MISSISSIPPI
STATE GEOLOGICAL SURVEY

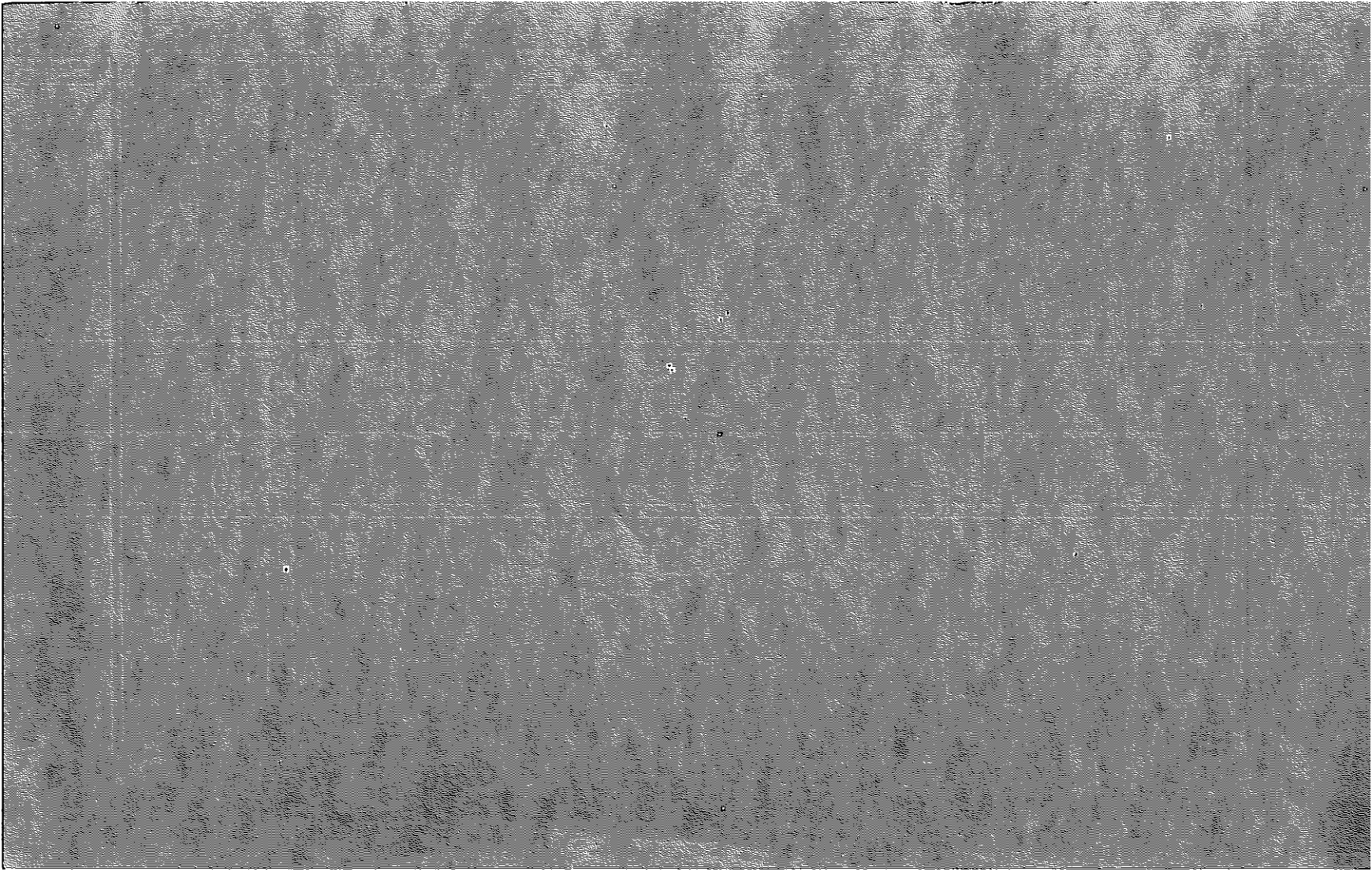
WILLIAM CLIFFORD MORSE, Ph. D.
Director

BULLETIN 29

A PRELIMINARY INVESTIGATION OF THE BLEACHING CLAYS OF MISSISSIPPI

By
HARRY X. BAY, Ph. D.

1935



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Field work and report completed under the auspices of the United States Geological Survey with funds alloted by the Federal Administration of Public Works

MISSISSIPPI GEOLOGICAL SURVEY

ALFRED BENJAMIN BUTTS, Ph.D., LL.B.
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LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi, September 15, 1935

Dr. Alfred Benjamin Butts, Chancellor
University, Mississippi

Dear Chancellor Butts:

Early in 1927 N. W. Dahlem submitted from his land south of Aberdeen in Monroe County a sample of clay that proved to be bentonite--thus gaining for himself the distinction of being the discoverer of this important economic mineral in Mississippi. An early examination of this deposit and the subsequent discovery by W. A. Williams of a bed of bentonite southeast of Booneville in Prentiss County led to the publishing in mimeograph form of Bulletin 22, a "Preliminary report on Bentonite in Mississippi" by Ralph E. Grim in January, 1928.

Subsequent discovery of beds in still other sections of the state and the exhaustion of the supply of Bulletin 22 led to further study of the deposits and to the preparation of Bulletin 22-A, "A supplementary report on Bentonite in Mississippi" by Hugh McDonald Morse--all prior to the installation of William Clifford Morse, the present director, on September 1, 1934.

A more thorough examination of these deposits has been made by Franklin Earl Vestal, and a most excellent report has been prepared by him and held by the Tennessee Valley Authority as a potential offering to the Mississippi Geological Survey only to be withdrawn at the last moment.

Through a grant from the Federal Emergency Administration of Public Works and under the direction of the United States Geological Survey, Harry X. Bay made, during the months of March, April, and May, 1934, a detailed reconnaissance survey of the bentonite in Mississippi. Not only so, but the samples were sent to the laboratory of the United States Geological Survey where all of them were tested for their bleaching properties under the direction of P. G. Nutting. Consequently, not only have three full months been spent in field investigations, but all the samples have been actually subjected to

laboratory tests to determine their fitness as a bleaching agent in the refining of mineral and vegetable oils and animal fats. A report on this work has, therefore, a two fold value.

The report was prepared by Dr. Bay and is entitled "A preliminary investigation of the Bleaching clays of Mississippi." Last summer during a series of conferences with officials of the United States Geological Survey, the manuscript was offered, without cost, through the kindness of the Director of the Federal Survey, Dr. W. C. Mendenhall, to the Director of the Mississippi Geological Survey. Because of the widespread interest in these beds of bentonite, some of which are proclaimed to be among the most valuable deposits in the world, this report is herewith submitted for publication as Mississippi Geological Survey Bulletin 29.

Very sincerely yours,

WILLIAM CLIFFORD MORSE, Director

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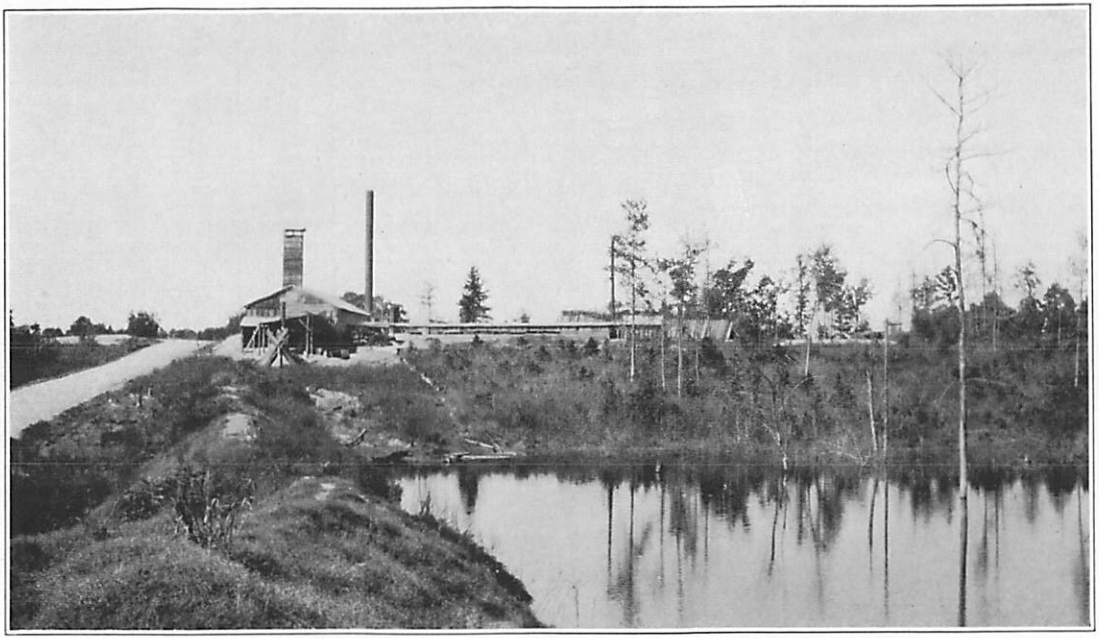

Plate 1.—Bentonite plant of Williams Brothers and Wroten Co., five miles south of Booneville, Miss. Photographed October 28, 1934, by W. C. Morse.

A PRELIMINARY INVESTIGATION OF THE BLEACHING CLAYS OF MISSISSIPPI

BY
HARRY X. BAY, Ph. D.

INTRODUCTION

The so-called "bleaching clays" are of two distinct types—naturally active and activable.

Naturally active bleaching clay has physical properties that 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 substance which, through a process of partial acid leaching, acquires physical properties that make it a highly active bleaching agent for oils. The most powerful of the bleaching clays are of this type. Although not all so-called "bentonites" are rendered active by chemical treatment, yet it is the bentonite clays that provide our most efficient activable clays.

Even though most naturally active clays are rendered less active by acid leaching, a few are improved by such leaching, and even the most powerful bleachers are inactive until leached.[1]

HISTORICAL SKETCH

The original use of bleaching clay (naturally active) was for removing grease and fat from woolen cloth during the process of fulling. This practice gave rise to the name of "fuller's earth." Naturally active clay was used in fulling cloth in England during the Middle Ages. The use of fuller's earth for cleansing cloth has now been largely replaced by more efficient methods.

The use of naturally active clay for bleaching edible oils in the United States started about 1880. N. K. Fairbanks & Co. of Chicago, learned that in the Orient the color of olive oil was improved by treating it with clay. A series of experiments with cottonseed oil showed that the clay used in England for fulling cloth (the original "fuller's earth") gave the best results of all the clays available at that time.[2]

The first attempt to work fuller's earth in the United States was made in 1891. A bed of Tertiary clay marl near Alexander, Ark.,[3] was opened by John Olsen. This clay was used for a short time by the

Southern Cotton Oil Co. of Little Rock, Ark. The material did not prove entirely satisfactory,[4] and the project was short-lived. In 1893 fuller's earth was discovered near Quincy, Fla., quite by accident.[5] An effort to burn brick on the property of the Owl Cigar Co. failed, but an employee of the company called attention to the close resemblance of the clay to the German fuller's earth. This discovery caused considerable excitement, as a result of which deposits of supposed fuller's earth were reported from several states, but the material from most deposits was found to be of no value as a bleaching clay. The original discovery deposit is now held by the Floridin Co., a large fuller's earth company with headquarters at Quincy.

Florida was the sole domestic producer of fuller's earth in 1895 and 1896, although small quantities may have been produced elsewhere for local consumption. Colorado and New York became producers in 1897, but the output in both States was small. Utah began production in 1898; Arkansas in 1901; Alabama and Massachusetts in 1904; Georgia, South Carolina, and Texas in 1907; California in 1908; Nevada in 1918; Illinois and Pennsylvania in 1922; Arizona in 1927; and Idaho in 1931.[6] Some states have produced fuller's earth continuously since their first year of reported production; others have ceased production; and still others that ceased production for a period of years have resumed operations. Sixteen plants contributed to the output of fuller's earth in the United States in 1933. Most of the present production comes from Georgia and Florida. From 1895 to 1923, Florida produced more fuller's earth than any other state, but in 1924 Georgia took first place. During 1933 the production of fuller's earth in the United States amounted to 251,158 short tons.

