[34] of Alabama and east Mississippi.

BAUXITE-KAOLIN ZONE

At a number of places in Tippah County kaolin and bauxite lie directly on the Porters Creek clay, from which they appear to have been formed. Typically, the change from pure kaolin to the unaltered Porters Creek clay is gradational. A few feet of kaolin are underlain by several feet of white clay which becomes more silty and micaceous with increasing depths until the white color gives way to yellowish and ocherous shades and these in turn grade into the blue-black micaceous silty Porters Creek clay. The bauxite, in turn, overlies and grades downward into the kaolin. In 1922 William C. and Paul F. Morse made a thorough examination of all bauxite deposits known at that time in Mississippi, and the published report[35] of their work includes some logs of test pits which show this gradation.

Though there has long been doubt concerning the origin of bauxite, it now appears that these kaolin and bauxite deposits were formed from the Porters Creek clay by weathering during the interim between the emergence of the Porters Creek clay and the deposition of the overlying Wilcox materials. It has long been known that prolonged weathering of a feldspar-rich rock may produce kaolin, the most notable example being the North Carolina kaolin deposits. In 1936 Bramlette[36] suggested that some low grade bauxite and kaolin in Arkansas had been thus formed from a blue clay similar to the Porters Creek clay and correlated with it. In 1937 Mellen[37] attributed some Mississippi kaolinitic material of earlier age to similar processes, and more recently he[38] has attributed the bauxite and kaolin which lie on the Porters Creek clay (thereby including all the known Mississippi bauxite) to weathering of the Porters Creek clay during the Midway-Wilcox (Paleocene-Eocene) interval. He has proposed that this material, formed during the Midway-Wilcox interval, be considered a separate formation, the "Betheden."

Pure kaolin has the composition $Al_2O_3.2SiO_2.2H_2O$; pure bauxite the approximate composition $Al_2O_3.2H_2O$. Porters Creek clay, as shown by analyses in the "Tests" section of this report contains, in addition to these substances, many other compounds. Berry[39] has shown from a study of the plant remains of that age that a humid sub-tropical climate prevailed in the United States after the deposition of the Midway materials, and it is known that such a climate accelerates the rate of weathering to a marked degree. Hence it is probable that at this time the more soluble substances in the Porters Creek clay, including much of the K_2O, CaO, MgO, and iron oxide, were largely dissolved by ground waters and removed, leaving a residuum rich in SiO_2 and Al_2O_3 which, combined with water, form kaolin. In places further weathering removed much of the silica, resulting in a still greater concentration of alumina and the formation of bauxite.

It is interesting to note that in Arkansas the world's best deposits of bauxite were formed at the same time as those in Mississippi, and that they are everywhere underlain by kaolin. There, however, the best material has been formed from syenite, a feldspar-rich rock unlike anything found at the surface in Mississippi, while low-grade bauxite, comparable to that found in Tippah County, is found dissociated from the syenite and lying on blue clay similar to the Porters Creek. Bramlette[40] suggests that some of this material may have been formed not from the clay, but from a feldspathic sand derived from the syenite areas and washed over the clay. In Mississippi, however, the bauxite and kaolin deposits appear to have been formed directly from the Porters Creek clay.

The kaolin and bauxite in Tippah County are irregular and spotty in their distribution, for which two explanations may be given. The first is that the materials were developed only locally in the places where they are now found, a somewhat reasonable explanation in view of the highly specialized conditions probably necessary to bring about this type of weathering. The second is that they were originally formed as a more or less continuous blanket over the pre-Wilcox surface, but that much of the material was removed by erosion prior to the deposition of the Wilcox sand. In many places the bauxite deposits are found at slightly higher elevations than the surrounding Porters Creek clay, a notable example being the Meadows bauxite deposit, which is described in the section of Economic Geology. This suggests either that the deposits were formed on small eminences, or that they are remnants of beds which formerly covered the region much more extensively. Though such a suggestion of widespread erosion does not appear to have been made previous to this work in Tippah County, it appears altogether logical. It is the idea of the present writer that shortly prior to the deposition of the Wilcox sands the region was slightly rejuvenated, perhaps by a slight uplift of the land, so that the streams had an increased erosive power and removed much of the bauxite-kaolin residuum. In harmony with this idea is the fact that in many places the basal portion of the overlying Ackerman formation consists of white silty clays, and sandy bauxitic clays, apparently formed by the erosion and transportation of the bauxite-kaolin blanket[1]. Further, the Paleocene-Eocene (Midway-Wilcox) contact is not flat, but shows definite topographic irregularities. Inasmuch as the Porters Creek clay is unable today to support a topography of appreciable relief but forms the Flatwoods belt, it seems unlikely that the clay could have supported an enduring topography shortly after it was formed. The presence of these buried topographic irregularities, therefore, suggests a dissection of the Midway surface shortly before it was covered by Wilcox sands.

The evidence here stated fits well the view long held by some, and recently adopted by the United States Geological Survey, that the lowermost Eocene strata should be set apart from the younger as a separate system or series, known as the Paleocene.

PALEOCENE-EOCENE (MIDWAY-WILCOX) CONTACT

With few exceptions, previous works on the geology of Mississippi state that the contact between the Porters Creek clay and the overlying Ackerman formation is gradational. However, the evidence just presented regarding the origin of the Tippah County kaolin and bauxite assumes an important unconformity between the

Midway and the Wilcox. Furthermore, in Tippah County, wherever the exposures are fresh, a sharp contact between the two series is almost invariably seen. Figure 8 shows one of these sharp contacts in a railroad cut about a quarter of a mile north of Walnut. Others may be seen (1) on U. S. Highway 72, 1 mile west of the railroad station at Walnut (SE. 1/4, Sec. 31, T.1 S., R.4 E.); (2) about 2 miles north of Falkner on a dirt road; (3) on the old Saulsbury road 2.3 miles northwest of its junction with Highway 15, on the northwest side of Bell Creek (NW. 1/4, Sec. 35, T.3 S., R.3 E.); (4) in a

Figure 8.—Paleocene-Eocene (Midway-Wilcox) contact in a railroad cut about a quarter of a mile north of Walnut. The man is standing on the contact. May 1939.

road cut about 2 miles northwest of Ripley (Sec. 15, T.4 S., R.3 E.); (5) about half a mile east of Shady Grove (near center Sec. 12, T.4 S., R.2 E.); and (6) about 2 1/2 miles northwest of Blue Mountain on the Deentown road. Mellen[42] has previously pointed out the presence of this unconformity.

Previous confusion as to the nature of this contact has been due probably to (1) failure to recognize the residual origin of kaolin and bauxite; (2) failure to recognize the presence of a thick sand bed at the base of the Wilcox; and (3) failure to recognize the fact that the upper phase of the Porters Creek clay may be as distinctly laminated as the Ackerman clay.

EOCENE SYSTEM—WILCOX SERIES

The Wilcox series, named for Wilcox County, Alabama, overlies the Midway in Mississippi, and with the establishment of the Paleocene system, becomes the basal Eocene series in the state. Only the two lowest formations of this series, the Ackerman and Holly Springs, are exposed in Tippah County.

ACKERMAN FORMATION

BASAL CLAYS

Locally at the base of the Wilcox series there are deposits of white silty clays suitable for pottery. Mellen[43] has suggested that at the beginning of Ackerman time some of the previously formed

Figure 9.—Interbedded white sandy bauxite and red Wilcox sand, on the J. D. Ketcham place. March 1939.

kaolinitic and bauxitic residuum was washed off the old land surface, mixed with silt and sand, and redeposited as the light-colored silty or sandy clays and sandy bauxite in the base of the Ackerman. For this material he has suggested the designation Fearn Springs formation. In Tippah County the clay is present in some abundance west of Blue Mountain near the Benton County line. At Flat Rock Church, in Benton County half a mile west of the Tippah line, about 90 feet of these silty clays are present between the kaolinitic clay which crops out in a stream ditch west of the church and the overlying sands on which the church is built. At the J. D. Ketcham place (near SE. cor. Sec. 14, T.3 S., R.3 E.), sandy bauxite is interbedded with red sand just above the Midway-Wilcox contact (Fig. 9).

The Fearn Springs formation of Mellen is not a continuous layer, but was apparently formed in certain favored localities or, if originally continuous, was largely swept away before deposition of the overlying material. No attempt has been made to map the Fearn Springs as a separate formation in Tippah County.

BASAL SAND MEMBER

According to Lowe[44], the lowest beds of the Ackerman formation, named for the town of Ackerman, Mississippi, are gray clays passing by easy transition into the underlying Porters Creek clay. Grim[45] was apparently the first to recognize a bed of sand lying at or near the base of the formation and Mellen[46] has more recently recognized the same bed in Winston County. This sand, which had previously escaped notice or, more likely, had been mistaken for Holly Springs sand, is probably about 100 feet thick in places, and so closely resembles the younger Holly Springs sand that it is impossible to differentiate the two by casual observation.

At its base the Ackerman sand contains a coarse grit with numerous pebbles and scattered quartz and quartzite boulders up to a foot or more in diameter[47]. These light-colored boulders are found in many places lying in creek beds not far below the Ackerman-Porters Creek contact, where they are conspicuous by contrast with the dark clay. The writer collected one of these boulders weighing 150 pounds which is, so far as is known, the largest ever found in this region. It is now in the collection of the Geology Department of the University of Mississippi.

The source of these boulders, and their method of transportation at a time when streams apparently were otherwise transporting only ordinary sand, are unknown. Rafting in such numbers by uprooted trees would presuppose the presence of a tremendous number of floating trees from a considerable distance, and rafting by floating ice would require a severe climate for which there is no evidence.

The red sand is well exposed in the county west of the Flatwoods, and produces a hilly topography. In several places it contains abundant angular and rounded lumps of light-colored laminated clay from 1 inch or less to 6 or 8 feet in diameter, producing what may be called a clay-ball breccia. The finest exposure of this material known to the writer is in the western part of Tippah County, about 1 1/2 miles north of Shady Grove, on the southeast wall of Caney Creek (Sec. 35, T.3 S., R.2 E.). For 75 feet above the Porters Creek clay, which is exposed at the base of the hill, a deep road cut exposes red sand which abounds in fragments of laminated white silty clay and of Porters Creek clay. Near the foot of the hill the contact appears to be broken by a small high-angle fault with a displacement of 3 or 4 feet. Above the breccia for a quarter of a mile scattered exposures of laminated Ackerman clay may be seen.

Figure 10.—Clay-ball breccia in the basal Ackerman red sand at the road corner near Doxey School. June 1939.

Other good exposures of breccia in Tippah County are (1) on the old Ripley-Saulsbury road in the SE. 1/4, Sec. 35, T.3 S., R.3 E., and (2) in the road corner near Doxey School (Fig. 10) (NW. 1/4, Sec. 15, T.4 S., R.3 E.). Just west of the Tippah County line, in Benton County, it is well exposed at two points on Mississippi Highway 4, 1.8 and 2.4 miles respectively east of the Junction of Highways 4 and 5.

At a number of places the Ackerman sand contains corrugated and tubular concretions, formed by the transportation and deposition of iron compounds by ground water. Figure 11 shows one of these concretions beside Mountain Street in Blue Mountain, just above the Blue Mountain College campus.

UPPER CLAY MEMBER

Overlying the sand member of the Ackerman formation are dark-gray laminated silty lignitic clays which resemble the material at the type locality near Ackerman. Locally the beds contain strata of lignite and beds rich in siderite concretions. Good exposures of this member of the formation are found at only a few places in Tippah County, one of the best being along the road 1 1/2 miles north of Shady Grove, south of the breccia described in the previous section. In Benton County, however, the Ackerman clays form a belt several miles wide with many good exposures along the highways.

Figure 11.—Tubular and corrugated ferruginous sandstone concretions in red Wilcox sand near the top of Blue Mountain. July 1938.

HOLLY SPRINGS SAND

The Holly Springs sand, named for the town of Holly Springs, Mississippi, consists chiefly of about 500 feet of red and white stratified sand, in many places micaceous and clayey, with subordinate layers of white clay. Though not definitely identified, the formation is believed to be present in the northwestern part of Tippah County (Fig. 3).

A bed of pink and white laminated silty clay bearing abundant leaf impressions is exposed about half a mile north of Oak Grove School northwest of a road corner, below 40 to 50 feet of red sand in a deep erosion ravine (SE. 1/4, SE. 1/4, Sec. 8, T.2 S., R.3 E.). This clay layer is so similar in appearance to clay beds in the Holly

Springs formation in Benton, Marshall, and Lafayette counties that it, too, is believed to be in that formation.

The Holly Springs sand is, therefore, believed to overlap the Ackerman clay which is abundantly exposed in southern and central Benton County not far west of the Benton-Tippah County line, and possibly overlaps the Ackerman sand also, so that in northern Tippah County it may lie directly on the Porters Creek clay. The separation of the Holly Springs sand from the practically identical Ackerman sand would probably require tracing the Holly Springs-Ackerman contact for several miles in Benton County. Because it was impracticable to do this, the two sands have not been separated for this report.

The Holly Springs sand produces a rugged country even more conspicuous than that resulting from the Ackerman sand, probably because of its greater thickness.

POST-EOCENE DEPOSITS

PLIOCENE OR PLEISTOCENE

STREAM TERRACES

In some parts of Mississippi important river terraces have been developed at a far more recent time than the underlying strata so far considered. Shaw[48] has studied some of these and suggested that they were formed during the Pliocene period. Their widespread development along the Tombigbee and Mississippi Rivers suggests that they are remnants of flood plains formed at a time when the land was relatively lower with respect to sea level than it is now. Subsequent lowering of the sea level or uplift of the land caused the streams to entrench themselves in these old flood plains and to wash them away slowly, so that only remnants of them are left today. Monroe[8] has suggested that they may be the result of sea level fluctuations during Pleistocene (glacial) time, associated with the accumulation and melting of the great ice sheets which covered large parts of northern North America and Europe.

Little attention was devoted to such terrace problems in Tippah County, though it is quite likely that careful work along the main drainage lines would reveal the presence of terraces. If they are present, they are probably in the form of "second bottoms," nearly flat alluvial material at somewhat higher elevations than the main flood plains or "bottoms."

The most striking example of material believed to be of such origin which was noted in Tippah County is about 2 miles east of Shady Grove where a red clayey sand is exposed in various cuts along the road (Sec. 8, T.4 S., R.3 E.). This material so resembles the Wilcox sands that at first it was assigned to that series, but a later check on the elevations showed that its contact with the underlying exposed Porters Creek clay is about 75 feet below the level at which that contact would be expected at this place, and is probably part of an old river terrace formed from material derived from the nearby Wilcox-capped hills.

PLEISTOCENE AND RECENT

FLOOD PLAIN ALLUVIUM

After a main stream has cut its valley as deeply as conditions will permit, the more rapidly flowing tributaries tend to bring to that stream more sediment than it can transport. In times of flood this excess material is spread over the valley in thin layers of clay, silt, or sand, forming almost level surfaces known locally as "bottoms," technically as flood plains. Such flood plain alluvium is found along the courses of all the main streams in Tippah County, and even extends nearly to the heads of some of the tributaries. Where well exposed, as in the artificially dug channels, it typically consists of bluish or grayish clayey material, containing abundant plant remains, and is overlain by a few feet of coarser silt and sand.

The lower material probably accumulated slowly over a long period of time before the coming of the white man, when forested slopes permitted only a minimum of erosion, and when the bottoms contained heavy growths of cane and hardwoods. The coarser upper stratum probably represents the silting up of the "bottoms" due to the greatly accelerated rate of erosion consequent upon the cutting of the forests and the plowing of the land since the white man's occupation.

The age of the lower material is best demonstrated by the recent discovery of the bones of a mastodon in the channel of Dry Creek. In 1938 Mr. Ed Koon found a jaw bone with teeth in place, protruding from the bank of the channel (probably close to W. edge of the SW. 1/4, Sec. 12, T.5 S., R.5 E.). This was identified by F. F. Mellen, and the discovery is particularly interesting because the bones of this extinct elephant-like animal have never before been found so far inland in Mississippi though they are occasionally encountered in the southern part of the state and near Vicksburg and Natchez.

In the summer of 1939, with the help of several WPA laborers, the bank was dug away and many more bones recovered, bones now in the possession of the Department of Geology at the University of Mississippi. Several ribs, two or three vertebrae, a shoulder blade, and parts of two femurs were found. The femur bones appeared to be upright in the gray mud, while the other bones showed no systematic arrangement. All were found near the middle of a layer of blue-gray sticky clay, containing plant remains, which constitutes the lowest 5 feet of the channel. Above this is about 10 or 12 feet of more silty and sandy flood plain alluvium. It appears that the blue-gray clay represents material which collected slowly in a flood plain swamp, into which the mastodon apparently wandered, and in which he became hopelessly bogged and died.

Since mastodons are known to have lived in North America during the Pleistocene (glacial) period, and to have become extinct at about the end of that period, it seems reasonable to attribute the older, lower portions of the flood plains to that period. The sandy, upper part of the alluvium has evidently been deposited within recent years.

COLLUVIUM

Rainwash, landslips, and other less important processes cause a slow downward migration of the surface layers so that in many places the hillslopes are mantled with material which has moved downward as much as 100 feet or more below its original position. Such migrations, however, except in the case of landslips, destroys any stratification which the material may have originally possessed. This process is particularly effective where sand beds overlie clay, and, in Tippah County, is most pronounced along the Paleocene-Eocene (Midway-Wilcox) contact. Along that contact particular caution must be exercised in mapping because of the colluvial Wilcox sand which in many places veneers the surface to depths of 10 feet or more for as much as 100 feet below the contact. In such locations no assurance can be felt that any sand is in place unless it shows distinct stratification, and even then large-scale landslipping may cause confusion if its presence is not recognized. A striking example of such large-scale slipping can be seen by looking south from the road corner about 2 1/2 miles west of Blue Mountain (Fig. 12). Here a portion of a flat-topped hill, capped by about 40 feet of Wilcox sand resting on Porters Creek clay, has so slipped as to form a conspicuous terrace (SW. 1/4, Sec. 11, T.5 S., R.2 E.).

Figure 12.—Terrace formed about 1865 by the slipping of a portion of a hill of Porters Creek clay. Viewed from the road corner about 2 1/2 miles west of Blue Mountain. June 1938.

STRUCTURAL GEOLOGY

The strata exposed in Tippah County strike very nearly north and south, and dip westward (Fig. 3). The Cretaceous layers have a regional dip of about 25 to 30 feet to the mile, a fact well brought out during the mapping of the Owl Creek formation when it was found that wherever good exposures were encountered or its contacts could be determined with a fair degree of accuracy their elevations fitted such a dip very closely. Though no detailed mapping was attempted east of the Owl Creek outcrop belt, sufficient reconnaissance was conducted in the area of the Ripley formation to justify the assumption that any significant irregularities in that area would have been detected.

The Clayton formation likewise appears to have a regular dip of about the same degree, though a possible exception may be found in the northern part of the county. Here Muddy Creek, instead of flowing down the gentle dip slope to the west, or down the steep escarpment slope to the east, as do most of the streams in the Clayton outcrop area, flows practically parallel to the strike of that normally resistant formation for over 10 miles between Falkner and the Tennessee line, as though it were following the trace of a fault. From Tiplersville to the State line the valley is noticeably asymmetrical having the steep wall on the east, suggesting an easterly dip;

yet the Chalybeate Springs contact and another contact a mile to the east seem to indicate that the normal regional westward dip prevails. Unfortunately, the paucity of outcrops has made it impossible to correlate beds across this valley, so no further information has been obtained here regarding structural conditions.

If recognizable layers were present in the Porters Creek formation it is probable that they would show dips everywhere similar to those of the Clayton formation, on which it appears to lie conformably. The contact between the Porters Creek clay and the overlying Wilcox sands, however, shows a much lower dip with many irregularities, and since the two formations are separated by an unconformity resulting from an erosion interval which bevelled the dipping mass of clay, the Porters Creek clay lies in the form of a wedge between the Clayton formation and the Wilcox sands (Fig 3). This causes the overlying beds to show a gentler dip than the older beds, probably about 15 feet to the mile.

As has been mentioned in the section on the Porters Creek clay, the land surface on which the Wilcox sands were deposited was not smooth, but was undulating and in some places rough. Allowing for local irregularities of this unconformity, the Midway-Wilcox contact in the southern part of Tippah County indicates that the Porters Creek clay in that region dips gently toward the west. South and west of Walnut, however, in the region of the Tippah sand outcrops, conditions are much more confusing. Here the Midway-Wilcox contact is so irregular that it could not be mapped with accuracy in the time available; and as the contact is the only horizon that can be traced over any distance, and as irregularities are present almost everywhere along the contact, no definite conclusions can be safely drawn as to structural conditions.

Several observations in the Walnut region, however, seem worthy of mention. In a railroad cut 0.3 miles north of the Walnut railroad station a sharp Porters Creek-Wilcox contact stands at an elevation of about 485 feet. A new cut on Highway 15, nearly half a mile west shows the contact at about the same elevation. A cut on old U. S. Highway 72, about a mile west of the railroad station (SE. 1/4, Sec. 31, T.1 S., R.4 E.) shows the contact between the Tippah sand and the Wilcox sand at 470 feet. Two miles farther west on Highway 72 (SE. 1/4, Sec. 35, T.1 S., R.3 E.) the westernmost exposure of Porters Creek clay along the highway has an elevation of 550 to 560 feet (all altimeter readings). Thus from Walnut westward for about 1 mile the contact shows the regional dip, but beyond, it rises sharply, contrary to the dip. A country road half a mile south of old Highway 72 and essentially parallel to it, shows the contact rising in the same manner toward the west. Further, limited observations in the area south of Walnut indicate that the contact rises toward the south as well as toward the west over a distance of about 5 or 6 miles. In general, it appears from a study of the Walnut region that in the Porters Creek outcrop belt east of a line extending north-northwest for 3 or 4 miles from the vicinity of Falkner, thence north approximately along the line of the present contact into Tennessee, the Midway-Wilcox contact slopes toward the north and east instead of toward the west. This suggests the possibility that in pre-Wilcox times an escarpment may have extended northward along the line traced above, thus explaining the present abnormal conditions. On the contrary, it is possible, that these irregularities are the result of folding or faulting.

ECONOMIC GEOLOGY

INTRODUCTORY STATEMENT

The mineral resources of Tippah County are principally clays of various kinds, and subordinately sand and impure bauxite. In addition, there are small and probably unimportant deposits of ocher, "paint rock," marl, and lignite. The Porters Creek clay, which is locally bentonitic, may eventually be found suitable for some commercial use. Oil and gas are potential resources for which no good surface indications have been found.

CERAMIC CLAYS

INTRODUCTORY STATEMENT

As pointed out in the section on the bauxite-kaolin zone, kaolinitic clays were probably formed by alteration of the Porters Creek clay during the long Midway-Wilcox interval. If they ever formed a more or less continuous blanket deposit, that blanket was largely removed prior to the deposition of the Wilcox sands. Nearly all the samples of these clays show a downward gradation from a snow-white kaolin free from silt or mica, typically 3 to 5 feet thick, through several feet of increasingly silty and micaceous clays, to material marked by yellow and brown streaks, which in turn grades into material that is blue-black in color and conspicuously silty and micaceous, and which appears to be Porters Creek clay. Nearly all the test holes were abandoned as soon as they reached this blue-black micaceous and silty layer on the assumption that it was Porters Creek clay of no ceramic interest. Subsequent laboratory tests on some samples of this material, however, indicate that just below the kaolin there is a pottery clay, and that the underlying blue-black material is either a pottery clay or, in its more impure phases, is a brick and tile clay unlike the still lower Porters Creek clay. By the time this discovery was made the field work was completed and it was not possible to investigate the matter further. It may be that weathering of the Porters Creek clay has yielded a pottery-type clay, or it is possible that there is, locally or otherwise, a zone within the laminated phase of the Porters Creek clay which is essentially a pottery clay, the weathering of which has yielded the white clay and the bauxite. Pottery clays are also found locally above the kaolins. Brick and tile clays which are present in a few places above the kaolins appear to be kaolin or overlying pottery clay which has been altered and contaminated by recent weathering.

These clays have been classified in the laboratory according to uses, and, in descending order, that classification is typically as follows:

Brick and tile clays, produced by recent weathering and contamination of the underlying pottery and kaolinitic clays.

Pottery clays (Fearn Springs formation of Mellen).

Kaolins (Betheden formation of Mellen).

Pottery clays.

Bricks and tile clays, probably a gradation from the overlying clays into the Porters Creek clay.

So far as is known, these kaolinitic and associated clays are present in Tippah County in only four areas:

1. About 3 1/2 to 4 miles northwest of Falkner (Fig. 14) on and near the land of H. A. Hopper (referred to in the "Tests" section of this report as Regions D, E, and F).
2. About 2 1/2 miles west of Falkner on the properties of J. C. McElwain and R. O. Patrick (Region G of the "Tests" section).
3. About 7 miles west of Ripley on the properties of J. S. Pearce and E. P. Barber (Region H of the "Tests" section).

4. West of Blue Mountain (Fig. 15) where they are found:
   a. About 2 miles west of Blue Mountain on and near the properties of Mark Hill and D. D. Hill (Regions B and C of the "Tests" section).
   b. About 4 miles west of Blue Mountain near Flat Rock Church and on the properties of J. M. Gunter and Jim Hill (Region A of the "Tests" section).

Many auger holes were drilled in nearly all of these areas for representative samples and for a conception of the extent of the clays.

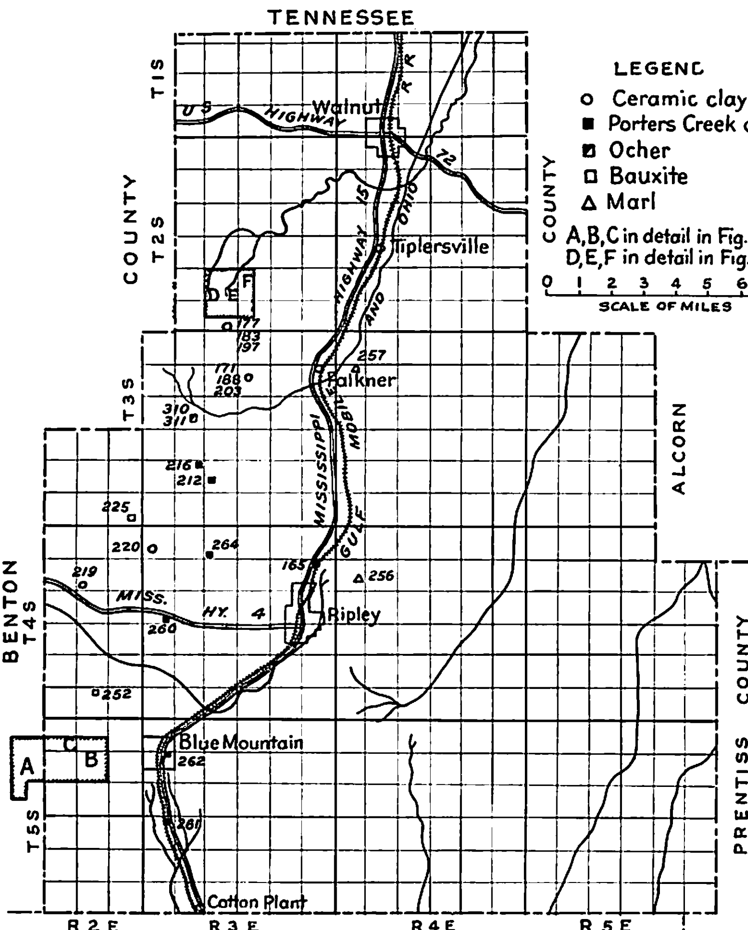

Figure 13.—Map of Tippah County showing the places from which samples were obtained. The shaded areas northwest of Falkner and west of Blue Mountain are enlarged in Figures 14 and 15.

In the following few pages are summaries of findings at each of the localities prospected. The last two are a short distance across the line in Benton County, but were included in this survey for the information they might reveal, since they are clearly of the same horizon as the others. These summaries also show, for the benefit of the non-technical reader, a few of the uses to which the "Tests" section of this report shows them suited. These summaries of uses are greatly condensed from the technical section of this report, to which the reader must refer for full details.

H. A. HOPPER AREA

Regions D, E, and F of the "Tests" section of this report

About 3 1/2 to 4 miles northwest of the Gulf, Mobile & Ohio Railroad station at Falkner an area of sand-capped hills and ridges affords several exposures of white clays of which many samples were taken (Fig. 14) for laboratory investigation. No careful estimates of acreage were made, but it is probable that about 50 to 75 acres are underlain by the clays, and in about a third to a half of this area the sand overburden is 20 feet or less.

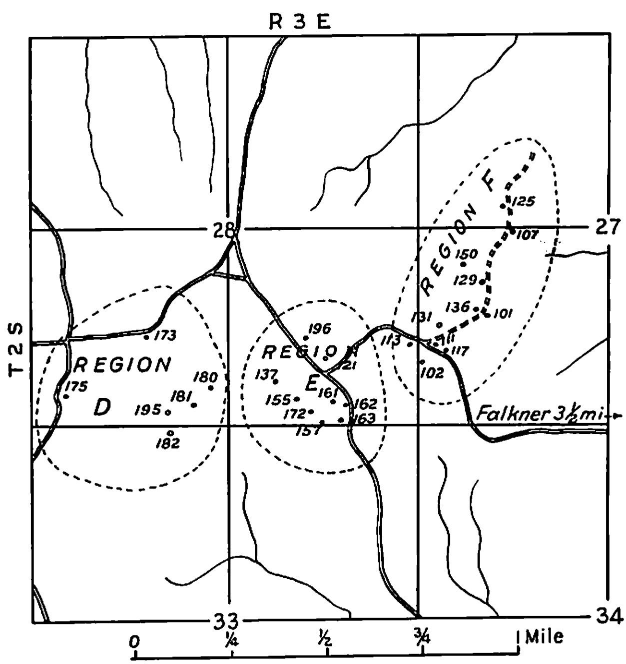

Figure 14.—Map of the H. A. Hopper area, northwest of Falkner, showing the locations of test holes.

Samples were tested from land of H. A. Hopper, H. L. Miskelly, B. W. Martindale, G. L. Peeler, and the National Forest (SW. 1/4, Sec. 27, S. 1/2, Sec. 28, NW. 1/4, Sec. 33, T.2 S., R.3 E.).

An outcrop in the road southeast of hole A111 (property of H. A. Hopper) shows a downward succession of coarse red Wilcox sand, kaolinitic clay nearly free from silt and mica, white silty clay, and Porters Creek clay. Another outcrop near hole A101 (property of H. A. Hopper) is the most striking of all the outcrops in the area, as the nearly flat ground is white and more or less free from vegetation. An outcrop near hole A155 (property of B. W. Martindale) is in a steep narrow ravine, and was found several years ago by F. E. Vestal[40]. At that time about 10 or 12 feet of clay was exposed, but in 1938 some of this had been concealed by slumping.

Hole A101 shows about 9 feet of white clay, kaolinitic in appearance. The log of this hole, shows well the transition from white kaolinitic clay to Porters Creek clay. Other samples were tested from the following test holes: A102, A107, A121, A125, A129, A131, A136, A137, A150, A157, A161, A162, A163, A172, A173, A175, A180, A181, A182, A195, A196.

In the "Tests" section of this report it is shown that a wide variety of clays is present in this area. Some of the kaolins are suitable for use in the manufacture of such articles as fire brick and other refractory products, light-colored and speckled face brick; other kaolins might be used in the manufacture of several kinds of porcelain, china ware, floor and wall tile, and art ware, as filler in paper, rubber, oil cloth, and linoleum, and as paint pigment.

The pottery clays, as shown in the "Tests" section, are suited to many uses, such as the manufacture of stoneware, art ware, kitchen ware, terra cotta, conduit, sanitary ware, faience, enameled face brick, light-colored face brick, and hollow tile. The clays which lie below the lower pottery clay rather generally, as well as somewhat similar ones above the kaolin, both of which are classified as brick and tile clays, could be used in the manufacture of such articles as face brick, common brick, structural tile, drain tile, and hollow facing tile.

As these three types of clay are intimately associated, there are many possibilities for blending the different kinds.

R. O. PATRICK PROPERTY

Part of Region G of the "Tests" section of this report

This property (SE. 1/4, Sec. 33, T.2 S., R.3 E.) lies about a mile south of that in the H. A. Hopper area and contains a small quantity of clays of probable commercial value (A177, A183, A197). In the "Tests" section it is shown that some of this clay is kaolinitic, while more of it is of the brick and tile type. These clays might be worked in conjunction with those in the nearby H. A. Hopper area.

J. C. MCELWAIN PROPERTY

Part of Region G of the "Tests" section of this report

About 2 1/4 miles west of Falkner and the Gulf, Mobile & Ohio Railroad, white clay is exposed in a road cut and has been found in a few nearby test holes. So far as known, the deposit does not extend more than a few hundred feet in any direction, and it has been found only on the land of J. C. McElwain (NW. 1/4, Sec. 10, T.3 S., R.3 E.), where it may underlie a few acres. At one place, a small erosion gully exposes a bauxitic material, bauxitic pisolites being strewn for a few feet over the surface, but this material is probably of too limited extent to be of any value.

Hole A171 shows the typical gradation from the white kaolinitic material, through silty and micaceous clays, to Porters Creek clay. Test holes A188 and A203 are also on this property.

In the "Tests" section it is shown that some of the clays from this property are kaolinitic, whereas others, from below the kaolin, are suitable for pottery, brick, and tile. The small quantity of clays on this property suggests that they might best be worked as a supplement to those in the H. A. Hopper area, about 2 1/2 miles to the north.

J. S. PEARCE PROPERTY

Part of Region H of the "Tests" section of this report

Extensive exposures of reddish clays, underlain by light-colored clays are present (A220) in an open pasture on land owned by Mr. Pearce (NE. 1/4, SW. 1/4, Sec. 6, T.4 S., R.3 E.). It seems probable that these clays are fairly extensive, though time was not available to prove that fact.

In the "Tests" section it is shown that the upper clays are suited to the manufacture of various kinds of red-burning brick and tile, and that the underlying white clays are sandy kaolins which seem suited, after washing, to the manufacture of various kinds of porcelain and chinaware, tile, and art ware, as well as for use as a filler in paper, rubber, oil cloth, and linoleum, or as a paint pigment.

E. P. BARBER PROPERTY

Part of Region H of the "Tests" section of this report

About 7 miles west of Ripley and about a quarter of a mile north of Highway 4 (Sec. 11, T.4 S., R.2 E.) there are small exposures of white silty clay on the land of E. P. Barber (A 219). This is a kaolin-type clay and it is possible that it is present more abundantly nearby, though none was found in a rapid survey of this property. In the "Tests" section of this report it is shown that such kaolin is suited to the manufacture of various kinds of porcelain and china ware, tile, and art ware, as well as for a filler in paper, rubber, oil cloth, and linoleum, and as a paint pigment.

MARK HILL REGION

Region B of the "Tests" section of this report

This region (Fig. 15) is about 2 miles west of the Blue Mountain Railroad station and near the road fork at the Mark Hill residence (NE. 1/4, NW. 1/4, Sec. 11, T.5 S., R.2 E.). White clay crops out beside the road about 200 yards north of the corner, and in a

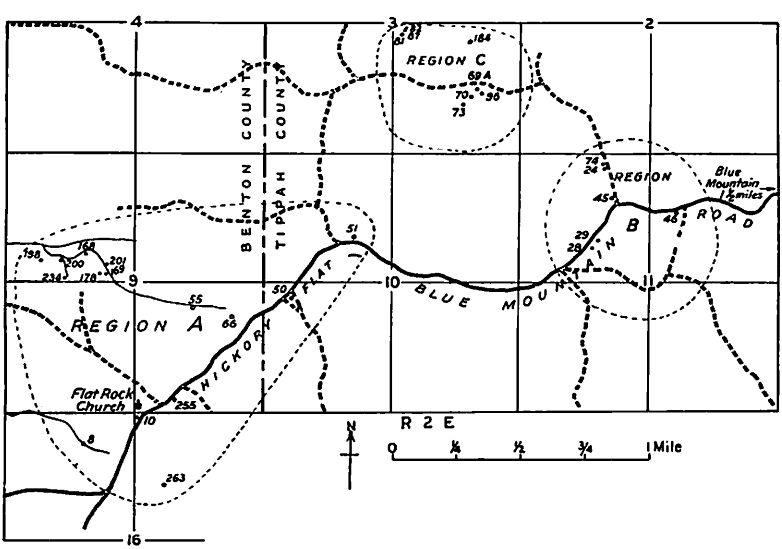

Figure 15.—Map of the area west of Blue Mountain showing the locations of test holes.

road cut a few hundred feet southwest of the corner. Mr. Hill reports that some years ago a landslip exposed white clay in the steep head of a ravine back of his house. Scattered test holes suggest that this clay does not extend far in any direction, but may underlie several acres in the immediate neighborhood of the road fork. The overburden in much of this area is between 5 and 10 feet.

The samples tested were obtained from the properties of T. H. Burford, Mark Hill, and G. T. Callicutt. Test holes A24, A28, A29, A45, A46, and A74 are from this region.

In the "Tests" section it is shown that some of the clays are kaolins, that might be used in the manufacture of fire brick and other refractory shapes. Test hole A45 penetrated 17 feet of clay which, in combination with other clay, could be used in the manufacture of high grade buff-colored speckled face brick. Though in this particular place the clay had 28 feet of overburden, it could doubtless be found nearby much closer to the surface. Other clays are suited for the manufacture of various porcelains, china ware, tiles, art ware, and glazes, as well as for filler in paper, rubber, oil cloth, and linoleum, and for a pigment in paint. Still other clays of the region might be used in the manufacture of many kinds of brick and tile, stoneware, conduit, and pottery.

D. D. HILL—T. H. BURFORD PROPERTIES

Part of Region C of the "Tests" section of this report

These properties (Fig. 15) are about three-quarters of a mile northwest of the Mark Hill residence (E. 1/2, Sec. 3, T.5 S., R.2 E.). No outcrops of white clay are known on these properties, but an exploratory auger hole beside a partially dug well about 500 yards west of the D. D. Hill residence and 50 feet north of the road, penetrated about 8 feet of white clay. Hole A69A, nearby on the south side of the road, revealed 11 feet of white clay, which was carefully sampled and tested.

This seam of clay was traced in auger holes several hundred yards, with a few interruptions, southwest along the slope of the ridge whose crest rises gradually to the west. To the northwest it seems to disappear in a short distance. It may underlie the central part of the ridge, but the overburden would be prohibitive. Near the site of hole A69A and the unsuccessful well on the opposite side of the road, there are probably several acres where the overburden does not exceed 15 or 20 feet.

Other holes from which samples were collected and tested are A70, A73, A96, and A184.

In the "Tests" section it is shown that most of the clays collected from these properties are kaolinitic, and are suitable for various refractory uses, such as fire brick, porcelain, china and dinner ware, floor and wall tile, pottery and art ware, and light-colored face brick. Though specimens of the lower clays were not sampled to sufficient depth in this area to prove their extent it seems likely, on the basis of laboratory findings, that pottery clays and brick and tile clays underlie the kaolinitic clays here as is so generally the case elsewhere in Tippah County.

W. L. ROBERSON PROPERTY

Part of Region C of the "Tests" section of this report

On the W. L. Roberson property (near the center of Sec. 3, T.5 S., R.2 E.) outcrops of a nearly white, somewhat pisolitic clay are present on the steep east wall of a small valley (Fig. 15).

Attempts to trace this clay more than 100 yards were unsuccessful, though not much time was available for the purpose. It seems unlikely, however, that clay having an overburden of 20 feet or less is available over more than 1 or 2 acres.

In its appearance this clay resembles that on the J. M. Gunter property about a mile and a half to the southwest, in the edge of Benton County.

As is shown in the "Tests" section, most of the samples from this property are hard kaolins, which might be used in the manufacture of refractory grog for use in fire brick and saggers. Below the kaolin there is a highly ferruginous clay which, in combination with the overlying clays, could be used in the manufacture of heavy clay products.

FLAT ROCK CHURCH DISTRICT

Part of Region A of the "Tests" section of this report

About 300 yards west of Flat Rock Church (Fig. 15), formerly the site of the old Hurley School, and about 300 or 400 yards north of the road and 35 feet below it (Sec. 9, T.5 S., R.2 E.) a small stream ditch affords one of the most spectacular exposures of white clay known in Mississippi (A8). The stream ditch, which is about 8 or 10 feet deep, in the bottom of a small, gently sloping valley, has been cut into the clay to depths of 6 to 8 feet for a distance of nearly a quarter of a mile. Where exposed, the clay is overlain by 3 to 4 feet of recent alluvium. In the upper parts of the exposures the clay appears to be almost entirely free from impurities, but in the lower portions it becomes increasingly silty and micaceous.

Several holes were drilled in the district in an attempt to trace the clay, but with little success. Holes drilled on the nearby ridges, some 20 or 25 feet above the outcrop, failed for the most part, to reach the position of the clay on account of rock layers which the auger could not penetrate. From the extent of the exposure in the ditch, however, it would seem that the clay must underlie several acres, only a part of which would be close to the surface.

In the road just south of the church there are exposures of light-gray silty clays (A10) of the type referred by Mellen to the Fearn Springs formation. The contact between these clays and the overlying sands is about 90 feet above the top of the kaolinitic bed in the nearby stream ditch. Repeated attempts to sample the entire series of clays were unsuccessful on account of rock layers which the augers could not penetrate. The same layer of clay in A10 is exposed about 200 yards northeast of the church, along the road to Blue Mountain (A255).

Test holes A55 and A66, several hundred yards northeast of Flat Rock Church (Fig. 15), sampled the lower and upper pottery clays, respectively. Hole A55 is beside a small stream channel which exposes in several places the lower pottery clay (below the kaolin), whereas hole A66, some 50 feet higher, is in the upper pottery clay. Unfortunately, hole A66 was not continued deep enough to afford a complete section of these interesting clays, but it seems very likely that there is here a variety of pottery clays, possibly with an intervening layer of kaolinitic clay. On the basis of a few scattered outcrops and test holes it seems probable that these clays underlie at least 25 to 50 acres of gently rolling, easily accessible land, in much of which the overburden is light. It is shown in the "Tests" section of this report that clays of the A55 type are suitable for use in the manufacture of porcelain, hotel china, pottery dinner ware, stoneware, and many other products. Samples from hole A66 showed up unfavorably in the laboratory, but it is probable that the samples were contaminated or otherwise not typical, for the clays at that place appear to be stratigraphically and otherwise like those from holes A10 and A50.

Other samples from this district, which were tested in the laboratory, are from test holes A50, A51, and A255. This district comprises property held in the names of the Salvation Army, S. W. Jackson, C. M. Hardin, and the Bank of Ripley and G. A. Hazard (Secs. 9 and 16, T.5 S., R.2 E.).

It is shown in the "Tests" section that the clay exposed in the upper portion of the stream ditch on the Salvation Army property is kaolin suitable for use in the manufacture of fire brick and refractory shapes. Below the kaolin there is the pottery-type clay only 2 feet of which was penetrated by test hole A8, but which is extensively exposed farther down the ditch. This pottery-type clay is suitable for the manufacture of stoneware, conduit, hollow facing tile, terra cotta, enameled face brick, light-colored face brick, art ware, and statuary. Probably it could also be combined with the overlying kaolin and used in the manufacture of light-colored face brick, flue lining, and medium grade refractory brick.

Because of their quality, variety, and quantity the clays from this district should be investigated by industrialists desirous of such clays.

J. M. GUNTER—JIM HILL PROPERTIES

Part of Region A of the "Tests" section of this report

These properties (central part of Sec. 9, T.5 S., R.2 E.) are about half a mile northwest of Flat Rock Church in Benton County (Fig. 15), and were mentioned by Lowe[50]. A small bluff on a stream, about 200 yards northwest of the Gunter house, shows a light cream-colored clay which is very tough and somewhat pisolitic (A200). Its exposure is on the side of a low ridge, but test holes on the opposite side of the ridge and in an open pasture about 150 yards northeast of the bluff failed to reveal its presence in those places. About 115 yards south of the bluff, toward the head of the small stream, hole A234 encountered about 11 feet of clay, free from silt and mica, at about the same elevation and beneath 11 feet of overburden.

As nearly as could be determined from scattered test holes, this clay does not extend far, though it probably underlies 2 or 3 acres on the low ridge where the overburden is not over 10 or 15 feet, and may even be much more extensive. About a quarter of a mile northwest of the bluff, across the broad bottom, a few holes indicated the presence of similar-appearing clay, though time was not available for tracing it.

It appears that the clay at the bluff (A200) resembles that on the W. L. Roberson property about a mile and a half to the northeast, in Tippah County.

Other samples from these properties, which were tested in the laboratory, are from test holes A168, A169, A178, A198, and A201.

It is shown in the "Tests" section that these are kaolinitic clays underlain by other clays of the pottery-type and of the brick and tile type. Some of the kaolins are suitable for the manufacture of various kinds of refractory shapes and light-colored face brick; other kaolins could be used in the manufacture of light-colored face brick, various kinds of porcelain, china ware, floor and wall tile, art ware, and as filler in paper, rubber, oil cloth, linoleum, and as a paint pigment. The underlying pottery-type and brick and tile type could be used for many purposes, either by themselves or in combination with the adjacent kaolins, such as for art ware, kitchen ware, stoneware, sanitary ware, light-colored face brick, structural tile, drain tile, and common brick.

