CLAY DEPOSITS OF THE TUSCALOOSA GROUP IN ALABAMA*

by

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ABSTRACT

Sediments of the Tuscaloosa Group, Upper Cretaceous Age, crop out in an arc that extends from North Carolina through the kaolin districts of South Carolina and Georgia, across Alabama, Tennessee, Kentucky and into southern Illinois. Deposits of clay, sand, and gravel were formed in a variety of geologic environments that include marine, lacustrine, lagoonal, fluvial and deltaic deposition. They accumulated on an eroded surface of pre-Triassic rocks.

In eastern Alabama clay beds within the Tuscaloosa Group that occur close to the contact of the pre-Cretaceous crystalline rocks comprise detrital accumulations derived from saprolite, and consist of kaolinite, montmorillonite, chlorite and quartz. Clays occurring somewhat stratigraphically higher in this section are mixtures of illite, kaolinite, quartz and minor amounts of montmorillonite and chlorite.

Westward in Alabama, clay in the Tuscaloosa Group occurs as thick irregular pockets and lenses of montmorillonite clay, whereas, in northwestern Alabama the clay is kaolinite with variable amounts of illite and montmorillonite. Some of the clay deposits in this area have been lateritized, resulting in the formation of bauxitic clay, which is a mixture of gibbsite and kaolinite.

INTRODUCTION

IRREGULAR lenticular deposits of clay occur throughout the sediments of the Tuscaloosa Group in Alabama. Many of the deposits are composed of predominantly montmorillonite minerals, some deposits are mixtures containing a high percentage of illite, and a few deposits are composed of nearly pure kaolinite. The kaolins occur in northwestern Alabama only.

This is a preliminary report on clay resources of the Tuscaloosa Group in Alabama. It is part of a state-wide investigation of clays and shales by the Geological Survey of Alabama in cooperation with the U.S. Bureau of Mines. The main objective of the investigation is evaluation of the clays for potential industrial development; however, the study includes basic research on the origin and depositional environment of clays.

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Previous Investigations

Smith and Johnson (1887) described the Cretaceous sediments below the Eutaw Formation and above the Pottsville Formation and proposed the name Tuscaloosa Formation after the town, county, and river in west Alabama where the formation is exposed. Smith and others (1894) stated, "The materials of this formation which are destined to become of great commercial importance in the future, are the clays which occur at intervals throughout it. These are in all respects similar to the clays of New Jersey which belong to the same geological horizon. At several places in the state, use has been made of these clays in the manufacture of ordinary stone ware, and lately in the manufacture of fire brick, but the beginning has hardly yet been made in their development."

Ries (1900) reported that clays from deposits in Colbert and Marion Counties could be used for refractory products. He also reported on other clay deposits in this belt from Georgia to Tennessee and stated that they are suitable for making pottery, brick and ceramic products. Bramlette and McVay (1935) gave evidence that the sands in the large clay deposits of eastern Marion County are similar to the sands in the Pottsville Formation, and suggested a pre-Tuscaloosa age for these deposits.

Method of Investigation

Field work on this project was done between February 1962 and September 1963. During this reconnaissance survey representative clay samples were collected in road cuts, mines and other exposures. Test data on samples taken prior to this investigation were reviewed.

GEOLOGIC SETTING

Sediments of the Tuscaloosa Group consist of clay, sand and gravel, deposited on a deeply eroded and weathered surface at the beginning of Late Cretaceous age. They crop out in an arc over 950 miles long that extends from eastern North Carolina, across South Carolina, Georgia, and Alabama, touching Mississippi, across western Tennessee and Kentucky into southern Illinois (Fig. 1).

These sediments accumulated in seas and in basins formed by the downwarping of the Atlantic Coastal Plain and the subsidence of the Mississippi Embayment. On the Atlantic slope, from North Carolina through Georgia and eastern Alabama, sediments dip gently southeastward toward the Atlantic Ocean and overlie metamorphosed crystalline rocks, but in western Alabama beds of sand, clay and gravel overlie indurated sediments of Paleozoic Age.

