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STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY REPORT
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This study of the stratigraphy of the Midway and Wilcox groups of Alabama and Mississippi was part of the extensive bauxite investigations carried on by the Geological Survey and the Bureau of Mines of the United States Department of the Interior in 1942 and 1943. The stratigraphic study was undertaken to determine in what formation or formations the bauxite deposits occur, under what paleogeographic conditions the bauxite-bearing formations were deposited, and when and under what conditions the bauxite was formed.

The results show that: 1. In eastern Alabama and in nearby Georgia, bauxite is found in lenticular clays in a nonmarine facies of the Nanafalia formation, of early Wilcox age. There is some indication that the clays are equivalent to clays in the lower part of the marine facies of the Nanafalia formation. In Mississippi, bauxite is found in conglomeratic nonmarine clays of the basal Fearn Springs sand member of the Wilcox formation, an horizon about equivalent to or possibly a little lower than that of the Alabama bauxite deposits, and it is also found in the Betheden formation, which consists of massive to conglomeratic kaolin, bedded to conglomeratic lignite and carbonaceous shale, fine sand, and, rarely, bentonite. The Betheden formation lies between the top of the marine Midway and the coarse sands generally regarded as the base of the Wilcox. In the columnar diagram the Betheden is shown as upper Midway, but it may represent a swampy coastal deposit of early Wilcox age that preceded deposition of the coarse sands. To a lesser extent, hauxitic clay is found in the upper part of the Porters Creek formation which underlies the Betheden. 2. Both marine and nonmarine facies are included in the present outcrop of the Nanafalia formation. Lines A-B and C-D on the index map indicate the approximate position of the strand line of the Nanafalia sea. Outcrops on the north, or landward, side of this strand line are nonmarine and bauxite-bearing. Outcrops on the south, or seaward, side are marine and contain no bauxite. 3. No bauxite or bauxitic clay in this region occurs in beds younger than early Wilcox.

It is thought that the formation of bauxite took place under subaerial conditions on the coastal plain, or in regions immediately adjacent to the coastal plain, of the Nanafalia sea, and that this formation may have taken place while the youngest clay of Wilcox age was being deposited, or shortly thereafter, and before any substantial amount of overburden had accumulated. It is also believed that certain conditions of climate and topography existed at that time which favored the formation of bauxite, and that these conditions affected whatever clays were exposed within the area where these physiographic conditions obtained. Thus, in addition to the Tertiary clays, it is possible that the much older clays in the Tuscaloosa group (Upper Cretaceous), as well as residual clays in areas of Paleozoic or other rocks, were exposed on this surface and subjected to the special physico-chemical conditions that altered them to bauxite.

General considerations regarding the source and formation of bauxite

The physico-chemical aspects of the alteration of kaolin to bauxite, or of montmorillonite to bauxite, perhaps with kaolin as an intermediate product, are beyond the scope of this study. Considerable attention has been paid, however, to the physical state of the clays, the paleogeographic or paleoecologic conditions under which they were deposited, and the probable geologic conditions or events have affected them since their deposition.

In eastern Alabama and western Georgia the bauxite apparently was formed by alteration in place of bedded or lenticular kaolin, as in practically all deposits there is a transition laterally or vertically from high-grade ore into kaolin. The bauxite of Kemper, Noxubee, and Winston Counties, in central Mississippi, on the other hand, is definitely derived from clay conglomerates, as there is a lateral transition from hard bauxite to soft conglomeratic kaolin; and clay-ball conglomerates occupy the same stratigraphic position as bauxite in sections close to bauxite deposits. In northern Mississippi, in Tippah, Benton, Union, and Pontotoc Counties, somewhat intermediate conditions exist, and both conglomeratic clay and maxxive kaolin occur in the bauxite-kaolin zone.

Both the conglomeratic bauxite of Mississippi and the bauxite of Alabama are called "pisolitic," but there is strong reason to doubt that the so-called pisolites are of the same origin in both areas. The pisolites in the Alabama bauxite may be the product of shrinkage or of concretion-forming processes, but the "pisolites" of the Mississippi deposits appear to be largely altered clay balls. The conglomeratic nature of the Mississippi bauxite is inferred from the fact that at some places the matrix is more silty or sandy than the conglomeratic particles and at other places the particles are more silty or sandy than the matrix. Commonly the more massive clays of northern Mississippi have a scattered "pisolitic" texture, but on close examination the balls are found to be rounded lumps of fine sand or fine sandy clay.

All of the conglomeratic bauxite that the writer has seen seems to have been formed from tightly packed conglomerates in which the clay or sandy clay matrix is no more permeable than the massive clay lenses of eastern Alabama and Georgia. In no case do loose clay-ball conglomerates with open air spaces or clay balls scattered in sand appear to be anything but kaolin. Whether derived from massive or conglomeratic clays, therefore, the east Alabama and Mississippi bauxite deposits have one thing in common, the clays from which they were formed were of very low permeability.

The bauxite and bauxitic clay of Mississippi, Alabama, and Georgia occur in deposits that certainly did not accumulate in the open ocean, though they may have formed in coastal lagoons. They are always found shoreward from the marine deposits, and the clay bodies in which they are included are decidedly more lenticular than those in the marine section. Deposition under nonmarine conditions is also indicated by the frequent occurrence of lignite both above and below the bauxite.

There is little to indicate that the formation of bauxite was related to any particular geologic event. Probably the desilicification of the clays was a special physic-chemical process made possible by the as yet undetermined conditions of climate and ground water. The theory that sink holes are a factor in the formation of bauxite deposits has been advocated almost since they first received the attention of geologists. The eastern Alabama area, probably as much as any other, has been greatly disturbed by sink-hole development in the underlying limestone of Midway age. A preliminary examination of many bauxite mines in the area might suggest that these sinks were the paths by which surface water percolated downward, and in so doing leached much of the silica from the clays filling the sinks. Some of the newer and larger mines, however, show little or no distrubance of either the bauxite or the overlying beds, and apparently the underlying limestone is undissolved. This, and the fact that in the Andersonville district of Georgia, where the stratigraphic sequence that includes the flat-lying bauxite-bearing beds is the same as that in the areas of disturbance, the underlying limestone is undissolved, strongly suggest: (1) that sink holes had nothing to do with the formation of the bauxite; (2) that the bauxite of the Barbour-Henry County region of Alabama and that of the Andersonville district of Georgia were both formed before the solution of the limestone; and (3) that the great distrubance of the Barbour-Henry County bauxite took place after its formation as a result of solution in the more than 100 feet of limestone below it.

Stratigraphy

The results of this study are shown in the two accompanying charts: one a correlation chart for the Midway, Wilcox, and lower Claiborne deposits; the other a columnar diagram showing the best of the measurable sections, both individual and composite, of the Midway and lower Wilcox deposits of Alabama and Mississippi.

The correlation and nomenclature herein used differ in some respects from that formerly accepted by the Geological Survey and the respective State Surveys. The most important changes affect the Wilcox. The Meridian sand, regarded by the Geological Survey as the basal member of the Tallahatta formation of lower Claiborne age, was found by the writer to pass into the lower part of the Holly Springs sand of northern Mississippi, formerly regarded as of Wilcox age by both the Mississippi and the Federal Geological Surveys. From this evidence both the Mississippi Geological Society and the Federal Geological Survey abandoned the name Holly Springs in favor of Tallahatta for all of Mississippi on the new (1945) geologic map of Mississippi. They also abandoned the name Ackerman formation in favor of Wilcox formation for use in Mississippi, following the common usage of petroleum geologists.

The lower unfossiliferous sands and lignite of the Bashi formation, as that formation was formerly defined in Alabama, are included in the underlying Tuscahoma sand, and the name Bashi is restricted to the upper fossiliferous greensand bed formerly taken as the top of the Bashi formation. The Bashi, as now restricted, is made the basal member [Bashi marl member] of the Hatchetigbee formation. These changes are made because of (1) the restricted occurrence of the lignite zone formerly taken as the base of the Bashi formation, (2) the lack of any persistent lithologic difference between the lower part of the Bashi (as formerly defined) and the underlying Tuscahoma, and (3) the close affinity between the fauna of the greensand of the Bashi and that of the overlying marls of the Hatchetigbee formation.

The Fearn Springs formation of the Missippi Geological Survey is recognized in this report as the basal member of the Wilcox formation of Mississippi. On being traced eastward the Fearn Springs sand member was found to be equivalent to the upper coarse sands of the Coal Bluff beds of Brantly in Alabama. The name Fearn Springs is therefore extended into Alabama to include these coarse sands, and the Fearn Springs sand member in Alabama is made the basal member of the Nanafalia formation of Wilcox age. The lower fossiliferous glauconitic sands and shales of Brantly's[1/] Coal Bluff beds are referred to the Midway on faunal evidence. The Ackerman formation, as previously recognized by the Federal Geological Survey in Alabama, was not definitely defined, but presumably it is a direct equivalent of Brantley's Coal Bluff beds. If so, the Fearn Springs sand member of the Nanafalia formation is the upper part only of the Ackerman formation, as used in Alabama. It is the basal part of the Ackerman formation as that formation has been defined in Mississippi.

In the Midway group the following changes are made: The lower glauconitic sands and shales of Brantly's[2/] Coal Bluff beds are designated the Coal Bluff marl member of the Naheola formation and assigned to the upper Midway. Not all the paleontologists who have examined the fauna of the Coal Bluff marl concurred in this assignment, but the majority favored a Midway age.