BAUXITE

Bauxite was recognized in Mississippi in 1921 and shortly thereafter was thoroughly prospected. The work done at that time was so thorough, and the published report[35] of the findings so complete, that it has not seemed worth while in this survey to duplicate the earlier investigations.

Since the earlier work, however, an unusual deposit has been found by Mr. W. D. Shelton on the land of W. T. Meadows (SE. 1/4, Sec. 36, T.3 S., R.2 E.). On both sides of a private road, which leads down a narrow ridge to Mr. Meadows' house, and about 200 yards north-northeast of the house, many large boulders of bauxite are in evidence. From the distribution of the outcrops and of the loose material it appears that bauxite underlies the entire ridge to a depth of about 60 feet. An auger hole in the stream bed at the base of an 18-foot bluff of soft bauxite shows its downward continuation for at least another 10 feet, below which depth the auger would not penetrate. Thus the total thickness appears to be at least 70 feet. In order to sample the material (A225) a trench was dug from the top of the ridge down the north side to a point 40 feet below the top.

Its lower end was at the same elevation as the top of the 18-foot bluff referred to above, so sampling was continued down the bluff on the opposite side of the steep ravine, and from the 10-foot auger hole at the base of the bluff.

Attempts to find the material on adjacent properties were of no avail, and the deposit appears to be very local and unusually thick. Its elevation is comparable with the well-exposed Wilcox breccia about half a mile to the west, previously referred to in the description of the Ackerman basal sand member, and it seems likely that the deposit represents a hill covered with bauxite which stood perhaps 50 feet above the old land surface at the beginning of Wilcox time. To account for such an unusual thickness is difficult, as it seems unlikely that a bauxite mantle would have been formed to that depth. It is possible that land slips or small faults have caused a layer 15 or 20 feet thick to be present at these different elevations. It is also possible that some unusual condition caused such a thickness of it to be concentrated in early Wilcox time at the foot of a bauxite-covered hill.

Mr. Shelton has also found many boulders of low-grade bauxite on the hill slopes of the A. N. Thompson place and on land now in the National Forest but formerly belonging to Strickland & Hazard (Sec. 20, T.3 S., R.3 E.). A trench sample was obtained from a place where the bauxite was 5.5 feet thick, the overburden only 1 or 2 feet. The distribution of the boulders suggests that the bauxite may underlie several acres, though the overburden of 25 or more feet would probably be excessive.

Another small deposit of bauxite (A252) caps a small hill 3.0 miles northwest of Blue Mountain on the land of E. M. Hardin (NE. 1/4, Sec. 35, T.4 S., R.2 E.). This deposit is only about 8 feet thick and underlies only about an acre.

OCHER

In a few places the extreme top of the Porters Creek clay has been altered to ocher, probably by weathering during the Midway-Wilcox interval. The only place in the county where much ocher is known is on the land of W. D. Shelton (Sec. 17, T.3 S., R.3 E.), where two auger holes of the present survey (A310 and A311), and others drilled by Mr. Shelton, indicate that the ocher bed is about 3 or 3 1/2 feet thick, and may underlie several acres. This ocher is discussed further in the "Tests" section of this report. An outcrop on the Eula McKinstry place near Blue Mountain (Sec. 1, T.5 S., R.2 E.) suggests the presence of ocherous clay, but an auger hole showed only a gray plastic clay with ocherous stains.

PORTERS CREEK CLAY

Unlimited quantities of Porters Creek clay are available in Tippah County for any conceivable use to which it might be suited, as the bed is about 200 feet thick and extends the entire north-south length of the county, as well as hundreds of miles in both directions beyond the bounds of Tippah County. Unfortunately, few important uses have been found for the material, though many experiments have been conducted on it. In Tennessee Whitlatch[51] has found that it can be used in making light-weight brick. Some of this clay is said to be a naturally active bleaching clay (fuller's earth), having greater bleaching powers than some material which has been produced by oil companies for that purpose[52]. In Tennessee a plant has been established for the processing of Porters Creek clay, which is then sold to petroleum refiners. Recently Norman J. Dunbeck has obtained a patent[53] on the use of Porters Creek and various other clays as bonding materials in preparing molds for foundry purposes. So far as is known to the writer, Porters Creek clay has not been used commercially for this purpose.

Several of the many places in Tippah County where the clay is abundantly exposed and easily accessible for large-scale production are listed in the earlier section of this report dealing with the Porters Creek clay, and one of them is shown in Figure 6.

Experiments in the laboratory of the Mississippi Geological Survey show that it possesses certain properties which indicate its possible future utilization in other fields. The "Tests" section of this report suggests possible important uses to which it might be put.

BENTONITE

Bentonite is a clay which, when suitably prepared, possesses many unusual properties including that of bleaching mineral and vegetable oils. It is probably an altered volcanic ash which fell into the seas following volcanic eruptions which may have been at a considerable distance. In color it is dark-gray, brown, blue, green, pink, yellow, cream, or nearly white. Typically it has a waxy appearance and cracks badly on drying. Bentonitic clays have been found in many parts of the country during recent years, and have been known in Mississippi since 1927[54]. Since that time three bulletins[55 56 57] on Mississippi bentonite have been published.

In his investigation Bay took samples of the Porters Creek clay from 18 places in Tippah County. These samples were tested in the laboratories of the United States Geological Survey and nearly all of them showed some bleaching qualities, either in their natural state or when treated with acid. About five samples reached the minimum requirements for commercial bentonite, but only three showed real promise. These three are described by Bay as coming from the following places: (1) an auger hole 2.3 miles north of Ripley on Highway 15, which sample "represents the most efficient naturally active bleaching clay found in Tippah County" [and in all the Porters Creek clay samples from Mississippi]; (2) an auger hole 2.8 miles west of Falkner; and (3) "the middle of a 5-foot exposure of mottled brownish-gray and yellow, waxy, hard and brittle clay that crops out in a cut on a local road 1.7 miles west of Ripley."

For several years Mr. W. D. Shelton has prospected for bentonite in the Porters Creek clay and has found material of a bentonitic appearance in several places. Samples of the material were collected during this survey and have been tested in the laboratory.

In Pontotoc County Mellen recently discovered a commercial bed of bentonite between limestone layers in the upper Ripley formation[58], and later Vestal and Mellen searched carefully for it at that horizon in Tippah County but without success[59].

SIDERITE

A short distance west of the Tippah County line, in Benton County, the iron carbonate $FeCO_3$, technically known as siderite and locally referred to as "paint rock," has been dug from time to time and smelted to pig iron or roasted for paint pigments. Deposits of this iron ore have been described by Lowe[60]. So far as is known most of the workable material is in Benton County, in the form of concretions and rock layers about a foot thick in the Ackerman clay. It is also found as concretions in the laminated upper phase of the Porters Creek clay in both Tippah and Benton counties. These concretions range in thickness from about an inch to a foot, and in diameter from a foot to several feet. The most promising exposures of siderite in Tippah County are at the following places: (1) about half a mile northeast of the county line on the Blue Mountain-Flat Rock Church road in a deep ravine just north of and parallel to the road (NW. 1/4, Sec. 10, T.5 S., R.2 E.), where blocks of fine-grained siderite which is reported to have been used at one time for hone-stones, form a layer about 6 inches thick in what appears to be laminated Porters Creek clay; (2) on the land of W. D. Shelton (Sec. 17, T.3 S., R.3 E.), where smaller fine-grained concretions are abundant in the Porters Creek clay; and (3) just south of the road corner in the SW. 1/4, Sec. 28, T.2 S., R.3 E., where two layers of siderite about 6 and 4 inches thick, and 5 feet apart, are exposed in a gully on the west side of the road, probably in the Ackerman formation. At a number of other places in the county outcrops of weathered siderite indicate the presence of the rock, but these deposits are probably too small, and too scattered, to be of commercial importance.

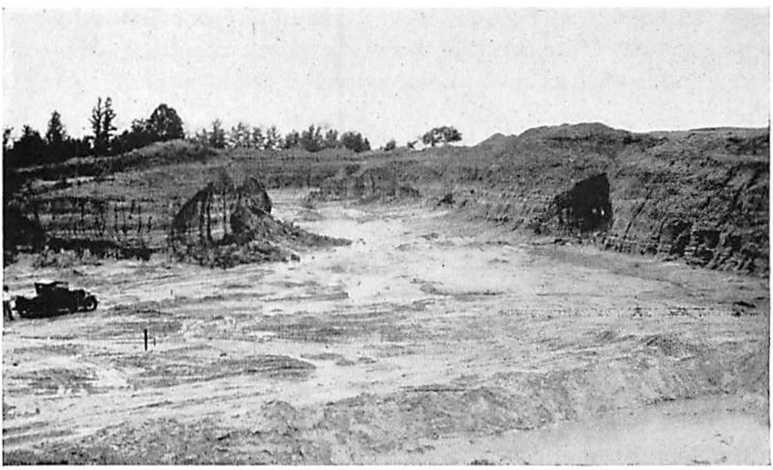

Figure 16.—Highway Department sand pit near the north edge of Walnut. Summer 1939.

SAND

The Wilcox sands are fine-grained to medium-grained, red, and fairly free from clayey impurities. From time to time they have been used as fine-grained aggregate for concrete and mortar. During 1938 and 1939 they have been used extensively by the Mississippi State Highway Department (Fig. 16) as topping material, for which purpose the sands are said to be so admirably suited that in some instances they have been hauled as much as 8 or 10 miles.

These sands cap the many Wilcox outliers (Fig. 3 and Pl. 1) in the Porters Creek belt, and make up the greater part of the Wilcox area in the county. Their red color is due to a coating of iron oxide on the grains, and it is possible that the sands could be used in the manufacture of glass if some economical means of removing the coating could be developed.

The coarsest of the sands are in the northern part of the county, especially at the following localities: (1) in a gully northwest of the road corner half a mile north of Oak Grove School (SE. 1/4, Sec. 8, T.2 S., R.3 E.); (2) at the outlier near the Ollie Hines place (Sec. 13, T.2 S., R.3 E.); (3) at the top of a small hill on the H. A. Hopper property (SW. 1/4, Sec. 27, T.2 S., R.3 E.); and (4) in the vicinity of the road corner on the G. L. Peeler place (SW. 1/4, Sec. 28, T.2 S., R.3 E.). At each of these localities except the first named, which is probably in the Holly Springs formation, the coarse sand appears to be a local accumulation immediately above the Midway-Wilcox contact. It does not appear to persist horizontally more than a few hundred yards and so far as can be determined is probably 30 feet or less in thickness.

Some of the sand deposits are fairly accessible to the railroad, (Pl. 1) but commercial exploitation of others would be handicapped by the necessity of hauling the sand over the Flatwoods belt to a shipping point. The present condition of the roads in those areas would restrict operations to dry weather, though a 2-inch or 3-inch course of gravel would convert them to all-weather roads.

MARL

Marl is, strictly speaking, a highly calcareous clay, but the term is often loosely applied to any unconsolidated material which contains appreciable quantities of lime and clay together with sand and, in many cases, glauconite. Material of this latter nature is found at many localities in Tippah County in the outcrop areas of the Owl Creek formation, the upper part of the Clayton formation, and portions of the Coon Creek tongue of the Ripley. Because of their relatively high content of lime and phosphate they have some value as fertilizer, as was pointed out long ago by Hilgard[61].

Inasmuch as there appears to be little interest in such material at present, when higher-grade commercial fertilizers are readily available, it has not seemed advisable to devote time to a study of these marls, especially as Hilgard published analyses of them, one of which[62] is reproduced herewith.

HILGARD'S ANALYSIS OF MARL FROM MR. WILHITE'S, SEC. 27, T.2 S., R.4 E., TIPPAH COUNTY

Insoluble sand and clay	73.410
Potash	0.702
Soda	(detn. lost)
Lime	6.315
Magnesia	0.886
Brown oxide of manganese	0.050
Peroxide of iron	7.055
Alumina	5.888
Phosphoric acid	0.046
Carbonic acid, water and loss	5.640
	100.000

PHOSPHATE

As was noted in the stratigraphic section of this report a phosphate-rich layer in the Clayton formation is present about 1 1/2 miles east of Falkner. Where exposed along the road it is about 1 foot thick, though it has been reported to be 2 or 3 feet thick nearby. Material from this bed is said to have been used to a limited extent to fertilize nearby fields, with good results.

No evidence has been found to indicate that this bed continues for any appreciable distance, though the same horizon may be represented by the fossil-rich exposures previously described in the discussion of the Clayton formation. Five of these exposures appear to be near the top of the Clayton formation, and it is possible that other thin deposits of phosphate might be found at this horizon.

LIGNITE

Lignite is present in several counties in Mississippi where Ackerman strata crop out. In an earlier bulletin of the Survey[63] data were given on many of these deposits.

Lignite, a material intermediate between peat and bituminous (soft) coal, is used in many parts of the world where true coal is not available, but in a region such as Tippah County, which is close to large bituminous-producing areas, such material can hardly be considered of value unless it is present in large quantities, of good grade, and fairly accessible. These conditions are not fulfilled in any known lignite deposit in Tippah County. As a matter of record, however, deposits which have been observed are mentioned here: (1) on the land of J. W. Bready (Sec. 18, T.1 S., R.4 E.) just south of the Tennessee State line, a bed 3 feet thick is exposed in a small ravine between his house and barn; (2) in the bed of Shelby Creek (Sec. 23, T.3 S., R.2 E.) a 1-foot bed is exposed at an old mill site; and (3) in most of the regions where kaolinitic clays are exposed small amounts of lignite and lignitic clays are found just above the clay, where they probably represent the remains of peat bogs which may have contributed to the development of the white clay.

OIL AND GAS

It has been pointed out in the section on Structural Geology that suggestions of abnormal structural conditions such as would be favorable to oil and gas accumulation have been found in the region around Walnut. These indications, however, are too meager to afford much promise that oil or gas is present.

It may be remarked in this connection, however, that all of the strata in the Coastal Plain region lie as great blankets over Paleozoic rocks of far greater age. Long before the strata now exposed were deposited, the older rocks may have been warped or faulted in such a manner as to form oil and gas traps, and subsequent erosion of these rocks could have produced a smooth or gently undulating surface upon which the younger strata were deposited. If such buried structures do exist, as well they may, no evidence of them would be expected on the present surface; only expensive geophysical prospecting by means of seismographs or other delicate instruments in the hands of skilled operators could detect their presence.

TEST HOLE RECORDS

In the several pages which follow there are reproduced the records (logs) of those test holes from which samples were tested in the laboratory. Many more exploratory holes were drilled with the aim of finding other worthwhile deposits or of tracing those already known, but it does not seem worthwhile to reproduce them here. Records of those other test holes are on file at the office of the Mississippi Geological Survey.

In most instances small metal tags bearing the numbers of the holes were tacked to nearby trees. Later the prefix "A" was added to all Tippah County test hole records and samples to distinguish them in the laboratory from samples collected in other counties in the state.

SALVATION ARMY PROPERTY

TEST HOLE A8

Location: T.5 S., R.2 E., Sec. 16, NW.1/4 (Benton County), in a stream ditch where white clay is exposed, about 350 yds. west of the road from a point in front of the S. W. Jackson house, and 550 yds. west southwest of Flat Rock Church Drilled: July 28-29, 1938

Elevation: About 110 ft. below Flat Rock Church Water level: 10 ft. (seep)

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.6	4.6	Clay, white plastic; free from grit; between 3.0 and 4.6 grades into next lower clay; P1
2	9.0	4.4	Clay, yellow; white streaks and lignitic streaks; P2
3	10.0	1.0	Clay, yellow; light-blue streaks; P3
4	17.0	7.0	Clay, light-blue; a few yellow streaks down to 12.6; at 11.0 thin layer of sand rock about 1 inch thick; at 13.0 layer of yellow sand rock probably 2 or 3 inches thick; below 13.0 increasingly silty and somewhat micaceous; P4
5	19.0	2.0	Clay, dark-blue; believed at time of drilling to be Porters Creek clay, but, on basis of ceramic properties, probably a pottery clay; P5

Remarks: Top of this hole in bottom of ditch at top of clay layer, and at base of overlying 3.6-foot layer of flood plain alluvium.

S. W. JACKSON PROPERTY

TEST HOLE A10

Location: T.5 S., R.2 E., near the S. edge of Sec. 9 (Benton County), 200 ft. south of Flat Rock Church, in a ditch on north side of road, just below red sand beds Drilled: June 28-30, 1938

Elevation: 20 ft. below the Church Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	9.1	9.1	Clay, white slightly silty plastic; yellow streaks; P1
2	12.1	3.0	Clay, blue micaceous slightly silty plastic; C1
3	25.0	12.9	Clay, light-gray micaceous slightly silty; lignitic streaks; P2
4	26.7	1.7	Clay, yellow micaceous slightly silty plastic; gray streaks
5	30.4	3.7	Clay, gray micaceous highly silty plastic; yellow streaks
6	32.0	1.6	Clay, gray arenaceous; lignitic streaks; rock in bottom of hole

T. H. BURFORD PROPERTY

TEST HOLE A24

Location: T.5 S., R.2 E., Sec. 11, NE.1/4 of NW.1/4, on west side of road 200 yds. northwest of road fork at Mark Hill residence Drilled: May 31, 1938

Elevation: 8 ft. below center of road Water level: 17.0 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	2.7	2.7	Soil and subsoil
2	12.1	9.4	Clay, white silty semi-plastic; C1
3	13.1	1.0	Clay, white semi-plastic; lignitic streaks
4	17.3	4.2	Clay, white silty semi-plastic; C2
5	24.0	6.7	Clay, gray slightly silty slightly micaceous semi-plastic; blue streaks; C3
6	24.4	0.4	Clay, white slightly micaceous plastic; black streaks
7	25.6	1.2	Clay, Porters Creek

T. H. BURFORD PROPERTY

TEST HOLE A28

Location: T.5 S., R.2 E., Sec. 11, SE.1/4 of NW.1/4, on the southeast side of road and 40 yds. south of house Drilled: May 31, 1938

Elevation: 8.5 ft. below the house Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	6.5	6.5	Soil and subsoil, yellow
2	9.2	2.7	Sand, yellow and white coarse argillaceous
3	10.5	1.3	Sand, blue and white argillaceous
4	14.4	3.9	Sand, red argillaceous
			Midway
5	19.4	5.0	Clay, light-blue silty micaceous slightly plastic; C1
6	20.0	0.6	Clay, probably grading into Porters Creek clay

Remarks: This hole is on a hill above road cut where several feet of pottery clay is exposed. The 5-foot layer between 14.4 and 19.4 of this hole corresponds with the 3.4-foot layer between 10.6 and 14.0 of hole A29.

T. H. BURFORD PROPERTY

TEST HOLE A29

Location: T.5 S., R.2 E., Sec. 11, SE.1/4 of NW.1/4, 46 yds. southeast of road and 40 yds. north of house Drilled: May 31, June 1, 1938

Elevation: 5.5 ft. below the house Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	5.9	5.9	Soil and subsoil, red
2	10.6	4.7	Sand, coarse argillaceous
			Midway
3	14.0	3.4	Clay, yellow micaceous plastic; blue streaks; C1
4	16.5	2.5	Clay, light-blue silty micaceous; yellow streaks; C2
5	17.2	0.7	Clay, Porters Creek

Remarks: See remarks on hole A28.

T. H. BURFORD PROPERTY

TEST HOLE A45

Location: T.5 S., R.2 E., Sec. 11, NE.1/4, of NW.1/4, in ditch on west side of road 135 ft. northwest of road fork at Mark Hill residence

Drilled: June 7, 1938

Elevation: 23.0 ft. above A24 Water level: 23.0 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	24.0	24.0	Sand, yellow; gray streaks
2	25.6	1.6	Sand, white; fairly free from impurities
3	28.0	2.4	Clay, yellow highly silty semi-plastic; gray streaks
			Midway
4	45.0	17.0	Clay, light-gray arenaceous semi-plastic slightly micaceous; C1
5	45.4	0.4	Same, but very sandy
6	48.6	3.2	Clay, same as clay from 28.0 to 45.0; C1
7	52.2	3.6	Clay, probably grading into Porters Creek clay

Remarks: Some sand from wet banks may be mixed with clay samples.

MARK HILL PROPERTY

TEST HOLE A46

Location: T.5 S., R.2 E., Sec. 11, SW.1/4 of NE.1/4, 16 ft. south of center of road about 1/4 mi. east of the corner at Mark Hill residence, and 245 ft. west of center of road leading south from the Blue Mountain road

Drilled: June 7, 1938

Elevation: 2.5 ft. below center of road, and 18 ft. below road at Mark Hill residence

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	9.0	9.0	Clay, yellow-gray silty plastic pisolitic; P1
2	9.8	.8	Clay, gray micaceous semi-plastic
3	10.5	.7	Clay, gray micaceous; dark streaks
4	11.0	.5	Rock in bottom of hole

S. W. JACKSON PROPERTY

TEST HOLE A50

Location: T.5 S., R.2 E., Sec. 10, NW.1/4 of SW.1/4, about 15 ft. southeast of center of road and about 150 yds. northeast of a mail box at foot of the hill

Drilled: Aug. 3, 1938

Elevation: About the level of the road

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	1.5	1.5	Clay, bluish-gray arenaceous; P1
2	4.4	2.9	Clay, gray friable; reddish lumps; very little silt; no mica; P2
3	10.0	5.6	Clay, gray massive micaceous plastic; very little silt; light-yellow streaks; P3
4	11.3	1.3	Clay, dark-gray plastic; very little silt; lignitic streaks; P4
5	14.0	2.7	Clay, bluish-gray very silty friable; no mica; very small lignitic streaks; P5
			Midway?
6	16.1	2.1	Clay, yellow-gray plastic; very little silt; no mica; a few purple streaks; P6
7	21.8	5.7	Clay, yellow plastic micaceous; very little silt; a few gray streaks; gradual change to the clay below; P7
8	23.0	1.2	Clay, dark-blue grayish micaceous friable very silty; P8
9	27.0	4.0	Clay, gray very silty micaceous semi-plastic; a few yellow streaks; P9
10	28.4	1.4	Clay, dark-gray bluish micaceous; a few small ferruginous rocks; P10

Remarks: There appears to be a large acreage of this clay. Overburden of about 10 ft. of clay and red sand exposed in road cut above the test hole. Samples were from two 4-inch holes about 5 feet apart.

Bank of Ripley and G. A. Hazard property

Test hole A51

Location: T.5 S., R.2 E., Sec. 10, SE.1/4 of NW.1/4, on north side of road about 0.4 mi. northeast of the Benton County line, and about 100 yds. east of a road fork Drilled: June 7, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.8	3.8	Sand, red argillaceous
2	9.4	5.6	Clay, blue; yellow streaks; C1
3	14.0	4.6	Clay, argillaceous semi-plastic; yellow and blue streaks
4	16.4	2.4	Clay, dark-blue plastic; very little mica; streaks of lignite; C2
5	19.6	3.2	Clay, dark-brown lignitic; C3
6	24.1	4.5	Clay, dark-blue plastic lignitic slightly micaceous; C4
7	25.2	1.1	Clay, yellow plastic silty micaceous
8	35.8	10.6	Clay, gray-blue silty slightly micaceous, plastic; C5

Remarks: This clay is extensively exposed in road cuts. Maximum overburden is about 28 ft.

Bank of Ripley and G. A. Hazard property

Test hole A55

Location: T.5 S., R.2 E., Sec. 9, SE.1/4 (Benton County), about 260 yds. west of hole A66 Drilled: June 13-14, 1938

Elevation: About 50 ft. below A66 Water level: 12.8 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	.6	.6	Soil and subsoil, red arenaceous, micaceous
2	7.7	7.1	Clay, gray micaceous plastic; brown streaks and pebbles; C1
3	32.0	24.3	Clay, blue micaceous arenaceous plastic; probably Porters Creek clay

BANK OF RIPLEY AND G. A. HAZARD PROPERTY

TEST HOLE A66

Location: T.5 S., R.2 E., Sec. 9, SE.1/4 (Benton County), about 200 yds. S. 80° W. of intersection of road and county line Drilled: Aug. 8, 1938

Elevation: About 10 ft. below A10 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.8	3.8	Soil and subsoil, yellow
2	5.5	1.7	Clay, blue and yellow silty; at 5.5 becomes slightly more blue; P1
3	9.5	4.0	Clay, bluish silty; yellow streaks; P2
4	14.4	4.9	Clay, olive drab very silty; at 13.3 a few yellow streaks; P3
5	15.0	0.6	Clay, blue; gray streaks

Remarks: Outcrops of basal Ackerman clays exposed on slopes north and west of test hole.

T. H. BURFORD PROPERTY

TEST HOLE A69A

Location: T.5 S., R.2 E., Sec. 3, NE.1/4 of SE.1/4, about 30 ft. south of road and about 250 ft. south of partially dug old well

Drilled: June 28-29, 1938

Elevation: About 2 ft. above the road Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	3.2	3.2	Soil and subsoil, clay and sand, red
2	14.2	11.0	Clay, white plastic; very little grit; P1
3	15.0	.8	Clay, blue; brown streaks; some lignite; P2
4	16.0	1.0	Clay, mottled friable lignitic silty; P3

Remarks: Samples obtained from auger hole in bottom of a pit in overlying sand. An earlier exploratory hole 7 ft. away showed, below P3, 4 ft. of gray arenaceous, slightly micaceous clay grading into Porters Creek clay.

T. H. BURFORD PROPERTY

TEST HOLE A70

Location: T.5 S., R.2 E., Sec. 3, NE.1/4 of SE. 1/4, 234 ft. southwest of hole A69A
Drilled: June 15, 1938

Elevation: 3 ft. below A69A
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	3.0	3.0	Soil and subsoil
2	11.5	8.5	Clay, white micaceous plastic; a few gypsum crystals; P1
3	12.8	1.3	Clay, yellow micaceous plastic; C1
4	17.6	4.8	Clay, white micaceous plastic; P1
5	18.2	.6	Clay, blue lignitic
6	21.0	2.8	Clay, white micaceous plastic silty; C2
7	23.1	2.1	Clay, Porters Creek

Remarks: Numbers 2 and 4 were combined as P1 for testing.

T. H. BURFORD PROPERTY

TEST HOLE A73

Location: T.5 S., R.2 E., Sec. 3, SE.1/4 of SE.1/4, 258 ft. southwest of hole A70
Drilled: June 16, 1938

Elevation: 20 ft. above A69A
Water level: 25.9 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil
2	11.3	7.3	Clay, red highly silty; gray streaks
			Midway
3	13.1	1.8	Clay, white semi-plastic; C1
4	21.0	7.9	Clay, yellow pisolitic; C2
5	23.9	2.9	Clay, yellow slightly plastic; thin laminae of rock
6	27.0	3.1	Clay, white silty micaceous plastic; yellow streaks; C3
7	27.6	.6	Sand rock
8	35.5	7.9	Same as the 3.1 feet of clay above the sand rock; hole closed on rock; C3

T. H. BURFORD PROPERTY

TEST HOLE A74

Location: T.5 S., R.2 E., Sec. 11, NE.1/4 of NW.1/4, in ditch beside road 210 yds. north of road corner at Mark Hill residence Drilled: June 28, 1938

Elevation: 4 ft. below A24 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	6.5	6.5	Clay, white slightly silty plastic; P1
2	12.0	5.5	Clay, white silty semi-plastic; yellow streaks
3	14.5	2.5	Clay, bluish-gray arenaceous semi-plastic; C1
4	18.2	3.7	Clay, bluish-gray; lignitic streaks
5	19.9	1.7	Clay, gray highly silty micaceous
6	20.0	.1	Clay, Porters Creek

W. L. ROBERSON PROPERTY

TEST HOLE A81

Location: T.5 S., R.2 E., Sec. 3, NW.1/4 of SE.1/4, near center of Sec., 270 yds. north of the road Drilled: June 21, 1938

Elevation: not determined Water level: 14.1 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox?
1	3.7	3.7	Sand-clay, red
			Midway
2	5.8	2.1	Clay, light-gray lumpy arenaceous plastic; C1
3	8.6	2.8	Clay, white plastic; yellow streaks; C2
4	10.9	2.3	Clay, light-blue semi-plastic
5	14.4	3.5	Clay, light-gray semi-plastic; red streaks
6	18.4	4.0	Clay, blue micaceous slightly silty; yellow streaks; probably Porters Creek clay

Remarks: Difficult of access; heavy overburden in most places.

W. L. ROBERSON PROPERTY

TEST HOLE A82

Location: T.5 S., R.2 E., Sec. 3, NW.1/4 of SE.1/4, near center of Sec., about 50 yds. northeast of hole A81 Drilled: June 22, 1938

Elevation: 21 ft. above A81 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	7.0	7.0	Sand-clay, red
2	12.1	5.1	Sand, yellow fine
			Midway
3	21.3	9.2	Clay, white slightly silty plastic; yellow streaks; C1
4	24.5	3.2	Clay, yellow lumpy
5	27.0	2.5	Clay, blue highly silty; yellow streaks; hole closed on rock; C2

Remarks: Difficult of access; heavy overburden in most places.

W. L. ROBERSON PROPERTY

TEST HOLE A87

Location: T.5 S., R.2 E., Sec. 3, NW.1/4 of SE.1/4, near center of Sec., about 40 yds. northeast of hole A81 and 10 yds. southwest of hole A82

Drilled: Aug. 8-9, 1938

Elevation: 11 ft. above A81 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.0	2.0	Soil and subsoil, red
2	4.9	2.9	Sand, yellow
			Midway
3	7.4	2.5	Clay, white pisolitic silty; P1
4	12.0	4.6	Clay, white slightly silty; yellow streaks; P2
5	20.4	8.4	Clay, yellow highly silty; a few small sand rocks from 13.7 to 20.4; P3
6	23.0	2.6	Clay, white silty micaceous; yellow streaks; P4
7	23.5	.5	Clay, Porters Creek

Remarks: Difficult of access; heavy overburden in most places.

T. H. BURFORD PROPERTY

TEST HOLE A96

Location: T.5 S., R.2 E., Sec. 3, SE.1/4 of SE.1/4, 50 yds. southeast of hole A69A
Drilled: July 1, 1938
Elevation: 11 ft. below A69A
Water level: 18.0 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.0	4.0	Soil and subsoil, red
2	13.2	9.2	Clay, white; red streaks; C1
3	16.4	3.2	Clay, white; red streaks; some lignite; somewhat pisolitic; C2
4	21.0	4.6	Clay, black highly lignitic plastic slightly micaceous; C3

H. A. HOPPER PROPERTY

TEST HOLE A101

Location: T.2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, beside road, 900 ft. northeast of road corner
Drilled: July 29 and Aug. 8, 1938
Elevation: 17 ft. below A111
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	2.0	2.0	Soil and subsoil, red and sandy
2	4.5	2.5	Clay, dark-gray; at 3.0 feet, gradually changes to a blue-gray clay; P1
3	11.0	6.5	Clay, white; free from grit; P1
4	14.0	3.0	Clay; at 11.0 gradually becomes silty; P2
5	16.0	2.0	Clay, very silty and micaceous; some yellow streaks; gradually becomes more yellow at 16.0; P3
6	18.0	2.0	Clay, yellow and micaceous; some streaks of white clay; P4
7	20.0	2.0	Clay, purple slightly micaceous; yellow streaks; P5
8	21.5	1.5	Clay, purple and yellow silty; altered Porters Creek clay; P5
9	22.5	1.0	Clay, probably Porters Creek

Remarks: Hole is in outcrop of white clay beside road.

H. L. Miskelly property

Test hole A102

Location: T.2 S., R.3 E., Sec. 27, SW.1/4 of SW.1/4, 294 ft. southwest of hole A111 Drilled: Aug. 4, 1938
Elevation: 10 ft. below A111 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.3	4.3	Soil and subsoil, sandy, argillaceous red
2	4.7	.4	Clay, gray silty; yellow streaks
3	8.4	3.7	Sand, yellow and gray argillaceous micaceous
4	9.6	1.2	Clay, blue; yellow streaks; C1
5	11.3	1.7	Clay, lignitic tough highly plastic; at 11.0 feet, changes to gray clay containing lignite streaks; C2
			Midway
6	16.0	4.7	Clay, white silty; C3
7	20.2	4.2	Clay, yellow silty; gray streaks; rock in bottom of hole; C4

Remarks: Test hole A102A was a supplementary hole 5 feet away, drilled at a different time. Sample A102A C1 is from same stratum as A102 C3.

National Forest

Test hole A107

Location: T. 2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, on east side of small road about 350 yds. north of hole A101 Drilled: July 13, 1938
Elevation: 15 ft. below A111 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	2.0	2.0	Soil, sandy
2	4.8	2.8	Clay, bluish; sand streaks
3	7.6	2.8	Clay, blue plastic; very little mica; C1
4	15.6	8.0	Clay, white silty slightly micaceous plastic; C2
5	20.0	4.4	Clay, white silty micaceous
6	22.0	2.0	Sand; some blue-gray streaks; grading into Porters Creek clay

H. A. HOPPER PROPERTY

TEST HOLE A111

Location: T.2 S., R.3 E., Sec. 27, SW.1/4 of SW.1/4, 42 ft. east of the road fork which is 4.3 mi. northwest of Falkner Drilled: July 5-6, 1938

Elevation: 3 ft. above road fork Water level: 20.5 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.5	2.5	Soil and subsoil, red
2	12.0	9.5	Sand, red very coarse
3	14.0	2.0	Clay, grayish-yellow highly silty
4	17.0	3.0	Clay, reddish-gray silty slightly micaceous semi-plastic
5	18.5	1.5	Clay, white highly silty micaceous; yellow streaks
6	22.0	3.5	Sand, white and yellow very fine
			Midway
7	22.6	.6	Lignite
8	25.0	2.4	Clay, blue plastic; a little mica
9	36.0	11.0	Clay, white micaceous plastic silty; C1
10	38.0	2.0	Clay, white micaceous highly silty semi-plastic; hole closed in Porters Creek clay

NATIONAL FOREST

TEST HOLE A113

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SE.1/4, 350 ft. west of hole A111, south of road Drilled: July 6, 1938

Elevation: 23 ft. above A111 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.3	2.3	Soil and subsoil
2	23.0	20.7	Sand, red very coarse; C1
3	23.6	.6	Sand, white coarse
4	28.0	4.4	Sand, red coarse argillaceous micaceous
5	29.3	1.3	Clay, white highly silty micaceous
6	39.6	10.3	Sand, red; some clay balls

H. A. HOPPER PROPERTY

TEST HOLE A117

Location: T.2 S., R.3 E., Sec. 27, SW.1/4 of SW.1/4, 66 yds. southeast of hole A111, on hill
Drilled: July 5, 1938

Elevation: 22 ft. above A111
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
1	5.5	5.5	Sand, red
2	24.0	18.5	Sand, red coarse; lumps of white clay; P1
3	30.0	6.0	Sand, yellow coarse-grained; hole closed on rock

NATIONAL FOREST

TEST HOLE A121

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SE.1/4, 195 ft. north of road junction
Drilled: Aug. 15-17, 1938

Elevation: 15 ft. below road junction, and 15 ft. below A111
Water level: 21.0 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil, gray
2	6.0	2.0	Sand, yellow
3	8.0	2.0	Clay, yellow and gray arenaceous; P1
4	10.3	2.3	Clay, blue slightly silty; lignitic streaks; P2
			Midway
5	15.0	4.7	Clay, white slightly silty plastic; slightly contaminated; P3
6	16.7	1.7	Clay, white micaceous slightly silty semi-plastic; yellow streaks
7	21.0	4.3	Clay, yellow highly silty; white streaks
8	22.0	1.0	Clay, yellow highly silty micaceous; white and blue streaks; hole closed on rock

National Forest

Test hole A125

Location: T.2 S., R.3 E., Sec. 27, SW.1/4 of NW.1/4, beside road 0.5 mi. north of hole A111, and 324 ft. north of hole A107 Drilled: Aug. 5, 1938

Elevation: 14 ft. below A111, and 1.0 ft. above A107 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	0.8	0.8	Soil and subsoil, gray
2	4.5	3.7	Clay, dark-gray silty semi-plastic; red streaks; P1
3	6.0	1.5	Clay, white; some yellow sand and lignitic streaks; P2
4	8.0	2.0	Clay, white plastic; some gypsum crystals; P3
5	15.0	7.0	Clay, white slightly silty plastic; P4
6	17.5	2.5	Clay, white silty semi-plastic; P5
7	20.0	2.5	Clay, white; streaks of yellow sand; P6
8	23.0	3.0	Clay, bluish-gray highly silty highly micaceous; yellow streaks; P7
9	24.0	1.0	Clay, probably grading into Porters Creek clay; P8

H. A. Hopper property

Test hole A129

Location: T.2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, on small knoll 25 yds. west of road, about 150 yds. north of hole A101 Drilled: Aug. 15, 1938

Elevation: About 4 ft. lower than A101 and about 21 ft. lower than A111
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.0	1.0	Soil and subsoil, gray
2	3.0	2.0	Clay, bluish plastic; yellow streaks; C1
3	9.6	6.6	Clay, white silty; some yellow streaks; C2
4	15.0	5.4	Clay, white silty micaceous; C3
5	17.0	2.0	Clay, gray; streaks of purple clay; C4
6	18.0	1.0	Clay, probably grading into Porters Creek clay

Remarks: This is a second hole at the same locality as A129A, drilled in order to get better samples. Differences in the two test hole records may reflect actual differences, but more likely reflect differences in observations by different sample takers. A129 is probably the more reliable.

H. A. HOPPER PROPERTY

TEST HOLE A129A

Location: T.2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, on small knoll 25 yds. west of road, about 150 yds. north of hole A101 Drilled: Aug. 15, 1938

Elevation: About 4 ft. lower than A101 and about 21 ft. lower than A111

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.3	1.3	Soil and subsoil, gray clay, and sand
2	3.0	1.7	Clay, gray lumpy slightly silty friable
3	12.3	9.3	Clay, light-gray friable some mica; not much silt; C1
4	18.0	5.7	Clay, yellow highly micaceous; white streaks; probably grading into Porters Creek clay

Remarks: See remarks on A129

H. A. HOPPER PROPERTY

TEST HOLE A131

Location: T.2 S., R.3 E., Sec. 27, SW.1/4 of SW.1/4, 300 ft. N. 30° E. of hole A111 Drilled: July 23-25, 1938

Elevation: 6 ft. below A111 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.0	3.0	Soil and subsoil, red clay, silty
2	10.5	7.5	Sand, medium coarse
3	11.8	1.3	Sand, red coarse
4	12.5	0.7	Ocher
5	13.8	1.3	Clay, blue waxy tough plastic; no silt
6	17.9	4.1	Clay, gray plastic; C1
7	18.3	0.4	Clay, yellow micaceous; gray streaks
			Midway
8	18.8	0.5	Clay, blue plastic tough
9	19.3	0.5	Lignite
10	22.0	2.7	Clay, blue plastic tough; C2
11	27.0	5.0	Clay, white non-plastic tough; C3
12	29.5	2.5	Clay, same as above, but micaceous
13	33.5	4.0	Clay and sand, white highly micaceous
14	34.6	1.1	Clay, blue lumpy micaceous silty; probably grading into Porters Creek clay

Remarks: Samples C1 and C2 were too small for testing, so were discarded.

H. A. Hopper property

Test hole A136

Location: T.2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, 135 ft. west of hole A101
Drilled: Aug. 15, 1938

Elevation: 10 ft. below A101 and about 27 ft. below A111
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.6	1.6	Soil and subsoil, yellow
2	4.0	2.4	Clay, white silty micaceous; C1
3	10.6	6.6	Sand, bluish; yellow streaks; probably grading into Porters Creek clay

B. W. Martindale property

Test hole A137

Location: T.2 S., R.3 E., Sec. 28, SW.1/4 of SE.1/4, about 140 yds. northwest of hole A155
Drilled: July 25-28, 1938

Elevation: 10 ft. below A155 and about 30 ft. below A111
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	2.0	2.0	Soil and subsoil, gray clay; silty
2	10.1	8.1	Clay, white silty non-plastic; yellow streaks; C1
3	12.6	2.5	Clay, yellow micaceous; gray streaks; thin layers of fine sand
4	14.3	1.7	Clay, blue lumpy micaceous silty
5	16.0	1.7	Sand, yellow fine; a few lumps of blue clay
6	18.0	2.0	Clay, blue and gray lumpy micaceous; probably grading into Porters Creek clay

National Forest

Test hole A150

Location: T.2 S., R.3 E., Sec. 27, NW.1/4 of SW.1/4, 180 ft. southwest of a small cemetery which is west of the road   Drilled: Sept. 20, 1938

Elevation: about 3 ft. lower than A111 and 17 ft. above A129

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	11.2	11.2	Sand, red
			Midway
2	14.2	3.0	Clay, white silty; yellow streaks; C1
3	16.0	1.8	Clay, red and white plastic; some silt; C2
4	24.5	8.5	Clay, white silty slightly plastic; C3
5	26.3	1.8	Clay, gray highly silty; some mica; yellow streaks; C4

B. W. Martindale property

Test hole A155

Location: T.2 S.,R.3 E., Sec. 28, probably near SE. corner of SW.1/4 of SE. 1/4, 540 ft. southwest of road corner north of the T. E. Childers residence

Drilled: Aug. 17-18, 1938

Elevation: About 30 ft. below road corner, and about 20 ft. below A111

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.3	2.3	Soil and subsoil, gray
2	3.6	1.3	Clay, dark-gray slightly silty semi-plastic; P1
3	5.0	1.4	Clay, gray; some lignite; P2
4	6.3	1.3	Clay, gray silty slightly micaceous semi-plastic; P3
5	8.9	2.6	Clay, gray; some lignite; P2
			Midway
6	14.0	5.1	Clay, white highly plastic; P4
7	17.0	3.0	Clay, yellow micaceous slightly silty semi-plastic; white streaks; P5
8	21.9	4.9	Clay, white slightly micaceous semi-plastic; yellow streaks; probably grading into Porters Creek clay; P6

Remarks: This hole is about 75 ft. northeast of ravine where F. E. Vestal once found about 13 ft. of white clay.

B. W. MARTINDALE PROPERTY

TEST HOLE A157

Location: T.2 S., R.3 E., Sec. 28, near SW. corner SE.1/4 of SE.1/4, 100 yds. southeast of hole A155 Drilled: July 25-28, 1938

Elevation: 3 ft. below A155 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	5.5	5.5	Soil and subsoil, red
2	8.0	2.5	Clay, gray arenaceous micaceous
3	9.0	1.0	Clay, yellow; gray streaks
4	17.0	8.0	Clay, gray micaceous silty; C1
5	18.0	1.0	Clay, probably grading into Porters Creek clay

B. W. MARTINDALE PROPERTY

TEST HOLE A161

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SE.1/4, 354 ft. east of hole A155 Drilled: July 28-29, 1938

Elevation: 18 ft. above A155 Water level: 13.6 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.0	3.0	Soil and subsoil, red sand, and clay
2	8.6	5.6	Sand, yellow very fine
3	10.8	2.2	Sand, gray; yellow streaks
4	12.0	1.2	Clay, lignitic and sooty
5	13.6	1.6	Clay, gray; yellow streaks and lignitic streaks
			Midway
6	15.0	1.4	Clay, lignitic
7	23.8	8.8	Clay, white plastic; no silt; C1
8	28.2	4.4	Clay, highly silty micaceous plastic; C2
9	30.6	2.4	Sand, gray micaceous very fine
10	33.0	2.4	Clay, blue micaceous tough plastic; probably grading into Porters Creek clay

B. W. Martindale property

Test hole A162

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SE.1/4, about 75 yds. east southeast of hole A161 Drilled: Aug. 4, 1938

Elevation: About 10 ft. below A161 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil, red
2	9.5	5.5	Sand, yellow
			Midway
3	16.0	6.5	Clay, white silty plastic; yellow streaks; at 16.0 a rock about 1/16 inch thick; C1
4	19.0	3.0	Clay, white silty micaceous semi-plastic; yellow streaks; C2
5	22.4	3.4	Clay, silty micaceous semi-plastic; bluish-yellow streaks; C3
6	24.0	1.6	Clay, gray arenaceous micaceous semi-plastic
7	25.5	1.5	Clay, probably grading into Porters Creek clay

B. W. Martindale property

Test hole A163

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SE.1/4, 432 ft. south by west of hole A162 Drilled: Aug. 5, 1938

Elevation: 15 ft. below A162 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
1	3.0	3.0	Soil and subsoil, gray
2	15.0	12.0	Clay, yellow arenaceous micaceous; gray streaks; C1
3	16.0	1.0	Clay, grading into Porters Creek clay

L. A. Moran property

Test hole A165

Location: T.4 S., R.3 E., Sec. 12, NE.1/4 of NW.1/4, in ditch along east side of Highway 15, 1.8 mi. north of Ripley square Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
1	5.5	5.5	Porters Creek clay; C1
2	12.0	6.5	Porters Creek clay; C2

Remarks: Thicknesses are from the bottom. These samples, originally labeled A265, later had their numbers erroneously changed to A165.

