MISSISSIPPI STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph. D.
Director

BULLETIN 40

THE UPPER CRETACEOUS DEPOSITS

BY

LLOYD WILLIAM STEPHENSON

and

WATSON HINER MONROE

In cooperation with the
United States Geological Survey

UNIVERSITY, MISSISSIPPI

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MISSISSIPPI GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

Office of the State Geological Survey
University, Mississippi
August 14, 1940

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

Gentlemen:

A number of years ago, under the direction of the late E. N. Lowe, M.D., the Mississippi State Geological Survey and the U. S. Geological Survey undertook a cooperative geologic and water resources investigation of the State of Mississippi—the State Survey obligating itself to publish the geologic report; and the Federal Survey, the water resources report. The United States Geological Survey fulfilled its part of the agreement by publishing in 1928 Water-Supply Paper 576, The Ground-Water Resources of Mississippi, a paper of 515 pages, 3 figures, and 12 plates, one of the 3 colored plates of which is the "Reconnaissance Geologic Map of Mississippi."

The publishing of the present report, The Upper Cretaceous deposits of Mississippi by Lloyd William Stephenson and Watson Hiner Monroe, as Bulletin 40 by the Mississippi State Geological Survey will, after all these years, fulfill the State's part of the agreement.

The geologic field investigation of the Upper Cretaceous beds is largely the work of Dr. Lloyd William Stephenson, an authority on the Gulf and Atlantic Coastal Plain Geology, but the field revision, during the last four or five seasons, is mostly the work of Mr. Watson Hiner Monroe, his able assistant and associate.

The State Geological Survey has published a detailed stratigraphic report on the oldest rocks of the State, Bulletin 23, Paleozoic rocks. With the publishing of Bulletin 40, The Upper Cretaceous deposits, the State will have another excellent detailed stratigraphic report on the next oldest division of rocks—a report that will be especially valuable to the geologists and geophysicists of the oil corporations that are spending so many hundreds of thousands of dollars in Mississippi in the search for oil since the WPA, Mississippi State Geological Survey, and Yazoo County were so fortunate as to discover the Tinsley dome, now the Tinsley Oil Field of 70 producing wells.

Respectfully submitted,

William Clifford Morse,
Director and State Geologist

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THE UPPER CRETACEOUS DEPOSITS

LLOYD WILLIAM STEPHENSON AND WATSON HINER MONROE

ABSTRACT

The Cretaceous deposits of Mississippi appear in surface outcrops in the northeastern part of the State in a belt having a maximum width of about 50 miles east and west, a length of about 160 miles north and south, and an area of about 5,300 square miles. The area is bounded on the east by Alabama, on the north by Tennessee, and on the west and southwest by the inner edge of the overlapping Paleocene deposits, which forms roughly a curved line from northern Tippah County to central Kemper County, passing through the towns of Ripley, New Albany, Pontotoc, Houston, Starkville, and Shuqualak. The deposits are all in the Gulf Coastal Plain and its subdivision, the Mississippi Embayment. The physiographic divisions of Mississippi that lie within the belt are the Tombigbee and Tennessee River Hills, the Black Prairie Belt and the Pontotoc Hills. The two hilly districts include the highest and most rugged topography in the State. Altitudes above sea level rang from a minimum in the south of about 120 feet on Tombigbee River at the Alabama State line to a maximum in the north of 806 feet at Knob triangulation station 3 1/3 miles southwest by west of Iuka in Tishomingo County.

The geologic units of the Upper Cretaceous series recognized in Mississippi, in ascending order, are: The Tuscaloosa formation; the Eutaw formation, including the Tombigbee sand member at the top; the Selma chalk and its partial equivalents, the Coffee sand and the Ripley formation; and the Prairie Bluff chalk and its equivalent, the Owl Creek formation. The strata all dip gently to the west and southwest.

The Tuscaloosa formation rests unconformably on a basement of Paleozoic rocks of Devonian and Mississippian age, which crop out only in narrow irregular belts along Tennessee River, Yellow Creek, Bear Creek, and the headwaters of Mackys Creek. The formation consists of irregularly bedded sand, clay, gravel, and lignite, ranging from a maximum measured thickness of about 600 feet in southeastern Monroe County to a vanishing feather edge in northern Tishomingo County.

The Eutaw formation rests unconformably on the Tuscaloosa formation and partly overlaps it. The lower part of the formation consists of irregularly bedded sparingly glauconitic sand and fine

chert gravel, overlain by thinly bedded and cross-bedded fine- to medium-grained glauconitic sand and thin-bedded clay, the whole totalling a thickness of 300 feet or less; the upper part, known as the Tombigbee sand member, consists of 100 feet or less of massive fine glauconitic sand. From central Lee County the Eutaw formation is unconformably overlain by the Selma chalk southward to the Alabama line and by the Coffee sand northward to the Tennessee State line.

The Selma consists of more or less argillaceous and sandy chalk having a maximum thickness of about 900 feet in the southern part of the area of outcrop. In Lee County approximately the lower half of the chalk passes by intertonguing and merging northward into the nonchalky Coffee sand. In the northwestern part of Noxubee County the upper part of the chalk merges northward into the nonchalky Ripley formation, which extends northward in a gradually widening belt to the Tennessee line. From Lee County northward a middle portion of the Selma, 280 feet and less in thickness, maintains its identity as chalk northward to the Tennessee line and beyond. The Arcola limestone member of the Selma chalk consists in Mississippi of a single bed of hard pure limestone a foot or so thick, about 200 to 265 feet above the base of the Selma. It extends from Lee County southward to the Alabama line and beyond.

The Coffee sand is composed of irregularly bedded glauconitic sand and interbedded clay, much like the typical beds of the Eutaw formation.

The Ripley formation typically consists of fine calcareous, glauconitic sand, sandstone, sandy limestone, and subordinate beds of clay. In Union County, however, the median beds of the formation merge northward into a body of irregularly bedded gray, white, and red micaceous sand and clay, known as the McNairy sand member, which thickens and widens northward at the expense of the typical beds, until at the Tennessee line it embraces the greater part of the belt of outcrop. The lower typical beds of the formation, as they extend northward beneath the McNairy sand, are known as the Coon Creek tongue.

The Prairie Bluff chalk, the uppermost formation of the Upper Cretaceous series, rests unconformably on the Selma chalk in Kemper and in southern and central Noxubee County and on the Ripley formation from northern Noxubee County to southern Tippah County.

This unit consists of about 80 feet of more or less pure chalk characterized in its lower part by abundant phosphatic molds of mollusks.

In Pontotoc, Union, and Tippah counties the Prairie Bluff chalk intertongues with and merges laterally northward into the Owl Creek formation which is its approximate equivalent from Tippah County to southern Tennessee. The Owl Creek formation consists of 30 to 50 feet of compact, glauconitic fine argillaceous sand. Both the Prairie Bluff and the Owl Creek are unconformably overlain and partly overlapped by Midway (Paleócene) deposits.

The Cretaceous strata in Mississippi form a gently dipping monocline whose strike swings from S. 15° W. in the north to due south in the central part of the area and finally to S. 30° E. at the Alabama State line in the south. In general the strata dip about 30 feet per mile to the west and southwest normal to the strike. The only known variations from the regularity of this monocline structure are gentle folds in Lowndes and Itawamba counties. The Lowndes County fold, a few miles southeast of Columbus, upwarps the Eutaw formation possibly 50 feet higher than its normal position and elsewhere downwarps the Selma chalk; the axis of this anticline appears to trend about S. 35° W. Minor faulting is known at a few places and is especially common here and there along the outcrop of the Prairie Bluff chalk.

The Tuscaloosa formation has been correlated, on the basis of its fossil plant remains, with the Woodbine formation of the western Gulf region, and with the Raritan formation of the North Atlantic Coastal Plain; in terms of the European section it has been considered to be of Cenomanian age.

The meager invertebrate fossil fauna of the lower part of the Eutaw formation and the more abundant fauna of the upper part (Tombigbee sand member) indicate an age corresponding approximately to that of the Austin chalk of Texas; the Eutaw is probably about the equivalent in age of the Magothy formation of New Jersey, Delaware, and Maryland. The Austin chalk is of lower Senonian age, and has been correlated with the Coniacian and Santonian subdivisions. The Tombigbee sand is included within the lower part of the zone of *Exogyra ponderosa*, a major faunal zone in the Upper Cretaceous series of the Atlantic and Gulf Coastal Plain.

The Selma chalk where most fully developed near the Alabama State line includes beds corresponding in age in ascending order to the upper part of the Austin chalk, the Taylor marl, and the lower part of the Navarro group of Texas. Compared with the section in the North Atlantic Coastal Plain the Selma is equivalent to the Matawan group and to the lower part of the Monmouth group. About the lower two-thirds of the Selma chalk is included within the *Exogyra ponderosa* zone. About the upper third of the chalk lies within the lower half of the zone of *Exogyra costata,* a second and higher major faunal zone in the Upper Cretaceous series. The chalk is of middle and in part of late Senonian age.

The base of the Selma appears to be nearly uniform in age throughout its extent in Mississippi from the Alabama line to central Lee County; it appears to be unconformable on the underlying Tombigbee sand. Zones and traceable beds within the chalk in Mississippi include: The Arcola limestone member, from 1 to 2 feet of hard, pure limestone perforated by filled borings, lying from 200 to 265 feet above the base of the chalk and traceable from the Alabama line to southern Lee County; the *Diploschiza cretacea* zone 60 feet or less in thickness, lying about 180 feet above the Arcola limestone, and traceable from the Alabama line nearly to Tupelo; the *Exogyra cancellata* zone 100 to 150 feet thick, lying immediately above the *Exogyra ponderosa* zone, forming the lower part of the *Exogyra costata* zone, and traceable within the chalk from the Alabama line to the Tennessee line. The Coffee sand in northern Mississippi is of early Selma age and is entirely within the *Exogyra ponderosa* zone; the base of the Coffee sand is somewhat above the base of the *pondersosa* zone, and its top is well below the top of that zone. The Ripley formation is of late Selma age and occupies a median position within the *Exogyra costata* zone; it lies mainly above the *Exogyra cancellata* zone, though its base may descend low enough in northern Mississippi to fall partly within that zone. The Ripley is considered to be synchronous with a part of the Maestrichtian subdivision of the Senonian of Europe.

The Prairie Bluff chalk is not only similar in its lithologic characters to the Corsicana marl of the Navarro group of Texas, but carries a fauna which indicates its approximate, if not its actual, equivalence to that formation. However, the upper part of the Prairie Bluff chalk may be of Kemp age. The Prairie Bluff and its facies equivalent, the Owl Creek formation, are correlated approximately with the Red Bank sand of New Jersey; in terms of the European section they are of Maestrichtian age.

INTRODUCTION

In the winter of 1909-10 the Mississippi State Geological Survey, through its Director, Dr. E. N. Lowe, entered into an agreement with the United States Geological Survey, the terms of which provided for the preparation of two cooperative reports, one treating of the physiography and general geology of the State, to be published by the State, and the other treating of the ground-water resources of the State, to be published by the United States Government. The latter report was issued in 1928 as United States Geological Survey Water-Supply Paper 576, "The ground-water resources of Mississippi," prepared by L. W. Stephenson, W. N. Logan, and G. A. Waring, with discussions of the chemical character of the waters by C. S. Howard.

The report on the physiography and general geology was completed in 1922, but owing to the lack of State funds is was never published; however, in 1930 the Mississippi State Geological Survey issued as an advance chapter the part of the report treating of the Paleozoic rocks, of which Dr. W. C. Morse is the author, and in 1933 the chapter on the Midway (Paleocene) and Wilcox (Eocene) groups, of which Dr. Lowe is the author. With the appearance of these chapters, and of other papers by different authors covering parts of the Tertiary system, the need for the comprehensive report on the State as a whole did not seem so urgent as formerly, but it did seem desirable that the chapter on the Upper Cretaceous series should be made available to the public. The Federal Survey therefore undertook in 1936 to prepare this chapter for publication as a separate report.

The original field work on the Upper Cretaceous area was done before the advent of modern transportation facilities and improved roads, and the geologic boundaries, as shown on the map accompanying Water-Supply Paper 576 (Pl. 2 in pocket—scale 1:1,000,000) are therefore very much generalized. The geologic map accompanying the present report (Plate 1A) is on twice the scale of the map just cited, and the more detailed boundaries shown thereon record the results of field work in 1936 and 1938. Data obtained by the authors since the preparation of the original report have necessitated several changes in the classification of the deposits, the principal ones of which are: The recognition of the Coffee sand as a unit of formation rank; the recognition of the Prairie Bluff chalk as a distinct formation extending from Alabama into Mississippi, involving the abandonment of the name Oktibbeha as a tongue name; and the differentiation of the Owl Creek formation as a formation distinct from the Ripley formation. In consequence of the last two changes the names Selma and Ripley are slightly restricted in their application.

Since the completion of the manuscript of this bulletin, Mr. Monroe, the junior author, has continued his investigations in the adjoining State of Alabama. These studies have shown the need for two changes in the classification of the Upper Cretaceous sediments of the eastern Gulf region as presented in this Bulletin. The decision to make these changes was arrived at too late to permit the needed revision in the present report, and the reader is therefore asked to keep them in mind. They are as follows: (1) The upper sandy facies of the Selma chalk, including in Mississippi a thickness of 50 feet or more between the top of the *Exogyra cancellata* zone and the base of the Prairie Bluff chalk, is transferred to the Ripley formation and treated as a chalky facies of that unit. On the geologic map (Plate 1A) this sandy facies includes all the strata between the red line C and the basal boundary of the Prairie Bluff chalk. (2) For the purer facies of the Selma chalk, including about 500 feet of strata between the Arcola limestone member and the top of the *Exogyra cancellata* zone, the name Demopolis member of the Selma chalk, originally proposed by Dr. Eugene A. Smith (18, pp. 11-12) is revived. The revised classification will be used in a forthcoming paper by Mr. Monroe, to be published as a Bulletin of the Geological Survey of Alabama.

The authors acknowledge courtesies extended to them by the late Dr. E. N. Lowe, the former Director of the Mississippi State Geological Survey, and by Dr. W. C. Morse, the present Director. They also express their appreciation to Messrs. E. L. Spain, Jr., N. Rose, and F. F. Mellen and their associates of the Tennessee Valley Authority, for making available information derived from their field studies in the Cretaceous area. The geologic boundaries in the area covered by the Iuka quadrangle in northeastern Tishomingo County were copied with modifications from a geologic map prepared by Mr. Spain and his associates. The boundary of the Tuscaloosa formation and the underlying Paleozoic rocks was copied with modifications from the map published by Dr. Morse (51) in 1930. The geological boundary lines in Union and Tippah counties, as shown on the geologic map (Plate 1A), with the exception of the Selma-Ripley boundary, were taken with certain modifications from manuscript maps prepared by Dr. L. C. Conant and Mr. Andrew Brown under the auspices of the Mississippi State Geological Survey. The generous cooperation of these authors is gratefully acknowledged. Acknowledgment is due to Mr. P. A. Bethany of Macon, Miss., for his assistance in collecting invertebrate fossils from the Prairie Bluff chalk, and to Dr. W. A. Evans of Aberdeen, Miss., for guiding the junior author to the bentonite deposits of Monroe County.

In the lists showing the distribution of fossils from the several formations the fossil collections were made by the authors except as otherwise indicated.

Fossils are listed from many small typical outcrops that are not described in the text.

HISTORICAL REVIEW

The first published reference to deposits of Cretaceous age in Mississippi is that of Morton (1, pp. 22, 24), in 1834, who says: "This state has an extensive [Cretaceous] marl tract in the Chickasaw fields, near the borders of Tennessee. The characteristic fossils have been sent to me by my friend, Mr. Brewster. In the Choctaw country similar fossils are also very abundant."

In 1853 Marcou (3, p. 44) published a geological map of the United States accompanied by an explanatory text in which he notes the presence of Cretaceous strata in Mississippi and indicates their distribution on the map. The area of outcrop of these strata in Alabama and Mississippi is approximately shown, though the Cretaceous-Tertiary boundary is placed too far to the south and west.

A brief general account of some of the major geologic features of the State, accompanied by a small black and white geological map, was contributed by Lieber (4, pp. 41-47) in 1854. Carboniferous sandstone and limestone are represented as outcropping in small areas in the northeastern corner of the State. These are overlain by "Tertiary" deposits, which include all of the Tuscaloosa formation and most of the Eutaw formation of the Upper Cretaceous as now known in Mississippi. A small area of "older Cretaceous Greensand" is represented west of the "Tertiary" in the north. West of both the "Tertiary" and the greensand is shown a broad belt of "Cretaceous limestone" extending in a curve from the Tennessee boundary southward through Mississippi and around into Alabama, which includes, in addition to Cretaceous, considerable areas on the west and south now known to belong to the Paleocene.

The first officially prepared geological report of the State was issued in 1854 under the authorship of Wailes (5, pp. 232-273). He briefly discusses Cretaceous marls in northeastern Mississippi (pp. 232-236), water wells in Noxubee County (p. 256), water wells in Lowndes and Monroe counties (pp. 262-264), and vertebrate and invertebrate remains in the Cretaceous deposits (pp. 270-273).

Forty-one new species of mollusks from Mississippi and Alabama were described by Tuomey (6, pp. 167-172) in 1854. The specimens were obtained chiefly from the Cretaceous, but the species are too briefly described and most of the locality descriptions are inadequate; none of the species are illustrated.

The second official report on the geology of the State was issued in 1857 under the authorship of Harper (8). He describes the geology, paleontology, mineral resources and soils of the Cretaceous area of Mississippi (pp. 72-131). The deposits overlying the Carboniferous in the northeast (pp. 49-61), referred to the "orange sand group", belong in fact to the Tuscaloosa and Eutaw formations of the Upper Cretaceous. "Notes and additions" (pp. 263-320) contains additional information on the Cretaceous formations.

This report records much information which, to be useful, must be shorn of inaccurate and fanciful interpretation. The errors are due in part to the inadequacy of the observations, but also largely to the attempt of the author to force the facts to fit certain preconceptions in regard to the stratigraphic relations of the formations. The author believes, for instance, that the marine sands ("Glauconitic group") are all beneath the "Calcareous group" (Selma), and the Ripley formation is therefore represented as underlying the Selma, which in fact it overlies. The formations are represented on the map as outcropping in blocky areas separated from each other by east-west boundaries at right angles to the strike, a most surprising interpretation in view of the rather large amount of detailed information that was obviously at the author's disposal. The Cretaceous-Tertiary boundary is represented more nearly in its correct position than on any previous map, but in most places is several miles too far to the west and south. Despite its defects the report affords a much more complete account of the Cretaceus formations of Mississippi than any previous contribution.

Fifty-six new species of Cretaceous fossils were described by Conrad (9, pp. 323-335) in 1858. The fossils were collected by Dr. W. Spillman of Columbus, Miss., at the now classic Owl Creek Bluffs, 2 1/2 miles (3 miles in previous reports) northeast of Ripley, Tippah County, Miss.

About 35 additional Cretaceous species from Mississippi were described by Conrad (10, pp. 275-298) in 1860.

The third general report on the geology of Mississippi, prepared by Hilgard (11, pp. 60-106), appeared in 1860. This is a classic report of its kind, and ranks with Roger's reports on the geology of the Virginias (1834-1841), Tuomey's report on the geology of South Carolina (1848), Safford's report on the geology of Tennessee (1869), Kerr's report on the geology of North Carolina (1875), and the report of Smith, Johnson, and Langdon on the geology of the Coastal Plain of Alabama (1894). It is more comprehensive than Harper's Mississippi report (1857), and its presentation and the quality of its interpretations mark a long step forward in Coastal Plain geology.

Hilgard divides the Cretaceous deposits of Mississippi into four "groups," in ascending order, the Eutaw sand, the Tombigbee sand, the Rotten limestone, and the Ripley group, a classification which, with certain rather important modifications and numerous minor adjustments of detail, still remains practically applicable in a large part of the Cretaceous area. The basal portion of Hilgard's Eutaw has been differentiated from the higher beds and correlated with the Tuscaloosa formation of Alabama; in order more closely to express the facts it has been found desirable to extend the application of the name Eutaw to include the Tombigbee sand which becomes a member of the Eutaw formation; the application of the name Coffee sand of Safford has been extended into Mississippi; the term Rotten limestone has been superseded by the combined geographic and more accurate descriptive term, Selma chalk; the uppermost part of the Selma chalk is now considered a separate formation, the Prairie Bluff chalk; the part of Hilgard's Ripley group equivalent to the marl at Owl Creek is now known as the Owl Creek formation; the white crystalline limestone forming the upper part of Hilgard's Ripley was subsequently shown by Harris (1896) to be basal Eocene (Paleocene). The map lacks the character that a more detailed knowledge of the boundaries, subsequently obtained, makes possible in a modern map.

The classification of the Cretaceous is based primarily on lithologic differences, and, though many Cretaceous fossils are enumerated, no attempt is made to differentiate restricted paleontologic zones.

Although Hilgard's observations and interpretations have, in most important respects, stood the test of subsequent investigations, his inclusion of so large a portion of the surficial materials of the

State in that most remarkable formation, the "Orange sand group" (later called the "Lafayette formation"), and his explanation of its origin, indicate a failure on his part to break away from some of the older notions of cataclysmic processes to account for geologic phenomena.

Singularly the "Orange sand" is described as being present to a limited extent only, in the following areas: 1st, the territory of the "Bluff formation" (loess); 2d, the territory of the Jackson group (Eocene limestone); 3d, the territory of the "Rotten limestone"; and 4th, the "Flatwoods" region (Eocene clay). It, therefore, is assumed to cover all the Cretaceous area except "a large portion of the territory occupied by the Rotten Limestone group."

In the light of recent interpretations, based on methods of investigation not in use at the time Hilgard worked in Mississippi, it is possible to subdivide the materials assigned to the "Orange sand formation" in the Cretaceous area, as follows: The greater part of it, more or less shifted down the slopes by creep, wash, and landslides, is the weathered residuum of the underlying Cretaceous formations; a part in the valleys of Tennessee, Tombigbee, and Tuscumbia rivers and their tributaries, is river terrace alluvium; a subordinate part, particularly in Tishomingo and Alcorn counties, is (according to the views of E. W. Shaw) a mixture of residuum and older and stratigraphically higher gravel deposits, either in the nature of ancient terrace deposits or basal conglomerates of a formation now entirely destroyed by erosion, leaving the pebbles as the only evidence of their former existence.

A general report on the geology of Mississippi, prepared by Crider (20, pp. 12-22) was published by the United States Geological Survey in 1906. The author summarizes the knowledge of the Cretaceous deposits (pp. 12-22), indicating their distribution on a small geologic and topographic map (1 inch=37 1/2 miles). Much of the area mapped as Tuscaloosa properly belongs with the Eutaw, and the surface distribution of the Paleozoic rocks is exaggerated. A small area in Kemper and southern Noxubee counties mapped as Ripley is now known to be Paleocene (Midway group). Annotated lists of fossils from the Ripley formation and the Selma chalk, prepared by Dr. T. W. Stanton, were included.

The mineral resources of the State are discussed in a separate chapter, especial mention being made of clays in the Tuscaloosa formation (pp. 50-54), cement materials in the Selma chalk (pp. 76-83), gravels in the Tuscaloosa formation, which, however, are erroneously referred to the "Lafayette formation" (pp. 85-86), silica, unimportant seams of lignite, and ocher in the Tuscaloosa formation (pp. 87-89), and fertilizers in the Eutaw, Selma, and Ripley formations (p. 89).

Six species of echinoids from the Upper Cretaceous of Mississippi were described by Slocom (24) in 1909; four, from the vicinity of Pontotoc, Pontotoc County, were new. A few other fossils from the same neighborhood are listed.

A new fossil crinoid, *Marsupites americanus,* from the Cretaceous of Mississippi was described by Springer (26, pp. 117-161) in 1911. This record is especially interesting on account of the rarity of the remains of this class of animals in the Cretaceous deposits of the Atlantic and Gulf Coastal Plain.

In 1913 E. W. Berry (28, pp. 567-574) enumerated three species of fossil plants from the Tuscaloosa formation (now considered basal Eutaw) in a cut of the Southern Railway, 1 5/8 miles east of Iuka, Tishomingo County, and noted the association of water-worn pellets of amber with the plants (p. 570).

In a contribution on the Cretaceous deposits of the eastern Gulf region, including Mississippi, published in 1914, Stephenson (30) describes the major lithologic divisions of the Cretaceous deposits; reviews the history of the nomenclature; discusses and indicates by diagram (Pl. 10) the age relations of the formations based on the contained faunas, recognizing two major faunal zones and two subzones; and indicates the geographic distribution of the formations on a small scale geologic map (Pl. 9).

The second part of the report (pp. 41-74, Pls. 13-21) includes systematic descriptions and illustrations of the species and varieties of *Exogyra* in the eastern Gulf region and the Carolinas, together with a discussion of their geologic and geographic ranges and their value in determining the age relations of the deposit. Nine of the figured specimens are from Mississippi.

The Cretaceous-Eocene contact in the Coastal Plain was discussed by Stephenson (31, pp. 155-182) in 1915, and several localities in Mississippi were described in detail.

In 1915 Clark (32) described eleven echinoid species and one crinoid species from the Cretaceous of Mississippi, none of which were new, but the types of which are from Mississippi. The original descriptions are cited in the synonomy under each species.

A fourth official State report, giving a general account of the geology of the State, was issued in 1915, under the authorship of E. N. Lowe (33), and revised editions were issued as Bulletin No. 14, in 1919 and Bulletin No. 20, in 1925. The book contains summary descriptions of the physiography, the geology, the water resources, the mineral resources, and the soils of the Cretaceous area of Mississippi. With the exception of certain minor changes the Cretaceous portion of the geologic map is essentially a copy of Crider's map accompanying Bulletin 283 of the United States Geological Survey.

Two new species of fossil corals from the Cretaceous of Mississippi were described by Stephenson (34, pp. 115-131) in 1916. These are *Micrabacia hilgardi* and *M. mississippiensis* from the Ripley formation, at Lee's old mill site, Union County. He also records the questionably identified species *M. cribraria* from the Selma chalk in eastern Lee County.

In 1917 Stephenson (37, pp. 243-250) proposed and defined the new stratigraphic term "tongue," and cited several examples in Mississippi. However, one of these examples, the Oktibbeha tongue of the Selma, is now included in the Prairie Bluff chalk which is considered to be a unit of formation rank.

An important paper on the fossil floras from the Cretaceous formations of the eastern Gulf region, including Mississippi, was contributed by Berry (40, p. 14) in 1919. He describes four species from Mississippi, found near Iuka, Tishomingo County, only one of which, *Phyllites pistiaeformis*, is new.

In 1927 Gilmore (47, p. 452) recorded teeth of the mosasaur *Globidens alabamaensis* Gilmore from the Selma chalk near Saltillo, Lee County. *Globidens* had been known previously only from Alabama.

In 1928 Stephenson (48, pp. 29-43) described the Upper Cretaceous deposits in accordance with the accepted classification of that date. He treats the Coffee sand as a member of the Eutaw formation; most of the Prairie Bluff chalk is included in the Selma chalk; and the Owl Creek formation and part of the Prairie Bluff chalk are included in the Ripley formation. He does not recognize the unconformity between the Tuscaloosa and Eutaw formations, nor the one at the base of the Prairie Bluff and Owl Creek formations; he does not show the Arcola limestone member of the Selma. With the exceptions noted his interpretation of the geology is much the same as in the present report. Compared with the lines on the larger scale map accompanying the present report, the geologic boundary lines on the map, Plate 2, of his report, are more generalized and less accurately established.

Needham (49, pp. 117-120) in 1928 gave a brief review, with references, of the characteristics of the Ripley formation of Mississippi. Two sections in Oktibbeha County are described and a few fossils are listed.

The first record of bentonite in Mississippi was published by Grim (50, pp. 1-14) in 1928. He briefly describes deposits in Monroe and Prentiss counties and assigns them to the Eutaw formation. This report was supplemented by one by H. M. Morse (54, pp. 3-7) who describes in addition a deposit in Itawamba County.

The boundary between the Tuscaloosa formation and the underlying Paleozoic rocks in northeastern Mississippi is shown on a map published by W. C. Morse (51, p. 8) in 1930.

In a paper by Stephenson (52, pp. 1351-1361) in 1933 *Exogyra cancellata* Stephenson is recorded from 18 localities and *Anomia tellinoides* Morton from 9 of the 18 localities, all in a thin zone, bearing the name of the first mentioned fossil, in the Upper Cretaceous series of Mississippi (pp. 1355-1356).

In 1934 Needham (55, pp. 55-59) described the petrology of samples of the Tombigbee sand member of the Eutaw formation from Plymouth Bluff, Lowndes County. He concludes that the materials were derived chiefly from the crystalline complex of the southern Appalachian region under conditions of rather low relief and mature weathering. The materials are considered to have been transported by streams of low gradient, carrying much less than their capacity loads, and having relatively short courses to the sea; they are interpreted to have been deposited above wave base in an agitated and very shallow transgressing sea, but the lack of cross bedding in the sand does not support this view.

Stephenson (56, pp. 588-592) in 1935 reported *Diploschiza cretacea* Conrad from three localities in Mississippi. He describes *Diploschiza melleni* from the upper part of the Selma chalk and from the Oktibbeha tongue of the Selma chalk, both now included in the Prairie Bluff chalk.

In 1935 Bay (57, pp. 21-31) referred the bentonite deposits in northern Mississippi in part to the Coffee sand, in part to the Tombigbee sand member of the Eutaw formation, and in part to the lower part of the Eutaw formation. The oldest deposits, those thought by Bay to be in the lower part of the Eutaw, are now believed to be in the upper part of the Tuscaloosa.

Vestal (59, pp. 34-35) in 1936 reported the discovery of bentonite in the Ripley formation near Pontotoc, Pontotoc County, by Frederic F. Mellen.