The Tuscaloosa Group is divided into the Coker and Gordo Formations

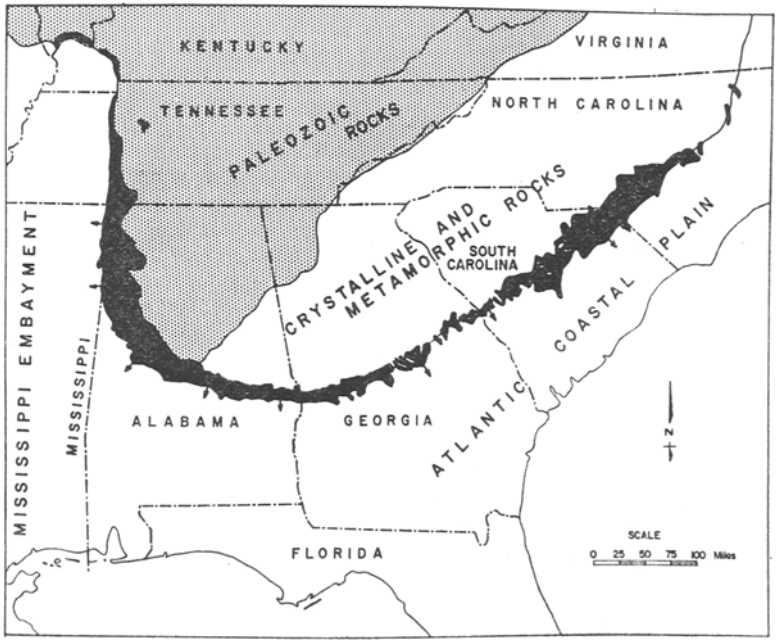

FIGURE 1.—Tuscaloosa Group outcrop in southeastern and central United States.

in central and western Alabama; however, the Coker and Gordo Formations are not recognized in eastern or northwestern Alabama.

The variable characteristics of the sediments, which consist mainly of cross-bedded sands with clay pockets and lenses, indicate complex fluvial and deltaic deposition. Some clays contain glauconite, indicating local marine deposition. Kaolinitic clays in northwestern Alabama apparently were deposited in fresh-water lakes or lagoons, because the clays contain no glauconite and are associated with lignitic clays.

EASTERN ALABAMA

Regional Setting

The sediments of the Tuscaloosa Group in eastern Alabama crop out in a westward-trending belt about 8 to 14 miles wide. The location of this area is shown in Fig. 2.

Scott (1960a) reports a south-southwestward dip of 30 to 40 ft per mile in Macon County and thicknesses ranging from 50 ft in the northern part

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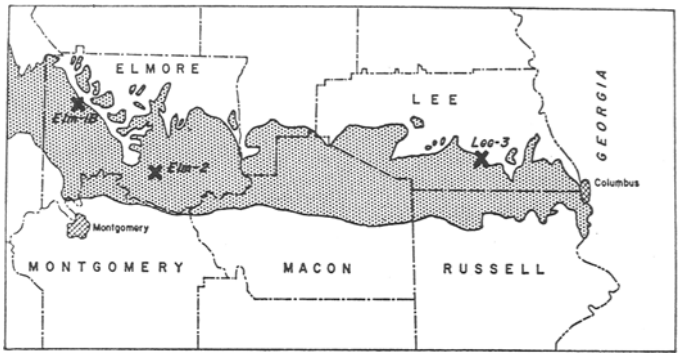

FIGURE 2.—Tuscaloosa Group outcrop in eastern Alabama.

of the county, near the crystalline outcrop, to 500 ft in the central part of the county, near the contact with the overlying Eutaw Formation. The Tuscaloosa sediments thicken to the south and are about 600 ft thick at the southern border of the county.

In Elmore County the southward-dipping monoclinal structure is interrupted by a series of grabens. These downthrown blocks are faulted parallel to the general strike of the sediments.

Clay Deposits

The contact between the Tuscaloosa sediments and the crystalline rocks has been prospected in eastern Alabama for clay deposits. The general sequence is arkosic sand overlying a deep saprolite zone, but some clay deposits occur on the contact. One deposit in Lee County, located in the NW¼ sec. 29, T. 18 N., R. 28 E., is a 4-ft bed of light gray clay consisting of kaolinite, quartz, partly decomposed feldspar and a small amount of montmorillonite. This deposit overlies weathered granite gneiss and, apparently, consists of detrital material derived from the eroded gneiss. The location of this deposit, designated as Lee–3, is shown in Fig. 2.