The Betheden formation, as used by the Mississippi Geological Survey, is here adopted. The exact correlation of the Betheden formation is in doubt because of its disconnected occurrences. It lies between marine beds of the Midway group and the lowest coarse sands of the Fearn Springs sand member of the Wilcox formation. It may be a nonmarine lagoonal equivalent of some part of the Naheola formation, or it may represent lagoons present at the beginning of Wilcox time over which the sands of the Fearn Springs were deposited.

1/ Brantly, J. E., Petroleum possibilities of Alabama, Pt. 2: Geol. Surv. Ala., Bull. No. 22, pp. 148-152, 1920.

2/ Op. Cit., pp. 148-152.

In this report the term Naheola formation is applied only to that part of the Midway group which lies above the Matthews Landing marl member of the Porters Creek clay. The Naheola includes the Coal Bluff marl member at the top and the underlying sands and shales.

The Matthews Landing marl is transferred from the Naheola formation to the Porters Creek clay, and is made to include all of the beds down to the top of the prairie-forming clay of the Porters Creek. The Matthews Landing is thus made to include the Graveyard Hill section of Smith[3], Johnson, and Langdon, which is generally referred to the Blacks Bluff interval, or Porters Creek. These changes are made because the top of the Matthews Landing marl member is sharply defined, whereas, especially in central Alabama where it attains its maximum development, there seems to be no definite line to separate it from the beds represented in the Graveyard Hill section. An interval of fossiliferous marls, sands, and sandy limestones with definite upper and lower boundaries is thus differentiated between the massive lower clay of the Porters Creek and the lower barren shales and sands of the Naheola.

The Tippah sand of northern Mississippi, formerly correlated with the Naheola formation, was found to underlie the main body of the Porters Creek clay. It is accordingly designated the Tippah sand lentil of the Porters Creek clay.

The term Clayton formation is retained with most of its former loosely defined boundaries. One minor change is made by including in the Clayton in northern Mississippi a bed of calcareous siltstone formerly regarded by the Mississippi Geological Survey as the base of the Porters Creek clay. This is done to make the base of the clay consistently the base of the Porters Creek in Mississippi, and also it is done because this siltstone carries the large nautiloid, Hercoglossa ulrichi, a marker for the upper part of the Clayton in central Alabama. Three new members representing regional facies or having distinctive lithology are differentiated in the Clayton.

In the region of the type locality in eastern Alabama the Clayton formation certainly includes the equivalent of the clay beds of the Porters Creek, and possibly includes the equivalent of the lower part of the Matthews Landing marl member of the Porters Creek. To the west the exact equivalence of the upper part of the Clayton formation of eastern Alabama is difficult to determine owing to the deep weathering of exposures in eastern Butler, Crenshaw, Pike, and Butler Counties, Ala. Fossils from the upper clays and marls in those counties, however, have been identified as of middle Midway (Graveyard Hill) age.

3/ Smith, E. A., Johnson, L. C., and Langdon, D. W., Report on the geology of the Coastal Plain of Alabama: Geol. Surv. of Ala., pp. 190, 493, 494, 1894.

If the Midway group were to be subdivided here for the first time, the writer would probably not treat the Clayton formation as he does. It was the feeling of several geologists with whom the writer discussed this problem, however, that the concept of the Clayton should not be changed. Actually the name Fort Gains limestone has priority over Clayton.

Midway group

Clayton formation

The type locality for the Clayton formation is a cut on the Central of Georgia Railroad about 1 mine east of Clayton, Barbour County, Ala. East of Butler County, Ala., the name is used for all of the Midway beds. In Butler County and westward in Alabama and Mississippi it is used only for the beds below the Porters Creek clay. The name McBryde limestone member is proposed for the characteristic upper limestone or "Nautilus rock" of the Clayton in Butler and Wilcox Counties, Ala., and the name Pine Barren member for the underlying member, a sequence of sands and marls with several layers of hard, crystalline "Turritella rock." To the west--western Alabama and Mississippi--the Clayton is represented by a single unit, the Chalybeate limestone member, composed of limestone, chalk, sand, and shale. In western Alabama and east central Mississippi the Clayton thins to just a few feet and may actually be overlapped by the Porters Creek clay in places. From Chickasaw County northward in Mississippi, however, the formation again thickens and in northern Mississippi is probably more than 60 feet thick.

At Clayton, Ala., the section consists of a lower zone of about 35 feet of sand and limestone, grading from non-calcareous, Halymenites-bearing sand at the base, through coarse sandy limestone to sand-free, hard, white limestone at the top; and an upper zone of about 15 feet of hackly gray clay that has been unsuccessfully mined for fullers earth. The formation thickens eastward to nearly 130 feet on the Chattahoochee River, where the upper clay is represented by smooth-textured argillaceous limestone. Most exposures away from the rivers, however, show only compacted sand, residual from the solution of the limestone, and crumpled clay. Most of the crumpling is due to the complete solution of the non-clastic zone in the limestone immediately below the clay.

Down-dip exposures of the Clayton formation on the Pea River in eastern Alabama show several feet of glauconitic, sandy limestone and glauconitic clay overlying the hackly clay. Fossil mollusks from a weathered limestone ledge well up in this clay near Brundidge, Pike County, Ala., were identified by Julia Gardner, of the Geological Survey, as similar to forms in the Graveyard Hill fauna of Wilcox County. This identification suggests that the upper part of the Clayton of eastern Alabama is equivalent to at least a part of the Matthews Landing marl member of the Porters Creek clay of western Alabama and Mississippi. Although the base of the upper clay of the Clayton in the type section in eastern Alabama has always been regarded as equivalent to the base of the Porters Creek clay in western Alabama, it is extremely difficult to trace this horizon through at the surface. The clay member of the Porters Creek thins in Butler County, central Alabama, and passes eastward into the middle part of limestone exposed near Rutledge and Luverne in Crenshaw County. This middle part of the limestone near Rutledge is very argillaceous and contains less than 25 percent calcium carbonate. It weathers to a sticky gray clay. The upper part of the limestone near Rutledge and Luverne is sandy and glauconitic and weathers to brown ferruginous sand, often of sufficiently high limonite content to be mined commercially. This sandy limestone is the exact equivalent of the Matthews Landing marl member of the Porters Creek clay to the west. Eastward the argillaceous limestone and the sandy limestone pass into the upper, predominantly argillaceous part of the Clayton formation. The lower part of the limestone near Rutledge and Luverne is a shell-bryozoan coquina rock with a little or no earthy matrix. It becomes sand in the lower part and passes imperceptibly into loose sand below. This limestone undoutedly connects at least the upper part of the McBryde limestone member of the Clayton recognized to the west with the upper non-sandy limestone of the type section of the Clayton formation. Due to solution this zone of pure limestone is almost never seen, but its solution undoubtedly accounts for the apparent settling and slight crumpling at the base of the clay throughout eastern Alabama, and the irregular contact of this clay on the underlying sand. This would indicate quite clearly that the base of the clay in the Clayton type section does correspond to the base of the Porters Creek clay to the west.

McBryde limestone member.--The name McBryde limestone member of the Clayton formation is proposed for the Nautilus rock of early authors, so called because of the abundance of the large nautiloid, *Hercoglossa ulrichi*. The type exposures are in road cuts along State Highway 100 in secs. 28 and 33, T. 12 N., R. 10 E., Wilcox County, Ala., about 3 miles west of McBryde station. In its type area it is a hard, white, fine-grained, sandy limestone, 20 to 25 feet thick. It directly overlies the crystalline, *Turritella*-bearing limestone of the Pine Barren member of the Clayton, and is overlain by a calcareous tongue of the Porters Creek clay. Thin ledges of limestone similar to the McBryde limestone are interspersed through several feet of the overlying Porters Creek clay. To the east, in Butler County, the McBryde thickens to about 100 feet, breaks up into shaly and more sandy beds with concretionary layers, and still farther east passes into limestone of the middle part of the undifferentiated Clayton formation. Westward the McBryde limestone member thins and becomes more argillaceous. It loses its distinctive lithologic character in western Wilcox County.

The westward correlation of the McBrude limestone member of the Clayton between the locality represented by section 54, in Sumter County, Ala., and that of section 69, in Wilcox County, Ala., is uncertain. Exposures of the McBryde in northwestern Wilcox County and in Marengo County, Ala., are poor, and traceable key beds are lacking. The beds assigned to the Clayton become thinner to the west. Furthermore, at Moscow bridge in Sumter County, Ala., and from there westward, a zone in the Clayton carrying abundant *Ostrea pulaskensis* lies just a few feet above the Cretaceous. In Wilcox and Butler Counties, Ala., the greatest concentration of this species is in the lower part of the McBryde limestone member and the upper part of the Pine Barren member, 80 feet or more above the base of the Midway group, although it is found less abundantly at higher and lower horizons. On the other hand, opposed to the above evidence of a thinning of the Clayton and overlap by the Porters Creek are the electric logs of wells recently drilled in Wilcox and Marengo Counties, Ala., and in several eastern Mississippi counties. These logs show "kicks" in the Porters Creek clay comparable to those that are caused by identifiable beds in the Pine Barren and McBryde limestone members of the Clayton in the McWilliams No. 1 well at Oak Hill in Wilcox County, and they suggest that the sandy beds in these members (Pine Barren and McBryde) pass into silt zones in the Porters Creek clay to the west, rather than that these members thin below it. If the latter is true, it means that the Chalybeate limestone member to the west is equivalent to only a lower part of the Pine Barren member rather than to the Pine Barren and McBryde limestone members combined. The writer is strongly of the opinion that the latter interpretation is incorrect.

