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THE BLEACHING CLAYS OF GEORGIA

By

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Note: The State Geologist takes pleasure in presenting below the general results of a preliminary investigation of the bleaching clays of Georgia. Fuller's earth, a form of bleaching clay, has long been one of Georgia's most important mineral industries. The annual production is valued at close to a million dollars. Georgia has in fact led in the domestic production of fuller's earth since 1924. In very recent years there has been a trend in the industries using bleaching clays toward the use of bentonitic type of clays that in the natural state have low bleaching power but when activated by treatment with acid have bleaching powers superior to that of fuller's earth. There is grave danger, therefore, that the use of Georgia fuller's earth may gradually decline.

The significance of this article is that deposits of the bentonitic or activable type of bleaching clay have been discovered in Georgia by this investigation. Funds were not sufficient to determine the extent of most of these deposits. Further prospecting should be done at once in the favorable areas outlined in this article if Georgia is to retain her leadership in the production of bleaching clays.

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INTRODUCTION

As a part of the program sponsored by the Federal Emergency Administration of Public Works, a preliminary investigation of the bleaching clays of Georgia was conducted by two parties of the United States Geological Survey. The first party, in charge of Mr. Bay, was in the field during the fall of 1934; the second, headed by Mr. Munyan, made its investigation in the spring of 1935.

The so-called "bleaching clays" may be separated into two distinct groups—the naturally active and the activable types.

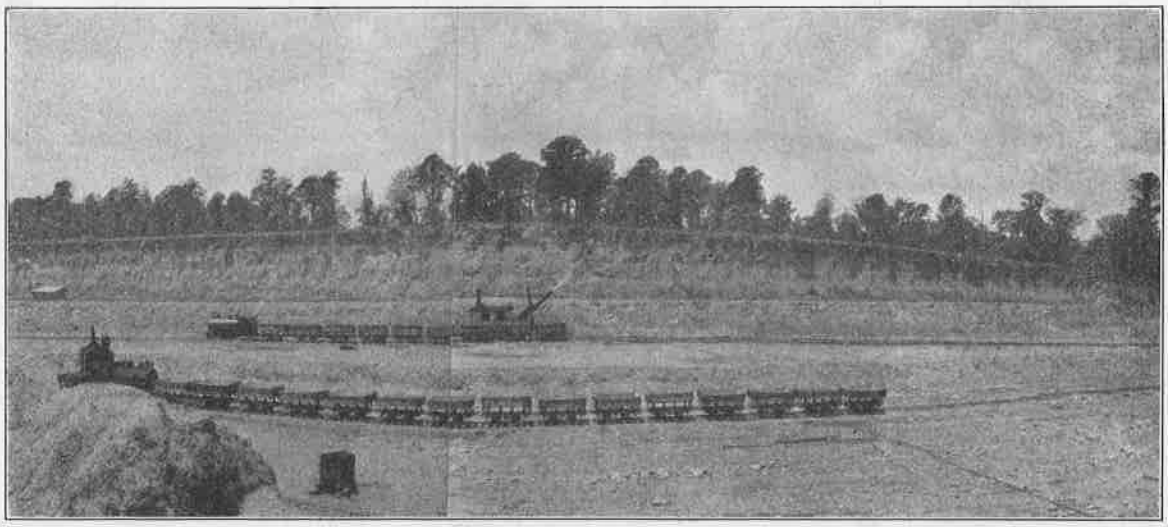
Naturally active bleaching clay is a mineral substance having physical properties, in the native state, which give it a capacity for decolorizing or clarifying (bleaching) oils and fats. Clay of this type is generally known as "fuller's earth."

Activable clay is a natural material which through a process of partial acid leaching acquires physical properties that make it a highly active bleaching agent for oils and fats. The most powerful of the bleaching clays belong to this group. Not all clays known as "bentonites" are made highly active by chemical treatment, but bentonites provide our most efficient activable clays.

A few naturally active clays are improved by acid leaching, but most of them are rendered less active by such leaching. The most powerful bleachers are inactive until leached.