The early history of acid-treated clays is somewhat vague. It has been stated[7] that the activation of clay by treatment with either concentrated or dilute acids has been practiced for many years in Europe and that Smith & Field of London have been using artificial silicates for decolorizing since 1873. Germany has long exported activated bleaching clay to the United States. The period between 1920 and 1925 probably saw the beginning of commercial production of acid-treated bleaching clays in the United States. The domestic production was pioneered by the Standard Oil Co. of California and the Filtrol Co., both working in California. The annual production of activated clay in the United States is now about 7,000 tons.

USES OF BLEACHING CLAY

The early uses of naturally active clay (fuller's earth) for scouring and cleansing long ago ceased to be important. Nearly 93 percent of all fuller's earth produced in the United States in 1933 was used in decolorizing mineral oils; about 6 percent was employed in treating vegetable oils and animal fats; and less than 1 percent was utilized for fulling cloth or for other purposes.[8]

Because certain of the activated clays show an efficiency three to five times as great as that of the naturally active clays of average commercial grade, such activated clays find their principal application in the refining of mineral and vegetable oils and animal fats.

PURPOSE AND AREA OF INVESTIGATION

The purpose of this investigation, made possible through a grant from the Federal Emergency Administration of Public Works under the direction of the United States Geological Survey, was to examine present commercial operations on bleaching clay and to locate new undeveloped deposits in the State of Mississippi. Not only were the known producing formations examined for unexploited deposits, but much time was also devoted to the nonproducing formations, with the hope of discovering areas of commercial potentiality.

That part of Mississippi included in this investigation is a more or less triangular area bounded on the north and east by state lines, on the south by a line extending westward from Waynesboro to Vicksburg, and on the west by a line extending northward from Vicksburg to Walnut. Although the area embraces all the geologic formations from Upper Cretaceous to Oligocene, only the following beds were studied:

Oligocene system
    Vicksburg series
Eocene system
        Jackson formation
        Porters Creek clay
Upper Cretaceous system
        Eutaw formation

The Eutaw formation was examined in Itawamba, Monroe, and Prentiss counties; the Porters Creek clay, in Chickasaw, Clay, Kemper, Noxubee, Oktibbeha, Pontotoc, Union, Tippah, and Webster counties; the Jackson formation, in Hinds, Jasper, Madison, Rankin, Scott, Smith, Wayne, and Yazoo counties; and the Vicksburg series, in Clarke, Hinds, Jasper, Rankin, Smith, Warren, and Wayne counties.

TIME AND METHOD OF WORK

The field work of this investigation was performed during the months of March, April, and May, 1934, and, because of limited funds, was confined to what might be called a detailed reconnaissance.

Prospecting consisted in the examination ot exposures and in the boring of test holes with a 3-inch cup auger of Iwan type. Two men were employed in handling the auger. Sufficient work was done with deposits showing commercial promise to ascertain their general extent and thickness, and numerous samples were taken at intervals throughout the most promising deposits to determine vertical and lateral variations in quality.

All samples were tested in the laboratory of the United States Geological Survey under the direction of P. G. Nutting,[9] whose procedure for testing samples has been as follows:

"The percolation method of testing bleaching power has been used---A 6--inch length of 3/8--inch glass tubing is constricted slightly at the lower end to retain a 1/4--inch disk of blotting paper. In this tube is placed the clay to be tested, about an inch deep. To avoid channeling, the clay is wet with gasoline, stirred with a wire, and allowed to settle and drain. Below is a 3-inch piece of the same tubing closed at the lower end in the form of a small test tube. A neutral black California crude (Kettleman) is used as the test oil. This is put in the upper tube with a pipette and allowed to percolate through the clay. The ratio of the height of the bleached oil to the height of the clay bleaching it is the bleach rating. Pennsylvania cylinder stock (not acid-treated), diluted 50-50 with naphtha, gives about the same bleach rating as the Kettleman crude oil. The clay is 150-mesh, dried to 160°-200° C. for at least an hour in an oven before the test, and the test is made at room temperature."

The tests herein reported refer to complete filtration, and the numerals given under the "bleach ratings" are the ratios of volumes of oil filtered to the volumes of clay used in filtering. In most tests, ratios are given for the first appearance of green, yellow, red, and black colors. For example, 1.5 in the column headed Gr. in a bleach rating means that 1.5 inches of bleached oil (water-white) passed through 1 inch of clay before the appearance of the green color. All samples were tested in both the natural state and the acid-leached state.

Examples of laboratory tests showing the behavior of contrasted types of bleaching clay are as follows:

Naturally active clay from the Attapulgus Clay Co's. mine at Attapulgus, Ga.

RAW				ACID-TREATED			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1.0	1.2	1.3	1.5	0.6	0.8	0.9	1.1

Activated clay from Smith County, Miss.

RAW				ACID-TREATED			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.3	0.4	0.4	0.4	1.2	1.8	2.4	3.6

According to the method of rating employed in the laboratory of the United States Geological Survey the lowest limit of bleach allowable for commercial application is given in the following ranges:

Naturally active clay (raw): Gr. 0.7; Yel. 0.9; Red 1.0; Bl. 1.2.

Activable clay (acid-treated): Gr. 1.4; Yel. 2.0; Red 2.4; Bl. 2.9.

PREVIOUS WORK

Activable clay was found several years ago in the Cretaceous beds of Monroe and Prentiss counties in northeastern Mississippi. This clay was aptly described by Grim[10] in 1928, and his work represents the first organized study of bleaching clays within the state.

During the summer of 1931, field geologic work for Eastman, Gardiner & Co. of Laurel, Miss., under the supervision of A. C. Trowbridge and Urban B. Hughes resulted in the discovery of a high-grade activable clay on the Glaze property, near Lemon in Smith County by Hughes and the submission of a sample to the United States Geological Survey by Trowbridge. Subsequently this company located extensive deposits of similar clay elsewhere in Smith County as well as deposits in Jasper and Wayne counties.

Morse[11] summarized the distribution of bleaching clays in the state in a bulletin published in 1934.

Certain bleaching-clay companies, now operating in the Southeast, have been active in prospecting the clay areas of Mississippi at different times during the past several years.

ACKNOWLEDGMENTS

The writer is grateful to P. G. Nutting of the United States Geological Survey for testing all samples and compiling the laboratory data appearing in this report. C. W. Cooke, also of the United States Geological Survey, supervised the investigation and helped particularly with stratigraphic problems. Thanks are due to U. B. Hughes, chief geologist of Eastman, Gardiner & Co. of Laurel, Miss., for his hearty cooperation in the furtherance of this work in central Mississippi.

ORIGIN AND NATURE OF BLEACHING CLAY

Although the bleaching clays are produced in great quantities by many independent operators, they have received little intensive study, and many of the important factors in relation to origin, distribution, and ultimate commercial applicability are not well understood. Not much is known of the cause of the decolorizing action (bleaching power) nor of its nature except that it is a selective adsorption of some kind. In this connection Nutting[12] states: "As the bleaching action (of clay) is essentially a selective adsorption of coloring matter on exposed solid surfaces in contact with the liquid to be decolorized, such surfaces must be the seat of bleaching action." Nutting's research led him to the conclusion that it is the presence of chemically open bonds or free valencies on a surface that makes it selectively adsorbing. In addition to the open bonds, the contributing factors conducive to adsorption are platy or cleavable crystalline structure, fineness of grain, and characteristic individual bonding of the atoms within the clay material.

MODE OF ORIGIN

Several theories have been proposed concerning the origin of deposits of naturally active clay. Miser[13] described such a clay in Arkansas which he concluded was the result of alteration in place of basaltic dikes that contained a high percentage of ferromagnesian minerals.

It has been said that the fuller's earth of Georgia was deposited as a calcareous clay in shallow waters. Shearer[14] stated: "The leaching of the calcium carbonate left a large volume of openings, while the silica originally present, together with that deposited from solution, formed a framework strong enough to hold the pores open."

Porter[15] and others have presented arguments favoring an origin of fuller's earth from basic rocks in which augites and hornblendes are

the prominent minerals. Porter stated further that "practically all workable deposits of fuller's earth are secondary in origin, having been redeposited in sedimentary series."

The deposits of earth being mined at Olmstead, Ill., have been interpreted as near-shore marine deposits.[16]

According to Davis and Messer,[17] "the California bleaching earth of the high-magnesia type seems to have been produced by the alteration of a basic crystal tuff that contained some rock fragments."

Grim[18] states that fuller's earth at Ivey, Utah, is a decomposed dacitic breccia underlying conglomerate that is at least in part fluviatile.

Natural leaching has very probably played an influential part, possibly far more influential than has hitherto been suspected, in the development of the various types of bleaching clays. Thus the physical and chemical environment of the clay-forming materials has been a most effective factor in the development of the ultimate product.

The most efficient activable clays are provided by the so-called "bentonites." That the original mineral substance of bentonite was volcanic ash seems well established. Bentonite has been defined by Ross and Shannon[19] as "a rock composed essentially of a crystalline clay-like mineral formed by devitrification and the accompanying chemical alteration of a glassy igneous material, usually tuff or volcanic ash; and it often contains variable proportions of accessory crystal grains that were originally phenocrysts in the volcanic glass." The term "bentonite" has sometimes been applied to clays not known to be volcanic in origin; but, for the purposes of this report, the definition of Ross and Shannon is followed.

Apparently the sedimentary materials that now make up the bleaching clays were transported to their ultimate sites of deposition either prior to or after the alteration of the original volcanic ash. Some of the known deposits are thought to be the result of alteration of transported stratified ash particles; others, of transportation after alteration had taken place. The agents of transportation are wind and water, and the most favorable sites of deposition are protected inland basins, shallow lakes, and the shallow undisturbed waters of continental shore lines. Ash may fall directly into fresh or saline basins and remain in place, or it may be deposited on unprotected land surfaces and subsequently be transported. During transportation there is likely to be contamination by the admixture of nonvolcanic ma-

terials, which in general do not have the bleaching properties that are apparently typical of decomposed ash. Nonvolcanic materials that have been transported are likely to be less efficient than volcanic ash that has remained at the site of the original deposition.

Recent field study by the writer and subsequent laboratory investigation by P. G. Nutting have brought to light evidence which may indicate that the major deposits of naturally active clay in the Southeastern States have been derived directly from volcanic ash or indirectly from the same source through bentonite. The probable sequence of change in quickly submerged and well protected ash falls is from ash to normal bentonite. On the other hand, where the ash has been subjected to considerable weathering, washing, and transportation, with dilute plant acids and bacteria perhaps assisting, the probable sequence is from ash to fuller's earth. It is thought that through a process of natural leaching, original ash falls may have been altered into activable clays, which, under proper environmental conditions--when leaching continued--were rendered more and more active until the ultimate naturally active state was reached. At the base, many beds of fuller's earth are highly activable (bentonitic?), but not naturally active. Active clays in general do not show recognizable ash structure, but the structure may have been lost during leaching.

Both Mississippi and Georgia contain all intermediate grades of bleaching clay, from partly leached bentonite, which has no bleaching power when raw, to true fuller's earth, which is naturally active and not subject to further activation by acid leaching. This being so, it might be expected from the theory proposed here that thick deposits would commonly grade downward from naturally active clays through less naturally active material into inactive but activable clays at the base--that part subjected to the least natural leaching. This variation in activability is characteristic of certain Georgia deposits. Samples from a 35-foot deposit of clay in the Twiggs clay member of the Barnwell formation, 2.5 miles south of Dry Branch, in Twiggs County, yielded the following bleach ratings:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
Top	0.9	0.8	0.9	1.1	0.9	1.3	1.4	1.6
Middle		no bleach			1.1	1.4	1.5	1.7
Base		no bleach			1.1	1.8	1.9	2.0

The upper part of this bed has been so thoroughly leached as to be fairly active in the natural state and is only slightly improved by acid leaching, whereas the middle and lower parts are nonactive until treated with acid. The base (which presumably has been leached least) is the most activable. In outward appearance, however, this bed appears to be essentially uniform from top to bottom.