J. M. GUNTER PROPERTY

TEST HOLE A168

Location: T.5 S., R.2 E., Sec. 9, near E. edge of SW.1/4 of NW.1/4 (Benton County), in middle of pasture about 137 yds. northeast of hole A200

Drilled: Aug. 10, 1938

Elevation: 14 ft. above A200 Water level: 23.6 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.5	2.5	Soil and subsoil, red
2	4.0	1.5	Clay, bluish-white; red streaks
3	6.5	2.5	Clay, white plastic slightly silty; C1
4	8.0	1.5	Clay, red sandy
5	10.2	2.2	Sand, white coarse rocky
6	14.0	3.8	Sand, rocky
7	17.0	3.0	Sand, gray
			Midway
8	22.0	5.0	Clay, white; some silt; slight change at 19.0 to streaks of brown; C2
9	28.6	6.6	Clay, yellow plastic slightly arenaceous; gradual change to next lower sand; C3
10	30.6	2.0	Sand, gray; yellow streaks

J. M. GUNTER PROPERTY

TEST HOLE A169

Location: T.5 S., R.2 E., Sec. 9, SE.1/4 of NW.1/4 (Benton County), about 270 yds. southeast of hole A168 and 125 yds. northeast of the Gunter residence

Drilled Aug. 10 and 23, 1938

Elevation: 2 ft. below A168 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.0	2.0	Soil and subsoil, loamy silty
2	5.3	3.3	Sand, gray; sandstone pebbles
3	6.0	0.7	Clay, white slightly silty plastic; yellow streaks
4	9.7	3.7	Clay, yellow silty; white streaks; a few pebbles and very thin laminae of iron carbonate; C1
5	14.2	4.5	Clay, yellow silty; thin laminae of iron carbonate; C2
6	15.5	1.3	Clay, mixed gray and yellow highly silty micaceous non-plastic
			Midway
7	17.8	2.3	Clay, gray slightly micaceous silty; C3
8	19.0	1.2	Clay, blue; believed by drillers to be Porters Creek clay, but probably material grading into Porters Creek clay

J. C. McELWAIN PROPERTY

TEST HOLE A171

Location: T.3 S., R.3 E., Sec. 10, SE.1/4 of NW.1/4, about 180 yds. southeast of road fork which is about 100 yds. east of Mr. McElwain's west boundary

Drilled: Sept. 14, 1938

Elevation: About 15 ft. below road fork Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.2	4.2	Soil and subsoil, yellow
2	8.0	3.8	Clay, white slightly silty; yellow streaks; C1
3	12.2	4.2	Clay, yellow silty; white streaks; at 12.0 a few hard lumps; C2
4	15.0	2.8	Clay, yellow and white highly silty; C3
5	17.3	2.3	Clay, blue highly silty; some mica; grading into Porters Creek clay; C4
6	34.0	16.7	Clay, black plastic micaceous; Porters Creek clay; C5

B. W. MARTINDALE PROPERTY

TEST HOLE A172

Location: T.2 S., R.3 E., Sec. 28, near SE. corner of SW.1/4 of SE.1/4, 100 yds. southwest of hole A161 Drilled: July 29-Aug. 5, 1938

Elevation: 8 ft. below A161 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.5	2.5	Soil and subsoil, white sand
2	4.0	1.5	Sand, red coarse
3	11.2	7.2	Clay, white; yellow streaks; C1
			Midway
4	15.6	4.4	Clay, gray highly silty; yellow streaks; C2
5	17.0	1.4	Sand, yellow; gray lumps
6	22.0	5.0	Clay, blue highly silty; probably grading into Porters Creek clay

NATIONAL FOREST

TEST HOLE A173

Location: T.2 S., R.3 E., Sec. 28, near center of SW.1/4, 30 ft. south of east-west road 990 ft. east of its junction with old Ripley-Saulsbury road

Drilled: Aug. 5-8, 1938

Elevation: 1 ft. above center of road — Water level: 18.5 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	1.5	1.5	Soil and subsoil, gray clay and sand
2	7.2	5.7	Clay, yellow micaceous silty; white streaks; C1
3	9.4	2.2	Sand, yellow coarse
4	12.3	2.9	Clay, very silty plastic micaceous
5	18.5	6.2	Clay, gray silty; yellow streaks; C3
6	20.4	1.9	Sand, fine; mixed colors
7	30.0	9.6	Clay, blue silty plastic slightly micaceous; C4

Remarks: No C2 sample collected.

NATIONAL FOREST

TEST HOLE A175

Location: T.2 S., R.3 E., Sec. 28, SW.1/4 of SW.1/4, 50 ft. east of old Ripley-Saulsbury road 480 ft. south of its junction with a road leading east

Drilled: Aug. 16-17, 1938

Elevation: 6.5 ft. above center of road — Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.5	4.5	Clay, white silty; yellow streaks; C1
2	10.6	6.1	Clay, gray highly silty micaceous; C2
3	14.9	4.3	Clay, gray silty; yellow streaks; C3
4	18.9	4.0	Clay, blue silty; yellow streaks; C4
5	23.3	4.4	Sand, gray highly micaceous
6	25.1	1.8	Clay, blue silty; C5
7	26.9	1.8	Clay, gray micaceous silty

R. O. PATRICK PROPERTY

TEST HOLE A177

Location: T.2 S., R.3 E., Sec. 33, near center of W.1/2 of SE.1/4, 230 yds. southwest of the Patrick residence — Drilled: Aug. 18, 1938

Elevation: 32 ft. above house — Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.0	1.0	Soil and subsoil, black sandy loam
2	5.1	4.1	Clay, yellow friable silty non-plastic; C1
3	8.4	3.3	Clay, yellow highly silty; few white lumps; C2
4	10.6	2.2	Clay, yellow silty micaceous; white streaks
5	13.1	2.5	Sand, yellow fine micaceous
6	16.0	2.9	Clay, gray silty micaceous; probably grading into Porters Creek clay

J. M. GUNTER PROPERTY

TEST HOLE A178

Location: T.5 S., R.2 E., Sec. 9, SE.1/4 of NW.1/4 (Benton County), about 50 yds. west of hole A169 — Drilled: Aug. 23-24, 1938

Elevation: 15 ft. above A169 — Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.5	3.5	Soil and subsoil, red clay, and silt
2	9.0	5.5	Clay, red silty non-plastic
3	10.0	1.0	Clay, gray silty; yellow streaks
4	12.0	2.0	Clay, dark lignitic plastic; no silt; C1
5	14.0	2.0	Clay, gray plastic slightly silty; C2
6	17.5	3.5	Clay, gray and yellow highly silty
7	18.0	0.5	Clay, gray highly silty; hole closed on rock

National Forest

Test hole A180

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SW.1/4, 440 yds. south of road fork about 0.5 mi. east of Old Ripley-Saulsbury road

Drilled: Aug. 5, 1938

Elevation: About 70 ft. below road fork and about 30 ft. below A111

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox?
1	4.0	4.0	Soil and subsoil, red
2	7.0	3.0	Clay, brownish silty micaceous
			Midway
3	10.6	3.6	Clay, white plastic silty micaceous; C1
4	19.0	8.4	Clay, white silty; yellow streaks; about 6 inches of lignite in white clay at 16 feet; C2
5	21.0	2.0	Sand, yellow; a few thin rock layers
6	23.0	2.0	Clay, Porters Creek

National Forest

Test hole A181

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SW.1/4, near south boundary of section, 122 yds. southwest of hole A180

Drilled: Aug. 8-9, 1938

Elevation: 2 ft. below A180

Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil, yellow sandy
2	5.3	1.3	Clay, black silty fairly plastic
3	8.0	2.7	Clay, light-blue silty; yellow streaks; at 6.4 more yellowish and silty
4	13.2	5.2	Sand, light-yellow fine; lignite at 13.2-14.0
			Midway
5	14.0	0.8	Lignite
6	20.0	6.0	Clay, white plastic pisolitic; C1
7	24.0	4.0	Clay, white and yellow semi-plastic silty rocky; C2
8	30.8	6.8	Clay, white and yellow silty; C3
9	34.0	3.2	Clay, bluish-white silty; hole closed on sand rock; C4

G. L. PEELER PROPERTY

TEST HOLE A182

Location: T.2 S., R.3 E., Sec. 33, NE.1/4 of NW.1/4, near north boundary of section, 129 yds. southwest of hole A181 Drilled: Aug. 16-17, 1938
Elevation: 1 ft. above A181 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	1.5	1.5	Soil and subsoil
2	2.5	1.0	Clay, brown lignitic
3	10.0	7.5	Sand, gray; at 7.0 changes to yellow
4	12.5	2.5	Clay, purple silty micaceous
5	15.5	3.0	Lignite; C1
6	16.6	1.1	Clay, purple plastic micaceous; C2
7	18.6	2.0	Clay, white micaceous; C3
8	28.4	9.8	Clay, silty; yellow and white streaks; C4
9	30.6	2.2	Clay, red sandy micaceous
10	31.6	1.0	Clay, brown sandy
11	34.6	3.0	Clay, white and red silty; hole closed on rock

R. O. PATRICK PROPERTY

TEST HOLE A183

Location: T.2 S., R.3 E., Sec. 33, near north edge of SW.1/4 of SE.1/4, 68 yds. southwest of hole A177 Drilled: Aug. 18, 1938
Elevation: 1 ft. below A177 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.0	1.0	Soil and subsoil, red
2	2.6	1.6	Clay, bluish-white silty
3	12.0	9.4	Clay, yellow silty; streaks of white; C1
4	16.6	4.6	Clay, white and yellow sandy micaceous; C2
5	20.0	3.4	Sand, red
6	21.0	1.0	Clay, probably grading into Porters Creek clay

D. D. HILL PROPERTY

TEST HOLE A184

Location: T.5 S., R.2 E., Sec. 3, NW.1/4 of SE.1/4, about 300 yds. north northwest of hole A69A, and about 275 yds. southwest of an old house place
Drilled: Aug. 23, 1938

Elevation: Not determined Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.6	1.6	Soil and subsoil, red
2	5.0	3.4	Clay, white pisolitic; yellow streaks; C1
3	5.6	0.6	Clay, purple; believed by drillers to be Porters Creek clay, but probably a pottery-type clay grading into the Porters Creek clay

J. C. McELWAIN PROPERTY

TEST HOLE A188

Location: T.3 S., R.3 E., Sec. 10, near center of NW.1/4, about 175 yds. east of road fork, which is about 100 yds. east of Mr. McElwain's west boundary, and about 125 yds. north of hole A171 Drilled: Aug. 30, 1938

Elevation: About 40 ft. below road fork Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	1.5	1.5	Soil and subsoil, clay and sand
2	6.5	5.0	Clay, light-gray slightly silty; C1
3	10.4	3.9	Clay, white highly silty; C2
4	11.2	0.8	Clay, gray micaceous; red sandy streaks
5	12.0	0.8	Sand, red; streaks of clay
6	12.6	0.6	Clay, Porters Creek

NATIONAL FOREST

TEST HOLE A195

Location: T.2 S., R.3 E., Sec. 28, SE.1/4 of SW.1/4, near south boundary of section, 95 yds. north of hole A182 Drilled: Aug. 16-17, 1938
Elevation: 1 ft. above A182 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.0	3.0	Soil and subsoil, red
2	7.0	4.0	Clay, gray silty; yellow streaks; at 5.0 becomes more yellow
3	9.0	2.0	Sand; mixed colors
4	10.0	1.0	Clay, blue highly silty
			Midway
5	11.0	1.0	Clay, brown lignitic
6	13.0	2.0	Clay, white silty semi-plastic; C1
7	18.0	5.0	Clay, yellow silty; hole closed on rock

NATIONAL FOREST

TEST HOLE A196

Location: T.2 S., R.3 E., Sec. 28, SW.1/4 of SE.1/4, 137 yds. northwest of hole A121 Drilled: Aug. 15-16, 1938
Elevation: 3 ft. below A121 and 18 ft. below A111 Water level: 11.0 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Recent colluvium
1	6.0	6.0	Soil and subsoil, red
2	16.0	10.0	Sand, coarse; mixed colors
			Midway
3	21.3	5.3	Clay, white silty plastic; C1
4	24.0	2.7	Clay, blue arenaceous micaceous plastic; probably grading into Porters Creek clay

R. O. PATRICK PROPERTY

TEST HOLE A197

Location: T.2 S., R.3 E., Sec. 33, near north edge of SW.1/4 of SE.1/4, 100 yds. west of hole A183 Drilled: Aug. 18, 1938

Elevation: 2 ft. above A183 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox?
1	2.0	2.0	Soil and subsoil, red
2	6.0	4.0	Sand, fine; mixed colors
3	7.0	1.0	Clay, blue silty semi-plastic; yellow streaks
			Midway
4	8.0	1.0	Clay, bluish semi-plastic; lignite streaks
5	10.0	2.0	Clay, white semi-plastic slightly micaceous; very little silt; a few yellow streaks; C1
6	17.0	7.0	Clay, white and yellow silty micaceous; C2

J. M. GUNTER PROPERTY

TEST HOLE A198

Location: T.5 S., R.2 E., Sec. 9, SW.1/4 of NW.1/4 (Benton County), about 400 ft. west of hole A200 Drilled: Aug. 23-24, 1938

Elevation: 25 ft. above A200 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.0	2.0	Soil and subsoil, clay and sand, gray
2	7.0	5.0	Clay, blue slightly silty semi-plastic; C1
3	12.0	5.0	Clay, blue highly silty semi-plastic; C2
4	18.9	6.9	Sand, gray fine-grained
			Midway
5	24.0	5.1	Clay, gray, yellowish arenaceous plastic; C3
6	26.1	2.1	Clay, bluish-gray arenaceous plastic; no mica; C4
7	27.5	1.4	Clay, gray very silty semi-plastic micaceous; purple streaks; C5
8	30.3	2.8	Clay, bluish-gray very silty slightly micaceous semi-plastic; C6
9	31.8	1.5	Sand, gray argillaceous medium-fine to coarse
10	32.6	0.8	Clay, dark-blue arenaceous, micaceous semi-plastic; probably grading into Porters Creek clay

J. M. GUNTER PROPERTY

TEST HOLE A200

Location: T.5 S., R.2 E., Sec. 9, SW.1/4 of NW.1/4 (Benton County), about 200 yds. northwest of the Gunter house Drilled: Aug. 10-11, 1938

Elevation: 14 ft. below house and about 25 ft. below A8 Water level: 20.5 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Recent colluvium
1	3.0	3.0	Soil and subsoil, yellow
2	5.9	2.9	Sand, yellow argillaceous
			Midway
3	15.9	10.0	Clay, white; very little silt; P1
4	17.0	1.1	Clay, yellow and blue silty; P2
5	19.6	2.6	Clay, white; streaks of lignite; P3
6	21.8	2.2	Clay, yellow rocky; P4
7	25.6	3.8	Clay, blue silty plastic; smaller sample because of rock which could not be penetrated by 9-inch auger but was penetrated by 4-inch auger; C1
8	26.2	0.6	Clay, dark-blue highly silty micaceous; C2

Remarks: 0 to 8.0 ft. was a 9-inch auger hole on hill above creek bank where clay is exposed. 8.0-14.0 ft. taken from trench on creek bank; 14.0-15.9 ft. from 9-inch hole at foot of trench; 15.9-21.8 ft. from 9-inch hole on creek bank; 21.8-26.2 ft. from 4-inch hole in bottom of 9-inch hole.

JIM HILL PROPERTY

TEST HOLE A201

Location: T.5 S., R.2 E., Sec. 9, SE.1/4 of NW1/4 (Benton County), about 200 yds. N. 30° E. of the Gunter house, 72 ft. north of outcrop of white clay in stream ditch Drilled: Aug. 25, 1938

Elevation: 8 ft. above outcrop of white clay Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil, clay and sand, red and gray
2	5.9	1.9	Clay, gray and yellow very silty semi-plastic
3	8.8	2.9	Clay, gray and yellow arenaceous plastic; a few lignitic streaks
			Midway
4	12.5	3.7	Clay, white plastic; very little silt; no mica; C1
5	14.0	1.5	Clay, white; very little silt; yellow streaks; no mica; a few lignitic streaks; C2
6	14.9	0.9	Clay, mottled gray and yellow; a few small rocks, probably iron carbonate rocks; C3
7	15.3	0.4	Rock, ferruginous; probably iron carbonate
8	16.2	0.9	Clay, yellowish-gray plastic very silty; a few small ferruginous rocks; hole closed on a rock

J. C. McElwain property

Test hole A203

Location: T.3 S., R.3 E., Sec. 10, SW.1/4 of NW.1/4, about 100 yds. east of Mr. McElwain's west boundary, and about 200 yds. south of road fork which is also about 100 yds. east of Mr. McElwain's west boundary, in a small gully just above place strewn with bauxite pisolites

Drilled: Aug. 30-31, 1938

Elevation: About 30 ft. below road fork   Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.0	4.0	Clay, yellow pisolitic; C1
2	7.0	3.0	Clay, pisolitic; more yellow in color; C2
3	9.0	2.0	Clay, yellow and blue sandy
4	10.5	1.5	Clay, yellow and purple fairly plastic; C3
5	12.0	1.5	Clay, white; C4
6	14.5	2.5	Clay, white silty micaceous; C5
7	16.0	1.5	Clay, brown sandy; white streaks
8	19.0	3.0	Clay, Porters Creek

H. E. Finger, Attorney-in-fact, property

Test hole A212

Location: T.3 S., R.3 E., Sec. 28, NW.1/4 of SW.1/4, 186 yds. southeast of house, 10 ft. southwest of gully   Drilled: Sept. 1, 1938

Elevation: 10 ft. below house   Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Porters Creek Clay
1	2.0	2.0	Soil and subsoil, sandy
2	5.5	3.5	Clay, brown; streaks of yellow sand; C1
3	10.8	5.3	Clay, dark-gray; some streaks of yellow; C2
4	11.5	0.7	Clay, glauconitic silty
			Bentonite taken from a shovel hole near bottom of ditch, and equivalent to 5.5-8.5 in auger hole; this material, when fresh, has a much waxier, more bentonitic appearence than the material from auger hole; C3

Remarks: This hole is about 10 ft. southwest of gully where a 3-foot exposure of bentonitic material commences about 5.5 feet below top of hole A212.

J. E. HUDDLESTON

TEST HOLE A216

Location: T.3 S., R.3 E., Sec. 29, NE.1/4 of NE.1/4, on ditch bank on edge of orchard, about 600 ft. northwest of house Drilled: Sept. 1, 1938

Elevation: 10 ft. above bottom of ditch Water level: 18.7 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Porters Creek clay
1	4.0	4.0	Soil and subsoil, gray
2	10.3	6.3	Clay, gray and yellow silty
3	26.0	15.7	Clay, gray non-plastic; C1

Remarks: Considerable Porters Creek clay exposed in stream banks near here, where trench sample (T) was taken, 2.0-10.0 ft.

E. P. BARBER PROPERTY

TEST HOLE A219

Location: T.4 S., R.2 E., Sec. 11, SW.1/4, 78 yds. southeast of house Drilled: Sept. 26, 1938

Elevation: 22 ft. below house Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	5.0	5.0	Sand
2	9.2	4.2	Clay, white and yellow silty; changes gradually to a reddish color; C1
3	11.8	2.6	Clay, white highly silty; some mica

Remarks: Hole closed on rock. Porters Creek clay believed to be under rock as it shows in ditch below hole.

J. S. PEARCE PROPERTY

TEST HOLE A220

Location: T.4 S., R.3 E., Sec. 6, NE.1/4 of SW.1/4, from ditch bank Collected: Sept. 30, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	8.0	8.0	Clay, red highly silty; C1
2	18.0	10.0	Clay, sandy white; yellow streaks; C2

Remarks: Trench sample from a stream ditch in an open field.

W. T. MEADOWS PROPERTY

TEST HOLE A225

Location: T.3 S., R.2 E., Sec. 36, SE.1/4, in ravine about 200 yds. northeast of the Meadows residence Collected: Aug. 19-22, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	39.6	39.6	Bauxitic material; P1
2	56.9	17.3	Bauxitic material; P2
3	66.9	10.0	Bauxitic material; hole closed on rock which auger would not penetrate; P3

Remarks: Upper 39.6 ft. from trench on south side of ravine; next 17.3 ft. from face of vertical bluff; lowest 10.0 ft. from auger hole near stream bed. Judging from appearance of road, there may be about 5.0 ft. more bauxite above sample.

J. M. GUNTER PROPERTY

TEST HOLE A234

Location: T.5 S., R.2 E., Sec. 9, SW.1/4 of NW.1/4 (Benton County), 117 yds. south of hole A200 Drilled: Sept. 6-7, 1938

Elevation: 5.5 ft. above A200 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	1.5	1.5	Soil and subsoil, red sand
2	4.0	2.5	Sand and sand rock, red
3	6.2	2.2	Clay, yellow silty; blue streaks; C1
4	8.5	2.3	Clay, white; laminae of yellow sand rocks
5	9.5	1.0	Clay, blue and purple silty lignitic
6	10.0	0.5	Sand, yellow and white
7	11.0	1.0	Sand, white
			Midway
8	21.9	10.9	Clay, white; very little mica; no silt; C2
9	23.2	1.3	Clay, white; some coarse sand; C3
10	26.5	3.3	Clay, blue very silty; C4
11	29.5	3.0	Sand, gray very fine
12	30.0	0.5	Clay, probably grading into Porters Creek clay

Remarks: Sample C1 discarded as it did not appear worth testing.

E. M. HARDIN PROPERTY

TEST HOLE A252

Location: T.4 S., R.2 E., Sec. 35, NW.1/4 of NE.1/4, on top of hill about 800 ft. N. 10° W. of junction of poor road with Macedonia road, 3.0 mi. northwest of Blue Mountain Collected: Sept. 9-13, 1938

Elevation: About 40 ft. above road junction Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.0	4.0	Bauxite, yellowish-gray crumbly; P1
2	8.0	4.0	Bauxite, yellowish-gray and red friable; bottom of pit was red clay and rock; P2

Remarks: These samples are from a pit on top of a small bauxite-strewn knoll.

E. M. HARDIN PROPERTY

TEST HOLE A255

Location: T.5 S., R.2 E., Sec. 9, SW.1/4 of SE.1/4 (Benton County), in ditch on south side of road 200 yds. northeast of Flat Rock Church

Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	5.5	5.5	Clay, gray silty plastic; C1
2	11.0	5.5	Clay, gray silty plastic; C2
3	16.5	5.5	Clay, gray silty plastic; C3

Remarks: Thicknesses are measured from bottom of ditch.

W. R. HILL ESTATE

TEST HOLE A256

Location: T.4 S., R.4 E., Sec. 7, NE.1/4 of SE.1/4, on wall of Owl Creek 350 yds. N. 60° E. of house Collected: Sept. 23, 1938

No.	Depth	Thick.	Description of strata and designations of samples
1	24.5	24.5	Owl Creek marl from creek bank; C1
2	26.5	2.0	Owl Creek marl from auger hole in stream bed; C1

Remarks: Samples taken from the steep bluff at the type locality of the Owl Creek formation.

J. L. REED PROPERTY

TEST HOLE A257

Location: T.3 S., R.4 E., Sec. 7, NE.1/4, from cut on north side of road about 1 mi. east of Falkner Collected: Sept. 26, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Clayton formation
1	2.5	2.5	Material overlying the marl; many shells; C1
2	4.0	1.5	Marl, very fossiliferous; many phosphatic nodules; C2
3	5.5	1.5	Material below the marl; C3

Remarks: Same material, from nearby places, is said to have been used successfully as a fertilizer.

A. M. YOUNG PROPERTY

TEST HOLE A260

Location: T.4 S., R.3 E., Sec. 18, SE.1/4, from ditch and bank on south side of Highway 4, about 4 mi. west of Ripley, on the east wall of Tippah Creek Collected: Sept. 14, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Porters Creek clay
1	19.3	19.3	Clay; C1
2	35.8	16.5	Clay; C2
3	51.0	15.2	Clay; C3

PAUL RAINEY ESTATE

TEST HOLE A261

Location: T.5 S., R.3 E., Sec. 19, NE.1/4, from ditch on west side of Highway 15 about 2.5 mi. south of Blue Mountain Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
1	4.5	4.5	Porters Creek clay; basal phase; somewhat bentonitic in appearance; C1
2	7.5	3.0	Porters Creek clay; basal phase; somewhat bentonitic in appearance; C2

Town of Blue Mountain

Test hole A262

Location: T.5 S., R.2 E., Sec. 7, north edge of NW.1/4 of NE.1/4, on south side of Main, or "Soapstone," Street, about 150 yds. east of Highway 15
Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
1	24.0	24.0	Porters Creek clay; C1
2	34.0	10.0	Porters Creek clay; C3
3	39.0	5.0	Porters Creek clay, glauconitic and sandy; probably a southern continuation of the Tippah Sand member; C2
4	47.0	8.0	Porters Creek clay; C3

Remarks: Samples obtained from ditch banks, except C2 which, because of poor exposure, was obtained from an auger hole. C3, unfortunately, collected from above and below C2, so not used in the laboratory tests.

S. W. Jackson property

Test hole A263

Location: T.5 S., R.2 E., Sec. 16, NE.1/4 (Benton County), in long ditch southeast of the Jackson house, and about 300 yds. southeast of a T V A power line
Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
			Porters Creek clay, laminated upper phase
1	10.5	10.5	Clay, black laminated; C1
2	23.0	12.5	Clay, black laminated; C2

Remarks: Samples collected from the ditch bank over a distance of about 300 yds. Thicknesses are measured from lower part.

Kate Davis property

Test hole A264

Location: T.4 S., R.3 E., Sec. 4, SW.1/4 of SW.1/4, on steep east wall of Tippah Creek
Collected: Sept. 21, 1938

No.	Depth	Thick.	Description of strata and designations of samples
1	25.0	25.0	Porters Creek clay; C1
2	52.0	27.0	Porters Creek clay; C2

Remarks: Samples taken from a 52-foot bluff from which clay has been previously obtained. Thicknesses are measured from the bottom of the bluff.

W. D. SHELTON PROPERTY

TEST HOLE A310

Location: T.3 S., R.3 E., Sec. 17, near center of SE.1/4, 350 ft. north of spring northwest of the Shelton house Drilled: Nov. 29, 1938

Elevation: 6 ft. below the spring Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	1.5	1.5	Soil, yellow sandy
2	8.6	7.1	Sand, yellow fine-grained; very little clay; slightly micaceous toward bottom
3	10.0	1.4	Clay, yellow and white laminated gritty
			Midway
4	13.4	3.4	Ocher, yellow gritty; somewhat darker toward bottom; at 11.6 a thin seam of white clay; C1
5	13.8	0.4	Clay, white

W. D. SHELTON PROPERTY

TEST HOLE A311

Location: T.3 S., R.3 E., Sec. 17, near boundary of NE.1/4 and NW.1/4, 800 ft. north of hole A310 Drilled: Nov. 29, 1938

Elevation: 8 ft. above A310 Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	5.4	5.4	Soil; yellow sand; at 4.8 thin rock laminae
			Midway
2	8.3	2.9	Ocher; a little white gritty clay at top; sample taken from 5.4-7.4 with 4-inch auger, remainder drilled with 2-inch auger but not sampled; C1
3	8.7	0.4	Clay, white

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TIPPAH COUNTY MINERAL RESOURCES

TESTS

THOMAS EDWIN McCUTCHEON, B.S., Cer.

INTRODUCTION

The clays of northeast Mississippi which include those of Tippah County have been referred to by a number of geologic writers in several publications of the Mississippi Geological Survey. Information relative to these clays, prior to the 1938-39 survey, has been of a rather general nature with conclusions drawn from information obtained at a few localities and from incomplete tests on grab samples which may or may not have been representative of the deposit or stratum under consideration. Previous information regarding a few of the many deposits in Tippah County does not take into consideration the stratigraphic position of the beds in relation to overlying and underlying beds, differences in characteristics and properties of the beds at different localities, and the economic possibilities of individual and composite strata.

In the present study, localities from which a number of samples were obtained have been separated into regions, hereafter referred to as Region A, Region B, Region C, etc. Though clays from different regions or localities are in a general sense very similar within their stratigraphic positions, the sequence of beds may not be consistent. Beds of certain clays may be thicker in one region than in another or may be missing entirely. Other beds of similar clays may be easily accessible in one region but covered with a prohibitive amount of overburden in another. Consequently, possibilities for development of certain clays may be more promising in one region than in another. The establishment of regions is purely geographic and was done to aid in the presentation of the results of tests and studies in a comprehensive manner.

A correlation of the clays from the several regions has been effected through a classification of all the clays tested. The classification is according to type of clay, uses, and accessory minerals. In a general sense the classification of the clays is relative to their stratigraphic position; however, in numerous instances accessory minerals are present in sufficient quantities to change the characteristics of the clay to such an extent that in the established classification these samples may not bear the general stratigraphic relation. Frequent reference should be made to the test hole drill record when reading this report.

RELATION BETWEEN STRATIGRAPHY AND CLASSIFICATION OF CLAYS

Although approximately 165 different samples of clay have been tested, there are only three distinct types represented. They are: (1) kaolinitic clays; (2) pottery clays; and (3) Porters Creek clays. These distinct types are available in very pure deposits, in deposits that seem to be gradational, and in deposits contaminated with sand, silt, lignite, limonite, limonitic sandstone, gypsum, ferro-manganese minerals, and muscovite. The accessory minerals may be present alone or in combination. The quantity varies from a trace to as much as 50 percent. Thus, it is readily seen that a great number of clays are possible which not only exhibit properties common to their distinct type but also exhibit properties influenced by the kinds and amounts of accessory minerals present. The numerous samples tested have been classified in order to clarify the wide variety of clays available.

Other than the three distinct types of clays mentioned above, brick and tile clays are in abundance but are not considered a distinct type of clay for they consist essentially of one or more of the above mentioned types with sufficient quantities and kinds of accessory minerals to make them suitable for use in heavy clay products.

Contamination within limits is not necessarily detrimental, in fact the usefulness of the clay with respect to heavy clay products such as brick, structural tile and hollow block, is dependent on the amount and kinds of accessory minerals present, for it is these that determine economical firing temperatures, adequate maturing ranges, desirable colors and textures, and suitable working properties. On the other hand, the value of clays suited for white ware, high grade refractories, fine pottery, paper filler, and pigments is dependent on the purity of the clay.

The kaolinitic clays have been divided into two groups. The division is due to the physical condition of the raw clays. The first group is the hard coarse-grained pisolitic non-slaking variety, and the second is soft fine-grained and completely slaking. Chemical analyses, thermal dehydration curves, and pyrometric properties of the two groups are comparable. Physical properties in the unburned state are distinctive. The two types of kaolin seem to be at the same stratigraphic horizon. They have been found separately in different test holes and both in the same test hole, the soft kaolin being below the hard kaolin, nowhere above. Fine-grained light burning clays are found both above (A121 6-10.3) and considerably below (A200 C2.) the hard coarse-grained kaolins, but they are the pottery clays

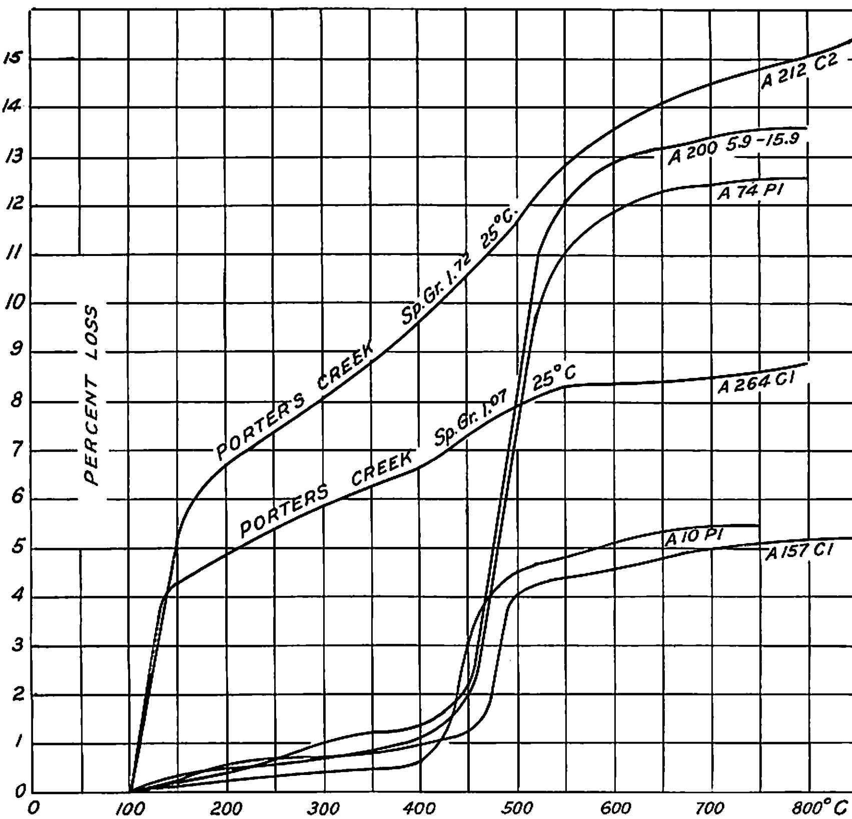

Figure 17.—Thermal dehydration curves of typical clays.

and are distinctly different from the soft fine-grained kaolins. The hard kaolins contain scattered pisolites and have been referred to by some writers as bauxite or bauxitic clays. They undoubtedly contain a small amount of hydrated alumina but not necessarily more than the soft fine-grained kaolins or pottery clays. It seems proper for the clay to be referred to as pisolitic but not bauxitic. Thermal dehydration curves of these clays show that nearly all of the water of crystallization is lost between 450° C. and 550° C. which is typical of a true kaolin. Most of the water of hydration of bauxite (gibbsite) is lost between 200° C. and 300° C. and that of diaspore, very abruptly at about 475° C.

Where the hard kaolin is near the surface and is not exposed, it is overlain by a few feet of sand or soil or both. When deeper, it is overlain by sand, or by sandy clays of the pottery type, or by lignitic clays. Where the strata above are of sufficient thickness, lignite or lignitic clays are usually present. Immediately below the hard kaolin is a concentration of ferruginous material, either grading upward where tight-bodied, impervious clays are immediately below or grading downward where micaceous, sandy or silty clays are present. At some test holes (A101) the gradation from hard kaolin to soft kaolin is continuous with the concentration of ferruginous material below. The same conditions are prevalent in regard to the fine-grained soft kaolins except that they seem to be more closely associated with lignite and lignitic clays. The soft kaolins grade downward into ferruginous, micaceous, sandy or silty clays of the brick and tile type or into tough plastic micaceous pottery clays. Some of the soft kaolins are obviously micaceous (A101 P2) and show less tendency toward cracking during burning.

The pottery clays are found above and below the kaolin horizon. Those above are generally associated with sand (A121 6-10.3) and lignite (A155 2.3-8.9) and in a few instances are contaminated with gypsum (A178 C1-C2, A198 C1-2). Stratigraphically these clays are the highest in the county. Those below the kaolin horizon are essentially micaceous and are of better quality than the pottery clays above. They are light to gray burning and the purer varieties are somewhat translucent and break with a porcelain fracture. Though the clays have an alumina-silica ratio of about 1 to 5, the high silica content is evidently due to a very finely divided mica-like mineral rather than to sand or silt (A157 C1, A203 C4-5, A51 C1-C2, A173 C3, A175 C1-C2).

An analysis of the mica-like material (plus a small amount of contamination) separated from clay (A101 P2) is as follows:

Residue From Sample A101 P2 Washed Through No. 60 Mesh Screen and Caught on No. 100 Mesh Screen

Ignition loss	3.89	Lime CaO	1.50
Silica SiO_2	73.47	Magnesia MgO	0.21
Alumina Al_2O_3	18.06	Potash K_2O	1.20
Iron Oxide Fe_2O_3	0.10	Soda Na_2O	0.04
Titania TiO_2	0.38		

Silica, as in finely divided mica, is one of the most desirable ways in which it could be introduced into a pottery body, for in such a state it does not expand and contract as much as an equivalent amount of silica in the form of quartz, flint, or silt when subjected to the heating and cooling cycles of burning and to thermal shock at lower temperatures; consequently, these clays are especially suitable for pottery dishes, oven ware, and other wares that are subjected to thermal shock.

The brick and tile clays, being impure varieties of other distinct types, are found at several stratigraphic horizons. The clays listed under "Brick and Tile Clays" in the accompanying classification do not include all of the clays and combinations of clays that are suitable. Most of the composite samples, listed under section No. 7, are suited for brick and tile; combinations of clays from other test holes are suitable; and some of the clays of the pottery type that have the lowest quality rating are suitable. In every region brick and tile clays are abundant.

Clays of the Porters Creek formation are at the lowest stratigraphic position relative to the other clays of the county. Conant* describes the formation as consisting of three phases: a basal glauconitic phase, the middle or typical phase, and an upper laminated silty micaceous phase. He states that the lower phase, which is tougher than the others and is somewhat bentonitic, is probably about fifty feet thick and grades upward into the typical massive gray-black clay which makes up the greater part of the formation. Above this is a strongly laminated silty micaceous clay which is present only locally, probably because it was removed by erosion which preceded the deposition of the Wilcox sediments.

Different samples of the same phase of the Porters Creek clay are remarkably uniform in both their physical and pyrometric prop-

* Conant, L. C., Observations on the Midway group: Jour. Mississippi Acad. Sci., p. 7, 1939.

erties. Clays of the different phases are distinctly different in all of their physical properties, in fact so different that it does not seem plausible that they would be from the same formation. The color of the clays is about their only common likeness. They may be readily distinguished from one another by their bulk specific gravity, the upper phase being 1.49-1.51, the middle phase 1.00-1.30, and the lower phase 1.72-1.81.

CLASSIFICATION OF CLAYS AND MINERALS

GENERAL

In the tables listing Physical Properties in the Unburned State of the clays in each region and under the heading, Type of Clay, is a classification number for each sample tested. The classification number refers to: (1) the general classification of clays in which is given a brief description of the clays, the group of clays within the particular classification, the thickness of the strata, a cross reference referring to region location, and a quality rating for each clay; (2) the section of this report on Possibilities for Utilization where a more detailed description of the clays is given.

The quality rating is based on the suitability of the clay for the use recommended. A quality rating of 1 indicates the best clay under a particular classification, and all clays within the classification having the same quality rating are comparable. A quality rating of 4 indicates the least desirable clay within the group. Clays of low quality rating in one classification would likely have a higher quality rating if placed in another group. For example, clays in the pottery classification contaminated with sand or ferruginous material would have a low quality rating for pottery but a higher rating if placed in the brick and tile group (A121 6-10.3).

CLASSIFICATION

1

KAOLINITIC CLAYS

Refractory coarse-grained white to light burning, containing hard non-slaking kaolin nodules and pisolites. Not overburned at cone 18.

A. CONTAINING LESS THAN 5 PERCENT ACCESSORY MINERAL AGGREGATES

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A8	0-3	3.0	1	A
A73	C 1	1.8	1	C
A74	P 1	6.5	1	B
A81	C 1	2.1	4	C
A81	C 2	2.8	2	C
A82	C 1	9.2	3	C
A87	4.9-12	7.1	3	C
A101	P 1	9.0	2	F
A121	10.3-15	4.7	1	E
A155	8.9-14	5.1	1	E
A181	C 1	6.0	1	D
A188	C 1	5.0	2	G
A200	5.9-15.9	10.0	1	A
A200	15.9-19.6	3.7	3	A
A234	C 2	10.9	3	A

B. CONTAINING AN APPRECIABLE AMOUNT OF QUARTZ SAND

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A184	C 1	3.4	1	C

C. CONTAINING AN APPRECIABLE AMOUNT OF QUARTZ SAND AND FERRO-MANGANESE MINERALS

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A45	C 1	17.0	1	B

2

KAOLINITIC CLAYS

Refractory fine-grained soft white to light burning, completely slaking. Not overburned at cone 18.