The bleaching clays as a rule are very fine-grained, but in many places they include an admixture of sand particles and mica. The colors are ordinarily light, ranging from white to gray or pale green, but they may be pink, tan, brown, dark green, blue, or even black. Freshly opened beds ordinarily exhibit a waxy or soapy luster, and some varieties may be cut into thin shavings like soap. Many varieties are hard and brittle, but some are soft and crumbly or even plastic. Certain types possess conchoidal fracture; others show platy, hackly, or no distinctive fracture. Jointing is common in most beds. The surfaces of many of the joint planes are darkened by manganiferous stain. Many bentonites have a strong affinity for water and will absorb three times their weight or as much as ten times their volume of water, with a consequent increase in volume. Most active clays do not slake in water, but slaking is a characteristic feature of the activable clays.

The original use of bleaching clay (naturally active) was to remove grease and fat from woolen cloth during the process of fulling. This practice gave rise to the name "fuller's earth," a term which has been retained in spite of the fact that earth



Fuller's earth mine at the Attapulgus Clay Company, Attapulgus, Decatur County, Georgia

for cleaning cloth has been replaced by more efficient materials so that the present time its use for that purpose is slight.

Nearly 93 per cent of all fuller's earth produced in the United States in 1933 was used in decolorizing minerals; about 6 per cent was employed in treating vegetable oils and animal fats; and less than 1 per cent was utilized for fulling cloth or for other purposes.[1]

The activated clays find their principal application in the refining of mineral and vegetable oils and animal fats. This type of clay is particularly valuable where strong bleaching properties are required.

The use of naturally active clay for bleaching edible oils in the United States began about 1880. English clay (that used for fulling cloth) was found to be the most satisfactory of all that were available at that time. The first attempt to mine fuller's earth in this country was made in 1891, when a bed of Tertiary clay was opened near Alexander, Arkansas. This material was used locally in the treatment of cottonseed oil. A short time later fuller's earth was discovered in the Hawthorn formation near Quincy, Florida. This find led to the development of mining activities in Georgia and Florida which, as clay operations, are second to none throughout the world.

During 1933 the production of fuller's earth in the United States amounted to 251,158 short tons, much of which came from Georgia and Florida. Georgia first entered the fuller's earth field in 1904 and has been the largest domestic producer since 1924, when its output for the first time surpassed that of Florida, which had led since 1895. Including 1933 the total production for Georgia reached 1,172,495 short tons.[2]

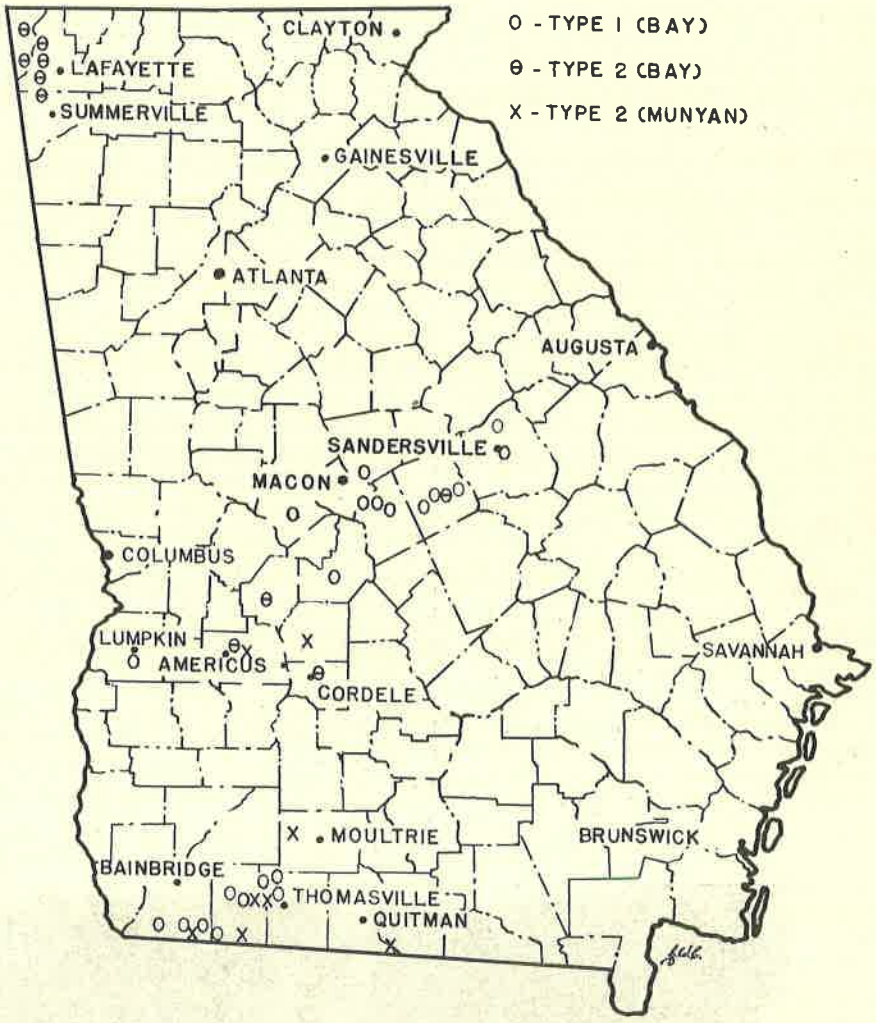
This total production represents a value of more than $16,000,000. Bleaching clay (fuller's earth) is, accordingly, one of the most valuable natural resources of the State.