Some deposits which probably have been subjected to complete leaching by natural causes have gone completely over to the naturally active type. This is exemplified by the deposit at Attapulgus, Ga., where the clay is not affected by acid leaching and has the same bleaching power before as after acid treatment. Other beds have apparently been leached to a point where the materials are natural bleaching agents of fairly high grade and still yield a high bleach rating after partial acid leaching--for example, the clay of Vicksburg age in Jackson County, Fla. Still others, such as the Vicksburg bentonite of Mississippi, are inactive in the natural state but highly active after partial acid leaching.

Thus, in the Southeastern States are found all intermediate types of bleaching clay--grading from those that are not naturally active but highly activable on the one hand, to those that are naturally active but not activable on the other. The evidence seems to indicate that the active and activable clays have had a common source and that in certain deposits the active clays have been derived from the activable clays by a process of natural leaching.

GENERAL DESCRIPTION OF BLEACHING CLAYS

The bleaching clays are usually very fine-grained, but in many deposits they carry an admixture of sand particles and mica. The bentonite in the Vicksburg series in Smith County, Miss., is remarkably free from grit, whereas the same series in Wayne County, Miss., is decidely sandy. The colors are usually light, ranging from white to pale green, but may be pink, tan, brown, gray, dark green, blue, or even black. Freshly opened exposures 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 crumble or are even plastic. Certain types exhibit conchoidal fracture; others show platy, hackly, or no distinctive fracture. Jointing is common in most beds. Bentonites of the Wyoming type have a strong affinity for water and will absorb three times their weight or as much as ten times their volume of it, resulting in an increase in volume of

ten or more times the original.[20] This "swelling" property is not characteristic of many of the so-called "bentonites" of other regions. The swelling bentonites are in general less activable than the non-swelling types. The activable clays commonly slake in water, but most active clays do not.

DISTRIBUTION OF BLEACHING CLAYS IN THE SOUTHEASTERN STATES

At various times in the geologic past volcanic ash has been distributed over wide areas, and it is believed that under favorable conditions finely divided ashy materials have been transported several hundred miles from the points of ejection before coming to rest. This is shown by the wide distribution of the Ordovician bentonite which is known to extend from Birmingham, Ala., northward to the Georgian Bay region, a distance of about 900 miles, and for an approximately equal distance east and west.[21] The linear distribution of the Vicksburg bentonite in the Southeastern States is nearly 300 miles.

If it is granted that the major deposits of bleaching clay (both active and activable) in the Southeastern States have been derived directly or indirectly from volcanic ash, it follows that these beds represent at least eleven periods during which volcanic ash was deposited in various parts of that area.

Beds of probable ash accumulation

Cenozoic:

Miocene:

Hawthorn formation: thick deposits of fuller's earth in Florida and Georgia.

Oligocene:

Vicksburg Series: Bentonite in Mississippi and bentonitic clays in Florida, Georgia, and Alabama (?)

Eocene:

Jackson formation: Probable ash falls shown by two thick beds of bleaching clay which are separated by 50 to 75 feet of sand in the Barnwell formation of Jackson age in Georgia; bentonite (?) and bentonitic (?) clay in the Jackson formation of Mississippi; bentonitic (?) clay in the Jackson formation of Alabama.

Lisbon formation: Bentonitic (?) clays in Clarke and Choctaw counties, Ala.

Porters Creek clay: Bleaching properties vary considerably over wide areas--southern Illinois, southeastern Missouri, western Tennessee, Mississippi and Alabama--probably due to differences in time and conditions of ash accumulation.

Mesozoic:

Upper Cretaceous:

Eutaw formation: Three beds of bentonite, one in each of the three members of the formation, in northeastern Mississippi.

Paleozoic:

Ordovician:

Chickamauga limestone: Two ash falls giving rise to two beds of bentonite, which are separated by heavy beds of limestone. Present in Chickamauga limestone of northwestern Georgia and northern Alabama, and in contemporaneous beds in Kentucky and elsewhere.

Volcanic activity during the Ordovician period is well established in Tennessee, Kentucky, Alabama, and Georgia.[22] Nelson[23] has suggested that the center of activity was located at some point between Fayette and Elliot counties, Ky.

There is much evidence supporting the possibility of widespread volcanic activity in the Southern States during Late Cretaceous time. Volcanic materials are present in Arkansas,[24] Oklahoma,[25] Louisiana,[26] Texas,[27] Mississippi,[28] and Alabama.[29] Ross, Miser, and Stephenson[30] have described volcanic vents of Cretaceous age in Arkansas, Oklahoma, and Texas, and there are probably others that have been concealed by younger formations. It appears that during Cretaceous time there was a ring of active volcanoes paralleling the shore line of the Gulf of Mexico.

It has been reported that there is evidence of volcanic activity during Tertiary time in Alabama,[31] Louisiana,[32] Texas,[33] and Arkansas.[34]

The discovery of volcanic tuff and agglomerate 65 to 90 miles south of San Antonio, McMullen County, Tex., led Bailey[35] to think that a volcano had been active at no great distance from that locality during the Oligocene period. An active volcanic vent in such a location might well have contributed ash to certain of the Southeastern States during middle and late Tertiary time.

Little is known of the locations of the Tertiary volcanoes that gave rise to the several ash falls of that time. It is possible that some of the volcanic vents that bordered the Gulf of Mexico during Cretaceous time became active again during the Tertiary and supplied thick beds of ash to the surrounding country.

BLEACHING CLAYS OF MISSISSIPPI

GENERAL FEATURES

The clays of Mississippi that have the most promising commercial future for bleaching are of the activable type. Although naturally active clay has been reported from the Catahoula sandstone of Smith County, samples examined by P. G. Nutting of the United States Geological Survey do not show any great promise. Some of these samples may give fair bleaching tests, but the material does not lend itself to granulation, which is a requirement in the bleaching of oils. The fact that the Catahoula "fuller's earth" resolves into a fine powder on grinding precludes its utilization in the percolation process of oil refining in which the naturally active clays find their important commercial application. The Porters Creek clay supplied some samples that showed low bleaching power in the native and leached states, but it is doubtful if this formation contains materials that will meet commercial requirements.

Activable clays exist in three distinct belts in Mississippi. Ranging from oldest to youngest these are the Cretaceous bentonites of the northeast, the Jackson bentonite (?) of the central part, and the Vicksburg bentonite of the central and east-central parts of the state.

The Cretaceous bentonites are in the Eutaw formation south of Fulton, in Itawamba County; (Tombigbee sand member) north and south of Aberdeen, in Monroe County; and (Coffee sand member) south of Booneville, in Prentiss County. The beds, 5 miles south of Booneville, are being worked by Williams Brothers & Wroten Co., the only producers of bleaching clay in the state at the time of the preparation of this report.

Bentonite (?) and a clay, here called "sub-bentonite," because it has certain of the physical properties of bentonite, are found in the Jackson formation in central Mississippi. The bentonite (?) is a part of the Yazoo clay member near Jackson, in Hinds County; near Lake, in Scott County; and at Satartia, in Yazoo County. This bed is thin and of very slight extent. The "sub-bentonite," an arenaceous and

limy bentonitic (?) clay, is present in thick beds in northern Wayne County, but is not of commercial interest, because of its inferior bleaching properties.

By far the most efficient activable bleaching clay found in Mississippi is that in the Vicksburg series in the central and eastern parts of the state. Extensive deposits of bentonite, extending in a narrow belt westward from Lemon and Lorena in Smith County, offer distinct commercial possibilities. High-grade bentonite also exists near Heidelberg, in southeastern Jasper County, but the thinness of the stratum precludes any considerable exploitation. In central and eastern Wayne County, the extensive deposits of arenaceous bentonite have bleaching properties that are much inferior to those of their correlatives to the west.

EUTAW FORMATION

Although definite stratigraphic relations have not been established, it is thought that bentonite representing three different ash falls belongs to various members of the Eutaw formation in northeastern Mississippi. From oldest to youngest these are: (1) a bed of bentonite in the lower part of the formation about 10 miles south of Fulton, in Itawamba County; (2) beds at two horizons in the Tombigbee sand member in central Monroe County (the lower of which is exposed in the bottoms of deep ravines and may possibly be correlative with the bed in Itawamba County); and (3) a bed in Prentiss County which probably belongs in the Coffee sand member. Although differing in minor details, all these deposits present many general features in common.

ITAWAMBA COUNTY

New Salem

A considerable deposit of bentonite lies in the vicinity of New Salem, a rural community on State Highway 25 about 10 miles south of Fulton. This massively bedded deposit is exposed by deeply cut ravines.

On the property of Mrs. L. E. Wheeler, there are several excellent exposures of bentonite, one of which, in the bottom of a deep ravine directly west of Christian's store, reveals 5.5 feet of soft yellowish bentonite, and a bore hole at the base of the section showed an additional 3.5 feet. The bentonite is separated into two distinct varieties: the upper 4 feet is light tan and soft; whereas the lower 5 feet is hard, brittle, and bluish gray (when fresh), and contains a slight arenaceous admixture and some carbonaceous material. The entire bed is waxy in appearance.

A combined section of the valley wall and the bore hole at the base is as follows:

Section of the Wheeler Exposure at Christian's Store

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

Samples from the middle portions of beds 3 and 4 were tested for oil-bleaching properties and yielded the following bleach ratings:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
Bed 4.....	0.1	0.2	0.2	0.3	1.4	2.0	2.1	2.1
Bed 3.....	0.5	0.6	0.6	0.6	1.1	1.5	1.6	1.6

Although definitely activable, these are obviously low-grade bleaching clays, the upper being the better of the two.

About 0.2 mile north, another exposure on the Wheeler farm in a ravine just west of the New Salem school and church reveals a bed of the tan clay only, the lower blue phase being absent. The total thickness of the bed is about 22 inches. It is overlain by about 85 feet of typical Eutaw sand. A bleach test of a sample from the middle of this 22-inch bed shows this material to be much higher in bleaching efficiency than that exposed at Christian's store. The bleach rating is as follows:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.0	0.1	0.1	0.1	1.6	2.4	2.7	3.0

Southwest of the Wheeler farm and 0.4 mile southwest of Christian's store on the White Springs road, a 1.5-foot bed of bentonite was encountered in a bore hole on the property of I. J. Evans. The bentonite bed is overlain by red medium to fine-grained sand, containing a manganiferous zone in its basal portion. The underlying material is an argillaceous glauconitic sand. That this part of the deposit is low in activable and active bleaching properties is shown in the following bleach rating of a sample taken from the middle of the bed:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.0	0.1	0.1	0.1	1.5	2.0	2.1	2.2

About 1.5 miles southeast of the New Salem church and school a 1.5 foot bed of soft mottled tan and brown bentonite is exposed in a spring that issues from the west valley wall of Bull Mountain Creek on the property of W. H. Johnstone. This exposure marks the eastern extension of the New Salem deposit, as Bull Mountain Creek has cut a wide valley that extends far below the bentonite horizon. The associated formations are the same as those in contact with the bentonite to the west and south. A sample from the middle of this exposed bed shows that the material fails to meet the requisites of commercial bleaching clay:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.0	0.1	0.2	0.2	1.2	1.6	2.2	2.4

It is thought that a deposit of bentonite covering many acres and including much of the Wheeler, Evans, Johnstone, and possibly other properties lies in the New Salem area, the exposures described above probably being on the outer edges of the main bentonite body where streams have cut through the overlying thick sand beds. With the available prospecting equipment and the short time that could

be afforded for study in this area, it was impossible to penetrate the great thicknesses of sand to reach the central body of the deposit. It does not extend east of the W. H. Johnstone farm and probably does not extend far west of the Evans property. The northern and southern limits are unknown. In the exposed sections, the bentonite bed is from 1.5 to 9.0 feet thick, and within the heavily covered body, it is possibly even thicker. The bleaching tests, with one exception, show that the bentonite is a low type of activable clay which is not at all naturally active. Although it is questionable whether the bleaching tests herein recorded are typical of the deposit in general, since it was possible to obtain samples only from the outer edges of the bed, the fact nevertheless remains that even though the inacessible clay should show a high degree of activability, any large-scale commercial exploitation is precluded by the very thick overburden.