Stephenson and Monroe (61, pp. 806-809) in 1937 proposed the extension of the application of the name Prairie Bluff chalk (formerly Prairie Bluff tongue of Selma chalk) from Alabama westward into Mississippi, for about 80 feet of chalk, formerly included in the upper part of the Selma chalk, and for equivalent chalk formerly called the Oktibbeha tongue of the Selma chalk. They also proposed the name Owl Creek formation for non-chalky beds in northern Mississippi equivalent in age to the Prairie Bluff chalk. These changes were considered desirable because the Prairie Bluff chalk is separated from the underlying Selma and Ripley units by an unconformity that continues northward at the base of the Owl Creek formation, separating it from the Ripley strata below.

In the same year (1937) Mellen (62) described a body of massive, residual clay intervening between the Paleozoic rocks below and the overlying Tuscaloosa formation, and named it the Little Bear residuum. He conceives that the kaolinitic and bauxitic clays of the Little Bear in the Tishomingo County area originated in situ from the decomposition of Mississippian strata (Paleozoic). He suggests that these clays may have economic value as refractory or structural material, as a body for porcelain tableware, and as paint pigments.

A reclassification of the stratigraphic units of the Upper Cretaceous in Mississippi and Alabama was proposed by Stephenson and Monroe (63, pp. 1639-1657) in 1938. The Selma chalk of west-central Alabama and east-central Mississippi is shown to be represented in northern Mississippi, in ascending order, by the Coffee sand, the middle part of the Selma, and the Ripley formation. The Arcola limestone member of the Selma chalk is described and named; its linear extent is shown to be from Lee County, Miss., to Bullock

County, Ala. The breaks in deposition at the top of the Tuscaloosa, the top of the Eutaw, the top of the Arcola limestone member of the Selma, and the base of the Prairie Bluff and Owl Creek are pointed out. The intertonguing and merging of the Prairie Bluff chalk and the Owl Creek formation between Pontotoc and Tippah counties are explained. The faunal zones in the series are described, and the units are correlated with formations in the western Gulf region, the Chattahoochee region in eastern Alabama and Georgia, and the north Atlantic Coastal Plain, and with the standard European section.

In 1939 Stephenson (64, pp. 96-99) described the preservation of fossil mollusks by clay replacement near Pontotoc. A bed of sand containing many Upper Cretaceous molluscan shells mechanically reworked in the base of the Clayton formation (Paleocene) is exposed in a railroad cut half a mile south by west of Pontotoc, Miss. This bed has been altered by circulating waters in such a way that the calcium carbonate originally composing the shells has been completely replaced by pure clay material which preserves the shell structure in finest detail. According to C. S. Ross, whose opinion is quoted, the replacing clay is beidellite of the montmorillonite group. He believes that the clay was carried in true chemical solution in the circulating ground water. Partial replacement by clay of the calcium carbonate of the shells is noted in this same basal Midway bed at several other localities in Pontotoc and Union counties. Further treatment of this subject with particular reference to the replacing clay was given by Ross and Stephenson (65, pp. 393-397) in 1939.

PHYSICAL GEOGRAPHY

GENERAL

Southern Mississippi forms a part of the main Gulf Coastal Plain of southern United States, and the northern part of the State extends into the subordinate physiographic division of the Coastal Plain to which the name Mississippi Embayment is commonly applied. The Gulf Coastal Plain is in general an extensive lowland ranging in altitude from sea level to about 1,000 feet above sea level and in width from 130 to over 500 miles. The plain is underlain by a series of sedimentary formations ranging in age from Cretaceous to Recent, and increasing in thickness from a feather edge along the inner border of the plain to an unknown maximum of perhaps 25,000 or 30,000 feet at the coast in the vicinity of the mouth of the Mississippi River. These deposits rest on a basement of ancient rocks in part of Paleozoic and in part of pre-Paleozoic age.

The Mississippi Embayment is a broad arm of the Gulf Coastal Plain extending from the main plain up the valley of the Mississippi River to the southern extremity of Illinois. The Embayment is bordered on the west, north, and east by outcropping sedimentary rocks of Paleozoic age.

Mississippi was divided by Lowe (33, pp. 28-34) into 10 topographic regions or districts: Tennessee River Hills, Black Prairie Belt, Pontotoc Ridge, Flatwoods, North Central Plateau, Jackson Prairie Belt, Long Leaf Pine Hills, Coastal Pine Meadows, Loess or Bluff Hills, and Yazoo Delta (Figure 1). Essentially the same classification is used in the present report.

The outcrop of the Cretaceous deposits is entirely within the first three regions—[Tombigbee and] Tennessee River Hills, Black Prairies, and Pontotoc Hills.

TOMBIGBEE AND TENNESSEE RIVER HILLS

A hilly area in northeastern Mississippi, having a maximum width in Itawamba County of about 20 miles and extending from the Tennessee State line southward adjacent to the Alabama line into Lowndes County, was called by Crider and Johnson (21, p. 2), and later by Lowe, (33, p. 29) the Tennessee River Hills. This name is not strictly appropriate, as the area lies mainly in the drainage basin of Tombigbee River, and only a relatively small part is in the basin of Tennessee River. The district is here designated the Tombigbee and Tennessee River Hills.

The district embraces the belts of outcrop of the prevailingly sandy Tuscaloosa, Eutaw, and Coffee formations of the Upper Cretaceous, and the relatively minor belts of Paleozoic rocks along the larger streams. The surface ranges from smoothly rounded hills of low relief separated by broad valleys, to hills and ridges of 200 feet relief with steep slopes, narrow crests, and narrow separating valleys. The tops of the hills range in altitude above sea level from 400 feet in the south in Lowndes and Monroe counties to a maximum of 806 feet near Iuka in Tishomingo County.

That part of the district in which the Tuscaloosa formation appears at the surface is characterized by steep slopes and more or less conical, but rounded hills, in general not as high as those underlain by the Eutaw formation farther west.

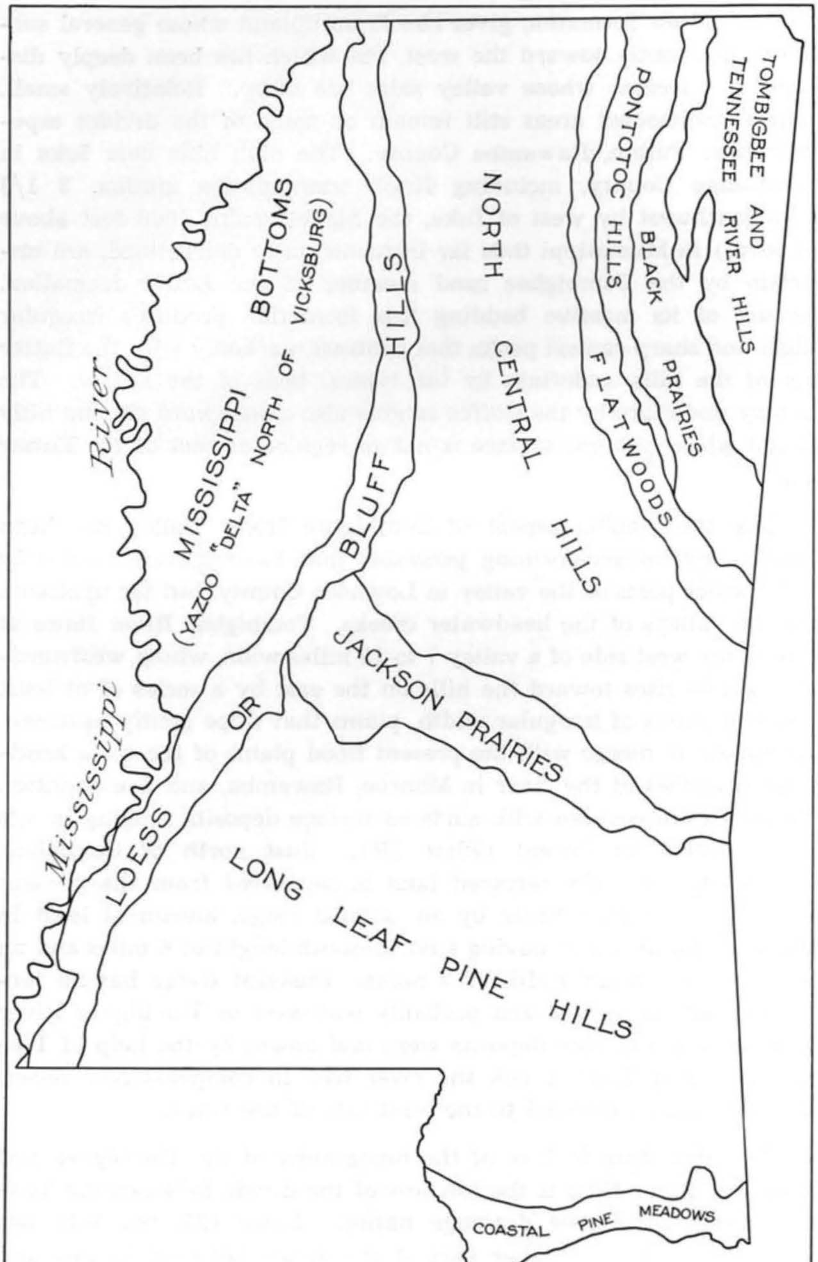

Figure 1.—Physiographic districts of Mississippi.

The Eutaw formation gives rise to an upland whose general surface slopes gently toward the west, but which has been deeply dissected by streams whose valley sides are steep. Relatively small, flattish undissected areas still remain on some of the divides especially near Fulton, Itawamba County. The high hills near Iuka in Tishomingo County, including Knob triangulation station, 3 1/3 miles southwest by west of Iuka, the highest point (806 feet above sea level) in Mississippi thus far instrumentally determined, are underlain by the Tombigbee sand member of the Eutaw formation. Because of its massive bedding this formation produces irregular ridges and sharp conical peaks that contrast markedly with the flatter tops of the hills underlain by the typical beds of the Eutaw. The country underlain by the Coffee sand is also a westward sloping hilly upland whose general surface is not so regular as that of the Eutaw belt.

The topographic aspect of Tombigbee River Valley has been modified by terrace-forming processes that have operated not only in the wider parts of the valley in Lowndes County, but far upstream into the valleys of the headwater creeks. Tombigbee River flows at or near the west side of a valley 7 to 15 miles wide, whose westward-sloping side rises toward the hills on the east by a series of at least 5 terrace plains of irregular width, plains that slope gently upstream and appear to merge with the present flood plains of the main headwater branches of the river in Monroe, Itawamba, and Lee counties. The plains are covered with surficial terrace deposits ranging in age from Pliocene to Recent (Plate 1B). Just north of Columbus, Lowndes County, the terraced land is separated from the present valley of Tombigbee River by an isolated ridge, known at least in part as Pleasant Ridge, having a north-south length of 6 miles and an east-west maximum width of 3 miles. Pleasant Ridge has no terrace deposit on its top, and probably was west of Tombigbee River at the time the terrace deposits were laid down; by the help of Tibbee River and Town Creek the river has, in comparatively recent times, shifted its channel to the west side of the ridge.

An interesting feature of the topography of the Tombigbee and Tennessee River Hills is the lowness of the divide between the Tennessee and Tombigbee drainage basins. Lowe (27, pp. 5-7) has pointed out that the higher part of the divide between Yellow and Mackys creeks, about 3 1/2 miles north by west of Paden, is a narrow ridge a few hundred yards wide and perhaps 50 feet high, and that it is probable that Mackys Creek at a point 4 miles below Paden is as low as Tennessee River at the north boundary of the State.

A recent survey by the Corps of Engineers, U. S. Army, to determine the feasibility of a canal connecting the Tennessee and Tombigbee Rivers shows that the crest of the divide near Paden is 569 feet above sea level. As the minimum pool altitude of Pickwick Lake, Tennessee River, is 408 feet above sea level, a cut of 173 feet would provide a channel 12 feet deep at low water.

BLACK PRAIRIES

West of the Tombigbee and Tennessee River Hills, extending from the Alabama State line in east-central Mississippi to the Tennessee line, is a district of subdued topography, 3 to 25 miles wide, known as the Black Prairies. This area is underlain mainly by the Selma chalk, but in Kemper and Noxubee counties it includes also the narrow belt of outcrop of the Prairie Bluff chalk. The surface ranges from nearly level plains to low broadly rounded hills rising in places to a maximum height of as much as 40 feet above the broad shallow separating valleys. The belt ranges in altitude above sea level from a minimum of 250 feet in the south in Noxubee County to over 500 feet in the north in Prentiss and Alcorn counties. In general the belt is lower than the Tombigbee and Tennessee River Hills on the east and lower than the Pontotoc Hills on the west.

In narrow areas bordering the larger streams, terrace-forming processes, operating during Pleistocene and Recent times, have modified the pevailing rolling topography to nearly flat plains immediately underlain by alluvial loams, clays, and sands. The best example of this kind of topography is in the valley of Tibbee River in Clay County where the terrace extends from the western part of the county to Tombigbee River Valley, and has a maximum width of 6 or 7 miles. West Point is situated on this plain.

PONTOTOC HILLS

The Pontotoc Hills lie west of the Black Prairies and form a belt ranging in width from about 21 miles on the Tennessee State line to a minimum of 2 or 3 miles in Oktibbeha and Noxubee counties. This area is underlain mainly by the sandy beds of the Ripley formation but includes also the Owl Creek formation, part of the Prairie Bluff chalk, and the bodering Clayton formation of the Midway series (Paleocene). The hills along the western side of the area rise

40 or 50 feet above the valleys and have gentle slopes and broadly rounded crests. The sharpness of the relief increases eastward reaching a maximum of 250 feet along the eastern side of the area where the crests of the hills are narrow, the slopes steep, and the valleys narrow. The hills range in altitude above sea level from 350 feet in the south to a maximum of nearly 800 feet in the north in the western part of Alcorn County.

From northern Union County to central Pontotoc County, the Pontotoc Hills form the divide between the Tombigbee River drainage system on the east and the streams that flow to Mississippi River on the west. In Tippah and Alcorn counties the Hills are drained by the headwater streams of Hatchie River, a tributary of the Mississippi in Tennessee. From central Pontotoc County southward the drainage of the Hills is effected by tributaries of Tombigbee River.

Shaw (39, pp. 149, 153) has pointed out that the tops of the Pontotoc Hills are accordant in altitude with tops of other high hills in northeastern Mississippi, and regards them as monadnocks remaining from erosion of the Highland Rim Peneplain of the Appalachian Mountains. The highest point so far determined in the Pontotoc Hills is Lebanon Mountain, 792 feet high, in western Prentiss County.

FLATWOODS

West of Pontotoc Hills and southwest of the Black Prairie Belt farther south is a gently undulating to slightly rolling wooded plain underlain by the dense, impervious Porters Creek clay (Paleocene) and known as the Flatwoods.

DISTRIBUTION AND GENERAL CHARACTER

The Upper Cretaceous formation of Mississippi appear at the surface in the northeastern part of the State, in an area of about 5,300 square miles, which has a maximum north-south length of about 160 miles and a maximum east-west width of 50 miles. Tennessee bounds the area on the north, and Alabama on the east, and the easternmost extension of the overlying and overlapping Paleocene strata determines its western border (map, Plate 1A). The deposits, chiefly of marine origin, consist of stratified sands, gravels, clays, chalks, marls, and impure sandy limestones, having a maximum thickness in east-central Mississippi of 2,000 feet or more; the bedding planes dip to the west and southwest at the nearly uniform rate of 30 feet to the mile. The deposits rest unconformably on a basement of limestones, sandstones, and shales belonging to the Devonian and Carboniferous systems of the Paleozoic. The rocks of the Paleozoic appear above water level along some of the larger streams in the extreme northeastern part of the State, and their upper eroded surface inclines slightly to the west and southwest at an angle which, where measured in the northern part of the State, does not exceed 30 feet to the mile; however, a well in Lowndes County shows that the inclination there is greater than 30 feet to the mile. The general attitude of the Upper Cretaceous strata and their relation to the underlying basement rocks and to the overlying Paleocene strata are shown in the five cross sections (A-A, B-B, C-C, D-D, and E-E, given in Plate 2).

The Upper Cretaceous deposits have been subdivided on the basis of their lithologic character, in ascending order into the following geologic units: Tuscaloosa formation, Eutaw formation (including Tombigbee sand member), Selma chalk and its partial equivalents the Coffee sand and the Ripley formation, and Prairie Bluff chalk and its equivalent the Owl Creek formation. The relation of these units to each other in different parts of the belt of outcrop is indicated in the accompanying generalized table; their distribution is shown on the geologic map, Plate 1A.

A few fossil plant remains have been found in the Tuscaloosa and in the lower or typical beds of the Eutaw formation, but no fossil marine invertebrates have been reported from these deposits in Mississippi, although in Alabama a few invertebrates have been found in both the lower beds of the Eutaw and in the Tuscaloosa. Marine invertebrates are common, however, in the upper half of the Tombigbee sand member of the Eutaw formation, and are present in greater or less abundance in all of the Upper Cretaceous sediments above the Tombigbee sand. Two major faunal zones have been differentiated in that part of the Upper Cretaceous series embraced between the middle of the Tombigbee sand and the top of the series: the *Exogyra ponderosa* zone includes the upper half of the Tombigbee and about the lower two-thirds of the Selma chalk and beds of equivalent age; the *Exogyra costata* zone includes the upper third of the Selma and the Prairie Bluff chalk, and their equivalents.

The Tuscaloosa formation is separated from the overlying Eutaw formation by an unconformity that is believed to record an erosion period of considerable length; the evidence suggests that the magnitude of this hiatus increases from the south toward the north. A bed of pebbles and coarse sand a few inches to a foot or more in

GENERALIZED TABLE OF UPPER CRETACEOUS FORMATIONS OF MISSISSIPPI.

Fossil zones		East-central Miss.	Latitude of Lee Co.	Northeastern Miss.
Exogyra costata		Prairie Bluff chalk	Owl Creek formation Prairie Bluff chalk	Owl Creek formation
Exogyra costata		Selma chalk	Ripley formation	Ripley formation
	Exogyra cancellata			
Exogyra ponderosa	Diploschiza cretacea		Selma chalk (root of large unnamed tongue) Tupelo tongue of Coffee sand Mooreville tongue of Selma chalk	Selma chalk (unnamed tongue) Coffee sand
		Eutaw form. { Tombigbee sand member Typical beds	Eutaw form. { Tombigbee sand member Typical beds	Eutaw form. { Tombigbee sand member Typical beds.
		Tuscaloosa formation	Tuscaloosa formation	Tuscaloosa formation

thickness is present at most places at the base of the Eutaw formation. The typical irregularly bedded sands and clays of the Eutaw formation grade upward with no evidence of a stratigraphic break into the massive glauconitic Tombigbee sand member. The basal few feet of the Selma chalk is very sandy and contains many phosphatic nodules and phosphatic molds of fossils and shells of the oyster family that have been reworked from the underlying Tombigbee sand; this bed is interpreted to be a basal conglomerate. The contact of the Tombigbee and Selma at many places is a sharp, irregular surface and is believed to be an unconformity. The time interval recorded by this unconformity is not considered a long one, however, for there is no marked change in fauna above the break.

About 265 feet above the base of the Selma chalk is a stratum of pure limestone, the Arcola limestone member (Ksa on the map, Plate 1A), a foot or more thick, which has been traced from Bullock County, Ala., to southern Lee County, Miss. The chalk below this bed is more argillaceous than that above it. The chalk immediately above the Arcola contains abundant phosphatic nodules, phosphatic molds of fossils, and reworked cobbles of limestone; this bed is believed to be a basal conglomerate and its base is interpreted, in Mississippi, as a diastem or possibly an unconformity. One hundred to 180 feet above the Arcola limestone member is the *Diploschiza cretacea* zone (D on the map), 60 feet or less in thickness, which has been traced by means of the shells of this characteristic species from Montgomery County, Ala., nearly to Tupelo, Miss.

No stratigraphic break has been recognized within the Selma chalk between the zones of *Exogyra ponderosa* and *E. costata,* and the line separating them (P on geol. map, Plate 1A) is drawn arbitrarily between the last appearance of *ponderosa* and the first appearance of *costata.*

The *Exogyra cancellata* zone is a restricted zone, 100 to 150 feet thick, forming the lower part of the larger *E. costata* zone. Typical shells of *E. cancellata* Stephenson and *Anomia tellinoides* Morton are confined in their vertical range to this thinner zone, not only in Mississippi, but throughout the length of the Atlantic and Gulf Coastal Plain and into Mexico. The upper part of the *E. costata* zone in Mississippi includes the upper part of the Selma chalk above the *E. cancellata* zone and the Prairie Bluff chalk and their nonchalky equivalents, the Ripley and Owl Creek formations in the northern part of the State.

The Selma chalk is separated from the overlying Prairie Bluff chalk by an unconformity, a stratigraphic break that has been traced into northern Mississippi where it separates the Ripley formation from the overlying Owl Creek formation.

The Upper Cretaceous series of Mississippi is separated from the overlying Paleocene by a stratigraphic break of major magnitude.

STRUCTURE

In general the Cretaceous strata of Mississippi exhibit simple monoclinal structure. In the northern third of the area of outcrop the beds strike about N. 15° E.; toward the south the trend of the strike curves around until in the latitude of Tupelo the strike is nearly north; on the Alabama line in Noxubee County the beds strike N. 30° W.

The dip varies from place to place, but in general averages about 30 feet to the mile except between Iuka and Corinth in the northern part of the region where the dip of the Tuscaloosa formation seems to be only about 20 feet to the mile.

In southern Lowndes County the strata have been bowed up into a gentle anticline, or possibly have been faulted up, for the Eutaw formation is exposed far southwest of the position in which it would outcrop if the strike were normal. The axis of the anticline trends about S. 35° W., nearly parallel with the folds in the eastern Appalachians in eastern Alabama. No adequate study has been given to this structural feature so that it is not possible to tell at present whether the strata are faulted or not, whether the anticline is closed on the northeastern end, or how much the beds have been upwarped. It is roughly estimated that the Eutaw strata exposed in the banks of Tombigbee River 5 miles south of Columbus have been upwarped at least 50 feet.

No large faults are known in northeastern Mississippi, but faults of small displacement are common, especially in the Prairie Bluff chalk. Faults in this formation have been observed in Kemper, Noxubee, Oktibbeha, Chickasaw, and Pontotoc counties. Time was not available for studying these faults in detail to determine whether they have common orientation or whether they form steps in displacements of greater magnitude.

TUSCALOOSA FORMATION

GENERAL FEATURES

NAME

The name Tuscaloosa was proposed in 1887 for the lowermost division of the Cretaceous of Alabama, typically exposed in the vicinity of Tuscaloosa, by Smith and Johnson (14, p. 95) who describe the formation as follows: "The most conspicuous rocks are purple and mottled clays interstratified with white, yellowish white, pink, and light purple micaceous sands, and near the base of the formation dark gray, nearly black, thinly laminated clays with sand partings. Typical sections of the mottled clays and white sands may be seen at Steeles Bluff and at Whites Bluff on Tuscaloosa River; and a beautiful section of the pink micaceous sands is exposed in two large gullies below Havana, in Hale County, near the residence of Hon. A. M. Avery. The dark gray laminated clays are well seen near and in the city of Tuscaloosa."

The pink micaceous sands in the gullies near Havana which the authors include in the Tuscaloosa are regarded by the present writers as referable to the basal portion of the overlying Eutaw formation.

The Mississippi representatives of the Tuscaloosa formation are included in the basal portion of Hilgard's Eutaw formation (11, pp. 62-68). The Tuscaloosa was first recognized in this State by Johnson (14, pp. 115-116) in 1887 who examined exposures of the deposits in Tishomingo and Itawamba counties, and both Smith and Johnson recognized the continuation of the formation without interruption into Mississippi, as shown by their geologic map (Pl. XI, p. 134), on which the Tuscaloosa is represented as intercepting the State line from northern Pickens County northward to Tennessee River.

In most subsequent papers the name Tuscaloosa is applied in Mississippi essentially as proposed by Smith and Johnson, but the more recent field studies have shown that on all the maps published prior to 1928, including that of the senior author (30), the Tuscaloosa-Eutaw boundary has been drawn too far to the west, except in Itawamba County.

AREAL DISTRIBUTION

The Tuscaloosa formation has its greatest development in Alabama where it appears at the surface, or is present beneath thin surficial deposits, along the inner margin of the Coastal Plain in a belt 8 to 40 miles wide, extending from Chattahoochee River westward and northwestward to the Mississippi and Tennessee State lines. Its surface area in Mississippi is relatively small. It crops out in the lower slopes of the valley of Buttahatchie River and its tributaries, Sipsey and Splunge creeks, in eastern Monroe County; in the lower slopes of the valleys of the East Fork of Tombigbee River and its tributaries from the east, and of Bull Mountain Creek and its principal tributary, Chubby Creek, in eastern Itawamba County; in the lower slopes of the valley of Mackys Creek in Prentiss County; and in the lower slopes of the valleys of Mackys and Indian creeks and their tributaries in Tishomingo County. Along the sides of these valleys the top of the formation gradually rises to the eastward, the strata finally reaching the upland surface in an irregular belt having a maximum width of 6 or 8 miles in eastern Itawamba County and extending into the eastern part of Tishomingo County.

The formation extends from Alabama into southern Tennessee where it forms a thin capping on the Paleozoic hills of eastern Wayne County, and dips slightly to the westward where it is believed to pinch out within a short distance beneath the overlapping Eutaw formation.

LITHOLOGIC CHARACTER AND THICKNESS

The Tuscaloosa formation in Mississippi is composed of sands, clays, gravels, and lignites, which exhibit great irregularity of bedding. They were laid down in part in the shallow marginal waters of the sea in which in early Upper Cretaceous time occupied the downwarping trough of the Mississippi Embayment, in part in bordering bays, lagoons, and marshes, and in part in the deltas of debouching streams. The maximum measured thickness of the formation near its outcrop in Mississippi is in the P. J. MacAlpine, Rye No. 1 well, in Sec. 15, T.15 S., R.17 W., Monroe County, which entered the top of the Paleozoic rocks at 591 feet. As the well did not start at the extreme top of the Tuscaloosa, the thickness of the formation in southeastern Monroe County probably slightly exceeds 600 feet. The formation becomes thinner to the north and is wanting in the extreme northern part of Tishomingo County.

That the thickness of the formation varies greatly in short distances, because of the uneven surface of the Paleozoic basement rocks, is shown by many wells that have penetrated the entire formation. J. P. Evans's Whiteside well in Lee County entered the Tuscaloosa at 444 feet and the Paleozoic at 518 feet—a thickness of only 74 feet of Tuscaloosa. P. J. MacAlpine's Cowart well in Monroe County penetrated 193 feet of Tuscaloosa before entering Paleozoic rocks. The Cowart well started about 45 feet below the Tuscaloosa-Eutaw contact. The City well at Amory reached the top of the Tuscaloosa at 240 feet and the base at 373 feet—a total thickness of 133 feet. The Amory Development Company's Bourland well about a mile southwest of Amory entered the Tuscaloosa at 309 feet and the Paleozoic at 476 feet, penetrating 167 feet of Tuscaloosa. The Ohio Oil Company's Cantrell well in Clay County penetrated 497 feet of Tuscaloosa between depths of 892 and 1,389 feet. The Thompson Oil and Gas Syndicate's Donahue well in Noxubee County entered the Tuscaloosa at 870 feet and was abandoned, apparently still in the formation, 865 feet below at a depth of 1,735 feet.

The gravels which are chiefly in the basal 175 feet or less of the formation are largely composed of angular to subangular coarse chert derived from the chert-bearing Mississippian limestones, which form part of the basement on which the Cretaceous deposits rest, and which crop out in the upland east of the Coastal Plain in Alabama and Tennessee. A few small smoothly rounded quartz pebbles were observed in the gravels at one place near Red Bay, Franklin County, Ala., and at several places in Itawamba County, but quartz larger than sand grains is rare in the formation in Mississippi and in the immediately adjacent parts of Alabama. Locally the gravels are irregularly indurated to ferruginous conglomerate. Interbedded with the gravels are numerous lenses of fine to coarse, current-bedded, more or less micaceous sand and subordinate layers of more or less sandy clay. The gravels have their greatest development east of Iuka in northeastern Tishomingo County where they probably have a maximum thickness of 100 feet, and where they are extensively mined for road metal and railroad ballast. Here they compose nearly all of the formation, and are interbedded with subordinate lenses of coarse sand and here and there lenses of white siliceous clay derived from the silica deposits of the underlying Paleozoic rocks. In places from a few feet to 30 feet of thinly laminated very fine sand, of the kind characteristic of the formation farther south, is present above the gravel. The gravel deposits of this area were classed by Hilgard with his "Orange sand" formation, and by Crider with the Lafayette formation.

Southward from Iuka irregularly bedded more or less micaceous sands and clays overlie the basal gravel, the gravel probably becoming somewhat thinner in that direction. The sands predominate over the clays, though the clays form conspicuous lenses and layers of different grades of purity, including light-bluish and grayish to white clays, some of which may prove to be of value in the manufacture of pottery. In Itawamba and Monroe counties a fairly persistent bed of bentonite crops out near the top of the formation. Subordinate lenses of gravel and lenses and layers of lignite are also present. Glauconite is rare in the sands of the Tuscaloosa, but very fine-grained highly leached glauconite has been observed at a few places, both in the middle of the formation in Alabama and near the top in Mississippi.

Figure 2.—Laminated sands and clays of the Tuscaloosa formation, with irregularly developed indurated and platy ferruginous sandstones; cut of Illinois Central Railroad, 1 1/4 miles southeast of Red Bay, Franklin County, Ala. Photo by L. W. Stephenson.

Good exposures of the formation are afforded by cuts of the Illinois Central Railroad southeast of Red Bay in Franklin County, Ala. Here the deposits consist of current-bedded gray, pinkish, yellowish, and purplish sands and clays with irregularly distributed corrugated and tubular ferruginous sandstones that are in fact a phenomenon of weathering (Figure 2).