The early history of acid-treated clays is somewhat vague. It has been stated[3] that the activation of clay by treatment with either concentrated or dilute acids has been practiced for many years in Europe. Germany has long exported activated bleaching clay to the United States. The commercial production of acid-treated bleaching clays in this country probably began in the period between 1920 and 1925. The present yearly production is thought to be about 7,000 tons.

DEPOSITS OF BLEACHING CLAY

Bleaching clays are widely distributed in Georgia, and although at the present time only the naturally active type (fuller's earth) is being produced, recent investigations have disclosed deposits of the activable type. The bleaching clays of the State occur in five distinct geologic units (see accompanying map.) From oldest to youngest these are (1) the bentonite in the Ordovician Chickamauga limestone, in the northwest; (2) the fuller's earth in the Eocene Midway formations, of Stewart County, (3) the fuller's earth in the Eocene Barnwell formation, in the central and east-central part; (4) the bentonitic (?) clay in the Oligocene Flint River formation in the (5) the fuller's earth and bentonitic (?) clay in the Miocene Hawthorn formation, in certain of the southern counties.

The accompanying map indicates most of



Outline map of Georgia showing general localities in which bleaching clays were examined. by H. X. Bay and A. C. Munyan as indicated. Type 1 includes the naturally active clays and type 2 the activable clays.

south-central and southwestern part; and the localities visited by Mr. Bay, but of those noted by Mr. Munyan all exposures not considered as of possible commercial value were omitted, and only those of the best quality are shown.

Ordovician (Chickamauga) bentonite

A bentonitic phase of the Ordovician Chickamauga limestone is exposed on both the eastern and western flanks of Lookout Mountain, in northwestern Georgia. In parts of Chattooga, Dade, and Walker counties this zone crops out in thin beds of steep dip.

The bentonite in this area occurs in two zones that are separated by several feet of bluish-gray limestone. The upper zone, which crops out in the vicinity of High Point station and Coopers Heights, in Walker County, reaches a thickness of about 2 feet and consists of mottled light-brown or pale-green soft, mealy, highly micaceous bentonite, which locally contains small white limy concretions and a slight admixture of fine-grained sand. The lower zone, which is well developed south and west of Cassandra, in Walker County, and at Harrisburg, in Chattooga County, reaches a maximum thickness of about 8 feet and is composed of greenish-gray to pale-green soft and mealy to hard and brittle, unctuous, very slightly sandy bentonite.