East of Bull Mountain Creek

A very small deposit of bentonite is east of Bull Mountain Creek on the farm of L. J. Stuckey, in Sec. 12, T. 11 S., R. 9 E. The bentonitic stratum lies near the top of the high hills that skirt the creek, and it probably represents an erosional remnant of a once more extensive body. Its stratigraphic relations point to a correlation with the bed lying west of the creek, in the New Salem area.

The bentonite is brownish to tan, hard, and waxy. The average thickness is about 3.0 feet. This deposit does not qualify as a commercial bleaching clay for oils in either the natural or the acid-leached state. After treatment with acid this clay is less efficient than many of the naturally active clays. The bleach rating of a sample from the middle of this 3-foot bed is given below:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.1	0.2	0.3	0.3	1.0	1.1	1.1	1.1

Although there is probably an extensive deposit of bentonite in the New Salem area, Itawamba County does not appear to offer bleaching clays that can be commercially exploited under present conditions. With present-day equipment and mining methods it would be highly unprofitable to attempt the removal of such great thicknesses of overburden (some in excess of 100 feet) to reach activable clay of so low a grade. Any profitable mining venture would necessarily be confined to the deep narrow valleys and the outer edges of the deposit, and the

available clay would support only a small-scale operation. The deposit east of Bull Mountain Creek is of no commercial significance.

MONROE COUNTY

Bentonite crops out in two localities in Monroe County--one in the Panther and Little Panther Creek areas, 5 miles south of Aberdeen, and the other at a place about 4.5 miles north of Aberdeen (Figure 1). At the southern area, two distinct beds of bentonite are present; at the northern, but one bed is present, probably representing a single ash fall. The rocks that include these deposits have been mapped[36] as part of the Tombigbee sand member of the Eutaw formation, and the bentonite beds are, therefore, tentatively assigned to that formation. Of the two bentonite beds in the Panther Creek locality, the lower one is exposed only in the deep valleys, and possibly represents ash deposited simultaneously with the ash of the lower Eutaw in Itawamba County. The stratigraphic relations are not clear, but Grim[37] is of the opinion that the zone of bentonite is probably "low down in the Eutaw, not more than 50 to 100 feet from the top of the Tuscaloosa."

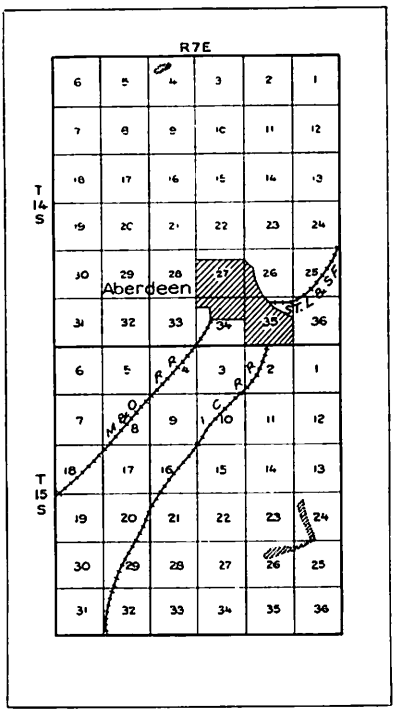

Figure 1.—Sketch map showing location of bentonite deposits in Monroe County, Miss.

Panther Creek Area

In the general area south of Aberdeen, tributaries of the Tombigbee River have carved deep valleys into the uplands, making a rough and rugged topography, and exposing in these deep ravines the bentonite beds.

Exposures of bentonite in the beds of Panther and Little Panther Creeks and their numerous tributaries about a mile west of the Tombigbee River are in parts of Secs. 24, 25, and 26, T. 15 S., R. 7 E. As stated before, this area lies about 5 miles south of the town of Aberdeen.

When this locality was visited only the lower bed of bentonite was visible, the upper one having been concealed by heavy slumping of overlying sand beds. This upper bed has been described by Grim[38] as follows:

"The upper bentonite outcrops on the top of a spur, 25 feet above Panther Creek. The top is covered by slump, so that only about 5 feet of the bed can be seen. Underlying this upper bed there is a layer of evenly bedded fine gray limy sand that has a thickness of about 35 feet. The contact between the sand and the overlying bentonite is not sharp but is rather a gradational one. The bentonite in less than a foot changes rapidly into the sand. Underlying this sand is the lower layer of bentonite. The contact, while not conformable, is fairly sharp."

There is an excellent exposure of the lower bentonite in the bed of Little Panther Creek on the property of N. W. Dahlem in Sec. 24, T. 15 S., R. 7 E., where 5 feet of massively bedded greenish-gray hard and waxy somewhat arenaceous bentonite lies above a dark bluish gray bentonite bed that has a thickness of several feet. A bore hole at this location revealed a combined thickness of 11 feet of bentonite. Grim[39] reports a relatively constant thickness of 7 to 9 feet for this lower bed. The material underlying the lower bentonite is a greenish-gray calcareous, glauconitic, slightly micaceous medium-to fine-grained sand.

Bleach ratings of samples from the middle portions of the upper and lower parts of the lower bentonite bed are as follows:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
Upper part	0.4	0.5	0.5	0.5	1.0	1.6	1.7	1.7
Lower part	.0	.1	.1	.1	1.1	1.6	1.7	1.7

Both the upper and lower parts of this bed are low in activable bleaching properties, and in natural bleaching property no better than ordinary soil. Samples were not collected from the upper bentonite bed.

So far as the lower bentonite bed is concerned, the presence of thick overburden and the low efficiency rating of the clay are not conducive to commercial development. It is reported that some years ago several thousand pounds of bentonite was mined from the lower bed on the Dahlem farm for testing, but commercial operation has not been attempted.

Meeks Property

A small deposit of bentonite on the farm of Wesley Meeks, 4.5 miles north of Aberdeen and 0.37 mile west of Thompson Memorial Church, in Sec. 4, T. 14 S., R. 7 E., lies near the tops of the hills and extends over an area of several acres. It is believed to be the same as the upper bentonite bed of the Panther Creek area. The bentonite is white, hard, and waxy. It contains fine dark mineral grains scattered throughout the stratum and markings that appear to be animal borings subsequently filled with sand, at the top of the bed. Bore holes showed this bed to have a maximum thickness of about 30 inches and an average of much less than that, probably not more than 18 inches. The overburden is about 20 feet in average thickness and consists of red and brown argillaceous, glauconitic sand. The underlying material is much the same as that lying above the bentonite. Although this bentonite is slightly superior in bleaching efficiency to the samples tested from the Panther Creek area, it is, as shown by the following bleach rating, a poor grade of activable bleaching clay:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.3	0.4	0.4	0.4	0.8	1.4	1.6	2.1

The nearest point of transportation is Aberdeen, which is served by the Illinois Central, Mobile & Ohio, and St. Louis and San Francisco railroads.

It is doubtful if the bentonite deposits of Monroe County will ever afford extensive commercial operation. The clay is of a low grade at best, and the thickest deposits are covered by thick overburden.

PRENTISS COUNTY

Three deposits of bentonite were noted in Prentiss County (Figure 2)--(1) on the farm of S. H. Wroten, in Sec. 36, T. 5 S., R. 7 E.; (2) in the NE ¼ Sec. 35, T. 5 S., R. 7 E.; and (3) on the property of John Duncan, in Sec. 11, T. 6 S., R. 7 E. These may possibly represent erosional remnants of a single original deposit, as all three are in the same general area, present similar stratigraphic relations, and lie near the tops of the hills. These bentonite beds are referred to the Coffee sand member of the Eutaw formation[40] and represent the youngest of the three Cretaceous ash falls in northeastern Mississippi.

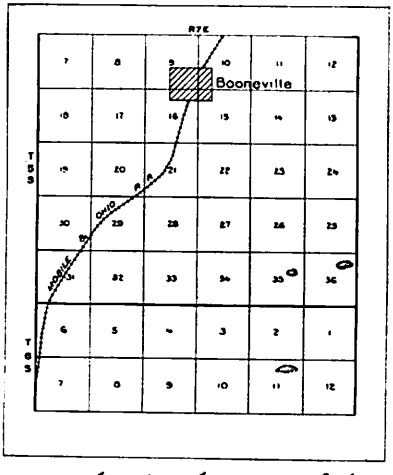

Figure 2.—Sketch map showing location of bentonite deposits in Prentiss County, Miss.

Prentiss County contains the only commercial bleaching clay mine operating within Mississippi at the time of the preparation of this report.

S. H. WROTEN PROPERTY

By far the best known of the Prentiss County bentonite deposits is that on the farm of S. H. Wroten, in Sec. 36, T. 5 S., R. 7 E. This deposit was first mentioned by Grim [41] in 1928 and later by Morse.[42] At the time of the preparation of the present report, H. C. and W. A. Williams and S. M. Wroten were here operating the only commercial bleaching-clay mine in the state. At the time this mine was visited 1 or 2 cars of dried raw bentonite were being shipped weekly. The dried clay is hauled by motor truck over an all-weather road to Booneville, a distance of about 5 miles, where it is transferred to railroad cars for long-distance shipping.

In the Wroten deposit the maximum thickness of the clay stratum is about 3 feet and the average about 1.5 to 2 feet. The overburden has a maximum thickness of about 25 feet and an average thickness of about 15 feet.

Section in mine pit on Wroten farm

		Feet
5.	Sand, red and brown micaceous, argillaceous medium-grained	12
4.	Shale, dark gray to bluish finely laminated micaceous, glauconitic, arenaceous	3
3.	Shale, reddish brown micaceous, arenaceous	1
2.	Bentonite, gray waxy hard, brittle, having a small percentage of admixed sand and very finely divided mica. Joint planes having ferruginous and manganiferous coatings. A few pockets of silty bentonitic clay and limy phases	2
1.	Sand, brownish medium-to fine-grained glauconitic	—

The bentonite is gray waxy hard and brittle, and exhibits conchoidal fracture. Included within the clay is a small percentage of fine sand and finely divided mica. Scattered throughout the stratum are pockets of inferior silty bentonitic clay and argillaceous limy bentonite, some of which reach a diameter of 2 feet or more. These foreign materials are distinctly inferior as bleaching agents (see bleach rating below) and must be separated from the marketable clay. The separation, which is necessarily done by hand, adds to the cost of production.

Samples for bleaching tests were taken from the middle of the bentonite bed and from the silty and limy phases. The results of the tests are given below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
Bentonite	0.3	0.4	0.4	0.4	1.4	2.2	2.7	2.9
Silty phase	.2	.3	.3	.3	1.2	1.4	1.4	1.4
Limy phase	.4	.5	.6	.6	1.0	1.4	1.5	1.6

This test shows that the Wroten bentonite meets the requirements of commercial bleaching clay and that the silty and limy phases are distinctly inferior.

The bentonite readily available for mining in this deposit is sufficient to maintain the present scale of production for some time.

SECTION 35, TOWNSHIP 5 SOUTH, RANGE 7 EAST

A thin bed of bentonite is exposed in a road cut about 5 miles southeast of Booneville, in the SE¼, NE¼ Sec. 35, T. 5 S., R. 7 E., Prentiss County. It is very small in extent, being confined to the top of a single small hill.

Section in a road cut in Sec. 35, T. 5 S., R. 7 E., Prentiss County

		Feet
3.	Sand, red and brown medium- to fine-grained argillaceous, micaceous	8.0
2.	Bentonite, light gray somewhat arenaceous very thin-bedded; most sandy along bedding planes	0.6
1.	Sand, brown medium-grained glauconitic	—

The clay is similar in appearance to that on the Wroten property, in Sec. 36, but is more arenaceous and exhibits thin bedding. The included sand is concentrated along the bedding planes.

A sample from the middle of the 0.6-foot bed gave the following oil bleach rating:

RAW				ACID-TREATED			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.5	0.6	0.6	0.6	0.8	1.5	1.7	2.5

This small deposit is of no commercial interest.

JOHN DUNCAN PROPERTY

The southernmost bentonite in Prentiss County is on the property of John Duncan in the NE¼, Sec. 11, T. 6 S., R. 7 E., about 7.5 miles southeast of Booneville. A single exposure in this deposit was examined and sampled.