A. CONTAINING LESS THAN 5 PERCENT ACCESSORY MINERAL AGGREGATES

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A8	10-17	7.0	4	A
A24	C 1	9.4	1	B
A24	C 2	4.2	1	B
A69A	P 1	11.0	2	C
A70	P 1	13.3	2	C
A70	C 1	1.3	4	C
A74	C 1	2.5	1	B
A96	C 1	9.2	3	C
A96	C 2	3.2	3	C
A102A	C 1	4.7	2	F
A102	C 3	4.7	2	F
A107	C 1	2.8	2	F
A107	C 2	8.0	2	F
A111	C 1	11.0	2	F
A129A	C 1	9.3	2	F
A129	C 1	2.0	2	F
A129	C 2	6.6	2	F
A131	C 3	5.0	2	F
A137	C 1	8.1	2	E
A168	C 2	5.0	2	A
A171	C 1	3.8	2	G
A180	C 1	3.6	2	D
A182	C 2-3	3.1	2	D
A195	C 1	2.0	3	D
A201	C 1	3.7	2	A
A201	C 2	1.5	4	A

B. Containing an appreciable amount of quartz sand

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A24	C 3	6.7	1	B
A69A	P 2-3	1.8	3	C
A96	C 3	4.6	3	C
A150	C 2	1.8	3	F
A150	C 3	8.5	2	F
A150	C 4	1.8	2	F
A162	C 1	6.5	3	E
A188	C 2	3.9	1	G
A196	C 1	5.3	2	E
A220	C 2	10.0	1	H

C. Containing an appreciable amount of muscovite mica and quartz sand

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A70	C 2	2.8	1	C
A101	P 2	3.0	1	F
A129	C 3	5.4	1	F
A136	C 1	2.4	1	F
A161	C 1	8.8	1	E
A169	C 3	2.3	1	A
A172	C 2	4.4	1	E
A197	C 1	2.0	1	G
A219	C 1	4.2	1	H

3

POTTERY CLAYS

Fine-grained cream and buff to gray burning, overburning at cones 13-18

A. Attains vitrification before overburning

1. Steel hard cones 1-3

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A102	C 1-2	2.9	2	F
A157	C 1	8.0	1	E
A175	C 3	4.3	3	D
A175	C 4	4.0	3	D
A178	C 1	2.0	4	A
A178	C 2	2.0	4	A
A198	C 1-2	10.0	4	A

2. Steel hard cones 5-7

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A50	0.5-14.0	13.5	3	A
A51	C 1	5.6	1	A
A51	C 2	2.4	2	A
A55	C 1	7.1	1	A
A121	6-10.3	4.3	3	E
A155	2.3-8.9	6.6	3	E
A173	C 3	6.2	1	D
A173	C 4	9.6	3	D
A175	C 1	4.5	2	D
A175	C 2	6.1	2	D
A203	C 4-5	4.0	1	G
A255	0.0-16.5	16.5	3	A

B. LESS VITREOUS BEFORE OVERBURNING THAN 3A, SLIGHTLY SILTY, STEEL HARD AT CONES 7-11

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A8	17.0-19.0	2.0	2	A
A10	P 1	9.1	2	A
A10	C 1	3.0	2	A
A28	C 1	5.0	2	B
A29	C 2	2.5	2	B
A51	C 4	4.5	2	A
A150	C 1	3.0	3	F
A172	C 1	7.2	3	E
A173	C 1	5.7	3	D
A200	C 2	0.6	1	A

C. CONTAINING AN APPRECIABLE AMOUNT OF LIGNITE

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A51	C 3	3.2	4	A

4

BRICK AND TILE CLAYS

Silty ferruginous and micaceous

A. Cream and buff to brown burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A29	C 1	3.4	2	B
A87	20.4-23.0	2.6	1	C
A101	14.0-21.5	7.5	2	F
A121	15.0-21.0	6.0	1	E
A155	14.0-21.9	7.9	2	E
A180	C 2	8.4	1	D

B. Cream to gray burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A73	C 3	11.0	1	C
A129	C 4	2.0	1	F
A161	C 2	4.4	1	E
A162	C 3	3.4	1	E
A181	C 4	3.2	1	D
A198	C 4-5-6	6.3	2	A
A200	C 1	3.8	2	A

C. Buff to red and brown burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A102	C 4	4.2	2	F
A162	C 2	3.0	1	E
A163	C 1	12.0	1	E
A177	C 1	4.1	2	G
A177	C 2	3.3	1	G
A181	C 2-3	10.8	2	D
A182	C 4	9.8	2	D
A183	C 2	4.6	1	G
A197	C 2	7.0	1	G

5

BRICK AND TILE CLAYS

Silty and ferruginous

A. Cream to gray burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A10	P 2	12.9	2	A
A50	14.0-27.0	13.0	1	A
A51	C 5	10.6	1	A

B. Buff to red and brown burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A46	P 1	9.0	1	B
A168	C 3	6.6	2	A
A169	C 2	4.5	2	A
A171	C 3	2.8	2	G
A183	C 1	9.4	3	G
A198	C 3	5.1	3	A
A201	C 3	0.9	2	A
A220	C 1	8.0	1	H

6

HIGHLY FERRUGINOUS CLAYS

Overburn before attaining maturity, of little economic value

A. Gray and buff to brown burning

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A8	3.0-10.0	7.0	4	A
A73	C 2	7.9	4	C
A82	C 2	2.5	4	C
A87	12.0-20.4	8.4	3	C
A169	C 1	3.7	4	A
A171	C 2	4.2	4	G
A200	P 4	2.2	4	A
A203	C 1-2	7.0	4	G

7

CLAYS OF COMPOSITE SAMPLES

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A87	4.9-23.0	18.1	3	C
A121	6.0-21.0	15.0	1	E
A125	0.8-24.0	23.2	1	F
A155	2.3-21.9	19.6	1	E
A171	4.2-34.0	29.8	4	G
A200	5.9-21.8	15.9	3	A

8

CLAYS GRADING INTO THE PORTERS CREEK FORMATION

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A50	P 10	1.4	1	A
A66 (?)	3.8-12.2	8.4	4	A
A171	C 4	2.3	4	G

9

CLAYS OF THE PORTERS CREEK FORMATION

A. Upper phase, bulk specific gravity 1.49-1.51

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A263	C 1	10.5	3	See log
A263	C 2	12.5	3	See log

B. Middle phase, bulk specific gravity 1.00-1.30

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A165	C 1	5.5	2	See log
A165	C 2	6.5	2	See log
A260	C 2	16.5	1	See log
A260	C 3	15.2	1	See log
A261	C 1	4.5	2	See log
A261	C 2	3.0	2	See log
A262	C 1	24.0	2	See log
A264	C 1	25.0	1	See log
A264	C 2	27.0	1	See log

C. LOWER PHASE, BULK SPECIFIC GRAVITY 1.72-1.81

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A171	C 5	16.7	4	G
A212	C 1	3.5	4	See log
A212	C 2	5.3	4	See log
A216	T	8.0	4	See log

10

BAUXITE

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A225	P 1	39.6	1	See log
A225	P 2	17.3	2	See log
A225	P 3	10.1	3	See log
A252	P 1	4.0	4	See log
A252	P 2	4.0	4	See log

11

MARL

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A256	C 1	26.5	4	See log
A257	C 1-2-3	5.5	4	See log

12

OCHER

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A310	C 1	3.4	2	See log
A311	C 1	2.9	2	See log

13

SAND

Hole No.	Sample No.	Thickness Feet	Relative Quality	Location Region
A113	C 1	20.7	2	See log
A117	P 1	18.5	2	See log

LABORATORY TESTS OF CLAYS AND MINERALS

REGION A

Region A is in Benton and Tippah Counties, within T.5 S., R.2 E., Secs. 9 and 16 of Benton County and T.5 S., R.2 E., Sec. 10 of Tippah County. Samples were secured from the properties of J. M. Gunter, the Salvation Army, Jim Hill, S. W. Jackson, C. M. Hardin, and the Bank of Ripley & G. A. Hazard. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A8	.0-3.0	1A	32.13	7.46	2.57	Fine, open	Cream
A8	3.0-10.0	6A	35.46	11.02	3.85	Fine, open	Yellow
A8	10.0-17.0	2A	27.10	5.93	2.04	Fine, open	Lt. gray
A8	17.0-19.0	3B	26.39	20.58	7.40	Fine, dense	Dk. gray
A168	C2	2A	N. D.	7.32	2.53	Fine, open	Cream
A168	C3	5B	32.97	32.71	4.83	Fine, open	Yellow
A169	C1	6A	32.53	14.61	5.16	Fine, open	Yellow
A169	C2	5B	31.38	15.45	5.46	Fine, open	Yellow
A169	C3	2C	23.34	11.46	3.99	Fine, open	Lt. gray
A178	C1	3A1	40.43	35.78	13.73	Fine, dense	Gray
A178	C2	3A1	32.98	31.59	11.89	Fine, dense	Gray
A198	C1-2	3A1	33.04	32.06	12.11	Fine, dense	Gray
A198	C3	5B	31.10	13.85	4.87	Fine, open	Yellow
A198	C4-5-6	4B	28.03	20.13	7.25	Fine, open	Lt. gray
A200	5.9-15.9	1A	34.12	10.26	3.56	Fine, open	Cream
A200	15.9-19.6	1A	32.56	6.18	2.11	Fine, open	Cream
A200	P4	6A	34.04	17.09	6.06	Fine, open	Yellow
A200	C1	4B	27.62	18.82	6.74	Fine, open	Yellow
A200	C2	3B	26.19	18.81	6.74	Fine, dense	Gray
A200	5.9-21.8	7	36.17	12.37	4.32	Fine, open	Cream
A201	C1	2A	30.96	17.49	6.21	Fine, open	Cream
A201	C2	2A	31.31	12.22	4.28	Fine, open	Yellow
A201	C3	5B	31.69	13.62	4.79	Fine, open	Yellow
A234	C2	1A	29.13	8.75	3.02	Fine, open	Cream
A10	P1	3B	25.30	14.11	4.98	Fine, open	Lt. gray
A10	C1	3B	24.81	17.23	6.14	Fine, open	Gray
A10	P2	5A	31.95	29.85	11.17	Fine, open	Gray
A50	0.5-14.0	3A2	24.38	19.76	7.09	Fine, open	Lt. gray
A50	14.0-27.0	5A	28.87	26.16	9.63	Fine, open	Gray
A50	P10	8	25.81	25.85	9.51	Fine, dense	Dk. gray
A255	.0-16.5	3A2	27.58	28.93	10.79	Fine, open	Lt. gray
A51	C1	3A2	29.75	12.69	4.43	Fine, open	Lt. gray
A51	C2	3A2	34.94	19.60	7.01	Fine, open	Gray
A51	C3	3C	42.67	14.63	5.16	Fine, open	Dark Brown
A51	C4	3B	28.03	25.02	9.18	Fine, dense	Gray
A51	C5	5A	26.58	14.36	5.05	Fine, open	Gray
A55	C1	3A2	27.48	15.45	5.46	Fine, open	Lt. gray
A66	3.8-12.2	8	32.50	38.52	15.01	Fine, dense	Lt. gray
A252*	.0-4.0	10	24.94	7.70	2.64	Granular	Yellow
A252*	4.0-8.0	10	23.87	6.17	2.11	Granular	Yellow

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs. sq. in.
A8	.0-3.0	38
A8	3.0-10.0	49
A8	10.0-17.0	127
A8	17.0-19.0	302
A200	5.9-15.9	68
A200	15.9-19.6	55
A200	5.9-21.8	58

Hole No.	Sample No.	Lbs. sq. in.
A10	P1	146
A10	P2	447
A50	0.5-14.0	195
A50	14.0-27.0	485
A255	.0-16.5	430
A66	3.8-12.2	672

* Test hole A252 is not in region A, see log.

SCREEN ANALYSES

HOLE A8 SAMPLE 0.0-3.0 FT.

Retained on screen	Percent	Character of residue
30	6.08	Abundance of hard kaolin; trace of limonite.
60	17.91	Abundance of hard kaolin; trace of limonite
100	14.19	Abundance of hard kaolin; trace of limonite
150	3.68	Abundance of hard kaolin; trace of limonite
200	4.00	Abundance of hard kaolin; traces of limonite and muscovite
250	4.60	Abundance of hard kaolin; trace of limonite
Cloth	49.54	Clay substance including residue from above

HOLE A200 SAMPLE 5.9-15.9 FT.

Retained on screen	Percent	Character of residue
30	14.45	Abundance of hard kaolin; trace of limonite
60	14.04	Abundance of hard kaolin; trace of limonite
100	10.20	Abundance of hard kaolin; traces of quartz and limonite
150	4.66	Abundance of hard kaolin; traces of quartz and limonitic clay
200	3.95	Abundance of hard kaolin; small amount of quartz; trace of limonite
250	3.19	Abundance of hard kaolin; small amount of quartz; trace of limonite
Cloth	49.51	Clay substance including residue from above

HOLE A10 SAMPLE P1

Retained on screen	Percent	Character of residue
30	0.65	Abundance of arenaceous nodules; small amounts of limonite, quartz, and ferruginous rock
60	1.06	Abundance of arenaceous nodules; small amounts of limonite and quartz; trace of hematite
100	0.93	Abundance of arenaceous nodules; small amount of limonite; traces of quartz, clay, and hematite
150	0.54	Abundance of arenaceous nodules; small amount of limonite; traces of muscovite, kaolin, and lignite
200	1.11	Abundance of quartz and white clay; small amounts of limonite, muscovite, and gray clay
250	2.49	Abundance of quartz; small amount of muscovite; traces of limonite and white clay
Cloth	93.22	Clay substance including residue from above

HOLE A10 SAMPLE P2

Retained on screen	Percent	Character of residue
30	12.03	Abundance of micaceous lignitic arenaceous clay nodules; trace of free lignite
60	10.77	Abundance of micaceous lignitic arenaceous clay nodules
100	4.98	Abundance of micaceous lignitic arenaceous clay nodules; trace of free lignite
150	2.15	Abundance of clay nodules; small amounts of free lignite and quartz; trace of muscovite
200	3.89	Abundance of gray clay nodules; small amounts of quartz, lignite, and muscovite
250	6.47	Abundance of quartz and gray clay; small amounts of muscovite and lignite
Cloth	59.61	Clay substance including residue from above

HOLE A50 SAMPLE 0.5-14.0 FT.

Retained on screen	Percent	Character of residue
30	0.28	Abundance of gypsum, quartz, and limonitic material; small amount of gray clay; trace of lignite
60	0.65	Abundance of gypsum, quartz, and limonitic material; small amount of gray clay; trace of lignite
100	1.02	Abundance of gray clay and lignite; small amounts of quartz and gypsum; traces of hematite and muscovite
150	0.24	Abundance of gray clay and limonite; small amounts of gypsum, hematite, quartz, and lignite; trace of muscovite
200	0.60	Abundance of quartz and gray clay; small amounts of gypsum, lignite, limonitic clay, and hematite; trace of muscovite
250	1.27	Abundance of quartz and gray clay; small amounts of limonitic clay, hematite, and lignite; trace of muscovite
Cloth	95.94	Clay substance including residue from above

HOLE A255 SAMPLE 0.0-16.5 FT.

Retained on screen	Percent	Character of residue
30	0.36	Abundance of limonitic nodules; considerable quantity of quartz; small amounts of arenaceous nodules and lignite; trace of plant fragments
60	1.08	Abundance of quartz; considerable quantity of arenaceous, limonitic nodules and gray clay; small amount of plant fragments
100	2.17	Abundance of gray clay; considerable quantity of limonitic nodules and quartz; small amount of muscovite
150	1.06	Abundance of gray clay; considerable quantity of limonitic nodules; small amounts of quartz and muscovite
200	2.42	Abundance of quartz and limonitic nodules; considerable quantity of gray clay; small amounts of muscovite; traces of ferruginous material and rutile
250	4.11	Abundance of quartz; considerable quantity of gray clay; small amounts of muscovite and limonitic nodules; trace of rutile
Cloth	88.80	Clay substance including residue from above

CHEMICAL ANALYSES*

Hole A8 Sample 0.0-3.0 ft.

Soluble salts	0.15	Moisture, air dried	1.31	Sulphur, SO_3	0.03
Ignition loss	13.60	Iron oxide, Fe_2O_3	0.48	Magnesia, MgO	0.22
Silica, SiO_2	42.62	Titania, TiO_2	0.95	Potash, K_2O	0.02
Alumina, Al_2O_3	41.87	Lime, CaO	0.25	Soda, Na_2O	0.11

Hole A200 Sample 5.9-15.9 ft.

Soluble salts	0.20	Moisture, air dried	1.42	Sulphur, SO_3	Trace
Ignition loss	15.88	Iron oxide, Fe_2O_3	1.85	Magnesia, MgO	0.19
Silica, SiO_2	42.52	Titania, TiO_2	1.63	Potash, K_2O	None
Alumina, Al_2O_3	36.84	Lime, CaO	0.49	Soda, Na_2O	0.06

Hole A10 Sample P1

Soluble salts	0.25	Moisture, air dried	1.54	Sulphur, SO_3	0.08
Ignition loss	5.81	Iron oxide, Fe_2O_3	0.16	Magnesia, MgO	0.27
Silica, SiO_2	71.86	Titania, TiO_2	0.55	Potash, K_2O	0.08
Alumina, Al_2O_3	21.03	Lime, CaO	0.41	Soda, Na_2O	0.31

Hole A10 Sample P2

Soluble salts	0.05	Moisture, air dried	1.57	Sulphur, SO_3	0.03
Ignition loss	6.68	Iron oxide, Fe_2O_3	1.29	Magnesia, MgO	0.51
Silica, SiO_2	65.39	Titania, TiO_2	1.25	Potash, K_2O	0.08
Alumina, Al_2O_3	23.09	Lime, CaO	1.30	Soda, Na_2O	0.19

Hole A50 Sample 0.5-14.0 ft.

Soluble salts	0.10	Moisture, air dried	1.08	Sulphur, SO_3	Trace
Ignition loss	6.74	Iron oxide, Fe_2O_3	0.78	Magnesia, MgO	0.26
Silica, SiO_2	66.91	Titania, TiO_2	1.15	Potash, K_2O	Trace
Alumina, Al_2O_3	23.39	Lime, CaO	0.65	Soda, Na_2O	0.25

Hole A255 Sample 0.0-16.5 ft.

Soluble salts	0.10	Moisture, air dried	2.70	Sulphur, SO_3	Trace
Ignition loss	6.44	Iron oxide, Fe_2O_3	0.30	Magnesia, MgO	0.26
Silica, SiO_2	69.55	Titania, TiO_2	0.65	Potash, K_2O	0.21
Alumina, Al_2O_3	21.63	Lime, CaO	1.19	Soda, Na_2O	0.35

* Analyses of residue washed through 250 mesh screen
M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

Hole A8

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A8 .0-3.0 Ft.	1	46.40	31.73	1.47	2.74	14.55	5.12	White Ch.
	3	43.58	29.43	1.49	2.65	17.55	6.25	White Ch.
	5	42.07	26.82	1.55	2.71	19.48	6.98	White Ch.
	7	41.86	26.06	1.60	2.77	21.82	7.91	White Ch.
	9	33.03	20.98	1.73	2.91	28.27	10.50	Lt. cream Ch.
	11	23.55	11.09	2.13	2.78	41.18	16.22	Lt. cream Ch., St. H.
	13	16.57	7.41	2.25	2.70	44.30	17.72	Lt. cream Ch.
	15	5.08	2.08	2.44	2.57	48.78	20.00	Bluish cream Ch.
	18	3.72	1.47	2.53	2.63	50.77	21.06	Bluish cream Ch.
A8 3.0-10.0 Ft.	1	49.70	33.69	1.48	2.93	13.49	4.72	Grayish pink Cr.
	3	44.17	28.25	1.56	2.80	18.75	6.71	Grayish pink Cr.
	5	39.69	23.13	1.74	2.88	26.78	9.88	Grayish pink Cr.
	7	36.24	20.32	1.79	2.80	28.54	10.62	Grayish pink Cr.
	9	19.56	9.18	2.13	2.66	40.29	15.80	Buff Cr., St. H.
	11	14.45	6.18	2.34	2.73	44.92	18.07	Buff Cr.
	13	8.03	3.34	2.41	2.61	47.32	19.28	Gray-buff Cr.
	15	4.44	1.83	2.43	2.55	47.72	19.48	Mottled brown Cr.
A8 10.0-17.0 Ft.	1	37.80	22.40	1.69	2.72	8.51	2.95	Grayish pink Cr.
	3	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	Grayish pink Cr.
	5	29.30	14.87	1.97	2.79	21.05	7.60	Cream
	7	25.63	12.56	2.04	2.77	25.12	9.22	Cream St. H.
	9	17.15	7.81	2.19	2.69	29.27	10.91	Gray-buff
	11	16.61	7.43	2.24	2.68	30.71	11.55	Gray-buff
	13	14.44	6.37	2.27	2.65	31.52	11.89	Gray-buff
	15	7.24	3.21	2.25	2.43	31.95	12.06	Mottled brown
A8 17.0-19.0 Ft.	1	33.26	19.09	1.76	2.61	2.35	.81	Cream
	3	29.89	16.41	1.82	2.60	6.51	2.25	Cream
	5	26.13	13.80	1.89	2.56	8.07	2.78	Cream
	7	24.77	12.88	1.93	2.57	10.22	3.56	Cream
	9	12.99	6.06	2.14	2.47	18.67	6.67	Lt. buff St. H.
	11	8.86	3.95	2.24	2.46	21.44	7.75	Gray-buff
	13	8.54	3.80	2.25	2.47	23.78	8.66	Gray-buff
	15	19.85	10.55	1.88	2.38	3.98	1.35	Gray, specked

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

Modulus of rupture, Hole A8

Sample	At cone	1	3	5	7	9	11	13	15	18
.0-3.0 ft.	Lbs./sq. in.	24	N.D.	44	40	104	181	236	276	289
3.0-10.0 ft.	Lbs./sq. in.	62	64	162	218	358	405	444	803	
10.0-17.0 ft.	Lbs./sq. in.	803	886	2280	2551	3278	3283	3329	1765	
17.0-19.0 ft.	Lbs./sq. in.	1483	1497	2721	4294	4973	5418	5103	2747	

HOLES A168, A169

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A168 C2	1	43.35	27.52	1.57	2.78	12.42	4.35	White	Cr.
	3	35.50	20.50	1.73	2.69	22.10	7.99	White	Cr.
	5	33.25	17.93	1.85	2.78	26.48	9.75	White	Cr.
	7	32.30	16.30	1.98	2.93	31.70	11.93	White	Cr.
	9	20.70	9.85	2.10	2.65	35.30	13.51	White	Cr., St. H.
	11	14.83	6.54	2.27	2.66	41.03	16.18	White	Cr.
	13	9.82	4.19	2.34	2.60	43.00	17.09	Cream	Cr.
	18	4.37	1.75	2.50	2.61	46.15	18.67	Gray	Cr.
A168 C3	1	24.58	12.43	1.98	2.26	23.40	8.50	Lt. red	
	3	19.22	9.22	2.08	2.58	28.80	10.71	Lt. red	
	5	16.05	7.34	2.19	2.60	32.45	12.28	Red	St. H.
	7	15.16	7.05	2.15	2.53	31.22	11.76	Red	
	9	14.93	6.85	2.18	2.57	31.95	12.10	Red	
	11	11.37	4.92	2.31	2.60	36.03	13.87	Reddish brown	
	13	9.95	4.18	2.38	2.64	38.75	15.10	Brown	
A169 C1	1	46.80	25.92	1.81	3.40	23.45	8.54	Salmon	
	3	31.86	16.95	1.88	2.78	25.18	9.22	Grayish pink	
	5	27.65	13.67	2.02	2.80	31.44	11.85	Grayish pink	St. H.
	7	19.83	9.19	2.16	2.69	35.40	13.55	Grayish pink	
	9	15.70	7.03	2.23	2.65	37.66	14.59	Gray-buff	Cr.
	11	15.57	7.04	2.21	2.63	37.66	14.28	Gray-buff	Cr.
	13	14.53	6.46	2.25	2.63	36.65	14.14	Gray-buff	Cr.
	15	5.36	2.30	2.33	2.46	43.30	17.23	Gunmetal	Cr.
A169 C2	1	30.25	15.53	1.94	2.79	23.28	8.46	Red	
	3	25.65	12.72	2.01	2.71	25.93	9.55	Red	
	5	24.38	12.33	1.98	2.61	25.20	9.22	Red	
	7	21.47	11.04	2.05	2.60	27.66	10.25	Red	
	9	20.95	10.17	2.06	2.61	28.30	10.50	Red	St. H.
	11	20.53	9.67	2.13	2.67	30.92	11.63	Reddish brown	
	13	19.00	8.82	2.15	2.66	30.65	11.51	Reddish brown	
	15	13.12	6.35	2.07	2.38	28.80	10.71	Gunmetal	
A169 C3	1	31.40	17.80	1.74	2.54	2.02	.70	White	
	3	27.66	15.38	1.80	2.48	4.50	1.52	White	
	5	27.45	15.28	1.80	2.49	5.74	1.97	White	
	7	26.28	14.33	1.83	2.49	6.24	2.15	White	
	9	18.45	9.52	1.94	2.38	13.12	4.61	Cream	St. H.
	11	17.82	8.93	2.00	2.43	15.34	5.42	Cream	
	13	14.46	7.05	2.05	2.40	16.55	5.87	Cream	
	15	5.59	2.61	2.14	2.27	21.30	7.67	Gray	
	18	4.32	2.05	2.11	2.21	13.55	4.76	Gray	

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

HOLES A178, A198

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A178 C1	1	19.00	9.62	1.97	2.43	23.50	8.54	Cream	Cr., St. H.
	7	3.32	2.15	1.54	1.60	31.28	11.76	Lt. gray	Cr.
	9	4.02	1.83	2.19	2.29	31.36	11.81	Lt. gray	Cr.
	11	5.74	2.62	2.19	2.32	30.45	11.42	Gray-buff	Cr.
	13	5.21	2.37	2.19	2.31	29.86	11.17	Gray-buff	Cr.
A178 C2	1	21.75	11.17	1.94	2.48	17.30	6.14	Lt. cream	St. H.
	5	16.93	8.02	2.12	2.45	22.75	8.26	Cream	Cr.
	7	10.16	4.72	2.16	2.40	26.26	9.67	Cream	
	9	4.09	1.89	2.17	2.26	27.85	10.33	Gray-buff	
	11	3.73	1.71	2.19	2.27	26.20	9.63	Gray-buff	
	13	7.13	3.29	2.17	2.33	26.58	9.79	Gray-buff	
A198 C1-2	1	23.55	12.57	1.87	2.45	14.76	5.10	Cream	
	3	20.20	10.24	1.97	2.47	16.00	5.65	Cream	St. H.
	5	13.65	6.60	2.07	2.40	23.45	8.54	Cream	
	7	6.95	3.19	2.13	2.20	25.10	9.18	Buff	
	9	5.80	2.66	2.17	2.27	25.63	9.43	Buff	
	11	4.60	2.10	2.18	2.34	25.73	9.47	Buff	
	13	3.31	1.60	2.18	2.31	26.28	9.67	Buff	
	15	9.43	4.65	2.03	2.24	21.38	7.71	Grayish-buff	Cr.
A198 C3	1	24.10	11.63	2.07	2.73	28.90	10.75	Reddish gray	St. H.
	3	23.80	10.99	2.16	2.84	28.95	10.79	Reddish gray	
	5	22.55	10.72	2.10	2.71	32.58	12.32	Reddish gray	
	7	15.56	7.10	2.19	2.59	34.00	12.93	Reddish gray	
	9	13.60	5.83	2.33	2.70	36.90	14.23	Reddish gray	
	11	10.40	4.33	2.40	2.67	38.60	15.01	Grayish brown	
	13	8.80	3.59	2.45	2.68	40.10	15.70	Grayish brown	
	15	9.52	4.37	2.18	2.40	32.70	12.37	Gunmetal	
A198 C4-5-6	1	27.50	14.95	1.84	2.54	13.86	4.87	Grayish white	
	3	26.32	13.73	1.92	2.60	16.80	5.98	Grayish white	
	5	22.90	11.52	1.99	2.57	19.85	7.13	Grayish white	St. H.
	7	20.70	9.48	2.19	2.76	25.82	9.51	Grayish buff	
	9	12.90	6.01	2.14	2.56	26.20	9.63	Grayish buff	
	11	10.73	3.92	2.17	2.44	27.45	10.16	Grayish buff	
	13	4.65	2.03	2.29	2.39	28.40	10.54	Grayish buff	
	15	2.84	1.90	2.24	2.34	31.70	11.93	Gray, specked	

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

Hole A200

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A200 5.9-15.9 Ft.	1	45.90	31.26	1.47	2.72	5.63	1.94	White	Ch.
	3	44.75	30.05	1.49	2.69	6.70	2.29	White	Ch.
	5	44.60	29.32	1.52	2.75	8.99	3.09	White	Ch.
	7	44.50	29.18	1.53	2.74	10.52	3.67	White	Ch.
	9	39.66	23.17	1.76	2.72	21.53	7.79	Cream	Ch.
	11	28.58	14.41	1.98	2.73	30.88	11.59	Cream	Ch., St. H.
	13	20.74	9.88	2.12	2.68	31.66	11.93	Cream	Ch.
	15	14.31	6.32	2.27	2.64	38.52	15.01	Cream, specked	Ch.
	18	11.72	4.97	2.36	2.67	43.02	17.18	Cream, specked	Ch.
A200 15.9-19.6 Ft.	1	43.93	29.04	1.52	2.70	15.44	5.46	White	Ch.
	3	40.45	25.25	1.60	2.68	20.15	7.25	White	Ch.
	5	40.00	24.10	1.62	2.78	21.25	7.67	White	Ch.
	7	32.26	17.35	1.86	2.75	31.77	11.98	Cream	Ch., St. H.
	9	27.11	13.84	1.96	2.69	34.79	13.29	Cream	Ch.
	11	18.69	9.03	2.07	2.55	37.95	14.73	Cream	Ch.
	13	14.98	6.75	2.22	2.61	43.18	17.18	Cream	Ch.
	15	7.70	3.28	2.40	2.60	46.53	18.87	Buff, specked	
	18	7.21	3.00	2.41	2.60	46.48	18.82	Buff, specked	
A200 P4	1	38.50	20.95	1.84	2.99	27.40	10.12	Buff	Ch., St. H.
	3	37.40	19.85	1.89	3.01	28.90	10.75	Gray-buff	Cr.
	5	26.95	12.82	2.10	2.88	37.08	14.32	Gray-buff	Cr.
	7	18.88	8.36	2.26	2.79	40.15	15.75	Gray-buff	
	9	14.49	6.43	2.25	2.63	41.15	16.22	Gray-buff	Cr.
	11	10.54	4.36	2.42	2.70	45.00	18.07	Gray-buff	
	13	10.18	4.26	2.39	2.67	44.60	17.87	Gray-buff	Cr.
	15	6.39	2.78	2.29	2.45	41.95	16.60	Gunmetal	Cr.
A200 C1	1	29.00	16.00	1.81	2.55	15.48	5.46	Cream	
	3	27.80	14.68	1.89	2.62	15.26	5.38	Cream	
	5	23.82	12.20	1.95	2.57	18.00	6.40	Cream	
	7	20.95	10.38	2.02	2.56	21.73	7.87	Lt. gray-buff	St. H.
	9	16.78	8.07	2.08	2.50	24.45	8.94	Lt. gray-buff	
	11	16.40	7.80	2.11	2.52	25.88	9.51	Lt. gray-buff	
	13	16.83	8.01	2.10	2.52	23.95	8.74	Lt. gray-buff	
	15	5.68	2.49	2.28	2.42	29.92	11.21	Brown	

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

Modulus of rupture, Hole A200

Sample	At cone	1	3	5	7	9	11	13	15	18
5.9-15.9 ft.	Lbs./sq. in.	39	86	93	224	512	502	540	658	847
15.9-19.6 ft.	Lbs./sq. in.	113	161	191	173	536	578	612	739	815

HOLES A200, A201

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A200 C2	1	28.80	16.25	1.77	2.49	5.29	1.80	White	
	3	28.08	15.45	1.82	2.67	7.44	2.57	White	
	5	25.10	13.42	1.87	2.50	10.50	3.63	White	
	7	20.98	10.85	1.93	2.44	13.25	4.65	Cream	
	9	15.72	7.85	2.00	2.38	16.24	5.76	Cream	St. H.
	13	15.73	7.71	2.04	2.42	18.32	6.55	Cream	
	15	13.14	7.15	1.84	2.12	10.37	3.59	Lt. gray	
A200 5.9-21.8 Ft.	1	46.32	32.35	1.47	2.73	15.84	5.61	Cream	
	3	42.68	27.11	1.58	2.75	19.16	6.86	Cream	Ch.
	5	41.22	26.85	1.60	2.74	22.26	8.07	Cream	Ch.
	7	36.26	20.51	1.77	2.79	28.17	10.45	Cream	Ch.
	9	30.94	16.37	1.89	2.74	32.11	12.15	Cream	Cr., St. H.
	11	26.76	13.10	2.04	2.79	36.99	14.27	Grayish cream	Cr.
	13	21.83	10.22	2.14	2.73	38.58	15.01	Grayish cream	Cr.
	15	10.00	4.27	2.34	2.60	45.53	18.37	Buff, specked	Cr.
	18	9.73	4.07	2.40	2.65	46.80	18.97	Buff, specked	Cr.
A201 C1	1	38.80	23.65	1.64	2.68	12.27	4.28	White	Cr.
	3	34.90	20.00	1.74	2.68	20.62	7.44	White	Cr.
	5	34.90	19.22	1.82	2.79	24.28	8.86	White	Cr.
	7	22.10	10.67	2.07	2.68	30.90	11.59	Cream	St. H.
	9	18.28	8.35	2.19	2.66	36.50	14.05	Cream	
	11	13.22	5.73	2.30	2.66	40.20	15.75	Cream	
	13	10.30	4.38	2.35	2.63	41.10	16.18	Cream	Cr.
	15	5.41	2.19	2.47	2.61	44.00	17.57	Gray	Cr.
	18	4.84	1.94	2.49	2.61	44.65	17.92	Gray	Cr.
A201 C2	1	35.10	20.35	1.72	2.65	19.63	7.05	Cream	Cr.
	3	33.40	17.98	1.85	2.79	26.13	9.63	Pink	Cr.
	5	30.40	16.22	1.87	2.69	26.23	9.67	Pink	Cr.
	7	21.55	10.30	2.09	2.70	34.50	13.15	Cream	Cr., St. H.
	9	18.08	8.20	2.21	2.66	38.13	14.82	Cream	Cr.
	11	15.26	6.77	2.25	2.66	39.03	15.24	Cream	Cr.
	13	11.40	4.91	2.33	2.63	41.20	16.22	Grayish cream	Cr.
	15	3.65	1.43	2.48	2.57	44.60	17.87	Grayish brown	Cr.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A200

Sample	At cone	1	3	5	7	9	11	13	15	18
5.9-21.8 ft.	Lbs./sq. in.	126	235	325	366	612	629	654	1114	995

HOLES A10, A201, A234

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A201 C3	3	35.80	18.26	1.96	3.05	26.50	9.75	Lt. red	
	5	29.95	14.77	2.03	2.90	29.40	10.96	Lt. red	
	7	25.10	11.52	2.18	2.91	34.00	12.93	Lt. red	St. H.
	9	24.50	11.00	2.22	2.94	35.60	13.64	Lt. red	Cr.
	11	15.54	6.41	2.43	2.87	41.15	16.22	Reddish brown	
	13	10.86	4.30	2.53	2.83	43.45	17.33	Reddish brown	
	15	9.55	4.18	2.28	2.52	36.70	14.14	Gunmetal	
A234 C2	1	44.40	27.47	1.58	2.69	12.80	4.46	White	Ch.
	3	41.10	25.92	1.67	2.72	16.18	5.72	White	Ch.
	5	38.70	23.18	1.62	2.90	18.76	6.71	White	Ch.
	7	34.40	19.52	1.76	2.78	22.75	8.26	White	Ch., St. H.
	9	31.48	16.55	1.90	2.69	27.67	10.25	White	Ch.
	11	19.65	9.10	2.16	2.69	37.67	14.59	Cream	Ch.
	13	16.23	7.27	2.23	2.66	39.08	15.24	Cream	Ch.
	15	9.06	3.84	2.35	2.59	41.25	16.27	Cream, specked	Ch.
	18	8.36	3.49	2.39	2.61	43.40	17.28	Cream, specked	Cr.
A10 P1	1	33.10	19.09	1.73	2.59	2.21	.77	Cream	
	3	30.29	16.92	1.79	2.57	5.22	1.80	Cream	
	5	28.09	15.23	1.84	2.56	8.23	2.85	Cream	
	7	26.88	14.53	1.85	2.53	8.56	2.95	Cream	
	9	22.83	11.63	1.97	2.56	16.18	5.72	Cream	
	11	17.49	8.41	2.08	2.55	18.25	6.52	Cream	St. H.
	13	14.28	6.81	2.10	2.44	19.13	6.86	Cream	
	15	6.23	2.82	2.21	2.36	23.38	8.50	Gray	
A10 C1	1	33.95	19.80	1.71	2.60	.00	.00	Cream	
	3	30.80	17.30	1.78	2.58	1.09	.37	Cream	
	5	27.60	15.06	1.83	2.53	7.12	2.46	Cream	
	7	24.80	12.97	1.91	2.54	9.93	3.45	Cream	
	9	23.47	12.05	1.95	2.55	13.60	4.76	Cream	St. H.
	11	12.86	6.02	2.14	2.46	19.55	7.01	Cream	
	13	9.65	4.37	2.21	2.44	24.52	8.98	Gray	
	15	6.10	2.75	2.21	2.36	24.20	8.82	Gray	
	18	14.40	7.64	1.89	2.21	11.86	4.14	Brownish gray	

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A10

Sample	At cone	1	3	5	7	9	11	13	15
P1	Lbs./sq. in.	654	1285	1795	3075	3925	4454	4713	4621

HOLES A10, A50

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A10 P2	1	30.63	18.10	1.69	2.44	2.50	.84	Cream	
	3	28.02	16.14	1.74	2.41	5.92	2.04	Cream	
	5	22.19	11.79	1.88	2.41	8.48	2.92	Buff	
	7	21.96	11.73	1.88	2.42	10.10	3.49	Buff	
	9	11.44	5.59	2.04	2.31	19.47	6.98	Buff	St. H.
	11	9.28	4.30	2.15	2.38	22.06	7.99	Gray	
	13	7.36	3.41	2.16	2.33	23.95	8.74	Gray	
	15	17.14	6.81	1.69	2.04	-1.80	-.60	Gray	
A50 0.5-14.0 Ft.	1	32.13	18.18	1.77	2.60	.58	.20	Cream	
	3	26.43	13.89	1.90	2.58	8.91	3.09	Cream	
	5	21.48	10.72	2.01	2.56	13.60	4.76	Cream	St. H.
	7	16.78	8.06	2.08	2.50	17.06	6.06	Cream	
	9	10.72	4.89	2.19	2.46	21.06	7.60	Buff	
	11	7.68	3.37	2.28	2.47	24.45	8.94	Gray-buff	
	13	3.53	1.51	2.35	2.43	25.81	9.51	Gray	
	15	13.20	6.91	1.91	2.21	9.91	3.45	Gray, specked	
A50 14.0-27.0 Ft.	1	34.20	20.10	1.72	2.64	1.52	.54	Cream	
	3	24.52	13.41	1.83	2.42	2.53	.87	Salmon	
	5	24.15	12.78	1.89	2.49	6.78	2.32	Salmon	
	7	23.52	12.47	1.89	2.46	7.76	2.67	Salmon	
	9	19.88	10.32	1.93	2.40	8.23	2.85	Salmon	
	11	15.60	7.66	2.04	2.41	14.67	5.16	Gray-buff	St. H.
	13	15.23	7.33	2.08	2.45	16.56	5.87	Gray-buff	
	15	9.51	5.53	1.72	1.90	-1.44	-.50	Brownish gray	
A50 P10	1	32.25	19.16	1.68	2.48	2.55	.87	Salmon	
	3	26.50	14.30	1.85	2.52	12.60	4.39	Lt. red	
	5	20.48	10.28	1.99	2.50	18.48	6.59	Red	St. H.
	7	15.30	7.27	2.10	2.49	23.55	8.58	Red	
	11	3.60	1.72	2.09	2.17	21.85	7.91	Brown	
	13	12.42	6.79	1.83	2.09	10.12	3.52	Brown	

Abbreviations: St. H., steel hard.

MODULUS OF RUPTURE, HOLE A10

Sample	At cone	1	3	5	7	9	11	13	15
P2	Lbs./sq. in.	1366	1550	1718	2130	3145	3501	3479	2704

MODULUS OF RUPTURE, HOLE A50

Sample	At cone	1	3	5	7	9	11	13	15
0.5-14.0 ft.	Lbs./sq. in.	1130	2604	2695	3034	5194	6008	5871	2588
14.0-27.0 ft.	Lbs./sq. in.	1337	1391	2071	2628	2776	2831	3084	1935

HOLES A51, A255

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A255 0.0-16.5 Ft.	1	23.85	12.53	1.90	2.50	8.32	2.88	Lt. buff	
	3	23.15	11.83	1.96	2.54	11.31	3.95	Lt. buff	
	5	19.30	9.62	2.01	2.49	13.31	4.68	Lt. buff	St. H.
	7	12.52	5.84	2.15	2.45	18.86	6.74	Lt. buff	
	9	9.23	4.23	2.20	2.42	20.32	7.32	Buff	
	11	8.77	3.97	2.21	2.42	21.04	7.60	Gray-buff	
	13	7.36	3.30	2.23	2.41	21.97	7.95	Gray-buff	
	15	13.08	7.12	1.84	2.13	6.66	2.29	Gray-buff	
A51 C1	1	37.35	23.50	1.59	2.53	2.10	.70	White	
	3	31.45	17.93	1.71	2.53	10.72	3.74	White	
	5	25.70	13.15	1.96	2.64	20.75	7.48	White	
	7	18.70	9.17	2.03	2.51	23.85	8.70	White	St. H.
	9	3.76	1.61	2.33	2.43	33.80	12.85	Lt. gray	
	11	1.28	.55	2.35	2.38	35.08	13.42	Lt. gray	
	13	8.60	3.83	2.25	2.45	30.08	11.25	Lt. gray	
	15	13.86	7.61	1.83	2.12	17.52	6.25	Med. gray	
	18	30.15	19.40	1.55	2.23	7.27	2.50	Med. gray	
A51 C2	3	34.55	20.35	1.76	2.59	9.42	3.27	White	
	5	26.05	13.65	1.91	2.58	16.95	6.02	Cream	
	7	25.18	13.48	1.86	2.49	20.15	7.25	Cream	St. H.
	9	17.95	8.48	2.12	2.58	27.90	10.33	Cream	
	11	7.85	3.46	2.27	2.47	33.08	12.54	Lt. gray	
	13	7.52	3.27	2.30	2.48	32.95	12.50	Lt. gray	
	15	.96	.42	2.31	2.33	33.95	12.93	Gray	
	18	11.15	5.74	1.94	2.19	21.10	7.60	Gray	Cr.
A51 C3	1	62.70	73.00	.90	2.65	5.84	2.01	White	
	3	56.10	55.30	1.01	2.46	16.66	5.91	White	
	5	51.90	43.25	1.20	2.44	29.85	11.17	Cream	
	7	51.80	40.55	1.28	2.41	34.40	13.11	Cream	
	9	45.75	34.10	1.34	2.50	37.70	14.59	Cream	
	11	43.00	30.08	1.43	2.50	40.90	16.08	Cream	
	13	42.10	29.38	1.44	2.48	41.95	16.50	Cream	
	15	30.55	19.30	1.58	2.28	46.80	18.97	Buff	St. H.
	18	17.94	10.97	1.79	2.24	52.35	21.92	Gray-buff	

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

MODULUS OF RUPTURE, HOLE A255

Sample	At cone	1	3	5	7	9	11	13	15
.0-16.5 ft.	Lbs./sq. in.	1760	2250	2789	2751	3625	5003	5323	2577

HOLES A51, A55, A66

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A51 C4	1	28.40	17.40	1.63	2.28	.03	.01	Cream	
	7	19.78	10.05	1.96	2.45	12.50	4.35	Buff	St. H.
	9	8.64	4.01	2.16	2.36	21.08	7.60	Gray-buff	
	11	7.50	3.46	2.17	2.34	22.05	7.99	Gray	
	13	6.93	3.14	2.21	2.37	23.48	8.54	Gray	
	15	7.53	3.66	2.06	2.23	17.47	6.21	Gray	
	18	19.70	11.52	1.71	2.13	.86	.30	Brownish gray	
A51 C5	1	34.60	20.80	1.66	2.55	-2.98	-1.01	Cream	
	3	30.88	17.94	1.72	2.49	5.50	1.87	Cream	
	5	29.80	16.70	1.79	2.54	7.90	2.71	Buff	
	7	27.80	15.28	1.82	2.52	10.04	3.49	Buff	
	9	19.12	9.89	1.95	2.42	15.64	5.53	Gray-buff	St. H.
	11	19.10	9.52	2.01	2.48	18.10	6.44	Gray-buff	
	13	18.50	9.21	2.01	2.47	18.56	6.63	Gray-buff	
	15	5.96	3.12	1.91	2.03	14.84	5.24	Gray-buff specked	
A55 C1	1	37.70	20.86	1.81	2.90	6.12	2.11	White	
	3	31.25	18.00	1.73	2.52	10.00	3.45	White	
	5	23.95	11.87	1.87	2.41	13.23	4.65	Cream	
	7	22.25	11.85	2.02	2.66	20.50	7.36	Cream	St. H.
	9	14.16	6.58	2.15	2.51	25.00	9.14	Cream	
	11	4.01	1.72	2.33	2.42	30.70	11.51	Lt. gray	
	13	7.13	3.12	2.29	2.46	28.80	10.71	Lt. gray	
	15	10.22	5.08	2.01	2.24	18.30	6.52	Gray, specked	
	18	18.08	10.37	1.74	2.24	6.64	2.29	Gray, specked	
A66 3.8-12.2 Ft.	1	21.08	11.59	1.82	2.39	5.64	1.94	Lt. salmon	
	3	15.65	7.94	1.98	2.35	10.67	3.70	Salmon	
	5	13.48	6.60	2.04	2.36	12.01	4.21	Lt. Red	St. H.
	7	9.42	4.68	2.02	2.23	12.69	4.43	Lt. red	
	9	15.45	7.99	1.93	2.29	11.00	3.81	Gray-buff	Bl.
	11	18.36	10.04	1.83	2.24	9.03	3.13	Gray-buff	Bl.
	13	19.91	10.76	1.85	2.31	5.71	1.97	Gray-buff	Bl.

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

MODULUS OF RUPTURE, HOLE A66

Sample	At cone	1	3	5	7	9	11	13
3.8-12.2 ft.	Lbs./sq. in.	2418	3330	4343	5124	4551	3761	2797

HOLE A252*

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A252* P1	1	48.70	29.22	1.67	3.24	15.94	5.65	Buff	
	3	45.65	26.65	1.71	3.15	18.68	6.67	Gray	
	5	43.80	25.23	1.73	3.17	21.18	7.63	Gray	
	7	42.50	23.10	1.84	3.22	23.07	8.38	Gray	
	9	42.50	22.50	1.89	3.28	26.33	9.71	Gray	
	11	40.15	20.75	1.90	3.24	26.67	9.84	Gray	
	13	38.15	20.08	1.94	3.07	27.25	10.08	Gray	
	15	15.40	6.30	2.45	2.90	40.45	15.89	Gunmetal	St. H.
A252* P2	1	55.80	36.95	1.78	3.10	15.82	5.61	Buff	
	3	47.40	28.46	1.74	3.16	19.57	7.01	Gray	
	5	44.25	25.66	1.72	3.09	21.45	7.75	Gray	
	7	43.45	22.23	1.86	3.16	25.14	9.22	Gray	
	9	42.90	22.05	1.95	3.14	28.35	10.54	Gray	
	11	42.15	21.25	1.95	3.18	28.20	10.45	Gray	
	13	40.65	21.70	1.98	3.17	28.45	10.58	Gray	
	15	15.73	6.51	2.42	2.87	40.55	15.94	Gunmetal	St. H.

Abbreviations: St. H., steel hard.

* Test hole A252 is not in region A, See log.

REGION B

Region B is within T.5 S., R.2 E., Sec. 11. Samples were secured from the properties of T. H. Burford, Mark Hill, and G. T. Callicutt. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A24	C1	2A	28.56	11.01	3.85	Fine, open	Lt. gray
A24	C2	2A	28.85	12.86	4.50	Fine, open	Lt. gray
A24	C3	2B	22.65	11.16	3.88	Fine, open	Lt. gray
A28	C1	3B	24.70	19.06	6.82	Fine, open	Lt. gray
A29	C1	4A	28.04	21.38	7.71	Fine, open	Yellow
A29	C2	3B	26.37	21.29	7.67	Fine, open	Lt. gray
A45	C1	1C	21.54	14.72	5.20	Fine, open	Lt. gray
A46	P1	5B	22.89	8.34	2.88	Fine, open	Yellow
A74	P1	1A	27.28	8.78	3.02	Fine, open	Lt. gray
A74	C1	2A	30.86	13.62	4.79	Fine, open	Lt. gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./sq. in.
A45	C1	195
A46	P1	130
A74	P1	23

SCREEN ANALYSES

HOLE A45 SAMPLE C1

Retained on screen	Percent	Character of residue
30	5.56	Abundance of micaceous gray clay, kaolin with quartz, and "clay ironstones"; small amounts of quartz and ferruginous material
60	7.84	Abundance of micaceous gray clay, kaolin with quartz, and clay ironstones; small amounts of quartz and ferruginous material
100	10.81	Abundance of quartz, gray clay, kaolin, and siderite; small amount of muscovite
150	5.66	Abundance of kaolin and gray clay; small amounts of siderite and muscovite
200	4.80	Abundance of quartz and muscovite; considerable quantity of gray clay and kaolin; small amounts of siderite and muscovite
250	2.91	Abundance of quartz and muscovite; considerable quantity of gray clay and kaolin; small amounts of siderite and muscovite
Cloth	62.42	Clay substance including residue from above

HOLE A46 SAMPLE P1

Retained on screen	Percent	Character of residue
30	1.33	Abundance of limonitic ferruginous material; small amount of quartz; trace of gypsum
60	6.91	Abundance of limonitic ferruginous material; considerable quantity of quartz; small amount of gypsum; trace of kaolinite
100	8.22	Abundance of quartz and limonite; small amount of white clay; trace of muscovite
150	9.65	Abundance of quartz and limonite; traces of white clay and muscovite
200	3.97	Abundance of quartz and limonite; small amount of white clay; traces of feldspar and rutile
250	1.10	Abundance of quartz and limonite; small amount of white clay; traces of rutile and muscovite
Cloth	68.82	Clay substance including residue from above

HOLE A74 SAMPLE P1

Retained on screen	Percent	Character of residue
30	0.37	Abundance of white clay filled with quartz; small amount of ferruginous material
60	4.13	Abundance of white clay filled with quartz; small amounts of quartz and plant fragments
100	5.30	Abundance of white clay and quartz; small amounts of plant fragments and muscovite
150	4.85	Abundance of white clay; considerable quantity of quartz; trace of rutile
200	4.10	Abundance of white clay and quartz
250	0.99	Abundance of white clay; considerable quantity of quartz; small amount of kaolinite; trace of feldspar
Cloth	80.26	Clay substance including residue from above

CHEMICAL ANALYSES*

HOLE A45 SAMPLE C1

Soluble salts	0.05	Moisture, air dried	1.13	Sulphur, SO_3	0.06
Ignition loss	8.44	Iron oxide, Fe_2O_3	1.14	Magnesia, MgO	0.15
Silica, SiO_2	60.51	Titania, TiO_2	0.14	Potash, K_2O	0.03
Alumina, Al_2O_3	30.09	Lime, CaO	0.85	Soda, Na_2O	0.25

HOLE A46 SAMPLE P1

Soluble salts	0.30	Moisture, air dried	1.27	Sulphur, SO_3	Trace
Ignition loss	12.02	Iron oxide, Fe_2O_3	7.20	Magnesia, MgO	0.15
Silica, SiO_2	45.88	Titania, TiO_2	2.15	Potash, K_2O	None
Alumina, Al_2O_3	31.47	Lime, CaO	0.73	Soda, Na_2O	0.04

HOLE A74 SAMPLE P1

Soluble salts	0.10	Moisture, air dried	1.48	Sulphur, SO_3	None
Ignition loss	12.05	Iron oxide, Fe_2O_3	0.45	Magnesia, MgO	0.31
Silica, SiO_2	43.77	Titania, TiO_2	1.15	Potash, K_2O	0.10
Alumina, Al_2O_3	41.69	Lime, CaO	0.48	Soda, Na_2O	0.17

* Analyses of residue washed through 250 mesh screen.