Exposures of the Chickamauga bentonite have been noted near Harrisburg station, in Chattooga County; in the vicinity of Trenton and Rising Fawn Furnace, in Dade County; and near High Point station, Coopers heights, Cassandra, and Cedar Grove, in Walker County.

Laboratory tests of numerous samples of this bentonite from Chattooga, Dade and

1 Minerals Yearbook for 1933, p. 973, 1934.
2 Minerals Yearbook for 1933, p. 976, 1934.
3 Bierce, N. E., Some historical notes on the origin of contact filtration: Nat. Petroleum News, Dec. 14, 1927, p. 102.

Walker counties show that in the natural state it is essentially lacking in oil-bleaching properties. The bleaching qualities are materially improved by partial acid leaching, and many samples were found that very nearly approached the lowest limit of bleach allowable for commercial activable clays. It is rather doubtful if under present conditions this clay could compete with the more efficient activated clays now supplying the market.

Both the upper and the lower bentonite beds lie between thick layers of hard limestone and are inclined at angles as great as 45°. The maximum thickness is thought not to exceed 8 feet. Such a thickness of clay occurring between thick limestone beds and dipping at high angles would offer serious difficulties in mining. These factors, coupled with the moderate degree of activability of the bentonite, probably preclude any large-scale commercial activity in this field.

Eocene (Midway) naturally active clay

The Eocene Midway formation of Georgia occurs in a narrow belt of northeast trend (extending from Fort Gaines, on the Chattahoochee River, to Montezuma, on the Flint River, and thence a short distance into Houston County). It is the surface formation over much of Clay, Quitman, Stewart, Randolph, Marion, Schley, Webster, and Macon counties.

Although consisting primarily of ferruginous sand and white clay, together with fossiliferous, limestone, marl and quartzite, the formation in certain areas is known to contain beds of low-grade naturally active clay (fuller's earth). Materials of this type are well developed in Stewart County and probably occur elsewhere within the State.

In the vicinty of Lumpkin, Stewart County, the fuller's earth stratum reaches a maximum thickness of about 20 feet and probably maintains an average of about 10 feet. The thickness varies considerably within short distances. A pit 5½ miles south of Lumpkin exposes 15 feet of dull gray to white (when dry) clay, which is more or less micaceous throughout, especially toward the base. The upper several feet is distinctly sandy, and the entire thickness includes a varying percentage of fine-grained sand. The bed is highly jointed, and the joint planes are discolored by iron and manganese stains. The clay breaks with conchoidal fracture.

Laboratory tests indicate that the clay in the Midway formation south of Lumpkin, in Stewart County, is a low-grade naturally active clay that is not materially affected by acid treatment. Its bleaching efficiency for oil is inferior to that of various fuller's earths being mined and marketed elsewhere in the State, and hence this clay cannot be expected to compete with the others.

Eocene (Barnwell) bleaching clay

Outcrops of fuller's earth and similar clays belonging to the Twiggs clay member of the Barnwell formation occur in a narrow belt extending more than halfway across the State. The westernmost exposures are in Dooly County, and the belt continues northeastward to the Savannah River near Augusta, with exposures in Houston, Crawford, Twiggs, Bibb, Bleckley, Wilkinson, Jones, Baldwin, Washington, Glascock, Jefferson, Burke, Richmond, and Columbia counties.

The Twiggs clay member consists typically of greenish-gray or dark-blue clay of low specific gravity, not plastic but breaking with hackly or conchoidal fracture. Some of the clay is free from grit, but most of it is slightly sandy, and interlaminated and interbedded sand is common. The fuller's earth grades laterally into limy clay of similar appearance and properties and thence into clayey limestone.

In the Pikes Peak area of Twiggs County and possibly elsewhere within the State there are two well-defined beds of fuller's earth separated by about 50 feet of clayey sand. The lower bed reaches a maximum thickness of about 45 feet; the upper bed probably about 25 feet. The lower bed is somewhat limy, especially so toward the base, where small limy nodules are common. It lies directly above the Ocala limestone.