Section on Duncan farm, 7.5 miles southeast of Booneville

		Feet
3.	Sand, medium- to fine-grained micaceous	12
2.	Bentonite, greenish gray waxy hard, brittle slightly arenaceous; ferruginous and manganiferous stain common along joint planes	2
1.	Sand, grayish green, medium- to fine-grained micaceous, glauconitic	—

The deposit contains a small percentage of very fine detrital quartz and mica. The bed is highly jointed, and the joint planes are commonly coated with manganiferous and ferruginous stains.

This deposit covers only a few acres. The overburden will probably range between 2 and 25 feet in thickness. The nearest railroad facilities are at Booneville, and at the time of examination the deposit could not be reached by an all-weather road.

The bleach rating of a sample from the middle of this 2-foot bed on the Duncan farm is as follows:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.4	0.5	0.5	0.5	1.1	1.7	2.2	2.9

This rating indicates that the Duncan deposit is a fairly good activable bleaching clay. However, owing to its inaccessibility and small extent, it offers little of commercial interest.

PORTERS CREEK CLAY

The Porters Creek clay of the Midway series exhibits many common characteristics throughout its wide area of outcrop, which extends from southeastern Missouri and southern Illinois southward through western Kentucky and Tennessee, through Mississippi, and into central Alabama; its correlatives extend eastward into southwestern Georgia.

The Porters Creek formation in Mississippi has been described[43] as consisting of about 100 feet of tough dark-gray to almost black clay, which as a rule is not distinctly stratified. The clay weathers to light gray or nearly white and, on drying, breaks into small masses

that shell or spall off in successive thin conchoidal layers. The clay is usually unctuous and may possess a decidedly waxy luster. Locally the formation is slightly arenaceous, micaceous, and glauconitic.

Oil bleaching tests made with numerous samples collected from the outcrops of the Porters Creek clay in Mississippi seem to indicate that at least a certain percentage of bentonite like material was contributed during the deposition of these nearshore marine deposits. As a result of the testing of numerous samples of the Porters Creek clay from southern Illinois to Alabama, Nutting[44] concluded that the formation is probably a silty bentonite which has been naturally leached to a low-grade fuller's earth. Grim's work[45] seems to suggest a bentonitic character for the Porters Creek clay at Olmstead, Ill., where the material is mined for a naturally active bleaching clay (fuller's earth). The formation as exposed at Olmstead is thought to be typical of the Porters Creek and to be essentially the same as that which crops out in a long, narrow belt 4 to 12 miles wide that extends from Alabama into Kemper County, Mississippi, and northwestward to the Tennessee State line.

Although a comprehensive and exhaustive study was not made of the Porters Creek clay in Mississippi, yet representative samples were procured along the outcrop in Chickasaw, Kemper, Noxubee, Oktibbeha, Pontotoc, Tippah, Union, and Webster counties, and many generalized data were compiled.

The Porters Creek clay does not appear to offer outstanding commercial potentialities in Mississippi, and consequently only brief descriptions of the sections examined are here recorded

CHICKASAW COUNTY

The outcrop of the Porters Creek clay occupies a belt about 5 to 10 miles wide in the western part of Chickasaw County. Bleach ratings of representative samples from four exposures of typical Porters Creek clay in this county are given below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1	0.3	0.4	0.5	0.6	0.6	0.9	1.3	1.5
2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.8
3	0.6	1.0	1.1	1.2	0.7	1.1	1.5	2.0
4	0.4	0.6	0.7	0.8	0.6	0.9	1.3	1.8

Sample 1 was collected from a road cut 1.2 miles north of Woodland on State Highway 15. This cut reveals 3 feet of light-gray (weathered), slightly arenaceous, slightly micaceous, noncalcareous clay. The material exhibits conchoidal fracture and is more or less waxy in appearance. This clay is not of commercial bleaching quality.

Sample 2 was collected from a cut on a local road 2.1 miles west of Woodland. The exposure consist of 4 feet of dark-gray to black thin-bedded slightly arenaceous, noncalcareous hard and brittle Porters Creek clay. This sample is distinctly below the commercial bleaching clay requirements.

Sample 3 was collected from a cut on the Montpelier road 3.2 miles east of Woodland. The exposure consists of 10 feet of dark greenish-gray slightly arenaceous, somewhat micaceous, hard and brittle noncalcareous clay. This material is a low-grade naturally active bleaching clay.

Sample 4 was collected from an exposure in a road cut 6.5 miles south of Houston on State Highway 15. At this point 8 feet of dark greenish-gray hard and brittle slightly arenaceous micaceous and calcareous clay is exposed. The material exhibits conchoidal fracture and is waxy in appearance. The Porters Creek clay at this place is not of commercial interest as a bleaching clay.

KEMPER COUNTY

The Porters Creek clay extends in a wide belt across the northeastern half of Kemper County.

Bleach tests of three samples of Porters Creek clay from Kemper County are given below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1	0.3	0.4	0.5	0.5	1.1	1.4	1.6	2.0
2	0.5	0.6	0.6	0.7	1.0	1.4	1.6	1.7
3	0.5	0.6	0.7	0.7	1.0	1.3	1.5	1.9

Sample 1 was obtained from the middle of a section exposed in a road cut 1.2 miles south of Electric Mills on United States Highway 45. The exposure shows 15 feet of black hard and brittle waxy finely micaceous, slightly arenaceous finely laminated Porters Creek clay.

The bleaching properties of this material are considerably improved by acid leaching (indicating bentonitic character), but the clay is not of commercial interest.

Sample 2 was taken from the middle of a road cut exposure 2.4 miles south of Sucarnoochee on United States Highway 45. At this locality the section consists of 12 feet of very dark gray brittle, very slightly arenaceous, thinly laminated clay. Although the bleaching action of this clay is improved by acid leaching, the quality is not equal to the commercial standards.

Sample 3 was obtained near the base of a 25-foot section exposed in a road cut along United States Highway 45, 1.7 miles south of Porterville. The clay is mottled chocolate-brown and black, hard and brittle, very slightly arenaceous, and finely micaceous. This sample is not of commercial interest. The fact that the bleaching power and color separation of the clay are distinctly increased by partial acid leaching is probably indicative of a rather high proportion of admixed bentonitic material.

NOXUBEE COUNTY

The Porters Creek clay extends across the southwestern part of Noxubee County. A thick exposure 3.9 miles west of Machulaville was visited. A road cut along State Highway 14 reveals 20 feet of dark to brownish-gray, hard and brittle, somewhat waxy, noncalcareous clay. A sample procured from the middle of this exposure gave the following bleach rating:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.4	0.5	0.7	0.7	1.0	1.3	1.8	2.1

The natural bleaching power of this sample is low, but the acid-treated fraction is somewhat better, although it does not meet commercial requirements.

A thin bed of Porters Creek clay is exposed in a road cut on State Highway 14, 7.6 miles west of the intersection of that road with United States Highway 45. At this location 4 feet of very dark gray to black thin-bedded brittle slightly sandy, noncalcareous clay is exposed. The bleaching test made on a sample collected near the base of this exposure gave the following ratings:

Raw				Acid-Treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.4	0.5	0.6	0.6	0.9	1.2	1.3	1.4

This material is of no commercial interest.

OKTIBBEHA COUNTY

The Porters Creek clay crops out widely over the western half of Oktibbeha County, but only a single exposure was examined. The section visited is 3.8 miles west of Starkville on United States Highway 81 and consists of 6 feet of dark-gray hard and brittle arenaceous, glautonitic, finely micaceous, slightly calcareous clay. That this material is not of commercial interest as a bleaching clay is revealed in the following bleach rating:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.5	0.6	0.7	0.7	0.8	1.1	1.3	1.5

PONTOTOC COUNTY

The Porters Creek clay crops out in a north to south belt across west-central Pontotoc County.

A bore hole 0.1 mile east of Mudcreek (Springville), in the SW¼, Sec. 4, T. 10 S., R. 2 E., penetrated 17 feet of light-brown to gray hard and brittle slightly arenaceous waxy clay. A representative sample, collected at a depth of 10 feet, yielded the following bleach rating:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.5	0.6	0.6	0.7	0.8	1.2	1.4	1.6

The Porters Creek is not of commercial interest as a bleaching clay at this place.

TIPPAH COUNTY

The Porters Creek formation crops out across the western part of Tippah County in a belt that averages about 5 miles in width.

Numerous sections of the Porters Creek were visited in this county, and representative samples were selected to test the bleaching powers of each. The bleach ratings of these samples are given below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1	0.6	0.8	1.0	1.0	1.0	1.4	1.5	2.4
2	0.4	0.5	0.6	0.6	0.5	0.8	1.2	1.5
3	0.7	0.9	1.1	1.2	0.8	1.1	1.3	1.7
4	0.8	0.9	1.0	1.0	0.7	0.9	1.4	1.8
5	1.1	1.4	1.6	1.9	0.6	0.9	1.0	1.2
6	0.6	0.8	0.9	1.0	1.0	1.6	2.0	2.3
7	0.6	0.8	0.9	1.0	1.1	1.7	2.2	2.4
8	0.5	0.6	0.8	0.9	0.8	1.4	1.8	2.4
9	0.9	1.1	1.3	1.6	1.1	1.6	1.8	2.3
10	0.5	0.6	0.7	0.9	0.9	1.6	1.9	2.1
11	0.9	1.2	1.5	1.6	1.2	1.4	1.8	2.1
12	1.0	1.4	1.6	1.8	1.2	1.4	1.9	2.1
13	0.6	1.0	1.1	1.4	0.5	0.7	0.9	1.1
14	0.5	0.6	0.7	0.9	0.3	0.4	0.5	0.5
15	0.5	0.7	0.9	1.3	0.5	0.6	0.8	1.1
16	0.8	1.0	1.4	1.6	0.8	1.2	1.3	1.8
17	1.0	1.2	1.4	1.7	0.9	1.3	1.5	1.9
18	1.1	1.2	1.3	1.3	0.6	0.9	1.4	1.6

Sample 1 represented a probable bentonitic phase of the Porters Creek formation, encountered in a bore hole 11.1 miles north of New Albany on State Highway 15, just north of the county line.

Section in a bore hole 11.1 miles north of New Albany

		Feet
3	Clay, tan very plastic, slightly sandy	7
2.	Clay, gray hard and brittle slightly arenaceous, unctuous; having manganiferous staining	13
1.	Clay, brownish gray very sandy	2

This material approaches very nearly the commercial requirements for both naturally active and activable clay.

Sample 2 was obtained from a bore hole 2 miles northwest of Blue Mountain. The auger penetrated 12 feet of yellowish to dark-gray and brown arenaceous, micaceous clay. The bleaching test of a composite sample from this 12-foot bed showed the material to be distinctly inferior as a bleaching clay for oil.

Sample 3 was a composite of a 12-foot bed of clay penetrated in a bore hole 2.5 miles east of Blue Mountain. At this locality the clay is greenish gray, very hard and brittle, slightly arenaceous, and waxy in appearance. This bed is underlain by a similar clay that is glauconitic and slightly calcareous. The bleach rating shows that the sample from this locality reaches the minimum commercial requirements for a naturally active bleaching clay.

Sample 4 came from a bore hole 1 mile north of Ripley on State Highway 15. This hole revealed a 16-foot bed of dark-gray brittle slightly arenaceous, micaceous waxy clay. This material is not of commercial interest as a bleaching clay for oil.

Sample 5, from a bore hole 2.3 miles north of Ripley on State Highway 15, represents the most efficient naturally active bleaching clay found in Tippah County. This material is a true fuller's earth, and, as shown in the table, bleaches considerably better in the raw state than after acid treatment. The Porters Creek at this locality is probably a bentonitic silt that has been rather extensively leached by natural processes. The bed is 18 feet thick and consists of dark greenish-gray, hard and brittle, slightly sandy and micaceous clay.

Sample 6, which was collected from a road cut exposure 0.8 mile north of Walnut on State Highway 15, activates fairly well by partial acid leaching. The bleaching efficiency is not, however, increased sufficiently to make this material of commercial interest.