M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

HOLES A24, A28, A29

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A24 C1	3*	40.45	25.50	1.59	2.66	10.92	3.81	White	Cr.
	5	40.20	22.18	1.81	3.03	22.05	7.99	White	Cr.
	7	33.50	18.65	1.79	2.69	21.60	7.79	White	Cr.
	9	32.40	18.00	1.80	2.66	21.60	7.79	White	Ch.
	11	29.90	15.36	1.94	2.77	26.95	9.96	White	Ch., St. H.
	13	23.88	11.83	2.02	2.65	30.70	11.51	Lt. cream	Ch.
	15	17.25	8.09	2.13	2.58	33.55	12.76	Lt. cream	Cr.
	18	16.60	7.45	2.22	2.67	38.60	15.01	Cream	Cr.
A24 C2	3	40.60	25.53	1.59	2.67	10.61	3.70	White	Cr.
	5	38.60	23.30	1.66	2.70	14.85	5.24	White	Cr.
	7	31.30	16.90	1.85	2.69	24.20	8.82	White	Cr.
	9	29.85	15.97	1.87	2.66	24.85	9.10	White	Cr., St. H.
	11	27.70	13.95	1.98	2.74	28.70	10.66	Cream	Cr.
	13	22.98	11.13	2.06	2.68	31.30	11.76	Cream	Cr.
	15	15.28	7.15	2.14	2.53	34.05	12.98	Cream	Cr.
	18	15.00	6.85	2.19	2.58	35.10	13.42	Cream	Cr.
A24 C3	5	36.90	19.45	1.80	2.69	13.00	4.54	White	Cr.
	7	30.10	16.52	1.82	2.61	13.12	4.61	White	
	9	30.15	16.05	1.85	2.60	14.78	5.20	White	
	11	29.90	15.86	1.88	2.60	15.12	5.45	White	
	13	28.80	15.56	1.88	2.60	15.70	5.53	White	
	15	23.30	11.90	1.95	2.55	17.90	6.36	Cream	St. H.
	18	22.40	11.18	2.00	2.58	19.94	7.17	Cream	
A28 C1	1	28.55	15.78	1.81	2.53	3.56	1.21	Lt. cream	
	3	25.65	14.32	1.79	2.41	4.44	1.52	Lt. cream	
	5	21.96	11.78	1.87	2.39	6.40	2.18	Cream	
	7	21.08	11.05	1.91	2.41	9.56	3.31	Cream	
	9	19.60	10.13	1.94	2.41	10.07	3.49	Cream	St. H.
	11	15.24	7.59	2.01	2.37	13.38	4.68	Cream	
	13	12.88	6.17	2.09	2.40	15.82	5.61	Lt. gray	
	15	11.03	5.82	1.92	2.16	9.68	3.34	Gray	
A29 C1	1	32.06	18.86	1.70	2.50	.00	.00	Cream	
	3	28.80	16.31	1.77	2.48	8.17	2.81	Salmon	
	5	23.75	12.63	1.88	2.46	11.65	4.06	Salmon	
	7	21.95	11.58	1.90	2.43	13.07	4.57	Salmon	
	9	18.90	9.58	1.97	2.43	17.80	6.32	Salmon	
	11	15.95	7.84	2.03	2.42	19.46	6.98	Buff	St. H.
	13	13.76	6.48	2.13	2.47	20.30	7.28	Buff	
	15	10.08	5.62	1.79	1.99	6.77	2.32	Brown, specked	
A29 C2	1	29.25	16.90	1.73	2.45	2.93	1.01	Cream	
	3	28.90	16.44	1.76	2.47	4.54	1.56	Cream	
	5	23.40	12.64	1.85	2.42	8.56	2.95	Cream	
	7	20.95	11.77	1.97	2.39	12.26	4.28	Buff	St. H.
	9	17.80	11.06	1.89	2.39	14.29	5.01	Buff	
	11	14.22	7.04	2.02	2.36	17.08	6.06	Buff	
	13	13.02	6.26	2.08	2.39	18.18	6.48	Buff	
	15	11.22	6.04	1.86	2.09	9.38	3.24	Gray	

* Data unreliable due to condition of test pieces.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

HOLES A45, A46, A74

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A45 C1	1	33.02	19.00	1.74	2.59	1.48	.50	Cream
	3	32.14	18.43	1.75	2.57	1.74	.60	Cream
	5	29.67	16.09	1.84	2.61	4.59	1.56	Cream
	7	29.36	15.95	1.84	2.62	5.88	2.01	Cream
	9	26.49	14.11	1.88	2.56	7.13	2.46	Lt. buff
	11	25.10	12.95	1.94	2.59	9.88	3.42	Buff
	13	23.93	12.17	1.96	2.58	12.24	4.28	Buff St. H.
	15	8.40	4.12	2.03	2.22	13.15	4.61	Lt. brown, specked
A46 P1	1	36.78	21.78	1.69	2.67	-.37	-.13	Cream
	3	35.38	20.77	1.70	2.64	.38	.13	Salmon
	5	29.30	15.44	1.90	2.69	7.18	2.46	Buff
	7	28.88	14.98	1.93	2.71	8.16	2.81	Buff
	9	27.30	13.95	1.93	2.64	9.32	3.24	Buff St. H.
	11	26.92	13.78	1.97	3.36	13.00	4.54	Buff
	13	25.55	12.72	2.01	2.70	14.32	5.05	Gray-buff
	15	12.54	5.97	2.10	2.41	19.95	7.17	Brown, specked
A74 P1	1	43.77	27.49	1.59	2.83	12.37	4.32	White Cr.
	3	40.38	25.07	1.62	2.72	13.55	4.76	White Ch.
	5	38.02	22.59	1.68	2.72	17.01	6.06	White Cr.
	7	34.90	19.74	1.77	2.72	21.13	6.63	White Ch., St. H.
	9	31.31	16.77	1.87	2.71	26.49	9.75	White Ch.
	11	22.24	10.47	2.12	2.73	34.27	13.07	Lt. cream Ch.
	13	19.90	9.24	2.16	2.69	35.62	13.69	Lt. cream Ch.
	15	11.10	4.82	2.30	2.59	39.35	15.38	Lt. cream Ch.
	18	9.72	4.08	2.39	2.64	42.05	16.65	Bluish white Ch.
A74 C1	1	42.50	27.38	1.55	2.70	13.23	4.65	White Cr.
	5	40.15	24.40	1.65	2.75	17.55	6.25	White Ch.
	7	32.50	18.12	1.80	2.66	24.90	9.10	White Ch.
	9	31.70	17.25	1.84	2.69	26.70	9.84	White Ch., St. H.
	11	23.90	11.50	2.08	2.73	35.40	13.55	White Ch.
	13	17.30	8.24	2.21	2.67	39.85	15.61	Lt. cream Cr.
	15	9.40	4.03	2.33	2.57	43.65	17.43	Bluish white Cr.
	18	8.36	3.52	2.37	2.59	43.40	17.28	Bluish white Cr.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A45

Sample	At cone	1	3	5	7	9	11	13	15
C1	Lbs./sq. in.	645	701	1112	1187	1542	1493	1716	2125

MODULUS OF RUPTURE, HOLE A46

Sample	At cone	1	3	5	7	9	11	13	15
P1	Lbs./sq. in.	828	624	1328	1140	1547	1807	1867	1831

MODULUS OF RUPTURE, HOLE A74

Sample	At cone	1	3	5	7	9	11	13	15	18
P1	Lbs./sq. in.	37	104	128	209	161	468	408	370	647

REGION C

Region C is within T.5 S., R.2 E., Sec. 3. Samples were secured from the properties of W. L. Roberson, D. D. Hill, and T. H. Burford. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A81	C1	1A	39.96	38.60	15.01	Fine, dense	Dk. gray
A81	C2	1A	35.42	26.20	9.63	Fine, open	Gray
A82	C1	1A	36.84	15.17	5.35	Fine, open	Lt. gray
A82	C2	6A	33.35	12.89	4.50	Fine, open	Lt. gray
A87	4.9-12.0	1A	34.88	1.47	.50	Fine, open	Lt. gray
A87	12.0-20.4	6A	33.38	9.40	3.24	Fine, open	Yellow
A87	20.4-23.0	4A	30.41	14.30	5.01	Fine, open	Gray
A87	4.9-23.0	7	35.10	18.41	6.59	Fine, open	Yellow
A184	C1	1B	27.37	6.63	2.29	Fine, open	Lt. gray
A69A	P1	2A	30.27	14.07	4.94	Fine, open	Lt. gray
A69A	P2-3	2B	25.05	16.75	5.95	Fine, open	Gray
A70	C1	2A	32.62	13.42	4.72	Fine, open	Cream
A70	C2	2C	29.91	14.89	5.24	Fine, open	Lt. gray
A70	P1	2A	34.88	22.75	8.26	Fine, open	Lt. gray
A73	C1	1A	30.75	7.03	2.42	Fine, open	Cream
A73	C2	6A	29.86	6.42	2.22	Fine, open	Yellow
A73	C3	4B	23.94	14.91	5.27	Fine, open	Lt. gray
A96	C1	2A	33.25	11.81	4.14	Fine, open	Lt. gray
A96	C2	2A	30.09	14.85	5.24	Fine, open	Lt. gray
A96	C3	2B	30.64	11.61	4.06	Fine, open	Dk. gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./ sq. in.	Hole No.	Sample No.	Lbs./ sq. in.
A87	4.9-12.0	75	A69A	P1	107
A87	12.0-20.4	70	A69A	P2-3	117
A87	20.4-23.0	306	A70	P1	119
A87	4.9-23.0	92			

SCREEN ANALYSES

HOLE A87 SAMPLE 4.9-12.0 FT.

Retained on screen	Percent	Character of residue
30	1.09	Abundance of white micaceous clay; considerable quantity of limonitic clay; small amount of plant fragments
60	9.30	Abundance of white micaceous clay; considerable quantity of limonitic clay; small amount of quartz
100	6.91	Abundance of limonitic clay; considerable quantity of white clay; small amounts of quartz and ferruginous material
150	4.54	Considerable quantities of limonitic clay and white clay; small amounts of quartz and carbonaceous material
200	5.95	Abundance of white clay; considerable quantity of limonitic clay; small amounts of quartz and carbonaceous material; trace of rutile
250	2.42	Abundance of white clay; considerable quantity of limonitic clay; small amount of quartz; traces of carbonaceous and ferruginous material
Cloth	69.79	Clay substance including residue from above

HOLE A87 SAMPLE 20.4-23.0 FT.

Retained on screen	Percent	Character of residue
30	1.78	Abundance of ferruginous rock and limonitic material; small amounts of gray micaceous clay and quartz; trace of hematite
60	2.31	Abundance of quartz, yellow clay and gray clay; considerable quantity of ferruginous material; trace of muscovite
100	3.00	Abundance of quartz, muscovite, and yellow clay; considerable quantity of gray clay; small amounts of ferruginous material and kaolin
150	1.91	Abundance of muscovite, yellow clay, and kaolin; small amount of ferruginous material; traces of quartz and hematite
200	2.63	Abundance of muscovite, yellow clay, and kaolin; traces of ferruginous material and quartz
250	2.95	Abundance of muscovite and quartz; small amounts of yellow clay
Cloth	85.52	Clay substance including residue from above

CHEMICAL ANALYSES*

HOLE A87 SAMPLE 4.9-12.0 FT.

Soluble salts	0.10	Moisture, air dried	1.79	Sulphur, SO_3	None
Ignition loss	13.52	Iron oxide, Fe_2O_3	0.40	Magnesia, MgO	0.87
Silica, SiO_2	41.73	Titania, TiO_2	3.00	Potash, K_2O	None
Alumina, Al_2O_3	39.05	Lime, CaO	1.18	Soda, Na_2O	0.04

HOLE A87 SAMPLE 20.4-23.0 FT.

Soluble salts	0.10	Moisture, air dried	2.03	Sulphur, SO_3	None
Ignition loss	5.99	Iron oxide, Fe_2O_3	1.55	Magnesia, MgO	0.43
Silica, SiO_2	70.12	Titania, TiO_2	1.40	Potash, K_2O	None
Alumina, Al_2O_3	20.32	Lime, CaO	0.65	Soda, Na_2O	0.06

* Analyses of residue washed through 250 mesh screen.

M. R. Livingston, analyst.

HOLES A81, A82

PYRO-PHYSICAL PROPERTIES

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A81 C1	1	36.45	21.40	1.70	2.68	10.36	3.59	Cream	
	3	34.08	19.75	1.72	2.61	11.95	4.18	Pink	
	5	28.70	15.08	1.90	2.67	20.00	7.17	Pink	Cr., St. H.
	7	17.75	8.01	2.21	2.69	32.68	12.37	Cream	Cr.
	9	16.48	7.52	2.19	2.63	32.10	12.11	Cream	Cr.
	11	6.38	2.58	2.48	2.65	40.00	15.66	Gray	
	13	6.21	2.50	2.48	2.65	38.85	15.14	Gray	
	15	5.00	2.03	2.46	2.59	38.70	15.05	Gray-buff	Cr.
	18	5.77	2.38	2.43	2.58	39.05	15.24	Gray-buff	Cr.
A81 C2	1	38.20	23.70	1.61	2.61	11.58	4.03	White	
	3	30.30	16.68	1.82	2.61	21.90	7.91	White	
	5	30.50	16.40	1.86	2.68	23.28	8.46	White	St. H.
	7	21.85	10.64	2.05	2.63	30.45	11.42	White	
	9	19.60	9.45	2.07	2.58	31.10	11.68	Lt. cream	
	11	12.08	5.47	2.21	2.51	35.42	13.59	Cream	
	13	10.30	4.59	2.24	2.50	36.10	13.87	Cream	
	15	6.22	2.64	2.38	2.52	37.35	14.46	Gray-buff	
	18	5.71	2.41	2.37	2.51	39.00	15.19	Gray-buff	
A82 C1	1	45.75	30.55	1.50	2.76	13.27	4.65	White	Cr.
	3	41.70	26.90	1.55	2.66	15.95	5.65	White	Cr.
	5	41.40	25.68	1.61	2.75	19.18	6.86	White	Cr.
	7	39.85	24.15	1.64	2.74	20.72	7.48	Grayish white	Ch.
	9	31.48	16.77	1.88	2.73	30.90	11.59	Grayish white	Ch.
	11	16.40	7.40	2.22	2.66	41.10	16.18	Lt. buff	Ch., St. H.
	13	14.50	6.54	2.24	2.62	41.40	16.32	Lt. buff	Ch.
	15	9.74	4.17	2.33	2.59	44.10	17.62	Buff, specked	Cr.
	18	9.37	4.05	2.31	2.55	43.85	17.53	Buff, specked	Cr.
A82 C2	1	38.65	22.05	1.75	2.86	21.59	7.79	Lt. gray	Cr.
	3	34.46	16.75	2.05	2.84	32.65	12.37	Pinkish gray	Cr., St. H.
	7	22.23	10.14	2.19	2.82	37.95	14.73	Pinkish gray	Cr.
	11	17.20	7.54	2.28	2.75	39.50	15.42	Gray-buff	Cr.
	13	13.54	5.78	2.35	2.71	41.50	16.37	Gray-buff	Cr.
	15	9.94	4.52	2.20	2.45	37.70	14.59	Gunmetal	Cr.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

Hole A87

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A87 4.9-12.0 Ft.	1	45.58	30.25	1.51	2.77	11.56	4.03	White Ch.
	3	42.81	21.75	1.58	2.76	16.11	5.72	Pink Ch.
	5	43.60	27.80	1.57	2.79	15.60	5.50	Pink Ch.
	7	37.50	22.05	1.70	2.72	21.58	7.79	Pink Ch.
	9	27.57	13.90	1.98	2.68	32.92	12.50	Cream Ch., St. H.
	11	20.74	9.54	2.17	2.74	39.10	15.24	Cream Ch.
	13	10.41	4.48	2.32	2.60	42.40	16.80	Gray-buff, specked
	15	8.15	3.42	2.38	2.60	44.80	17.97	Gray-buff, specked
	18	6.57	2.73	2.41	2.58	45.10	18.12	Gray-buff, specked
A87 12.0-20.4 Ft.	1	46.70	31.04	1.52	2.85	4.40	1.49	Salmon
	3	39.84	23.72	1.68	2.79	11.35	3.95	Salmon
	5	36.35	19.60	1.85	2.91	23.52	9.39	Salmon
	7	28.50	13.81	2.06	2.88	29.87	11.17	Salmon St. H.
	9	26.36	12.72	2.08	2.82	30.12	11.29	Salmon
	11	22.51	12.02	2.15	2.90	34.30	13.07	Tan
	13	21.58	9.50	2.27	2.90	38.93	15.19	Gray-buff
	15	9.52	4.20	2.27	2.51	38.32	14.91	Gunmetal
A87 20.4-23.0 Ft.	1	31.68	18.47	1.72	2.51	1.18	.40	Lt. cream
	3	26.91	14.99	1.80	2.46	7.72	2.67	Cream
	5	25.58	14.00	1.83	2.45	8.66	2.99	Cream
	7	19.93	10.63	1.90	2.38	11.57	4.03	Cream
	9	16.94	8.51	1.98	2.40	15.74	5.57	Cream
	11	13.80	6.75	2.04	2.37	19.65	7.05	Cream St. H.
	13	12.62	5.92	2.10	2.39	21.16	7.63	Grayish cream
	15	8.65	4.29	2.02	2.21	18.39	6.55	Grayish brown, specked
A87 4.9-23.0 Ft.	1	44.12	29.11	1.51	2.71	7.11	2.46	Pink
	3	38.62	23.19	1.67	2.72	16.90	5.98	Pink
	5	35.76	19.99	1.79	2.79	21.69	7.83	Pink
	7	32.78	17.46	1.86	2.79	26.23	9.67	Pink St. H.
	9	25.20	12.24	2.04	2.73	31.47	11.85	Pink
	11	24.44	11.71	2.09	2.76	32.53	12.32	Grayish cream
	13	22.11	10.42	2.11	2.70	34.16	13.02	Grayish cream
	15	7.22	3.13	2.31	2.49	39.22	15.33	Dark buff, specked

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

Modulus of rupture, Hole A87

Sample	At cone	1	3	5	7	9	11	13	15	18
4.9-12.0 ft.	Lbs./sq. in.	54	90	91	100	231	390	590	603	723
12.0-20.4 ft.	Lbs./sq. in.	283	325	1082	1242	1432	1688	2023	1383	
20.4-23.0 ft.	Lbs./sq. in.	1110	1512	2373	2305	3267	3880	4019	2814	
4.9-23.0 ft.	Lbs./sq. in.	248	261	622	835	1292	1321	1395	1809	

HOLES A69A, A70, A184

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A184 C1	1	42.15	26.92	1.56	2.70	8.06	2.78	White Cr.
	3	40.05	24.63	1.62	2.71	10.46	3.63	White
	5	37.75	22.98	1.64	2.64	11.72	4.10	White
	7	37.55	22.10	1.70	2.71	14.62	5.16	White
	9	33.70	18.95	1.78	2.69	19.35	6.94	White Cr.
	11	32.82	17.85	1.83	2.73	19.68	7.05	White
	13	30.80	16.44	1.87	2.70	22.80	8.26	White
	15	27.65	14.20	1.94	2.69	25.70	9.43	White, specked Cr.
	18	25.00	12.38	2.01	2.69	27.92	10.37	White, specked Cr. not St. H.
A69A P1	1	41.37	25.45	1.61	2.75	13.96	4.90	White Ch.
	3	38.40	23.05	1.67	2.77	14.29	5.01	White Ch.
	5	31.72	16.84	1.88	2.71	25.55	9.39	White Ch.
	7	19.23	8.91	2.17	2.69	30.15	11.29	Lt. cream Cr., St. H.
	9	27.91	14.00	1.99	2.67	35.37	13.55	Lt. cream Cr.
	11	12.90	5.71	2.26	2.59	37.03	14.32	Cream Cr.
	13	9.53	4.14	2.32	2.56	38.83	15.14	Cream Cr.
	15	6.25	2.56	2.39	2.61	42.80	16.37	Gray-buff Ch.
	18	5.55	2.32	2.45	2.53	41.50	16.99	Gray-buff Ch.
A69A P2-3	1	53.40	35.60	1.58	2.62	1.58	.54	Lt. cream Cr.
	3	44.10	27.24	1.50	3.21	4.64	1.59	Lt. cream Cr.
	5	39.75	25.13	1.70	3.14	4.76	1.63	Lt. cream Cr.
	7	37.18	22.23	1.69	2.69	6.25	2.15	Cream
	9	32.70	18.10	1.80	2.68	9.78	3.38	Cream
	11	32.62	17.73	1.84	2.74	13.77	4.83	Cream
	13	32.33	17.37	1.86	2.75	15.23	5.38	Lt. buff Cr.
	15	23.71	11.95	1.99	2.60	20.42	7.36	Buff Cr., St. H.
	18	21.38	10.47	2.04	2.60	21.01	7.60	Buff Cr.
A70 C1	1	43.35	27.96	1.55	2.74	13.48	4.72	Lt. cream Cr.
	3	33.20	18.95	1.76	2.62	23.46	8.54	Cream Cr.
	5	21.70	10.32	2.10	2.67	36.05	13.87	Cream Cr., St. H.
	7	19.60	9.07	2.17	2.69	38.20	14.82	Cream Cr.
	9	13.52	6.03	2.24	2.59	38.00	14.73	Cream Cr.
	11	12.08	5.29	2.29	2.60	40.40	15.84	Buff Cr.
	13	7.42	3.15	2.36	2.54	43.20	17.18	Buff Cr.
	15	6.29	2.65	2.37	2.53	43.60	17.38	Buff Cr.
	18	7.16	3.09	2.38	2.57	41.90	16.56	Buff Cr.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A69A

Sample	At cone	1	3	5	7	9	11	13	15	18
P1	Lbs./sq. in.	42	69	77	104	252	335	335	469	917
P2-3	Lbs./sq. in.	222	235	356	857	962	1261	1332	1579	1719

HOLES A70, A73

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A70 C2	1	38.25	24.32	1.57	2.55	8.66	2.99	White	
	3	31.40	17.93	1.75	2.55	18.05	6.44	White	
	5	23.33	11.95	1.95	2.55	25.50	9.35	White	
	7	23.10	11.80	1.96	2.54	26.33	9.71	Lt. cream	St. H.
	9	22.15	10.70	2.03	2.55	29.52	11.04	Lt. cream	
	11	20.38	10.01	2.07	2.55	31.60	11.89	Cream	
	13	11.64	5.23	2.23	2.52	34.85	13.33	Lt. gray	
	15	6.09	2.64	2.31	2.46	37.40	14.46	Bluish gray	
	18	4.29	1.94	2.21	2.31	33.20	12.58	Bluish gray	
A70 P1	1	42.04	26.52	1.58	2.75	11.93	4.17	White	Cr.
	3	34.42	19.77	1.77	2.65	21.89	7.91	White	Cr.
	7	33.55	18.95	1.78	2.68	22.85	8.30	Lt. cream	Cr.
	9	15.96	7.71	2.16	2.58	36.62	14.14	Cream	Cr., St. H.
	11	8.65	3.75	2.30	2.53	40.98	16.13	Lt. gray	Cr.
	13	7.17	3.07	2.33	2.51	41.37	16.32	Lt. gray	Cr.
	15	4.82	2.02	2.39	2.51	43.22	17.23	Gray-buff	Cr.
	18	4.89	2.13	2.29	2.40	40.57	15.94	Gray-buff	Cr.
A73 C1	1	41.60	27.65	1.56	2.76	26.72	9.88	White	Ch.
	3	41.20	25.96	1.58	2.70	24.60	8.98	White	Ch.
	5	37.60	23.00	1.63	2.75	18.65	6.67	White	Ch.
	7	37.60	22.95	1.71	2.79	19.03	6.82	White	Ch.
	9	36.85	21.10	1.74	2.76	21.05	7.60	White	Ch.
	11	33.40	18.05	1.85	2.76	25.80	9.47	Lt. cream	Ch., St. H.
	13	26.60	13.06	2.03	2.77	32.72	12.41	Lt. cream	Ch.
	15	20.73	9.52	2.18	2.75	37.85	14.68	Lt. cream	Ch.
	18	14.22	6.13	2.32	2.70	40.50	15.89	Lt. cream	Ch.
A73 C2	1	46.40	29.59	1.57	2.93	14.29	5.01	Pink	
	3	43.90	27.70	1.58	2.82	14.68	5.16	Pink	Ch.
	5	38.70	22.20	1.74	2.87	22.65	8.22	Grayish pink	Ch.
	7	36.85	20.35	1.81	2.89	25.25	9.27	Grayish pink	Ch.
	9	33.60	17.54	1.92	2.85	29.50	11.00	Grayish pink	Ch.
	11	28.25	13.52	2.09	2.91	36.00	13.82	Gray-buff	Ch., St. H.
	13	27.00	12.66	2.13	2.92	36.75	14.18	Gray-buff	
	15	9.66	4.19	2.31	2.55	41.75	16.51	Mottled brown	

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A70

Sample	At cone	1	3	7	9	11	13	15	18
P1	Lbs./sq. in.	183	221	566	755	1215	1305	1310	1549

HOLES A73, A96

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A73 C3	1	30.98	17.46	1.77	2.57	4.00	1.35	White	
	3	29.13	16.00	1.82	2.57	7.36	2.53	White	
	5	23.05	12.07	1.91	2.48	11.62	4.06	White	
	7	20.10	10.13	1.99	2.49	14.88	5.24	Lt. gray-buff	
	9	19.85	9.86	2.01	2.51	15.73	5.57	Lt. gray-buff	
	11	14.26	6.78	2.10	2.47	19.25	6.90	Lt. gray-buff	St. H.
	13	13.00	6.16	2.11	2.42	19.38	6.94	Lt. gray-buff	
	15	5.44	2.54	2.14	2.27	22.60	8.18	Grayish brown, specked	
A96 C1	1	52.75	33.03	1.60	3.38	12.12	4.24	White	Ch.
	3	46.00	28.55	1.61	2.99	12.77	4.46	White	Ch.
	5	28.10	15.55	1.70	2.71	23.10	8.38	White	Ch.
	7	26.45	14.40	1.95	2.70	31.00	11.63	Lt. cream	Ch., St. H.
	9	23.75	11.49	2.06	2.62	34.45	13.15	Lt. cream	Ch.
	11	11.93	5.17	2.31	2.59	40.20	15.75	Lt. cream	Cr.
	13	10.26	4.42	2.32	2.59	41.35	16.32	Lt. gray	Cr.
	15	5.35	2.20	2.43	2.57	44.10	17.62	Grayish buff	Cr.
	18	5.23	2.16	2.41	2.55	44.30	17.72	Grayish buff	Cr.
A96 C2	1	44.65	29.10	1.54	2.77	10.25	3.56	White	Ch.
	3	41.25	25.60	1.61	2.74	13.53	4.76	White	Ch.
	5	39.90	24.40	1.64	2.72	15.06	5.31	White	Ch.
	7	33.50	19.02	1.81	2.77	22.75	8.26	White	Ch.
	9	32.00	17.30	1.85	2.72	26.38	9.71	White	Ch., St. H.
	11	25.50	12.42	2.03	2.75	33.48	12.71	Lt. cream	Cr.
	13	22.08	10.31	2.14	2.75	36.15	13.91	Grayish white	Cr.
	15	11.99	5.17	2.31	2.63	40.75	16.03	Buff, specked	Cr.
	18	10.20	4.34	2.35	2.62	42.60	16.89	Buff, specked	Cr.
A96 C3	1	38.20	26.15	1.46	2.50	2.75	.94	White	
	3	34.80	21.99	1.58	2.49	12.78	4.46	White	
	5	34.20	21.45	1.61	2.42	13.06	4.57	White	
	7	33.15	20.00	1.62	2.42	13.52	4.76	White	
	9	32.30	19.88	1.67	2.40	14.62	5.16	White	
	11	28.08	16.12	1.74	2.38	22.45	8.15	Lt. cream, specked	St. H.
	13	27.80	15.90	1.75	2.37	22.10	7.99	Grayish white, specked	
	15	20.52	11.38	1.80	2.27	24.70	9.02	Buff	
	18	13.20	6.66	1.98	2.28	31.30	11.76	Buff	

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

REGION D

Region D is within T.2 S., R.3 E., Secs. 28 and 33. Samples were secured from the properties of National Forest and G. L. Peeler. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A173	C1	3B	24.51	13.97	4.90	Fine, open	Yellow
A173	C3	3A2	23.82	14.65	5.16	Fine, open	Lt. gray
A173	C4	3A2	20.84	7.34	2.53	Fine, open	Dk. gray
A175	C1	3A2	25.15	17.68	6.29	Fine, open	Lt. gray
A175	C2	3A2	23.15	14.24	5.01	Fine, open	Lt. gray
A175	C3	3A1	23.24	12.38	4.32	Fine, open	Gray
A175	C4	3A1	22.52	13.13	4.61	Fine, open	Dk. gray
A180	C1	2A	30.03	6.23	2.15	Fine, open	Cream
A180	C2	4A	28.13	15.34	5.42	Fine, open	Yellow
A181	C1	1A	29.97	8.32	2.88	Fine, open	Cream
A181	C2-3	4C	28.63	14.19	4.98	Fine, open	Yellow
A181	C4	4B	24.48	15.52	5.50	Fine, open	Lt. gray
A182	C2-3	2A	31.10	15.08	5.31	Fine, open	Gray
A182	C4	4C	27.93	7.05	2.42	Fine, open	Yellow
A195	C1	2A	32.12	9.96	3.45	Fine, open	Cream

PYRO-PHYSICAL PROPERTIES

HOLES A173, A175

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A173 C1	1	27.35	15.03	1.82	2.50	5.36	1.83	Buff	
	3	25.05	13.25	1.89	2.52	9.34	3.24	Buff	
	5	24.40	12.26	1.99	2.63	14.80	5.20	Buff	
	7	16.93	8.41	2.01	2.43	16.67	5.91	Buff	
	9	14.92	6.58	2.11	2.46	19.58	7.01	Buff	St. H.
	11	8.09	3.62	2.24	2.43	24.30	8.86	Lt. gray	
	13	9.43	4.25	2.22	2.45	24.50	8.94	Lt. gray	
	15	13.24	7.36	1.80	2.07	6.94	2.39	Gray	
A173 C3	1	25.85	13.96	1.85	2.50	5.77	1.97	Cream	
	3	22.20	11.41	1.94	2.50	10.67	3.70	Cream	
	5	15.55	7.49	2.08	2.46	16.05	5.68	Lt. buff	
	7	8.39	3.81	2.20	2.40	21.40	7.71	Lt. buff	St. H.
	9	8.00	3.58	2.23	2.43	22.12	8.03	Lt. buff	
	11	2.56	1.10	2.32	2.38	25.18	9.22	Lt. gray	
	13	3.36	1.44	2.33	2.42	26.46	9.75	Lt. gray	
	15	16.02	9.66	1.66	1.97	-4.30	-1.46	Lt. gray	
A173 C4	1	21.83	11.30	1.93	2.47	7.83	2.71	Buff	
	3	18.92	9.62	1.97	2.44	10.54	3.67	Buff	
	5	16.22	7.86	2.06	2.46	14.43	5.09	Buff	
	7	11.33	5.88	2.11	2.37	14.00	4.90	Grayish buff	St. H.
	9	6.54	2.89	2.26	2.42	22.20	8.03	Grayish buff	
	11	2.36	1.13	2.08	2.13	19.20	6.86	Gray	
	13	18.27	10.15	1.80	2.20	1.34	.47	Gray	
	15	18.00	13.04	1.38	1.68	-17.85	-6.36	Gray	
A175 C1	1	24.82	12.98	1.91	2.54	9.96	3.45	Cream	
	3	16.73	8.06	2.07	2.49	14.80	5.20	Cream	
	5	14.78	6.92	2.14	2.51	20.00	7.17	Cream	St. H.
	7	7.73	3.45	2.24	2.55	24.65	9.02	Buff	
	9	5.33	2.29	2.32	2.45	27.03	10.00	Buff	
	11	.70	.29	2.37	2.39	28.73	10.71	Gray	
	13	.50	.21	2.37	2.38	28.30	9.67	Gray	
	15	16.05	9.61	1.67	1.99	-1.64	-.57	Gray	
A175 C2	1	24.30	12.85	1.89	2.50	7.02	2.42	Cream	
	3	15.92	7.72	2.04	2.46	16.13	5.72	Cream	
	5	15.55	7.62	2.07	2.42	16.78	5.95	Cream	St. H.
	7	9.79	4.57	2.14	2.42	19.16	6.86	Grayish cream	
	9	6.79	3.01	2.25	2.37	23.70	8.62	Grayish cream	
	11	6.57	2.86	2.30	2.46	24.73	9.06	Lt. gray	
	13	2.52	1.09	2.32	2.38	25.35	9.31	Lt. gray	
	15	20.36	12.12	1.68	2.11	-2.09	-.70	Lt. gray	
A175 C3	1	20.60	13.02	1.99	2.51	13.17	4.61	Buff	
	3	13.82	6.52	2.12	2.46	19.50	6.98	Buff	St. H.
	5	10.67	4.90	2.18	2.44	21.13	7.63	Buff	
	7	8.27	3.75	2.21	2.41	22.58	8.18	Grayish buff	
	9	.49	.21	2.37	2.38	27.60	10.21	Grayish buff	
	11	.32	.14	2.27	2.28	24.20	8.82	Gray	
	13	.20	.09	2.30	2.31	26.08	9.59	Gray	
	15	14.48	8.82	1.64	1.92	-3.23	-1.11	Gray	

Abbreviations: St. H., steel hard.

HOLES A175, A180, A181

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A175 C4	1	21.55	11.14	1.94	2.47	7.84	2.71	Buff
	3	14.15	6.85	2.07	2.45	16.95	6.02	Buff St. H.
	5	13.83	6.67	2.07	2.41	17.17	6.10	Buff
	7	7.84	3.48	2.25	2.41	23.85	8.70	Gray
	9	1.30	.57	2.27	2.30	25.00	9.14	Gray
	11	1.38	.66	2.10	2.13	18.60	6.63	Gray
	13	.72	.33	2.14	2.16	18.85	6.74	Gray
	15	20.60	15.63	1.32	1.66	-30.00	-11.21	Gray
A180 C1	1	43.40	28.80	1.51	2.66	10.79	3.74	White Cr.
	3	39.40	24.40	1.61	2.67	18.72	6.71	White Cr.
	5	40.45	24.72	1.64	2.75	19.60	7.01	White Cr.
	7	36.93	21.83	1.69	2.68	22.10	7.99	White Cr.
	9	32.70	17.95	1.82	2.71	24.83	9.10	White Cr.
	11	29.40	15.16	1.94	2.74	31.96	12.06	White Cr., St. H.
	13	21.65	10.27	2.11	2.68	37.15	14.36	Cream Cr.
	15	6.48	2.69	2.41	2.58	45.40	18.27	Lt. gray Cr.
	18	4.57	1.86	2.45	2.57	46.25	18.72	Lt. gray Cr.
A180 C2	1	26.75	14.78	1.81	2.48	13.08	4.57	Cream
	3	26.90	14.62	1.84	2.51	15.74	5.57	Cream
	5	24.35	12.80	1.90	2.52	19.22	6.90	Cream
	7	20.30	10.11	2.01	2.52	23.05	8.38	Cream St. H.
	9	19.41	9.78	1.99	2.47	23.55	8.58	Buff
	11	15.34	7.34	2.09	2.47	26.10	9.59	Buff
	13	11.95	5.55	2.16	2.45	26.25	9.67	Buff
	15	4.58	2.09	2.19	2.30	29.08	10.83	Grayish brown, specked
	18	14.22	7.24	1.96	2.29	21.52	7.79	Grayish brown, specked
A181 C1	7	37.70	22.12	1.70	2.79	21.43	7.75	White Cr.
	9	35.12	19.63	1.79	2.76	26.52	9.79	White Cr.
	11	30.65	15.84	1.94	2.75	30.35	11.83	White Cr., St. H.
	13	26.28	12.97	2.03	2.73	34.48	13.15	White Cr.
	15	8.42	3.53	2.39	2.61	44.50	17.82	Lt. gray
	18	5.40	2.18	2.47	2.61	45.15	18.17	Lt. gray
A181 C2-3	1	31.32	17.25	1.77	2.73	14.74	5.20	Cream
	3	30.63	16.73	1.84	2.65	20.58	7.40	Grayish pink
	5	30.40	16.52	1.87	2.63	21.57	7.79	Grayish pink
	7	19.92	9.56	2.08	2.60	28.40	10.54	Buff St. H.
	9	16.48	7.50	2.18	2.61	31.28	11.76	Buff
	11	14.87	6.68	2.18	2.60	33.45	12.71	Buff
	13	12.23	5.62	2.20	2.48	34.30	13.07	Buff
	15	10.00	4.60	2.23	2.42	31.75	11.98	Mottled brown

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

HOLES A181, A182, A195

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A181 C4	1	28.13	15.45	1.82	2.53	9.40	3.24	Cream
	3	21.40	10.76	1.99	2.53	14.83	5.24	Cream
	5	20.20	10.04	2.01	2.52	17.63	6.29	Cream St. H.
	7	15.16	7.15	2.12	2.51	22.00	7.95	Cream
	9	12.05	5.57	2.17	2.47	24.30	8.86	Grayish cream
	11	9.57	4.31	2.22	2.45	24.90	9.10	Grayish cream
	13	6.65	2.89	2.30	2.35	27.75	10.29	Lt. gray
	15	11.53	6.21	1.86	2.10	11.25	3.92	Gray, specked
A182 C2-3	1	39.00	23.72	1.64	2.69	12.50	4.35	White
	3	30.65	17.28	1.82	2.63	24.05	8.78	White Cr.
	5	29.05	15.38	1.89	2.66	25.78	9.47	Cream Cr.
	7	23.45	11.62	2.02	2.63	30.67	11.51	Cream Cr., St. H.
	9	13.75	6.18	2.20	2.58	36.28	13.96	Cream
	11	13.42	6.09	2.23	2.55	37.65	14.59	Cream
	13	9.57	4.15	2.30	2.55	37.92	14.73	Lt. gray
	15	1.46	.60	2.42	2.46	42.60	16.89	Gray
	18	2.76	1.15	2.39	2.46	41.10	16.18	Gray
A182 C4	3	27.38	14.10	1.95	2.68	24.18	8.82	Lt. red
	5	25.68	12.67	2.03	2.73	26.63	9.84	Lt. red
	7	23.12	11.32	2.04	2.66	28.42	10.58	Lt. red St. H.
	9	15.61	7.08	2.21	2.61	33.45	12.71	Reddish brown
	11	11.50	5.19	2.21	2.50	33.45	12.71	Reddish brown
	13	4.09	1.72	2.38	2.48	36.55	14.09	Brown
	15	11.80	5.59	2.11	2.39	30.25	11.34	Brown Cr.
A195 C1	1	46.60	30.75	1.49	2.73	14.28	5.01	White Cr.
	3	45.40	30.55	1.54	2.72	14.43	5.09	White Cr.
	5	43.35	28.10	1.51	2.83	15.26	5.38	White Cr.
	7	37.90	22.27	1.70	2.74	23.25	8.46	White Cr.
	9	30.45	16.32	1.87	2.69	31.00	11.63	Cream Cr.
	11	29.86	15.38	1.92	2.79	33.67	12.80	Cream Cr.
	13	29.45	14.93	1.94	2.77	35.60	13.64	Cream Cr., St. H.
	15	9.30	3.92	2.37	2.61	45.50	18.32	Cream, specked
	18	4.27	1.71	2.49	2.60	47.40	19.28	Grayish cream Cr.

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

REGION E

Region E is within T.2 S., R.3 E., Sec. 28. Samples were secured from the properties of B. W. Martindale and National Forest. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A121	6.0-10.3	3A2	23.06	17.46	6.21	Fine, open	Gray
A121	10.3-15.0	1A	30.24	3.87	1.31	Fine, open	Cream
A121	15.0-21.0	4A	28.40	11.50	3.99	Fine, open	Yellow
A121	6.0-21.0	7	27.81	12.07	4.21	Fine, open	Gray
A137	C1	2A	29.23	10.45	3.63	Fine, open	Cream
A155	2.3-8.9	3A2	35.53	26.49	9.75	Fine, open	Dk. gray
A155	8.9-14.0	1A	32.92	8.89	3.06	Fine, open	Cream
A155	14.0-21.9	4A	31.31	9.86	3.42	Fine, open	Yellow
A155	2.3-21.9	7	31.76	14.68	5.16	Fine, open	Gray
A157	C1	3A1	25.39	17.63	6.29	Fine, open	Gray
A161	C1	2C	29.96	8.00	2.74	Fine, open	Lt. gray
A161	C2	4B	25.83	12.50	4.35	Fine, open	Lt. gray
A162	C1	2B	27.07	10.21	3.56	Fine, open	Yellow
A162	C2	4C	30.12	7.40	2.53	Fine, open	Yellow
A162	C3	4B	25.54	15.22	5.38	Fine, open	Lt. gray
A163	C1	4C	30.24	15.49	5.46	Fine, open	Yellow
A172	C1	3B	23.24	16.88	5.98	Fine, open	Yellow
A172	C2	2C	30.75	13.60	14.76	Fine, open	Lt. gray
A196	C1	2B	26.09	15.30	5.38	Fine, open	Lt. gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./ sq. in.
A121	6.0-10.3	174
A121	10.3-15.0	40
A121	15.0-21.0	68
A121	6.0-21.0	103

Hole No.	Sample No.	Lbs./ sq. in.
A155	2.3-8.9	220
A155	8.9-14.0	38
A155	14.0-21.9	55
A155	2.3-21.9	85

SCREEN ANALYSES

HOLE A121 SAMPLE 6.0-10.3 FT.

Retained on screen	Percent	Character of residue
30	6.16	Abundance of quartz; small amounts of limonitic material and plant fragments
60	7.99	Abundance of quartz and gray clay; small amount of ferruginous material; traces of kaolin and rutile
100	6.36	Abundance of quartz; small amounts of gray clay, limonitic clay, muscovite, and ferruginous material
150	2.68	Abundance of quartz; small amounts of gray clay, limonitic clay, muscovite, and ferruginous material
200	3.59	Abundance of quartz; small amounts of kaolin and muscovite; traces of hematite, limonite, and rutile
250	3.24	Abundance of quartz; traces of muscovite, rutile, hematite, and ferruginous material
Cloth	69.98	Clay substance including residue from above

HOLE A121 SAMPLE 10.3-15.0 FT.

Retained on screen	Percent	Character of residue
30	0.41	Abundance of quartz and white clay; small amount of gray clay; trace of limonite
60	1.92	Abundance of white clay; small amounts of limonite, gray clay, and quartz
100	4.15	Abundance of white clay; small amounts of gray clay, quartz; trace of muscovite
150	1.59	Abundance of white clay; considerable quantity of quartz; small amounts of gray clay, muscovite, and carbonaceous material
200	1.76	Abundance of white clay; considerable quantity of quartz; small amounts of gray clay, muscovite, and carbonaceous material
250	1.72	Abundance of white clay and quartz; traces of kaolinite, muscovite, and rutile
Cloth	88.45	Clay substance including residue from above

HOLE A121 SAMPLE 15.0-21.0 FT.