Another deposit, designated as Elm–1B, located in the NE¼SE¼ sec. 4, T. 19 N., R. 17 E., Elmore County, is very similar in appearance to that at Lee–3, but contains a higher percentage of montmorillonite and chlorite. It is a 4-ft layer of light-gray clay overlying granite saprolite and underlying gray sandy clay. The location is shown in Fig. 2. The approximate mineral analysis is given below with sample Elm–2.

Sample Elm–2 is a sample of gray calcareous clay from Elmore County, SW¼NE¼ sec. 34, T. 18 N., R. 19 E., taken from one of the grabens in the middle of the Tuscaloosa outcrop area. Mineral analysis of the sample indicates that the clay is from the Mooreville Chalk, the basal unit of the Selma Group of Upper Cretaceous Age. The presence of this chalk in

	Elm–1B Tuscaloosa Group-granite contact (percent)	Elm–2 Marine clay (percent)
Quartz	12 to 15	15 to 20
Kaolinite	40 to 50	20 ±
Illite (sericite)	3 to 5	10 to 15
Montmorillonite and chlorite	30 to 40	Not detected
Calcite	Not detected	20 to 25
Iron oxides	1 ±	1 ±
Heavy minerals	Not detected	1 to 2

contact with sediments from the middle of the Tuscaloosa Group indicates a downthrow of more than 500 ft displacement, because the Mooreville Chalk is separated from the Tuscaloosa Group by approximately 500 ft of sediment of the Eutaw Formation. The analysis is included here for comparison.

Evaluation of Clays, Eastern Alabama

Clays from this area have been used to make bricks and pottery. There has been insufficient work to make a full evaluation of the clay potential of this region.

WEST-CENTRAL ALABAMA

Regional Setting

The sediments of the Tuscaloosa Group in west-central Alabama crop out in a belt that extends in a northwesterly direction from eastern Autauga County through Tuscaloosa County. The sediments overlap schists and phyllites in Chilton County and overlap Paleozoic shales, sandstones and limestones in Bibb and Tuscaloosa Counties. The outcrop belt widens from about 9 miles in eastern Autuaga County to a maximum width of 28 miles in Tuscaloosa and Hale Counties, excluding outliers of Tuscaloosa gravel north of the Black Warrior River. The location of this area is shown in Fig. 3.

Autauga and Chilton Counties

Scott (1960b) reports that the basement contact between the crystalline rocks and the Coker Formation of the Tuscaloosa Group in Autauga County is an erosional surface that slopes south-southwest at 45 to 55 ft per mile. He reports that the Coker Formation consists of three separate lithologic units that have a combined thickness of 625 ft in the subsurface. The basal unit consists of beds of sand, gravel, boulders and varicolored

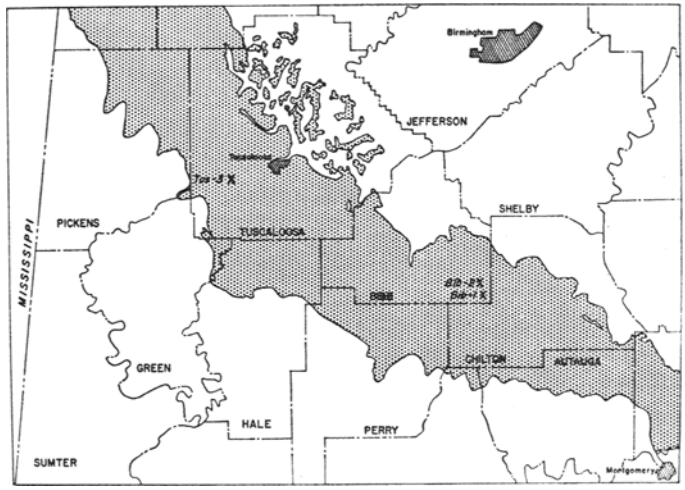

FIGURE 3.—Tuscaloosa Group outcrop in west-central Alabama.

clay deposited under deltaic conditions. The middle unit consists of well-sorted sand, fissile clay and calcerous sandstone of marine origin, and the upper unit consists of deltaic sand, gravel and varicolored clay. The Gordo Formation ranges in thickness from 115 ft at the outcrop to 250 ft in the subsurface in the southern part of the county.

The clays exposed at the surface in Autauga and Chilton Counties are small lenses of varicolored clay in cross-bedded sands. Few deposits exceed 5 ft in thickness.