Sample 7 was obtained from an auger hole at the side of State Highway 2, 0.7 mile west of Walnut. The section at this point consists of 16 feet of mottled dark-gray and yellowish, hard and brittle, somewhat arenaceous, slightly micaceous Porters Creek clay. This clay meets the bleaching requirements of a low-grade commercial activable clay; and, although the bleach rating is about 60 percent of that of the best activable clays, the material is nevertheless of little commercial significance

Sample 8 was collected from a 10-foot bed of Porters Creek clay exposed in a road cut along State Highway 2, 2.4 miles west of Walnut. The clay at this place is very dark gray to brown, finely laminated

and free of sand. The bleach rating of this clay is very similar to that of Sample 7. The relatively high bleaching properties of the untreated fractions of both samples may be due to a partial leaching by weak plant acids.

Sample 9 is a noncommercial clay of the activable type, encountered in a bore hole 3.1 miles west of Tiplersville. This material is a very dark gray to black, finely laminated, slightly arenaceous, slightly micaceous clay that breaks with conchoidal fracture and weathers to a very light gray.

Sample 10 was collected from an auger hole 2.2 miles northeast of Tiplersville on the Chalybeate road. The section revealed 14 feet of dark-gray, hard and brittle, finely micaceous, sandy clay. This bed is of no commercial importance.

Sample 11 is from an auger hole 0.9 mile west of Falkner on a local road. The bed is 20 feet thick and consists of dark-gray, hard and brittle, somewhat sandy and micaceous clay. The material is of little commercial importance.

Sample 12, as shown by the bleach rating, represents material that is fairly efficient in the raw state. The sample came from a bore hole 2.8 miles west of Falkner. This section differs from the typical Porters Creek clay in being somewhat glauconitic.

Sample 13 came from an auger hole that penetrated 18 feet of low-grade naturally active clay on the John Mauldin property 4.1 miles southwest of Ripley. The clay is very dark gray and is slightly sandy and micaceous.

Sample 14 was taken from an exposure on the J. M. Sheldon farm, in Sec. 4, T. 4 S., R. 3 E., 4 miles northwest of Ripley. The exposed section consists of 6 feet of very light gray (weathered) laminated clay. This material is of no commercial interest as a bleaching clay.

Sample 15 is a very low grade bleaching clay of the naturally active type. The material was selected from a 50-foot exposure on the farm of Mrs. Kate Davis, in Sec. 4, T. 4 S., R. 3 E., about 4 miles northwest of Ripley. This thick section, which is exposed in the valley wall of a small stream, consists of very dark gray, hard and brittle clay that breaks with a conchoidal fracture and is essentially free of sand.

Sample 16 is indicated by the bleach rating to be a fairly good naturally active bleaching clay. The sample was obtained from an auger hole 2.8 miles northwest of Ripley on a local road. It is a clay, mottled very dark gray and yellowish-brown, hard and brittle, slightly waxy, somewhat sandy and micaceous. The bed penetrated is 20 feet thick.

Sample 17 ranks high as a naturally active bleaching clay. It was taken from 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.

Sample 18 was taken from an auger hole at the side of State Highway 15, 1.2 miles south of Blue Mountain. The clay is dark gray, hard and brittle, slightly micaceous, and waxy in appearance. This sample is a very low grade fuller's earth.

UNION COUNTY

The Porters Creek formation extends in a narrow belt from north to south across west-central Union County. Bleaching tests of three samples from this county are given below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1	0.7	0.9	0.9	1.0	0.7	1.1	1.4	1.6
2	0.9	1.0	1.1	1.3	0.6	0.9	1.3	1.9
3	0.5	0.6	0.6	0.7	0.8	1.2	1.4	1.6

Sample 1 is of a clay of no commercial interest as a bleaching agent for oils. It is from the middle of an 8-foot exposure of dark-gray, hard and brittle, somewhat sandy and micaceous clay, which crops out in a road cut along State Highway 30, 3.8 miles west of New Albany.

Sample 2 represents the most efficient oil bleaching clay of the three. It is a very low grade fuller's earth and is of little commercial importance. The bed from which this sample was taken consists of

17 feet of greenish-gray, hard and brittle, slightly sandy and micaceous clay. The section was encountered in an auger hole about 6 miles southwest of New Albany.

Sample 3 is of a clay of no commercial interest. The material was collected from a 14-foot bed that crops out in a road cut about 9 miles west of Ingomar. The clay is dark brownish gray, slightly micaceous, and finely sandy.

WEBSTER COUNTY

The Porters Creek clay crops out in the eastern part of Webster County. Samples from only two localities in this county were subjected to oil bleaching tests. Neither sample represents a bleaching clay of commercial interest.

One sample was collected from a thin bed of dark-gray to brown, hard and brittle, slightly micaceous clay, that crops out along State Highway 15, 5.9 miles north of Maben. The second sample came from the middle of a 10-foot bed of clay exposed in a road cut along State Highway 15, just north of Mantee. Here, the Porters Creek formation consists of dark greenish-gray, laminated, slightly sandy, finely micaceous, noncalcareous clay.

JACKSON FORMATION

The Yazoo clay member of the Jackson formation is characterized by two zones that are probably bentonitic---one in the very base of the member, and above the greensands of the Moodys marl member; the other near the top of the Yazoo. Both zones are local and do not extend throughout the outcrop of the Yazoo clay. Although recognizable shards of volcanic ash are lacking* in the thick plastic clay beds that characterize the Jackson formation, the fact that numerous samples collected at random over the outcrop are all somewhat activable suggests that some ash was being contributed throughout the deposition of the Yazoo clays, and that during two periods there were relatively heavy concentrations of ash. The activable character of the Yazoo clay is indicated by the following bleach ratings of samples from Jasper, Clarke, Scott, and Hinds counties:

* In the personal communication dated April 13, 1934, C. S. Ross of the United States Geological Survey made the following statement concerning four samples of typical Yazoo clay: "All resemble unusually fine-grained sedimentary clays but lack the abundant fine-grained quartz that commonly characterizes such clays. None of the samples examined shows any evidence of recognizable volcanic material, and all contain finely disseminated calcite in addition to that represented by shell fragments."

	Raw	Acid-treated	Acid soluble (percent)
	gr.	gr.	
1. Jasper	0.6	1.0	35.0
2. "	.5	1.1	65.7
3. "	.5	1.0	28.7
4. "	.6	1.0	26.1
5. "	.6	.9	31.6
6. "	.5	1.1	33.9
7. Clarke	.4	1.3	40.8
8. "	.2	1.1	25.9
9. Scott	.2	1.1	24.7
10. "	.3	1.0	22.5
11. "	.6	1.1	25.5
12. "	.3	.8	18.5
13. Hinds	.4	1.3	26.5
14. "	.4	1.2	21.3

NOTE: Bleach rating is for the first appearance of green only.

Jasper County: 1, 4.6 miles west of Rose Hill: 2, 1.4 miles north of Louin; 3, 1.1 miles northwest of Montrose; 4, 1.4 miles north of Montrose; 5, 3.4 miles north of Montrose; 6, 2.2 miles south of Garlandsville.

Clarke County: 7, 1.4 miles south of Pachuta; 8, 3 miles south of Pachuta.

Scott County: 9, 0.4 mile west of Lake; 10, 1.6 miles west of Forest; 11, 9.8 miles west of Forest; 12, 0.9 mile east of Morton.

Hinds County: 13, 3 miles south of Jackson; 14, 3.5 miles southwest of Jackson.

The upper bentonitic (?) bed, within the upper 15 or 20 feet limits of the member, appears to be relatively widespread, in spite of the fact that it reaches a maximum thickness of not more than 1 foot. What is believed to be the same bed crops out at various places in Scott, Hinds, and Yazoo counties, and is possibly present to the east but escaped notice in this rapid study. In Scott and Hinds counties the thin bed of greenish-gray clay is intercalated between thick beds of typical yellowish-brown and greenish-gray plastic Yazoo clay. In Yazoo County the beds associated with the cream-colored clay consist of chocolate-brown laminated, slightly arenaceous clay.

The lower bentonitic (?) bed (here called a "sub-bentonite"), which lies directly above a thick bed of fossiliferous greensand marl (probably Moodys marl member of the Jackson formation), has, in

Mississippi, been found only in northeastern Wayne County, where a maximum aggregate thickness of about 60 feet of the "sub-bentonite" is present.

HINDS COUNTY

In Hinds County the upper bentonitic (?) phase of the Jackson formation was found in a single locality. The bed was penetrated in a bore hole on United States Highway 51, 3.7 miles south of its junction with Highway 18, just north of Caney Creek School. The clay, 1 foot thick, is light greenish-gray, waxy, and hard and brittle. It is underlain by a pale bluish-gray calcareous plastic clay, and is overlain by a yellowish to brown calcareous plastic clay. Laboratory tests showed that this material does not have the bleaching properties of a commercial activable clay.

Although of no commercial value, the bentonite (?) at this locality is of geologic interest, as it helps to place definitely the stratigraphic position of this upper horizon. The contact between the Yazoo clay and Forest Hill sand can be seen 0.1 mile south of the bore hole that penetrated the bentonitic stratum. This serves to place the zone high in the Yazoo clay member, probably within 15 or 20 feet of the top.

SCOTT COUNTY

A thin bed of bentonite (?) is exposed in a deep gully in the NW¼, SE¼, SW¼ Sec. 34, T. 6 N., R. 9 E., in Scott County, at a horizon thought to be correlative with that in Hinds County described above. The bentonite (?) in this exposure is 4 to 12 inches thick, greenish gray, waxy in appearance, and essentially free of grit and lime. Numerous selenite crystals are scattered throughout the bed--a feature not noted elsewhere in bentonitic beds in Mississippi. The associated beds consist of thick "rubbery" clays, which are much jointed, selenitic, calcareous, and slightly manganiferous, Several bore holes in this vicinity showed the clay bed to be of very slight extent and to be confined to the top of what is locally known as "Bald Hill".

Two samples from this deposit were tested for oil-bleaching properties with the following results:

	Raw	Acid-treated
	GR.	GR.
Sample from exposure	0.2	1.5
Sample from bore hole	0.1	1.4

NOTE: Bleach rating is for the first appearance of green only.

The bleach rating of this clay indicates commercial quality, but owing to the small thickness and slight extent of the deposit it would not support mining developments.

YAZOO COUNTY

A thin bed of bentonite (?) crops out on a hillside half a mile northeast of Satartia on State Highway 3 in Yazoo County. This material is creamy white, unctuous, waxy in appearance, essentially free of grit, and has a tendancy to crumble to a mealy mass on drying. In the exposed section its thickness ranges between 8 and 14 inches; in a bore hole its thickness is one foot.

Section in a bore hole near Satartia

		Feet
3.	Clay, chocolate-brown finely arenaceous laminated; resembling bentonite in appearance	9
2.	Bentonite (?) cream colored unctuous waxy	1
1.	Clay, chocolate-brown, similar to bed 3	—

Bleach tests of representative samples from each of these three beds resulted in the following ratings:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
Bed 1	0.3	0.4	0.4	0.4	1.0	1.4	1.4	1.4
Bed 2	.0	.1	.1	.1	1.0	1.5	1.7	2.1
Bed 3	.2	.3	.3	.3	1.4	1.8	1.8	1.9

The bleach ratings show this bentonite (?) (bed 2) to be a low-grade activable clay that does not meet commercial requirements. They show an activability in the associated clays (beds 1 and 3) indicative of an appreciable percentage of bentonitic matter.

The clay near Satartia crops out in the valley wall of the Yazoo River, where the overlying heavy loess beds have been removed by the stream. Because of the very thick loess bed that blankets the area adjoining the Yazoo River valley, the bentonite (?), even though high in oil-bleaching properties, would not support a commercial mining operation.

WAYNE COUNTY

An extensive deposit of what seems to be bentonitic clay is located about 3 miles east of Matherville, in Sec. 6, T. 10 N., R. 5 W., and Sec. 31, T. 11 N., R. 5 W. in Wayne County. An excellent exposure of this material appears in a cut 3.2 miles east of Matherville on the road to Coyt. Although decidedly bentonitic in appearance, this clay does not have the highly activable character of many of the true bentonites. The appearance of the clay and its low activability lead to the assumption that the material is bentonitic and that the bleaching power has been materially reduced by the admixture of nonactivable silt and clay during deposition. This thick bed of sub-bentonite lies on a fossiliferous greensand marl which is referred to the basal member (Moodys marl) of the Jackson formation, thus placing the sub-bentonite in the base of the Yazoo clay member.