During this investigation sections of the fuller's earth beds in the Twiggs clay member were examined in Crawford, Houston, Jones, Twiggs, Washington, and Wilkinson counties. The lithologic character, general features, and modes of occurence of the clay are more or less uniform throughout this general area. In spite of the homogeneity of the clay beds a considerable variation in oil-bleaching efficiency has been noted in samples tested from this region. Many samples failed to meet the requirements of commercial bleaching clay, even though they appeared to be identical with others that were true commercial clays. Although the Twiggs clay has long been known to be naturally active material suitable for oil refining, its activable character has apparently gone unnoticed. In general, the oil-bleaching quality of the Twiggs clay is improved by treatment with acid. In most occurrences the increase in bleaching efficiency would not be sufficient to warrant acid treatment on a commercial scale, but locally the clay reaches a degree of activability that compares favorably with the oil-bleaching properties of the activated clays that supply the present demands. A marked degree of activability was noted in the fuller's earth in certain exposures of the lower clay zone in Twiggs County and also south and west of Irwinton, in Wilkinson County. It is thought entirely possible that careful and methodical prospecting will disclose phases of the Twiggs clay in central and eastern Georgia that are sufficiently activable and extensive to support commercial development.

By far the best-known deposit of fuller's earth in the central part of the State is that being mined by the General Reduction Company, of Macon. This company began mining operations at Pikes Peak, in Twiggs County, in 1908, and has been active since that time. A small mine is being worked by Marvin Hall, 7½ miles northeast of Irwinton, Wilkinson County, and F. H. Opper, Inc., of Savannah, controls a deposit between Irwinton and McIntyre, also in Wilkinson County. It is reported that the bleaching clay marketed from the Barnwell formation is particularly adapted to the refining of vegetable oils and animal fats, and a large part of the output is utilized for those purposes.

Oligocene (Flint River) Clay

The Oligocene Flint River formation[4] of Georgia consists principally of bright-red clayey sand, with which are associated beds of iron-stained, more or less sandy clay, that is pale-green to greenish-gray and light-gray, unctuous, plastic to hard and brittle or soft and mealy. This material is a naturally active bleaching agent for oils, as well as being itself activable. In activability the Flint River clay is somewhat similar to the Ordovician bentonite found in the northwestern part of the State. Although no volcanic ash structures have been reported from this material, its appearance and acid activability suggest a derivation from volcanic ash, and it is possible that this zone is correlative with the extensive bentonite zone in the Oligocene of Mississippi and elsewhere.

Several exposures of Oligocene bentonitic (?) clay were visited by Mr. Bay during the initial survey. He noted the occurrence of beds near Cordele, Crisp County; Montezuma, Dooly County; Oglethorpe, Macon County; and Americus, Sumter County. In the later investigation by Mr. Munyan a great many more exposures were located, but most of them are of no commercial interest at present. There are two, however, which may be worthy of attention—one east of Americus and the other northwest of Vienna, in Dooly County. The time available permitted only a very hurried survey of the clays in the Flint River formation, and it is possible that further examination will disclose beds that are extensive enough and activable enough to support commercial development. It is thought that a thorough investigation of the Flint River outcrop is warranted by the data now at hand. The formation extends southwestward from the Oconee River in Laurens County across Pulaski, Dooly, and Sumter counties, where the outcrop divides. One tongue roughly follows the course of the Flint River in a narrow belt

[4]The Deposits of Vicksburg (Oligocene) age in Georgia and adjacent regions, formerly correlated with the Glendon limestone of Alabama, are probably somewhat younger than the typical Glendon and have recently been named "Flint River formation" by C. W. Cooke (Am. Assn. Petroleum Geologists Bull. vol. 19, p. 1170, August, 1935).

across Crisp, Dougherty, Mitchell, Grady, and Decatur counties, and the other tongue trends southwestward in a broken belt of outcrops through Terrell, Randolph, Calhoun, and Early counties. The most extensive outcrops of the formation are in the upland areas of Pulaski, Dooly and Sumter counties, and it is here that prospecting is likely to prove the most fruitful.