Bibb County

Extensive clay deposits occur in eastern Bibb County, which are composed of thin, interbedded sands and clays. The change in sedimentation indicates deposition in a bay or large lagoon rather than in a river or delta. The deposits in some areas contain enough clay for economic use.

The approximate analyses of two samples, taken a little more than a

	Bib–1	Bib–2
Quartz	50 to 60	50 ±
Illite (sericite)	15 to 18	10 to 12
Montmorillonite	10 ±	20 to 25
Kaolinite	10 to 12	3 to 5
Iron oxides	5 to 8	5 to 8
Chlorite	Not detected	Not detected

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mile and a half apart, are given to illustrate the variable clay mineral content. Sample Bib–1 was taken in the NW¼NW¼ sec. 29, T. 22 N., R. 12 E., and sample Bib–2 is from the SW¼ sec. 18, of the same township. Sample Bib–2 was taken up-dip nearer the potential source.

Tuscaloosa County

In Tuscaloosa County, the contact between the top of the Pottsville Formation and the base of the Tuscaloosa Group dips southward from 30 to 35 ft per mile (Paulson *et al.*, 1962). The lower part of the Coker Formation is composed of gravel, coarse cross-bedded white to yellow sands and irregular lenses and pockets of gray plastic clay. The upper part of the Coker Formation consists of coarse cross-bedded sand with beds of sandy varicolored clay. The Gordo Formation rests on a thin but persistent bed of gravel and is composed of sand and varicolored clays. The Coker Formation is approximately 500 ft thick and the Gordo 300 ft thick, making a total thickness of 800 ft for the Tuscaloosa Group.

The thick gray plastic clays in the Coker Formation are predominately montmorillonite clays. They turn brown to purple on weathering owing to oxidation of iron minerals present. The approximate analysis of a typical deposit, Tus–3, center of SW¼ sec. 28, T. 21 S., R. 11 W., is as follows:

	%
Montmorillonite	30 to 40
Quartz	20 to 33
Glass (volcanic)	10 to 15
Illite	5 to 10
Ferric oxide	2 to 3
Heavy minerals	0.5 to 1

A minor amount of kaolinite was found in another sample of gray plastic clay from this area. The other constituents are montmorillonite and minor amounts of illite and quartz. These clays are a serious problem in foundations and road construction because they have little resistance to shear and will slump when wet.

The clays higher in the Coker Formation are varicolored lenses in cross-bedded sands. The colors vary from brown to red, orange, purple and gray. The colors persist in the subsurface and are not the result of recent weathering. The varicolored clays contain less montmorillonite than the gray clays.

Clays in the Gordo Formation are similar to the varicolored clays of the upper Coker Formation, but they contain minor amounts of glauconite. This indicates marine deposition. The Coker–Gordo contact and clay deposits of both formations are shown in Plate 1.

Evaluation of Clays, West-Central Alabama

The very plastic gray clays found in the lower part of the Tuscaloosa sediments can be used as a binder for foundry sands. Also, they can be used for blending with other clays when additional plasticity is needed.

The clay deposits in the upper part of the Tuscaloosa, except those that are too sandy, can be used for making brick, tile and other ceramic products. In the past, these clays have been used for making jugs and pottery.

NORTHWEST ALABAMA

Regional Setting

The sediments of the Tuscaloosa Group crop out in a north-trending band extending from Tuscaloosa County through western Lauderdale County into Tennessee. They overlap the eroded surface of limestones, shales and sandstones of the Mississippian and Pennsylvanian Systems. The width of the outcrop belt, excluding isolated outliers, varies from about 35 miles in Pickens and Lamar Counties to about 20 miles in Lauderdale County near the Tennessee line. The location of this area is shown in Fig. 4.

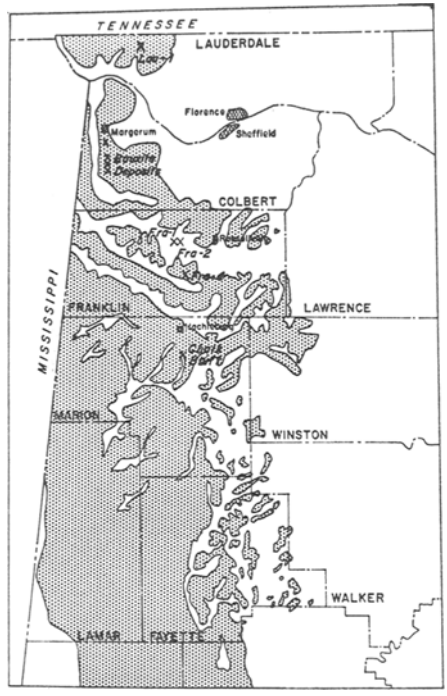

FIGURE 4.—Tuscaloosa Group outcrop in northwestern Alabama.