Pine Barren member.--The name Pine Barren member is here proposed for the lower member of the Clayton formation in Wilcox and Butler Counties, Ala. The member can be traced as a distinct unit across most of Crenshaw County, but can not be differentiated from the rest of the Clayton formation east of Crenshaw County.

The type exposures of the Pine Barren member of the Clayton are in the road cuts and ditches on the south side of Pine Barren Creek, along State Highway No. 100, from the southern junction with State Highway No. 11 to the bed of the creek at McConnicos Mill in the SE$\frac{1}{4}$ sec. 21, T. 12 N., R. 10 E., Wilcox County, Ala. The lower beds of the member are well exposed in cuts along State Highway No. 43 in secs. 27 and 28, T. 13 N., R. 9 E., Dallas County, Ala., and on the road descending the bluff to old Canton Landing on the Alabama River in Wilcox County. The "Turritella rock of Smith 4/, Johnson, and Langdon--a hard, crystalline, very fossiliferous, coarse, sandy limestone about 8 feet thick--forms the top of the Pine Barren member of the Clayton. Below this "Turritella rock" is a sequence consisting of limestone, sandy clay shale, and loose to moderately porous, to tight, fine-grained calcareous sand. Beds of crystalline Turritella-bearing limestone occur at several levels in these lower beds. A coarse-grained, sandy, channel limestone or calcareous sand occurs sporadically at the base.

The thickness of the Pine Barren member of the Clayton formation, derived by adding the greatest measured thickness of individual beds, is about 175 feet. There is evidence, however, that the beds thin and thicken at the expense of each other and that the actual thickness may be nearer 100 feet. Careful study of cuttings from the McWilliams No. 1 well at Oak Hill, close to the type locality, should give an accurate measurement for this member. The "Turritella rock" at the top was regarded by Smith 4/, Johnson, and Langdon as the base of the Midway

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4/ Op. cit., pp. 193-198.

group and the beds below were placed in the Cretaceous. They were first placed in the Tertiary by Harris, who included them in his Midway group. Hercoglossa ulrichi occurs throughout this member, but is less abundant than in the McBryde limestone member of the formation. The possibility of an alternative correlation between the localities represented by sections 54 and 69 in the columnar diagram is included in the discussion of the McBryde limestone member of the Clayton.

Chalybeate limestone member.--The name Chalybeate limestone member is proposed to designate those beds of the Clayton formation that are in Mississippi and west of the Tombigbee River in Alabama. The type locality is a ravine just north of the main street of Chalybeate, probably in the south-center of sec. 3, T. 2 S., R. 4 E., Tippah County, Miss. The member is about 80 feet thick at this locality but thins southward to less than 10 feet in Clay County, Miss. From there, southeastward along the strike to the Tombigbee River, it thickens to about 25 feet.

The member contains hard, crystalline, extremely fossiliferous limestone; interbedded soft to tough marls; dark leaf-bearing shales; glauconitic sand; and a fossiliferous siltstone at the top. The leached appearance of sand near the top suggests that part of it may have been calcareous sand or sandy limestone.

In the county reports of the Mississippi Geological Survey for Tippah, Union, and Pontotoc Counties, the Clayton formation is divided into two unnamed members; a basal limestone and marl member, and an upper marl, clay and sand member. The highest fossiliferous siltstone here included in the Chalybeate limestone member was regarded as the base of the Porters Creek clay in the Mississippi reports. It is here included in the Clayton formation in order to make the base of the clay the base of the Porters Creek throughout Mississippi, and because it contains Hercoglossa ulrichi, the large nautiloid that characterizes the McBryde limestone and Pine Barren members in central Alabama, but which has not been observed to range higher.

The hard, crystalline limestone that forms part of the Chalybeate limestone member of the Clayton in northern Mississippi is very sandy and weathers to a reddish-brown sand with little loss in volume. This sandy zone thins southward from the type area, becomes less calcareous, and pinches out in Chickasaw County, Miss. The sand recurs sporadically south of this as a channel-filling, basal sandstone, and a similar channel sand occurs at the base of the Pine Barren member in Wilcox County, Ala. In places in northern Mississippi the channel sand, as well as the base of the sandy limestone, carries an abundance of reworked Cretaceous fossils, usually phosphatic, but in some areas in northern Mississippi they are beautiful beidellite replacements.

From Chickasaw County, Miss., to the Tombigbee River the beds referred to the Chalybeate limestone member of the Clayton, above the basal sandstone, are glauconitic sandy to silty chalks and calcareous clays with beds or reefs of the small oyster, Ostrea pulaskensis. There are no key beds that can be traced through or that would suggest a direct correlation with the named members or parts of them in central Alabama. As pointed out in the discussion of the McBryde limestone member, the correlation between the localities represented by sections 54 and 69 is uncertain, and electric logs suggest that the Chalybeate limestone member may include the equivalents of only the lower beds of the Pine Barren member, and that the higher beds of the Pine Barren and McBryde limestone members may grade laterally into the Porters Creek clay.

Porters Creek clay

The Porters Creek clay is named from exposures on Porters Creek, west of Middleton, Hardeman County, Tenn. In addition to the typical clay facies it includes the Tippah sand lentil in the lower part, in the northern part of Tippah County, Miss., and the Matthews Landing marl member at the top, from Winston County, Miss., to Butler County, Ala. At the outcrop in northern Mississippi the Porters Creek is about 200 feet thick, but it thickens southward in the subsurface to about 600 feet. It is typically a dark, sparsely to moderately silty and micaceous, montmorillonitic, marine clay, with conchoidal fracture and scattered glauconite zones and lime nodules. The highest beds are laminated and sandy and have a considerable number of ferruginous indurations along sand partings. Large flattened concretions of siderite that alter to limonite upon exposure are common in the upper part. In many sections in northern Mississippi the laminated sandy clays at the top of the Porters Creek are leached white.

The typical clay facies of the Porters Creek clay extends from southern Illinois and southeastern Missouri to the Tombigbee River in western Alabama. East of the Tombigbee River the clay becomes decidedly calcareous and thins between the thickened Clayton formation below and the thickened Matthews Landing marl member of the Porters Creek above. This calcareous clay is responsible for the narrow band of clay prairie, or "flatwoods," in Marengo, Wilcox, and western Butler Counties, Ala. In Butler County the Porters Creek clay is less than 20 feet thick. Equivalent beds east of Butler County are included in the Clayton formation. The algal limestone at Rutledge, Crenshaw County, Ala., a very argillaceous limestone which is characterized by large umbrella-shaped calcareous algae and which weathers to a sticky gray clay, is the eastward extension of clay facies of the Porters Creek. The name Sucarnoochee clay, formerly used for the entire Porters Creek clay of western Alabama as well as for the calcareous clay east of the Tombigbee River, has been abandoned.

Tippah sand lentil.--Although no type locality was designated for the Tippah sand lentil of the Porters Creek clay, exposures on the south side of the valley of Hurricane Creek in the SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 12, T. 2 S., R. 3 E., Tippah County, Miss., might be so regarded. The lentil consists of loose, white to yellow, glauconitic, Halymenites-bearing sand with some calcareous ledges, especially at the top and bottom. The Tippah sand lentil was formerly believed to lie at the top of the Porters Creek and was correlated with the Naheola formation of Alabama. Actually it lies near the base of the Porters Creek and is lower stratigraphically than the type exposures of the Porters Creek clay. It is here regarded as a lentil in the Porters Creek clay. References have been made in the literature to several of these sand lenses in Tennessee, but only one sand lens is present in Mississippi.

Matthews Landing marl member.--The Matthews Landing marl is here removed from the Naheola formation and made an upper member of the Porters Creek clay, and it is here emended to include the upper marls and limestones of the Graveyard Hill section of Smith 5/, Johnson, and Langdon in central Alabama. The member takes its name from old Matthews Landing on the Alabama River, in the northern part of sec. 12, T. 12 N., R. 6 E., Wilcox County, Ala. The beds at Matthews Landing are equivalent to the fossilferous zone at Naheola Bluff, on the Tombigbee River. In central Alabama the member consists of glauconitic sandy marl, sand, and limestone, but west of the Alabama River it becomes a sandy glauconitic clay that on weathering forms considerable concretionary limonite. The Matthews Landing marl member extends from Winston County, Miss., to eastern Butler County, Ala., where it is last definitely recognized. If there are equivalent beds to the east, they are included in the Clayton formation. West of the Tombigbee River the member is between 3 and 8 feet thick, but east of the Tombigbee it thickens and in eastern Wilcox County is about 100 feet thick. Smith 6/, Johnson, and Langdon believed that the upper marls and limestones of their Graveyard Hill section, here included in the Matthews Landing marl, pass to the west into the upper part of the "Black Bluff" or Porters Creek clay. The writer has found, however, that the line of demarcation between the upper marl facies and the lower clay facies remains fairly sharp, suggesting that the marls and limestones do not pass into clay, but that the entire member as here interpreted thins to the west.

Although the inclusion of the marls of Graveyard Hill in the Matthews Landing marl had not been definitely proposed, it has been common practice not to differentiate them in the subsurface. For example, the Alabama Geological Survey's interpretation of the McWilliams No. 1 well at Oak Hill, which was only about 2 miles from Graveyard Hill, refers all marls down to the clay of the Porters Creek clay to the Naheola formation.