Eastward in Alabama, the Tuscaloosa formation becomes much thicker, having a thickness of 1,000 feet or more in the region of Warrior River. Here the basal portion of the formation is composed in part of gravel, chiefly chert (14, pp. 115-116), though the accumulations of gravel are thinner and much less extensive than in northeastern Mississippi.

The varicolored sands overlying the clay in the Havana gullies, which Smith and Johnson (14, p. 111) referred to the Tuscaloosa, should, in the opinion of the writers be regarded as forming the lower part of the Eutaw formation.

STRATIGRAPHIC AND AGE RELATIONS

In northeastern Mississippi the Tuscaloosa formation rests with unconformable relations on basement rocks belonging to both the Devonian and Mississippian. Farther south in Mississippi the buried basement rocks belong to the Pennsylvanian. The time interval represented by the unconformity along its outcrop was extremely long, for several important series and systems of rocks are absent, which if present in Mississippi would intervene between the Pennsylvanian and Upper Cretaceous sediments. These include the rocks of the Permian, Triassic, Jurassic, and Lower Cretaceous. This probably means that northeastern Mississippi was a land surface during most of the vast period of time that elapsed between the deposition of the Pennsylvanian rocks and the transgression of the sea in which the Upper Cretaceous sediments were laid down.

In Alabama the youngest rocks on which the Tuscaloosa formation rests belong to the Pennsylvanian which forms the basement in a large area extending from Franklin to Tuscaloosa counties. East of Tuscaloosa County the basement at different places is formed of rocks ranging in age from pre-Cambrian (crystallines) to Pennsylvanian.

The surface on which the Tuscaloosa formation rests is highly irregular. The writers have not studied the topography of this surface in sufficient detail to understand the nature of the pre-Cretaceous drainage system but estimate that the relief is of the magnitude of 100 feet or more in Tishomingo County.

The Tuscaloosa formation is overlain unconformably by the Eutaw formation and is in part overlapped by it (Figure 7). Before deposition of the Eutaw, the top of the Tuscaloosa was eroded nearly to a peneplain whose surface is irregular in detail. At several places in Tishomingo County the basal beds of the Eutaw formation fill ancient stream channels in the Tuscaloosa formation, so that the base of the Eutaw cuts across the bedding planes of the Tuscaloosa (Figure 8). The basal beds of the Eutaw formation are composed in part of chert gravel, the pebbles of which are small and subangular, probably derived chiefly from the gravel of the Tuscaloosa formation.

In northern Tishomingo County the Eutaw formation rests on a one-foot bed of chert cobbles derived from the underlying Mississippian formations. This thin bed may represent the Tuscaloosa formation, or may be a basal gravel of the Eutaw formation.

The Tuscaloosa deposits were laid down in a sea which transgressed from west-central Alabama northwestward through Mississippi. Consequently, the formation has its maximum thickness (1,000 feet) in Alabama, from whence it gradually diminishes until in northern Tishomingo County it is completely overlapped by the Eutaw formation.

In small areas bordering Bear Creek in Tishomingo County, Bull Mountain Creek in Itawamba, and Buttahatchie River in Monroe, the formation is unconformably overlain by terrace loams, sands, and gravels of Pleistocene and Recent age.

PHYSIOGRAPHIC EXPRESSION

In the relatively small area in eastern Tishomingo and Itawamba counties where the formation immediately underlies the upland surface, the topography is strongly hilly except as it has been modified by Pleistocene and Recent terrace forming processes along the valley slopes of Bear and Bull Mountain creeks. In fact, this is one of the roughest, most broken areas in the State. The dividing ridges range in altitude from 600 to 680 feet above sea level. The lowest parts of the area are along Tennessee River and Bear Creek, where within the limits of the Iuka quadrangle the 380-foot contour closely hugs the stream banks. Springs and small tributary streams are numerous. Some of the larger creeks have broadened their flood plains slightly, but most of the small streams have narrow deep valleys bordered by steep slopes and divides. The gradients of the small streams are comparatively gentle from near their headwaters to their mouths, the rate of slope ranging from 50 feet or less to 70 or 75 feet to the mile. The gradients of the spring branches that feed the main creeks are steep, some of them descending at the rate of 100 feet or more within a quarter of a mile.

The maximum surface relief slightly exceeds 200 feet in places and in general ranges from 50 to 200 feet. Using a commonly accepted term for the description of such features, stream dissection may be said to have just about reached maturity. That is, more or less pronounced slopes predominate over flat or nearly flat tracts. The roughness of the area is somewhat increased and the gradients of the streams are somewhat affected by the Paleozoic rocks which crop out in the lower slopes of the valleys of Tennessee River, Bear Creek, and some of the tributary creeks, in places forming steep or even precipitous bluffs overlooking the flood plains.

This area is included in the physiographic division to which the name Tombigbee and Tennessee River Hills is applied (Figure 1). East of Bear Creek in Alabama, and northeast of Tennessee River in Tennessee, these hills are even more rugged than in Mississippi.

FOSSIL CONTENT

The lower part of the Tuscaloosa formation in Alabama has yielded many well preserved fossil leaves. In Mississippi leaves have been reported from beds at Maxey's old mill site, southeast of Fulton, Itawamba County. Beds of lignite, which are very subordinate and so far as known are of no commercial importance, are present in places in the formation both in Alabama and Mississippi. No well preserved mollusks have been found in the formation, but a few obscure prints of *Ostrea* and *Volsella* associated with poorly preserved leaves have been noted in clays of the formation 4 miles east by north of Maplesville, Chilton County, Ala.

LOCAL DETAILS

TISHOMINGO COUNTY

The great gravel deposit in Tishomingo County, east of Iuka, which has been so extensively used for road metal and railroad ballast, was thought by Hilgard, and later by Crider, to belong to the so-called Lafayette formation (Pliocene?). Smith and Johnson in 1887 (14, pp. 115-116) and Logan in 1909 (25, p. 111), however, referred these gravels to the Tuscaloosa formation, a correlation that has subsequently been verified. The stratigraphic position of the gravel is clearly shown in a long cut of the Southern Railway, southeast of Iuka.

SECTION IN CUT OF SOUTHERN RAILWAY A MILE SOUTHEAST OF IUKA

	Feet
Pliocene? surficial deposit	
Weathered yellowish to reddish argillaceous sand, blotched with pink and drab in places, containing scattered smoothly rounded quartz pebbles up to 3 inches in diameter, and a few chert pebbles, in the lower 1 to 5 feet. This deposit, which is about 7 feet thick on the hill-top, extends down the slope to the southeast as an unconformable blanket of colluvium 5 to 10 feet thick over all the Cretaceous strata mentioned in this section	7
Unconformity	
Eutaw formation	
Harsh gray sandy clay, blotched with red and pink; fairly sharp contact with sand below	1
Strongly current-bedded medium-grained greenish-gray glauconitic sand, blotched with yellow and purple, containing clay films 1 to 6 inches apart, which are involved in the cross-bedding; also contains scattered thin ferruginous plates	21
Weathered glauconitic sand poorly exposed in cut for about three-tenths of a mile, estimated thickness	15
Laminated clay having partings of fine micaceous, slightly glauconitic sand, the sand content important above and decreasing towards the base; the clay is drab above but is darker below, becoming a dark lignitic clay in the lower 6 feet; in the basal 2 or 3 feet are seams of lignite up to an inch thick, containing grains and lumps of fossil resin which reach slightly more than an inch in length; the dark clays and lignitic sands yielded a few imperfect leaf impressions, among which E. W. Berry (28, p. 570; 40, p. 14) has identified *Andromeda wardiana* Lesquereux, *Androvettia carolinensis* Berry, *Phyllites pistiaeformis* Berry, and *Sequoia reichenbachi* (Geinitz) Heer. The clay is sharply segregated from the underlying gravel (Figure 3)	18
Unconformity	
Tuscaloosa formation	
Gravel composed of subangular chert pebbles, similar to that described in the succeeding sections; top of gravel about 580 feet above sea level	2+
	64+

The glauconitic sands in the preceding section were referred by Crider (20, pp. 12-13) to the Tuscaloosa formation, and the bottom interval of 18 feet was considered Tuscaloosa by Berry (40, p. 14) who stated, however, that "the northward extension of the Tuscaloosa in Mississippi is younger than the main body of the deposits in Alabama."

Figure 3.—Gravel member of the Tuscaloosa formation overlain by laminated and lignitic leaf-bearing and amber-bearing clay of the Eutaw formation; cut of Southern Railway, 1 1/2 miles southeast of Iuka, Tishomingo County. Photo by L. W. Stephenson.

The chert gravels are well exposed in several pits north and south of the track in the vicinity of Gravel Siding, 2 1/4 to 3 1/4 miles southeast of Iuka. In one of these, owned by the Tishomingo Gravel Company, the following section was exposed when examined in 1909.

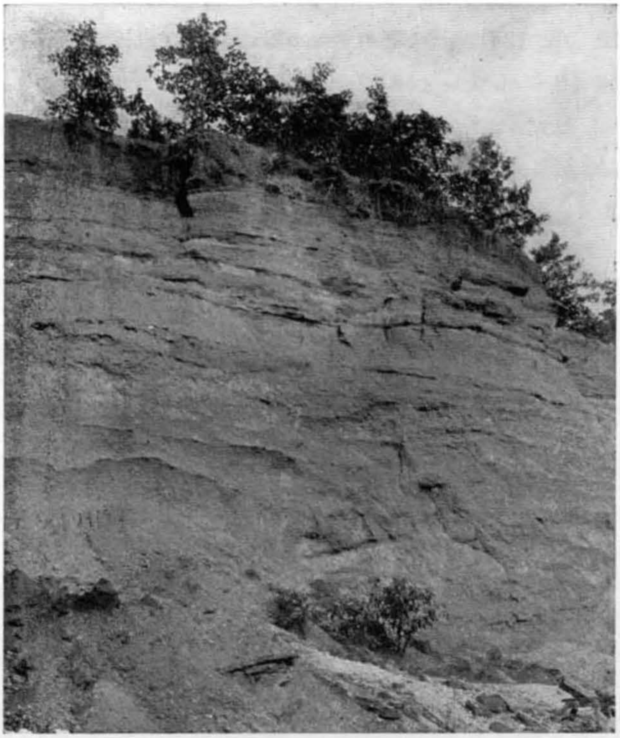

Figure 4.—Gravel member of the Tuscaloosa formation; abandoned pit north of the Southern Railway, 2 1/2 miles southeast of Iuka, Tishomingo County. Photo by E. W. Shaw.

SECTION IN PIT OF TISHOMINGO GRAVEL COMPANY, 2 1/4 MILES SOUTHEAST OF IUKA

	Feet
Tuscaloosa formation	
Brown weathered sand containing scattered bunches of pebbles, irregularly indurated with ferruginous cement along the base; top about 605 feet above sea level	5
Irregularly bedded gravel and sand, locally indurated with ferruginous cement, interstratified toward the base with long thin lenses of laminated dark micaceous, sandy clay	15
Gravel consisting chiefly of subangular pebbles and cobbles of chert having maximum lengths of 5 or 6 inches; locally slightly indurated to ferruginous conglomerate	35
	55

Within a mile to the southeast a maximum thickness of 80 feet of gravel was observed in some of the pits, and it may even exceed 150 feet in this vicinity (Figure 4).

A 15-foot exposure in a railroad cut 3 miles southeast of Iuka shows irregular streaks of ferruginous conglomerate through the gravel (Figure 5). A spring of free-flowing water emerges from the gravel at a point about level with the track.

Figure 5.—Detail of gravel in a cut of the Southern Railway, 3 miles southeast of Iuka; shows irregularly developed ferruginous conglomerate and spring issuing from the gravel. Photo by L. W. Stephenson.

A cut opened in 1938 half a mile east of the State line reveals a large lens of silty clay interstratified with chert gravel (Figure 6.)

SECTION IN CUT OF U. S. HIGHWAY 78 ON EASTWARD-FACING SLOPE OF BEAR CREEK VALLEY, COLBERT CO., ALA., ONE-HALF TO ONE MILE EAST OF MISSISSIPPI STATE LINE.

Feet

Soil and terrace deposit

16. Mottled yellow and red argillaceous, silty, fine sand containing scattered quartz and a few chert pebbles in upper part and pockets of quartz pebbles in lower part. Underlying laminated sand reworked into base in such a way that contact is not distinct.......13

Unconformity (in general irregular, but indistinct)
Tuscaloosa formation

15. Thin-bedded and thinly laminated argillaceous, finely micaceous, silty, very fine sand; some laminae are carbonaceous	13
14. Hard very light-gray (almost white) very fine silty clay. Down the hill where the road cut is not so deep this material has weathered to yellow, gray, and pink, but in all deeper cuts the color is gray. Two feet above the base is a discontinuous layer of brown iron ore from 3 inches to 1 foot thick	23
13. Cross-bedded light gray micaceous fine sand interbedded with brown fine sandy clay; contains layers of ferruginous sandstone up to 1 inch thick and layers of light-brown to yellow highly ferruginous sand; lower part contains stringers, thin beds, and pockets of chert gravel including pebbles up to 1 1/2 inches long, but averaging about 1/4 inch in longest dimension	11
12. Fine chert gravel made up of pebbles averaging 1/4 inch in diameter, but ranging from 1/25 to about 2 inches in length, in a matrix of ferruginous medium-grained sand; no bedding observable; this fine pebbly gravel merges downward into coarser cobbly gravel containing cobbles up to 6 inches long; contains lumps or boulders of fine sandy and silty clay up to 10 feet long. Some layers of pebbles are cemented by iron oxide to form a conglomerate in which some of the pebbles of chert have been partly and some completely replaced by hydrous iron oxide	33
11. Pink and white silty clay containing more or less chert gravel; the upper part of this bed is very pink	11
10. Chert gravel composed of pebbles of all sizes from 1/25 to 6 inches long	5
9. Silty clay containing scattered pebbles	4
8. Gravel	1
7. Silty clay containing scattered pebbles	1
6. Chert gravel in matrix of sandy and silty clay	1
5. Pink and white silty clay containing considerable chert gravel	4
4. Coal-black highly carbonaceous, silty clay containing many small pellets of charred wood (fusain) from 1/8 to 1/4 inch in diameter; passes upward into white clayey silt; thin stringers of chert gravel rare; in upper part of deposit are a number of beds of black and pink siliceous clay and some fine chert gravel; top is bright-red silty clay	20
3. Toward the east is chert gravel similar to that below, but toward the west this interfingers with pink and white clayey silt, and within a distance of 100 feet the entire layer is represented by silt	7
2. Mixture of clay, silt, sand, gravel, and cobbles, weakly bedded but with little orientation of pebbles; contains many lenses or boulders of silty clay	17
1. Material similar to the overlying bed, but includes a mass of silty clay (locally called a "white horse") the base of which is not exposed	35
	199

The base of the section is 43 feet above the level of water impounded by Pickwick Dam. Colluvial sand and gravel and a Tertiary terrace deposit conceal the underlying material in this interval. Beds 3 and 4 interfinger with gravel toward the east showing that the mass of silty clay and gravel from bed 3 to bed 11 is a large lens deposited at the same time that gravel was being deposited nearby. After deposition of bed 11 a large channel was scoured out cutting away parts of

Figure 6.—Intraformational unconformity within the Tuscaloosa formation. Bedded silt, clay, and gravel have been gouged out by strong floodwaters crossing an alluvial fan or delta, and the resulting channel has been filled with cross-bedded gravel. U. S. Highway 78, eastward-facing slope of Bear Creek Valley, 1/2 mile east of Mississippi State line in Colbert County, Ala. Photo by W. H. Monroe.

beds 11 to 6 (Figure 6). This channel was filled with cross-bedded chert pebbles and cobbles before the deposition of bed 12. Beds 11 to 3 have an apparent dip of 10° S. 80° W.

For nearly 5 miles to the northeast of Iuka on the Eastport road the surface materials are in large part the reddish weathered products of the glauconitic sands of the Eutaw formation. The chert gravels of the Tuscaloosa are exposed in the road bed where it descends to a small branch valley in Sec. 33, T.2 S., R.11 E., about 2 1/4 miles southwest of Eastport, where the top of the gravel bed lies about 553 feet above sea level.

SECTION ON IUKA-EASTPORT ROAD, 2 1/4 MILES SOUTHWEST OF EASTPORT

	Feet
Colluvium	
Red micaceous fine sand containing scattered quartz pebbles and fragments of ironstone	5
Unconformity	
Eutaw formation	
Red highly cross-bedded micaceous, glauconitic fine sand passing downward into highly cross-bedded sand and chert gravel; chert cobbles as long as 4 1/2 inches at base. 3 to	11
Unconformity (contact slopes 10° east-northeast cutting across the bedding of the Tuscaloosa formation)	
Tuscaloosa formation	
Thin-bedded micaceous red and white fine sand. 3 to	11
Poorly assorted chert pebbles and cobbles cemented in part by large irregular tubes of ironstone	22
Massive white, yellow, and pink compact silt, partly concealed; to water level in creek	17

This section illustrates well the irregular surface of the Tuscaloosa-Eutaw contact. A section about a tenth of a mile south-southwest and about 20 feet higher on the hill reveals the steeply sloping contact and is seemingly a continuation of the section given above. It was thought at first that the material called Eutaw might be a terrace deposit or colluvium, but the absence of quartz pebbles, which are common in terrace deposits near Iuka, and the marked cross bedding indicate that this material belongs to the Upper Cretaceous.

From about 7 1/2 miles north of Iuka, northward, the Eutaw formation is separated from the underlying Paleozoic rocks by a foot or less of large chert cobbles which may be either a feather edge of the Tuscaloosa, or a basal conglomerate of the Eutaw formation; the latter interpretation implies an overlap of the Eutaw onto the Paleozoic and the complete cutting out of the Tuscaloosa formation. The irregular surface of the Paleozoic rocks is aptly illustrated by the presence in northern Tishomingo County of unquestioned small outliers of Tuscaloosa gravel, apparently filling old stream channels on the pre-Tuscaloosa surface, one of which deposits is described in the section below. To the north, south, and east of this deposit the Eutaw rests directly on Paleozoic rocks.

SECTION ON SOUTHWARD-FACING SLOPE ON ROAD LEADING DOWN TO YELLOW CREEK VALLEY, NEAR CENTER OF SEC. 34, T.1 S., R.10 E.

	Feet
Pliocene (?) terrace deposit	
Brick-red clayey sand containing intercross-bedded gravel, composed mostly of well-rounded chert pebbles, but some quartz; bed of ironstone at base. (Top about 500 feet above sea level.)	28
Unconformity	
Eutaw formation	
Light-brown fine glauconitic sand; bed of corrugated ironstone at base	1
Unconformity	
Tuscaloosa formation	
Well-rounded to angular chert pebbles and cobbles jumbled together with no noticeable bedding	26
Concealed to bend in road from south to due east at mouth of small valley	38
	93

A section 2 1/2 miles east of the preceding locality, described under the heading, Eutaw, shows sand and gravel of the Eutaw formation resting on Paleozoic chert.

At the foot of the northward-facing slope down to Lard Branch Valley on Mississippi Highway 25 in Sec. 33, T.1 S., R.10 E., the following section is exposed:

SECTION ON MISSISSIPPI HIGHWAY 25 AT LARD BRANCH

	Feet
Eutaw formation	
Highly glauconitic cross-bedded sand	10
Unconformity	
Tuscaloosa formation	
Large angular cobbles	1
Compact white and pink silt (silica?) containing interbedded thin layers of pebbles. This bed may be slightly reworked material residual from the Paleozoic	16
Concealed to flood plain of Lard Branch	10
	37

The southward continuation of the heavy bed of chert gravel which is so prominently developed east of Iuka appears in numerous outcrops in the vicinity of Tishomingo along and near the Illinois Central Railroad. The railroad cuts to the northwest between Tishomingo and Paden reveal the basal glauconitic sands of the overlying Eutaw formation.

The erosional unconformity between the Tuscaloosa and Eutaw formations is well shown in a road cut on Mississippi Highway 25, 2 miles northeast of Tishomingo (Figure 7) on the southward-facing slope of Cripple Deer Creek, SE.1/4, NE.1/4, Sec. 11, T.5 S., R.10 E.

Figure 7.—Unconformity between the Tuscaloosa and Eutaw formations (hammer) on Mississippi Highway 25, Sec. 11, T.5 S., R.10 E., Tishomingo County. Note pre-Eutaw erosion of Tuscaloosa thin-bedded sand. Photo by W. H. Monroe.

SECTION 2 MILES NORTHEAST OF TISHOMINGO

	Feet
Colluvium	
Red sand containing fragments of ironstone	4
Eutaw formation	
Cross-bedded fine glauconitic, micaceous sand; at base a bed of red sand and fine chert gravel, 6 to 12 inches thick	5
Unconformity (contact slopes into hill cutting across bedding of Tuscaloosa formation)	
Tuscaloosa formation	
Thinly laminated very fine micaceous sand	12
Coarse chert gravel, upper 3 inches cemented by iron	5
Cross-bedded light reddish-brown and light-gray sand containing a few pebbles; upper foot and bottom 2 inches cemented by iron	6
Pink and white clay-like silt (silica?) containing quartz, much of which shows euhedral secondary growth, and pale brownish chalcedony	8
	40

About half a mile north of Neil station is a long cut in which glauconitic sands of the Eutaw formation overlie the Tuscaloosa formation.

SECTION AT SOUTH END OF CUT OF ILLINOIS CENTRAL RAILROAD HALF A MILE NORTH OF NEIL STATION

	Feet
Eutaw formation	
Weathered reddish-brown sand with clay laminae	12-15
Gray to pinkish and purplish loose markedly glauconitic highly cross-bedded sand, the thickest cross-bedded band having a plunge slope at least 15 feet long	20
Unconformity	
Tuscaloosa formation	
Dark drab laminated clay containing thin interbedded layers of sand	15

The laminated clay in the section is rather closely underlain by gravel of the Tuscaloosa formation which appears in poor exposures from the level of the track to 35 feet below, in ravines between the cut and Neil station.

Poorly exposed basal chert gravels of the Tuscaloosa formation were observed near the public road to a height of about 50 feet above the alluvial bottom, on the westward-facing slope of Bear Creek Valley about 2 1/2 miles east of Belmont. Fragments of corrugated ferruginous sandstone derived from the Tuscaloosa sands above the gravel are numerous on the slopes to the tops of the hills which here rise 70 or 80 feet above the bottom lands.

The uneven surface of the Paleozoic-Tuscaloosa contact is indicated in the southern half of Tishomingo County by marked variations in the thickness of the Tuscaloosa formation. As previously indicated, the Tuscaloosa is nearly 200 feet thick on U. S. Highway 78 near the Mississippi-Alabama State line, and it appears to be about 100 feet thick on Pennywinkle Creek in Sec. 16, T.4 S., R.11 E. Near Tishomingo, however, the Tuscaloosa is much thinner, and at Bay Springs on the Booneville-Dennis road just west of Mackys Creek, in Sec. 26, T.6 S., R.9 E., sand of the Eutaw formation is exposed only 45 feet above the top of Paleozoic sandstone. Any Tuscaloosa present in this hill is concealed by colluvium.

Locally in eastern Tishomingo County the Tuscaloosa formation contains lenses of white clay that have attracted attention on account of their possible value in the manufacture of pottery. Logan (25, pp. 107-121) has published descriptions and analyses of several of these clays. The sands overlying the clays, which he refers to the "Lafayette formation," are probably for the most part the weathered products of either the Eutaw or the Tuscaloosa formation.

RED BAY, ALABAMA

The Tuscaloosa formation is more completely revealed in exposures in the vicinity of Red Bay, which is situated just across the line from the northeastern corner of Itawamba County, in Franklin County, Alabama, than in any similar series of exposures that have been examined in Mississippi. Particular mention may be made of a section in a deep gully near the site of the old Red Bay post office, and exposures in cuts of the Illinois Central Railroad within 2 miles southeast of Red Bay (Figure 2).

PRENTISS COUNTY

The Tuscaloosa formation crops out only in the lower slopes of valleys tributary in Mackys Creek in the southeast corner of the county. Thirty-seven feet above the bridge over a small branch of Mackys Creek northwest of the center of Sec. 9, T. 7 E., R. 9 E., very fine mealy pink and yellow sand of the Tuscaloosa is overlain unconformably by the Eutaw formation, which consists of fine red glauconitic sand containing fine chert gravel with a bed of ferruginous material at the base. The contact of the two formations was noted at a few other places east of this exposure.

ITAWAMBA COUNTY

The Tuscaloosa formation crops out over most of the eastern third of Itawamba County and in the valleys of Bull Mountain Creek and the East Fork of Tombigbee River. The formation is overlain by the Eutaw to the west of the East Fork and on the long ridge between that stream and Bull Mountain Creek.

The contact of the Tuscaloosa and Eutaw formations is crossed many times on Mississippi Highway 25 between Smithville and Fulton. One of the best exposures along this highway is in a cut on the northeastward-facing slope of a small branch in Sec. 30, T.11 S., R. 9 E.

Section on Mississippi State Highway 25

Eutaw formation	Feet
Highly weathered red sand	2
Massive ledge of ironstone	1
Fine chert gravel and tubular ironstone with irregular base; contains a large silicified log	1

Unconformity	
Tuscaloosa formation	
Yellow and red fine to medium sand containing particles of white clay, passing downward into dark blue-gray argillaceous sand containing well-rounded quartz grains and fresh feldspar grains; contains a few small well-rounded pebbles up to 1/8 inch long	9
Slightly manganiferous silty siderite encrusted with iron oxide	0.5
Dark blue-gray clay	1
	14.5

Near Fulton the contact of the Tuscaloosa and Eutaw formations is exposed in road cuts north, west, and south of town. On the road to Tupelo (U. S. Highway 78) the contact is poorly exposed 45 feet above the bottom lands of the East Fork of Tombigbee River on the westward-facing slope of the valley.

East of Fulton U. S. Highway 78 crosses the upland between the East Fork of Tombigbee River and Bull Mountain Creek. Most of the exposures along the highway are of the Eutaw formation, but the underlying Tuscaloosa formation is exposed in the lower slopes of the deeper valleys, the contact being well exposed on the hill west of Chubby Creek (Sec. 6, T. 10 S., R. 10 E.) on U. S. Highway 78, 2 miles west of Tremont.

SECTION ON U. S. HIGHWAY 78, 2 MILES WEST OF TREMONT

	Feet
Eutaw formation	
Highly weathered red sand containing clay balls	5
Cross-bedded very fine glauconitic yellow sand	4.5
Highly cross-bedded sand, fine chert gravel, and tubular ironstone	3.5
Unconformity	
Tuscaloosa formation	
Thin-bedded and cross-bedded, very fine light-gray sand and argillaceous sand; highly micaceous, light and dark blue-gray sand in unweathered portions; much comminuted plant material and some well preserved leaves	42
Small exposures of sand and clay, but mostly concealed to flood plain of Chubby Creek	72
	127.0

New cuts made since this section was described reveal much more of the Tuscaloosa formation.

The Tuscaloosa crops out at many places on the road from Tremont to Red Bay, Alabama. A road cut 8/10 mile due north of Tremont on the Red Bay road (Sec. 4, T. 10 S., R. 10 E.) reveals the following section (Figure 8).

SECTION ON RED BAY ROAD, 8/10 MILE NORTH OF TREMONT

	Feet
Pliocene or Pleistocene terrace deposit	
Cross-bedded gravel composed of subangular to well-rounded pebbles, mostly chert, in a matrix of red sand; a bed of ironstone at base	15
Unconformity	
Tuscaloosa formation	
Light- and dark-gray, some pinkish, very fine sandy clay; ironstone at base	9
Harsh white micaceous sand	8
	32

Figure 8.—Unconformity between Tuscaloosa formation and Pliocene or Pleistocene terrace deposit in Sec. 4, T.10 S., R.10 E., Itawamba County. Note the different character of bedding in the terrace deposit and in the Tuscaloosa, shown in Figure 9. Photo by W. H. Monroe.

The terrace gravel in this section is apparently of very nearly the same mineral composition as the Tuscaloosa near by, from which it probably was largely derived. Terrace gravel is readily distinguished from gravel of the Tuscaloosa formation in this neighborhood by the character of the bedding. Most of the terrace gravel is stratified or cross-bedded, whereas the Tuscaloosa gravel, although it may be in beds, has no noticeable orientation of pebbles and the gravel is not stratified within the beds.

A mile and a half north of Bull Mountain Creek (Sec. 14, T. 9 S., R. 10 E.) a large pit on the west side of the Red Bay road shows 25 feet of Tuscaloosa sand and gravel (Figure 9). The gravel is composed mostly of chert pebbles but includes a few well-rounded quartz pebbles. This exposure exhibits barrel- or pipe-shaped iron cemented bands such as are characteristic of many of the Tuscaloosa deposits.

Near Silas Mill on the Smithville-Tremont road and near New Salem on the Smithville-Fulton road are small deposits of bentonite in the upper part of the Tuscaloosa formation. Bay (57, pp. 21-25) in his report on the bleaching clays of Mississippi placed these beds in the basal part of the Eutaw formation.