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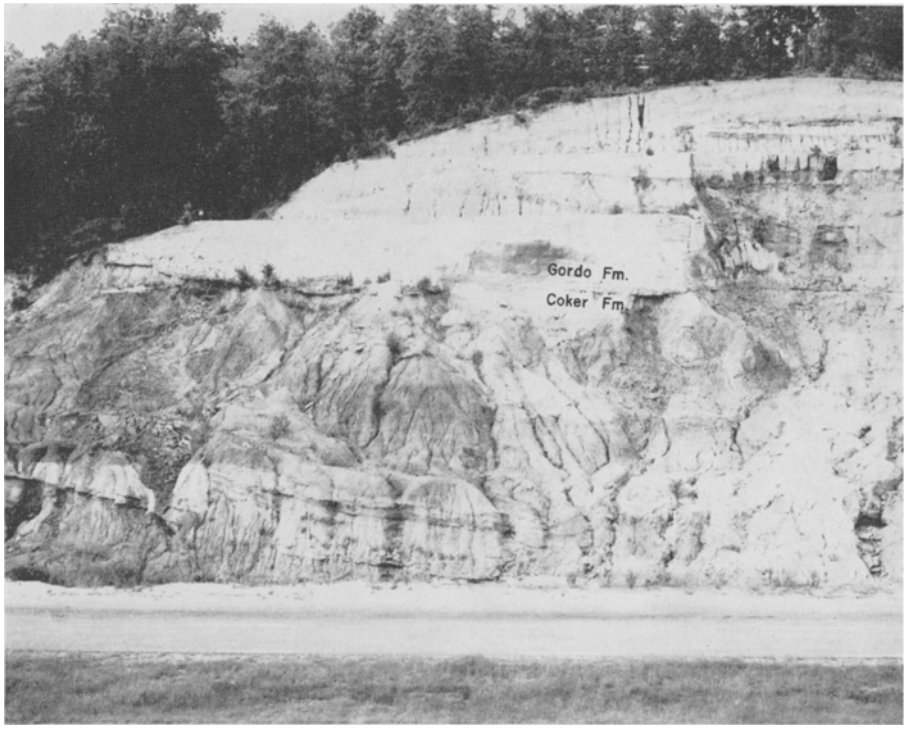

PLATE 1.—Coker–Gordo contact and clay deposits exposed on U.S. Highway 82, above the east bank of the Sipsey River, Tuscaloosa County.

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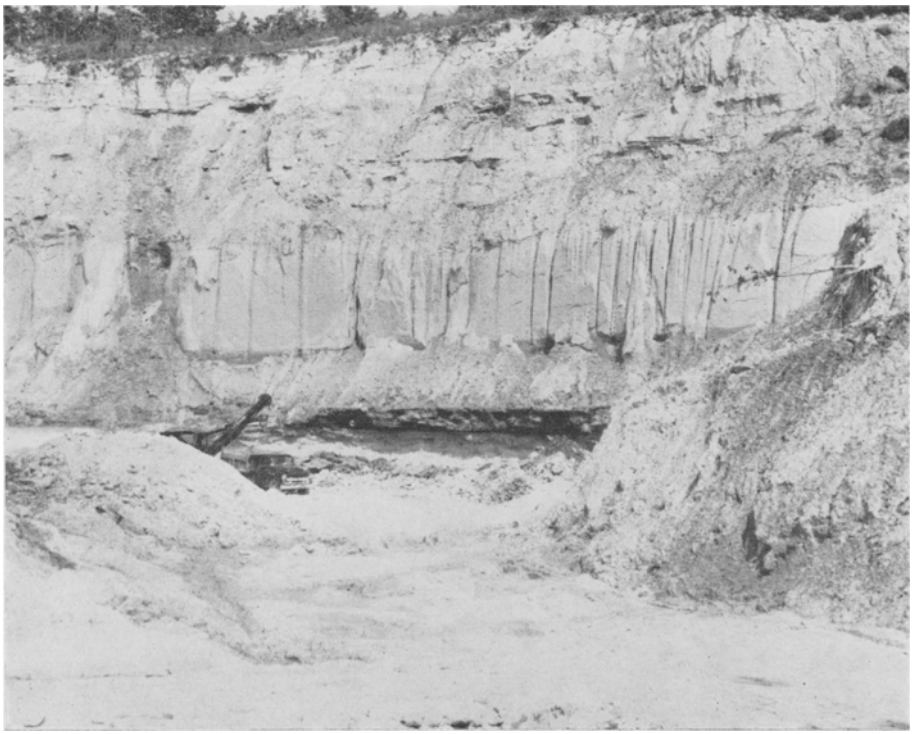