A section (Fig. 3) from north to south across parts of Sec. 31, T. 11 N., R. 5 W. and Sec. 6, T. 10 N., R. 5 W. gives an idea of the thickness and linear distribution of this bed of sub-bentonite.

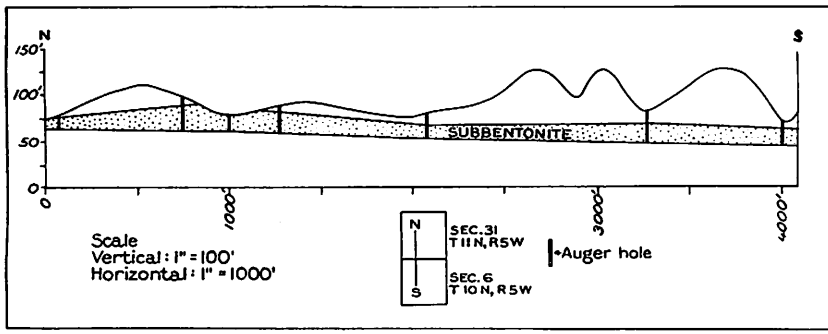

Figure 3.—Cross section of the deposit of sub-bentonite east of Matherville, Wayne County, Miss.

Numerous bore holes were put down in this locality, and the deposit was traced over an area covering many acres. The bed was found to dip southward at a low angle. The material reaches a maximum thickness of nearly 60 feet and was found to be separated into three distinct phases. The characters of the three zones are revealed in the generalized section below:

Generalized section in Sec. 6, T. 10 N., R. 5 W., Wayne County

		Feet
6.	Clay, tan to yellowish highly arenaceous and slightly calcareous	4
5.	Sub-bentonite, mottled tan and gray slightly arenaceous silty; having a few lime nodules in the upper 3 feet	20
4.	Marl, bluish green fossiliferous sub-bentonitic	20
3.	Sub-bentonite, mottled tan and gray slightly arenaceous, argillaceous; having numerous soft white limy nodules	17
2.	Like bed 3, having an abundance of medium-grained dull green glauconite	2
1.	Greensand marl, greenish gray fossiliferous (Moodys marl?)	—

Below is a group of oil-bleach ratings of bore-hole samples, of which three were taken from beds 3, 4, and 5 respectively:

	Raw	Acid-treated
	gr.	gr.
Bed 3	0.2	1.1
"	0.2	1.1
"	0.3	1.1
Bed 4	0.2	1.0
"	0.2	1.3
"	0.2	0.9
Bed 5	0.6	1.1
"	0.3	1.3
"	0.1	1.0

NOTE: Bleach rating is for the first appearance of green only.

Despite the great thickness and wide distribution of this deposit it cannot qualify as a potential producer, because of the low bleaching power of the clay.

About 3 miles southeast of this deposit, a 15-foot bed of sub-bentonite was encountered in a bore hole on the property of John Davis, in the SW¼, NW¼, Sec. 9, T. 10 N., R. 5 W. At this place the entire thickness is a homogeneous tan to gray, slightly arenaceous and fossiliferous, waxy-appearing sub-bentonite. Samples of this clay were found to possess bleaching properties comparable to those described above. Consequently the deposit has no commercial significance.

VICKSBURG SERIES

The Vicksburg series crops out in a narrow belt that extends from the Alabama line in northern Wayne County in a general westerly direction across Wayne, Clarke, Jasper, Smith, Rankin, Hinds, and Warren counties. The series is composed of sands, clays, marls, and limestones that have a thickness of about 185 feet near the Alabama line and probably about 145 feet in the vicinity of Vicksburg.[46] These beds have been divided,[47] from the base upward, into the Forest Hill sand (in the west)--the Red Bluff clay (in the east); the Marianna limestone; the Glendon limestone; and the Byram marl.

Rather extensive deposits of bentonite are in the Vicksburg series in Smith and Wayne counties, and lesser deposits in Jasper County. Their exact stratigraphic position is uncertain, but they are thought to be younger than the Marianna limestone. In most places in Smith and Jasper counties, the bentonite rests unconformably on the "chimney rock" of the Marianna limestone. In Sec. 9, T. 3 N., R. 7 E., Smith County, an auger hole showed the bentonite to be overlain by a fossiliferous sandy marl (Byram?). A part of the bentonite deposit on the A. P. James farm, in Sec. 32, T. 4 N., R. 6 E., Smith County, is overlain by 4 to 6 feet of alternating beds of soft marl and indurated blue-gray limestone, which is probably of Byram age. Morse[48] reports that in Smith County "these clays lie unconformably on the Byram marl and overlap the Glendon limestone and the Marianna limestone and in some instances rest upon the Forest Hill member." The writer has not observed any bentonite lying on the Byram and Forest Hill beds in this area. Ordinarily the material above the bentonite consists of red, reddish-brown, and brown sands, sandy clays, and clays, which are somewhat manganiferous just above the bentonite horizon.

The eastermost extension of the bentonite beds of the Vicksburg series is in Wayne County, where the clay is gray, more or less sandy, thick- and thin-bedded, and in some places interbedded and interlaminated with sand. Although the bentonite of Wayne County is thick and of widespread distribution, its efficiency for bleaching oil is low, and consequently these beds are of little commercial importance.

The Vicksburg bentonite of Smith and Jasper counties constitutes an extraordinarily high type of activable bleaching clay for oils and has definite commercial possibilities. After partial leaching with acid, this clay is equal to the best foreign and domestic activable bleaching clays and is far superior to some that are being marketed at the present time.

The western extension of the bentonite in Smith County comprises three chief classes--(1) a dense translucent very waxy material, which ranges from a light greenish-gray to a dark red-brown, breaks out in blocks, dries very hard, and exhibits conchoidal fracture; (2) a porous variety, usually light yellowish-gray, also in blocks, which is rather soft and commonly coated with red iron oxide; and (3) fine bentonite which consists of granular and seam material, is usually dark, and contains an excess of iron.

The dense variety (1) in many places constitutes the center of the bed; the porous type (2) the top and bottom, though masses of the porous material may be in the dense, and vice versa. C. S. Ross of the United States Geological Survey reports that microscopic examinations show that the dense material is a very fine-grained clay substance, only partly retaining the original ash structure, whereas the porous variety shows this structure clearly and consists of clay material and a glassy-appearing substance that may be zeolite (clinoptilolite?). The dense variety is chemically and mechanically tough; the porous and granular varieties yield readily to acid and grinding. The acid solubility of all three varieties is high, but that of the seam material, which is usually rich in iron, is highest of all. After acid leaching, there is little difference in the bleaching power of the three varieties, all of which become snow white.

JASPER COUNTY

The Vicksburg series crops out in a belt 3 to 5 miles wide across the southern part of Jasper County. Bentonite is known in three areas within this county--(1) a thin but rather widespread deposit about 1.5 miles northeast of Heidelberg; (2) a small deposit along the east fork of Tallahalla Creek, about 5 miles west of Heidelberg; and (3) a thin local deposit exposed in a cut on the Gulf, Mobile & Northern Railroad, north of Bay Springs.

Heidelberg area

A deposit of bentonite that covers an area of nearly 200 acres lies about 1.5 miles northeast of Heidelberg, in the SE¼, Sec. 28 and the S.½ N.½ and S.½ Sec. 27, T. 1 N., R. 13 E., on the following properties: Sec. 28, Leroy McFarland and Mrs. J. A. Taylor; Sec. 27, Mrs. N. G. Travis, W. Thigpen, K. Dease, G. Dease, H. McFarland, and T. L. Cooper.

The bentonite of this deposit is of the porous variety described above and is white to yellowish. An exposure in a road cut on United States Highway 45, 1 mile northeast of Heidelberg, shows the bentonite lying directly above the Marianna "chimney rock."

In the 176 auger holes bored in tracing out this deposit, the bed had an average thickness of 1.4 feet, an average overburden of 12.3 feet, a maximum thickness of 3 feet, and a maximum overburden of 28 feet. A bleaching test of a representative sample of the Heidelberg bentonite gave the following rating:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.3	0.5	0.5	0.5	1.8	2.4	3.0	3.6

This material is a very high type of activable clay and is well above the minimum commercial requirements.

The New Orleans & Northeastern Railroad passes within a half mile of the western extension of this deposit.

In spite of the high quality and ready accessibility of the bentonite in the Heidelberg area, the thinness of the stratum (as compared with that in Smith County) is unfavorable to commercial utilization. It is doubtful if this deposit will ever warrant any large-scale exploitation.

Tallahalla Creek area

A very small deposit of bentonite is in the valley of the east fork of Tallahalla Creek on the properties of George Green, Ed. Green, and Tom Green in parts of Secs. 33 and 34, T. 1 N., R. 12 E., Choctaw meridian, and on the farm of John Ratliff, which lies directly to the south in the northern part of Sec. 3, T. 10 N., R. 11W., St. Stephens meridian.

A good exposure of the bentonite bed is in a deep ravine 200 yards directly north of the dwelling of Ed. Green, where the following section may be seen:

Section on Ed. Green farm, in Sec. 33, T. 1 N., R. 12 E., Jasper County

		Feet
4.	Clay, red to brown sandy; becoming highly manganiferous toward the base	10
3.	Bentonite, light yellowish to tan and gray hard and brittle waxy	3
2.	Limestone, light gray soft fosiliferous "chimney rock" (Marianna limestone)	12
1.	Clay, dark blue massively bedded fossiliferous (Red Bluff)	—

Considerable prospecting was done on the Green and Ratliff properties, and the bentonite was found to be very thin and highly irregular in distribution. No oil-bleaching tests were made with this material. This deposit is of no commercial interest.

The deposit in the railroad cut north of Bay Springs was not investigated.

Detailed prospecting failed to reveal any extensive distribution of bentonite west of Tallahalla Creek in Jasper County.

SMITH COUNTY

The Vicksburg Series bears extensive deposits of very high grade activable clay in the northwestern part of Smith County. This area affords distinct commercial possibilities for large-scale production of activable clays, and mining activity is predicted for it within the near future.

At the time of this report five deposits of bentonite are known in northwestern Smith County, and additional prospecting may disclose others. The deposits are in T. 4 N., R. 6 E.; Tps. 3 and 4 N., R. 7 E.; T. 3 N., R. 8 E.; and T. 4 N., R. 8 E. (Fig. 4). They are described below.

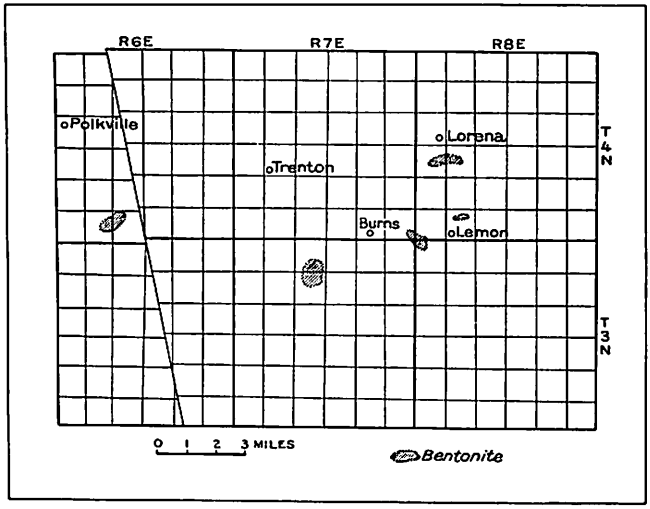

Figure 4.—Sketch map showing location of bentonite deposits in Smith County, Miss.