The Matthews Landing marl has generally been included in the Naheola formation, but V. M. Foster 7/ in a recent report on the geology of Lauderdale County, Miss., regarded the interval as at the top of the Porters Creek clay. The difference between the Matthews Landing marl and the Naheola formation is very apparent in Mississippi where the Matthews Landing marl is sombre and clayey like the underlying Porters Creek clay, whereas the Naheola above is largely loose yellow to white sand.

5/ Op. cit., pp. 190, 191.

6/ Op. cit., pp. 188-192.

7/ Foster, V. M., Geology, in Lauderdale County Mineral Resources: Mississippi Geol. Survey Bull. 41, p. 25, 1940.

It is the writer's opinion that where two formations are recognized within a wholly conformable sequence, the boundary should be drawn at a line that is sharp, recognizable, and persistent. The contact of the Matthews Landing marl with the overlying shales and sands of the Naheola formation is always sharp, whereas the position of the base of the Matthews Landing marl, as that member was formerly interpreted, was very much a matter of opinion. The base as here defined is more definite, although in some sections there is a transition through 2 or 3 feet. The writer proposes, therefore, that the base of the Naheola formation be drawn at the base of the barren shales, that the Matthews Landing marl be made to include the upper marlsand limestones of the Graveyard Hill section of Smith[8], Johnson, and Langdon, and that as thus defined the Matthews Landing marl constitutes the uppermost member of the Porters Creek clay.

Although the separation of the Matthews Landing marl from the Naheola formation might seem undesirable to palentologists, to whom the Naheola has been the fossiliferous Matthews Landing marl, it should make little difference to field geologists, to whom the Naheola has always been the thick section of barren shales and sands. The Matthews Landing, as formerly interpreted, is thin and seldom seen, whereas the overlying shales of the Naheola are conspicuous for the steep topography and excellent sections they provide nearly everywhere.

Naheola formation

The Naheola formation is named from Naheola Bluff, on the Tombigbee River in the SE$\frac{1}{4}$ sec. 30, T. 15 N., R. 1 E., Choctaw County, Ala. The formation is here restricted to the sand and shale beds above the Matthews Landing marl member of the Porters Creek clay. The lower glauconitic sands and shales of the Coal Bluff beds of Brantly[9], in western Alabama, are added at the top as the Coal Bluff marl member of the Naheola.

The author believes that the Naheola formation is generally absent east of central Butler County, Ala., although a few feet of fine gray sand immediately underlying the Nanafalia in a few outcrops near Henderson in southwestern Pike County may represent it. In eastern Butler County it is a silty clay-shale bed less than 10 feet thick, which thickens westward to about 30 feet in easternmost Wilcox County. Farther west, sand laminae develop in it, thickening rapidly to sand beds; the whole formation thickens to nearly 160 feet near Oak Hill in eastern Wilcox County. The formation continues to the west in Alabama as a dark, laminated, fine-grained sand with interlaminated clay and shale. In Lauderdale County, Miss., it breaks up into definite sand and shale beds with shale-filled channels cutting across sand zones. In northern Kemper County the formation is mainly a medium-fine-grained, very micaceous sand carrying the marine boring,

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8/ Op. cit., p. 190.

9/ Brantly, J. E., Petroleum possibilities of Alabama: Geol. Survey Ala., Bull. No. 22, pp. 148-152, 1920.

Halymenites. It thins rapidly to the north and is not recognized north of southeastern Winston County, unless the Betheden formation is a nonmarine equivalent of at least part of it, a possibility that will be discussed below. At the type locality of the Fearn Springs sand member of the Wilcox formation (column 31), the Betheden formation rests directly on the Matthews Landing marl member of the Porters Creek clay.

In Alabama the Naheola formation is uniformly sombre. The fine sand is commonly very micaceous and locally carries a fine green mineral that may be glauconite; but no large botryoidal or capsule-shaped grains were seen. Comminuted plants are common in both the sand and clay laminae. The laminated sand and shale member is overlain by lignite that ranges from a streak to a bed locally 7 feet thick. In Mississippi the thicker sand beds are white to yellow, weather red, are commonly very micaceous, and likewise contain what may be very fine glauconite.

In westernmost Wilcox County and eastern Marengo County the Naheola formation contains a glauconitic shell marl that has not been reported previously. It is not shown in the columnar diagram because its position within the Naheola has not been accurately determined, but it appears to lie near the middle of the formation. The best known exposure of this bed is near the top of the hill on the slope on the east side of Goose Creek in the NW¼ sec. 11, T. 13 N., R. 5 E., about 1 mile ease of Lamison, Wilcox County, Ala. It is exposed in a weathered condition at several places in nearby Marengo County, and can also be seen near the top of the long hill south of Beaver Creek on U. S. No. 43, probably in the southeast corner of sec. 9, T. 14 N., R. 3 E., Marengo County. Its greatest thickness is about 4 feet.

Coal Bluff marl member.--The name Coal Bluff marl member of the Naheola formation is restricted to the lower glauconitic sandy marls and shales of the Coal Bluff beds of Brantly.[10] The upper coarse sands are considered to be of Wilcox age, for reasons discussed below. The member is named from Coal Bluff, on the west side of the Alabama River in sec. 7, T. 11 N., R. 7 E., Wilcox County, Ala., where the base of the shell marl rests on the upper lignite bed of the shale member of the Naheola formation. The type locality is difficult to reach except by boat, but the member is excellently exposed just below the bridge on State Highway No. 11 over Gravel Creek, in the NW¼ sec. 22, T. 11 N., R. 7 E. The thickness of the member varies from place to place, but probably averages about 35 feet. It has been traced from western Butler County west to eastern Choctaw County, Ala., beyond which it becomes non-fossiliferous and is not differentiated from the rest of the Naheola formation.

The Coal Bluff marl member of the Naheola is a near-shore or estuarine deposit, as evidenced by the fact that at many places in Marengo County the glauconite

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10/ Op. Cit., pp. 148-152.

bed thickens or thins greatly within short distances, and is even absent locally. It is much thicker, for instance, in borrow pits in the SE¼ sec. 21, T. 14 N., R. 3 E., than it is a little more than a mile to the south in cuts along State Highway No. 13 in the extreme south of sec. 28. These relations indicatethat the envirornment suitable for the accumulation of glauconite and the existence of a marine fauna was spotty, perhaps in bays or sounds, cut off by bars to the south, or shallowing near them.

The best preserved fossils thus far collected from the Coal Bluff marl member of the Naheola formation were obtained from a creek bed just west of the old store at Caledonia, in the SW¼ sec. 29, T. 11 N., R. 10 E., Wilcox County, Ala. Several micropaleontologists who have examined the Formainifera from this locality expressed the opinion that they are of Wilcox age. Others who have examined the Foraminifera, as well as those who examined the Ostracoda and Mollusca, believe the fauna to be of Midway age. Those favoring a Wilcox age were petroleum geologists, and a reasonable explanation for the divergence of opinion lies in the fact that the common practice among petroleum geologists is to locate the Midway-Wilcox boundary at the top of the Matthews Landing marl member of the Porters Creek clay.

Betheden formation

The name Betheden (Beth-é-den) formation was set up by F. F. Mellen[11] for a discontinuous deposit of sand and clay which he believed to be residual from the weathering and reworking of the uppermost Midway beds during a period of emergence prior to the deposition of the basal sands of the Wilcox group. The type locality is a Livingston's Spring just east of Betheden, in the SW¼SE¼ sec. 23, T. 16 N., R. 13 E., Winston County, Miss. Examination of many other sections of the Betheden indicates, however, that although some of its constituents may have been reworked from the Midway deposits, it is not a residue, but a transported nonmarine sedimentary deposit lying between the top of the marine clays of the Midway and the lowest coarse nonmarine sands of the Wilcox. It consists of sand; sandy to non-sandy, dark to white clay; shale, some of it leaf-bearing; lignite; and rarely bentonite. It includes some conglomeratic clay. Fresh water mussels have been found in the formation at several localities in Pontotoc and Tippah Counties, in northern Mississippi. Its greatest thickness is about 50 feet.

It is difficult to give a typical section for the Betheden formation because of the great variation in its composition. Sand, massive kaolin beds, and cly-ball conglomerates are common constituents of the lower and middle part, and laminated leaf-bearing clay and shale are common in the upper part. Locally, however, any one of these constituents may make up the greater part of the formation.

11/ Mellen, F. F., Mississippi State Geological Survey Bull. 38, p. 26, 1939.

In general, two types of lithologic sequences exist, one showing what is probably the normal sequence of beds, the other a channel deposit.

Where present, the normal sequence everywhere overlies leached, laminated, marine Porters Creek clay. Gray to white kaolin, at many places showing plant inclusions and bedded or irregular bodies of fine white sand, commonly rests directly on the leached Porters Creek clay, but rarely a thin sand bed occurs at the base of the kaolin. Granular siderite is common in the kaolin. In much of the kaolin there is an intricate system of cracks, which suggests that it had been dried and cracked by the sun many times. In most sections the kaolin grades upward to silty, carbonaceous, clay shale or lignite, at places carrying excellent fossil leaves. Locally, however, a bed of fine white sand lies between the kaolin and the carbonaceous shale, and in some sections this sand makes up the main body of the formation. Clay balls commonly occur scattered throughout this sand, and frequently form a conglomerate at the top.