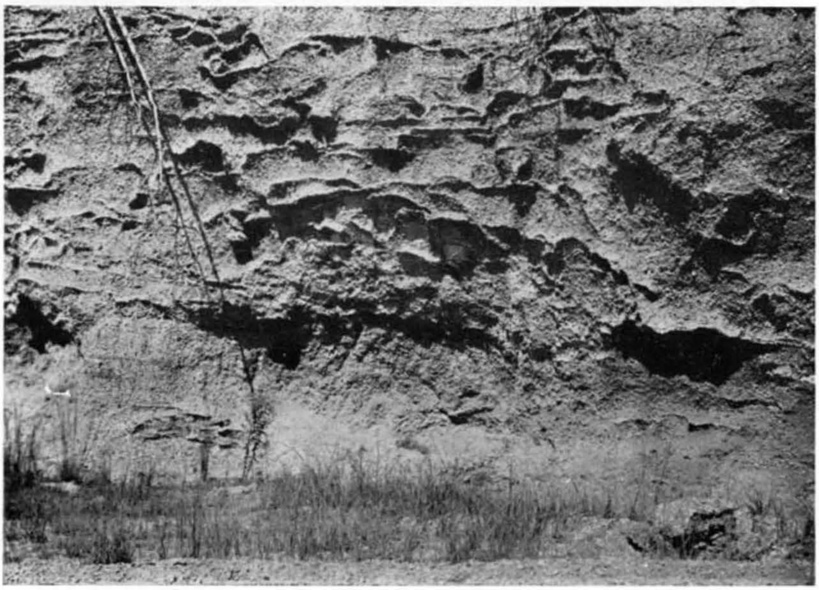

Figure 9.—Gravel in the Tuscaloosa formation in Sec. 14, T.9 S., R.10 E., Itawamba County. Note lack of orientation of pebbles within beds and pillow-shaped crusts of limonite. Photo by W. H. Monroe.

The deposit of bentonite near Silas Mill is exposed half a mile east of the Smithville-Tremont road, 117 feet above Bull Mountain Creek Valley at the SE. Cor., Sec. 12, T.11 S., R.9 E. The material underlying the bentonite is a fine argillaceous sand containing slightly rounded quartz grains, fresh feldspar, some zircon and chalcedony, but no glauconite. This sand is characteristic of the Tuscaloosa and does not resemble the Eutaw. A quarter of a mile southeast of the bentonite locality on the road to Hopewell Church, cross-bedded red sand of the Eutaw formation unconformably overlies thin-bedded micaceous sand of the Tuscaloosa formation; here the altitude of the Tuscaloosa-Eutaw contact is about 50 feet higher than the bentonite bed, and seems to indicate that this bed is in the Tuscaloosa formation.

Bentonite at about the same stratigraphic position was reported by Bay (57, p. 22) near New Salem.

SECTION ON EASTWARD-FACING SLOPE OF BULL MOUNTAIN CREEK VALLEY ALONG ABANDONED ROAD EAST OF NEW SALEM CHURCH, SEC, 9, T. 11 S., R. 9 E.

	Feet
Eutaw formation	
Fine sandy clayey soil; bed of fine chert gravel at base. To top of hill	12
Unconformity. (Not seen in section, but considerable chert gravel and fragments of silicified wood unconformably overlying the uppermost Tuscaloosa bed are exposed at approximately the same altitude in a shallow road cut 200 feet west.)	
Tuscaloosa formation	
Stratified yellow sand and light-gray clay	11
Yellow very fine sand (may be in part slumped from overlying bed as these two upper beds are partly concealed by colluvium)	11
Finely micaceous mealy very fine sand interlaminated with very fine sandy silty clay, tinted with green, purple, brown, and yellow; very finely glauconitic in some beds; sand beds are progressively thicker downward in section; thin corrugated beds of ferruginous sandstone are common	33
Finely cross-bedded, highly micaceous (in small flakes), finely glauconitic (grains small and scarce) white, pink, green, buff, and yellow, very fine sand; weathered portion is highly micaceous light-red sand; much thin, corrugated ferruginous sandstone at base	17
Bentonite, poorly exposed and thickness undetermined, but reported by local prospector, Mr. Lewis Moore, to be about 4 feet. Exposed part	1
Concealed by colluvium	12
Light-brown and gray micaceous fine sand containing many flakes and balls of clay; cut into breccia-like blocks by ferruginous sandstone; wad (MnO_2) common as coating on lumps of clay	5
Concealed to flood plain of small branch	6
	108

This exposure is at the crest of a small anticline. The bentonite bed is only 16 feet lower (barometer) here than at the Silas Mill locality. As the two localities are 3 miles apart, the bed should be from 60 to 90 feet lower at New Salem than at Silas Mill. Evidence of overlap of the Eutaw over the Tuscaloosa is suggested by differences in the thickness of Tuscaloosa above the bentonite at New

Salem church, where the thickness is 72 feet and at the Filtrol Corporation mine on the Sebe Cole property (Sec. 24?, T. 11 S., R. 9 E.,) where the base of the Eutaw formation is 52 feet above the top of the bentonite.

The westernmost observed exposure of the contact of the Tuscaloosa and the Eutaw is on the Greenwood road (near NW. Cor., Sec. 25, T.10 S., R.8 E.), 1 1/2 miles southwest of Beans Ferry Bridge over the East Fork of Tombigbee River. An unconformity between the Tuscaloosa and Eutaw formations was noted 25 feet above the flood plain of the East Fork of Tombigbee River.

Hilgard (11, pp. 64-65) in 1860 described strata exposed at Warren's mill on Mackys Creek which he referred to his Eutaw formation, but which may belong to the Tuscaloosa formation as now defined. The exact site of Warren's mill has not been ascertained by the present writers, but it is probably near Warren Bluff in Sec. 20, T.7 S., R.9 E.

In 1884 L. C. Johnson (14, pp. 115-116) examined beds of lignite and laminated clay in the valley of Reeds Creek in Itawamba County, which he regarded as underlying the typical Eutaw of Smith and Johnson in Alabama. Specific localities at which outcrops of lignite were examined were Maxey's old mill (Sec. 9, T. 10 S., R. 9 E.), Reeds Mill at Chaneys (Secs. 20 and 17, T.10 S., R.9 E.), and Barnards Bluff on the East Fork of Tombigbee River. At Maxey's old mill the lignite bed was 2 feet thick and leaf impressions were observed in clay.

Crider (20, pp. 53-54) discussed the presence in Itawamba County of sands, clays, and lignites, which the writers would refer to the Tuscaloosa formation.

Brown (22, p. 34) noted lignitic beds, that belong to the Tuscaloosa formation, at several places in the county.

The clays described by Crider and other clays suitable for different grades of pottery from several other localities in eastern Itawamba County were discussed by Logan (25, pp. 124-129) in 1909.

Maxey's mill on Reeds Creek 4 or 5 miles southeast of Fulton, subsequently known as Palmer's mill, was visited by E. W. Berry and the senior author in 1909. An eighth of a mile above the mill, at a spring on the left slope of the valley, 5 or 6 feet of greenish-gray laminated micaceous, glauconitic sand and clay containing comminuted plant fragments is poorly exposed just above the spring, and similar materials were seen in poor exposures to a height of 10 or 12 feet above the spring. Beneath the sands and clays is a bed of impure, pyritiferous lignite, 12 or 15 inches thick, partly covered by water of the spring.

A similar exposure was examined on the same side of the valley in a small branch about half a mile above the spring. Here the lignite, which is impure with clay, is about a foot thick and is overlain by 5 or 6 feet of laminated sand and clay. Lignite is reported elsewhere in this vicinity and the lignite layer is probably fairly persistent in this valley. No well preserved fossil leaves were found at the exposures examined.

MONROE COUNTY

The Tuscaloosa formation crops out in the valleys of Bull Mountain, Splunge, Weavers, and Sipsey creeks and in the valley of Buttahatchie River. The formation consists in general of thinly laminated very fine micaceous sand and light-colored clay, but east of Sipsey Creek some poorly assorted gravel crops out beneath the sand and clay.

The only deposits of gravel found in the Tuscaloosa are in the northeastern part of the county. A gravel pit at the east side of the road on the east side of Sipsey Creek Valley (SE. 1/4, Sec. 18, T.13 S., R. 16 W.), 2 1/4 miles south by east of Splunge, reveals about 5 feet of gravel overlain by 4 feet of thin-bedded light-gray clay containing very little sand; about three-fourths of the pebbles are chert and one-fourth quartz, and they range up to 2 inches in length. This may be a terrace deposit, but no clay like that above the gravel was seen in any terrace deposit in the area.

Two deposits of bentonite in Monroe County are assigned to the upper part of the Tuscaloosa formation by the junior author. One deposit is on the Charles Cox farm in Sec. 10, T. 12 S., R. 17 W., and the other is about a mile and a half north of Greenwood Springs (59, p. 28). The bentonite on the Cox farm crops out about 70 feet below the top of the upland in a bed about 6 feet thick. The altitude is a little lower than the contact of the Tuscaloosa and Eutaw formations as exposed on the Amory-Splunge road, about 2 miles along the strike to the south, but the stratigraphic position of the deposit with respect to the contact was not determined.

The Tuscaloosa-Eutaw unconformity is exposed in a section on a steep westward-facing slope of Johnsons Hill (NW 1/4, Sec. 1, T. 12 S., R. 9 E.), 4 1/2 miles east of Smithville.

SECTION 4 1/2 MILES EAST OF SMITHVILLE

	Feet
Eutaw formation	
Highly cross-bedded ferruginous, glauconitic sand containing thin plates of ferruginous sandstone and many small white clay balls; heavy tubular ferruginous sandstone and much fine chert gravel at base	18
Unconformity	
Tuscaloosa formation	
Massive light-gray slightly sandy clay with dark-gray and pink streaks	27
Light-brown very fine slightly micaceous sand interbedded with lenses of gray clay, and containing many plates of ferruginous sandstone; to valley floor	28
	73

The site of the Cowart well, half a mile west of Johnsons Hill, is 55 feet below the contact. This well penetrated about 193 feet of Tuscaloosa before entering Paleozoic rocks. The thickness of the Tuscaloosa here, therefore, appears to be about 235 feet, assuming a west dip of 20 to 30 feet per mile.

The Tuscaloosa-Eutaw contact is also well exposed on a local road on the southeastward-facing slope of Buttahatchie River Valley, about 10 miles southeast of Aberdeen (Figure 10).

Fine sand and clay referred to the Tuscaloosa formation were observed in the southeastern part of the county on the lower slopes of the hills a mile west of Cochrans Bridge on the Aberdeen road, and a mile and a half west of the Rye Bridge on the Hamilton road near the foot of the hill west of Buttahatchie River. Good exposures of the contact of the Tuscaloosa and Eutaw formations were not seen at the latter locality. The Tuscaloosa passes under the Eutaw formation not far southwest of the Rye Bridge in Buttahatchie Valley.

Both the wells whose logs are given below started near the top of the Tuscaloosa formation in the eastern part of Monroe County. The Cowart well is near the northern boundary of the county and the Rye well near the southern boundary. The well at Gattman (21, p. 69), which entered the Paleozoic at 211 feet, is about half way between the other two. The wells show that the Tuscaloosa thickens rapidly toward the south.

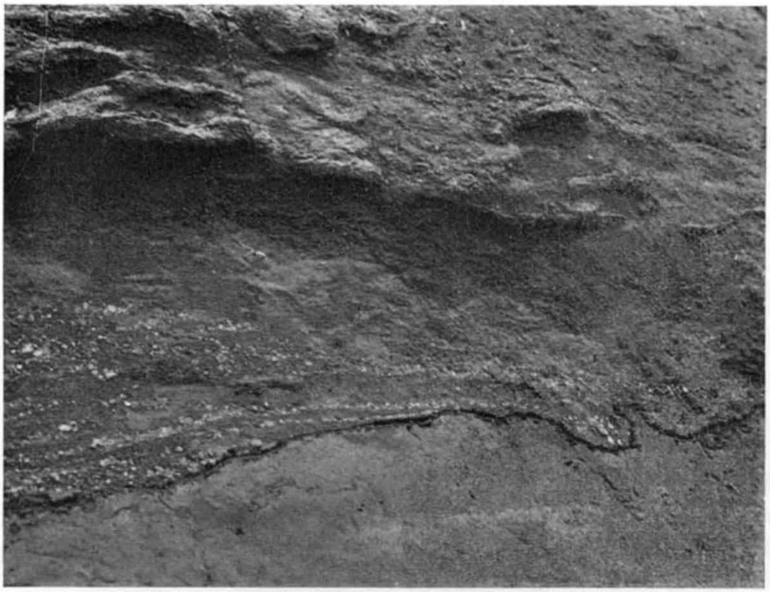

Figure 10.—Unconformity between the Tuscaloosa and Eutaw formations on the southeastward-facing slope of Buttahatchie River Valley about 10 miles southeast of Aberdeen on a local road, Monroe County. Photo by F. F. Mellen.

PARTIAL LOG OF THE P. J. MACALPINE COWART No. 1 WELL, NE. 1/4, SW. 1/4 Sec. 2, T.12 S., R.9 E.

(Altitude of derrick floor 342 feet above sea level)

	Thickness Feet	Depth Feet
Tuscaloosa formation		
Brown surface clay	7	7
Creek sand, gray, soft	53	60
Fine gravel, gray, soft	60	120
Fine sand, gray, soft	30	150
Coarse gravel, gray, soft	25	175
Sandy shale, pink, soft	18	193
Paleozoic rocks	3605	3798

PARTIAL LOG OF THE P. J. MACALPINE—FRANK L. RYE NO. 1 WELL
NE. 1/4, SW. 1/4, SEC. 15, T.15 S., R.17 W.
(Altitude of derrick floor 258 feet above sea level)

	Thickness Feet	Depth Feet
Tuscaloosa formation		
Surface clay and sand	70	70
Gravel, sand, soapstone	90	160
Water-bearing sand gravel	10	170
Sand, gravel, clay	117	287
Gumbo and gravel	56	343
Hard rock	1	344
Gumbo	25	369
Soft sand	15	384
Gumbo	30	414
Sand and gravel	25	439
Gumbo and gravel	15	454
Sand rock	1	455
Soft sand	5	460
Gumbo	2	462
Gumbo, pink	55	517
Gumbo and streaks of gravel, large pebbles and gumbo	48	565
Gravel composed of small pebbles; water bearing	4	569
Gumbo, hard, mixed with pebbles; streak of gumbo without pebbles	21	590
Paleozoic rocks	2341	2931

LOWNDES COUNTY

The Tuscaloosa formation crops out only on the lower slopes of Buttahatchie River Valley in the northeastern part of Lowndes County. It consists of light-gray and red micaceous sand and clay, highly weathered in the exposures examined.

EUTAW FORMATION

GENERAL FEATURES

NAME

The name Eutaw was first used in 1860 in Hilgard's (11, pp. 60-68) classification of the Cretaceous of Mississippi, for all the strata between the Paleozoic basement rocks and his Tombigbee sand group. He says (p. 61): "I adopt this name in view of these beds having been first examined in detail, and recognized as being of Cretaceous age, by Tuomey, near Eutaw, Ala., where they are characteristically developed." Tuomey, (2, pp. 118-120) though he recognized the Cretaceous age of these beds, did not propose a formational name for them.

In 1887 Smith and Johnson (14, pp. 86-95) accepted the name Eutaw for the typical beds near Eutaw, but they modified its application in Alabama by setting off the extensively developed and well characterized Tuscaloosa formation below, and by including in the Eutaw the Alabama representatives of Hilgard's Tombigbee sand. They showed that the Tuscaloosa formation is also present and is distinguishable from the Eutaw type of deposits in Mississippi. Recent work has shown, however, that the Tuscaloosa is much thinner in Mississippi than in Alabama and is not extensively exposed, appearing only in the lower slopes and bottoms of the creek valleys in eastern Monroe and Itawamba counties, and forming the upland only in a belt having a maximum width of 5 to 6 miles in eastern Tishomingo and northeastern Itawamba counties. The great bulk of the deposits included by Hilgard in his Eutaw is similar in kind to the deposits in the type section near Eutaw, and, since he classed the great gravel beds of the Tuscaloosa with his "Orange sand," it is not surprising that he included the remaining rather meagerly developed and only superficially studied deposits of the Tuscaloosa type in the Eutaw.

The inclusion of the Tombigbee sand in the Eutaw was a logical procedure, since the Tombigbee differs from the typical Eutaw chiefly in having been formed in slightly deeper off-shore waters, thus producing a more massive type of bedding. Both are characteristically glauconitic, though the Tombigbee is more strongly so, and besides is more calcareous and contains a greater number of fossils. There appears to be a gradation in lithologic character from the one to the other, making it difficult, or perhaps impossible, to draw a sharp line between them. However, since the massive Tombigbee type of sand is traceable from Mississippi eastward nearly across Alabama, it is appropriate that the name be retained with member rank.

The Coffee sand of Tennessee and northern Mississippi, which was formerly classed as a member of the Eutaw formation by the senior author, is here treated as a unit of formation rank.

AREAL DISTRIBUTION

The Eutaw formation crops out in Mississippi, or is locally covered only by relatively thin terrace deposits, in a belt 15 to 20 miles wide, west of the area of outcrop of the Tuscaloosa formation and east of that of the Selma chalk and of the Coffee sand, including more than the eastern half of Lowndes County, approximately the eastern three-fifths of Monroe, about two-thirds of Itawamba, about the eastern quarter of Prentiss, and the western three-fifths or more of Tishomingo. The formation continues northward into Tennessee.

The eastern margin of the formation is very irregular, due to the extension of the gently inclined Tuscaloosa strata far down the creek valleys before their disappearance beneath water level; the western margin is less deeply indented by the streams.

From Mississippi the area of outcrop of the formation extends eastward entirely across Alabama as a belt 3 to 15 miles wide, finally pinching out in Georgia a few miles east of Chattahoochee River.

LITHOLOGIC CHARACTER AND THICKNESS

The Eutaw formation is predominantly composed of more or less glauconitic fine to medium-grained more or less micaceous sand that was deposited in shallow marine waters. Many fine examples of various types of marine cross bedding are exhibited, including finely cross-bedded small irregular lenses produced by the action of waves near the lower limit of their action and all intermediate stages of irregular bedding between this type and the coarse flow and plunge structure in which the cross-bedded band may be as much as 8 feet thick, and the length of the plunge slope 15 feet or more; beds 2 to 3 feet thick exhibiting these types of cross bedding are shown in Figures 15 to 20. Some of these pictures also illustrate the types of marine bedding in which cross-bedded strata of uniform thickness are separated by nearly horizontal true bedding planes. The sands range in color from white through grays to greenish gray, and locally are stained to shades of yellow, brown, red, pink, and purple by the oxidation of the glauconite and perhaps other iron-bearing minerals. Good examples of variegated deposits are: The pinkish and purplish sands in the deep cut of the Illinois Central Railroad at Leedy on the Tishomingo-Alcorn County line; the purplish sands in a gully near the Splunge road 8 miles east of Amory, Monroe County; and the purple, pink, red, and yellow sands (14, p. 111) in the gullies near Havana, Hale County, Ala.

Throughout an important part of the terrane the sand is interstratified with subordinate thin laminae, laminated layers, and some more massive layers of clay, which is commonly dark-gray to nearly black, though lighter colored clays exists in places. Most of the clays contain comminuted plant fragments, and small pieces of lignite are common or even abundant in some parts of the terrane. The surficial weathered facies are universally deep reddish to brownish due chiefly to the oxidation of the iron contained in the glauconite. The rain waters absorbed by the sands have dissolved the iron in the zone of humic acids, and as the waters have percolated downward they have redeposited the iron in the lower parts of the zone of weathering in the form of sandy oxidized concretions and platy layers. In places conspicuous masses of ferruginous sandstone have thus been formed. Most of the surficial weathered materials were referred by Hilgard to his "Orange sand" formation.

In general, the materials of the Eutaw are fine to medium in texture, but small lenses and stringers of small pebbles are in the lower part of the formation where the present inner margin of the formation is nearer the ancient shore line of the Eutaw sea than it is farther to the southeast in Alabama. Stringers of small subangular chert pebbles, the individual pebbles of which have maximum lengths of about half an inch, are numerous in highly cross-bedded glauconitic sand near the base of the formation, in places in the hills east of Mackys Creek in northern Itawamba County. Lenses and stringers of chert pebbles are found also in the basal 50 feet of the formation at exposures in the immediate vicinity of Iuka, Tishomingo County. A bed of fine subangular chert gravel is present nearly everywhere at the base of the formation.

The Eutaw formation appears to thin toward the north. The Eutaw was penetrated between depths of 490 and 870 feet in the Thompson Oil and Gas Syndicate's Donahue well (SE. 1/4, NE. 1/4, Sec. 25, T. 16 N., R. 17 E.), Noxubee County, a thickness of 380 feet of the Eutaw formation. In Mr. Lewis C. Chapman's water well (Sec. 3, T. 16 N., R. 18 E.) in Noxubee County (see Selma chalk, Noxubee County) the thickness of the Eutaw is 395 feet. In the Anderson Drilling Company's Hardy well (Sec. 9, T. 17 N., R. 17 E.) in Lowndes County 390 feet of Eutaw was penetrated between depths of 300 and 690 feet (43, pp. 121-122). The Ohio Oil Company's Cantrell well in Clay County (Sec. 16, T. 15 S., R. 5 E.) penetrated 362 feet of Eutaw between 530 and 892 feet (see Selma chalk, Clay County). Only 254 feet of Eutaw was found in J. P. Evans's Whiteside well in Lee County (Sec. 16, T. 9 S., R. 7 E.) between depths of 190 and 444 feet (see Selma chalk, Lee and Itawamba Counties).

For convenience of treatment the Eutaw formation may be differentiated into the lower or typical part having a thickness of 200 or 250 feet and characterized by irregularity of bedding and by the presence of thin clay laminae and thicker laminated clay layers, and the Tombigbee sand member described below.

TOMBIGBEE SAND MEMBER

In Alabama and in east-central Mississippi the upper 100 feet or less of the Eutaw formation is composed chiefly of massive glauconitic, more or less calcareous sand with indurated layers and concretionary masses (Figures 12 and 13) at intervals. The Tombigbee member is overlain by the Selma chalk and, in the northern part of Mississippi, by the Coffee sand. The change from the typical Eutaw strata below to massive sand above is not abrupt, but is marked by a band of more or less cross-bedded sand and laminated clay. Marine invertebrate fossils are present in certain layers, particularly within the upper 50 feet, but a large part of the member is nonfossiliferous. This massive band of sand has been traced northward through Mississippi into Hardin County, Tennessee. From Lee County northward the upper limits of the member are not as easily determined as farther south, because parts of the overlying Coffee sand are also of massive character. Two beds of bentonite are interbedded with the sand, south of Aberdeen in T.15 S., R.7 E. (57, pp. 25-27).

STRATIGRAPHIC AND AGE RELATIONS

Throughout its outcrop in Mississippi the Eutaw formation is separated from the underlying Tuscaloosa formation by an erosional unconformity. In places in northern Tishomingo County the Eutaw formation completely overlaps the Tuscaloosa and rests directly on chert of Mississippian age, unless a thin basal bed of cobbles, at few places more than 2 feet thick, derived from the underlying chert, should be considered Tuscaloosa. The uppermost beds of the Tuscaloosa formation range from coarse gravel and cobbles to thinly bedded very fine sand, in different parts of Mississippi. At several places in Tishomingo County the basal beds of the Eutaw fill old stream channels cut into the Tuscaloosa during the erosion interval between the times of deposition of the two formations. At nearly all outcrops the base of the Eutaw formation consists of cross-bedded glauconitic sand and fine chert gravel, at many places cemented by limonite into hard tubular and corrugated sandstone. The unconformity which separates the Tuscaloosa and Eutaw formations in Mississippi continues eastward across Alabama into Georgia.

From Itawamba County southward through Mississippi and eastward through Alabama to Montgomery County, the Tombigbee sand member of the formation is unconformably overlain by the Selma chalk and throughout this distance the Eutaw maintains a nearly uniform thickness and is an approximately synchronous band of deposits; from Montgomery County eastward the formation becomes thinner at the expense of the lower part and finally pinches out a few miles beyond Chattahoochee River in Georgia. North of Itawamba County conditions favorable to the deposition of glauconitic sands of the Eutaw type persisted to a later time than they did farther to the south, so that here deposits of glauconitic sand interbedded with clay are synchronous with the lower 250 feet or more of the chalk of east-central Mississippi and Alabama; these sediments constitute the Coffee sand. The exact contact between the Tombigbee sand member of the Eutaw formation and the overlying Coffee sand was observed well exposed at only a few places, one of which is in Prentiss County (see Coffee sand, Prentiss County).

In an area 5 to 7 miles wide, bordering Tombigbee River in Lowndes and Monroe counties, and extending with decreasing width up the valleys of the principal tributaries of the Tombigbee in Lee, Itawamba, and Prentiss counties, the Eutaw is unconformably overlain by loams, sands, and gravels laid down on terrace plains cut in the Eutaw deposits by the meandering of the streams during Pliocene, Pleistocene, and Recent times.

PHYSIOGRAPHIC EXPRESSION

The topography in the area of outcrop of the formation is in general hilly, having the characteristics of a district underlain by unconsolidated sands. Crider and Johnson (21, p. 2) included this area, together with the areas in the northeast in which the Tuscaloosa formation and the Coffee sand crop out, in the physiographic division to which the name Tombigbee and Tennessee River Hills is applied. The altitude above sea level of these hills ranges from 350 or 400 feet in Lowndes, Monroe, and Lee counties in the south and southwest, to 806 feet in one isolated hill in Tishomingo County in the northeast. This hill in Sec. 27, T.3 S., R.10 E., 3 1/3 miles southwest by west of Iuka at the Knob triangulation station is the highest point thus far surveyed in Mississippi. In general the eastern part of the belt is higher than the western, the elevations along the Alabama boundary ranging from 500 to 650 feet.

The stage of dissection represented by the topography is that of maturity, or the stage in which pronounced slopes prevail over flat or nearly flat surfaces. The character of the topography ranges from low hills of 40 or 50 feet relief, having gently curved profiles, to hills and ridges of 150 to 200 feet relief having steep slopes, narrow crests, and narrow separating valleys. The one extreme is represented by the low rounded hills of portions of Prentiss and western Itawamba counties in proximity to the junctions of the numerous streams composing the upper Tombigbee drainage system; the other extreme is best exhibited at the headwaters of the eastern and northernmost tributaries of the Tombigbee in Monroe, Itawamba, Prentiss, and Tishomingo counties, and in a sharply dissected belt several miles wide bordering Tennessee River in Tishomingo County. In the latter county are a few small isolated monadnock-like hills of roughly circular outline which rise 100 or 150 feet above most of the surrounding hills, reaching altitudes of 700 to 800 feet. E. W. Shaw, who visited most of these hills, states that they are capped with hard ferruginous sandstone, the resistant character of which has doubtless been a contributing factor to their preservation. Two typical examples of such hills are the one 3 1/3 miles to the southwest (Knob triangulation station), and the other 5 miles to the northwest of Iuka, just east of the western boundary of the Iuka topographic sheet.

The lower part of the Eutaw formation, which is composed of thin-bedded sand and clay, has been eroded in such a manner as to produce a deeply dissected plateau whose surface slopes gently toward the west in conformity with the dip of the formation; a typical example is in central Itawamba County where the tops of the hills and ridges are fairly flat or gently rounded, but are separated by deeply incised valleys, giving a rugged appearance to the country in general. The Tombigbee sand member, on the other hand, is composed of massive sand which gives rise to steep-sided, more or less conical peaks, a type of topography that appears much more rugged, though actually less deeply dissected, than the country farther east underlain by the typical beds of the Eutaw. The two hills near Iuka mentioned above are examples of peaks underlain by Tombigbee sand, although they happen to be capped by thin beds of indurated Coffee sand, outliers of the main body of that formation.

The topographic aspect of the Eutaw belt has been materially modified by terrace-forming processes which have operated during Pliocene, Pleistocene, and Recent times, in an area bordering Tombigbee River, extending from Lowndes County, where the width is about 12 miles, far upstream, with decreasing width toward the headwaters of the principal tributaries. About five terrace stages are recognizable in this belt in Lowndes and Monroe counties, each indicated by plains of greater or less extent. The area covered by terrace deposits is shown on the map of surficial deposits (Plate 1B), but the individual terraces are not differentiated.

The hills of the Eutaw belt contrast strongly with the subdued topographic aspect of the Black Prairie belt, the area to the west in which the Selma chalk is the underlying formation.

FOSSIL CONTENT

The distribution of the larger invertebrate fossils and a few fragments of vertebrate fossils of the Tombigbee sand member of the Eutaw formation is shown by counties (from south to north) and localities in the accompanying table. A few fossil plants from a locality near Iuka, Tishomingo County, are listed under Tuscaloosa, Tishomingo County. The significance of the fossils is discussed in a later chapter.

Fossil localities in the Tombigbee sand member of the Eutaw formation

6918.—Plymouth Bluff, right bank, Tombigbee River, 4 to 5 miles northwest of Columbus, Lowndes County, bed 5 of section.

6916, 17202, 17247.—Plymouth Bluff, right bank, Tombigbee River, 4 to 5 miles northwest of Columbus, Lowndes County, bed 4 of section.

6914.—Plymouth Bluff, right bank, Tombigbee River, 4 to 5 miles northwest of Columbus, Lowndes County, bed 3 of section.

6915.—Plymouth Bluff, right bank, Tombigbee River, 4 to 5 miles northwest of Columbus, Lowndes County, bed 2 of section.

6450, 6921.—Bluff a few hundred yards above the railroad bridge at Columbus, Lowndes County.

17245.—7 miles east-southeast of Columbus, Lowndes County. (N. 1/2, Sec. 3, T.19 S., R.17 W.)

6449—Bartons Bluff, Tombigbee River in Clay County, 10 1/2 miles northwest of Columbus.

6448.—Vinton Bluff, Tombigbee River in Clay County, about 12 1/2 miles northwest of Columbus.

6925.—Bluff on Tombigbee River below railroad bridge at Aberdeen, Monroe County.

6922, 6923, 6924.—Blue Bluff, right bank of Tombigbee River, about 3 miles above Aberdeen, Monroe County.

6887, 6888 (in part).—One mile west of old Cotton Gin Port (Sec. 9, T.13 S., R.7 E.) 4 miles west of Amory on eastward-facing slope of Tombigbee River Valley, Monroe County.

9517.—A quarter of a mile west of Marietta on the Baldwyn road, Prentiss County.

6458b.—Near Hare's old mill site on Big Brown Creek, 9 miles east of Booneville, Prentiss County.

17782.—Northeastward-facing slope of Youngs Creek Valley (Sec. 9, T.6 S., R.8 E.) 7 1/2 miles southeast of Booneville, Prentiss County.