LORENA AREA

A deposit of bentonite covering an area of about 112 acres lies on the property of L. J. Husbands in Secs. 19 and 20, T. 4 N., R. 8 E., about a half mile south of Lorena. It is confined to the area of the Vicksburg outcrop and is thought to lie above the Marianna limestone, although separated from the limestone by intervening beds of brownish arenaceous and manganiferous clay. A typical section, as revealed in a test pit, is as follows:

Section in a test pit on the L. J. Husbands farm, Smith County

		Feet
5.	Clay, brown arenaceous; having numerous small ferruginous concretions at the top and scattered white siliceous nodules as much as 3 inches in diameter below	8
4.	Clay, mottled red and gray tough plastic very slightly arenaceous, which is highly manganiferous toward the base and which includes detrital bentonite fragments	3

3. Bentonite, light yellowish gray porous rather soft and mealy; grading downward into pale greenish gray and tan dense translucent hard and brittle very waxy material; intermixed with dark granular seam material throughout..... 4
2. Clay, yellowish brown arenaceous; manganiferous at the top..... 4
1. Limestone, soft bluish-gray..... —

Results from 110 auger holes bored in the deposit on the Husbands property show the bed to have an average thickness of 3.5 feet and an average overburden of 15.1 feet; a maximum thickness of 7.5 feet and a maximum overburden of 45 feet. It is estimated that 650,000 tons of high-grade material is readily available for mining in this deposit.

The efficiency of this material for bleaching oils is high as the following bleach ratings reveal:

	RAW				ACID-TREATED			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1.....	0.3	0.4	0.4	0.4	1.2	1.8	2.4	3.6
2.....	0.0	0.0	0.0	0.0	1.9	2.6	3.2	4.1
3.....	0.2	0.3	0.3	0.3	1.9	2.4	2.9	3.7

1. From exposure in gully west of the Husbands dwelling.
2. From auger hole in the western extension of the deposit.
3. From auger hole in eastern extension of the deposit.

Although the deposit is bisected by a good all-weather road (State Highway 35), which connects it with the town of Forest, some 12 miles to the north, the fact that the clay would have to be trucked this distance to connect with the nearest railroad is unfavorable to commercial operation. It is thought, however, that the high quality of the material and the large quantity of available clay will sufficiently offset the disadvantage of inaccessibility to make the exploitation of this deposit feasible. It is probably the best suited to commercial operation of all the bentonite beds now known in Smith County.

LEMON AREA

Bentonite was first noticed in Smith County by a party of geologists engaged in geologic mapping for Eastman, Gardiner & Co. of Laurel, Miss. This party discovered an exposure of bentonite in a

deep gully on the property of A. T. Glaze, in Sec. 32, T. 4 N., R. 8 E. Subsequent prospecting revealed a small deposit of high-grade activable clay in the area adjoining the exposure. These adjoining deposits lie about three-fourths mile north of Lemon and about 1.5 miles south of the Lorena deposit. The Lemon and Lorena deposits are not connected.

Section in a gully on the A. T. Glaze farm, Sec. 32, T. 4 N., R. 8 E., Smith County

		Feet
6.	Sand, red argillaceous medium- to fine-grained	10
5.	Clay, reddish brown and tan slightly arenaceous	3
4.	Clay, mottled pink, light gray, and black; and intercalated bentonitic layers manganiferous	1
3.	Bentonite, light yellowish to tan soft more or less porous; which grades downward into very hard and brittle light greenish-gray and tan translucent, very waxy material, which contains casts of echinoids. The bed is highly jointed, and the joint planes are usually coated with manganiferous stain	3
2.	Clay, brownish to black manganiferous, arenaceous	2
1.	Limestone, bluish gray	—

A series of auger holes on the Glaze property showed the bentonite bed to have an average thickness of 3.0 feet and an average overburden of 17.8 feet; a maximum thickness of 4.0 feet and a maximum overburden of 25.0 feet. The deposit is estimated to cover about 15 acres. Its excellent bleaching properties are revealed below:

	Raw				Acid-treated			
	GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
1	0.4	0.5	0.5	0.5	1.6	2.6	3.3	4.0
2	0.3	0.4	0.4	0.4	1.7	2.7	3.3	4.0
3	0.0	0.1	0.1	0.1	1.7	2.3	2.6	3.0
4	0.3	0.4	0.4	0.4	1.8	2.9	3.5	4.5

1. From outcrop on eastern extension of deposit.
2. From outcrop in south-central part of deposit.
3. From auger hole in western extension of deposit.
4. From "discovery" exposure.

After partial acid leaching the Glaze bentonite becomes a very excellent bleaching clay, and the deposit is worthy of commercial attention. Sample 4 is higher in bleaching efficiency than any other tested sample from Smith County.

The disadvantage of inacessibility applies to this deposit as well as to the Lorena deposit. The Lemon deposit is also bisected by State Highway 35, which connects it with the railroad at Forest, 13.5 miles to the north.

Burns area

Two large deposits of bentonite are in the vicinity of Burns, one about 1.5 miles to the east of the village and the other 2 miles to the southwest.

The deposit east of Burns is in the SE¼ Sec. 36, T. 4 N., R. 7 E.; the SW¼ Sec. 31, T. 4 N., R. 8 E.; the NW¼ Sec. 6, T. 3 N., R. 8 E.; and the NE¼ Sec. 1, T. 3 N., R. 7 E. It is on farms owned by J. L. Hegwood, Oliver Burns, A. W. Stennett, John Barnes, John Barnes, Jr., and E. N. Currie, Jr. The extent of this deposit is unknown, but it is believed to cover more than 100 acres, and the thickness is known to reach 6 feet. Much of the deposit is covered by only a slight over burden.

Representative samples from this deposit give the following bleach ratings:

	Raw		Acid-treated	
	GR.	BL.	GR.	BL.
Oliver Burns	0.3	0.4	1.1	2.8
J. L. Hegwood	0.2	0.3	1.7	3.9
John Barnes	0.2	0.3	1.7	3.0
A. W. Stennett	0.2	0.3	1.5	3.2

These bleach ratings indicate that the bentonite is a high type of activable clay; that it has distinct commercial possibilities. The nearest railroad point is Forest, about 15 miles away.

The second deposit of bentonite in the Burns area lies on cut-over timber lands belonging to Eastman, Gardiner & Co. of Laurel, and the Edgar Adams Lumber Co. of Morton, in parts of Secs. 4 and 9, T. 3 N., R. 7 E. The limits of the deposit have not been determined, but they

are known to embrace an area at least 3,000 feet long by 1,000 feet wide. Additional prospecting will probably show even greater dimensions and will possibly prove this deposit to be the largest in Smith County.

A considerable portion of the deposit lies under an overburden that does not exceed 15 feet and that probably averages about 4 feet in thickness. A part of the eastern extension of the bed is overlain by bluish-gray limestone which is thought to be of Byram age.

The bentonite consists typically of light- to greenish-gray, hard and brittle, dense waxy more or less translucent material. The uppermost fraction is somewhat soft and mealy. On the outer edges the deposit is considerably iron-stained.

The high oil-bleaching efficiency of this bentonite is shown in the following bleach tests of two samples from bore holes in the western extension of the bed:

Raw		Acid-treated	
GR.	BL.	GR.	BL.
0.2	0.3	1.1	3.9
0.2	0.3	1.2	4.1

This deposit, which can be reached only by an abandoned logging trail, is several miles from an all-weather road. Its nearest railroad is at Forest, about 16 miles away. Thus it is the most inaccessible of all the Smith County deposits.

A single auger hole west of this deposit, on the west side of Little Oakohay Creek, revealed 3 feet of bentonite which is similar in appearance to that east of the Creek. Its limits have not been determined.

Polkville area

A large deposit of bentonite lies about 3 miles southeast of Polkville in Secs. 32 and 33, T. 4 N., R. 6 E., just north of Strong River, on the properties of A. P. James, C. Hughes, P. C. Duckworth, W. F. McNeece, A. F. Arinder, and the Edgar Adams Lumber Co. Its limits are unknown, but about 100 acres of the Hughes and James farms are reported to be underlain by bentonite. The entire deposit probably covers an area several times that large.

On the Hughes and James properties, the stratum has an average thickness of about 3 feet and a probable average overburden of 17 or 18 feet. The maximum thickness of bentonite is reported to be about 6 feet, and the greatest overburden is slightly over 50 feet. A portion of the bed on the A. P. James farm is overlain by 4 or 6 feet of alternate soft marl beds and hard limestones (Byram?).

A sample from the middle of a 3-foot bed exposed in a prospect pit on the James property in Sec. 32, T. 4 N., R. 6 E., yielded the following bleach ratings:

Raw		Acid-treated	
GR.	BL.	GR.	BL.
0.3	0.4	1.3	4.3

This is a very high type of activable clay and warrants commercial attention.

The nearest railroad is at Morton, about 16 miles to the north, and the connecting roads are poor. Inaccessibility is, therefore, the only feature unfavorable to commercial activity in this area.

WAYNE COUNTY

Numerous good exposures of bentonitic clay are in the area of the Vicksburg outcrop in T. 9 N., Rs. 5 and 6 W. in Wayne County. A cursory investigation of this area indicated that these clays extend over several hundred acres, have thicknesses of as much as 20 feet, and have a slight overburden.

The Wayne County bentonite is gray to slightly brownish, massively bedded, hard and brittle, arenaceous, in some places argillaceous, and exhibits conchoidal fracture. During the period of ash accumulation in this area non-ashy materials (sand and clay) were contributed to the site of deposition and were intermixed with the ash that subsequently became bentonite. The admixed nonvolcanic materials are apparently not activable and greatly reduce the efficiency of the clay for oil bleaching. The Wayne County bentonite is distinctly inferior to the beds of the same age in Smith and Jasper counties.

Bleach ratings of several typical samples of the Vicksburg bentonite from Wayne County are given below:

	RAW	ACID-TREATED
	GR.	GR.
1	0.2	1.3
2	.2	1.1
3	.2	1.2
4	.1	1.1
5	.2	1.2
6	.1	1.1

NOTE: Bleach rating is for the first appearance of green only.

1. Auger sample,composite of a 6-foot bed, J. Jordan farm, Sec. 4, T. 9 N., R. 6 W.
2. Sample from exposure on the same property, middle of an 8-foot bed.
3. Auger sample, composite of a 10-foot bed, NW¼, NW¼ Sec. 30, T. 9 N., R. 6 W.
4. Auger sample, composite of a 14-foot bed, 0.3 mile south of Tokio on Waynesboro road.
5. Auger sample, composite of a 4-foot bed, 0.4 mile south of Tokio on Waynesboro road.
6. Auger sample, composite of a 13-foot bed, 0.4 mile east of Tokio.

The southern extremity of the bentonite area is about 8 miles north of Waynesboro, which is the nearest railroad point. Owing to inferiority of bleaching qualities, it is believed that the bentonite of this area cannot compete with that of the same age to the west.

CATAHOULA SANDSTONE

Rather extensive deposits of naturally active clay have been reported from the Catahoula sandstone of Smith County. The present investigation did not include a study of this formation, but a single sample from the "fuller's earth" deposit near Mize, in Smith County, was submitted to the United States Geological Survey for examination. This sample which is soft and powdery and does not lend itself to granulation--a necessary property of clays to be used in the natural state for the bleaching of oil--gave the following bleach rating:

Raw				Acid-treated			
GR.	YEL.	RED	BL.	GR.	YEL.	RED	BL.
0.4	0.6	0.7	0.8	0.5	0.6	0.7	0.9

The test shows the clay to be very low in bleaching power and not to be of commercial value.

SUMMARY AND CONCLUSIONS

The bleaching clays of the State of Mississippi that show most commercial promise are those of the activable type.

Such clays are in the Eutaw formation (Upper Cretaceous), the Porters Creek clay (Lower Eocene), the Jackson formation (Upper Eocene), and the Vicksburg series (Oligocene). Of these activable clays that meet commercial qualifications are the Eutaw and Vicksburg bentonites.

Of these commercial clays in turn, the uppermost of the three Eutaw bentonites--that of the Coffee sand member--is better adapted to commercial utilization than the other two; and, so far as known, the Vicksburg bentonite is the best activable clay of them all.

The uppermost Eutaw bentonite crops out in Prentiss County, where a small mine is in operation 5 miles south of Booneville. The Vicksburg bentonite in Smith County offers excellent mining opportunities. And the most promising Smith County bentonites are those in the Lorena, Burns, and Polkville areas.

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