The channel sequence always rests on dark, unleached Porters Creek clay, showing that if a leached zone ever were present, it was scoured away. The base of the channel deposit is everywhere made up of conglomeratic material consisting of clay balls, lignite lumps, and pieces of Porters Creek clay. The deposit is always sandy, ranging from scattered sand between conglomeratic particles to mostly sand with only scattered conglomeratic material. The basal conglomerate or sand grades up into white kaolin, and the kaolin into carbonaceous shale. In two holes drilled by the Bureau of Mines in southwestern Union County, Miss., bentonite was found to take the place of the kaolin, suggesting that secondary channels filled with volcanic ash cut the kaolin. The carbonaceous shale appears to form the top of both the normal and channel sequences. This and the fact that the leached Porters Creek clay and the kaolin that immediately overlies it in the normal sequence are never found below a channel indicates that the relative position of the channel is at the base of or within the sand and conglomeratic clay zone that is locally present in the middle part of the normal section.

The writer's picture of the sequence of events that produced the above deposits is about as follows: The laminated beds at the top of the Porters Creek clay were elevated above sea level and subjected to subaerial leaching, and the clays were partly kaolinized. Locally these clays were reworked, with little transportation of material, to form massive bodies of clay with some of the fine sand from the Porters Creek clay redeposited in beds and pockets. Plant material was either incorporated in the clay during transportation, or penetrated it later as roots. Following the redistribution of the clays, they were subjected to wetting and drying as indicated by the intricate system of cracks. Locally they are bauxitic, although rarely entirely bauxite. Following the period of wetting and drying, fine to medium white sand containing scattered clay balls was deposited locally from a new source; the large amount of the sand practically precludes the possibility of its having been reworked from the Porters Creek clay. Near the top of the sand, concentrations of the clay balls are abundant, and commonly some massive kaolin is present overlying the beds containing the clay balls. The greater part of the bauxite of northern Mississippi was found in the conglomeratic and massive clay just mentioned.

At about the time the beds of sand and clay balls were being deposited, scouring took place locally and channels we.e cut through the underlying beds down into unweathered Porters Creek clay. The clay-ball conglomerates in the channels, which are thus taken to be stratigraphically equivalent to the conglomerates in the normal section, are, like them, commonly bauxitic. As indicated above, bentonite is known to have been deposited in a late stage of the formation of the channel deposits.

Following the cutting and filling of the channels, gray silty carbonaceous shales, grading upward into less silty, leaf-bearing clays, were despoited over wide areas. Locally these clays pass laterally into lignite.12/

12/ Since this paper was written the writer has had occasion to restudy notes on several sections observed in northern Kemper County, Miss., where the Naheola section is complete. These sections indicate that deep channels are cut into the lower beds of the Naheola formation and filled by the sand of the base of the Coal Bluff marl member, which, as has been stated, was not recognized this far north as a separate unit. This relationship might provide a clue to the preplexing problems arising in sections of the Betheden formation. It is suggested that the normal Betheden section represents the normal Naheola-Coal Bluff sequence, but that the channel-type section of the Betheden represents the scouring away of the lower member of the Naheola prior to deposition of the Coal Bluff marl member. If this interpretation is correct, the Midway-Wilcox contact might be located at any one of three possible horizons as follows:

1. The base of the Naheola formation. This is the horizon commonly picked in the subsurface. There is some justification for its acceptance at the surface for in northern Mississippi this horizon separates marine from non-marine beds.

2. The base of the Coal Bluff marl member of the Naheola. Several micropaleontologists who studied the fauna of the Coal Bluff marl regarded it as basal Wilcox. This interpretation would find justification at the surface, if the above interpretation of the channels in the Betheden is correct, in which case the Coal Bluff marl member would fill deep channels in beds below it.

3. The base of the Fearn Springs sand member of the Nanafalia formation. The molluscan faunas commonly regarded as lower Wilcox all lie above this horizon. The stratigraphically lowest occurrence of Ostrea thirsae, a commonly accepted guide to the lower Wilcox, is in this member. This interpretation finds justification in the surface outcrops of the Fearn Springs sand which fills deep channels in beds below and consists partly of coarse sand and gravel that are commonly interpreted as the indicators of a break of importance.

Although no concerted effort was made during the course of the bauxite investigations to establish a correlation between the Mississippi and Arkansas deposits, the writer, at a late stage in the work, did examine several of the Arkansas mines. He was impressed with the similarity of the sequence observed in the Arkansas mines with that of the channel-type section of the Betheden formation in Mississippi. His opinion is that the Midway-Wilcox contact as interpreted by the bauxite parties working in Arkansas is horizon 2 stated above.

In the columnar diagram (column 31 and northward) and in the small correlation chart, the Betheden formation is plotted as an upper formation of the Midway group, suggesting a correlation with the Naheola formation, but it is possible that the Betheden is a swamp or lagoonal deposit of lower Wilcox age. It is impossible to trace the formation continuously at the surface, as it is absent in many places along the strike. The equivalence of the Betheden and the Naheola is suggested by the following: (1) the Betheden is found only to the north of the area where the Naheola is definitely recognized; (2) the Naheola carries some beds of comminuted plants and lignite such as are common in the Betheden; (3) at the southernmost exposure of beds assigned to the Betheden it rests directly on the Matthews Landing marl member of the Porters Creek, the normal position for the Naheola; and (4) in Winston County, Miss., where beds assigned to the Betheden outcrop, drilling down the dip shows that a section comparable in lithologic composition and thickness to the Naheola formation of Alabama intervenes between the Matthews Landing marl member of the Porters Creek clay and the basal sands of the Fearn Springs sand member of the Wilcox formation. If this correlation is correct, the comparatively thin exposures and disconnected occurrences of the Betheden formation at the outcrop indicate overlap by beds of Wilcox age.

Beds of Wilcox age

The name Wilcox is not based on a type exposure, an objection commonly voiced against employing it at all. It was derived from either Wilcox County or a now abandoned Wilcox post office, in Alabama. Its usage has, however, displaced other names that were better defined and that had definite type localities.

In Alabama the Wilcox group consists of the Nanafalia formation, the Tuscahoma sand, and the Hatchetigbee formation. The Fearn Springs sand member is made the basal member of the Nanafalia formation and the Bashi marl member is made the basal member of the Hatchetigbee formation.

The classification adopted by the Geological Survey for the new geologic map of the State of Mississippi, largely on the basis of recommendations of the Mississippi Geological Society, is followed in this report. In this classification the Wilcox is treated as a formation, equivalent to the whole Wilcox group in Alabama. Two members are recognized, the Fearn Springs sand member at the base and the Bashi marl member in the upper part.

In 1943, while working on the new Mississippi geologic map, the writer found that the type Holly Springs formation of northern Mississippi, formerly included in the Wilcox and correlated with the Tuscahoma sand of Alabama, is the nonmarine equivalent of the Tallahatta formation to the south. The name Holly Springs was accordingly abandoned in favor of Tallahatta for all of Mississippi.

The removal of the beds designated as the Holly Springs from the Wilcox group left the Ackerman formation as the only unit formerly recognized by the Federal Geological Survey in the Wilcox of Mississippi. Although usually correlated with the Nanafalia formation of Alabama, the Ackerman formation at its type locality in Mississippi was found to be correlated with beds well up in the Tuscahoma sand of Alabama. It was decided, therefore, that rather than attempt to redefine Ackerman and perhaps add to the existing confusion, it would be better at present to adopt Wilcox formation for all beds of Wilcox age in Mississippi.

Wilcox formation

The Wilcox is over 800 feet thick in southeastern Neshoba County, Miss., but thins northward along the strike, largely as a result of overlap by the Claiborne group, to less than 100 feet at the Tennessee line.

The Wilcox formation of Mississippi consists mainly of dark shales and fine, gray, and olive-colored sands, although coarser white to red sand is the main constitutent of the basal Fearn Springs sand member. The formation is strongly cross-bedded, and channels occur at all levels. Both shales and sands are very lenticular, but with more detailed work it may be found that zones either predominantly sandy or predominantly shaly can be traced for considerable distances. The formation is mainly nonmarine in Mississippi, although, as indicated on the new State geologic map of Mississippi, marl beds, of Wilcox age in Alabama (the Bashi marl member of the Hatchetigbee formation and a lower fossiliferous marl at the base of the "pseudobuhrstone" of the Nanafalia formation), can be traced into Mississippi for a short distance. Ostrea thirsae has been found in the lower marl in the northeast corner of sec. 14, T. 7 N., R. 18 E., Lauderdale County, Miss— the first record of the occurrence of this species in an outcrop in Mississippi. In northern Mississippi, near Legion State Park, dark shales equivalent to the "pseudobuhrstone" beds of the upper Nanafalia carry fresh-water mussels and large fresh-water gastropods of the genus Melania.

Fearn Springs and member.--The Fearn Springs sand member of the Wilcox formation has not previously been recognized as a unit by the Federal Geological Survey. Its type locality is a cut along a country road north of the center of sec. 3, T. 13 N., R. 14 E., Winston County, Miss. In addition to the fine-grained sands and clay originally assigned to the unit by Mellen[13], it also includes coarse sand exposed farther down the hill, originally believed to be colluvium, but actually forming the main part of the member. Below the coarse sand and resting on the Matthews Landing marl member of the Porters Creek clay is a thin but typical section of the Betheden formation.

13/ Mellen, F. F., Mississippi State Geological Survey Bull. 38, p. 33, 1939.