Retained on screen	Percent	Character of residue
30	1.52	Abundance of micaceous limonitic nodules; small amount of quartz; trace of ferruginous material
60	3.11	Abundance of micaceous limonitic nodules; small amounts of muscovite and quartz; trace of ferruginous material
100	3.93	Abundance of white clay and muscovite; considerable quantity of limonitic clay
150	3.41	Abundance of white clay and muscovite; considerable quantity of limonitic clay; small amount of quartz
200	9.19	Abundance of muscovite, quartz, white clay, and limonitic clay
250	7.04	Abundance of quartz and muscovite; small amounts of white clay and limonitic clay; trace of rutile
Cloth	71.80	Clay substance including residue from above

HOLE A155 SAMPLE 2.3-8.9 FT.

Retained on screen	Percent	Character of residue
30	2.90	Abundance of gray and lignitic clay nodules; small amount of lignite; trace of quartz
60	7.19	Abundance of bentonitic clay; small amounts of lignite and gray clay; trace of plant fragments
100	8.15	Abundance of bentonitic clay, grayish white clay and lignite; traces of limonite and muscovite
150	5.26	Abundance of white clay; considerable quantity of bentonitic clay; small amount of quartz; traces of lignite and limonite
200	5.47	Abundance of grayish white clay; small amounts of quartz, lignite, and bentonitic clay; traces of limonite and muscovite
250	5.79	Abundance of grayish white clay; small amounts of quartz, lignite, and bentonitic clay; traces of limonite and muscovite
Cloth	65.24	Clay substance including residue from above

HOLE A155 SAMPLE 8.9-14.0 FT.

Retained on screen	Percent	Character of residue
30	1.94	Abundance of micaceous, limonitic nodules and lignitic bentonite clay lumps; small amounts of quartz
60	5.36	Abundance of lignitic bentonitic clay nodules and limonitic clay nodules; small amounts of quartz, muscovite, and white clay
100	6.64	Abundance of muscovite and gray clay; small amounts of limonitic clay, quartz, and lignitic clay
150	2.04	Abundance of muscovite and gray clay; small amounts of limonite, kaolin, and lignitic clay; trace of quartz
200	4.56	Abundance of kaolin; small amounts of limonitic clay, gray clay, lignitic clay, and quartz; trace of muscovite
250	3.57	Abundance of quartz and limonitic clay; small amounts of kaolin, gray clay, lignite, and muscovite
Cloth	75.89	Clay substance including residue from above

HOLE A155 SAMPLE 14.0-21.9 FT.

Retained on screen	Percent	Character of residue
30	2.01	Abundance of micaceous, limonitic clay nodules; small amounts of quartz and lignite
60	3.33	Abundance of micaceous limonitic clay nodules; small amounts of quartz and muscovite; traces of clay and ferruginous rock
100	4.19	Abundance of muscovite and limonitic clay lumps; small amounts of clay and lignite
150	3.32	Abundance of muscovite and white clay; considerable quantity of limonitic clay; small amounts of quartz; trace of biotite
200	6.17	Abundance of muscovite; considerable quantity of quartz; small amounts of white and limonitic clay; trace of ferruginous rock
250	5.38	Abundance of quartz; small amounts of limonitic clay and white clay; traces of feldspar, kaolinite, and rutile
Cloth	75.60	Clay substance including residue from above

HOLE A157 SAMPLE C1

Retained on screen	Percent	Character of residue
30	0.12	Abundance of ferruginous material; considerable quantity of limonitic clay nodules; small amount of quartz
60	0.52	Considerable quantity of ferruginous material; small amounts of limonitic clay and quartz
100	0.51	Abundance of quartz; considerable quantity of muscovite; small amounts of limonitic clay nodules and ferruginous material
150	2.32	Abundance of quartz; small amounts of limonitic material and muscovite
200	1.72	Abundance of quartz; small amount of muscovite; traces of biotite and limonite
250	1.10	Abundance of quartz; considerable quantity of muscovite; traces of limonite and magnetite
Cloth	93.71	Clay substance including residue from above

CHEMICAL ANALYSES*

HOLE A121 SAMPLE 6.0-10.3 FT.

Soluble salts	0.30	Moisture, air dried	1.02	Sulphur, SO_3	None
Ignition loss	7.96	Iron oxide, Fe_2O_3	1.10	Magnesia, MgO	0.32
Silica, SiO_2	64.44	Titania, TiO_2	1.40	Potash, K_2O	0.05
Alumina, Al_2O_3	24.34	Lime, CaO	0.96	Soda Na_2O	0.07

HOLE A121 SAMPLE 10.3-15.0 FT.

Soluble salts	0.10	Moisture, air dried	1.07	Sulphur, SO_3	0.03
Ignition loss	12.32	Iron oxide, Fe_2O_3	0.60	Magnesia, MgO	0.27
Silica, SiO_2	44.58	Titania, TiO_2	1.30	Potash, K_2O	0.01
Alumina, Al_2O_3	39.74	Lime, CaO	0.35	Soda, Na_2O	0.25

HOLE A121 SAMPLE 15.0-21.0 FT.

Soluble salts	0.10	Moisture, air dried	0.72	Sulphur, SO_3	Trace
Ignition loss	10.98	Iron oxide, Fe_2O_3	1.67	Magnesia, MgO	0.16
Silica, SiO_2	49.95	Titania, TiO_2	2.15	Potash, K_2O	0.07
Alumina, Al_2O_3	33.95	Lime, CaO	0.61	Soda, Na_2O	0.14

HOLE A155 SAMPLE 2.3-8.9 FT.

Soluble salts	0.10	Moisture, air dried	1.52	Sulphur, SO_3	None
Ignition loss	10.38	Iron oxide, Fe_2O_3	1.14	Magnesia, MgO	0.17
Silica, SiO_2	55.36	Titania, TiO_2	1.90	Potash, K_2O	0.07
Alumina, Al_2O_3	30.29	Lime, CaO	Trace	Soda, Na_2O	0.27

HOLE A155 SAMPLE 8.9-14.0 FT.

Soluble salts	0.10	Moisture, air dried	1.12	Sulphur, SO_3	None
Ignition loss	12.50	Iron oxide, Fe_2O_3	1.50	Magnesia, MgO	0.88
Silica, SiO_2	49.51	Titania, TiO_2	2.60	Potash, K_2O	0.15
Alumina, Al_2O_3	33.11	Lime, CaO	None	Soda, Na_2O	0.56

HOLE A155 SAMPLE 14.0-21.9 FT.

Soluble salts	0.10	Moisture, air dried	0.93	Sulphur, SO_3	Trace
Ignition loss	11.94	Iron oxide, Fe_2O_3	1.20	Magnesia, MgO	0.05
Silica, SiO_2	46.37	Titania, TiO_2	0.90	Potash, K_2O	0.05
Alumina, Al_2O_3	38.51	Lime, CaO	0.87	Soda, Na_2O	0.13

HOLE A157 SAMPLE C1**

Soluble salts	None	Moisture, air dried		Sulphur, SO_3	Trace
Ignition loss	6.62	Iron oxide, Fe_2O_3	0.81	Magnesia, MgO	0.23
Silica, SiO_2	67.47	Titania, TiO_2	0.20	Potash, K_2O	0.11
Alumina, Al_2O_3	23.47	Lime, CaO	1.00	Soda, Na_2O	0.23

* Analyses of residue washed through 250 mesh screen

** Analysis of whole sample

M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

Hole A121

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A121 6.0-10.3 Ft.	1	31.91	17.86	1.78	2.62	-3.90	-1.32	Cream	
	3	30.13	16.11	1.87	2.43	-4.05	-1.39	Cream	
	5	28.37	14.88	1.87	2.68	.13	.07	Cream	
	7	23.02	11.71	1.91	2.66	2.29	.77	Cream	
	9	22.32	11.19	1.96	2.54	6.38	2.18	Cream	St. H.
	11	20.00	10.49	2.00	2.57	8.11	2.81	Lt. buff	
	13	19.77	9.59	2.02	2.53	8.43	2.92	Lt. buff	
	15	14.52	6.98	2.08	2.43	13.24	4.65	Buff, specked	
	18	8.53	3.92	2.17	2.38	14.89	5.24	Brown	
A121 10.3-15.0 Ft.	1	43.28	27.84	1.55	2.74	11.26	3.92	White	Cr.
	3	41.35	25.58	1.62	2.70	14.77	5.20	White	Cr.
	5	39.58	23.81	1.67	2.75	17.65	6.29	White	Cr.
	7	32.23	20.43	1.74	2.75	20.99	7.56	White	Cr.
	9	28.18	14.56	1.93	2.69	30.10	11.25	Cream	Cr., St. H.
	11	22.70	10.69	2.12	2.75	35.15	13.46	Cream	Cr.
	13	17.65	7.94	2.22	2.70	37.83	14.68	Cream	Cr.
	15	9.22	3.91	2.35	2.65	41.33	16.32	Cream	Cr.
	18	5.90	2.43	2.42	2.58	42.75	16.99	Lt. gray	Cr.
A121 15.0-21.0 Ft.	1	39.48	24.80	1.59	2.63	11.78	4.10	Cream	
	3	31.23	17.27	1.79	2.59	15.43	5.46	Lt. buff	
	5	30.63	16.56	1.85	2.67	17.29	6.14	Lt. buff	
	7	27.53	14.37	1.92	2.65	19.68	7.05	Lt. buff	
	9	24.43	12.50	1.97	2.53	21.98	7.95	Buff	
	11	24.02	12.06	1.99	2.62	25.21	9.27	Buff	St. H.
	13	20.02	9.67	2.07	2.59	25.79	9.47	Buff	
	15	7.55	3.43	2.20	2.38	30.65	11.51	Brown	
	18	6.59	3.05	2.17	2.32	30.95	11.63	Brown	
A121 6.0-21.0 Ft.	1	38.72	24.19	1.60	2.61	5.52	1.90	Cream	
	3	35.45	20.86	1.71	2.57	11.78	4.10	Cream	
	5	33.30	18.65	1.78	2.68	14.52	5.12	Cream	
	7	30.49	17.10	1.78	2.65	14.96	5.27	Cream	
	9	25.47	12.97	1.95	2.57	22.57	8.18	Lt. buff	St. H.
	11	23.78	12.16	1.96	2.64	23.19	8.42	Lt. buff	
	13	20.27	9.86	2.06	2.58	26.33	9.71	Lt. buff	
	15	10.77	4.98	2.16	2.43	30.33	11.38	Buff, specked	
	18	7.55	3.39	2.22	2.41	31.72	11.98	Brown	

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

Modulus of rupture, Hole A121

Sample	At cone	1	3	5	7	9	11	13	15	18
6.0-10.3 ft.	Lbs./sq. in.	429	1014	1023	1699	1734	1728	1838	2092	2316
10.3-15.0 ft.	Lbs./sq. in.	151	177	193	591	673	1152	1342	1587	1555
15.0-21.0 ft.	Lbs./sq. in.	1175	1185	1373	2324	2332	3074	3090	2985	2747
6.0-21.0 ft.	Lbs./sq. in.	495	1014	1270	1896	2501	2585	2616	3517	3612

HOLES A137, A155

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A137 C1	1	42.40	27.65	1.53	2.67	10.72	3.74	White	Cr.
	3	39.60	24.10	1.64	2.72	16.23	5.76	White	Cr.
	5	32.30	17.88	1.81	2.67	24.65	9.02	White	Cr.
	7	29.60	15.85	1.87	2.65	27.45	10.16	Cream	Cr.
	9	25.25	12.50	2.02	2.71	33.00	12.50	Cream	Cr., St. H.
	11	15.14	6.80	2.23	2.62	39.15	15.28	Cream	Cr.
	13	14.32	6.35	2.25	2.63	39.65	15.52	Cream	Cr.
	15	4.21	1.73	2.44	2.55	44.10	17.62	Gray	
	18	3.91	1.59	2.46	2.56	44.65	17.92	Gray	
A155 2.3-8.9 Ft.	1	35.01	21.68	1.62	2.49	10.94	3.81	Lt. cream	
	3	30.92	17.93	1.72	2.53	17.50	6.21	Lt. cream	
	5	27.72	15.56	1.78	2.46	22.22	8.07	Lt. cream	
	7	22.28	11.80	1.89	2.43	23.54	8.58	Cream	St. H.
	9	15.35	7.85	1.97	2.33	28.47	10.58	Cream	
	11	12.13	5.86	2.07	2.36	31.16	11.72	Cream	
	13	10.64	5.02	2.12	2.37	32.23	12.19	Gray-buff	
	15	11.24	5.62	2.01	2.26	28.72	10.71	Gray-brown	
	18	17.62	9.65	1.82	2.22	21.50	7.75	Gray-brown	
A155 8.9-14.0 Ft.	1	45.75	30.99	1.48	2.72	11.93	4.17	White	Cr.
	3	43.33	28.45	1.52	2.68	15.09	5.31	White	Cr.
	5	42.43	26.65	1.59	2.77	19.43	6.98	White	Cr.
	7	38.93	23.28	1.67	2.73	22.15	8.03	White	Cr.
	9	27.42	14.18	1.96	2.69	34.08	12.98	Lt. Cream	Cr., St. H.
	11	20.75	9.73	2.13	2.69	38.37	14.91	Cream	Cr.
	13	17.60	8.08	2.18	2.64	39.65	15.52	Cream	Cr.
	15	6.13	2.56	2.39	2.54	45.67	18.42	Gray	Cr.
	18	5.39	2.20	2.45	2.59	46.77	18.97	Gray	Cr.
A155 14.0-21.9 Ft.	1	36.78	22.40	1.64	2.60	11.77	4.10	Cream	
	3	35.86	21.14	1.70	2.65	14.14	4.98	Pink	
	5	33.20	18.53	1.79	2.68	19.18	6.86	Pink	
	7	26.45	13.67	1.93	2.64	24.52	8.98	Buff	
	9	22.87	11.54	1.98	2.58	27.38	10.12	Buff	St. H.
	11	21.79	10.62	2.04	2.65	28.71	10.71	Buff	
	13	18.18	8.67	2.10	2.57	31.46	11.85	Buff	
	15	6.31	2.79	2.26	2.41	36.00	13.82	Brown	
A155 2.3-21.9 Ft.	1	39.44	25.21	1.57	2.59	22.38	8.11	Cream	
	3	36.31	21.90	1.66	2.60	27.12	10.04	Cream	
	5	33.01	18.54	1.79	2.66	31.48	11.85	Cream	
	7	26.64	13.76	1.93	2.64	36.70	14.14	Cream	
	9	23.27	11.75	1.98	2.58	38.26	14.87	Cream	St. H.
	11	19.56	9.39	2.08	2.59	40.11	15.75	Cream	
	13	14.43	6.67	2.16	2.53	43.02	17.14	Buff	
	15	5.40	2.34	2.31	2.44	48.45	19.84	Brown	

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

MODULUS OF RUPTURE, HOLE A155

Sample	At cone	1	3	5	7	9	11	13	15	18
2.3-8.9 ft.	Lbs./sq. in.	1647	1773	2377	3141	4466	4124	3617	1848	1991
8.9-14.0 ft.	Lbs./sq. in.	62	91	163	145	695	812	852	893	837
14.0-21.9 ft.	Lbs./sq. in.	886	1206	1200	2077	2349	3105	3088	2426	
2.3-21.9 ft.	Lbs./sq. in.	447	1171	1713	1742	2418	2976	3492	4115	

HOLES A157, A161, A162

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A157 C1	1	29.65	16.74	1.77	2.52	1.78	.60	Cream	
	3	20.25	10.10	2.00	2.49	16.22	5.76	Cream	St. H.
	5	15.23	7.37	2.06	2.43	17.72	6.32	Cream	
	7	14.38	6.85	2.10	2.45	19.52	7.01	Buff	
	9	1.04	.45	2.29	2.31	25.73	9.47	Gray	
	11	.47	.23	2.31	2.32	26.78	9.88	Gray	
	13	.36	.16	2.25	2.26	24.85	9.10	Gray	
	15	17.37	10.23	1.64	2.05	.35	.13	Gray	
A161 C1	1	42.80	27.85	1.53	2.69	11.00	3.81	White	Cr.
	3	37.60	22.95	1.63	2.62	16.00	5.65	White	Cr.
	5	35.48	20.35	1.74	2.70	20.75	7.48	White	Cr.
	7	35.22	20.08	1.75	2.70	21.70	7.83	White	Cr.
	9	26.88	14.23	1.89	2.43	27.50	10.16	Lt. cream	Cr.
	11	24.73	12.12	2.04	2.71	33.10	12.54	Cream	Cr., St. H.
	13	17.82	8.22	2.17	2.64	36.90	14.23	Cream	Cr.
	18	7.27	3.06	2.38	2.56	42.15	16.70	Gray-buff	Cr.
A161 C2	1	27.75	15.66	1.77	2.45	10.48	3.63	Grayish white	
	3	23.10	12.18	1.90	2.47	16.55	5.87	Grayish white	
	5	22.75	11.82	1.93	2.49	18.28	6.52	Grayish white	
	7	22.65	11.75	1.93	2.50	18.72	6.71	Grayish white	
	9	21.00	10.78	1.95	2.47	19.53	7.01	Grayish white	
	11	16.15	7.84	2.06	2.33	23.00	8.34	Grayish cream	St. H.
	15	8.25	3.83	2.15	2.34	26.70	9.84	Gray, specked	
A162 C1	1	39.75	25.27	1.57	2.61	5.98	2.04	Cream	
	3	39.10	24.35	1.61	2.64	8.78	3.02	Cream	
	5	39.66	23.95	1.65	2.74	11.31	3.95	Cream	
	7	34.10	18.92	1.80	2.73	18.72	6.71	Cream	
	9	29.35	15.20	1.91	2.69	22.22	8.07	Cream	St. H.
	11	29.03	15.18	1.93	2.73	23.77	8.66	Cream	
	13	28.80	14.75	1.95	2.74	24.12	8.82	Cream	
	15	22.80	10.81	2.11	2.73	29.50	11.00	Buff, specked	
	18	16.58	7.71	2.15	2.58	31.58	11.89	Buff, specked	
A162 C2	1	35.80	21.93	1.63	2.54	8.42	2.92	Cream	
	3	33.20	19.08	1.74	2.60	16.92	6.02	Pink	
	5	32.90	18.12	1.82	2.71	18.27	6.52	Pink	
	7	22.55	11.44	1.97	2.55	25.58	9.39	Lt. buff	
	9	21.08	10.58	1.99	2.53	26.60	9.79	Buff	St. H.
	11	22.65	11.14	2.03	2.62	27.10	10.00	Buff	
	13	22.18	11.00	2.03	2.62	26.80	9.88	Buff	
	15	8.16	3.69	2.22	2.41	33.63	12.80	Brown	

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

HOLES A162, A163, A172, A196

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A162 C3	1	30.85	17.12	1.80	2.61	9.65	3.34	Cream	
	3	26.25	14.17	1.85	2.51	14.13	5.01	Cream	
	5	26.08	13.75	1.90	2.57	15.38	5.42	Cream	
	7	23.70	12.14	1.95	2.57	17.90	6.36	Lt. buff	
	9	18.30	9.05	2.02	2.48	21.10	7.60	Lt. buff	St. H.
	11	17.60	8.49	2.07	2.51	21.50	7.75	Lt. buff	
	13	17.30	8.38	2.07	2.50	22.58	8.18	Lt. buff	
	15	9.08	4.37	2.08	2.29	23.72	8.66	Grayish brown, specked	
A163 C1	1	29.97	16.73	1.79	2.56	15.30	5.38	Salmon	
	3	29.95	16.33	1.82	2.58	17.76	6.32	Salmon	
	5	29.65	16.00	1.87	2.67	19.88	7.13	Salmon	
	7	25.46	13.03	1.95	2.62	23.46	8.54	Salmon	
	9	20.70	10.12	2.03	2.51	23.85	8.70	Buff	St. H.
	11	19.15	9.46	2.05	2.59	26.26	9.67	Buff	
	13	19.45	9.34	2.09	2.59	28.35	10.54	Buff	
	15	8.93	4.26	2.09	2.30	28.52	10.62	Brown	
A172 C1	1	28.25	15.38	1.83	2.56	-6.22	-2.15	Buff	
	3	23.25	12.00	1.93	2.52	12.12	4.24	Buff	
	5	19.12	9.46	2.02	2.50	14.34	5.05	Buff	
	7	17.94	8.85	2.03	2.47	15.97	5.65	Buff	
	9	15.25	7.25	2.10	2.48	18.40	6.55	Buff	
	11	7.31	3.19	2.27	2.47	25.92	9.55	Gray	St. H.
	13	6.86	2.54	2.31	2.45	26.10	9.59	Gray	
	15	16.73	9.81	1.71	2.05	-1.78	-.60	Gray	
A172 C2	1	39.60	25.78	1.54	2.54	6.30	2.15	White	
	3	35.82	22.33	1.60	2.50	8.21	2.85	White	
	5	30.48	16.90	1.80	2.59	22.15	8.03	White	
	7	26.85	14.58	1.84	2.52	23.30	8.46	White	
	9	24.70	13.25	1.85	2.47	23.85	8.70	White	
	11	19.35	9.49	2.04	2.53	30.65	11.51	Cream	St. H.
	13	18.72	9.02	2.07	2.55	31.00	11.63	Cream	
	15	7.76	3.48	2.23	2.41	36.50	14.05	Gray	
	18	7.36	3.29	2.23	2.41	36.58	14.09	Gray	
A196 C1	1	36.70	22.60	1.62	2.57	3.06	1.04	White	
	3	36.55	21.65	1.69	2.68	9.66	3.34	White	
	5	31.43	17.76	1.77	2.58	15.07	5.31	White	
	7	26.83	14.08	1.90	2.61	19.44	6.98	White	
	9	20.63	9.97	2.07	2.61	23.40	8.50	Cream	St. H.
	11	19.92	9.74	2.04	2.55	24.33	8.90	Cream	
	13	17.30	8.13	2.13	2.57	28.75	10.71	Cream	
	15	10.64	4.79	2.22	2.49	31.52	11.89	Grayish cream	
	18	6.72	2.92	2.30	2.46	31.00	11.63	Lt. gray	

Abbreviations: St. H., steel hard.

REGION F

Region F is within T.2 S., R.3 E., Sec. 27. Samples were secured from the properties of H. A. Hopper, H. L. Miskelly, and National Forest. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A101	P1	1A	29.95	17.07	6.06	Fine, open	Lt. gray
A101	P2	2C	26.84	16.56	5.87	Fine, open	Lt. gray
A101	14.0-21.5	4A	23.98	20.45	7.36	Fine, open	Gray
A102A	C1	2A	28.92	9.14	3.17	Fine, open	Cream
A102	C1-2	3A1	30.67	28.50	10.58	Fine, dense	Dk. gray
A102	C3	2A	28.05	13.30	4.65	Fine, open	Lt. gray
A102	C4	4C	28.94	11.15	3.88	Fine, open	Yellow
A107	C1	2A	27.25	10.38	3.59	Fine, open	Lt. gray
A107	C2	2A	28.45	12.96	4.54	Fine, open	Lt. gray
A111	C1	2A	33.59	12.76	4.46	Fine, open	Lt. gray
A125	0.8-24.0	7	26.41	19.56	7.01	Fine, open	Gray
A129	C1	2A	32.56	14.10	4.94	Fine, open	Lt. gray
A129	C2	2A	31.14	16.94	6.02	Fine, open	Lt. gray
A129	C3	2C	24.45	10.35	3.59	Fine, open	Yellow
A129	C4	4B	26.94	14.23	5.01	Fine, open	Gray
A129A	C1	2A	31.78	14.63	5.16	Fine, open	Lt. gray
A131	C3	2A	31.98	9.03	3.13	Fine, open	Lt. gray
A136	C1	2C	27.27	16.51	5.87	Fine, open	Gray
A150	C1	2B	26.08	17.86	6.36	Fine, open	Gray
A150	C2	2B	32.33	16.59	5.87	Fine, open	Pink
A150	C3	2B	29.42	8.92	3.09	Fine, open	Lt. gray
A150	C4	2B	25.14	14.30	5.01	Fine, open	Lt. gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./sq. in.	Hole No.	Sample No.	Lbs./sq. in.
A101	P1	94	A101	14.0-21.5	174
A101	P2	84	A125	0.8-24.0	135

SCREEN ANALYSES

HOLE A101 SAMPLE P1

Retained on screen	Percent	Character of residue
30	1.14	Abundance of gray clay; small amounts of gypsum, limonitic clay, and quartz
60	6.16	Abundance of clay; traces of limonite, gypsum, and quartz
100	4.35	Abundance of clay; traces of limonite, gypsum, and muscovite
150	3.47	Abundance of clay; small amount of quartz; traces of limonite and carbonaceous material
200	4.16	Abundance of clay; small amount of quartz and muscovite; trace of limonite
250	1.65	Abundance of clay; small amounts of quartz, muscovite, and rutile
Cloth	79.07	Clay substance including residue from above

HOLE A101 SAMPLE P2

Retained on screen	Percent	Character of residue
30	0.07	Abundance of micaceous, limonitic sand lumps and gypsum; small amounts of quartz, clay, plant fragments, and carbonaceous material
60	0.32	Abundance of gypsum; considerable quantity of micaceous, limonitic sand lumps; small amounts of quartz and clay
100	0.85	Abundance of muscovite; small amounts of biotite, kaolin, clay, and limonitic clay
150	5.52	Abundance of muscovite and quartz; small amount of kaolin; trace of biotite
200	8.00	Abundance of muscovite and quartz; small amount of kaolin; trace of rutile
250	4.60	Abundance of muscovite and quartz; small amount of kaolin and rutile
Cloth	80.64	Clay substance including residue from above

HOLE A101 SAMPLE 14.0-21.5 FT.

Retained on screen	Percent	Character of residue
30	0.92	Abundance of micaceous, limonitic clay; considerable quantity of quartz conglomerate; small amounts of quartz and ferruginous material
60	2.59	Abundance of quartz and yellow clay; considerable quantity of kaolin; traces of carbonaceous material and muscovite
100	5.67	Abundance of quartz and muscovite; considerable quantity of yellow clay; small amounts of kaolin and ferruginous material
150	6.09	Abundance of quartz and muscovite; considerable quantity of kaolin; small amounts of limonite
200	9.90	Abundance of quartz and muscovite; considerable quantity of kaolin; small amount of limonitic clay
250	8.46	Abundance of quartz; considerable quantity of muscovite and kaolin; small amount of limonitic clay
Cloth	66.36	Clay substance including residue from above

HOLE A125 SAMPLE 0.8-24.0 FT.

Retained on screen	Percent	Character of residue
30	0.31	Abundance of limonitic arenaceous nodules; considerable quantity of gypsum
60	1.05	Abundance of limonitic arenaceous nodules; considerable quantity of gypsum; small amounts of muscovite and quartz
100	1.95	Abundance of muscovite; considerable quantity of clay nodules; small amount of limonitic material; trace of ferruginous material
150	2.41	Abundance of clay nodules; considerable quantity of muscovite; small amounts of limonite and ferruginous material
200	6.07	Abundance of quartz; considerable quantity of muscovite; traces of limonite and ilmenite (?)
250	1.83	Abundance of quartz; considerable quantity of muscovite; small amount of clay; traces of limonite and ilmenite (?)
Cloth	86.38	Clay substance including residue from above

CHEMICAL ANALYSES*

Hole A101 Sample P1

Soluble salts	0.10	Moisture, air dried	0.77	Sulphur, SO_3	None
Ignition loss	12.61	Iron oxide, Fe_2O_3	0.64	Magnesia, MgO	0.15
Silica, SiO_2	45.80	Titania, TiO_2	1.45	Potash, K_2O	None
Alumnia, Al_2O_3	38.56	Lime, CaO	0.29	Soda, Na_2O	0.06

Hole A101 Sample P2

Soluble salts	0.45	Moisture, air dried	1.07	Sulphur, SO_3	None
Ignition loss	11.40	Iron oxide, Fe_2O_3	0.31	Magnesia, MgO	0.13
Silica, SiO_2	50.07	Titania, TiO_2	2.10	Potash, K_2O	Trace
Alumnia, Al_2O_3	36.72	Lime, CaO	Trace	Soda, Na_2O	0.09

Hole A101 Sample 14.0-21.5 ft.

Soluble salts	0.10	Moisture, air dried	0.86	Sulphur, SO_3	Trace
Ignition loss	7.65	Iron oxide, Fe_2O_3	1.37	Magnesia, MgO	0.08
Silica, SiO_2	61.80	Titania, TiO_2	1.40	Potash, K_2O	0.08
Alumina, Al_2O_3	26.80	Lime, CaO	0.27	Soda, Na_2O	0.22

Hole A125 Sample 0.8-24.0 ft.

Soluble salts	0.20	Moisture, air dried	1.07	Sulphur, SO_3	None
Ignition loss	9.43	Iron oxide, Fe_2O_3	0.60	Magnesia, MgO	0.09
Silica, SiO_2	58.00	Titania, TiO_2	1.50	Potash, K_2O	None
Alumina, Al_2O_3	28.97	Lime, CaO	0.81	Soda, Na_2O	0.03

* Analyses of residue washed through 250 mesh screen

M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

HOLES A101, A102

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A101 P1	1	42.93	27.57	1.56	2.73	8.78	3.07	White Cr.
	3	35.75	20.63	1.73	2.70	18.10	6.44	White Cr.
	5	35.62	20.24	1.76	2.73	17.99	6.40	White Cr.
	7	32.80	18.51	1.77	2.64	19.97	7.17	White Cr.
	9	27.12	13.86	1.93	2.64	25.35	9.31	Cream Cr., St. H.
	11	14.91	6.69	2.22	2.61	33.90	12.89	Cream Cr.
	13	12.15	5.42	2.25	2.56	35.28	13.51	Cream Cr.
	15	5.08	2.14	2.38	2.51	39.30	15.33	Gray-buff Cr.
	18	4.26	1.78	2.40	2.51	38.47	14.96	Gray-buff Cr.
A101 P2	1	34.99	21.22	1.62	2.53	4.11	1.42	White
	3	28.05	15.50	1.81	2.51	11.95	4.17	White
	5	27.75	15.34	1.82	2.52	14.05	4.94	White
	7	23.14	11.98	1.92	2.52	16.96	6.01	White
	9	21.79	11.46	1.93	2.51	18.11	6.48	White St. H.
	11	18.02	8.86	2.03	2.48	23.18	8.42	Lt. cream
	13	15.30	7.39	2.07	2.45	23.81	8.70	Lt. cream
	15	8.10	3.71	2.22	2.38	28.52	10.62	Lt. gray
	18	7.01	3.17	2.21	2.38	28.36	10.54	Lt. gray
A101 14.0-21.5 Ft.	1	31.09	17.75	1.75	2.54	-1.49	-.50	Cream
	3	28.00	15.46	1.83	2.52	.06	.03	Pink
	5	28.50	15.54	1.85	2.56	4.10	1.39	Pink
	7	27.18	14.69	1.85	2.52	5.07	1.73	Pink
	9	19.36	9.80	1.98	2.46	11.34	3.95	Buff St. H.
	11	16.05	7.81	2.05	2.46	13.26	4.65	Buff
	13	14.62	7.00	2.09	2.45	14.80	5.20	Buff
	15	4.66	2.18	2.17	2.28	17.58	6.25	Grayish brown, specked
	18	8.27	4.29	1.95	2.13	10.51	3.67	Grayish brown, specked
A102A C1	1	41.50	26.50	1.57	2.68	10.72	3.74	White Cr.
	3	41.05	25.75	1.57	2.64	12.45	4.35	White Cr.
	5	40.45	25.35	1.62	2.75	15.15	5.35	White Ch.
	7	29.70	15.33	1.94	2.76	29.80	11.13	Lt. cream Ch.
	9	26.60	13.45	1.97	2.69	30.85	11.59	Lt. cream Cr.
	11	24.57	11.70	2.10	2.78	33.10	12.54	Lt. cream Cr.
	13	14.02	6.12	2.29	2.67	39.80	15.56	Cream Cr., St. H.
	15	6.77	2.81	2.41	2.59	42.80	16.99	Lt. gray Cr.
	18	4.85	1.96	2.48	2.61	44.60	17.87	Lt. gray Ch.

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A101

Sample	At cone	1	3	5	7	9	11	13	15	18
P1	Lbs./sq. in.	353	419	795	1644	1917	1949	2093	2340	2248
P2	Lbs./sq. in.	663	857	1310	2255	2292	2839	2950	4045	3359
14.0-21.5 ft.	Lbs./sq. in.	1153	1294	1336	1354	1844	2221	2385	2379	1873

HOLES A102, A107

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A102 C1-2	1	27.90	15.94	1.75	2.43	3.74	1.28	Lt. cream	
	3	18.20	8.77	2.07	2.44	23.10	8.38	Cream	St. H.
	5	16.40	7.93	2.08	2.53	23.90	8.70	Cream	
	7	14.68	7.04	2.08	2.47	24.70	9.02	Cream	
	9	10.00	4.56	2.20	2.35	28.00	10.37	Lt. buff	
	11	7.59	3.37	2.21	2.44	27.95	10.37	Lt. buff	
	13	6.17	2.80	2.25	2.44	30.18	11.29	Gray-buff	
	15	6.06	2.85	2.13	2.27	25.00	9.14	Gray-buff	
A102 C3	1	41.60	26.18	1.59	2.78	4.20	1.42	White	Cr.
	3	40.95	24.90	1.60	2.74	6.90	2.36	White	Cr.
	5	39.05	23.70	1.64	2.72	12.00	4.17	White	Cr.
	7	35.00	21.88	1.65	2.70	15.56	5.50	White	Cr.
	9	23.63	11.31	2.06	2.65	31.90	12.02	Lt. cream	Cr.
	11	21.45	10.40	2.09	2.64	33.00	12.50	Lt. cream	Cr.
	13	12.88	5.60	2.30	2.63	39.75	15.56	Lt. cream	Cr., S. H.
	15	4.66	1.92	2.43	2.55	42.35	16.80	Lt. gray, specked	Cr.
	18	3.18	1.29	2.47	2.55	43.70	17.43	Gray	Ch.
A102 C4	1	41.10	26.10	1.77	2.74	11.58	4.03	Grayish cream	
	3	32.55	17.96	1.81	2.69	23.50	8.54	Grayish pink	
	5	31.60	16.74	1.89	2.76	26.50	9.75	Grayish pink	
	7	25.40	12.92	1.97	2.64	29.25	10.91	Grayish pink	St. H.
	9	18.00	8.20	2.20	2.65	37.95	14.73	Grayish pink	
	11	16.94	7.71	2.20	2.68	37.10	14.32	Gray-buff	
	15	10.19	4.33	2.35	2.62	40.80	16.03	Gray-buff	
	18	1.36	.54	2.49	2.53	44.50	17.82	Mottled brown	
A107 C1	1	42.15	26.12	1.61	2.79	9.75	3.38	White	Cr.
	3	38.40	23.45	1.64	2.66	10.75	3.74	Cream	Cr.
	5	38.20	22.60	1.69	2.72	13.88	4.87	Cream	Cr.
	7	30.90	16.86	1.84	2.72	20.90	7.52	Cream	Cr.
	9	29.25	15.33	1.91	2.65	24.10	8.74	Cream	Cr.
	11	22.22	10.53	2.11	2.71	31.10	11.68	Cream	Cr., St. H.
	13	21.95	10.20	2.15	2.76	33.60	12.76	Cream	Cr.
	15	11.68	5.21	2.24	2.54	35.10	13.42	Cream, specked	
	18	7.68	3.31	2.32	2.51	37.45	14.50	Cream, specked	
A107 C2	1	37.50	23.20	1.62	2.58	6.53	2.25	White	
	3	33.30	16.60	1.76	2.65	16.04	5.68	Lt. cream	
	5	26.55	13.95	1.90	2.59	22.20	8.03	Lt. cream	
	7	22.87	11.35	2.01	2.61	25.62	9.43	Lt. cream	
	9	22.45	11.22	2.00	2.58	26.55	9.79	Lt. cream	
	11	15.65	7.18	2.18	2.58	32.15	12.15	Cream	St. H.
	13	13.11	5.88	2.23	2.57	33.20	12.58	Cream	
	15	6.39	2.75	2.32	2.48	36.35	14.00	Lt. gray	
	18	1.14	.49	2.35	2.38	37.00	14.27	Lt. gray	

Abbreviations: Cr., cracked; Ch., checked; St. H. steel hard.

HOLES A111, A125, A129

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A111 C1	1	45.60	30.88	1.48	2.72	11.93	4.17	White	Ch.
	3	43.15	27.78	1.55	2.74	16.95	4.34	White	Ch.
	5	36.00	21.20	1.70	2.65	22.95	6.02	White	Ch.
	7	27.62	13.93	1.98	2.74	35.10	13.42	Cream	Ch., St. H.
	9	23.45	11.44	2.05	2.68	36.82	14.23	Cream	Cr.
	11	17.30	7.84	2.21	2.67	41.25	16.27	Cream	Cr.
	13	14.32	6.31	2.28	2.65	43.15	17.18	Cream	Cr.
	15	5.54	2.29	2.42	2.56	47.50	19.33	Lt. gray	
	18	5.30	2.16	2.45	2.59	47.45	19.33	Lt. gray	
A125 0.8-24.0 Ft.	1	33.14	19.41	1.71	2.55	1.13	.40	Cream	
	3	26.94	14.61	1.86	2.54	10.02	3.49	Cream	
	5	24.12	12.27	1.97	2.59	16.66	5.91	Cream	
	7	23.08	11.69	1.98	2.57	17.19	6.10	Cream	
	9	19.24	9.45	2.04	2.53	18.77	6.71	Lt. buff	St. H.
	11	15.67	7.42	2.11	2.51	22.55	8.18	Lt. buff	
	13	12.70	5.88	2.16	2.48	23.45	8.54	Lt. buff	
	15	5.92	2.63	2.29	2.37	26.51	9.79	Gray	
	18	9.51	4.44	2.14	2.37	24.02	8.78	Gray	
A129 C1	1	61.40	43.20	1.42	3.69	14.58	5.12	Cream	Cr.
	3	42.85	27.55	1.56	2.72	18.22	6.52	Cream	Cr.
	5	41.05	25.20	1.63	2.77	18.40	6.55	Cream	Cr.
	7	28.40	14.67	1.94	2.71	31.00	11.63	Cream	Cr., St. H.
	9	23.30	11.52	2.03	2.65	33.07	12.54	Cream	Cr.
	11	8.33	4.99	2.29	2.60	41.90	16.56	Cream	Cr.
	13	7.84	3.54	2.35	2.57	43.35	17.28	Cream	Cr.
	15	4.97	2.04	2.43	2.56	45.35	18.27	Lt. gray	
	18	5.93	2.43	2.45	2.60	45.70	18.42	Gray	
A129 C2	1	34.85	21.15	1.65	2.53	12.33	4.32	White	
	3	30.12	16.77	1.80	2.51	18.75	6.71	White	
	5	28.28	15.68	1.80	2.57	19.25	6.90	White	
	7	26.60	13.08	1.95	2.63	28.10	10.41	Cream	St. H.
	9	19.20	9.56	2.01	2.49	28.20	10.45	Cream	
	11	9.78	4.35	2.25	2.49	35.85	13.78	Grayish cream	
	13	9.41	4.15	2.26	2.50	36.10	13.87	Grayish cream	
	15	2.33	.98	2.36	2.42	38.80	15.10	Lt. gray	
A129 C3	1	32.10	19.00	1.69	2.49	3.87	1.32	Cream	
	3	32.70	19.40	1.69	2.50	5.24	1.80	Cream	
	5	33.75	19.80	1.71	2.58	5.97	2.04	Cream	
	7	30.40	17.05	1.78	2.56	9.71	3.38	Cream	
	9	27.48	15.18	1.81	2.49	9.77	3.38	Cream	
	11	21.33	10.92	1.95	2.48	17.23	6.14	Lt. buff	St. H.
	13	21.08	10.76	1.96	2.49	17.08	6.06	Lt. buff	
	15	10.42	4.97	2.09	2.34	23.75	8.66	Gray-buff	
	18	4.50	2.14	2.11	2.20	23.65	8.62	Brown	

Abbreviations: Cr., cracked; Ch., checked; St. H., steel hard.

MODULUS OF RUPTURE, HOLE A125

Sample	At cone	1	3	5	7	9	11	13	15	18
0.8-24.0 ft.	Lbs./sq. in.	1202	1246	2063	2422	3492	3658	3753	3830	2595

HOLES A129, A131, A136, A150

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A129 C4	1	34.48	20.43	1.68	2.48	5.36	1.83	Cream	
	3	32.15	19.15	1.74	2.41	5.66	1.94	Cream	
	5	27.60	15.82	1.69	2.57	9.38	3.24	Cream	
	7	26.03	14.32	1.82	2.46	12.97	4.54	Cream	
	9	25.10	13.80	1.82	2.43	12.33	4.32	Cream	
	11	21.10	10.93	1.93	2.45	21.88	7.91	Lt. gray-buff	St. H.
	13	21.25	10.97	1.93	2.46	18.60	6.63	Lt. gray-buff	
	15	5.54	2.58	2.15	2.27	26.08	9.59	Grayish brown	
	18	15.30	8.45	1.81	2.14	11.70	4.04	Grayish brown	
A129A C1	1	34.45	20.60	1.67	2.55	12.95	4.54	White	
	3	28.88	15.85	1.82	2.56	22.16	8.03	White	
	5	26.60	14.42	1.84	2.51	23.00	8.34	Lt. cream	
	7	21.40	10.73	1.99	2.53	28.20	10.45	Cream	St. H.
	9	16.23	7.59	2.14	2.55	32.95	12.50	Cream	
	11	8.34	3.63	2.29	2.50	38.00	14.73	Lt. grayish cream	
	13	7.38	3.14	2.35	2.54	39.70	15.52	Lt. grayish cream	
	15	1.20	.50	2.39	2.42	39.90	15.61	Lt. gray	
	18	1.12	.57	2.36	2.38	39.25	15.33	Lt. gray	
A131 C3	1	44.80	29.18	1.53	2.62	10.78	3.74	White	Cr.
	3	41.85	27.45	1.60	2.71	15.60	5.53	White	Cr.
	5	40.80	25.45	1.54	2.78	18.00	6.40	White	Cr.
	7	29.75	15.38	1.93	2.75	31.80	11.98	Cream	Cr.
	9	21.65	10.34	2.09	2.67	37.15	14.36	Cream	Cr., St. H.
	11	15.53	6.90	2.25	2.65	40.50	15.89	Cream	Cr.
	13	15.22	6.77	2.25	2.66	41.75	16.51	Cream	
	15	4.26	1.74	2.45	2.56	46.70	18.92	Lt. gray	
	18	4.05	1.62	2.50	2.60	47.55	19.38	Lt. gray	
A136 C1	1	33.33	19.92	1.67	2.52	2.57	.87	Cream	
	3	29.50	16.80	1.75	2.49	7.64	2.64	Cream	
	5	27.90	15.76	1.77	2.45	8.99	3.09	Cream	
	7	19.85	10.10	1.97	2.46	17.42	6.21	Cream	St. H.
	9	16.87	8.43	2.00	2.41	19.33	6.94	Cream	
	11	15.50	7.60	2.04	2.42	19.55	7.01	Cream	
	13	12.13	5.85	2.07	2.36	21.92	7.95	Cream	
	15	2.51	1.14	2.21	2.26	26.28	9.67	Gray	
	18	8.33	4.10	2.03	2.22	20.28	7.28	Gray	
A150 C1	1	32.10	18.42	1.74	2.57	3.43	1.18	Cream	
	3	27.47	15.00	1.83	2.53	7.46	2.57	Cream	
	5	27.00	14.65	1.84	2.52	8.43	2.92	Lt. buff	
	7	19.75	9.79	2.02	2.52	16.84	5.98	Lt. buff	
	9	15.17	7.30	2.08	2.45	19.72	7.09	Lt. buff	St. H.
	11	13.00	6.07	2.14	2.46	20.72	7.48	Lt. buff	
	13	12.78	5.94	2.15	2.47	21.20	7.63	Buff	
	15	5.40	2.41	2.24	2.37	25.25	9.27	Brown	
	18	9.33	5.14	1.81	2.00	5.62	1.94	Brown	

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

HOLE A150

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A150 C2	1	38.00	23.05	1.65	2.66	7.54	2.60	Pink	
	3	36.95	21.25	1.74	2.76	13.33	4.68	Pink	
	5	32.35	18.10	1.79	2.65	16.13	5.72	Pink	
	7	23.40	11.23	2.08	2.72	28.72	10.71	Buff	St. H.
	9	21.85	10.30	2.12	2.72	28.40	10.54	Buff	
	11	20.87	9.93	2.10	2.66	29.10	10.83	Buff	
	13	18.84	8.76	2.15	2.65	30.10	11.29	Buff	
	15	5.46	2.42	2.26	2.39	33.45	11.71	Mottled brown	
A150 C3	1	39.40	24.92	1.58	2.61	7.32	2.53	White	
	3	38.28	23.10	1.64	2.65	11.95	4.17	White	
	5	33.65	19.40	1.73	2.61	15.30	5.38	Lt. cream	
	7	28.32	14.60	1.94	2.71	23.80	8.66	Cream	St. H.
	9	21.35	10.38	2.05	2.60	28.65	10.66	Cream	
	11	21.28	10.10	2.11	2.69	29.35	10.96	Cream	
	13	19.50	9.22	2.11	2.63	29.80	11.13	Cream	
	15	11.00	4.92	2.23	2.51	35.35	13.55	Mottled gray	
	18	8.45	3.65	2.32	2.53	38.35	14.91	Mottled gray	
A150 C4	1	32.70	19.20	1.70	2.53	2.19	.74	White	
	3	29.80	16.42	1.79	2.52	8.65	2.99	White	
	5	28.80	16.04	1.81	2.58	9.00	3.09	Lt. cream	
	7	25.00	13.08	1.91	2.54	13.00	4.54	Cream	
	9	22.30	11.48	1.94	2.50	14.33	5.05	Cream	St. H.
	11	21.65	10.90	1.98	2.53	18.68	6.67	Cream	
	13	19.60	9.65	2.03	2.52	18.96	6.78	Cream	
	15	6.65	3.01	2.21	2.37	27.15	10.04	Mottled gray	
	18	5.31	2.40	2.21	2.33	24.65	9.02	Mottled gray	

Abbreviations: St. H., steel hard.