Miocene (Hawthorn) naturally active clay

The Miocene Hawthorn formation in Georgia has never been formally described under that name. Veatch and Stephenson's[5] Alum Bluff formation and Marks Head marl and part of their Altamaha formation[6] appear to be equivalent to the typical Hawthorn formation of Florida.

The Hawthorne formation in Georgia is generally light-colored. It contains much fine sand mingled with white clay. Coarse sand and angular gravel are also common, and parts of the formation are hardened to sandstone. Associated with these sands and clays are extensive beds of drab, gray, and greenish-gray fuller's earth, and mottled gray and tan bentonitic (?) clays.

The Hawthorn formation occupies a broad hilly belt (Tifton upland or "wiregrass region") that extends from the Florida line to Waynesboro and lies between the lowlands bordering the Flint River (Dougherty plain) and the coastal terraces. It underlies the terrace deposits and is exposed in some of the valleys that cut through them.

The fuller's earth in the Hawthorn formation is light-gray to greenish gray, unctuous, hard and brittle. The fracture is either hackly or conchoidal. In many places where the overburden is thick the earth contains lenses of hard clayey limestone and small masses of crystalline calcite. The bleaching-clay bed is usually directly overlain by a thin bed of gray or bluish-gray plastic, gumbolike clay ("short-bread").

The fuller's earth of the Hawthorn formation differs from that of the Barnwell formation in that for the most part its bleaching efficiency is not affected by acid treatment. An exception was noted near Ochlocknee, in Thomas County, where samples of the Hawthorn from a bore hole proved to be truly activable. In many occurrences the plastic "short-bread" that overlies the true fuller's earth is activable to a degree approaching that of the Ordovician bentonite of northwestern Georgia.

The fuller's earth beds in the Hawthorn formation of southwestern Georgia support the most extensive bleaching-clay operations within the State. At the present time deposits in Decatur County contribute an appreciable part of the total world production of fuller's earth. Large deposits of naturally active clay of commercial grade occur in northcentral Thomas County and to a lesser extent in Grady County. These deposits constitute valuable reserves, and should the beds now being mined become depleted or should the market be expanded, Thomas and Grady counties would be in line for commercial development.

The later investigation by Mr. Munyan showed the presence of considerable activable clay in the Hawthorn. The exposures that yielded the most promising material are, in Grady County, a few miles east of Cairo and just north of the Florida boundary; in Brooks County, in the southeast corner, just west of the Withlacoochee River; and in Colquitt County, several miles west of Moultrie.

SUMMARY

Bleaching clays are known to occur within five geologic formations in Georgia — the Ordovician Chickamauga limestone, the Eocene Midway formation, the Eocene Barnwell formation, the Oligocene Flint River formation, and the Miocene Hawthorn formation. Both naturally active and activable clays are represented.

Inferior activable clay occurs in the Chickamauga limestone in Chattooga, Dade, and Walker counties. The commercial possibilities of this clay are doubtful.

Naturally active clay is found in the Midway formation in Stewart County, but it is not sufficiently active to compete with present-day commercial clays.

Extensive beds of clay occur in the Twiggs clay member of the Barnwell formation in Crawford, Houston, Jones, Twiggs, Washington, and Wilkinson counties. Fuller's earth is being produced from beds at this horizon in Twiggs and Wilkinson counties. This clay is activable as well as being naturally active, and locally it may be sufficiently activable to justify acid treatment.

Bentonite-like clays are found in the Flint River formation in Crisp, Dougherty, Dooly, Macon, and Sumter counties. These materials are activable, and certain beds may meet commercial requirements.

Extensive deposits of high-grade naturally active clay are found in the Hawthorn formation in southwestern Georgia. These beds support large commercial bleaching-clay operations.

Activable clay that may prove, with future work, to be of commercial value, has also been discovered in the Hawthorn.

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5 Veatch, Otto, and Stephenson, L. W., Geology of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 26, 1911.

6 Cooke, C. W., Oral communication.