The Fearn Springs member varies greatly both in thickness and texture, but in general the thickest sections carry the coarsest material. The greatest thickness, about 100 feet, and very coarse throughout, was found in northern Lauderdale and southern Kemper Counties, Miss. The fine-grained sands and clays which commonly mark the top of the Fearn Springs are decidedly lenticular. Some of the lenses pinch out completely within a single exposure. For this reason the contact with other Wilcox beds above is frequently indistinct. The member thins northweard, becomes finer textured, and, in northern Mississippi, is indistinguishable from the overlying Wilcox. Clay-ball conglomerates are common in the Fearn Springs. Most of the clay balls are composed of unaltered kaolin, but some, notably on the Flora property in northern Kemper County (column 33), are composed of bauxite. However the bauxitic conglomerates are very localized, for a similar deposit of conglomeratic clay near the Flora bauxite that resembled the ore, even to the extent of having a similar system of halloysite veins, was found to be non-bauxitic.

The Fearn Springs extends into Alabama where it forms the basal member of the Nanafalia formation, the oldest formation of the Wilcox group in this State. It is commonly Halymenites-bearing in Alabama, and at many localities the upper beds carry impressions of marine mollusca, including Ostrea thirsae. It is not well developed east of western Pike County, Ala., although a few feet of coarse, clay-ball bearing sand at the base of the Nanafalia at Fort Gaines may represent it.

The Fearn Springs is more of a channel sand in Alabama than in Mississippi, and thickens and thins greatly along the strike. Its greatest measured thickness in Alabama is 80 feet, near Forest Home in western Butler County, but it is absent entirely in eastern Butler County. The channels seen in Alabama are interpreted as prongs of a sand probably continuous in the continental facies, but fingering out in the marine facies to the south.

In the thinner sections of the Fearn Springs in Alabama, the sand is fine below, grading to coarse or even gravelly above, and in such sections appears to rest with little break on the Midway group. Locally, however, greater accumulations of coarse sand and gravel lie in channels scoured out of the lower fine sands as well as out of the upper beds of the Midway, and rest on dark clays and shales of the Midway with sharp contact. In such sections the break at the Midway-Wilcox contact appears to be pronounced.

So little difference exists between the faunas of the highest Midway and the lowest Wilcox that paleontologists have difficulty in distinguishing them. Even where the apparent break is greatest, it is believed that it is due largely to an abrupt change in the coarseness of the material deposited and concurrent scouring of the beds below, and that the hiatus in time is small.

Nanafalia formation

The Nanafalia formation, the lowest formation in the Wilcox group of Alabama, is named from old Nanafalia Landing on the Tombigbee River, in the SE¼ sec. 31, T. 14 N., R. 1 E., Marengo County, Ala. The upper coarse sand of the Coal Bluff beds of Brantly, here included in the Nanafalia as the Fearn Springs sand member, was discussed above. The thickness of the Nanafalia above the Fearn Springs ranges from about 25 feet to about 100 feet. It is roughly divisible in western Alabama into two zones--the upper part predominantly sandstone, sandy claystone, and laminated clay (Grampian Hills rock or "pseudobuhrstone" of Smith 14/, Johnson, and Langdon), and the lower part loose to tough sand with ledges or concretionary zones of sandstone. This lower part is commonly referred to as the "*Ostrea thirsae* beds," from the fossil it locally carries in great numbers, although the species occurs throughout the Nanafalia formation. The writer has not seen *O. thirsae* outside the Nanafalia, however. The type locality at Nanafalia Landing exposes only a few feet of the upper sandstone and claystone facies. This facies is best developed in central and eastern Alabama; in western Alabama it grades into a dark clay shale that can be traced into Mississippi at least as far as northern Winston County, in and near Legion State Park. The underlying "*Ostrea thirsae* beds" are best developed in central Alabama, but pass into a non-fossiliferous, sparsely glauconitic sand a short distance west of the Tombigbee River. Impressions of this species have been found sproadically in the Fearn Springs in western Alabama.

The Nanafalia formation in easternmost Alabama consists of two sand to clay sequences owing to the development in that area of a persistent loose sand and an underlying dark clay shale immediately below the upper "pseudobuhrstone member". The lower sequence grades from the base of the formation up into the dark clay shale. The higher sequence grades from the loose sand up into the clay and claystone of the "pseudobuhrstone". This twofold division extends into the continental facies in the bauxite area and most, if not all, of the bauxite appears to have been formed from clays at the top of the lower sequence. There is 20 feet of dark clay at this horizon in the marine section at Fort Gaines.

Tuscahoma sand

The Tuscahoma sand is named from old Tuscahoma Landing on the Tombigbee River, in sec. 31, T. 13 N., R. 1 W., Choctaw County, Ala. The formation thickens from about 80 feet near the Chattahoochee River to between 300 and 500 feet in western Alabama. It consists for the most part of non-fossiliferous, fine, firm gray to olive sand and dark shale, but locally it includes some loose, white to yellow sands, and some lignite.

14/ Smith, E. A., Johnson, L. C., and Langdon, D. W., Report on the geology of the Coastal Plain of Alabama: Geol. Surv. of Ala., pp. 170-173, 1894.

Several fossiliferous marls or glauconitic sands occur in the Tuscahoma, but only two are of consequence. Probably the best known is the Bells Landing marl member of the Tuscahoma sand, named from an old landing on the Alabama River in northwestern Monroe County, Ala., where it is well exposed. Smith, Johnson, and Langdon 15/ report Bells Landing fossils in their section at Tuscahoma Landing, but no fossiliferous beds were observed at that place by the writer. The other, the Greggs Landing marl member, a fossiliferous zone in the lower part of the Tuscahoma, has been traced from Choctaw County, Ala., to Georgia, and is much better developed to the east than to the west. The most fossiliferous part of the Greggs Landing marl member of the Tuscahoma is a highly glauconitic bed lying about 20 to 25 feet lower stratigraphically than the sparsely fossiliferous horizon at Greggs Landing, but the characteristic Greggs Landing fossils occur throughout the intervening zone. The persistent glauconite bed is shown in the diagram as the base of the Greggs Landing marl member. It crosses the Tombigbee River at Barneys Upper Landing in southwestern Marengo County. The top of the fossiliferous zone is not sharp and the upper part, as seen at Greggs Landing, consists of fine, cross-bedded, olive-colored sand, indistinguishable, except for the shells, from the overlying barren beds of the Tuscahoma.

The basal beds of the Tuscahoma sand vary greatly. At many places in eastern Alabama they are coarse, gravelly, and glauconitic, and locally they carry a few Greggs Landing fossils. To the west they are finer-grained, sometimes thinly laminated and shaly, but more often massive and firm with more or less abundant shale. In central Marengo County, Ala., near Sweetwater, there is over 60 feet of loose white sand at the base of the Tuscahoma.

The Tuscahoma sand as used in this report includes sands, shales, and lignites formerly regarded as the lower part of the Bashi formation. The lignites at the base of these beds are well exposed at Yellow Bluff on the Alabama River. Work done by the writer has shown that these lignites are only locally developed and that no continuously mappable contact occurs at or near this horizon.

Hatchetigbee formation

The Hatchetigbee formation, the uppermost formation of the Wilcox group of Alabama, is named from Hatchetigbee Bluff on the Tombigbee River, probably in the southwest corner of sec. 16, T. 18 N., R. 1 W., Washington County, Ala. The type locality is a fossiliferous exposure at the crest of the Hatchetigbee anticline, down-dip from the main outcrop. Along the main outcrop the formation is unfossiliferous above the basal Bashi marl member. The Hatchetigbee formation is about 150 feet thick in western Alabama but thins to the east to less than 15 feet at the Chattahoochee River. The formation consists of interlaminated and interbedded fine-grained, gray to olive sands and shales, and some lighter-colored loose sand, all of the same type as the beds of the underlying Tuschahoma

15/ Op. cit., p. 167.

sand. In fact, without the Bashi marl member to mark the base of the Harchetigbee formation, the writer knows of no way to differentiate the beds from the Bells Landing marl member of the Tuscahoma to the top of the Wilcox group.

Bashi marl member. The Bashi marl member of the Hatchetigbee formation is named from Bashi Creek, in northwestern Clarke County, Ala., but is best known from its exposure at Woods Bluff on the Tombigbee River in the southern part of sec. 10, T. 11 N., R. 1 E., Clarke County, Ala. The fossiliferous beds at Woods Bluff are now inundated by backwater from a dam. The Bashi ranges in thickness from 2 to 25 feet. In some places it splits up into two or three distinct beds and there the thickness is greater. It is a very fossiliferous glauconitic sand, commonly carrying large, rounded, calcareous concretions that weather to a snuffy brown powder. These concretions do not, however, distinguish the member, as similar concretions are found in the marls of the Tuscahoma sand, and to a lesser extent in the Nanafalia formation and the Midway group. As a fossiliferous bed it has been traced from southeastern Stewart County, Ga., to southwestern Kemper County, Miss., the northwesternmost point at which marine mollusks characteristic of this member have been found being at a road fork in the SW¼ sec. 7, T. 9 N., R. 14 W., Kemper County. A sparsely glauconitic sand, believed to a continuation of this member, and carrying Halymenites but no other fossils, can be traced much farther to the northwest. This sand is exposed at the Gulf, Mobile and Ohio Railroad crossing over Highway No. 15, in sec. 31, T. 13 N., R. 13 E., Winston County, Miss., and at places as much as 5 miles to the northwest of this locality.

As was stated above, the sands, shales, and lignites, here referred to the upper part of the Tuscahoma sand, were formerly grouped with the marl bed to constitute a Bashi formation. The Bashi marl is here regarded as the basal member of the Hatchetigbee formation, largely on faunal evidence. Several species of mollusks formerly believed to be guide fossils for either the Bashi or the higher marls of the Hatchetigbee have been found to occur in both. On the other hand, the conspicuous fossils of the Nanafalia and Tuscahoma formations, such as the large Turrietllas, T. mortoni and T. praecincta, are not known in the Bashi or in the higher beds.