REGION G

Region G is within T.3 S., R.3 E., Sec. 10 and T.2 S., R.3 E., Sec. 33. Samples were secured from the properties of J. C. McElwain and R. O. Patrick. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A171	C1	2A	36.27	12.41	4.35	Fine, open	Cream
A171	C2	6A	38.27	16.24	5.76	Fine, open	Yellow
A171	C3	5B	33.28	21.27	7.67	Fine, open	Yellow
A171	C4	8	38.00	35.24	13.51	Fine, open	Gray
A171	4.2-34.0	7	39.08	25.68	9.43	Fine, dense	Dk. gray
A177	C1	4C	36.29	12.67	4.43	Fine, open	Yellow
A177	C2	4C	27.43	10.04	3.49	Fine, open	Yellow
A183	C1	5B	31.55	11.84	4.14	Fine, open	Yellow
A183	C2	4C	26.66	13.37	4.68	Fine, open	Yellow
A188	C1	1A	31.26	7.06	2.42	Fine, open	Cream
A188	C2	2B	21.50	11.68	4.06	Fine, open	Lt. gray
A197	C1	2C	31.95	16.46	5.83	Fine, open	Lt. gray
A197	C2	4C	29.06	15.47	5.46	Fine, open	Yellow
A203	C1-2	6A	34.65	16.85	5.98	Fine, open	Yellow
A203	C4-5	3A2	26.90	19.97	7.17	Fine, open	Gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./sq. in.
A171	4.2-34.0	252

PYRO-PHYSICAL PROPERTIES

Hole A171

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A171 C1	1	47.65	32.18	1.48	2.83	8.83	3.06	White	Ch.
	3	41.90	26.30	1.59	2.75	20.53	7.40	White	Ch.
	5	38.86	23.22	1.67	2.74	23.30	8.46	White	Ch.
	7	35.30	19.82	1.78	2.75	26.85	9.92	Cream	Ch.
	9	26.00	13.20	1.97	2.66	35.10	13.42	Cream	Ch., St. H.
	11	19.15	8.86	2.16	2.67	40.60	15.94	Cream	Ch.
	13	16.56	7.38	2.24	2.69	42.35	16.80	Cream	Ch.
	15	9.47	3.97	2.38	2.63	47.20	19.18	Grayish cream	Ch.
	18	5.08	2.07	2.44	2.57	45.80	18.47	Lt. gray	Cr.
A171 C2	1	38.53	22.04	1.75	2.85	26.20	9.63	Salmon	Ch.
	3	35.28	19.90	1.77	2.74	27.30	10.08	Grayish pink	Cr.
	5	31.05	15.65	1.98	2.88	35.13	13.46	Grayish pink	Cr.
	7	20.58	9.20	2.24	2.61	41.90	16.56	Buff	Cr., St. H.
	9	17.88	7.93	2.26	2.75	42.15	16.70	Buff	Cr.
	11	14.94	6.33	2.36	2.77	45.15	18.17	Buff	Cr.
	13	9.79	4.02	2.43	2.70	46.25	18.72	Buff	Cr.
	15	6.09	2.55	2.39	2.54	45.90	18.52	Gunmetal	Cr.
A171 C3	1	27.80	15.32	1.81	2.50	17.44	6.21	Salmon	
	3	27.70	14.65	1.90	2.61	18.85	6.74	Salmon	
	5	25.20	12.94	1.95	2.60	21.14	7.63	Salmon	
	7	23.86	11.97	1.99	2.62	22.00	7.95	Salmon	
	9	17.50	8.44	2.07	2.51	26.35	9.71	Buff	St. H.
	11	16.66	7.88	2.11	2.54	27.42	10.16	Buff	
	13	13.00	5.99	2.17	2.49	29.95	11.21	Buff	
	15	10.10	4.83	2.09	2.33	27.52	10.21	Brown, specked	
A171 C4	1	13.03	6.34	2.05	2.36	20.93	7.56	Salmon	
	3	16.20	7.92	2.05	2.44	22.15	8.03	Lt. red	
	5	8.07	3.98	2.03	2.21	21.10	7.60	Greenish red	Bl., St. H.
	7	1.99	.87	2.28	2.33	29.05	10.83	Reddish brown	
	9	7.92	3.95	2.01	2.18	19.45	6.98	Greenish red	Bl.
	11	13.47	7.10	1.90	2.19	14.96	5.27	Greenish gray	Bl.
	13	2.41	1.09	2.22	2.27	27.65	10.25	Greenish gray	
	15	17.46	11.26	1.55	1.88	-4.25	-1.46	Brownish gray, overburned	
A171 4.2-34.0 Ft.	1	13.17	6.32	2.09	2.40	28.12	10.45	Reddish buff	St. H.
	3	20.01	9.86	2.03	2.54	26.67	9.84	Reddish buff	
	5	17.67	8.75	2.02	2.45	26.12	9.63	Reddish buff	
	7	9.54	4.40	2.18	2.40	32.04	12.11	Reddish buff	
	9	12.25	6.75	1.82	2.08	16.16	5.72	Reddish brown	Bl.

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

Modulus of rupture, Hole A171

Sample	At cone	1	3	5	7	9
4.2-34.0 ft.	Lbs./sq. in.	2070	2469	2835	1842	1641

Holes A177, A183, A188

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A177 C1	1	30.75	16.15	1.90	2.75	28.02	10.41	Lt. red
	3	30.60	16.49	1.86	2.67	27.80	10.29	Lt. red
	5	25.00	12.13	2.06	2.75	34.20	13.12	Lt. red
	7	22.10	10.49	2.11	2.70	36.10	13.87	Lt. red St. H.
	9	14.28	6.44	2.22	2.59	38.30	14.87	Reddish gray
	11	12.50	5.51	2.29	2.62	40.35	15.84	Grayish brown
	13	11.33	4.90	2.31	2.61	41.40	16.32	Grayish brown
	15	6.37	2.74	2.32	2.48	42.25	16.75	Brown
A177 C2	1	29.90	16.14	1.85	2.64	17.67	6.29	Salmon
	3	28.75	15.90	1.81	2.54	17.06	6.06	Buff
	5	27.23	14.82	1.84	2.53	18.96	6.78	Buff
	7	24.37	12.44	1.96	2.59	22.20	8.03	Buff
	9	22.80	10.98	1.98	2.53	23.40	8.50	Buff St. H.
	11	22.25	10.90	2.03	2.61	26.05	9.59	Gray-buff
	13	18.75	8.96	2.09	2.54	27.42	10.16	Gray-buff
	15	6.19	2.89	2.15	2.29	30.40	11.38	Brown
A183 C1	3	36.72	19.40	1.89	2.99	27.65	10.25	Lt. red Cr.
	5	31.88	16.20	1.97	2.89	30.80	11.55	Lt. red Cr.
	7	25.75	12.10	2.13	2.87	35.60	13.64	Lt. red St. H.
	9	23.60	10.82	2.18	2.85	36.20	13.91	Lt. red Cr.
	11	16.30	6.92	2.36	2.81	41.55	16.41	Grayish brown Cr.
	13	11.22	4.54	2.47	2.78	43.50	17.33	Grayish brown Cr.
	15	7.78	3.32	2.34	2.54	40.40	15.84	Gunmetal
A183 C2	1	28.55	15.64	1.78	2.55	14.34	5.05	Salmon
	3	26.92	15.17	1.82	2.48	15.72	5.57	Salmon
	5	26.68	14.66	1.82	2.43	18.04	6.44	Salmon
	7	23.60	12.30	1.92	2.51	20.26	7.28	Salmon-buff St. H.
	9	21.58	10.96	1.95	2.49	21.40	7.71	Buff
	11	18.86	9.41	2.01	2.47	21.75	7.87	Buff
	13	17.82	8.77	2.03	2.47	23.86	8.70	Buff
	15	7.95	3.73	2.13	2.31	27.40	10.12	Brown, specked
A188 C1	1	43.90	28.76	1.52	2.71	13.67	4.79	White Cr.
	3	43.35	27.75	1.56	2.76	14.18	4.98	White Cr.
	5	41.85	26.85	1.56	2.68	16.26	5.76	White Cr.
	7	33.12	15.45	2.21	3.35	33.10	12.45	White Cr., St. H.
	9	29.38	15.05	1.95	2.76	39.55	15.47	Cream Cr.
	11	21.03	9.74	2.16	2.73	41.40	16.32	Cream Cr.
	13	12.34	5.31	2.32	2.79	43.75	17.48	Cream Cr.
	15	5.13	2.06	2.48	2.63	46.40	18.77	Grayish white Cr.
	18	5.12	2.06	2.48	2.61	46.00	18.57	Lt. buff

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

HOLES A188, A197, A203

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks	
A188 C2	1	32.28	18.46	1.75	2.58	2.80	.94	White	
	3	31.05	17.37	1.79	2.59	5.87	2.01	White	
	5	30.05	16.78	1.79	2.55	6.94	2.39	White	
	7	24.73	12.84	1.92	2.55	11.74	4.10	Lt. cream	
	9	23.75	12.33	1.92	2.52	12.88	4.50	Lt. cream	St. H.
	11	23.90	12.43	1.92	2.53	13.04	4.57	Lt. cream	
	13	22.35	11.60	1.93	2.48	13.24	4.65	Cream	
	15	19.63	9.79	2.00	2.49	16.38	5.80	Cream, specked	
	18	15.42	7.36	2.09	2.48	19.28	6.90	Cream, specked	
A197 C1	1	34.52	21.38	1.61	2.47	13.12	4.61	Lt. cream	
	3	30.00	16.58	1.81	2.59	22.28	8.07	Cream	
	5	25.70	13.96	1.84	2.48	23.44	8.54	Cream	
	7	15.62	7.50	2.08	2.47	31.73	11.98	Cream	St. H.
	9	11.83	5.45	2.17	2.46	35.70	13.69	Cream	
	11	10.40	4.72	2.20	2.46	36.25	13.96	Cream	
	13	10.00	4.47	2.24	2.48	37.15	14.36	Lt. buff	
	15	4.97	2.14	2.32	2.44	39.55	15.47	Gray	
	18	2.78	1.21	2.30	2.37	38.90	15.14	Gray	
A197 C2	1	29.15	16.82	1.73	2.53	13.67	4.79	Salmon	
	3	29.15	16.16	1.74	2.54	13.77	4.83	Salmon	
	5	28.10	16.25	1.79	2.47	13.93	4.90	Salmon	
	7	24.15	12.92	1.87	2.46	20.60	7.40	Salmon	
	9	21.56	10.82	1.92	2.45	21.85	7.91	Buff	
	11	20.48	10.43	1.96	2.42	23.80	8.66	Buff	St. H.
	13	19.94	10.36	1.99	2.40	25.25	9.27	Buff	
	15	6.91	3.27	2.11	2.27	27.88	10.33	Brown	
A203 C2-3	1	43.60	25.93	1.68	2.98	16.10	5.68	Cream	Cr.
	3	42.10	24.45	1.72	2.96	22.70	8.22	Pink	Cr.
	5	36.93	20.47	1.80	2.88	26.58	9.79	Pink	Cr.
	7	28.00	13.68	2.10	2.91	35.88	13.78	Buff	St. H.
	9	26.75	13.07	2.05	2.79	33.80	12.85	Buff	Cr.
	11	21.43	9.45	2.27	2.89	41.10	16.18	Buff	
	13	18.68	8.01	2.33	2.87	42.00	16.60	Buff	Cr.
	15	3.49	1.40	2.50	2.59	46.05	18.62	Dark brown	
A203 C4-5	1	28.08	15.62	1.80	2.50	10.30	3.56	Cream	
	3	25.75	13.88	1.86	2.51	13.97	4.90	Cream	
	5	24.48	13.11	1.87	2.48	15.60	5.50	Cream	
	7	16.98	8.26	2.05	2.47	22.62	8.22	Cream	St. H.
	9	13.87	6.61	2.10	2.44	24.25	8.86	Cream	
	11	9.05	4.06	2.23	2.45	27.58	10.21	Grayish cream	
	13	8.64	3.88	2.23	2.44	27.90	10.33	Lt. gray	
	15	5.49	2.57	2.14	2.26	24.90	9.10	Gray	
	18	13.24	6.95	1.91	2.20	15.40	5.42	Gray	

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

REGION H

Region H is within T.4 S., R.2 E., Sec. 11, and T.4 S., R.3 E., Sec. 6. Samples were secured from the properties of E. P. Barber and J. S. Pearce. Detailed locations of test holes are given in the Test Hole Drill Records.

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Type of clay	Water of plasticity in percent	Drying Shrinkage		Texture	Color
				Volume in percent	Linear in percent		
A219	C1	2C	34.13	16.64	5.91	Fine, open	Lt. gray
A220	C1	5B	18.79	11.86	4.14	Fine, open	Red
A220	C2	2B	21.48	15.76	5.57	Fine, open	Lt. gray

MODULUS OF RUPTURE

Hole No.	Sample No.	Lbs./sq. in.
A220	C1	200
A220	C2	180

SCREEN ANALYSIS

HOLE A220 SAMPLE C2

Retained on screen	Percent	Character of residue
30	0.29	Abundance of quartz; considerable quantity of limonitic, arenaceous material; small amount of ferruginous rock
60	5.84	Abundance of quartz; small amount of limonite; traces of ferruginous rock and plant fragments
100	10.99	Abundance of quartz; considerable quantity of limonite; small amounts of ferruginous rock and kaolinite
150	14.46	Abundance of quartz; considerable quantity of limonite; small amount of kaolinite; trace of magnetite.
200	4.15	Abundance of quartz; small amounts of kaolin and limonite; trace of magnetite
250	1.85	Abundance of quartz; considerable quantity of kaolin; small amounts of feldspar, muscovite and limonite; trace of magnetite
Cloth	62.42	Clay substance including residue from above.

CHEMICAL ANALYSIS*

HOLE A220 SAMPLE C2

Soluble salts	0.10	Moisture, air dried	1.22	Sulphur, SO_3	Trace
Ignition loss	8.26	Iron oxide, Fe_2O_3	1.65	Magnesia, MgO	0.44
Silica, SiO_2	62.20	Titania, TiO_2	1.75	Potash, K_2O	None
Alumina, Al_2O_3	24.17	Lime, CaO	0.79	Soda, Na_2O	0.17

* Analysis of residue washed through 250 mesh screen
M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

HOLES A219, A220

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Color and remarks
A219 C1	1	31.45	17.55	1.78	2.58	10.69	3.70	Cream
	3	30.87	17.32	1.79	2.61	17.10	6.06	Cream
	5	26.70	14.03	1.90	2.60	19.92	7.17	Cream
	7	17.74	8.42	2.11	2.56	29.45	11.00	Cream St. H.
	9	11.74	5.72	2.22	2.55	32.72	12.41	Buff
	11	11.02	4.97	2.25	2.50	33.30	12.63	Buff
	13	10.71	4.72	2.27	2.54	33.30	12.63	Buff
	15	1.92	.82	2.34	2.38	36.30	13.96	Gray
	18	8.77	4.33	2.02	2.21	26.05	9.60	Gray
A220 C1	04	30.03	16.12	1.86	2.67	-2.00	-.67	Lt. red
	01	29.63	15.88	1.86	2.66	-2.00	-.67	Lt. red
	2	29.39	15.72	1.86	2.65	-1.87	-.64	Lt. red
	4	29.31	15.66	1.87	2.65	-1.53	-.54	Red
	6	28.94	15.45	1.87	2.64	-.82	-.30	Red
	8	28.92	15.40	1.88	2.64	-.59	-.20	Red
	10	28.30	14.98	1.89	2.63	.36	.13	Red
	14	21.23	11.02	1.93	2.45	6.30	2.06	Reddish brown, specked
A220 C2	04	30.54	16.80	1.80	2.57	-.55	-.20	Cream
	01	30.23	16.80	1.80	2.57	.00	.00	Cream
	2	30.14	16.79	1.82	2.58	1.10	.37	Cream
	4	29.18	15.79	1.82	2.62	1.11	.40	Cream
	6	29.14	15.56	1.87	2.64	4.30	1.46	Cream
	8	28.72	15.28	1.88	2.65	4.64	1.59	Cream
	10	26.78	13.87	1.93	2.63	7.48	2.57	Cream
	14	18.00	9.03	2.00	2.43	6.00	2.03	Lt. buff, specked

Abbreviations: St. H., steel hard.

MODULUS OF RUPTURE, HOLE A220

Sample	At cone	04	01	2	4	6	8	10	14
C1	Lbs./sq. in.	254	263	283	327	334	369	457	600
C2	Lbs./sq. in.	658	804	895	972	1029	1217	1384	1510

PORTERS CREEK CLAY—UPPER PHASE

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Sample No.	Water of plasticity in percent	Bulk specific gravity	Drying shrinkage		Texture	Color
			Volume in percent	Linear in percent		
A263C1	37.24	1.510	12.50	4.35	Silty	Dk. gray
A263C2	39.85	1.490	16.32	5.80	Silty	Dk. gray

PYRO-PHYSICAL PROPERTIES

Hole A263

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	
A263C1	1	36.85	23.80	1.55	2.45	11.07	3.85	Lt. brown	Not St. H.
	3	35.95	22.88	1.57	2.45	11.82	4.14	Red	Not St. H.
	5	29.25	16.65	1.76	2.48	18.54	6.63	Reddish brown	Not St. H.
	7	20.33	10.70	1.90	2.39	25.87	9.51	Reddish brown	Not St. H.
	9	13.07	7.10	1.84	2.11	26.35	9.71	Reddish brown	Not St. H.
A263C2	1	36.35	23.70	1.54	2.41	10.47	3.70	Lt. brown	Not St. H.
	3	31.53	19.08	1.65	2.41	17.58	6.25	Red	Not St. H.
	5	19.48	11.28	1.73	2.14	20.25	7.28	Reddish brown	St. H.
	7	11.37	6.51	1.75	1.97	22.40	8.11	Reddish brown	St. H.
	9	6.64	4.95	1.34	1.44	-1.78	-.69	Gunmetal (Bl.)	St. H.

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

PORTERS CREEK CLAY—MIDDLE PHASE

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Sample No.	Water of plasticity in percent	Bulk specific gravity	Drying shrinkage		Texture	Color
			Volume in percent	Linear in percent		
A165C1	71.22	1.230	37.63	14.59	Open	Dk. Gray
A165C2	64.08	1.240	23.41	8.54	Open	Dk. Gray
A260C1	79.42	1.171	34.59	13.20	Open	Dk. Gray
A260C2	86.27	1.052	29.30	10.91	Open	Dk. Gray
A260C3	86.48	1.135	26.99	9.96	Open	Dk. Gray
A261C1	76.62	1.321	40.15	15.75	Open	Dk. Gray
A261C2	83.92	1.260	39.09	15.24	Open	Dk. Gray
A262C1	66.48	1.205	27.16	10.04	Open	Dk. Gray
A264C1	76.32	1.071	20.46	7.36	Open	Dk. Gray
A264C2	77.87	1.112	28.19	10.45	Open	Dk. Gray

Modulus of rupture of composite samples A264C1-A264C2 are: dried 25°C, 170 lbs. per sq. inch; dried 110°C, 219 lbs. per sq. inch.

SCREEN ANALYSES

HOLE A264, SAMPLES C1, C2

Retained on screen	Percent		Character of residue
	C1	C2	
30	21.32	10.23	Abundance of micaceous gray clay nodules; white clay nodules in C2; trace of limonite
60	38.32	47.48	Abundance of micaceous gray clay nodules; white clay nodules in C2
100	13.60	17.87	Abundance of micaceous gray clay nodules; white clay nodules in C2; small amount of limonite
150	6.48	9.61	Abundance of micaceous gray clay nodules; small amount of limonite
200	4.37	5.56	Abundance of micaceous gray clay nodules; trace of limonite
250	3.11	4.15	Abundance of micaceous gray clay nodules; traces of muscovite and limonite
Cloth	12.80	5.10	Clay substance including residue from above

CHEMICAL ANALYSIS

HOLE A264 SAMPLE C1

Soluble salts	0.70	Moisture, air dried	4.37	Sulphur, SO_3	0.67
Ignition loss	6.95	Iron oxide, Fe_2O_3	1.67	Magnesia, MgO	0.32
Silica, SiO_2	72.58	Titania, TiO_2	0.25	Potash, K_2O	None
Alumina, Al_2O_3	17.64	Lime, CaO	0.71	Soda, Na_2O	0.02

M. R. Livingston, analyst

PYRO-PHYSICAL PROPERTIES

HOLES A165, A260

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	
A165C1	1	49.90	41.25	1.21	2.41	12.78	4.46	Buff	Not St. H.
	3	48.60	39.38	1.23	2.40	12.67	4.43	Buff	Not St. H.
	5	47.90	37.88	1.26	2.43	17.20	6.10	Lt. red	Not St. H.
	7	46.60	34.85	1.33	2.46	21.50	7.75	Lt. red	Not St. H.
	9	42.15	30.66	1.37	2.38	24.52	8.98	Buff	Not St. H.
	11	42.75	29.95	1.43	2.50	27.82	10.33	Buff	Not St. H.
	13	42.40	30.25	1.40	2.45	25.67	9.43	Buff	Not St. H.
	15	Melted						Brown	St. H.
A165C2	1	51.00	43.90	1.16	2.37	9.85	3.42	Buff	Not St. H.
	3	50.30	42.70	1.18	2.36	10.77	3.74	Lt. red	Not St. H.
	5	50.80	42.30	1.20	2.45	12.60	4.39	Lt. red	Not St. H.
	7	50.15	41.25	1.21	2.44	14.33	5.05	Lt. red	Not St. H.
	9	48.95	39.40	1.22	2.34	14.72	5.20	Lt. red	Not St. H.
	11	47.90	38.40	1.27	2.48	17.48	6.21	Buff	Not St. H.
	13	46.65	35.75	1.30	2.44	17.64	6.29	Buff	Not St. H.
	15	.42	.19	2.15	2.13	50.40	20.84	Brown	St. H.
A260C1	1	57.15	49.50	1.15	2.69	17.53	6.25	Cream	Not St. H.
	3	52.85	43.90	1.18	2.50	16.67	5.91	Salmon	Not St. H.
	5	49.00	40.40	1.21	2.38	16.74	5.95	Salmon (Cr.)	Not St. H.
	7	45.60	33.68	1.35	2.48	27.70	10.25	Salmon-buff (Cr.)	Not. St. H.
	9	41.90	30.53	1.37	2.45	29.05	10.83	Buff (Cr.)	Not St. H.
	11	31.08	18.28	1.70	2.47	43.25	17.23	Buff (Cr.)	Not St. H.
	13	31.60	19.17	1.65	2.41	40.80	16.08	Buff (Cr.)	Not St. H.
	15	Melted						Brown	St. H.
A260C2	1	56.35	52.70	1.07	2.44	15.30	5.38	Cream (Cr.)	Not St. H.
	3	56.50	50.30	1.12	2.35	19.84	7.13	Salmon	Not St. H.
	5	50.90	44.05	1.15	2.50	21.60	7.79	Salmon (Cr.)	Not St. H.
	7	50.00	40.05	1.25	2.50	25.53	9.39	Buff	Not St. H.
	9	47.35	37.45	1.26	2.40	28.55	10.62	Buff (Cr.)	Not St. H.
	11	42.75	29.90	1.43	2.50	37.38	14.46	Buff	Not St. H.
	13	33.05	20.30	1.63	2.43	43.35	17.28	Buff	Not St. H.
	15	Melted						Brown	St. H.
A260C3	1	55.00	50.90	1.08	2.40	14.83	5.24	Cream	Not St. H.
	3	54.00	47.85	1.13	2.45	18.72	6.71	Salmon	Not St. H.
	5	50.10	42.40	1.18	2.37	23.80	8.66	Salmon	Not St. H.
	7	47.65	37.55	1.24	2.47	27.05	10.00	Buff	Not St. H.
	9	46.70	36.95	1.29	2.34	27.15	10.04	Buff (Cr.)	Not St. H.
	11	41.85	29.05	1.44	2.48	37.10	14.32	Buff	Not St. H.
	13	38.00	25.20	1.51	2.43	39.82	15.61	Buff	Not St. H.
	15	Melted						Brown	St. H.

HOLES A261, A262, A264

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	
A261C1	1	50.40	37.32	1.35	2.72	18.55	6.63	Cream (Cr.)	Not St. H.
	3	41.40	29.65	1.40	2.38	21.33	7.71	Salmon (Cr.)	Not St. H.
	5	39.80	27.60	1.44	2.39	24.55	8.98	Buff (Cr.)	Not St. H.
	7	38.85	26.65	1.46	2.38	24.75	9.06	Buff (Cr.)	Not St. H.
	11	25.80	14.53	1.77	2.39	38.85	15.14	Dark buff (Cr.)	Not St. H.
	13	25.52	14.88	1.73	2.33	37.05	14.32	Dark buff (Cr.)	Not St. H.
	15	Melted						Brown	St. H.
A261C2	1	48.45	39.55	1.22	2.38	17.04	6.06	Cream (Cr.)	Not St. H.
	3	46.90	37.30	1.26	2.37	18.98	6.78	Salmon (Cr.)	Not St. H.
	5	46.00	35.06	1.31	2.43	20.55	7.40	Buff (Cr.)	Not St. H.
	7	44.30	32.50	1.36	2.55	25.45	9.35	Buff (Cr.)	Not St. H.
	9	42.25	30.93	1.37	2.37	28.38	10.54	Buff (Cr.)	Not St. H.
	11	36.10	22.95	1.57	2.47	34.80	13.29	Dark buff (Cr.)	Not St. H.
	13	34.70	22.00	1.58	2.42	35.12	13.46	Dark buff (Cr.)	Not St. H.
	15	Melted						Brown	St. H.
A262C1	1	49.80	40.95	1.22	2.43	13.85	4.87	Cream (Cr.)	Not St. H.
	3	47.62	36.72	1.27	2.38	17.63	6.29	Salmon	Not St. H.
	5	46.60	36.65	1.30	2.48	19.20	6.86	Salmon (Cr.)	Not St. H.
	7	41.15	27.20	1.45	2.47	27.13	10.04	Buff	Not St. H.
	9	35.40	24.10	1.47	2.27	29.00	10.79	Buff	Not St. H.
	11	34.52	21.57	1.60	2.45	34.00	12.93	Dark buff (Cr.)	Not St. H.
	13	19.20	10.28	1.88	2.32	41.80	16.51	Brown (Cr)	Not St. H.
	15	Melted						Brown	St. H.
A264C1	1	55.80	52.10	1.07	2.42	16.04	5.68	Buff	Not St. H.
	3	54.55	49.90	1.09	2.41	17.60	6.25	Salmon	Not St. H.
	5	53.10	45.70	1.16	2.47	22.57	8.18	Buff	Not St. H.
	7	51.60	42.35	1.19	2.52	24.70	9.02	Buff	Not St. H.
	9	49.90	41.90	1.22	2.37	25.38	9.31	Buff	Not St. H.
	11	48.95	39.75	1.23	2.41	26.90	9.92	Buff	Not St. H.
	13	46.00	33.90	1.36	2.52	33.75	12.85	Buff	Not St. H.
	15	Melted						Brown	St. H.
A264C2	1	54.30	49.20	1.10	2.42	14.00	4.90	Cream	Not St. H.
	3	53.35	47.40	1.12	2.41	16.40	5.80	Salmon	Not St. H.
	5	52.25	44.30	1.18	2.47	19.20	6.86	Buff	Not St. H.
	7	49.50	39.40	1.23	2.49	23.15	8.42	Buff	Not St. H.
	9	48.30	39.35	1.26	2.37	24.70	9.02	Buff	Not St. H.
	11	45.60	34.20	1.33	2.45	29.15	10.87	Buff	Not St. H.
	13	43.45	31.80	1.40	2.52	33.60	12.76	Buff	Not St. H.
	15	Melted						Brown	St. H.

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

MODULUS OF RUPTURE, HOLE A264

Sample	At cone	4	6	8	10	12
C1 C2	Lbs./sq. in.	505	519	515	614	737

PORTERS CREEK CLAY—LOWER PHASE

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Sample No.	Water of plasticity in percent	Bulk specific gravity	Drying shrinkage		Texture	Color
			Volume in percent	Linear in percent		
A171C5	49.93	1.720	51.68	21.54	Dense	Dk. gray
A212C1	61.85	1.815	73.75	36.01	Dense	Dk. gray
A212C2	72.87	1.720	81.77	43.33	Dense	Dk. gray
A216T	58.00	1.785	74.05	36.26	Dense	Dk. gray

Modulus of rupture: Sample A216T; 998 lbs. per sq. inch.

PYRO-PHYSICAL PROPERTIES

Hole A171

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	
A171C5	1	21.15	14.50	1.46	1.85	-3.61	-1.25	Brown (Bl.)	St. H.
	3	22.75	18.35	1.24	1.60	-30.25	-11.34	Reddish brown (Bl.)	St. H.
	5	25.05	21.82	1.15	1.53	-33.20	-12.58	Reddish brown (Bl.)	St. H.
	7	*	*	*	*	*	*	Reddish brown (Bl.)	St. H.

* Data unreliable due to condition of test pieces.

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

Note: Samples A212C1, A212C2 and A216T were burned to cone 1 and were bloated and cracked to such extent that data are unreliable.

BAUXITE

CHEMICAL ANALYSES OF BAUXITE, HOLE A225

SAMPLE P1 (0.0-39.6 FT.)

Soluble salts	0.25	Moisture, air dried	1.28	Sulphur, SO_3	0.11
Ignition loss	15.99	Iron oxide, Fe_2O_3	16.11	Magnesia, MgO	0.44
Silica, SiO_2	26.10	Titania, TiO_2	1.45	Potash, K_2O	0.09
Alumina, Al_2O_3	38.54	Lime, CaO	0.77	Soda, Na_2O	0.22
Manganese, MnO	0.59	Phosphorus, P_2O_5	0.46		

SOLUBLE AND INSOLUBLE VALUATION

Soluble Al_2O_3	37.85	Soluble Fe_2O_3	12.70	Insoluble	35.28

SAMPLE P2 (39.6-56.9 FT.)

Soluble salts	0.30	Moisture, air dried	2.93	Sulphur, SO_3	0.03
Ignition loss	12.06	Iron oxide, Fe_2O_3	19.80	Magnesia, MgO	0.45
Silica, SiO_2	36.37	Titania, TiO_2	2.25	Potash, K_2O	0.02
Alumina, Al_2O_3	26.86	Lime, CaO	0.43	Soda, Na_2O	0.42
Manganese, MnO	1.25	Phosphorus, P_2O_5	0.07		

SOLUBLE AND INSOLUBLE VALUATION

Soluble Al_2O_3	25.27	Soluble Fe_2O_3	18.70	Insoluble	43.69

SAMPLE P3 (56.9-66.9 FT.)

Soluble salts	0.20	Moisture, air dried	0.63	Sulphur, SO_3	0.03
Ignition loss	17.70	Iron oxide, Fe_2O_3	22.05	Magnesia, MgO	0.27
Silica, SiO_2	33.32	Titania, TiO_2	2.25	Potash, K_2O	0.03
Alumina, Al_2O_3	23.02	Lime, CaO	0.19	Soda, Na_2O	0.10
Manganese, MnO	0.81	Phosphorus, P_2O_5	0.56		

SOLUBLE AND INSOLUBLE VALUATION

Soluble Al_2O_3	15.59	Soluble Fe_2O_3	19.44	Insoluble	47.01

M. R. Livingston, analyst

MARL

SCREEN ANALYSES

Hole A257, Samples C1, C2, C3

Retained on screen	Percent			Character of residue
	C1	C2	C3	
30	10.08	10.49	3.59	Abundance of gray micaceous silt nodules; considerable quantity of limonitic clay nodules; small amounts of aragonite, shell fragments, siderite, glauconite, and quartz; traces of pyrite and gypsum
60	28.99	31.25	19.38	Abundance of gray clay nodules and micaceous silt nodules; considerable quantity of aragonite, shell fragments, siderite, glauconite, and limonitic clay nodules; small amounts of quartz and muscovite; traces of glauconite and gypsum
100	14.32	19.23	17.87	Abundance of gray clay nodules, silt nodules, and muscovite; considerable quantity of aragonites, shell fragments, siderite, glauconite, and limonitic clay nodules; small amount of quartz; trace of gypsum
150	6.99	6.55	11.05	Abundance of quartz, silt nodules, muscovite, and gray clay nodules; considerable quantity of limonitic material, shell fragments, siderite, and biotite
200	11.71	8.20	19.35	Abundance of quartz, muscovite, and gray clay nodules; considerable quantity of silty nodules, shell fragments, glauconite, limonite, and quartz; trace of biotite
250	2.45	1.69	2.90	Abundance of quartz and gray clay nodules; considerable quantity of muscovite, glauconite, silty nodules, and limonite; traces of biotite and shells
Cloth	25.66	22.59	25.86	Clay and silt including residue from above

CHEMICAL ANALYSIS

HOLE A256 SAMPLE C1

Soluble salts	1.00	Moisture, air dried	3.17	Sulphur, SO_3	1.67
Ignition loss	9.41	Iron oxide, Fe_2O_3	3.75	Magnesia, MgO	Trace
Silica, SiO_2	60.50	Titania, TiO_2	0.85	Potash, K_2O	0.03
Alumina, Al_2O_3	20.75	Lime, CaO	4.75	Soda, Na_2O	0.51

M. R. Livingston, analyst

OCHER

SCREEN ANALYSES

HOLE A310 SAMPLE C1

Retained on screen	Percent	Character of residue
30	0.88	Abundance of limonitic clay
60	6.43	Abundance of limonitic clay; trace of quartz
100	8.17	Abundance of limonitic clay; small amount of quartz
150	7.62	Abundance of limonitic clay; small amount of quartz
200	4.60	Abundance of limonitic clay; considerable quantity of quartz
250	4.38	Abundance of limonitic clay; considerable quantity of quartz
Cloth	77.92	Clay substance including residue from above

HOLE A311 SAMPLE C1

Retained on screen	Percent	Character of residue
30	0.97	Abundance of limonitic clay nodules with quartz embedded
60	7.77	Abundance of limonitic clay nodules with quartz embedded
100	6.68	Abundance of limonitic clay nodules; small amount of quartz
150	11.30	Abundance of quartz; considerable quantity of limonitic clay nodules
200	10.31	Abundance of quartz; considerable quantity of limonitic clay nodules
250	5.27	Abundance of quartz; considerable quantity of limonitic clay nodules
Cloth	57.70	Clay substance including residue from above

SAND

SCREEN ANALYSES

HOLE A113 SAMPLE C1

Retained on screen	Percent	Character of residue
30	69.87	Abundance of quartz
60	12.60	Abundance of quartz; small amount of feldspar; trace of hematite
100	4.60	Abundance of quartz and muscovite; small amount of feldspar; traces of hematite and carbonaceous material
150	1.14	Abundance of quartz and muscovite; small amounts of hematite and feldspar; trace of rutile
200	0.79	Abundance of quartz; small amounts of muscovite, feldspar, clay, and hematite; trace of rutile
250	0.64	Abundance of quartz; traces of muscovite, hematite, and rutile
Cloth	10.36	Fine residue from above

HOLE A117 SAMPLE P1

Retained on screen	Percent	Character of residue
30	41.70	Abundance of quartz
60	31.59	Abundance of quartz, considerable quantities of muscovite, feldspar, and hematite; trace of kaolin
100	8.07	Abundance of quartz; considerable quantities of muscovite, feldspar, and hematite; trace of kaolin
150	3.42	Abundance of earthy hematite, considerable quantity of quartz; small amounts of feldspar and muscovite; trace of kaolin
200	2.61	Abundance of earthy hematite; considerable quantities of quartz and muscovite; trace of feldspar
250	0.92	Abundance of earthy hematite; small amounts of muscovite and feldspar
Cloth	11.69	Fine residue from above

POSSIBILITIES FOR UTILIZATION

1 and 2

KAOLINITIC CLAYS

1A. Refractory coarse-grained, white to light burning, containing hard non-slaking kaolin nodules and pisolites. Not overburned at cone 18. Less than 5 percent accessory mineral aggregates.

The most typical clays of this group are: A8 0-3, A74 P1, A87 4.9-12, A200 5.9-15.9 and A234 C2. The other clays in the group are of the same variety but contain varying amounts of soft kaolin. In as much as the hard kaolin grades into soft kaolin, samples containing both are common.

The following are typical average properties: water of plasticity, 31.6 percent, linear drying shrinkage, 3.2 percent, green modulus of rupture, 54 pounds per square inch; porosity at cone 9, 30.3 percent, at cone 18, 7.2 percent; linear shrinkage at cone 9, 10.9 percent, and at cone 18, 17.5 percent. There is a general tendency for the clays to check during burning; consequently, modulus of rupture values are low and erratic but are higher and more consistent for the clays containing more of the soft kaolin (A101 P1, A121 10.3-15). The fusion points or pyrometric cone equivalents of typical clays are: A8 0-3, cone 34; A74 P1, cone 34; A101 P1, cone 33; A121 10.3-15, cone 33; A155 8.9-15, cone 33; A200 5.9-15.9, cone 34.

The clays in group 1A are characterized by their low strength and shrinkage in the unburned state, their tendency to check during burning, their high porosity at elevated temperatures, and their high refractory values. They are especially suited for making refractory grog when calcined between cones 11 and 15. The grog thus produced is suitable for use in No. 1 first quality fire brick, refractory shapes, and saggers.

The individual deposits of these clays do not extend over more than several acres; however, the deposits are widespread and the strata of many are 5 to 13 feet in thickness and are not overlain by excessive overburden.

Clay A184 C1 in classification 1B and clay A45 C1 in classification 1C would be desirable for making high grade buff colored and speckled face brick if blended with a low maturing clay of the pottery type (3A1).

2A. Refractory fine-grained soft, white to light burning, completely slaking kaolins. Not overburned at cone 18. Less than 5 percent accessory mineral aggregates.

The clays in this group contain very small amounts of sand, mica and limonitic clay nodules. Exception to this is clay A8 10-17 which is of the general type but is contaminated with ferro-manganese minerals. The typical clays are of such purity in their natural state that it is well worth while that they be washed, as such beneficiation would place them in a rank equal to the better grades of domestic and foreign kaolins.

The following are typical average properties: water of plasticity, 30.9 percent, linear drying shrinkage, 4.8 percent, green modulus of rupture, 118 pounds per square inch; porosity at cone 9, 23.2 percent, at cone 18, 5.7 percent; linear shrinkage at cone 9, 12.0 percent, and at cone 18, 17.0 percent. There is a general tendency for the clays to develop longitudinal cracks during burning which may be attributed to laminations developed in pressing the briquettes. In any event it does signify the type of plasticity developed and the fineness of the clay grains. A tendency to crack during burning is not unusual for fine-grained kaolins and is not necessarily detrimental to this type of clay. The raw color of most of the clays is white to cream. The color is generally listed as light gray in the tables of Physical Properties in as much as the distinction between pure white and nearly white is a matter of opinion unless the color is optically determined. In the strictest sense the clays are not pure white though they may be considered so by the layman.

High grade soft fine-grained kaolins are usually washed before being placed on the market. The clays in this group, having quality ratings of one and two, when washed free of the small amounts of impurities would be especially suitable for compounding into bodies of ceramic white ware which includes electrical, chemical, and table porcelain, hotel china and dinner ware, ceramic floor and wall tile, dust pressed wall tile, pottery shapes and art ware. They are well suited for use in compounding glazes and enamels. For non-ceramic purposes, they are suited for use as a filler in paper, rubber, oil cloth and linoleum, and as a pigment for paint.

The whitest of the clays in the raw state and those containing the smallest amount of impurities are: A24 C1, A24 C2, A74 C1, A102A C1, A102 C3, A107 C1, A111 C1, A129A C1, A129 C1, A131 C3, A171 C1, A180 C1, A195 C1 and A201 C1.

The thickness of the strata of the clays in this group varies between 2 feet and 13 feet. Several of the better samples are from strata 9 feet to 12 feet in thickness. The clays are generally accessible and are not covered with excessive overburden. They are of commercial value and could be developed profitably.

The soft kaolins in classifications 2B and 2C are of the same general character as those mentioned above except that they contain more sand, mica, or both. They have good working properties, fair strength, and are not inclined to check or crack during burning.

The typical average properties of clays in classification 2B are as follows: water of plasticity, 26.2 percent, linear drying shrinkage, 4.5 percent; porosity at cone 9, 25.4 percent, porosity at cone 18, 11.6 percent; linear shrinkage at cone 9, 6.7 percent and at cone 18, 10.6 percent.

The clays in classifications 2B and 2C which have the higher quality ratings are well worth beneficiating by washing for use as in 2A. The clays of the lower quality rating, when blended with local clays of the pottery type (3A1-2), are suitable for making high grade white to cream face brick (A150 C1, C2, C3, C4), (A220 C2), (A101 P2), (A161 C1). Fire brick of about No. 2 quality can be made from these clays when using the semi-dry press process.

3
POTTERY CLAYS

The pottery clays are the most versatile type in the county. They exhibit considerable variation in their properties and even though they have been classified into three groups this classification is not adequate. The division into groups has been made on a basis of earliest maturing temperatures which is probably the most important property for this type of clay. The clays are not typical of ball clays, bond clays, or kaolins but exhibit some properties common to all and are consequently suitable for many products without the addition of other clays and ceramic materials such as flint and feldspar. They are suitable for blending with other clays which lack the properties they possess. They are found above and below the kaolinitic clays and in deposits not associated with other types. They are readily accessible for blending with the kaolinitic clays or for use alone.

3A Fine-grained, cream and buff to gray burning, overburning at cones 13-18. Attains vitrification before overburning.

1. Steel hard at cones 1-3.

The typical average properties of this group of clays are: water of plasticity, 27.9 percent, linear drying shrinkage, 8.3 percent; porosity at cone 3, 17.2 percent, at cone 11, 3.0 percent; linear shrinkage at cone 3, 6.8 percent, and at cone 11, 9.5 percent.

The clays are suitable for use as the sole constituent of low maturing art pottery, as a flux and bond clay in higher maturing bodies used for stoneware, art ware, kitchen ware, terra cotta, conduit, and light colored face brick. Clays A178 C1, A178 C2, and A198 C1-2 crack and rupture during burning and should not be used alone in heavy ware but are the best in the group for use as flux and bond clays.

2. Steel hard at cones 5-7.

The typical average properties of the clays in this group are: water of plasticity, 27.2 percent, linear drying shrinkage, 6.4 percent, green modulus of rupture, 280 pounds per square inch; porosity at cone 3, 25.2 percent, at cone 11, 5.7 percent; linear shrinkage at cone 3, 4.2 percent, and at cone 11, 9.2 percent. The fired modulus of rupture varies with the individual sample and ranges between 1014-2604 pounds per square inch at cone 3, and between 1835-6008 pounds per square inch at cone 11. The clays having a quality rating of 1 are the whitest burning at elevated temperatures and are especially suitable for use in whiteware bodies as enumerated for clays under classification 2A, and as the sole constituent of bodies for art ware, pottery dinner ware, kitchen ware, high grade stoneware, sanitary ware, and faience. The clays in this group are worth beneficiating by washing for use in the best grades of white ware and for the production of glazes and enamels. They possess excellent suspending properties for slip, glaze, and enamel batches.

3B Less vitreous before overburning than 3A, slightly silty, steel hard between cone 7-11.

The typical average properties of the clays in this group are: water of plasticity, 25.5 percent, linear drying shrinkage, 6.6 percent, green modulus of rupture, 224 pounds per square inch; porosity at cone 3, 27.7 percent, at cone 13, 11.0 percent; linear shrinkage at cone 3, 2.2 percent, at cone 13, 7.8 percent; modulus of rupture at cone 3, 1931 pounds per square inch, and at cone 13, 5208 pounds per square inch.

The clays in group 3B are suited for use in making stoneware, conduit, glazed and unglazed hollow facing tile, terra cotta, faience, enameled face brick, garden pottery, statuary, and cream and buff to gray face brick.