PLATE 2.—Kaolin pit of the Thomas Alabama Kaolin Company.

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Faulting that accompanied the downwarping of the Mississippi Embayment started prior to the deposition of the Tuscaloosa sediment and continued after the deposition of some of the clay deposits. The general regional dip at the contact is 15 to 20 ft per mile westward.

The most persistent stratigraphic unit in the Tuscaloosa Group is a thick bed of chert gravel. It forms the base of the formation from Franklin County northward, but in Marion County it is underlain by sands and clays. Sand with clay lenses also overlies the gravel. The formation subdivisions of the Tuscaloosa Group are not recognized north of Marion County.

Chalk Bluff, Marion County

The kaoline deposit known as Chalk Bluff, in Marion County, is one of the largest clay deposits in the area and is the only deposit that has been mined to any extent. The kaolin crops out on both sides of Camp Creek, south of Hackleburg. Kaolin has been mined from this area for the last quarter of a century and the total production is estimated to approach one million tons.

The clays rest on weathered shale of the Pottsville Formation. The shale is exposed in a drainage ditch leading from a pit east of Camp Creek and in a ditch along a county road north of the east pits. The Tuscaloosa–Pottsville contact in the mine area is approximately 150 ft lower than the contact north and east of the pits. The difference in elevation is due to faulting. A view of one of the east side pits is shown in Plate 2. This photograph shows the sand overburden, the lignitic clay zone overlying the kaolin and the kaolin which is being mined.

The lower clay seam is massive sandy kaolin to clayey sand with the sand content increasing with depth. The sandy clay bed is 15 ft thick in one of the east pits where the full thickness is exposed. A band of reddish and white mottled clay separates the sandy clay from the main kaolin seam in the east pits and a thin bed of sandy lignitic clay separates the sandy clay from the kaolin seam in the west pit, but where the lignitic clay has been removed by erosion, the kaolin rests on the eroded surface of the sandy clay. Thick deposits of plastic carbonaceous clay are exposed below the main kaolin zone in limited areas on both sides of the creek. The mineral content and relationship of these clays to the main kaolin seam have not been determined.

The kaolin zone thickens to the southwest. The full thickness of the kaolin was found to be 9 ft in the eastern pit and 27 ft in the western pit, but the top of the clay was eroded and the full thickness was found in only three exposures. The kaolin seam is nearly pure kaolinite mixed with minor amounts of quartz. It is overlain by a second zone of lignite and sandy carbonaceous clay, but much of this zone has been removed by erosion.

Clays in Brown Iron Ore Pits, Franklin County

Plastic brown, red and yellow clays are found associated with the iron ore in Franklin County, Russellville Brown Iron Ore District. The deposits of clay and iron ore are in depressions overlying the Bangor Limestone of Mississippian Age, and below the Tuscaloosa gravel. These clays contain residuum derived from the leaching of the Bangor Limestone. Gray to white clay lenses occur stratigraphically higher in the gravel. Approximate mineral analyses of clays associated with the iron ore and clays in the gravel overburden are given below, in percent:

	Clays below iron ore	Clay bed over iron ore	Clays in gravel over iron ore
	Fra–2	Fra–4	Fra–1
Quartz	25 ±	40 to 50	50 ±
Kaolinite	35 to 40	25 to 30	25 ±
Illite (sericite)	12 to 15	3 to 5	10 ±
Montmorillonite	5 to 8	Not detected	2 to 3
Feldspar	2 to 3	2 to 3	2 to 5
Glass (altered) (volcanic ?)	10 to 15	8 to 10	1 to 2
FeO	2 to 5	8 to 10	1 to 2
Heavy minerals*	1 to 5	Not detected	5 to 8

*Heavy minerals are mostly tourmaline, zircon, hornblende and chlorite.