Location of sections

1. Ravine just north of center of town of Chalybeate, probably south-center of sec. 3, T. 2 S., R. 4 E., Tippah County, Miss.

2. South side of the valley of creek, SW¼SE¼ sec. 12, T. 2 S., R. 3 E., Tippah County, Miss.

3. Composite section along road and in gullies west of road from west-center of sec. 21 to center of sec. 16, T. 2 S., R. 4 E., Tippah County, Miss.

4. Road cut and auger hole, SW¼SE¼ sec. 29, T. 3 S., R. 3 E., Tippah County, Miss.

5. Creek head and road cut just west of road-Y, west of center of sec. 17, T. 4 S., R. 4 E., Tippah County, Miss.

6. Road cut just south of road-T, NE¼ sec. 35, T. 4 S., R. 2 E., Tippah County, Miss.

7. U. S. Bureau of Mines core drill hole, Fowler No. 1, NE¼ sec. 31, T. 5 S., R. 2 E., Benton County, Miss.

8. Road cut on south side of valley of creek, NW¼ sec. 8, T. 6 S., R. 3 E., Union County, Miss.

9. Road cut on south side of valley of King's Creek, NW¼ sec. 29, T. 7 S., R 3 E., Union County, Miss.

10. U. S. Bureau of Mines core-drill hole, Pinedale No. 33, western part of sec. 4, T. 8 S., R. 1 E., Union County, Miss.

11. U. S. Bureau of Mines core-drill hole, Pontotoc No. 42, NW¼NE¼ sec. 2, T. 10 S., R. 1 E., Pontotoc County, Miss. (A similar section partly exposed in nearby road cuts.)

12. Road cut, center of sec. 6, T. 10 S., R. 3 E., Pontotoc County, Miss.

13. Deep cut on Gulf, Mobile, and Ohio Railroad, near NE. corner sec. 8, T. 10 S., R. 3 E., Pontotoc County, Miss.

14. Road cut just south of road-T about midway of line between secs. 19 and 20, T. 10 S., R. 1 E., Pontotoc County, Miss.

15. East side of creek valley, SW¼ sec. 18, T. 11 S., R. 1 E., Pontotoc County, Miss.

16. West side of creek valley NW¼ sec. 4, T. 12 S., R. 3 E., Chickasaw County, Miss.

17. Top of hill on west side of valley of Houlka Creek, SW¼ sec. 28, T. 13 S., R. 3 E., Chickasaw County, Miss.

18. Road cut on south side of valley of Johnson Creek, SW$\frac{1}{4}$ sec. 4, T. 20 N., R. 13 E., Clay County, Miss.

19. Sand pit and auger hole, SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 12, T. 20 N., R. 11 E., Webster County, Miss.

20. Road cut, north-center of sec. 29, T. 19 N., R. 12 E., Oktibbeha County, Miss.

21. Steep hill, east-center of sec. 30, T. 19 N., R. 12 E., Oktibbeha County, Miss.

22. Road cut and auger hole just north of road-T, NE$\frac{1}{4}$ sec. 20, T. 18 N., R. 12 E., Oktibbeha County, Miss.

23. Road cut and auger holes on hill south of road-T, south of center of sec. 20, T. 16 N., R. 12 E., Winston County, Miss.

24. Composite section of road cuts, ditches, and auger holes at road-T, SE$\frac{1}{4}$ sec. 23, T. 16 N., R. 12 E., and east side of Noxubee River valley north-center of sec. 19, T. 16 N., R. 13 E., Winston County, Miss.

25. Road cuts and auger holes on south side of valley of Sulfur Springs Creek, west-center of sec. 10, T. 15 N., R. 12 E., Winston County, Miss.

26. Composite section from road cuts and auger holes near Livingston's Spring at Betheden, south-central part of sec. 23, T. 16 N., R. 13 E., Winston County, Miss.

27. South side of valley of Mill Creek, NE. corner sec. 3, T. 15 N., R. 13 E., Winston County, Miss.

28. Section on abandoned road, north-center of sec. 3, T. 14 N., R. 14 E., Winston County, Miss.

29. Section along creek from Highway 14 to head of creek, center of sec. 4, T. 14 N., R. 14 E., Winston County, Miss.

30. Section along road, in gullies, and in an auger hole east of Moody farm house, SE$\frac{1}{4}$ sec. 33, T. 14 N., R. 14 E., Winston County, Miss.

31. Road cut, gully, creek exposures, and auger holes at type locality of Fearn Springs member, north of center of sec. 3, T. 13 N., R. 14 E., Winston County, Miss.

32. Road cuts, auger holes, and exposures along creek south of road near W. H. Hubbard, Sr., bauxite, east of center of sec. 8, T. 13 N., R. 15 E., Noxubee County, Miss.

33. Exposure and auger holes at bauxite mine on J. C. Flora property, northwest corner of sec. 10, T. 12 N., R. 16 E., Kemper County, Miss.

34. Road cuts and auger holes on east side of creek valley at Sciples Mill, SW$\frac{1}{4}$ sec. 24, T. 12 N., R. 15 E., Kemper County, Miss.

35. Road cut, ditch, and auger hole at a creek NE$\frac{1}{4}$ sec. 34, T. 12 N., R. 15 E., Kemper County, Miss.

36. Road cuts, south of center of sec. 20, T. 11 N., R. 15 E., Kemper County, Miss.

37. South side of valley of branch on side road, about center of NW$\frac{1}{4}$ sec. 4, T. 11 N., R. 16 E., Kemper County, Miss.

38. South side of valley of Sucarnoochee Creek, sec. 21, T. 11 N., R. 16 E., Kemper County, Miss.

39. Road cut on Highway 45, NE$\frac{1}{4}$NW$\frac{1}{4}$ sec. 19, T. 12 N., R. 18 E., Kemper County, Miss.

40. South side of valley of creek on abandoned road, south-center of sec. 1, T. 9 N., R. 15 E., Kemper County, Miss.

41. South side of valley of Sucarnoochee Creek, SW$\frac{1}{4}$ sec. 23, T. 11 N., R. 16 E., Kemper County, Miss.

42. Composite section including exposures along Highway No. 39 from Daleville to Blackwater Creek, along an abandoned road east of center of sec. 33, and between Blackwater and Cullum, T. 9 N., R. 16 E., Kemper County, Miss.

43. Road cuts on west side of valley of a branch, NE$\frac{1}{4}$ sec. 19, T. 10 N., R. 17 E., Kemper County, Miss.

44. Composite section, including exposures along road, NE$\frac{1}{4}$ sec. 33, and in large gully south of road; auger holes along road and in gully, and the south side of valley of Pawticfaw Creek, east of center of sec. 34, T. 10 N., R. 17 E., Kemper County, Miss.

45. Composite section from several gullies east of old Highway No. 45, SE$\frac{1}{4}$ sec. 19; from auger hole at foot of hill north of the road-T; and from exposures in NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 20, and along the abandoned road, north-center of sec. 17, T. 9 N., R. 18 E., Kemper County, Miss.

46. Composite section, including exposures in road cut and sand pit, NE$\frac{1}{4}$ sec. 36, T. 8 N., R. 16 E., and along abandoned road, NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 31, T. 8 N., R. 17 E., Lauderdale County, Miss.

47. Gully and log road east of old Highway 45, east of center of sec. 30, T. 9 N., R. 18 E., Kemper County, Miss.

48. Big gully, west of center of sec. 11, T. 8 N., R. 18 E., Lauderdale County, Miss.

49. Abandoned road, east of center of sec. 21, T. 18 N., R. 4 W., Sumter County, Ala.

50. Road cuts and auger holes on the east side of valley of Toomsuba Creek, SE$\frac{1}{4}$ sec. 11, and NE$\frac{1}{4}$ sec. 14, T. 7 N., R. 18 E., Lauderdale County, Miss.

51. Composite section of steep hill on east-west road, SW$\frac{1}{4}$ sec. 26, and hill and auger hole on unmapped road, about northwest corner of sec. 22, T. 17 N. R. 4 W., Sumter County, Ala.

52. Cut on the Alabama, Tennessee and Northern Railroad, north-center of sec. 28, T. 17 N., R. 3 W., Sumter County, Ala.

53. Section in creek bluff and road cut on east side of valley of a creek NW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 5, T. 17 N., R. 1 W., Sumter County, Ala.

54. Bluff on Tombigbee River about one-half mile below bridge at Moscow, near center of sec. 25, T. 17 N., R. 1 W., Sumter County, Ala.

55. Composite section from large sand pit south of Kinterbish Creek, east-center of sec. 33, T. 16 N., R. 2 W., Sumter County; from road cuts and auger holes, south center of sec. 5; from cuts along Highway No. 29, secs. 3 and 10, T. 15 N., R. 2 W.; and from the south side of Tuckabum Creek valley, north center of sec. 22, T. 14 N., R. 2 W., Choctaw County, Ala.

56. South side of valley of Kinterbish Creek, NW$\frac{1}{4}$ sec. 19 and SW$\frac{1}{4}$ sec. 18, T. 15 N., R. 1 W., Choctaw County, Ala.