4 and 5

BRICK AND TILE CLAYS

The brick and tile clays have been classified in two ways: the first according to dominant kinds of accessory minerals; and second, according to their burned color. The typical average properties of the several varieties are summarized below.

4A Silty, ferruginous, and micaceous. Cream and buff to brown burning.

Water of plasticity, 27.6 percent, linear drying shrinkage, 6.4 percent, green modulus of rupture, 240 pounds per square inch; porosity at cone 3, 27.6 percent, porosity at cone 13, 13.2 percent; linear shrinkage at cone 3, 2.8 percent, and at cone 13, 7.4 percent.

4B Silty ferruginous and micaceous. Cream to gray burning.

Water of plasticity, 26.0 percent, linear drying shrinkage, 5.6 percent; porosity at cone 3, 26.6 percent, at cone 13, 13.7 percent; linear shrinkage at cone 3, 4.5 percent, at cone 13, 8.5 percent.

4C Silty, ferruginous and micaceous. Buff to red and brown burning.

Water of plasticity, 29.4 percent, linear drying shrinkage, 4.1 percent; porosity at cone 3, 29.9 percent, at cone 13, 15.2 percent; linear shrinkage at cone 3, 7.0 percent, and at cone 13, 11.9 percent.

5A Silty and ferruginous. Cream to gray burning.

Water of plasticity, 29.1 percent, linear drying shrinkage, 8.6 percent, green modulus of rupture, 466 pounds per square inch; porosity at cone 3, 27.8 percent, at cone 13, 13.69 percent; linear shrinkage at cone 3, 1.6 percent, and at cone 13, 7.0 percent.

5B Silty and ferruginous. Buff to red and brown burning.

Water of plasticity, 30.7 percent, linear drying shrinkage, 4.9 percent, green modulus of rupture, 130 pounds per square inch; porosity at cone 3, 29.1 percent, at cone 13, 14.0 percent; linear shrinkage at cone 3, 8.2 per cent, at cone 13, 13.3 percent.

The brick and tile clays offer a wide range of material suitable for numerous varieties of face brick, common brick, structural tile, fire-proofing, flue lining, drain tile, and hollow facing tile. All of the clays have a long maturing range, possess excellent plastic and firing properties and adequate strength. The clays under classification 4A-B-C appear to be closely associated with the pottery clays and are essentially micaceous. The clays in group 5A-B are more like the kaolinitic clays. Those burning red and dense at early temperatures seem to be associated with the surface soil or mantle rock and underlying pottery clays of the type found above the kaolin horizon. As most of the brick and tile clays are closely associated with other types, their properties may be altered to suit particular requirements by the addition of other clays.

6

HIGHLY FERRUGINOUS CLAYS

A. Gray and buff to brown burning, over-burned before attaining maturity

The clays in this group are not suited for ceramic purposes when used alone. They are fairly high in alumina and their principal flux is iron oxide. Maturity is developed abruptly at elevated temperatures and is accompanied by cracking and checking. They may be used for heavy clay products if blended with clays of the pottery type or with composite mixtures of the several beds of which they are a part.

7

CLAYS OF COMPOSITE SAMPLES

Composite samples were made up using a proportionate amount of clay from each stratum in a single test hole. Information regarding the different strata of individual test holes (except A121) are found elsewhere in this report. The composites were made to illustrate possibilities for utilization of a greater thickness of clay. Since the composites were made up before the properties of the several clays composing them were known, it follows that proportions were not always made to the best advantage. For example, the composite of hole A200 contains too much kaolinitic clay for the amount of pottery clay present. In this hole the pottery clay was not sampled to its entire thickness, and possibly a better composite sample would result from using more of the pottery clay. The composite A200 is much like sample A200 5.9-15.9, 15.9-19.6 in as much as these clays dominate the mixture. The composite from hole A171 is unsatisfactory, because the Porters Creek clay, which this hole penetrated, caused the development of a vesicular structure during burning. Composites from holes A121, A125, A155, and A87 are suited for the manufacture of light colored face brick, fire proofing, flue lining, and a fair grade of refractory brick.

8

CLAYS GRADING INTO THE PORTERS CREEK FORMATION

The clays in this group are to be avoided when considering their use in ceramic ware. They are similar in character to the clays in the upper and lower phase of the Porters Creek formation which possess undesirable burning properties.

9

CLAYS OF THE PORTERS CREEK FORMATION, UPPER PHASE

A. Upper phase, bulk specific gravity 1.49-1.51

The typical range of properties of the clays in this group are: water of plasticity, 37-39 percent, linear drying shrinkage, 4-5 percent; porosity at cone 1, 36-37 percent, at cone 7, 11-20 percent, linear shrinkage at cone 1, 3-4 percent, at cone 7, 8-9 percent.

These clays are more characteristic of the middle or typical phase than clays from the lower phase of the formation. Other than the difference in physical states between the upper and middle phases, the silt content of the upper phase is the most distinguishing characteristic. The silt increases the bulk specific gravity from 1.0-1.2 of the middle phase to 1.49-1.51 for the upper phase.

The clays in the upper phase of the Porters Creek formation possess fair working properties and dry without difficulty. Their burning properties are undesirable because they have a very short maturing range before overburning. They could be used in the manufacture of common brick, but since common brick are also used as face brick, brick made from these clays would have a limited market. They are suitable for making fire proofing (hollow tile) and farm drain tile but are not suitable for use in products that must resist frost such as face brick or those requiring structural strength such as load bearing hollow tile. The clay is not suitable for blending with tight bodied clays such as those of the pottery group, for when present in appreciable amounts they cause bloating.

9

CLAYS OF THE PORTERS CREEK FORMATION, MIDDLE PHASE

B. Middle phase, bulk specific gravity 1.0-1.2

The properties of the middle phase of the Porters Creek clay are distinctly different from those of the usual varieties of clay. The clay is unique and may have possibilities far exceeding present knowledge. To assist in further investigation by others, the unusual combination of properties will be discussed in more detail than usual. Two investigations, other than routine, are underway in the laboratory of the Mississippi Geological Survey at the present time. The results obtained to date (October 1940) are given in this report.

PROPERTIES

The unweathered clay is dark bluish-gray when wet, and a dull, dark gray when dry. Clay exposed to the weather becomes an olive drab color when wet and a yellow to light gray when dry.

The structure of the clay is conchoidal and appears to be slightly laminated, but it is believed the apparent laminations are drying cracks in as much as the unweathered clay when carefully dried slakes in water into semi-concentric shell-like fragments. The clay first disintegrates into large shell-like fragments which in turn disintegrate into smaller and still smaller fragments. Disintegration ceases when the fragments reach about the size of a pea. Parallel planes of laminated structure are not present on any of the fragments during or after slaking. Practically no fine clay is produced by slaking. The wet clay has a soapy feel, and when rubbed between the hands with water, fine grained collodial clay is produced. Weathering does not seem to alter the structure of the clays or noticeably affect any other properties except color.

The freshly mined clay is tough and apparently plastic. About 40 per cent of its weight is water which is tenaciously held during drying; and when air dried at room temperature over a period of months, contains 7 to 8 percent water at 100°C. When dried at this temperature the clay is very hard and tough, and when thrown against a hard surface will bounce with about the resiliency of a baseball. The clay can be crushed and ground without difficulty; however, the grain size produced is dependent on the efficiency of the grinding apparatus. The clays used in routine tests were crushed and ground to pass a 20 mesh screen; however, it will be noted from the accompanying screen analyses that only a small fraction of the clay was fine enough to pass the 250 mesh screen even after blunging in water.

Of the several samples tested the water of plasticity ranged between 64 percent and 86 percent. The wide variation is likely due to differences in the fineness of grinding and the amount of wedging to produce a workable plasticity. It has been noted that fine ground clay will absorb greater quantities of water than coarse ground clay to developing comparable plastic qualities. The ground dry clay when first wet with water is devoid of plasticity. It has a mealy texture with a little adhesion. As the mixing and the wedging is continued plasticity develops, and more water is required to make the mass workable. After the clay has reached a workable plasticity, large quantities of water can be added, and with additional wedging and mixing the clay will again become stiff. It is evident that the water of plasticity varies with the fineness of grain and the amount of wedging. Such variations do not appreciably effect the bulk specific gravity of different samples but is reflected in the linear drying shrinkage which ranges between 7 and 15 percent.

Dry strength is affected by the final temperature of drying. The moduli of rupture of composite samples A264 C1-C2 are 170 pounds per square inch when dried at 25°C and 219 pounds per square inch when dried at 110°C.

The bulk specific gravity of test pieces from different samples of clay varies within the average narrow limits of 1.0 to 1.2 which is by far the lightest weight naturally occuring clay that has ever come to the attention of the writer. Even though the average linear shrinkage at cone 1 is 5.3 percent, the bulk specific gravity of the fired test pieces is still approximately the same as the unburned test pieces and is only slightly altered at higher temperatures, the average being 1.2 at cone 5. It seems that the loss in weight during burning up to cones 5-7 is proportional to the volume change.

The clay dries without warping or cracking and is accompanied by a normal shrinkage, all of which is unusual for a clay of such high water content.

The clay is not appreciably altered during burning up to cones 5-7. The average porosity at cone 1 is 48.8 percent, and at cone 9, 44.2 percent. The average linear shrinkage at cone 1 is 5.3 percent and at cone 9, 9.4 percent. The bulk specific gravity gradually increases from 1.1 at cone 1 to 1.2 at cone 5 and 1.3 at cone 9. Beginning at about cone 5-7 changes in porosity, shrinkage, and bulk specific gravity occur more rapidly and though the clay is open bodied at cone 13 (porosity 36.06 percent) it melts to a vitreous chocolate-brown glob at cone 15. The clay does not become steel hard before overburning. The fired modulus of rupture ranges between 505 pounds per square inch at cone 4 and 737 pounds per square inch at cone 12. The low average burning strength appears to be due to hair-like checks which extend in all directions. Experiments were conducted in an attempt to overcome checking by adding various amounts of ball clay to the Porters Creek clay. It was found that the ball clay increased the burning strength in accordance with the amount of ball clays used but was not appreciably effective in quantities less than fifty percent.

The development of hair-like checks during burning is an inherent characteristic of the clay which may be modified by additions of other clays and be lessened by slow burning or increased by fast burning. Samples burned at a rate in excess of one thousand degrees centigrade per hour disintegrated into irregular shaped fragments that would pass a one quarter inch mesh screen and be retained on a ten mesh screen. The fragments were steel hard but not overburned.

The fracture of the burned Porters Creek clay, which had previously been ground and formed into test pieces, is granular and uneven.

POSSIBILITIES

The possibilities of the middle phase of the Porters Creek clay are obviously in the field of light-weight materials; however the limitations of the clay must be realized for successful utilization.

Whitlatch* recommended the clay for the use as insulating and acoustical brick and attributed cracking during burning to drying strains and suggested finer grinding as a remedy. It is the opinion of the writer that the Porters Creek clay is not suitable for making brick by either the plastic or dry-press process and that should cracks or checks which develop during burning be attributed to drying

* Whitlatch, G. I. Light-weight product possibilities of the Porters Creek clay of west Tennessee, Tennessee Div. Geology, Resources of Tennessee. (2nd ser.) No. 1, pp. 10 and 23, 1937.

strains, finer grinding of the clay would increase the difficulty by increased drying shrinkage and increasing the burden of removing abnormal amounts of water necessary to develop a workable plasticity with finer ground clay.

Even though the clay has fair working properties in the raw state and can be made into light weight building units of good insulating quality, such products would have a limited use due to structural weakness and their high porosity would preclude exterior use.

The high porosity of the burned clay is attributed to microscopic pores which are characteristic of efficient high temperature insulation products. The application of brick in this field is limited to use as back up brick on account of structural weakness as heretofore described.

Possibilities for making burned light-weight aggregate from the clay appears to be its most promising ceramic use, for as such, undesirable weakness developed during burning is obviated and desirable light-weight qualities are preserved. Two types of aggregate, hard and soft, can be produced by burning in rotary kilns. The type of aggregate produced can be controlled by the rate of burning. The soft aggregate is applicable for use in a wide variety of burned clay products when used as a grog and bonded together with plastic clays. It is likely that the structural strength of such products would be ample for use as light-weight brick and block for insulating building units and for light-weight aggregate for insulating concrete, applicable for use in concrete block and monolithic construction where medium strength is required. The fast burned aggregate, which is steel hard, is suitable for use in stronger and more durable products.

9

CLAYS OF THE PORTERS CREEK FORMATION, LOWER PHASE

C. Lower phase, bulk specific gravity 1.72-1.81

The clays from the lower phase of the Porters Creek formation are unsuited for ceramic purposes. The average water of plasticity is 60.6 percent, and the average linear drying shrinkage is 34.3 percent. The typical green modulus of rupture is 998 pounds per square inch. Shrinkage from the plastic to dry states is excessive, and during burning the dense, tight-bodied clays crack, rupture, and bloat. They may be burned in a rotary kiln for the purpose of developing the optimum degree of bloating, and in such condition the burned vesicular clay can be crushed and used as a light weight aggregate for concrete.

The high dry strength of the clay suggests the possibility for use as a bond in molding sand. These clays are known to have bleaching properties of about one half the efficiency of commercial fullers earth. They do not respond to beneficiation by acid treatment. Their use for rotary drilling mud has been considered, but apparatus for testing the clay for this use has not been available. In as much as the clay has a bentonitic character and is very abundant, possibilities for use as drilling mud should be investigated by commercial interests.

10
BAUXITE

The largest deposit of bauxite in Tippah County is that on the W. T. Meadows property; T.3 S., R.2 E., Sec. 36. It is represented by material from test hole A225. Chemical analyses were made on the ore from three intervals representing a thickness of 66.9 feet. The alumina content is too low for a good grade of ore and decreases with depth. Iron and silica increase with depth. The ore is low grade and is not adaptable to present day processes of refining and utilization. The phosphorus content precludes the use of the ore for ferro-silicon.

Bauxite from test hole A252 is of low grade and is not of commercial value. The material was tested as a clay and the results are given with the data of other clays in region A.

11
MARL

Samples of marl are represented by materials from test holes A256 and A257. Marl from test hole A256 was tested as a clay but the burned test pieces disintegrated in water. The lime content is too high for the marl to be of ceramic value and is too low for use as a raw material for rock wool, cement, and similar products.

12
OCHER

A fair grade of yellow ocher is represented by materials from test holes A310 and A311. Screen analyses indicate that both samples are uniform and only slightly contaminated. The ocher retained on the several screens is soft and friable and can easily be reduced to a powder. Sample A310 C1 contains 18.08 percent Fe_2O_3 and Sample A311 C1 contains 18.56 percent Fe_2O_3. Both samples are evidently from the same bed.

The value of an ocher is not necessarily based on its iron content but rather on its color and physical state. The fineness of the particle size renders the ocher more valuable as a pigment by increased coloring power than a hard ore such as hematite which may have a higher iron content but which is difficult to reduce to a fine state of division. Samples A310 C1 and A311 C1 when heated, turn to a beautiful rouge of potent coloring power. The ocher appears to be of value as a yellow and red paint pigment and should be investigated by commercial interests.

13

SAND

Deposits of sand represented by samples A113 C1 and A117 P1 are suitable for masonry and concrete. Their screen analyses indicate that the samples possess an excellent size gradation and are fairly free of clay and silt. The deposits are 18.5 feet and 20.7 feet in thickness and are covered by a relative small thickness of overburden.

EXPERIMENTAL INVESTIGATIONS OF THE PORTERS CREEK CLAY, MIDDLE PHASE

GENERAL

From the routine tests of the Porters Creek clay two possibilities for utilization were evident which warranted further study. These are the uses of the clay as a rotary drilling mud and as a burned light-weight aggregate. The preliminary experiments show possibilities not heretofore discovered. The investigation is not complete nor are the results considered conclusive but are given here to assist other investigators and commercial interests. Sample A264 C1-2 is considered an average typical sample and was used in this investigation.

ROTARY DRILLING MUD

FUNCTIONS AND PROPERTIES OF MUD FLUID USED IN ROTARY DRILLING*

"In its flow through the circulating system the mud fluid has a variety of different functions to perform. It must carry all of the

* Uren, Lester Charles, Petroleum production engineering, p. 230, 1934.

drill cuttings from the bottom of the hole to the surface and discharge them into the settling ditch. It must absorb heat generated by the drilling bit in cutting through the rock formation, and heat generated in the drill pipe by frictional contact on the walls of the well. To prevent caving, it must deposit clay in the wall rocks of the well, aided by the plastering action of the drill pipe. It must seal the pores of sands yielding high-pressure gas or water which might prove troublesome or dangerous in drilling and shut off unusually permeable, low-pressure formations, fissures or crevices into which the fluid might flow in sufficient quantity to cause loss of circulation. By its weight, it must be capable of providing sufficient hydrostatic pressure to prevent high-pressure gas, oil or water from entering the well.

"To fulfill these requirements satisfactorily, the mud fluid used should develop maximum plastering action, the solid particles should be capable of remaining in suspension for a long period of time without tendency toward rapid settling, and it should be relatively free from sand. It must have a sufficient density to provide the necessary hydrostatic pressure to resist the highest gas, oil, and water pressures that may be encountered. It must have sufficient density and viscosity to hold the drill cuttings in suspension with minimum tendency to settle out. However, the viscosity should not be excessive, otherwise an unduly difficult pumping problem may be created. These properties are secured only by careful selection of the clay used in preparation of the mud fluid. Different types of clay vary widely in their properties, and fluids prepared with them vary correspondingly. Clays satisfactory in every particular for this purpose are not plentiful and must often be brought into the oil fields from remote deposits at considerable expense."

EXPERIMENTAL DATA

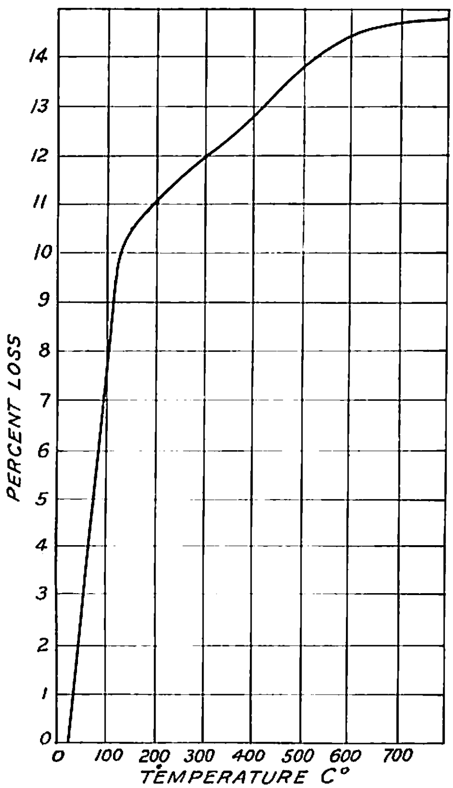

TABLE 1

Thermal dehydration—

Time, 7 hours

Temp C°	Percent loss
25	0.0
100	7.85
150	10.50
200	11.08
250	11.60
300	11.94
350	12.28
400	12.66
450	13.31
500	13.82
550	14.16
600	14.40
650	14.53
700	14.65
750	14.77
800	14.82

140-150°C is probably the optimum temperature for drying.

Figure 18.—Thermal dehydration curve of the Porters Creek clay (middle phase), sample A264 C1-2.

TABLE 2

Porters Creek clay, air dried, ground 8 hours with water in pebble mill

Temperature 22°C

Percent Clay	Sp. G. True	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
			Viscosity	Imm. Gel.	12 min. Gel.		
27.00	1.205	1.200	135.0	115	80	10.00	52.00
25.70	1.190	1.190	84.0	95	60	9.90	51.50
24.50	1.180	1.180	55.0	75	55	9.80	51.25
23.42	1.169	1.170	40.0	60	40	9.75	51.00
22.50	1.160	1.160	25.0	45	30	9.70	50.50
21.60	1.152	1.155	17.0	35	25	9.60	50.00
20.76	1.144	1.150	15.0	30	25	9.55	49.75
20.00	1.137	1.140	11.5	25	20	9.50	49.50
19.30	1.130	1.135	10.0	25	20	9.45	49.50

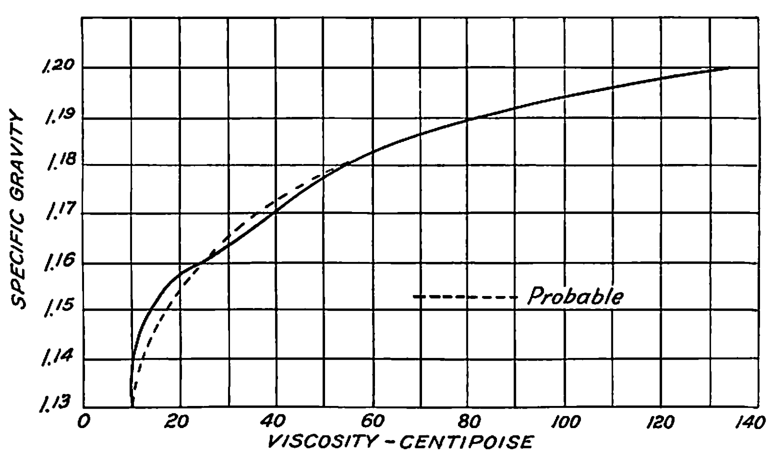

Figure 19.—Relation between viscosity and specific gravity of drilling fluid, Porters Creek clay (middle phase), sample A264 C1-2.

TABLE 3

Porters Creek clay through 250 mesh screen, dried 140°C. Mixed with water and blunged 30 minutes

Temperature 22°C

Percent Clay	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
		Viscosity	Imm. Gel.	12 min. Gel.		
29.4	1.23	20	35	35	10.2	53.5

TABLE 4

Reduced Sp. G. of above with water and blunged 5 minutes

23.0	1.165	5.5	9	N. D.	9.72	50.25
Blunged 30 minutes more						
23.0	1.165	7	15	N. D.	9.72	50.25
Blunged 30 minutes more						
23.0	1.165	8	15	N. D.	9.72	50.25

TABLE 5

85 percent Porters Creek clay and 15 percent Pontotoc bentonitic clay ground 3 hours with water in pebble mill

Temperature 25°C

Percent Clay	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
		Viscosity	Imm. Gel.	12 min. Gel.		
20	1.14	13	40	45	9.5	49.5

TABLE 6

Porters Creek clay ground 3 hours with water in pebble mill. Dried 100°C blunged 30 minutes

Temperature 24°C

Percent Clay	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
		Viscosity	Imm. Gel.	12 min. Gel.		
27.8	1.21	40	45	40	10.5	53

TABLE 7

Reduced Sp. G. of above with water and blunged 5 minutes						
27.0	1.20	20	40	40	10.0	52
Blunged 30 minutes more						
27.0	1.20	27	50	50	10.0	52
Reduced Sp. G. of above with water and blunged 5 minutes						
20.0	1.14	6.5	17	25	9.5	50
Blunged 30 minutes more						
20.0	1.14	7.5	20	35	9.5	50
Blunged 60 minutes more						
20.0	1.14	8.5	25	45	9.5	50

TABLE 8

Porters Creek clay ground with water in pebble mill 8 hours. NaOH added. percent based on weight of dry clay 100°C and blunged 5 minutes

Temperature 22°C

Percent Clay	Percent NaOH	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
			Viscosity	Imm. Gel.	12 min. Gel.		
22.5	0	1.160	20	45	30	9.7	50.5
22.5	0.2	1.160	25	45	75	9.7	50.5
22.5	0.6	1.160	25	20	80	9.7	50.5
22.5	1.0	1.160	150*	120	165	N. D.	N. D.
22.5	1.4	1.160	650 grams for 600 R. P. M.	200	250	N. D.	N. D.
22.5	1.8	1.160	N. D.	270	300	N. D.	N. D.
22.5	2.2	1.160	N. D.	650	600	N. D.	N. D.
22.5	3.0	1.160	N. D.	850	450	N. D.	N. D.
22.5	4.0	1.160	N. D.	550	450	N. D.	N. D.
13.5	4.0	1.090	90	60	70	9.0	47.0
11.75	1.8	1.080	8.5	12	12	9.0	47.0
11.75	2.0	1.080	69	45	65	9.0	47.0
11.75	2.2	1.080	72	50	55	9.0	47.0
10.00	2.2	1.068	11	10	12	8.9	46.5
10.00	3.0	1.063	25	35	35	8.9	46.5
10.00	3.5	1.063	40	35	30†	8.9	46.5

* Viscosity estimated by extending calibration curve.

† 12 hour gel 30 grams—no evidence of settling.

TABLE 9

Porters Creek clay ground 8 hours with water in pebble mill. Salt (NaCl) added and blunged 5 minutes. Percent salt on basis dry clay 100°C

Temperature 22°C

Percent Clay	Percent NaCl	Sp. G. Hydr.	Stormer			Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
			Viscosity	Imm. Gel.	12 min. Gel.		
22.5	0.0	1.160	20	45	30	9.7	50.5
22.5	0.4		15	35	35		
22.5	0.8		10	30	35		
22.5	1.2		13	30	40		
22.5	1.4		10	25	35		
22.5	2.2		11.5	35	35		
22.5	4.0		11.0	30	35		
22.5	5.0		11.5	30	35		
22.5	6.0	Increasing	11.5	35	40	Increasing	Increasing
22.5	7.0		15	35	45		
22.5	8.0		13	40	50		
22.5	9.0		15	40	45		
22.5	10.0		15	40	45		
22.5	12.0		17	45	50		
22.5	14.0		17	55	55		
22.5	18.0		20	50	55		
22.5	28.0		23	55	60		
22.5	38.0	1.200	34	65	70	10.0	52.0

Increase in wt./gal. is due to increase in salt. 38 percent salt is equivalent to adding 0.3 pounds salt per gallon of original mud.

TABLE 10

85 percent Porters Creek clay and 15 percent Pontotoc bentonitic clay ground 3 hours with water in pebble mill. Salt (NaCl) added, percent based on dry weight of clays 100°C. Blunged 5 minutes

Temperature 25°C

Percent Clays	Percent NaCl	Sp. G. Hydr.	Stormer Viscosity	Stormer Imm. Gel.	Stormer 12 min. Gel.	Wt./gal. Hydr.	Hydrostatic pressure 100 Feet
20	0	1.14	13	40	45	9.5	49.5
20	1.0		17	45	50		
20	2.0		17	45	80		
20	3.0	Increasing	17	55	85	Increasing	Increasing
20	5.0		17	50	50		
20	10.0		18.5	50	30		
20	20.0		22.5	50	85		
20	40.0		31.5	60	50		
20	80.0	1.25	66	80	35	10.5	54.0

TABLE 11

Water added to reduce Sp. G. of mud used in last determination of table 10 and blunged 5 minutes.

1.20	18.5	40	30	10.0	52.0

Increase in wt./gal. in table 10 is due to salt. 80 percent salt is equivalent to adding 1 pound of salt to a gallon of original mud.

SUMMARY AND CONCLUSIONS

The Porters Creek clay is slow to disintegrate in water (Table 3), but if finely ground and introduced into the drilling fluid during the early stages of the drilling operation its highly colloidal properties developed with aggitation (Table 4). As the drilling proceeds and a greater volume of mud is needed, more clay and water can be added. Sodium hydroxide (NaOH) appears to be a potent base to control viscosity (Table 7); however, sodium chloride (NaCl), a salt that is frequently encountered in drilling operations, is only slightly effective (Table 9). A 9.7-pound salt free mud of the Porters Creek clay loses viscosity at the first trace of salt but not enough to drop the sand or cuttings as the gel strength is only slightly effected. Further increases in salt (Table 9, and 10) have no appreciable effect even though viscosity and gel strength increase with larger amounts of salt, density or weight per gallon is also increased which may account for the apparent increase in viscosity and gel strength with increasing salt content. A small amount of water (Table 11) restores the mud to a workable consistency. Most of the sample muds were left standing overnight and some were left standing for over a month. In no instance was there any evidence of settling.

These experiments suggest that the middle phase of the Porters Creek clay could be used successfully as a rotary drilling mud in salt bearing formations, salt beds, and in marine exploration.

The wall building qualities of the mud have not been investigated, nor have properties under heat and pressure been studied. The behavior of the mud in the presence of salt appears to be its outstanding characteristics and its use as a drilling mud should be thoroughly investigated.

BURNED LIGHT-WEIGHT AGGREGATE

Light-weight aggregate for use in concrete falls into six types of material. They are: vitrified clay having a vesicular structure; slag, a porous and a vesicular by-product from blast furnaces; vermiculite, an exploded mica-like mineral; cinders, from burned coal; calcined diatomaceous earth of high porosity; and lately, a friable cellular product made by blowing melted slag. Of these several products vitrified vesicular clay and blast furnace slag give concrete of strength approaching that using stone, gravel and sand as the aggregate. They have some insulating value over stone, gravel, and sand, but their chief advantage is a saving in dead weight with little loss in strength. The other light-weight aggregates except cinders are used chiefly for their insulating value and cinders are used mostly because they are cheap. Strengths of concrete made from these aggregates are low and this necessitates larger mass construction to obtain sufficient strength.

So far as it is known to the writer no light-weight aggregate is produced that will make concrete which has strength approaching stone, gravel, and sand concretes and has the lightness of weight and the insulating value of some of the weaker and more porous aggregate concretes.

Experiments on the Porters Creek clay indicate that a burned aggregate of this material will produce a concrete approaching the rock and sand concretes for strength and will possess greater leviety than vitrified vesicular clay aggregate concrete and insulating qualities equal to the better insulating aggregate concretes.

EXPERIMENTAL PROCEDURE

The work so far consists of burning lumps of clay at 2000°F. and crushing this to aggregate of size to pass a one quarter inch mesh screen. A screen analysis was made but no adjustment in size gradation was made to control void space. The bulk specific gravity of the aggregate retained on, and that passing a 10 mesh screen was determined. Concrete mixtures consisting of varying amounts of aggregate, Portland cement and water were made and formed into cylindrical test pieces 4 inches in diameter and 6 inches tall. The test pieces were cured 30 days in a damp cellar and their crushing strengths were determined according to A.S.T.M specifications. Porosity and absorption were determined in the usual manner and weight per cubic foot was calculated.

The aggregate, being burned at a moderate temperature, was not steel hard and would not have been appreciably harder if burned at a higher temperature short of fusion when burned at a slow rate. It was pointed out in the part of this report dealing with the pyrophysical properties of the Porters Creek clay that a fast burned aggregate does become steel hard and still possesses a high degree of leviety. It is this type of aggregate that is expected to produce the stronger concrete which possesses unusual insulating qualities. The type of concrete tested was made of the slow burned aggregate which probably represents the most economical kind to produce and which possesses maximum leviety and insulating qualities and moderate strength.

EXPERIMENTAL DATA

Screen Analysis of Porters Creek Clay Aggregate

Through	Retained	Percent
1/4 inch	10 mesh	25.0
10 mesh	30 mesh	47.8
30 mesh	100 mesh	18.0
100 mesh	pan	9.2

Composition of Concretes Tested

Concrete No.	Portland cement by wt.	Portland cement by vol.	Porters Creek clay aggregate by wt.	Porters Creek clay aggregate by vol.
A	20	10.5	80	89.5
B	30	16.5	70	83.5
C	40	23.8	60	76.2
D	50	31.7	50	68.3
E	60	41.0	40	59.0

Note: The water used was approximately 1/3 of the total weight of concrete.

Properties of Concretes Tested

Crushing strength in pounds per square inch

Concrete	Maximum	Minimum	Mean
A	585	525	555
B	845	760	800
C	1175	1030	1107
D	1520	1325	1425
E	2045	1710	1920

Weight per cubic foot

Concrete	Maximum	Minimum	Mean
A	70.0	67.5	68.5
B	73.0	70.6	72.0
C	76.5	74.4	75.5
D	81.4	78.5	80.0
E	87.0	83.0	85.2

Absorption in percent

Concrete	Maximum	Minimum	Mean
A	46.6	44.7	45.8
B	37.0	35.5	36.8
C	32.0	28.9	30.5
D	28.2	24.0	26.0
E	26.2	21.0	23.5

Porosity in percent

Concrete	Maximum	Minimum	Mean
A	47.0	45.8	46.2
B	42.1	39.5	41.0
C	38.2	35.0	36.8
D	35.0	32.5	33.0
E	33.0	29.5	31.3

WEIGHT OF SOLID MATERIALS

Burned Porters Creek clay	75	Lbs. per cu. ft.
Face brick	150	" " " "
Common brick	125	" " " "
Granite*	170	" " " "
Limestone*	165	" " " "
Sandstone*	150	" " " "

WEIGHT OF AGGREGATES

Burned Porters Creek clay	40-45	Lbs. per cu. ft.
Vitrified vesicular clay	50-60	" " " "
Loose rock*	100	" " " "
Gravel, clean*	100	" " " "
Sand, dry*	90	" " " "
Cinders*	45	" " " "

WEIGHT OF CONCRETES

Burned Porters Creek clay	70-85	Lbs. per cu. ft.
Vitrified vesicular clay	100	" " " "
Stone and gravel*	145	" " " "
Sand*	135	" " " "
Cinders*	110	" " " "

STRENGTH OF CONCRETES

	Compression strength in Lbs. Per Sq. In.
Burned Porters Creek clay	1000-2000
Granite or trap rock*	1400-3300
Gravel or hard limestone or hard sandstone*	1300-3000
Soft limestone or sandstone*	1000-2200
Cinders*	400- 800

* Peele, Robert, Mining Engineering Handbook, p. 2378 (1927).

SUMMARY AND CONCLUSIONS

It was noted that the dry concrete specimens were resistant to the capillary action of water. It would be expected that a concrete of such high porosity would absorb water rapidly and by capillary action would soon become saturated. Test pieces containing 50 percent Portland cement by weight or 34.5 percent by volume, partly submerged in water were wet about one inch above the water line on six hours standing and did not appear to be wet any higher on standing 24 hours. A burned brick made entirely of Porters Creek clay when subjected to the same test was wet its entire height above the water line (8 in.) in six hours. It is believed that the resistance to capillary action of the concrete made from Porters Creek clay aggregate is due to one of two causes or to both. (1) The capillary trains in the Porters Creek clay are broken and disconnected when crushed into aggregate, and (2), the capillary trains are nearly small enough to prevent water entering and that soluble silicates of the Portland cement, which may penetrate the aggregate while the concrete is setting, hardens and clogs the pores to such an extent that they are somewhat impermeable under capillary action. Should further investigation prove the apparent resistance of the concrete to capillary action, the aggregate would truly be unique and solve the problem of wet-wall liability of insulating concretes.

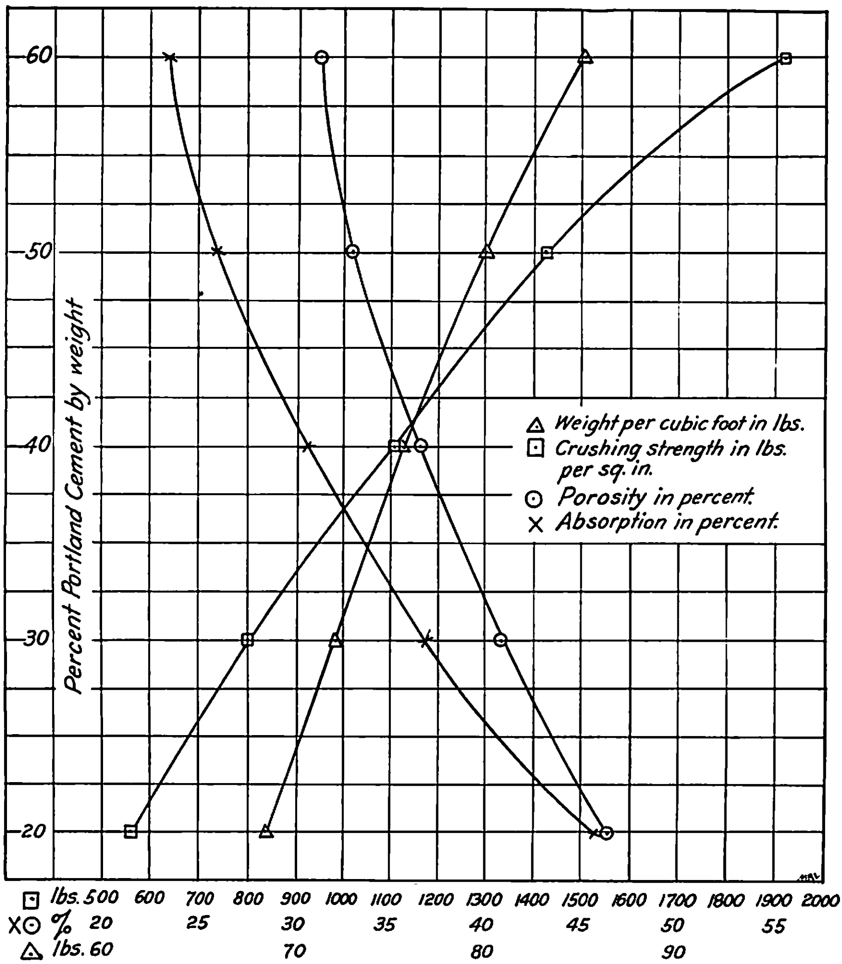

Figure 20.—Properties of light-weight Porters Creek clay aggregate concrete.

The applications of light-weight insulating concrete is well known, and it appears that such concrete made from the slow burned Porters Creek clay aggregate is applicable to the major uses and that the fast burned aggregate is applicable where great strength is required.

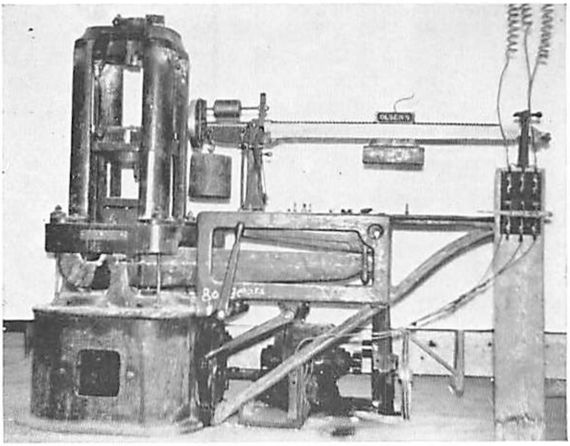

Figure 21.—Olsen 50-ton testing machine in the laboratory of the School of Engineering at the University of Mississippi used in determining the crushing strength of the light-weight Porters Creek clay aggregate concrete.

LABORATORY PROCEDURE

PREPARATION

Samples of clay were dried between 110° and 120° C. 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 clay which had passed the 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 two sizes: 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. Each test piece was identified as to hole number, sample number and individual piece number. The identification was made by stamping the necessary letters and numerals on the test pieces. A shrinkage mark of 10 centimeters was stamped on the long bars. Sixty long bars and 100 short bars 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 a mercury volumeter. 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 were placed in dessicators, and on cooling to room temperature they were reweighed and revolumed. The 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 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 for the American Ceramic Society. The linear shrinkage was calculated from the volume 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 a temperature of 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 2,100° 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 kept boiling for four hours. They were allowed to cool in the water to room temperature and were reweighed as before mentioned. Immediately thereafter the volumes of the test pieces were determined in a mercury volumeter. Volume shrinkage, porosity, absorption, bulk specific gravity, and apparent specific gravity were calculated in accordance with methods outlined by the American Ceramic Society. The long bars were broken on a Fairbanks testing machine to determine modulus of rupture. Five long bars were burned and tested for each cone temperature indicated in the table of pyro-physical properties. Three short bars were fired as test pieces for each clay and at each cone.

CHEMICAL ANALYSES

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

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

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

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

Manganese: Manganese was determined in the filtrate from alumina determination. Unless the carbonate fusion in the silica determination was blue, no manganese determination was made. Manganese was precipitated as the dioxide from a buffered acetate solution by oxidation with bromine. The dioxide was filtered off, ignited, and weighed as Mn_3O_4.

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

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 practicable with the apparatus at hand.

Sulphur: Sulphur 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 of each clay and the average 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.

Soluble Iron Sulfate: A ten-gram sample of clay was digested for one hour, cooled, and filtered. An aliquot of the filtrate was reduced with test lead and titrated with dichromate solution for iron determination. Another aliquot was acidified, and the sulfates were precipitated with $BaCl_2$, ignited, and weighed. From these two determinations, the soluble iron sulfate was calculated, assuming all the iron was present as sulfate if a sufficient amount of SO_4 was present. In all cases, the total SO_4 was slightly greater than would be necessary to combine with the iron found.

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	2,039
1	1,125	2,057	1,160	2,120
2	1,135	2,075	1,165	2,129
3	1,145	2,093	1,170	2,138
4	1,165	2,129	1,190	2,174
5	1,180	2,156	1,205	2,201
6	1,190	2,174	1,230	2,246
7	1,210	2,210	1,250	2,282
8	1,225	2,237	1,260	2,300
9	1,250	2,282	1,285	2,345
10	1,260	2,300	1,305	2,381
11	1,285	2,345	1,325	2,417
12	1,310	2,390	1,335	2,435
13	1,350	2,462	1,350	2,462
14	1,390	2,534	1,400	2,552
15	1,410	2,570	1,435	2,615
16	1,450	2,642	1,465	2,669
17	1,465	2,669	1,475	2,687
18	1,485	2,705	1,490	2,714
19	1,515	2,759	1,520	2,768
20	1,520	2,768	1,530	2,786

Cone 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 ordinarily occur in the usual commercial 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 re-agents, 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.

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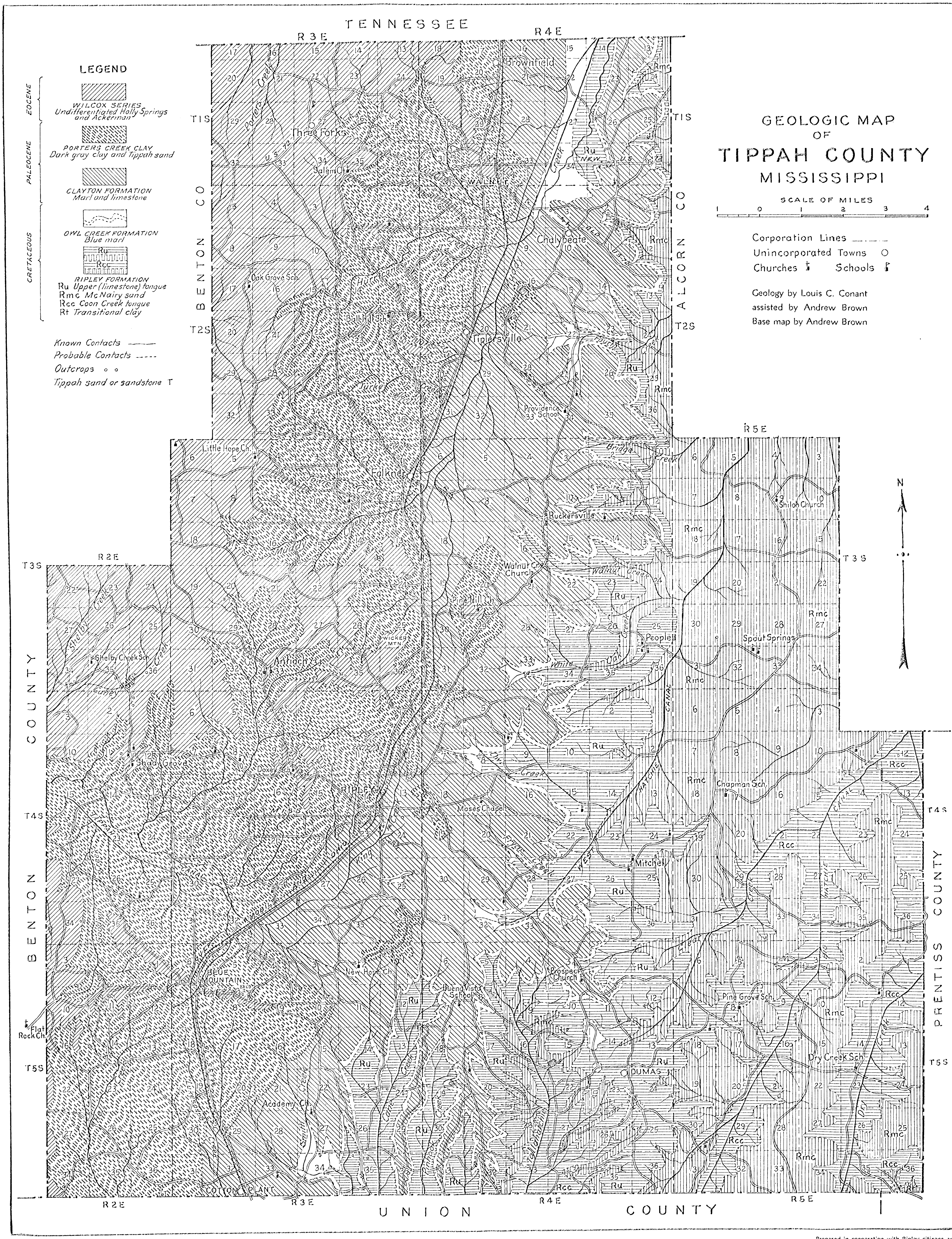
The Eastern Clay Products Company loaned apparatus for testing drilling mud.

PAGE REFERENCE TO TEST HOLES



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