At intervals throughout the Eutaw formation are layers of glauconitic sand containing in abundance tubes constructed by a problematical organism. These tubes have a subdued, closely crowded, tuberculated surface and a thin wall usually preserved either as a white clay-like substance or as iron oxide. The tubes are half an inch to an inch in diameter. Specimens submitted to the late Dr. F. H. Knowlton were regarded by him as identical with *Halymenites major* Lesquereux, a problematical form first described from the marine Upper Cretaceous deposits of the Western Interior. Lesquereux, Knowlton, and others of the earlier paleontologists regarded these tubes as the remains of marine plants, probably fucoids, but recently published evidence suggests that they are the borings of crustaceans (66, pp. 253-254).

Distribution of Eutaw (Tombigbee) fossils

Species	Lowndes County						Clay County		Monroe County			Prentiss County		
	6918 - Plymouth Bluff, bed 5	6916 etc. - Plymouth Bluff, bed 4	6914 - Plymouth Bluff, bed 3	6915 - Plymouth Bluff, bed 2	6450 etc. - Columbus	17245 - Columbus, 7 mi. ESE	6449 - Bartons Bluff	6448 - Vinton Bluff	6925 - Aberdeen	6922 etc. - Blue Bluff	6887 etc. - Cotton Gin Port	9517 - Mariette	6458b etc. - Hare's old mill	17782 - Booneville, 7 1/2 mi. SE
Echinodermata:														
Marsupites americanus Springer		X												
Vermes:														
Hamulus squamosus Gabb											X			
H. major Gabb		X												
Mollusca:														
Pelecypoda:														
Inoceramus (several species)		X		X						X		X		
Ostrea plumosa Morton			X			?	X	X	X	X	X	X	?	X
O. whitei Stephenson														X
O. panda Morton					X						X			
Gryphaea aff. G. wratheri Stephenson					X		X	X		X				
Gryphaeostrea vomer (Morton)					•						X			
Exogyra ponderosa Roemer	X		X		X		X	X	X	X	X	X	X	X
E. ponderosa erraticostata Stephenson	X									X	X			
Pecten (Neithea) hartmani Kniker?	X		X								X			
P. (N.) casteeli Kniker					?		?	X		?	?		X	
P. (Camptonectes) bellisculptus Conrad?					X									
Anomia argentaria Morton			?				?	?					X	
A. olmstedi Stephenson										X	X			
Clavagella armata Morton?											X			
Cephalopoda:														
Eutrephoceras sp. (large)		X							X					
Baculites asper Morton					X									
Placenticeras aff. P. guadelupae (Roemer)		X							X	X				
P. aff. P. planum Hyatt		X												
Mortoniceras delawarense (Morton)		X												
M. aff. M. texanum (Roemer)		X												
Muniericeras sp.		X												
Aptychus spinosus Cox						X								
Vertebrata:														
Shark teeth			X				X	X		X	X			
Hemiptychodus mortoni (Mantell)								X						

The numbers are those of collections of the U. S. Geolcgical Survey in the U. S. National Museum.

LOCAL DETAILS

LOWNDES COUNTY

The Eutaw formation crops out in the northeastern half of Lowndes County, but much of its outcrop area, as shown on the geologic map (Plate 1A), is covered by terrace deposits (Plate 1B).

Good exposures of typical thin-bedded sand and clay are afforded by the cuts of Mississippi Highway 12, about 2 miles northeast of Columbus, one being at the Luxapallila Creek bridge near the city waterworks pumping station (Sec. 11, T.18 S., R.18 W.).

SECTION ON LUXAPALLILA CREEK, 2 MILES NORTHEAST OF COLUMBUS

	Feet
Pleistocene terrace deposit	
Sandy loam and sand having a heavy bed of gravel along the base	16
Unconformity	
Eutaw formation	
Dark laminated lignitic clay with fine micaceous and glauconitic partings and thin layers of sand; the clay contains comminuted fragments of vegetable matter	4
	20

The clay is exposed in the banks of the creek for a distance of about a quarter of a mile above the bridge.

A similar section is in the left bank of Luxapallila Creek at the wagon bridge south of Steens, a small village on the Southern Railway (Sec. 28, T. 17 S., R. 17 W.), 2 1/2 miles west of the Alabama State line.

SECTION ON LUXAPALLILA CREEK SOUTH OF STEENS

	Feet
Pleistocene terrace deposit	
Loose gray sand	3
Heavy bed of gravel, the pebbles of which are chiefly brown and gray chert, with, however, a small percentage of quartz	6
Unconformity	
Eutaw formation	
Gray laminated clay with partings and thin layers of gray slightly glauconitic sand; the laminae of clay are in part ferruginous and present bright-yellow ochre-like tints	1
	10

Between Steens and McCrary, on the Mobile and Ohio Railroad, 9 miles east of Columbus, the upland hills, which reach a maximum altitude of 360 or 370 feet above sea level and extend 3 or 4 miles westward from Alabama into Lowndes County, are composed chiefly of Eutaw sands and clays, overlain by gravels probably of Pliocene or Pleistocene terrace origin. Although exposures are poor along the public road connecting these towns, the Eutaw deposits may be inferred, from the nature of the residual products, to be chiefly the characteristic glauconitic sands and drab clays of the formation; and this inference is in part confirmed by one poor outcrop on the northward-facing slope of Magby Creek Valley (Sec. 15, T.18 S., R.17 W.), 2 1/2 miles north of McCrary.

SECTION ON NORTHWARD-FACING SLOPE OF MAGBY CREEK VALLEY, ON THE STEENS ROAD ABOUT 2 1/2 MILES NORTH OF MCCRARY

	Feet
Pleistocene (?) terrace deposit	
Yellowish sandy loam	5
Red argillaceous sand with streaks of dark sandy clay	5
Gravel composed chiefly of chert, with some quartz, in a matrix of red sand	4
Unconformity	
Eutaw formation	
Laminated gray clay with fine partings of sand	12
Massive greenish-gray glauconitic sand	15
	41

The lower part of the Eutaw has been raised into a low anticline south of Columbus and crops out at places where, if the dip were normal, the Tombigbee sand member would be seen. One of these places is at the crossing of the Luxapallila Creek on the Pickensville, Ala., road at the southeast edge of Columbus (Sec. 27, T. 18 S., R. 18 W.), where 11 feet of blue-gray thin-bedded, hackly clay with partings of fine sand and mica, is exposed.

Another good exposure is on the left bank of Tombigbee River at a sharp bend to the south (SW.1/4, Sec. 10, T.19 S., R.18 W.), 5.3 miles south-southeast of the highway bridge across Tombigbee River at Columbus.

SECTION ON BANK OF TOMBIGBEE RIVER, 5.3 MILES SOUTH-SOUTHEAST OF COLUMBUS

	Feet
Pleistocene terrace deposit	
Sandy silt	9
Red and yellow sand and gravel	14
Unconformity	
Eutaw formation	
Thin-bedded, flaky dark gray micaceous clay with some sandy beds; the upper 5 feet is very sandy, but at top is a 6-inch bed of clay; to water level	23
	46

The bluffs of Tombigbee River in Lowndes, Clay, and Monroe counties afford typical exposures of the Tombigbee sand member. Should it seem desirable to designate a particular locality as preeminently typifying the member, the choice of anyone familiar with the area would be Plymouth Bluff on the west side of the river (Sec. 14, T.19 N., R.17 E.), 4 miles northwest of Columbus. Hilgard (11, p. 74), the author of the name, described this bluff as "one of the

Figure 11.—Tombigbee sand member of Eutaw formation overlain by Selma chalk, Plymouth Bluff, Tombigbee River, Lowndes County. The Tombigbee-Selma contact lies well up toward the top of the bluff; the prominent ledge of bench-forming sandstone contains innumerable prints and molds of several large species of Inoceramus. Photo by L. W. Stephenson.

best and most characteristic exposures of the Tombigbee Sand Group." The section exhibits nearly 50 feet of marine sand containing numerous individuals of several common and characteristic species of fossil mollusks, and includes about 35 feet of the Selma chalk which overlies the sand. The bluff has been described by several previous writers but the importance of the locality justifies another description here (Figure 11).

Selma chalk		Feet
7.	Bluish-gray strongly argillaceous, slightly sandy, sparingly glauconitic chalk, weathering to light gray or nearly white; contains in middle and upper parts *Hamulus squamosus* Gabb, *Ostrea plumosa* Morton and *Exogyra ponderosa* Roemer (U. S. G. S. Coll. 6919).	30
6.	Gray sandy chalk above, grading downward into massive chalky, glauconitic sand with a partly indurated, nodular layer at the base; small phosphatic nodules and internal molds of pelecypods and gastropods are widely scattered in the lower 8 feet of the bed, and are most numerous in the lower 1 foot; fragments of a very large, poorly preserved ammonite noted in a whitish, chalky layer 3 or 4 feet below the top	15
Unconformity (not conspicuously developed)		
Eutaw formation (Tombigbee sand member)		
5.	Gray massive glauconitic sand with several discontinuous indurated, nodular layers; contains many shells of *Exogyra ponderosa* Roemer, and a few other fossils in the upper 2 or 3 feet (Coll. 6918)	23
4.	Ledge of resistant calcareous, glauconitic sandstone which has produced a bench 20 to 30 feet wide (Figure 11); contains many impressions of *Inoceramus* (probably representing several species), and a few other fossils including *Placenticeras* aff. *P. guadalupae* (Roemer), *Mortoniceras* sp., *Eutrephoceras* sp. (large), and *Marsupites americanus* Springer (rare) (Colls. 6916, 17202 and 17247)	1
3.	Greenish-gray, glauconitic massive sand; contains *Ostrea plumosa* Morton, *Gryphaea* sp., *Exogyra ponderosa* Roemer, *Pecten* (*Neithea*) sp., *Anomia* sp. and shark teeth (Coll. 6914)	9
2.	Ledge of calcareous, glauconitic sandstone; contains *Inoceramus* sp. (Coll. 6915)	2/3
1.	Compact gray calcareous, glauconitic sand; only the upper 2 feet of this bed is exposed midway of the length of the bluff, but it rises in both directions to maximum exposed thicknesses of 11 feet at the down stream end of the bluff and 16 feet at the upstream end	16
		94 2/3

The Tombigbee sand of the Plymouth Bluff section is well exposed to a height of 50 feet about a mile downstream from the bluff proper where the upper part of the section is obscured by vegetation.

In 1911 Springer (26, pp. 158-161) described a new species of fossil crinoid, *Marsupites americanus,* from the Tombigbee sand at Plymouth Bluff; the material was collected by Mr. Frederick Braun who, however, did not indicate the exact bed in which he found it.

As crinoids are rare in the Cretaceous deposits of the Atlantic and Gulf Coastal Plain, this is an especially interesting record. One plate of *Marsupites americanus* Springer was found in 1936, in the matrix of a specimen of a large ammonite (*Mortoniceras* sp.) (Coll. 17247) which was collected from a large loose slab of sandstone lying at the water's edge; obviously this slab had fallen from the projecting edge of layer 4 of the section. This discovery fixes the stratigraphic position of *Marsupites americanus* Springer more exactly than did the original record; additional plates were collected from this layer in 1939.

SECTION IN BLUFF OF TOMBIGBEE RIVER AT COLUMBUS

	Feet
Pleistocene terrace deposit	
Mottled reddish-yellow and brownish very coarse more or less ferruginous, argillaceous sand	6
Unconformity	
Eutaw formation (Tombigbee sand member)	
Compact greenish-gray massive very micaceous and glauconitic sand. more or less weathered to brownish and yellowish tints	28
Similar sand, partly indurated; contains a few fossils (Colls. 6450 and 6921)	2
Compact greenish-gray to dark-green micaceous, glauconitic sand with numerous argillaceous tubes of *Halymenites major* Lesquereux; a lignitized tree limb 2 to 3 inches in diamenter was observed; contains a few other fossils (Colls. 6450 and 6921)	30
	66

The Tombigbee sand member crops out in Lowndes County on both sides of Tombigbee River as far south as the western end of Union Bluff, which is on the right bank (S.1/2, Sec. 19, T.17 N., R.19 E.), on the upland east of the river as far south as Columbus, and in a broad area east of the river about 8 miles southeast of Columbus. The member does not crop out in Luxapallila Valley partly because of an upwarp of the lower part of the Eutaw formation and partly because of the relatively lower altitude of the valley. The large area of outcrop in the southeastern part of the county is apparently caused by downwarping on the eastern flank of the upwarp.

Southeast of Plymouth Bluff, Tombigbee River flows in an alluvial valley about 3 miles wide bordered on both sides by steep scarps. The hill on the east side of the valley, known as Pleasant Ridge, is composed entirely of Tombigbee sand and its weathered products. Good exposures of the Tombigbee may be seen on U. S. Highway

45, especially in Columbus and at the north side of the ridge in the southern part of Sec. 20, T. 17 S., R. 18 W.

The upper part of the Tombigbee sand member is exposed in several road cuts near Barksdale School, 7 miles east by south of Columbus. On the eastward-facing slope of a branch of Ellis Creek (near center, N.1/2, Sec. 3, T.19 S., R.17 W.), about 7 1/2 miles east-southeast of Columbus, 9 feet of fossiliferous (Coll. 17245) very glauconitic, calcareous, argillaceous sand (Tombigbee) is overlain by sand and gravel of a Pleistocene (?) terrace deposit.

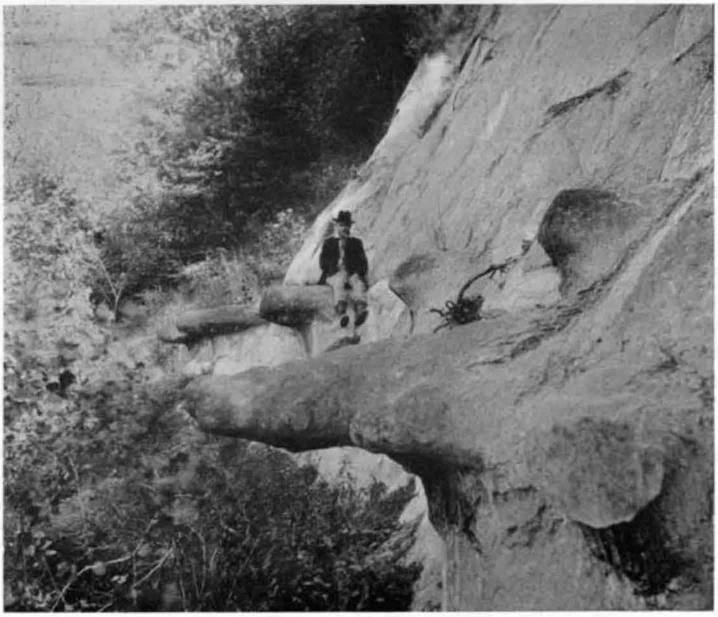

Figure 12.—Tombigbee sand member of Eutaw formation with large oval concretionary masses of sandstone, Bartons Bluff, Tombigbee River, 9 miles east by north of West Point, Clay County. Photo by L. W. Stephenson.

CLAY COUNTY

The course of Tombigbee River, which forms a part of the eastern boundary of Clay County, lies 1 to 3 miles east of the western edge of the belt of Tombigbee sand, and good exposures are afforded by some of the bluffs along the river. One of these is at Bartons Bluff, half a mile below the ferry of the same name, 8 1/2 miles east by north of West Point (11, p. 68).

SECTION AT BARTONS BLUFF, TOMBIGBEE RIVER, RIGHT BANK, 8 1/2 MILES EAST BY NORTH OF WEST POINT

	Feet
Eutaw formation (Tombigbee sand member)	
Compact greenish-gray glauconitic sand, somewhat argillaceous in some layers, especially toward the top; a few feet above the base is a prominent partly indurated, concretionary ledge (Figure 12), and discontinuous ledges were observed at other places; along the base is a layer containing large numbers of phosphatic pebbles, shark teeth, and fragments of bone (Coll. 6449)	60
Eutaw formation (typical)	
Stratified, in places laminated, irregularly bedded dark gray and yellow glauconitic sand	15
	75

At Vinton Bluff, 2 miles upstream from Barton's Ferry, is another good exposure of the Tombigbee sand, about half a mile long.

SECTION AT VINTON BLUFF, TOMBIGBEE RIVER, RIGHT BANK, ABOUT 8 1/2 MILES NORTHEAST BY EAST OF WEST POINT

	Feet
Eutaw formation (Tombigbee sand member)	
Greenish-gray glauconitic sand, mottled with yellow and red	8
Greenish-gray compact argillaceous, very micaceous, glauconitic sand	5
Dark-gray compact finely arenaceous and micaceous shaly clay	3
Greenish-gray compact argillaceous, very micaceous sand, grading downward into next layer	3
Greenish-gray compact slightly argillaceous and micaceous, glauconitic sand, with 3 indurated concretionary layers respectively, at the base, 4 feet above the base, and 3 feet below the top; these are discontinuous along the bluff; contains fossils (Coll. 6448); a layer 1 foot thick along the base contains large numbers of phosphatic pebbles and shark teeth, and corresponds to a similar layer in the section at Bartons Bluff	15
Eutaw formation (typical)	
Laminated, irregularly stratified dark drab micaceous clay and yellowish to almost white glauconitic sand; in places the clay contains comminuted vegetable fragments, lignite, and fine gypsum crystals	13
	47

The contact of the Tombigbee sand with the overlying Selma chalk is well exposed on the right bank of Town Creek near the southeast corner of the NE.1/4, Sec. 11, T.17 S., R.7 E., where 15 feet of fine glauconitic gray sand containing *Exogyra ponderosa* Roemer is overlain by 6 feet of clay residual from the Selma chalk.

MONROE COUNTY

The Eutaw formation crops out on the slopes of the upland between Tombigbee and Buttahatchie River Valleys, on the tops of the hills east of the Buttahatchie and its tributaries, and north of Amory on the lower slopes of the hills on both sides of the East Fork of Tombigbee River. The Eutaw is concealed over much of this area by terrace deposits that underlie five terraces of Pliocene (?) and Pleistocene age, in Tombigbee River Valley; these range in altitude up to about 175 feet above the river. The Eutaw consists of cross-bedded and massive glauconitic, micaceous sand and of thinly laminated dark gray clay and glauconitic sand. The lower part of the formation contains considerable fine chert gravel.

SECTION IN GULLY ABOUT 10 MILES EAST OF ABERDEEN

	Feet
Pleistocene terrace deposit (?)	
Deep-red ferruginous sand, containing stringers and small lenses of pebbles in the lower 4 feet	10
Unconformity	
Eutaw formation	
Gray laminated clay with partings and thin layers of sand	2
Red weathered glauconitic sand, with thin clay laminae at intervals of 2 to 12 inches; in places where the sand is less weathered it is greenish gray and pink, and the glauconite grains are distinctly visible	7
	19

SECTION OF EUTAW FORMATION IN GULLY ON THE SPLUNGE ROAD, 8 MILES EAST OF AMORY AND 4 MILES EAST OF HATLEY

	Feet
Deep-red weathered ferruginous sand of massive aspect	20
Fine loose, finely cross-bedded purplish slightly glauconitic, slightly micaceous sand, with numerous thin films of clay; contains many friable argillaceaus tubes of *Halymenites major* Lesquereux	10
Concealed	10
Loose yellowish and brownish finely cross-bedded, moderately glauconitic sand with clay films	5
	45

Down the ravine below the base of the preceding section a layer of stratified marine clay several feet thick, containing comminuted vegetable fragments, is poorly exposed; a line of springs emerges along the contact between the clay and the overlying sand. The clay films in the sand 20 to 30 feet below the top are well shown in Figure 13.

Tombigbee River crosses the contact between the Tombigbee sand member and the underlying typical beds of the Eutaw at several places in its wide meanders from one side to the other of its broad valley, as, for example, at a low cliff at the highway bridge south of Aberdeen.

Figure 13.—Eutaw formation containing films of clay and Halymenites major Lesquereux; gully south of public road, 8 miles east of Amory, south of the road to Splunge, Monroe County. Most of the white dots are cross sections of H. major. Photo by L. W. Stephenson.

SECTION AT HIGHWAY BRIDGE SOUTH OF ABERDEEN

	Feet
Pleistocene alluvium	
Fine gray sand	16
Unconformity	
Eutaw formation (Tombigbee sand member)	
Fine glauconitic sand containing many tubes of *Halymenites major* Lesquereux	12
Eutaw formation (typical)	
Thin-bedded gray sand and clay	6
	34

Three feet of dark blue-gray clay with thin partings of fine micaceous, glauconitic sand of the Eutaw formation is overlain unconformably by alluvial gravel and brown silty clay containing wood fragments, at a bend on the left bank of Tombigbee River, 3 1/2 miles southwest of Hamilton station, which is on the St. Louis-San Francisco Railway.

Two other sections on Tombigbee River are described below:

SECTION AT BLUE BLUFF, TOMBIGBEE RIVER, RIGHT SIDE, ABOUT 3 MILES NORTH OF ABERDEEN

	Feet
Eutaw formation (Tombigbee sand member)	
3. Brownish, yellowish, and greenish-yellow weathered marine sand, somewhat argillaceous in the upper 6 to 8 feet	25
2. Gray massive glauconitic, calcareous, micaceous sand; in the lower 30 feet are concretionary masses, some arranged in discontinuous layers and others irregularly distributed; fossils were collected in about the middle third of the bed (Colls. 6922, 6923)	62
Eutaw formation (typical)	
Dark-gray laminated clay with seams and pockets of fine sand; contains some comminuted vegetable matter	3
	90

SECTION ON TOMBIGBEE RIVER, RIGHT BANK, BELOW THE BRIDGE OF THE ST. LOUIS-SAN FRANCISCO RAILWAY, ABERDEEN

	Feet
Pleistocene terrace deposit	
Greenish-gray and yellowish sandy clay, stratified in the lower portion	15
Unconformity	
Eutaw formation (Tombigbee sand member)	
Dark-gray massive compact glauconitic, somewhat calcareous and argillaceous sand, with partly indurated ledges and some irregular indurated masses; contains *Ostrea plumosa* Morton, *Exogyra ponderosa* Roemer, *Eutrephoceras* sp., *Placenticeras* aff. *P. guadalupae* Roemer, *Mortoniceras* sp. (Coll. 6925)	20
	35

The preceding section is cut in the edge of a Pleistocene terrace plain which lies 35 or 40 feet above low water level of the river (Figure 14). The town of Aberdeen is on the next higher plain which is about 60 feet above low water level.

Many of the higher hills east of Tombigbee River are believed to be capped by sand derived from the Tombigbee sand member of the Eutaw, but in the time available its presence there was not verified. The weathered products of the typical Eutaw and its member are not readily distinguishable.

Figure 14.—Tombigbee sand member of Eutaw formation containing ledges of calcareous sandstone, bluff of Tombigbee River, Aberdeen, Monroe County. Photo by L. W. Stephenson.

Two beds of bentonite have been reported by Bay (57, pp. 25-27) in the Tombigbee sand member of the Eutaw; both beds are exposed about 5 miles south of Aberdeen (Secs. 24, 25, and 26, T.15 S., R.7 E.), and the higher bed crops out about 4 miles north (Sec. 4, T.14 S., R.7 E.). However, one of these deposits may be in the typical beds of the Eutaw just below the Tombigbee sand.

The contact of the Tombigbee sand member with the overlying Selma chalk is not exposed at many places in Monroe County, because over much of the county the Selma has been deeply weathered to a residual silt. On the old highway from Aberdeen to Cotton Gin Port, the contact is exposed in a road cut 8 miles north of Aberdeen (NW. corner Sec. 22, T.13 S., R.7 E.).

SECTION IN ROAD CUT 8 MILES NORTH OF ABERDEEN

	Feet
Selma chalk	
Sandy, glauconitic chalk containing a few phosphatic molds of mollusks	3
Unconformity	
Eutaw formation (Tombigbee sand member)	
Calcareous, highly glauconitic sand; a persistent bed of *Exogyra ponderosa* Roemer 3 feet above base; contains also *Pecten* (*Neithea*) sp.	7
	10

Three and eight-tenths miles east of Strongs, 3 feet of fine glauconitic, calcareous sand (Tombigbee sand), containing *Exogyra ponderosa,* is overlain by 1 foot of sandy, glauconitic chalk (Selma chalk), which yielded one phosphatic mold of *Turritella* sp.

A mile and a half west of the site of old Cotton Gin Port on Tombigbee River, 4 miles west of Amory, a section in bald spots and gullies along the public road on the eastward-facing slope of Tombigbee River valley exhibits the uppermost beds of the Tombigbee sand and the lowermost beds of the overlying Selma chalk.

SECTION IN PUBLIC ROAD, A MILE AND A HALF WEST OF COTTON GIN PORT, 4 MILES WEST OF AMORY

	Feet
Selma chalk	
A somewhat argillaceous and sandy facies of the chalk; contains fossils (Colls. 6886 and 17207)	20
Unconformity (?)	
Eutaw formation (Tombigbee sand member)	
Very calcareous sand with many shells of *Exogyra ponderosa* Roemer	6
Massive glauconitic sand, very calcareous in the upper part, becoming less so below; contains many fossils (Coll. 6887); base 20 or 25 feet higher than low water level of Tombigbee River	100
	126

Fossils weathered chiefly from the upper layer of the Eutaw formation are shown in Figure 15.

Hilgard (11, pp. 66-67) described sections in the vicinity of Coulters Ferry, 3 or 4 miles north of the preceding locality, which afford good exposures of the uppermost beds of the Tombigbee sand and the basal beds of the Selma chalk.

The Eutaw formation in Monroe County is apparently from 300 to 400 feet thick. The well of the municipal water plant at Amory (48, p. 337) entered the Tuscaloosa formation at 240 feet. The Bourland well, whose log is given below, penetrated all the Eutaw formation except the Tombigbee sand member.

Figure 15.—Fossils, chiefly shells of Exogyra ponderosa Roemer and Gryphaea sp. weathered from the uppermost beds of the Tombigbee sand and the lowermost beds of the Selma chalk; gullies 4 miles west of Amory (a mile west of Cotton Gin Port), Monroe County. Photo by L. W. Stephenson.

DRILLER'S LOG OF THE AMORY DEVELOPMENT COMPANY'S BOURLAND NO. 1 WELL (NE.1/4, NE.1/4, SEC. 2,T.13 S., R.19 W.) ABOUT A MILE SOUTHWEST OF AMORY

	Thickness Feet	Depth Feet
Eutaw formation (including surficial Pleistocene terrace deposit.)		
Top soil (includes Pleistocene terrace deposit)	87	87
Lignite	5	92
Sandy shale	38	130
Gumbo shale	120	250
Gray sand	9	259
Lignite	2	261
Gray sand and gravel	47	308
Rock	1	309

Tuscaloosa formation		
Gumbo shale	13	322
Rock	1	323
Gumbo shale	17	340
Sand and gravel	15	355
Hard sandstone	7	362
Coarse gravel	18	380
Red gumbo	80	460
Blue gumbo	16	476
Paleozoic rocks	2531	3007

(Altitude of derrick floor 274 feet above sea level)

LEE COUNTY

In Lee County the Tombigbee sand member at the top of the Eutaw formation is exposed only in the southeastern corner—low in the valleys of Shoaf, Boguegaba, and Boguefala Creeks and their tributaries. It consists of massive ferruginous, glauconitic fine sand where weathered, and of soft calcareous sand in fresher exposures.

ITAWAMBA COUNTY

The Eutaw formation crops out over most of the western two-thirds of Itawamba County, except in the valley of the East Fork of Tombigbee River where the underlying Tuscaloosa formation is exposed in the lower slopes, and along the western boundary of the county where the Tombigbee sand member is overlain by the Mooreville tongue of the Selma chalk as far north as Ratliff and by the Coffee sand north of Ratliff.

The typical beds of the Eutaw formation consist, in general, of cross-bedded red glauconitic sand (Figure 16) and subordinate amounts of thin-bedded sand and clay; the overlying Tombigbee sand member consists of massive glauconitic fine sand.

From Dorsey eastward to within 6 miles of the Alabama State line the hills are composed chiefly of the glauconitic sands and subordinate gray laminated marine clays of the Eutaw. The Tuscaloosa formation froms the lower slopes of the East Fork of Tombigbee River and its tributaries from the east and appears at the surface from beneath the Eutaw in the upper slopes of the eastward-facing slope of Bull Mountain Creek Valley. Outliers of the Eutaw overlying the Tuscaloosa formation are present capping many of the hills in the southeast, east of Bull Mountain Creek. The Eutaw sands and clays, weathered at the surface to dark-reddish and reddish-brown tints, may be seen in hundreds of poor exposures in these hills; a few good exposures, some of which are described below, appear in the banks of streams or in the deeper road cuts. Poorly preserved tubes of *Halymenites major* Lesquereux are common in the sands and were noted especially on the Tupelo-Fulton road (U. S. Highway 78) three-fourths of a mile east of Mantachie Creek, and on the Red Bay road 9 1/4 miles northeast of Fulton.

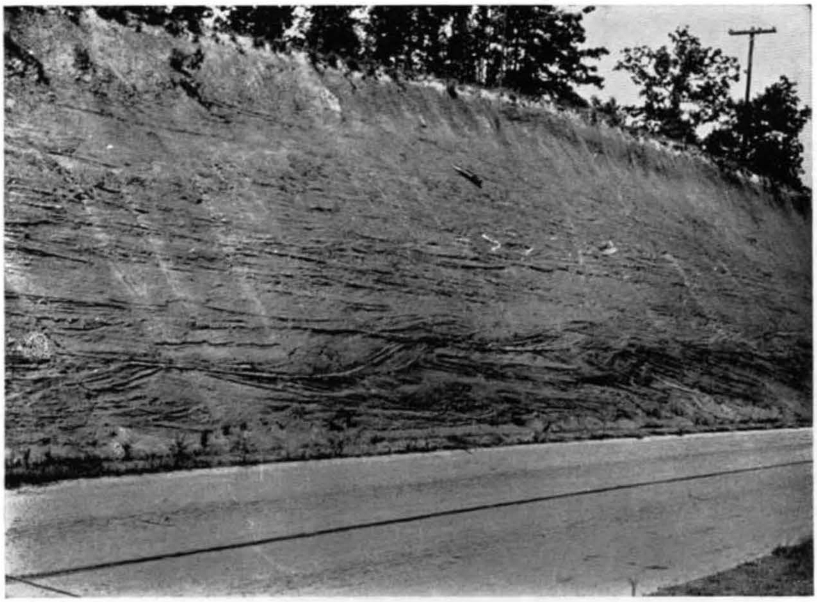

Figure 16.—Cross bedding in the upper part of the Eutaw formation not far below the base of the Tombigbee sand member, on the Tupelo road 3 miles west by south of Fulton, Sec. 34, T.9 S., R.8 E., Itawamba County. Photo by W. H. Monroe.