Fra–2, sample of brownish-yellow plastic clay from pit below iron ore, pit 6½ miles west of Russellville, SE¼NE¼ sec. 31, T. 6 S., R. 12 W.

Fra–4, sample of red and yellow-plastic clay, 4-ft bed resting on iron ore below Tuscaloosa gravel, NW¼SE¼ sec. 17, T. 7 S., R. 12 W.

Fra–1, sample from small pocket of light gray sandy clay in gravel overburden over iron ore, same location as sample Fra–2, taken approximately 20 ft higher in section.

Clays in Tuscaloosa Sands

Numerous clay deposits occur throughout the Tuscaloosa sands in northwestern Alabama. The size varies from less than an inch to over 15 ft thick. Many of the small deposits examined in western Colbert and Franklin Counties are nearly pure kaolinite mixed with quartz sand, but most of the larger deposits are mixtures of clay minerals.

Bauxitic Clays, Margerum District, Colbert County

Impure bauxitic clays, which are mixtures of gibbsite and kaolinite, occur in irregular pockets in the Tuscaloosa gravels in western Colbert

County. These are small "high-silica" deposits and they have not been used commercially. Two chemical analyses of samples taken from a pit south of Margerum are given below with the mineral analyses computed from the chemical analyses:

	Light reddish bluff bauxite, few pisolites %	Buff pisolitic bauxite %
Al_2O_3	46.9	43.9
SiO_2	13.7	27.0
Fe_2O_3	14.0	7.8
TiO_2	1.7	1.2
LOI	24.3	20.1
Gibbsite	54	32
Kaolinite	30	59
Hematite	14	8
Anatase	2	1
	100	100

Apparently the clays were deposited in deep parts of stream channels. There is some question as to whether these bauxites were lateritized during the Cretaceous Period or whether they were clay deposits exposed and lateritized during the Early Eocene Age. Much of the bauxite, apparently, has been resilicated to kaolinite, because this material has the chemical composition of kaolinite and the pisolitic texture of bauxite.

Some kaolin deposits in the Tuscaloosa gravel in Lauderdale County are very similar to the bauxite deposits. The approximate analysis of a sample of this clay from a deposit in the NE¼NW¼ sec. 24, T. 1 S., R. 14 W., Lau–1, is as follows:

	%
Quartz	55 to 60
Kaolin	35 to 40
Feldspar	2 to 3
Glass (volcanic)	1 to 3
Iron oxides	1 ±
Illite	Not detected
Montmorillonite	Not detected

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Evaluation of Clays, Northwest Alabama

The kaolins from the Chalk Bluff area, Marion County, are used in making ceramic glazes, in ceramic ware, as a carrier for insecticides, in blends to lighten the color for buff face bricks and in refractories. Tests made on other clays throughout the area have proved that many of the deposits are suitable for making face brick, tile and other ceramic products. Potential economic clays occur in all counties in this area.

CONCLUSIONS

Clay deposits in the Tuscaloosa Group in Alabama are among the underdeveloped mineral potentials of Alabama. Results of tests made by the U.S. Bureau of Mines have shown that many of the clay deposits can be used to make ceramic products. Investigation by the Geological Survey of Alabama has shown that many of the potential economic clays are available in sufficient quantities to warrant additional commercial development.

ACKNOWLEDGMENTS

The mineral analyses were made by the late Howard P. Hamlin, U.S. Bureau of Mines, Metallurgy Research Laboratory, Norris, Tennessee. These are approximate analyses, with estimates based on X-ray diffraction and examination using a petrographic microscope. Sample Lee–3 was analyzed by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Tuscaloosa, Alabama, and the composition of clays in Tuscaloosa County was checked by Robert Ehrlich, Louisiana State University.

Appreciation is expressed to W. M. Harris, Manager, Thomas Alabama Kaolin Company, for permission to examine the kaolin mines at Chalk Bluff in Marion County, and assistance in making a study of the mine area. Appreciation is also expressed to B. F. Buie, Florida State University, for reviewing basic data used in this manuscript, and to W. G. Hooks, University of Alabama, for critical review of the manuscript.

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