57. Road cut and auger hole, south-center of sec. 27, T. 15 N., R. 1 W., Choctaw County, Ala.

58. Composite section from a bluff on south branch of Landrums Creek, probably SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 23, and from the following road cuts: (a) on south side of valley of the creek, south-center of sec. 23; (b) in north-center sec. 26; and (c) on south side of valley of Double Creek in east-center of sec. 33, T. 14 N., R. 1 E., Marengo County, Ala.

59. Steep hill west of Little Beaver Creek, SW$\frac{1}{4}$ sec. 18, T. 14 N., R. 2 E., Marengo County, Ala.

60. Road cut and gully at top of hill, SW$\frac{1}{4}$ sec. 16, T. 14 N., R. 2 E., Marengo County, Ala.

61. South side of valley of Sweetwater Creek, NE$\frac{1}{4}$ sec. 22, T. 13 N., R. 2 E., Marengo County, Ala.

62. Road cut on steep hill, northwest corner of sec. 36, T. 14 N., R. 2 E., Marengo County, Ala.

63. Composite section from a long hill, SE$\frac{1}{4}$ sec. 9, and road cuts north-center of sec. 9, T. 14 N., R. 3 E., Marengo County, Ala.

64. Composite section from south side of valley of Beaver Creek, east of center of sec. 35, and road cuts and auger holes along section line road, between section 28 and 34, T. 14 N., R. 3 E., Marengo County, Ala.

65. Composite section from road cuts, SW¼ sec. 4, NW¼ sec. 9, the east-center of sec. 8, and secs. 28, 33, and 34, T. 13 N., R. 4 E., on the south side of the valley of Baptizing Creek, sec. 35, T. 13 N., R. 4 E.; and on south side of the valley of Dry Creek, north-center of sec. 15, T. 12 N., R. 4 E., Marengo County, Ala.

66. Composite section from (a) creek and road cut exposures on Highway 5 from Turkey Creek, SW¼ sec. 10 to the cross road, SE¼ sec. 21, and (b) exposures along old road and cut on Southern Railway, NE¼ sec. 15, T. 12 N., R. 5 E., Wilcox County, Ala.

67. Road cut on a hill, SW¼ sec. 25, T. 12 N., R. 5 E., Wilcox County, Ala.

68. South side of valley of Dixon Creek, SE¼ sec. 23, and also partly, of sec. 26, T. 13 N., R. 6 E., Wilcox County, Ala.

69. Composite section from: (a) exposures on Highway 28; (b) abandoned road to old Prairie Bluff Landing; and (c) a large bluff on Shell Creek, NE¼ sec. 7, T. 13 N., R. 7 E., Wilcox County, Ala.

70. Composite section from: (a) bed of Gravel Creek to top of hill to south: (b) bluffs along Gravel Creek east of the road; and (c) auger holes in sec. 22, T. 11 N., R. 7 E., Wilcox County, Ala.

71. Bed of Shoal Creek to top of second hill south, NE¼ sec. 15, T. 11 N., R. 8 E., Wilcox County, Ala.

72. Long hill, SE¼ sec. 20, T. 11 N., R. 9 E., Wilcox County, Ala.

73. Composite section along road and in gullies and creeks along State Highway No. 100 from cross road, sec. 31, T. 11 N., R. 10 E., to bed of Pine Barren Creek, sec. 21, T. 12 N., R. 10 E.; and long hill on State Highway No. 10, NW¼ sec. 17, T. 11 N., R. 10 E., Wilcox Xounty, Ala. The basal contact is exposed about 1½ miles east of Carlowville on the road to Minter, Dallas County.

74. Cuts along used and abandoned roads NW¼ sec. 7, T. 10 N., R. 11 E., and along State Highway No. 10, south-center of sec. 31, T. 11 N., R. 11 E., Wilcox County, Ala.

75. Composite section from cuts along State Highway No. 47 between the Wilcox-Monroe County line and Old Texas, Tps. 9 and 10, R. 11 E., Monroe County; the long hill, SE¼ sec. 34; and along the east-west road, secs. 13, 14, and 15, T. 11 N., R. 11 E., Wilcox County, Ala.

76. Section along road and in gully near top of hill, SE¼ sec. 20, to Cedar Creek, sec. 4, and along the hill on Ridgeville road, SE¼ sec. 9, T. 11 N., R. 12 E., Butler County, Ala.

77. Composite section from auger hole in bed of Pine Barren Creek, NW$\frac{1}{4}$ sec. 23, to the top of hill, south of center of sec. 27, T. 10 N., R. 12 E.; and south side of valley of Pine Barren Creek, sec. 18, T. 10 N., R. 13 E., Butler County, Ala.

78. Section along road and in creeks from southwest corner of sec. 21 to NW$\frac{1}{4}$ sec. 16, T. 11 N., R. 13 E., Butler County, Ala.

79. South side of valley of Peary Creek, center sec. 25, T. 10 N., R. 13 E., Butler County, Ala.

80. West side of valley of branch of Stallings Creek, SE$\frac{1}{4}$ sec. 20, T. 10 N., R. 14 E., Butler County, Ala.

81. Composite section from long hill, NW$\frac{1}{4}$ sec. 2; exposures along road from NW$\frac{1}{4}$ sec. 22, to bed of a creek, SE$\frac{1}{4}$ sec. 18; center of sec. 19, T. 11 N., R. 14 E.; the SE$\frac{1}{4}$ sec. 1, and probably partly NE$\frac{1}{4}$ sec. 12, T. 11 N., R. 13 E.; and east side of valley of Stallings Creek, south of center of sec. 4, T. 10 N., R. 14 E., Butler County, Ala.

82. Road cut and auger hole on south side of valley of a creek north of center of sec. 14, T. 9 N., R. 15 E., Butler County, Ala.

83. South side of valley of Piegon Creek, SE$\frac{1}{4}$ sec. 26, T. 9 N., R. 15 E., Butler County, Ala.

84. East side of valley of Creek crossing abandoned road SW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 6, T. 8 N., R. 16 E., Butler County, Ala.

85. Between State Highway No. 10 and Road-Y to the south, SW$\frac{1}{4}$ sec. 23, T. 9 N., R. 16 E., Crenshaw County, Ala.

86. West side of valley of Silom Creek, SW$\frac{1}{4}$ sec. 34, T. 9 N., R. 17 E., Crenshaw County, Ala.

87. Composite section from exposures on the west side of valley of Little Patsaliga Creek, northeast corner sec. 8; east center of sec. 7; road cuts, secs. 19, 20, 33, and 34, T. 10 N., R. 17 E.; road cuts, SE$\frac{1}{4}$ sec. 16 and NE$\frac{1}{4}$ sec. 21, T. 9 N., R. 17 E.; and large spring sink, SW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 4, T. 8 N., R. 18 E., Crenshaw County, Ala. The middle calcareous portion is largely residuum and may have been much thicker than plotted.

88. Section of bluff and auger hole at base, probably SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 34, T. 8 N., R. 19 E., Pike County, Ala.

89. Road cut at road-T, east center of sec. 22, and exposures in iron mine 0.2 mile northwest, NE$\frac{1}{4}$ sec. 22, T. 8 N., R. 19 E., Pike County, Ala.

90. Composite section from steep hill, SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 7, T. 8 N., R. 20 E., and road cuts, sec. 36, T. 8 N., R. 19 E., Pike County, Ala.

90a Local sand lens, center of sec. 24, T. 8 N., R. 19 E., Pike County, Ala.

91. Composite section from ravine just west of Boy Scouts swimming pool in city limits of Troy, Ala., probably SE¼ sec. 30, T. 10 N., R. 21 E.; a long hill from road-T, SE¼ sec. 26 to east center of sec. 27; and road cuts and gullies east of center of sec. 31, T. 9 N., R. 21 E., Pike County, Ala.

92. East side of valley of creek east of midpoint of the section line road between secs. 18 and 19, T. 7 N., R. 21 E., Coffee County, Ala.

93. Gully south of farm road, SW¼ sec. 3, T. 8 N., R. 22 E., Pike County, Ala.

94. Composite section from washed out road at site of old Minchiners Bridge, probably SE¼NW¼ sec. 34, T. 8 N., R. 23 E., Barbour County, and sections and auger holes, sec. 3, T. 7 N., R. 23 E., Dale County, Ala.

95. East side of valley of Pea River, probably west center of sec. 4, T. 9 N., R. 24 E., Barbour County, Ala.

96. South side of valley of Pea Creek, NW¼ sec. 29, T. 10 N., R. 25 E., Barbour County, Ala.

97. Road cuts, gullies, and auger holes from NE¼ sec. 24 to West Fork of Choctawhatchee River; and limestone exposed in Blue Spring, T. 8 N., R. 25 E., Barbour county, Ala.

98. Cut of the Central of Georgia Railway, and gully east of track, NE¼ sec. 4, T. 10 N., R. 26 E., Barbour County, Ala. (Clayton limestone type locality.)

99. Big gully, SW¼ sec. 1, T. 9 N., R. 27 E., Barbour County, Ala.

100. Bauxite mine along U. S. No. 241 northeast of Richards Crossroads, probably SE¼ sec. 20, T. 9 N., R. 28 E., Barbour County, Ala.

101. Chester Scott mine, SW¼ sec. 35, T. 9 N., R. 28 E., Henry County, Ala.

102. Big gully and auger hole, NW¼SE¼ sec. 7, T. 8 N., R. 29 E., Henry County, Ala.

103. Composite section along Chattahoochee River from just south of bridge at Fort Gaines, Ga., to just below Thomas Mill Creek, SW¼ sec. 3, T. 8 N., R. 29 E., Henry County, Ala.