Exposures in the hills east of Mackys Creek in the northern part of the county reveal stringers of chert pebbles in the glauconitic sands, a typical locality being in the public road east of Spencer's store, 2 miles east of the East Fork of Tombigbee River, and 6 miles east by south of Kirkville. Here stringers of small subangular chert pebbles up to half an inch or more in length are very numerous in highly cross-bedded glauconitic sand. In stratigraphic position this sand is less than 100 feet, perhaps less than 50 feet, above the base of the Eutaw.

At the foot of an eastward-facing slope on U. S. Highway 78, 4/5 of a mile east of Dorsey, thin-bedded, dark-gray flaky clay of the Eutaw formation is overlain by massive, glauconitic sand of the Tombigbee sand member. The contact is 65 feet lower than an exposure of Selma chalk (Mooreville tongue) half a mile to the west.

The contact of the Tombigbee sand member and the main body of the Eutaw formation is well exposed on a road 2 1/2 miles due east of Ratliff (NW. cor. Sec. 18, T.8 S., R.8 E.); the Selma chalk (Mooreville tongue), is exposed on a hill south of this place.

SECTION ON EASTWARD-FACING SLOPE OF HILL 2 1/2 MILES EAST OF RATLIFF

	Feet
Eutaw formation (Tombigbee sand member)	
Massive highly calcareous, glauconitic, micaceous sand; indurated ledge 17 feet above base; contains *Exogyra ponderosa* Roemer, and *Gryphaea* sp.	27
Eutaw formation (typical beds)	
Cross-bedded and thin-bedded glauconitic, micaceous sand and thin-bedded gray sandy clay	28
	55

One deposit of bentonite was found a mile and a half southeast of Evergreen on the land of Mr. W. R. Hall (SE. Cor. Sec. 6, T.11 S., R.8 E.). This deposit is near the contact between the typical beds of the Eutaw and the overlying Tombigbee sand member; the bentonite may belong with the former, for a tenth of a mile toward the west at about the same altitude highly cross-bedded sand, such as is characteristic of the main body of the Eutaw, is exposed.

SECTION ON EASTWARD-FACING SLOPE OF BOGUEFALA CREEK VALLEY ON LAND OF W. R. HALL

	Feet
Eutaw formation (Tombigbee sand member?)	
Red sand containing highly weathered tubes which may be *Halymenites major* Lesquereux	8
White and cream-colored silty bentonite	1
Massive glauconitic sand containing *Halymenites major* Lesquereux	26
Concealed to valley	30
	65

The bentonite in the section is at about the same stratigraphic position as the lower bentonite bed on Panther Creek south of Aberdeen, Monroe County, described by Bay (57, pp. 25-27).

The contact of the Tombigbee sand member of the Eutaw formation and the overlying Selma chalk is well exposed at many places near Dorsey.

SECTION IN GULLY NORTH OF U. S. HIGHWAY 78, 1/10 MILE WEST OF DORSEY

	Feet
Selma chalk (Mooreville tongue)	
Very argillaceous and sandy chalk (Coll. 17252); altitude at top about 380 feet above sea level	21
Unconformity	
Eutaw formation (Tombigbee sand member)	
Massive very calcareous, glauconitic sand (Coll. 17801)	5
	26

PRENTISS COUNTY

The Eutaw formation crops out in the eastern and southeastern parts of Prentiss County in an area comprising about one-fourth of the county. The lower part of the formation consists of cross-bedded fine sand and fine chert gravel; overlying this is fine thin-bedded sand and flaky clay. At the top of the formation is gray massive fine glauconitic sand, the Tombigbee sand member.

The Tuscaloosa formation underlies the Eutaw in a small area in the southeastern corner of the county in the valley of Mackys Creek.

The Eutaw formation is well exposed on the Dennis road about 17 miles southeast of Booneville on the westward-facing slope of a branch of Mackys Creek (Sec. 28, T.6 S., R.9 E.).

SECTION ON WESTWARD-FACING SLOPE OF BRANCH OF MACKYS CREEK

	Feet
Eutaw formation	
Red sparingly micaceous, glauconitic fine sand with well-rounded grains, containing scattered small chert pebbles and *Halymenites major* Lesquereux; the upper part (4 feet) is colluvium and contains a concentration of chert pebbles and small blocks of ferruginous sandstone	23
Layers of interlaminated micaceous fine glauconitic sand and gray flaky micaceous, clay interbedded with layers of cross-bedded micaceous glauconitic sand	21
Highly glauconitic fine sand containing abundant tubes of *Halymenites major* Lesquereux	4
	48

The contact of the Tombigbee sand member with the typical beds of the formation below is exposed on the Booneville-Tishomingo road half a mile east of Jensay Creek (SE Cor. Sec. 19, T.5 S., R.9 E.).

Thin-bedded sand and clay (typical Eutaw) is overlain by 16 1/2 feet of massive glauconitic sand of the Tombigbee sand member. The contact is marked by a thin bed of ferruginous sandstone.

On the Baldwyn road a quarter of a mile west of Marietta a cut on the eastward-facing slope of a small branch reveals 10 feet of light-gray massive calcareous, micaceous, slightly glauconitic fossiliferous (Coll. 9517) sand, in places slightly indurated with calcium carbonate. Similar sand containing *Exogyra ponderosa* Roemer crops out in the slopes in the immediate vicinity of Marietta. These sands are believed to represent the northward extension of the Tombigbee sand member of the Eutaw formation.

At Hare's old mill site on Big Brown Creek, 9 miles east of Booneville, the steep hill east of the creek, which is about 80 feet high, is composed in the lower part of dark gray more or less calcareous, glauconitic, micaceous sand representing the Tombigbee sand member of the Eutaw, as shown by exposures in the bluff at the old mill site; in the road leading up the hill to the eastward the upper 30 feet of the exposure consists of weathered yellowish, reddish, and brownish sand probably of Coffee age. Within 20 feet of the base of the exposure fossils were collected from the Tombigbee sand member (Colls. 6458-b and 6911).

TISHOMINGO COUNTY

The Eutaw formation crops out over much of Tishomingo County. In the east it appears only on the tops of the hills; farther west it makes up the body of the upland hills; and in the extreme west it appears in the slopes of Yellow Creek Valley and its tributaries. The formation is underlain by the Tuscaloosa formation in the southern and eastern parts of the county and by Paleozoic formations in the northern part. Along the Alcorn County line and in the northwestern corner of the county the Eutaw is overlain by the Coffee sand.

In the northern part of the county the Eutaw formation completely overlaps the Tuscaloosa formation and rests directly on Paleozoic rocks, as for example on Mississippi Highway 25 from Yellow Creek north to the Tennessee State line. From Iuka to the slope down to Yellow Creek all exposures are the typical Eutaw beds, the Tombigbee sand member of the Eutaw, or both; the Eutaw is partly covered by a thin mantle of red sand and quartz gravel residual from a high level terrace deposit. On the slope down to Yellow Creek a few feet of gravel is exposed between the Eutaw and the underlying Paleozoic basement. One and a half miles north of Yellow Creek on the slopes down to a small branch sand of the Eutaw formation is exposed resting on a one-foot bed of cobbles, which in turn rests on Paleozoic rock; the cobble bed may be a basal gravel of the Eutaw formation. On the northward-facing slope of Lard Branch Valley, 2 3/4 miles north of Yellow Creek, Eutaw sand rests on Tuscaloosa silt and gravel. From Lard Branch to the Tennessee State line the exposures on Highway 25 show sand of the Eutaw formation resting on a bed of gravel a foot or less thick, like that described above, composed largely of cobbles derived from the immediately underlying Paleozoic rock.

SECTION ON A SECONDARY ROAD ON THE NORTHWARD-FACING SLOPE OF WHETSTONE BRANCH VALLEY (NE.1/4, SEC. 36, T.1 S., R.10 E.) 3 1/2 MILES EAST OF HIGHWAY 25 NEAR SHORT

	Feet
Colluvium	
Brick-red sand containing quartz pebbles derived from a terrace deposit on higher slopes; merges downward into Eutaw formation. From 2 to	5
Eutaw formation	
Brick-red glauconitic very fine sand containing some fine chert gravel and a few tubes of *Halymenites major* Lesquereux; tubular ironstone in lower 2 feet	22
Basal gravel of Eutaw (?) (may represent Tuscaloosa); subrounded to angular chert pebbles and cobbles	1.5
Unconformity	
Paleozoic chert	1

The Paleozoic-Cretaceous contact is 75 feet by barometer above the bed of Whetstone Branch at a ford.

The only fossils thus far collected from the typical beds of the Eutaw formation in Mississippi are some plants from the lower 18 feet of the formation in a section exposed a mile and a half east of Iuka. (See Tuscaloosa formation, Tishomingo County.) Berry (40, p. 14) has identified from the lower 6 feet of this bed the following species of plants: *Andromeda wardiana* Lesquereux, *Androvettia carolinensis* Berry, *Phyllites pistiaeformis* Berry, and *Sequoia reichenbachi* (Geinitz) Heer. He correlated this bed with the Tuscaloosa formation, but the field work by the present authors in 1936 showed that the bed should be included in the Eutaw formation.

The Eutaw formation is revealed in a fine series of exposures in cuts of the Illinois Central Railroad and the Southern Railway in Tishomingo and Alcorn counties.

A section in the bank of a small branch a short distance west of the station at Iuka and just south of the Southern Railway reveals sands not far above the base of the Eutaw.

SECTION NEAR THE SONTHERN RAILWAY STATION AT IUKA

	Feet
Eutaw formation	
Deep reddish-brown weathered ferruginous sand, with irregular pockets or lenses of pebbles in the basal portion	4
Yellowish-green micaceous sand, with thin laminae of gray clay in places, and about 6 feet above the base a long, thin lens of gravel composed chiefly of chert pebbles; altitude at base approximately 542 feet above sea level	11
	15

Within five-eighths of a mile west of the station, shallow railroad cuts reveal weathered laminated sands and clays of the Eutaw similar to those in the preceding section. A surficial deposit, 2 to 10 feet thick, composed of weathered sands, sandy loams, and gravels, overlies the Eutaw in these cuts; in general the surficial gravels are distinguishable from those of the Eutaw by the large percentage of smoothly rounded quartz pebbles which they contain, but in places the contact has been very much obscured by weathering.

SECTION IN CUT OF SOUTHERN RAILWAY, 1 1/2 MILES WEST OF IUKA

	Feet
Eutaw formation	
Greenish-gray weathered sandy clay	4
Massive very glauconitic sand, with numerous blotches of iron stain; the grains of glauconite are weathered to brown	5
Loose glauconitic sand, with numerous laminae of drab clay; in part regularly bedded and in part finely current bedded; the grains of glauconite are weathered to brown	18
	27

SECTION IN CUT OF SOUTHERN RAILWAY, 1 1/2 MILES NORTHWEST OF BURNSVILLE

	Feet
Eutaw formation (Tombigbee sand member)	
Yellow and brown ferruginous sand, formed by the weathering of glauconitic sand	10
Dark-gray compact massive micaceous marine sand, with yellow stains on the surface	20
	30

The sands and gravels forming the upper part of the Tuscaloosa to within a few feet of its top are well exposed just to the northwest of Tishomingo station on the Illinois Central Railroad, and the basal sands of the Eutaw appear in a series of cuts on this railroad between Tishomingo and Paden. The following section, which may be regarded as typical of the exposures in these cuts, is about seven-eighths of a mile northwest of Tishomingo.

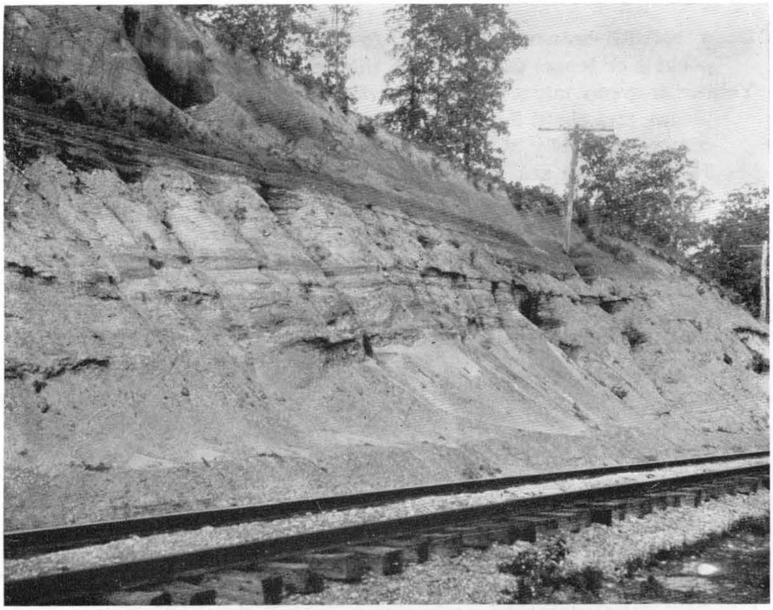

Figure 17.—Irregularly bedded sands and laminated clays near the base of the Eutaw formation; cut of Illinois Central Railroad, a mile southeast of Paden, Tishomingo County. Photo by L. W. Stephenson.

SECTION IN CUT OF ILLINOIS CENTRAL RAILROAD, SEVEN-EIGHTHS OF A MILE NORTHWEST OF TISHOMINGO

	Feet
Surficial deposit	
Brown sand, with lines of pebbles near the base	6
Unconformity	
Eutaw formation	
Massive gray clay which to the eastward abruptly gives place to sand; the clay reappears, however, at the same level in the next cut to the southeast	4
Fine loose light-gray micaceous sand	4
Laminae of gray very micaceous, sandy clay with partings and fine layers of micaceous sand	7
Fine light-gray micaceous sand with stratification lines faintly discernible	4
	25

Several silicified logs were noted in the Eutaw sands in these cuts.

An instructive section is afforded by a cut 1 mile southeast of Paden (Figure 17).

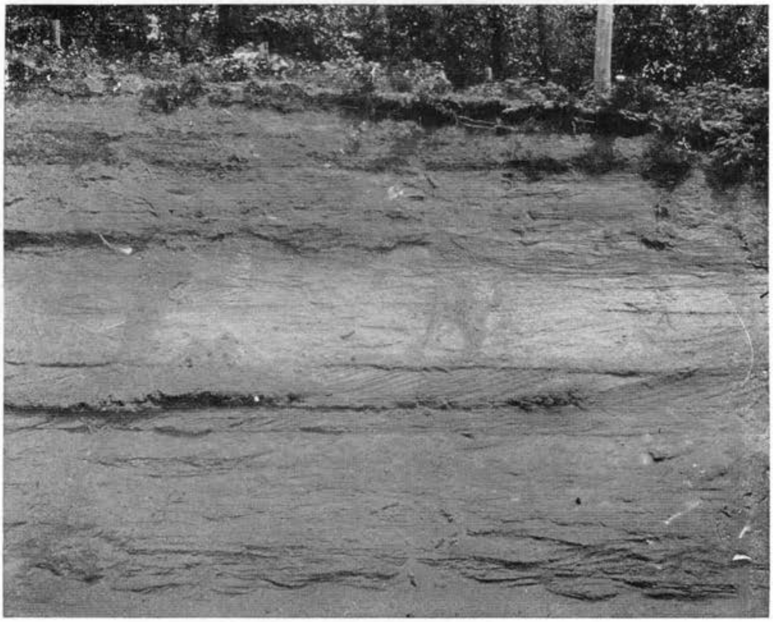

Figure 18.—Cross bedding in Eutaw formation in cut of Illinois Central Railroad, 4 miles northwest of Paden, Tishomingo County. Two types of cross bedding are shown: A layer exhibiting flow and plunge structure bounded by horizontal bedding planes occupies the middle of the section; fine cross bedding in small irregular lenses probably produced by the to and fro motion of the water near the lower limit of wave action, appears both above and below the plunge and flow structure. Photo by L. W. Stephenson.

SECTION IN CUT OF ILLINOIS CENTRAL RAILROAD, 1 MILE SOUTHEAST OF PADEN

	Feet
Surficial formation	
Yellow, argillaceous sand with lines of pebbles in the basal 2 or 3 feet	10
Unconformity	
Eutaw formation	
Loose yellow sand	6
Laminated gray clay with partings of fine sand; noted one flattened log of lignite 12 inches wide and 1 1/2 inches thick	4

Irregularly bedded fine micaceous, slightly glauconitic sand and subordinate laminae and thin layers of clay; toward the southeast end of the cut in the midst of the sands is a lens of slickensided dark carbonaceous, somewhat lignitic clay, 100 feet long and 7 feet thick, containing much comminuted vegetable matter and a few very poorly preserved leaves; one fruit was noted; a portion of a silicified tree trunk, which must originally have been at least 3 feet in diameter, was noted in the sand about 10 feet above the level of the track 15

35

Figure 19.—Flow and plunge structure in Eutaw formation; cut of Illinois Central Railroad, 2 1/2 miles northwest of Paden, Tishomingo County. Photo by L. W. Stephenson.

The large lens of carbonaceous clay in the section just described probably marks the place where a Cretaceous stream emptied into the shallow Eutaw sea.

The glauconitic sands of the Eutaw are well exposed in numerous cuts 1 to 4 miles northwest of Paden. Some of the cuts afford good examples of marine cross-bedding of at least two types: first, that manifested by beds 1 to 3 feet or more in thickness, limited above and below by horizontal lines, with regular flow and plunge structure between; and second, that manifested by numerous small intertonguing, relatively short, thick lenses with flow and plunge structure on a small scale (Figures 18 and 19). A peculiar bedding phenomenon is exhibited in a cut 2 1/2 miles from Paden where the numerous clay laminae of the Eutaw sands end sharply against a submarine sand filled channel in which clay laminae are absent (Figure 20). The nature of the current which produced this channel in the midst of glauconitic marine sands is problematical. About a

Figure 20.—Gray marine sand apparently occupying a current-cut submarine channel in laminated sands and clays of the Eutaw formation; cut of Illinois Central Railroad, 2 1/2 miles northwest of Paden, Tishomingo County. Photo by L. W. Stephenson.

mile from Paden the Eutaw sands contain interbedded layers of dark laminated clay, reaching 4 or 5 feet in thickness. A typical section is described below.

Section in cut of Illinois Central Railroad 4 miles northwest of Paden

Surficial deposit	Feet
Gray leached sand grading downward into brown harsh sand with a few small pebbles along the base; glauconite grains derived from the underlying Eutaw formation are in the basal 2 feet	7

Unconformity

Eutaw formation

Greenish-gray and brown strongly glauconitic, micaceous sand with numerous interbedded thin layers of dark clay; this layer is damp and forms a dark band along the cut; 2 small seepage springs emerge from it	6
Medium-compact light greenish-gray finely cross-bedded strongly glauconitic and micaceous sand, with numerous fine films of clay which are involved in the cross-bedding	25
	38

Between Leedy station (13 1/4 miles southeast of Corinth) and a point 1 mile southeast of Holcut (18 3/4 miles from Corinth), shallow cuts reveal here and there massive marine sands which represent the northward extension of the Tombigbee sand member of the Eutaw formation. Specific localities are the following: One mile southeast of Holcut, 10 to 12 feet of massive gray glauconitic sand in several cuts; just southeast of Holcut station in several cuts 8 to 10 feet of compact massive micaceous, strongly glauconitic sand; at the overhead bridge 4 or 5 feet of sand of this character interstratified with thin laminae of clay which is greenish gray at the base, weathering to brown above, and unconformably overlain by 3 or 4 feet of surficial weathered, loamy sand with pebbles along the base. Massive gray sands were noted in shallow cuts a short distance northwest of Holcut. Several shallow cuts within 3 miles southeast of Leedy reveal more or less weathered dark gray marine sands, and 15 feet of these sands appear in the cut bank just back of the station.

SELMA CHALK

GENERAL FEATURES

NAME

The name Selma was proposed in 1894 by Smith, Johnson, and Langdon (15, p. 276), as a coname with the somewhat misleading descriptive term Rotten limestone. The latter was introduced by Winchell (7, pp. 91-92) in 1857 for the great Cretaceous chalk terrane of Alabama. Hilgard (11, pp. 276-283) accepted Winchell's name for the formation in Mississippi, and the term was in common use in both states until 1894, since which time the geographic term Selma has been the accepted designation. This name was well chosen, for a good exposure of the chalk is afforded by the bluff of Alabama River at Selma, one of the typical localities mentioned by Winchell. The upper 80 feet of the Selma chalk of Smith, Johnson, and Langdon has recently been differentiated from the Selma under the formation name Prairie Bluff chalk (61, pp. 806-809).

AREAL DISTRIBUTION

The Selma chalk extends into Mississippi from Alabama as a belt about 24 miles wide in northeastern Kemper and in Noxubee counties, whence it trends northward, becoming somewhat narrower, with the margins irregular in detail, through parts of Lowndes, Oktibbeha, Clay, Monroe, and Chickasaw counties, to the southern part of Lee County. Here a tongue of impure chalk or chalky clay, the Mooreville tongue, extends 18 or 20 miles to the north through eastern Lee and western Itawamba counties, and is separated from the main chalk to the west by a corresponding southward extending tongue of sand, the Tupelo tongue, of the Coffee sand. From western Lee and eastern Pontotoc counties the main body of the chalk extends northward through parts of Union, Prentiss, and Alcorn counties as a belt 4 to 12 miles wide. In Tennessee this belt becomes narrower, and the formation finally loses its identity, probably by merging into non-chalky sand and clay, some 25 or 30 miles north of the Tennessee State line. The distribution of the chalk is shown on the map, Plate 1A.

In Alabama the Selma belt maintains a width of 20 to 25 miles as far east as the longitude of Montgomery, beyond which it rapidly narrows, finally ending in Russell County.

LITHOLOGIC CHARACTER AND THICKNESS

The Selma is essentially a chalk formation, ranging in composition from facies in which the content of lime carbonate is 85 per cent or more, to highly impure chalky clays and sands. In general, no difficulty is experienced in distinguishing the chalk from either the underlying Eutaw formation or the Selma's partial equivalents, the Coffee sand and the Ripley formation. Smith in 1903 (18, pp. 11-12) attempted to subdivide the terrane in Alabama into three parts on the basis of the relative amounts of lime and clay. The lower portion, which he estimated to include approximately one-third of the total thickness of the formation, contains 25 per cent or more of clayey impurities, his Selma division. The middle portion, estimated to embrace one-third of the total thickness, contains less than 25 per cent of clayey impurities, his Demopolis division. The upper portion, embracing the remainder of the formation, contains 25 per cent or more of clayey impurities, his Portland division. The upper part of his Portland division is now treated as a separate formation, the Prairie Bluff chalk. Although the lower and middle divisions are traceable into Mississippi, the lower passes into sandy beds—the Coffee sand—and the middle gradually becomes less pure toward the north. The upper division does not conform strictly to the definition, since some of the beds particularly in the uppermost part—the Prairie Bluff chalk—contain less than 25 per cent of clayey impurities (Table of analyses). The impurities mentioned by Smith as distinguishing the upper and lower divisions of the chalk are not all of a clayey character, for important percentages of sandy impurities are present in considerable thicknesses of the strata, especially in the upper division in western Alabama and east-central Mississippi. Smith's three member names cannot be practically applied in the middle and northern parts of the Cretaceous belt in Mississippi. In general the chalk of northern Mississippi is more sandy and argillaceous than the typical chalk farther south. In places fossil shells form an important part of the lithologic content.

The chalk consists of fine relatively soft more or less argillaceous and sandy limestone having a chalky texture. A unit consisting of one or more layers of nearly pure hard limestone is the Arcola limestone member, 200 to 265 feet above the base of the chalk. In fresh exposures the chalk is dark gray to bluish gray, but dries to light gray and white, producing the glaring bald spots of the prairies and the white bluffs bordering the streams. The chalk was deposited in marine waters less than 100 fathoms deep, probably for the most part less than 50 fathoms deep, as indicated by the presence in many layers, particularly in the less pure facies, of great numbers of large shells of the family Ostreidae. The question of the origin of the lime composing the chalks of the Gulf Coastal Plain has only recently been systematically studied. Frizzell (60, pp. 7-15) states that the calcareous remains of foraminifera and other marine organisms form only a small part of the chalk; from 85 to 98 per cent of the calcium carbonate is made up of the calcareous remains of minute flagellate algae called coccolithophores which lived in the warm clear and relatively shallow waters covering portions of the submerged Coastal Plain; these plant organisms can be seen only with a high-power microscope, for their microskeletons are from 2 to 10 microns, (.00008 to .0004 inch) long. Locally fossil shells of mollusks form an important part of the lithologic content of certain layers of the chalk. The chalk weathers to fertile clay soils ranging in color from dark grayish-brown to nearly black, the Black Prairies, or to thinner brownish or reddish-brown silty clay soils, the "post oak lands."

Analyses of samples of Selma chalk from several localities in Mississippi are given in the following table:

ANALYSES OF SELMA CHALK FROM MISSISSIPPI

	Exogyra cancellata zone	Upper part of *Exogyra ponderosa* zone							*Exogyra ponderosa* zone between Arcola limestone and *Diploschiza cretacea* zone		Arcola limestone member
	1	2	3	4	5	6	7	8	9	10	11
Silica (SiO_2)	9.09	8.06	8.52	8.88	25.27	10.90	14.84	25.40	32.81	22.76	1.13
Alumina (Al_2O_3)	7.47	5.94	6.60	5.94	4.81	1.96	15.59	6.88	11.75	4.56	.68
Iron oxide (Fe_2O_3)					10.35	1.42	4.50	8.62	4.65	6.46	
Lime (CaO)	45.38	47.41	47.00	44.65	32.85	45.79	32.89	26.37	22.69	34.31	54.55
Magnesia (MgO)	None	.06	None	1.22	.84	.88	.41	.58	1.53	.05	Trace
Carbon dioxide (CO_2)	35.61	37.20	36.88	....	25.60	35.73	27.10	23.70	22.61	28.25	42.81
Sulphur trioxide (SO_3)	....	....	....	....	.62	....	3.30	.64	1.55	.43	....
Water (H_2O)	1.08	1.32	1.00	1.88	.40	2.84	1.08	....	2.75	2.10	.40
Calcium carbonate (Ca CO_3) equivalent[a]	80.99	84.61	83.88	79.73	58.62	81.77	58.70	47.06	40.52	61.23	97.35

a The figures given for calcium carbonate ($CaCO_3$) may be slightly too high as a small part of the lime (CaO) may be present as a silicate. The figures were obtained by calculating the total CaO to carbonate.

1. Sample from bluff on Noxubee River at Macon, Noxubee County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 209, 1905.

2. Sample from bluff on Noxubee River, 5 miles east of Shuqualak, Noxubee County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 216, 1905.

3. Sample from old Columbus road, 6 miles north of Macon, Noxubee County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 216, 1905.

4. Sample from land of J. B. Brooks near Crawford, Lowndes County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 52, 1907. Sample may be from *Exogyra cancellata* zone.

5. Sample from near Osborne, Oktibbeha County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 50, 1907. Sample may be from *Exogyra cancellata* zone.

6. Sample from cistern at Okolona, Chickasaw County. Analyst unknown. Hilgard, E. W., Report on geology and agriculture of Mississippi, p. 101, 1860.

7. Sample from 1 mile west of Tupelo, Lee County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 47, 1907.

8. Sample from cut of Southern Railway, 1/8 mile west of station at Corinth. Alcorn County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 44, 1907.

9. Sample from clay pit of West Point Brick Manufacturing Company, West Point, Clay County. Analyst unknown. Mississippi Geol. Survey Bull. 13, p. 42, 1916.

10. Sample from 2 1/2 miles south of Tupelo, Lee County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 47, 1907.

11. Sample from old quarry, southwest side of Bogue Chitto Creek, 1/2 mile east of Prairie Rock and 12 miles east of Macon, Noxubee County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 213, 1905.

Small concretionary nodules of iron pyrites, probably marcasite, usually approximately spherical and not more than 1 or 1 1/4 inches in diameter, are common, though somewhat widely scattered in the chalk. When taken from fresh material the crystal faces covering the surface of the nodules are bright and glittering, but in most natural exposures the oxidation of the iron has tarnished or rusted the mineral.

Certain layers of the chalk are phosphatic, the phosphate being either disseminated through the matrix or segregated in the molds of mollusks or in nodules, some of which are high in phosphatic content. The most complete study of the Cretaceous phosphates of Alabama is that of Smith (15, pp. 454-487), who recognized two phosphatic bands, one a few feet thick at the base of the chalk and one 30 to 35 feet thick at the top of the chalk, now included in the Prairie Bluff chalk. No special study has been made of the phosphatic content of the chalk in Mississippi but it is known to contain this substance in places, and both bands described by Smith extend into Mississippi. A third layer of phosphatic material, thinner than the other two, has been found just above the Arcola limestone member of the Selma.

The structure of the chalk is typically massive, but the more argillaceous and sandy facies usually exhibit distinct bedding plains, and even the purer facies, where they are subjected to weathering in the faces of bluffs, clearly show stratification lines indicating that the rock is made up of layers differing from each other slightly in lithologic character and in hardness.

In western Alabama the formation has a measured thickness of about 900 feet in a well at Livingston, Sumter County. The thickness in Mississippi immediately adjacent to Alabama is comparable to, though somewhat less than, that at Livingston, but at all points to the north in Mississippi the thickness is less than that amount. At Shuqualak, Noxubee County, this formation and the Prairie Bluff chalk are together 760 feet thick; at Starkville, Oktibbeha County, the combined thickness of the Selma, Ripley, and Prairie Bluff is about 700 feet; in Clay County, the Selma is about 570 feet thick; at Houlka, Chickasaw County, about 570 feet thick; at Sherman, Pontotoc County, where only the middle part of the Selma of Alabama and east-central Mississippi is represented, it is only 280 feet thick; and at Kossuth, Alcorn County, it is only 250 feet thick.

MOOREVILLE TONGUE

The basal part of the Selma chalk of east-central Mississippi is represented in northern Mississippi by nonchalky strata, chiefly sands with subordinate amounts of clay, belonging to the Coffee sand. The passage from chalk to sand takes place in western Itawamba and eastern Lee counties, and is accomplished by intertonguing of chalk and sand and by merging of the one type of deposit into the other. Two conspicuous tongues are developed: one of impure chalk, known as the Mooreville tongue of the Selma, which projects from the basal part of the chalk northward into the Coffee type of deposits; and another of sand, the Tupelo tongue of the Coffee sand, which extends southward from the main body of the Coffee sand into the chalk, the Mooreville tongue below interlocking with the Tupelo tongue above (37, pp. 243-250). These relations are diagrammatically shown in Plate 2, Sections B-B and F-F.

The material composing the Mooreville tongue consists chiefly of impure argillaceous chalk and shaly, chalky clay or marl; and that in the exposure in a gully near the Fulton road, three-quarters of a mile west of Mooreville, may be regarded as typical. The thickness of the Mooreville tongue as shown by the log of the Tupelo Municipal Water and Light Plant well (see Lee County) is about 200 feet.

ARCOLA LIMESTONE MEMBER

Within the Selma chalk, and ranging above its base from 200 feet near Mooreville to 265 feet in Noxubee County, is a persistent bed of hard fairly pure limestone a foot or more thick. This bed has been traced from its type locality at old Arcola on Warrior River in Alabama, northwestward into Mississippi, and thence northward to Lee County where it appears to end in the upper part of the Mooreville tongue of the Selma. The limestone was noted by Smith (15, pp. 279-280) who described it as follows:

"Underlying the Demopolis limestone there is a stratum of undetermined thickness of a tolerably pure limestone of light yellow color, filled with concretionary lumps, cylinders, etc., of clay. When this clay washes out it leaves the limestone perforated in every direction, which circumstance is referred to in the name 'bored rock.' Below Arcola this bored rock is quite thick, and has bedding planes two or three feet apart, which cause [?] the rock to break up into large cubical blocks.

"At Arcola and at Hatch's Bluff, on the Tuscaloosa [Warrior], the bored rock is near the top of the bluff, and underlying it is softer and crumbling Rotten Limestone of the usual character. The bored rock has sometimes been burned for lime, and its outcrop may be followed westward as far at least as Sherman, in Sumter County. It forms a rocky ridge wherever it comes to the surface."

Stephenson in 1909 observed this limestone at Hatchs Bluff on Warrior River, where it consists of two two-foot beds separated by a two-foot bed of chalk and lies about 40 feet above water level.

The limestone was named Arcola limestone member of Selma chalk by Stephenson and Monroe (63, pp. 1635-1637) in 1938. It forms an excellent key bed and is useful in studying the geologic structure of the generally featureless chalk.

In Mississippi the Arcola member apparently consists of only one limestone bed about a foot thick. South of Mooreville it is only about 10 feet below the base of the Tupelo tongue of the Coffee sand, which there overlies the Mooreville tongue. East of Verona, Lee County, the limestone crops out on the eastward-facing slope of Old Town Creek and is overlain by Selma chalk, the Tupelo tongue having there merged down dip into sandy chalk.

An unconformity or diastem overlain by chalk containing numerous phosphatic molds of fossils has been noted at several places above the Arcola limestone in Alabama between the type locality of the member at Arcola Bluff on Warrior River and Union Springs, Bullock County. Phosphatic nodules and molds have been observed above the limestone in Mississippi on the Columbus-Mayhew road, Lowndes County; near Gibson and on a branch of Mattubby Creek, Monroe County; and near Mooreville, Lee County. Although this stratigraphic break has not been observed in the Coffee sand it is possible that it may represent a widespread cessation in deposition in the eastern Gulf region.

The line of outcrop of the limestone is shown on the geologic map, Plate 1A.

STRATIGRAPHIC AND AGE RELATIONS

In east-central Mississippi and in western Alabama, where the Selma chalk has its maximum thickness of about 900 feet, it unconformably overlies the Tombigbee sand member of the Eutaw formation and is unconformably overlain by the Prairie Bluff chalk. The

Tombigbee sand is the underlying unit from Itawamba and Lee counties southward to Noxubee County, and thence eastward through Alabama to Macon County.

The contact of the Tombigbee sand with the Selma is uneven in detail. The base of the Selma is sandy and in places contains an abundance of phosphatic molds of fossils, a few phosphatic nodules, and shells of the oyster family, some of which were reworked from the underlying Tombigbee sand; this bed is considered a basal conglomerate. The unconformity has been traced from Lee County, Miss., through Alabama, into Georgia. Although the unconformity is widespread in extent the time interval it represented is believed not to have been very long.

When the main body of the Selma chalk is traced northward in Mississippi the lower and upper parts of it are found to merge laterally into nonchalky equivalents which are treated as separate formational units, whereas the intervening middle portion maintains its chalk characteristics and is mapped as the northward continuation of the Selma chalk. Thus in western Itawamba County and in Lee County the lower 200 feet or more of the chalk passes into a sandy equivalent to which the name Coffee sand is applied. The passage from chalk to sand is accomplished by an intertonguing of chalk and sand, the principal bodies of which are the northward extending Mooreville tongue of the Selma and the overlying southward extending Tupelo tongue of the Coffee sand. It follows therefore that from Lee County northward to and beyond the Tennessee State line the formation underlying the Selma is the Coffee sand.

The main body of the Selma chalk is unconformably overlain by the Prairie Bluff chalk in central and southeastern Noxubee County and to the southeastward in Alabama to and a few miles beyond Livingston, Sumter County. In northwestern Noxubee County about the upper 75 feet of the Selma merges northward into a body of sand and clay, which has long been known as the Ripley formation, a formation that overlies the correspondingly restricted body of chalk from Noxubee County to and beyond the Tennessee State line.

In consequence of the northward merging of the lower and upper parts of the Selma chalk into nonchalky equivalents, the sequence of lithologic units of Selma age in northern Mississippi, named in ascending order are: The Coffee sand 250 feet or more thick; the restricted body of Selma chalk 250 to 280 feet thick, embracing less than the middle half of the main body of the chalk; and the Ripley formation, which, near the Tennessee line, has increased to an estimated thickness of 350 or 400 feet. The stratigraphic relations of the Selma and its equivalents are shown graphically in Plate 2.

Along some of the tributary streams entering Tombigbee River from the west and northwest, notably along Tibbee River in Clay County, and along Noxubee River in Noxubee County, the chalk is unconformably overlain by terrace loams, clays, and sands of Pleistocene and Recent age. The largest area of this sort is along the Tibbee and its tributaries where the terraced belt has a maximum width of 6 or 7 miles and extends from the western part of Clay County to the Tombigbee. The small outliers of Selma east of Tombigbee River south of Columbus, Lowndes County, are unconformably overlain by the sand and gravel of a Pleistocene terrace deposit of Tombigbee River.

Locally in Alcorn County the chalk is covered by a thin mantle of brown loam—the eastern remnants of the great loess blanket extensively developed farther west on the bluffs of the Mississippi River.

PHYSIOGRAPHIC EXPRESSION

The belt of outcrop of the Selma chalk is characterized by topography of low relief, ranging from nearly level plains (Figure 21) to hills of 10 to 50 feet relief, presenting long, gentle, smoothly curved slopes separated by broad, shallow valleys. In general the altitude of the Selma upland in Mississippi rises from about 200 feet in the south in Noxubee County to 550 feet or more in the north in Prentiss and Alcorn counties. The area is commonly referred to as the Black Prairie belt, because of the rich black soil to which the chalk weathers, though much of the area is not strictly prairie land. In topographic aspect the Black Prairie belt is in strong contrast to that of the Pontotoc Hills which border it on the west from Oktibbeha County to the Tennessee boundary; the altitude of these hills ranges from 350 feet in the south to nearly 800 feet in the north, and they are separated from the Selma plain by a pronounced escarpment representing differences in elevation at different places along its trend of 50 to 200 feet. In Noxubee and Kemper counties the Black Prairie belt includes along its southeastern border the belt of outcrop of the Prairie Bluff chalk. Here the prairie country is bordered on the southwest by the Flatwoods, underlain by the Porters Creek clay (Paleocene).

The Black Prairie belt is also lower than the Tombigbee and Tennessee River Hills to the east underlain by the Eutaw formation and by the Coffee sand, where the upland elevations range from 350 feet in Lowndes County to 650 feet in Tishomingo County, in which isolated hills even exceed 800 feet. Although there is a sharp contrast in the topography of these two physiographic districts, there is no marked difference in altitude as one passes from the upland of the former to that of the latter, the greater elevation of the hilly upland being attained gradually from west to east and from south to north.

Figure 21.—Nearly level prairie land in the Selma chalk belt, 6 or 7 miles east of Macon, Noxubee County. Photo by L. W. Stephenson.

The Mooreville tongue of the Selma is expressed in the subdued topographic aspect of the area underlain by it in western Itawamba and eastern Lee counties; the low smoothly rounded hills of this area contrast markedly with the more broken and hilly aspect of the country both to the east, underlain by the prevailingly sandy strata of the Eutaw formation, and to the west, underlain by the sandy strata of the Tupelo tongue of the Coffee sand.

The relatively low altitude of the Black Prairie country is due not to structural downwarping but to the fact that the materials composing the Selma have lent themselves more readily to the processes of erosion than have the sands which predominantly compose the adjacent Eutaw formation, Coffee sand, and Ripley formation. The clay particles partly composing the chalk are very small and are much more easily carried in suspension in running water than are the larger sand grains, and the calcium carbonate which composes 40 to 80 per cent or more of the chalk is dissolved by the water with comparative rapidity and carried away in solution by the streams. The rain water falling on the compact chalk is unable to sink into it, and the greater part of it quickly runs off on the surface; a greater amount of material is therefore carried in suspension than would be true in an area having an equal rainfall but underlain by porous sand capable of absorbing an important percentage of the water.

The drainage of the Black Prairie belt is accomplished by tributaries of Tombigbee River flowing to the east and southeast, except in the extreme north in Alcorn and northern Prentiss counties where drainage is effected by Tuscumbia River. The belt, therefore, has a general slope from the central part of Prentiss County to the south and from the foot of the Pontotoc hills to the southeast. All the larger streams crossing the belt have their source in perennial springs in the Pontotoc hills or, farther south, in the hills formed by the Wilcox sediments (Eocene) in Choctaw, Winston, and Kemper counties; and their channels contain running water throughout the year. Many of the smaller streams originate within the limits of the Black Prairie belt where, because of the compact chalk, little rain water is absorbed, springs are rare, the run off is rapid, and the channels are without running water (Figure 22) except during and immediately following rains.

In limited areas bordering the larger streams the prevailing rolling topography of the Selma belt has been modified to nearly flat plains by terracing processes that have operated during Pleistocene and Recent times. Perhaps the most notable example of this kind of topography is in the valley of Tibbee River in Clay County where the terraced area extends from the western part of the county eastward to Tombigbee River Valley, and has a maximum width of 6 or 8 miles. The town of West Point is situated on the principal and highest terrace. These plains are underlain by terrace loams, sands, and clays which produce thinner and lighter soils than those derived from the chalk.

On exposed knolls and slopes throughout the Black Prairie belt the soils that were formerly held by the roots of vegetation have, since the beginning of cultivation by the white men, been removed by erosion, leaving the chalk exposed as gullied patches of gray or glaring white, the so-called "bald spots."

Figure 22.—Dry bed of an intermittent creek in the Selma chalk belt, half a mile west of Okolona, Chickasaw County. Photo by L. W. Stephenson.

FOSSIL CONTENT

The Selma chalk includes parts of two major fossil zones, the *Exogyra ponderosa zone* and the *Exogyra costata* zone. In the accompanying table the larger fossils of the Selma are listed by stratigraphic position, counties (from south to north), and localities. In the *Exogyra ponderosa* zone six subdivisions have been differentiated: The basal beds of the Selma, the section between the basal beds and the Arcola limestone member, the Arcola limestone member, the section between the Arcola limestone member and the *Diploschiza cretacea* zone, the *Diploschiza cretacea* zone, and the upper part of the *Exogyra ponderosa* zone. North of Lee County all of the *Exogyra ponderosa* zone except that above the *Diploschiza cretacea* zone is represented by the Coffee sand. The part of the *Exogyra costata* zone included in the Selma chalk has been divided into the *Exogyra cancellata* zone and the upper sandy facies. The upper sandy facies merges northward into nonchalky sands of the Ripley formation in the northern part of Noxubee County.

The remains of foraminifera are present in most facies of the chalk, though their abundance has been exaggerated in most text books treating of the American chalks. These tiny shells are as a rule not readily seen either with the unaided eye or with a hand lens, but they can usually be detected when samples of the chalk are examined with a high-power microscope. The foraminifera of the Selma have not yet been critically studied.

The bulk of the chalk is composed of the calcareous remains of the tiny plants known as coccolithophores, which have not been systematically studied.

Fossil localities in the Selma chalk

17807.—Northward-facing slope of hill, 1/4 mile north of T-road intersection (NE. Cor., SE. 1/4, SE.1/4, Sec. 23, T.12 N., R.18 E.), 4 miles northeast by east of Scooba, Kemper County.

6480f.—Old U. S. Highway 45 on hill south of Wahalak Creek (Secs. 4 and 9, T.12 N., R.18 E.) about 6 miles north of Scooba, Kemper County.

6479b.—U. S. Highway 45 on northward-facing slope of Running Water Creek Valley (Sec. 28, T.14 N., R.17 E.), 4 3/4 miles south of Noxubee River Bridge at Macon, Noxubee County.

6476.—Louisville road about 2 miles from Macon (Sec. 6, T.14 N., R.17 E.), Noxubee County.

6479c, 17800.—U. S. Highway 45 on northward-facing slope of Running Water Creek Valley (Sec. 28, T.14 N., R.17 E.), 4 1/2 miles south of Noxubee River Bridge at Macon, Noxubee County.

6841.—Cut of Mobile and Ohio Railroad, 3 miles south of Macon (Sec. 17, T.14 N., R.17 E.), Noxubee County.

6478, 17486.—Plantation of T. W. Brane (Sec. 8, T.14 N., R.17 E.), 2 1/2 miles south of Macon, Noxubee County. L. W. Stephenson and P. A. Bethany, collectors.

6475.—Bluff on left side of Noxubee River, 1/4 mile below the highway bridge at Macon, Noxubee County.

17487.—Two miles northwest of Macon (Sec. 29, T.15 N., R.17 E.), Noxubee County. P. A. Bethany, collector.

6840.—Cranford Bridge road, 3 miles northwest of Macon, Noxubee County.

Distribution of Selma fossils

Species	Exogyra costata zone																											
	Upper sandy facies				Exogyra cancellata zone																							
	Kemper County		Noxubee County		Noxubee County						Clay County			Chickasaw County					Lee County		Pontotoc County	Union County	Prentiss County		Alcorn County			McNairy Co., Tenn.
	17807 - Scooba, 4 mi. NE	6480f - Scooba, 6 mi. N	6479b - Macon, 4 3/4 mi. S	6476 - Macon, 2 mi. W	6475c etc. - Macon, 4 1/2 mi. S	6841 - Macon, 3 mi. S	6478 etc. - Macon, 2 1/2 mi. S	6475 - Macon	17457 - Macon, 2 mi. NW	6840 - Macon, 3 mi. NW	6862 - Cedar Bluff, 1 mi. E	6850 - Caradine store, 2 mi. SE	6859 - Caradine store, 1/4 mi. S	17224 - McCondy, 2 mi. E	6866 - Okolona, 4 1/2 mi. W	6865 - Okolona, 3 mi. W	6864 - Okolona, 2 mi. W	6867 - Okolona, 2 1/2 mi. NE	6472 - Shannon, 8 mi. W	6465 - Bethany, 1/4 mi. W	6863 - Tupelo, 6 mi. W	17262 - Bridge Creek	6871 - Blackland, 1 mi. W	6456 - Booneville, 3 1/2 mi. NW	6459 - Bald Knob	6879 - Corinth, 2 3/4 mi. NW	6878 - Wenasoga, 1 1/4 mi. SE	17223 - Blue Cut
Coelenterata:																												
Micrabacia cribraria Stephenson?																												
Echinodermata:																												
Echinocorys sp.																												
Vermes:																												
Hamulus onyx Morton								X																				
H. squamosus Gabb																												
H. major Gabb																												
Molluscoidea:																												
Terebratulina filosa Conrad																												
Mollusca:																												
Pelecypoda:																												
Nucula percrassa Conrad		X																										
Inoceramus sp.								X												X								
Ostrea plumosa Morton		X	X	X	X	X	X	X		X	X	X	X	X				X	X	X				X	X	X		X
O. whitei Stephenson																												
O. tecticosta Gabb		X		X	X	X	X			X								X		X				X	X	X	X	X
O. sloani Stephenson																												
O. panda Morton					X		X	X	X									X	X		X			X	X			
O. falcata Morton		X	X	X	X		X			X	X	X	X		X			X	X	X	X			X	X	X	X	X
O. mesenterica Morton						X																X						X
O. sp. (long, thin form)			X	X	X																							
Gryphaea mutabilis Morton			X	X	X	X	X	X		X		X	X	X				X		X	X		X	X	X	X		X
G. convexa (Say)																												
G. aff. G. wrathori Stephenson																												
Gryphaeostrea vomer (Morton)								X											X					X				
Exogyra costata Say (wide costae)						X						X						X	X	X	X	?	X		X	X		
E. costata Say (medium costae)	X	X	X	X	X							X																
E. costata Say (narrow costae)													X															
E. cancellata Stephenson					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
E. ponderosa Roemer																												
E. ponderosa erraticostata Stephenson																												
Trigonia sp.																												
Pecten (Neithea) hartmani Kniker?							X																					
P. (Neithea) casteeli Kniker?																												
Diploschiza cretacea Conrad																												
Lima reticulata Forbes			X																									
Anomia argentaria Morton	X	X	X	X	X		X						X					X	X	X				X	X	X		X
A. tellinoides Morton							X	X		X	X	X	X	X				X		X				X	X	X		
Paranomia scabra (Morton)		X	X	X	X	X	X	X		X	X	X	X	X				X	X	X	X	X		X	X	X	X	
Liopistha alternata Weller																												
Cymella bella Conrad?																												
Veniella conradi (Morton)																				X								
Etea carolinensis Conrad?																												
Durania austinensis (Roemer)?																												
Durania sp.																												
Titanosarcolites? sp. (fragment)									X																			
Gastropoda:																												
Gyrodes abyssinus (Morton)?																												
Xenophora leprosa (Morton)?																												
Cephalopoda:																												
Baculites asper Morton																												
Mortoniceras sp.																												
Belemnitella americana (Morton)			X	X	X																							
Vertebrata:																												
Ptychodus sp. (tooth)																												
Shark teeth																										X		
Fish jaw																												
Globidens aff. G. alabamensis Gilmore																												
Bone fragments																												

Species	Exogyra ponderosa zone																																														
	Upper part of zone																						Diploschiza cretacea zone												Arcola ls.					Basal beds							
	Noxubee County	Lowndes County	Chickasaw County			Lee County										Prentiss County				Alcorn County			Clay County	Monroe County	Lee County	Noxubee County	Clay County				Monroe County			Lee County	Monroe County	Clay County	Monroe County	Lee County	Itawamba County	Lowndes County					Monroe County	Itawamba County	
	494 - Macon, 4 mi. N	17203 - Artesia	6889 - Okolona, 1/2 mi. W	6890 - Okolona	6891 - Okolona, 1 mi. NE	17208 - Tupelo, 5 3/4 mi. W	6895 - Tupelo, 3 1/2 mi. W	6896 - Tupelo, 3 mi. W	5894 - Tupelo, 3 1/4 mi. W	5898 - Tupelo, 1 1/2 mi. W	17803 - Saltillo, 1 mi. W	Near Saltillo	6901 - Guntown, 2 mi. W	6902 - Guntown, 1 mi. W	6903 etc. - Guntown	6906 - Blackland, 1/2 mi. E	6457 - Booneville, 1 1/2 mi. SW	6455 - Booneville	6455b - Booneville	6913 - Corinth, 3 mi. S	6460 - Corinth, 3 mi. SE	9496 - Corinth, 2 1/2 mi. SE	17205 - Tibbee Station, 2 mi. E	17226 - Prairie, 3 mi. W	6897 etc. - Tupelo, 2 1/2 mi. S.	6880 - Brooksville, 12 mi. E	6881 - West Point, 3 1/2 mi. W	6882 - West Point, 2 mi. W	6583 - West Point	6884 - West Point, 2 mi. E	6892 - Okolona, 7 mi. NE	6893 - Nettleton, 4 mi. SW	17250 - Gibson, 1 mi. E	6899 - Verona, 1 3/4 mi. E	17248 - Amory, 9 1/2 mi. W	6385 - West Point, 5 1/2 mi. E	17249 - Aberdeen, 7 mi. NE	9521 - Mooreville, 1/2 mi. E	6452 - Mooreville, 2 mi. E	17244 - Union Bluff	17243 - Columbus, 8 1/2 mi. SE	17804 - Columbus, 7 1/2 mi. SE	6920 - Gullies, Plymouth Bluff	6919 - Plymouth Bluff, bed 7	6886 etc. - Cotton Gin Port	9519 - Mooreville, 5 mi. NE	17252 - Dorsey
Coelenterata:																																															
Micrabacia cribraria Stephenson?																																							X								
Echinodermata:																																															
Echinocorys sp.		X																																													
Vermes:																																															
Hamulus onyx Morton																		X			X								X		X			X		X		X	X								
H. squamosus Gabb																													X	X	X			X		X							X	X	X		
H. major Gabb																																												X	X	
Molluscoidea:																																															
Terebratulina filosa Conrad																							X	X																							
Mollusca:																																															
Pelecypoda:																																															
Nucula percrassa Conrad																																															
Inoceramus sp.																	X																		X												X
Ostrea plumosa Morton					X									X	X		X	X	X	X	X	X		X	X		X	X	X	X	X		X			X				X	X		X	X	X	X	
O. whitei Stephenson																																												X	X	
O. tecticosta Gabb																																															
O. sloani Stephenson																					X	X																									
O. panda Morton									X																					X													X				X
O. falcata Morton							X		X				X	X			X	X		X	X	X			X												X										
O. mesenterica Morton																																															
O. sp. (long, thin form)																																															
Gryphaea mutabilis Morton					X			X					X	X	X		X	X			X	X																									
G. convexa (Say)	X		X	X			X	X	X	X					X	X		X	X		X			X							X		X														
G. aff. G. wrathori Stephenson																																												X		
Gryphaeostrea vomer (Morton)									X		X		X		X		X	X	X	X	X	X		X							X			X													
Exogyra costata Say (wide costae)																																															
E. costata Say (medium costae)																																															
E. costata Say (narrow costae)																																															
E. cancellata Stephenson																																															
E. ponderosa Roemer			X		X	X			X	X			X	X	X	X	X	X			X	X			X	X		X		X	X		X			X	X		X				X	X	X	X	
E. ponderosa erraticostata Stephenson											X						X		X												X	X	X				X						X		X	X	X
Trigonia sp.																						X																									X
Pecten (Neithea) hartmani Kniker?																																												X		
P. (Neithea) casteeli Kniker?																																												X		
Diploschiza cretacea Conrad																							X	X	X																						
Lima reticulata Forbes																						X																									
Anomia argentaria Morton															X		X	X	X	X	X	X										X		X		X	X		X								
A. tellinoides Morton																																															
Paranomia scabra (Morton)															X		X	X	X	X	X	X						X			X		X	X													
Liopistha alternata Weller																																					X										
Cymella bella Conrad?																																							X								
Veniella conradi (Morton)																																					X	X	X								
Etea carolinensis Conrad?																																						X									
Durania austinensis (Roemer)?																										X																					
Durania sp.																																				X							X				
Titanosarcolites? sp. (fragment)																																															
Gastropoda:																																															
Gyrodes abyssinus (Morton)?																																	X														
Xenophora leprosa (Morton)?																																															X
Cephalopoda:																																															
Baculites asper Morton																																	X														
Mortoniceras sp.																																												X		
Belemnitella americana (Morton)																																															
Vertebrata:																																															
Ptychodus sp. (tooth)																																										X					
Shark teeth																													X	X											X	X					
Fish jaw																																												X		
Globidens aff. G. alabamensis Gilmore												X																																			
Bone fragments																																									X						

The numbers are the collection numbers of the U. S. Geological Survey; the collections are in the U. S. National Museum.

6862.—Mississippi Highway 10 near the west end of the bridge over Line Creek (Sec. 22, T.20 N., R.14 E.) a mile east of Cedar Bluff, Clay County.

6860.—Bald spots near the West Point-Houston road, 2 miles southeast of Caradine store, Clay County.

6859.—Bald spots near the West Point-Houston road, 1/4 mile south of Caradine store, Clay County.

17224.—Bald spot about 2 miles east by north of McCondy (SW.1/4, Sec. 28, T.14 S., R.5 E.), Chickasaw County.

6866.—Houston road, 4 1/2 miles west of Okolona, Chickasaw County.

6865.—Houston road, 3 miles west of Okolona, Chickasaw County.

6864.—Houston road, 2 miles west of Okolona, Chickasaw County.

6867.—Pontotoc road, 2 1/2 miles northwest of Okolona, Chickasaw County.

6472.—Gullies south of the Troy road, 8 or 9 miles west of Shannon, Lee County.

6465.—Bald spots and gullies on westward-facing slope of Tishomingo Creek Valley, 1/4 mile west of Bethany, Lee County.

6863.—Gullies on westward-facing slope north of the Pontotoc road (Mississippi Highway 6), 6 miles west of Tupelo, Pontotoc County.

17262.—Bed of Bridge Creek just below bridge on section-line road (N. edge Sec. 8, T.7 S., R.5 E.), Union County.

6871.—Bald spots near public road a mile west of Blackland, Prentiss County.

6456.—Bald spots and gullies near Ripley road, 3 1/2 miles northwest of Booneville, Prentiss County.

6459, 6459b.—"Bald Knob" on the Joseph Reynolds place, 3 miles west of Corinth, Alcorn County.

6879.—Cut on Southern Railway, 2 3/4 miles northwest of Corinth, Alcorn County.

6878.—Cut on Southern Railway, 1 1/4 miles southeast of Wenasoga, Alcorn County.

17221.—Blue cut on Mobile and Ohio Railroad, 4 1/2 miles north of Corinth, Miss., just north of the State line in McNairy County, Tennessee.

494.—Four miles north of Macon, Noxubee County.

17203.—Bald spot, 1/3 mile northwest of the railroad station at Artesia, Lowndes County. Selma chalk just above *Diploschiza cretacea* zone.

6889.—Bed of dry branch near crossing of Houston road, half a mile west of Okolona, Chickasaw County.

6890.—Bald spot on west edge of Okolona, Chickasaw County.

6891.—Bald spots, a mile northeast of Okolona, Chickasaw County.

17208.—Bed of Coonewar Creek at crossing of Mississippi Highway 6, about 5 3/4 miles west by south of the business center of Tupelo, Lee County.

6895.—Pontotoc road (Mississippi Highway 6), 3 1/2 miles west of Tupelo, Lee County.

6896.—Pontotoc road (Mississippi Highway 6), 3 miles west of Tupelo, Lee County.

6894.—Chesterville road, 3 1/4 miles west of Tupelo, Lee County.

6898.—Chesterville road, 1 1/2 miles west of Tupelo, Lee County.

17803.—U. S. Highway 45 (Sec. 17, T.8 S., R.6 E.), a mile west by north of Saltillo, Lee County.

A locality near Saltillo, Lee County. J. M. Sullivan, collector.

6901.—Bald spot on Blair road, 2 miles west of Guntown, Lee County.

6903, 6904.—Cut on Mobile and Ohio Railroad just north of the station at Guntown, Lee County. Base of Selma chalk just above the Coffee sand.

6908.—Bald spots near public road, half a mile east of Blackland, Prentiss County.

6457.—Bald spots near Geeville road, 1 1/2 miles southwest of Booneville, Prentiss County.

6455.—Above track level in the cut of the Mobile and Ohio Railroad south of the station at Booneville, Prentiss County.

6455b.—Below track level in the cut of the Mobile and Ohio Railroad south of the station at Booneville, Prentiss County. Base of Selma chalk just above the Coffee sand.

6913.—Cut of Mobile and Ohio Railroad, 3 miles south of Corinth, Alcorn County. This collection includes fossils from both the basal Selma and the top of the Coffee sand.

6460.—Cut of Southern Railway, 3 miles southeast of Corinth, Alcorn County. Base of Selma chalk just above the Coffee sand.

9496.—Stevensons cut on Illinois Central Railroad, 2 1/2 miles southeast of Corinth, Alcorn County. Base of Selma chalk just above the Coffee sand. Bed 4 of section.

17205.—Mississippi Highway 25, near center of Sec. 7, T.19 N., R.16 E., 2 miles west of Tibbee Station, Clay County.

17226.—Bald spots near eastern edge of alluvial plain of Sakatonchee River (NW. Cor., Sec. 7, T.15 S., R.6 E.), Monroe County.

6897, 17216.—Washes in field east of Tupelo-Verona road (NE.1/4, NW.1/4, NE.1/4, Sec. 13, T.10 S., R.5 E.), 2 1/2 miles south of Tupelo, Lee County.

6880.—One quarter mile east of the house on the old Allen Gavin place (NE.1/4, Sec. 30, T.16 N., R.19 E.), Noxubee County. Selma chalk just above the Arcola limestone member.

6381.—Bank of Sakatonchee River just below bridge of the Montpelier road (Mississippi Highway 10), 3 1/2 miles west of West Point, Clay County.

6882.—Montpelier road (Mississippi Highway 10), 2 miles west of West Point, Clay County.

6883.—Abandoned pit of the West Point Brick, Tile, and Lumber Company, just north of West Point, Clay County.

6884.—Gullies on Terrell farm, 2 miles east of West Point, Clay County. Selma chalk just above the Arcola limestone member.

6892.—Gullies on Erskine Miller farm west of road at Black Oak Grove Church, 7 miles (?) northeast of Okolona, Monroe County.

6893.—Foot of eastward-facing slope of Old Town Creek Valley on Okolona road about 4 miles southwest of Nettleton, Monroe County.

17250.—Bank of drainage ditch on south side of Mississippi Highway 8 (Sec. 28, T.14 S., R.6 E.), a mile east of Gibson, Monroe County. Selma chalk just above the Arcola limestone member.

6899.—One and three-fourths miles east of Verona (SE.1/4, Sec. 20, T.10 S., R.6 E.), Lee County.

17248.—Westward-facing slope of a branch valley of Mattubby Creek, 9 1/2 miles west by south of Amory (SE.1/4, Sec. 10, T.13 S., R.6 E.), Monroe County.

6885.—Land of H. B. Strong, eastward-facing slope of Town Creek Valley near the Bartons Ferry road, 5 1/2 miles east by north of West Point, Clay County.

17249.—Southwestward-facing slope of a branch valley of Mattubby Creek (Near NW. Cor., NE.1/4, Sec. 2, T.14 S., R.6 E.), Monroe County.

9521.—Banks of small branch tributary of Long Creek, half a mile east of Mooreville on U. S. Highway 78, Lee County.

6452.—U. S. Highway 78, about 2 miles east of Mooreville, Itawamba County.

17244.—Western end of Union Bluff on right bank of Tombigbee River (Sec. 19, T.17, N., R.19 E.), Lowndes County.

17243.—Northward-facing slope of Ellis Creek Valley, farm of J. H. Sparks (Sec. 16, T.19 S., R.17 W.), Lowndes County.

17804.—Northward-facing slope of Ellis Creek Valley on Columbus-Pickensville road (Sec. 17, T.19 S., R.17 W.), Lowndes County.

6920.—Gullies near abandoned public road for a quarter of a mile south of Plymouth Bluff, 4 to 5 miles northwest of Columbus, Lowndes County.

6919.—Plymouth Bluff, right bank, Tombigbee River, 4 to 5 miles northwest of Columbus, Lowndes County, bed 7 of section.

6886, 6888 (in part), 17207.—A mile west of the site of old Cotton Gin Port (Sec. 9, T.13 S., R.7 E.), 4 miles west of Amory, on eastward-facing slope of Tombigbee River Valley, Monroe County.

9519.—Mantachie road, 5 miles northeast of Mooreville, Itawamba County.

17252.—Gullies on north side of U. S. Highway 78 (Sec. 36, T.9 S., R.7 E.), west edge of Dorsey, Itawamba County.

LOCAL DETAILS

KEMPER COUNTY

Only the upper part of the Selma chalk, mainly the *Exogyra costata* zone including the *Exogyra cancellata* zone, appears at the surface in Kemper County, but the underlying *Exogyra ponderosa* zone is believed to be represented in a small area in the extreme northeastern corner of the county. However, no fossils known to be restricted to the *E. ponderosa* zone have been collected.

Numerous bald spots near Binnsville (Secs. 5 and 6, T.12 N., R.19 E.), show hard chalk containing fossils of the *Exogyra cancellata* zone.

Selma chalk equivalent in age to the Ripley formation in northern Noxubee County underlies a narrow belt along the southwestern edge of the belt of outcrop of the formation and is exposed in the lower part of a section on old U. S. Highway 45, on the hill south of Wahalak Creek (Secs. 4 and 9, T.12 N., R.18 E.). This section is described as a local detail in Kemper County under the heading "Prairie Bluff chalk."

NOXUBEE COUNTY

The Selma chalk is exposed over the northeast half of Noxubee County; the beds composing it strike about north-northwest.

Between Macon and the eastern edge of the Selma belt, a distance of 14 or 15 miles, bald spots and other exposures of Selma chalk are rare, the unweathered chalk being almost completely concealed by a blanket of residuum, the soils of which have been classified by the Bureau of Soils chiefly under the names Houston clay and Oktibbeha clay. This area typically represents the Black Prairie belt of the State.

That part of the formation below the Arcola limestone member is concealed at most places by dark-brown and black clay, residual from the chalk, and by terrace deposits of Tombigbee River. The limestone, about a foot thick, is well exposed on U. S. Highway 45 near the north edge of Sec. 15, T. 16 N., R. 18 E.; at Cliftonville on the north edge of Sec. 23, T. 16 N., R. 18 E.; in the NE 1/4 Sec. 30, T. 16 N., R. 19E.; three-quarters of a mile east of Prairie Point in the northwest corner of Sec. 20, T.16 N., R.19 E.; and on the eastward-facing slope of a small branch in the SE.1/4, Sec. 4, T.14 N., R.19 E.

In a field one quarter mile east of the house on the old Allen Gavin place (NE.1/4, Sec. 30, T.16 N., R.19 E.), numerous shells of *Exogyra ponderosa* Roemer and several fragments of *Durania* sp.

(Coll. 6880) were found loose in the soil, having weathered from the underlying Selma chalk. Many blocks of weathered Arcola limestone are associated with the shells.

In Noxubee County the Arcola limestone member appears to be about 265 feet above the base of the Selma chalk, as shown in the well at Mr. Lewis C. Chapman's plantation, 2 1/2 miles north-northwest of Cliftonville.

LOG OF WELL OF LEWIS C. CHAPMAN (SEC. 3, T.16 N., R.18 E.)

	Thickness Feet	Depth Feet
Surface soil and clay	32	32
Selma chalk		
Chalk rock, firm and white on drying	148	180
Eutaw formation		
Sand, water-bearing	100	280
Clay	130	410
Sand, water-bearing	50	460
Clay	90	550
Sand, water-bearing	25	575
Tuscaloosa formation		
Red pipe clay	85	660
Sand (artesian water with 11-foot head)	65	725

The top of this well is 55 feet below an exposure of the Arcola limestone, about a mile southwest of the well. If the dip here is 30 feet to the mile, the top of the Arcola would be about 85 feet higher than the top of the well at the well site. This indicates a thickness of Selma below the Arcola limestone member of about 265 feet, which is essentially the same thickness as found in wells in adjacent parts of Alabama.

Other wells near the outcrop of the Arcola reached the Eutaw at depths of 250 to 300 feet (21, p. 69; 21, p. 70).

The small but important bivalve species *Diploschiza cretacea* was observed in outcrops of the chalk at the following localities: On the westward-facing slope of Ash Creek at Cooksville (Sec. 17, T. 13 N., R. 19 E.); a tenth of a mile east of Center Point (Sec. 3, T. 14 N., R. 18 E.); three-tenths of a mile north of X Prairie (Sec. 16, T. 15 N., R.18 E.); and in bald spots 400 feet north of the road corner 11 1/2 miles north by east of Macon (SW.1/4, Sec. 1, T.16 N., R.17 E.).

The base of the *Diploschiza cretacea* zone appears to be about 450 feet above the base of the Selma chalk in adjacent parts of Alabama and is probably at about the same position in Noxubee County.

Bald spots of chalk near the boundary of the *Exogyra ponderosa* and *Exogyra costata* zones are numerous along the road leading north from Macon to Mt. Moriah Church for a distance of 4 or 5 miles.

The *Exogyra ponderosa* zone is apparently about 650 to 675 feet thick in Noxubee County. The logs of three wells that penetrate the zone are published in Water-Supply Paper 576 (48, pp. 358, 361). The present writers have modified the correlations given in that paper to the extent of considering that the first greensand logged in the wells of the Mobile and Ohio Railroad at Brookville and at Macon is the uppermost bed of the Eutaw formation, whereas in the Water-Supply Paper all sand was placed in the Eutaw. It seems likely that the driller who bored wells for the Mobile and Ohio Railroad consistently logged the lower part of the Selma chalk as soft sand. Brookville is about a mile east of the outcrop of the uppermost part of the *Exogyra ponderosa* zone; the thickness given for the Selma in the wells at Brookville, 612 feet in the Mobile and Ohio well and 650 feet in the town well, is, therefore, about 20 to 30 feet less than the thickness of the zone. Macon is about a mile west of the outcrop of the top of the *E. ponderosa* zone; the thickness of Selma given in the log of the Mobile and Ohio well at that place, 676 feet, is, therefore about 20 to 30 feet greater than the thickness of the zone.

The bluff on the left side of Noxubee River a quarter of a mile below the highway bridge at Macon shows 55 feet of characteristic Selma chalk of the *Exogyra cancellata* zone, somewhat more calcareous in the upper than in the lower part, unconformably overlain by 10 feet of Pleistocene terrace deposit consisting of poorly exposed reddish and yellowish argillaceous sand with a few scattered pebbles. The chalk contains scattered subspherical concretions of iron pyrites and is sparingly fossiliferous (Coll. 6475). Other collections from the *Exogyra cancellata* zone in the Selma are listed in the table showing distribution of fossils in the Selma chalk (Colls. 6840, 6841, 6478, and 17486).

The upper part of the Selma chalk (the part of the *Exogyra costata* zone above the *Exogyra cancellata* zone) in the middle and southern parts of the county is equivalent in age to the Ripley formation in the northern part of the county. This part of the Selma is more sandy and micaceous than the chalk below.

On the northward-facing slope of Running Water Creek Valley (Sec. 28, T.14 N., R.17 E.), 4.5 to 4.9 miles south of Noxubee River bridge at Macon on U. S. Highway 45, the strata described in the following section are exposed:

SECTION ON U. S. HIGHWAY 45, 4.5 TO 4.9 MILES SOUTH OF MACON

	Feet
Prairie Bluff chalk	
4. Hard, brittle chalk containing abundant phosphatic nodules and phosphatic molds of fossils; upper part consists of fine sandy chalk. (Colls. 6479, 6839, 17210, 17485 and 17802)	17
3. White somewhat sandy, argillaceous limestone	1
Unconformity	
Selma chalk	
2. Dark bluish-gray argillaceous, sandy chalk (Coll. 6479b); scattered phosphatic nodules at base (equivalent to Ripley formation)	47
1. Bluish-gray to white argillaceous chalk containing in lower 25 feet shells of *Exogyra cancellata* Stephenson and other fossils. (Colls. 6479c and 17800)	33
	98

Fairport, 5 miles west of Crawford, is on a low sandy ridge about 1 1/2 miles wide, the crest of which is about 80 feet higher than Noxubee River bottom. Greenish-gray finely sandy clay was observed poorly exposed half a mile east of Fairport near the foot of the slope leading up to the ridge, but no good outcrop of the strata composing the ridge was seen. The topography of the ridge is like that of the area underlain by the Ripley, which is more fully developed farther north in Mississippi, and the ridge is, in fact, the southward continuation of the Ripley belt. Southward from its area of typical development in Tippah, Union, and Pontotoc counties, the Ripley thins and merges into the Selma chalk, a fact determined by numerous observations between Macon and Houston. This interpretation finds a part of its confirmation in exposures of chalk south of Fairport.

LOWNDES COUNTY

The Selma chalk is the country rock throughout the greater part of Lowndes County west of Tombigbee River. The position and westward dip of the chalk beds are such that normally they would not be expected to appear anywhere east of the river, but in the extreme southeast the chalk is involved in a northeast-southwest synclinal structure which has caused it to extend a mile or so across to the north side of the river, and which has resulted in the preservation from erosion of small remnants of chalk within a few miles to the north. As the chalk north of the river is largely covered by terrace sand and gravel, it can be seen at the surface only at a few places, several of which are described or mentioned below.

The northernmost remnant appears in the southward-facing slope of Greens Creek Valley about 6 miles east-southeast of Columbus (Sec. 5, T.19 S., R.17 W.), where two feet of slightly argillaceous chalk is overlain by 16 feet of sand and gravel.

The southern remnant crops out at several places south of Ellis Creek on the Columbus-Pickensville (Alabama) road. The best exposure observed is on the southeastward-facing slope of Nash Creek Valley about 9 miles southeast of Columbus (center of Sec. 28, T. 19 S., R. 17 W.).

SECTION ON SOUTHEASTWARD-FACING SLOPE OF NASH CREEK, COLUMBUS-PICKENSVILLE ROAD

	Feet
Terrace deposit (Pleistocene?)	
Red sand and gravel	16
Unconformity	
Selma chalk	
Sandy, highly argillaceous, micaceous, highly glauconitic chalk containing some phosphatic nodules. Weathers into bald spots	19
Concealed for about 300 feet to southeast	3
Eutaw formation (Tombigbee sand member)	
Calcareous, micaceous, very glauconitic sand	23
	61

A mile and a half due north of the Nash Creek locality on the farm of Mr. Joe H. Sparks, on the northward-facing slope of Ellis Creek Valley, in Section 16, the Selma chalk has an exposure of about 20 feet of dark gray flaky calcareous clay that yielded fossils (Coll. 17243).

The unconformity between the Tombigbee sand and the Selma is exposed a mile west of the Sparks farm on the Columbus-Pickensville road (Sec. 17, T. 19 S., R. 17 W.).

SECTION ON NORTHWARD-FACING SLOPE OF ELLIS CREEK VALLEY, COLUMBUS-PICKENSVILLE ROAD

	Feet
Terrace deposit (Pleistocene?)	
Sand and gravel	25
Unconformity	
Selma chalk	
Bedded, very glauconitic, micaceous, sandy chalk; basal two feet very sandy; contains phosphatic nodules, waterworn phosphatic pebbles, a shark tooth and a fragment of *Ptychodus* sp. tooth (Coll. 17804)	13
Unconformity	
Eutaw formation (Tombigbee sand member?)	
Bedded sand and gray clay	3
Dark grayish-brown hackly clay	1
Concealed to flood plain of Ellis Creek	20
	62

The materials in the lower part of this section resemble the strata of the Eutaw below the Tombigbee sand member, but it is possible that local conditions during Tombigbee time could account for this type of sediment at this stratigraphic position.

On Tombigbee River the top of the Tombigbee sand member of the Eutaw formation dips under water down stream at the western end of Union Bluff on the right bank (Sec. 19, T. 17 N., R. 19 E.), where the following section is exposed:

SECTION AT WESTERN END OF UNION BLUFF, RIGHT BANK OF TOMBIGBEE RIVER

	Feet
Selma chalk	
Fine-grained sandy, glauconitic, argillaceous, micaceous chalk having many phosphatic nodules in lower part. (Coll. 17244)	25
Gray clay	1
Unconformity	
Eutaw formation (Tombigbee sand member)	
Fine highly glauconitic, argillaceous sand; forms a soft ledge	1
	27

At the eastern end of the bluff and in the bed of James Creek, a mile and a quarter down the river, only Selma chalk is exposed.

The base of the Selma chalk is seen in contact with the underlying Eutaw sands at Plymouth Bluff on Tombigbee River, 4 miles northwest of Columbus. When examined in 1910 fossils (Coll. 6920) weathered from the chalk were numerous in gullies along the old public road (now abandoned) for a quarter of a mile south of the place where the road passes nearest to the crest of the bluff.

The Arcola limestone member is exposed on the slopes of streams flowing north into McCowers Creek in Secs. 3 and 4, T.17 N., R. 17 E; on the Columbus-Mayhew road (new Starkville road) in the northwest corner of Sec. 32, T. 19 N., R. 17 E.; and near the center of Sec. 18, T. 19 N., R. 17 E. A few phosphatic molds were observed about 5 feet above the Arcola limestone in Sec. 32. The relatively greater resistance to erosion of this hard limestone has resulted in the formation of an easily recognizable eastward-facing escarpment which was traced entirely across the county, but at many places along the crest of the escarpment no limestone is present at the immediate surface because it has disintegrated into black residual clay.

The Arcola limestone appears to be at about 260 feet above the base of the Selma chalk in Lowndes County. The Anderson Drilling Company Hardy No. 1 well (43, pp. 121, 122), drilled in 1920 and 1921 in the NW. 1/4, SE. 1/4, Sec. 9, T. 17 N., R. 17 E., was located on the outcrop of the Selma chalk about half a mile southwest of the outcrop of the limestone bed. The thickness of the Selma chalk in this well, 300 feet, is probably about 20 to 40 feet greater than the thickness of that part of the Selma below the Arcola limestone.

The belt of outcrop of the *Diploschiza cretacea* zone is in the western part of the county. Fossils from this zone were observed in the ditch at a road corner in the NE. 1/4, Sec. 18, T. 17 N., R. 17 E; in a bald spot at the southern edge of McCowers Creek Valley on Mississippi Highway 25, Sec. 2, T. 17 N., R. 16 E.; a mile north of Artesia on Mississippi Highway 25, Sec. 8, T. 18 N., R. 16 E.; and on the Mayhew-Starkville Road from 0.8 to 1.7 miles west of the Mobile & Ohio Railroad in Secs. 29 and 31, T. 19 N., R. 16 E. The thickness of the zone is greater than 20 feet near Mayhew.

The top of the *Diploschiza cretacea* zone appears to be about 450 feet above the base of the Selma chalk in Lowndes County. The town of Artesia is built on the Selma chalk at the top of or just above the zone, and the well of J. V. Mitchell, the log of which is published in Water Supply Paper 576 (48, p. 311), penetrated the zone and all the Selma below the zone, reaching the Eutaw formation at a depth of 450 feet.

The plane dividing the *Exogyra ponderosa* and the *Exogyra costata* zones comes to the surface near the southwestern corner of the county. The village of Crawford is built on chalk containing *Exogyra* *cancellata* Stephenson, but no fossils restricted to that zone were observed for a distance greater than a quarter of a mile to the east or more than a mile to the north.

The Lowndes County Oil and Development Company Carr Estate No. 1 well was drilled north of Crawford in 1932 in the NW.1/4, NW 1/4, Sec. 34, T. 17 N., R. 16 E. Although no log of this well is available, Mr. Robert L. Steffey of Jackson, Miss., has reported that the well reached the top of the Eutaw formation at a depth of 620 feet. This suggests a thickness of Selma chalk below the top of the *Exogyra ponderosa* zone of about 600 feet.

The Buck Cook well, half a mile north by east of Penn, is located a mile or less east of the outcrop of the top of the *Exogyra ponderosa* zone and thus penetrated all the zone included within the Selma chalk except a few feet at the top. The log of the Cook well is copied below from Water-Supply Paper 576 (48, p. 311) with modifications in the correlation of the beds.

LOG OF WELL OF BUCK COOK, LOCATED ON THE UPLAND HALF A MILE NORTH BY EAST OF PENN

(Adapted from description by J. C. Reeder, driller)

	Thickness Feet	Depth Feet
Selma chalk		
Soil, residual from the Selma	2.5	2.5
Red clay residual from the Selma	5.0	7.5
Chalk	400.0	407.5
Sand (?) with layers of sandstone (?) at top and bottom each 10 inches thick (Arcola limestone member?)	3.5	411.0
Pipe clay	249.0	660.0
Eutaw formation		
Sand and shells	10.0	670.0
Sand, water bearing	50.0	720.0

OKTIBBEHA COUNTY

The Selma chalk crops out only in the eastern and northeastern parts of Oktibbeha County in a belt from 1 to 8 miles wide.

The zone of *Diploschiza cretacea* has been observed in the northeastern corner of the county by Mr. Frank Seiler of the Department of Geology and Geography of Mississippi State College.

The contact between the *Exogyra ponderosa* and *Exogyra costata* zones intersects the surface along a line about 2 1/2 miles west of Muldrow, half a mile southwest of Osborn, and near Sessums. Hard chalk containing *Gryphaea convexa* Say, which is rarely found above the *Exogyra ponderosa zone,* was observed on the eastward-facing slope of a branch near the center of Sec. 4, T. 19 N., R. 15 E. In the same section half a mile due west, hard chalk containing *Exogyra cancellata* Stephenson was observed.

The upper 40 feet of the Selma chalk is exposed on a steep eastward-facing scarp in the SW. 1/4, Sec. 2, T. 17 N., R. 15 E. The upper 15 feet of this exposure consists of slightly sandy and micaceous chalk, the lower 5 feet of which contains *Exogyra cancellata* Stephenson. Other fossils observed include *Exogyra costata* Say, *Ostrea falcata* Morton, *Gryphaea mutabilis* Morton, *Gryphaeostrea vomer* (Morton), and *Paranomia scabra* (Morton).

In the northeast impure argillaceous chalk, probably the extreme upper part of the Selma, is exposed three-quarters of a mile northwest of the Rocky Hill Church-Muldrow road in the NW. 1/4, Sec. 2, T. 19 N., R. 14 E. The chalk is overlain by 70 feet of calcareous sand of the Ripley formation and contains an assemblage of fossils essentially the same as at the preceding locality.

CLAY COUNTY

The Selma chalk closely underlies an area in Clay County extending from an irregular north-south line passing near Cedar Bluff, Griffith, and Caradine store, eastward to within 2 or 3 miles of Tombigbee River. Over much of this area the chalk is concealed by the relatively thin alluvium of Tibbee River and its tributaries, by terrace deposits, and by a thick mantle of clay residual from the chalk.

Good exposures of the lower part of the chalk were observed on the road east from White in the eastern part of the county. Chalk is exposed in the bottom of Town Creek near the northeast corner of Sec. 29, T. 16 S., R. 7 E., and on the eastward-facing slope of the valley a quarter of a mile to the west, where a 6-inch indurated ledge of limestone interbedded in the chalk crops out 10 feet above the flood plain.

On land of H. B. Strong, eastward-facing slope of Town Creek Valley, near the Bartons Ferry road, 5 1/2 miles east by north of West Point, about 30 feet of an argillaceous facies of the chalk is exposed in gullies. A thin indurated crust about midway between the top and bottom of the exposure is composed chiefly of fragments of *Ostrea falcata* Morton?. Weathered from the chalk are numerous fossils (Coll. 6885).

The Arcola limestone member was observed only near West Point. Two-tenths of a mile east of the Southern Railway in the northwest corner of Sec. 19, T.17 S., R.7 E., it is at the top of a steep eastward-facing scarp; 2 1/4 miles east of town near the southwest corner of Sec. 7, T. 17 S., R. 7 E., it is interbedded in an argillaceous facies of the Selma chalk and crops out in the public road about 20 feet lower than the tops of the hills; here were recognized in the chalk *Hamulus onyx* Morton, *Ostrea plumosa* Morton, and *Exogyra ponderosa* Roemer.

West Point is situated on a belt of terraced land 3 1/2 to 6 miles wide, bordering Tibbee River and its tributaries, the immediately underlying material of which consists of 10 to 25 feet of greenish-gray fine argillaceous sand, more or less weathered, mottled in tints of red, pink, and yellow; this material originated as Pleistocene terrace deposits. These conceal the underlying Selma chalk except in occasional small exposures. The only place in the immediate vicinity of West Point where the Selma was observed was in an abandoned pit of the West Point Brick, Tile & Lumber Company just north of town, where a poorly exposed impure facies of the chalk, consisting of greenish-gray calcareous, finely micaceous, sandy clay, yielded a few fossils (Coll. 6883).

Two miles west of West Point the following section appears in a cut of the Montpelier road (Mississippi Highway 10) in Sec. 16, T. 17 S., R. 6 E.:

SECTION ON THE MONTPELIER ROAD, 2 MILES WEST OF WEST POINT

	Feet
Pleistocene terrace deposit	
Mottled red, pink, and yellow argillaceous, ferruginous sand	14
Light-green massive fine sand	2
Laminated gray clay, locally stained to an ochre-like brown, becoming calcareous toward base	2
Unconformity	
Selma chalk	
Greenish-gray compact calcareous, fossiliferous clay (Coll. 6882)	3
	21

The *Diploschiza cretacea* zone is concealed at most places by alluvial deposits of Sakatonchee River, but crops out on Mississippi Highway 25, 2 miles west of Tibbee Station (center Sec. 7, T. 19 N., R.16 E.), where white argillaceous chalk was observed, containing *Diploschiza cretacea* Conrad, *Terebratulina filosa* Conrad, *Ostrea plumosa* Morton, *Anomia argentaria* Morton and *Gryphaea* sp. (Coll. 17205).

In 1930 and 1931 the Ohio Oil Company drilled a 4680-foot well, known as the Cantrell No. 1 well, in the NE. 1/4, NE. 1/4, Sec. 16, T. 15 S., R. 5 E. The well was located on the outcrop of the Selma chalk about midway between the *Diploschiza cretacea* zone and the top of the *Exogyra ponderosa* zone.

LOG OF THE OHIO OIL COMPANY CANTRELL NO. 1 WELL

(Adapted from driller's log. Altitude of derrick floor 270 feet above sea level)

	Thickness Feet	Depth Feet
Surficial deposit		
Sandy clay	7	7
Selma chalk		
Gray lime rock	36	43
Chalk rock	7	50
Gray lime rock	12	62
Gummy chalk with streaks of hard rock	187	249
Chalk rock	51	300
Sand	30	330
Gummy shale	25	355
Lime and soapstone	25	380
Sandy shale	45	425
Blue rock	105	530
Eutaw formation		
Sand	30	560
Broken lime and sand	128	688
Sand	2	690
Hard lime and sand rock	23	713
Hard lime with streaks of sand	55	768
Sandy shale and boulders	37	805
Broken sand and lime	20	825
Broken lime and sand	67	892
Tuscaloosa formation		
Pink gumbo	28	920
Sand and lime	21	941
Lime	2	943
Gypsiferous gumbo (red beds at 950')	7	950
Red shale and broken lime	77	1027
Red gummy shale	33	1060
Blue gummy shale, streaks of gravel	22	1082
Red shale and gumbo	53	1135
Gummy red shale	55	1190
Red gumbo	18	1208
Broken lime shells with streaks of gummy shale	44	1252
Fine gravel and sand	48	1300
Coarse gravel and shale	22	1322
Broken lime and shale	67	1389
Paleozoic rocks	3291	4680

Hard blue-gray chalk, exposed 1.1 miles west of Abbott (SE. cor., Sec. 17, T. 16 S., R. 5 E.), contains *Exogyra cancellata* Stephenson and other fossils common to this zone. Compact gray argillaceous chalk containing *Gryphaea convexa* Say is exposed 0.4 mile east of Abbott. As this fossil is rarely found above the *Exogyra ponderosa* zone the dividing line between the *Exogyra ponderosa* and *Exogyra costata* zones is believed to be near Abbott, probably a little west of the town.

Caradine store is in the northern part of the county (NW.1/4, Sec. 14, T.15 S., R.4 E.), 9 miles northwest of Abbott. Within 4 or 5 miles southeast of this store bald spots of Selma chalk are common about the headwaters of numerous small creeks tributary to Houlka Creek. Many fossils weathered from the chalk lie loose on these exposures, among which may be mentioned *Exogyra cancellata* Stephenson and *Anomia tellinoides* Morton (Colls. 6859 and 6860).

The top of the Selma chalk is well exposed 4.2 miles west of Abbott, on the eastward-facing slope of a prong of Underwood Creek at the eastern edge of the Pontotoc Hills (SE.1/4, Sec. 14, T.16 S., R.4 E.). Very impure light-brown argillaceous, micaceous chalk contains *Exogyra costata* Say, *E. cancellata* Stephenson, *Gryphaea mutabilis* Morton, and *Paranomia scabra* (Morton).

An interval of 50 feet of fossiliferous Selma chalk, representing the upper part of the formation, is exposed along Mississippi Highway 10 near the west end of the bridge over Line Creek, a mile east of Cedar Bluff (Sec. 22, T.20 N., R.14 E.) (Coll. 6862).

MONROE COUNTY

The Selma chalk immediately underlies the surface in approximately the western third of Monroe County. Only that part of the formation included in the *Exogyra ponderosa* zone is present; it is much more impure than the chalk in higher parts of the formation and weathers readily to a black or brown clay from which most of the lime has been leached; consequently large bald spots such as are characteristic of the purer facies of the chalk are rare, and the fresh rock is not seen except in artifical excavations and on steep slopes where the overlying mantle of residual clay has been stripped away.

The unconformable contact of the Selma with the underlying Eutaw formation and the phosphatic material in the basal bed of the Selma near Cotton Gin Port (Colls. 6886 and 17207), near Strongs, and 8 miles north of Aberdeen, are described under the heading "Eutaw formation, Monroe County." A few phosphatic molds of mollusks were collected from a layer of very argillaceous chalk in the lower part, and possibly near the base, of the Selma, in a gully on the southwestward-facing slope of a branch valley of Mattubby Creek near the northwest corner of the NE.1/4, Sec. 2, T.14 S., R.6 E. (Coll. 17249).

The Arcola limestone member forms an irregular north-south line in the western tier of townships and is seen in a few outcrops as far south as the latitude of Gibson. It is estimated to lie 220 to 240 feet above the base of the Selma in this county.

No outcrops of the member were seen in the southern part of the county, probably because of the thick cover of residual clay, but a steep, eastward-facing scarp a mile to a mile and a half east of the Mobile & Ohio Railroad at about the place where the limestone was expected to crop out may have been caused by this hard bed, now concealed by the clay.

The logs of a well near Prairie and a well near Strongs are published in Water-Supply Paper 576 (48, pp. 339, 340). Prairie is a mile west of this scarp and Strongs is a mile east of it. The Eutaw was reached in the well a mile east of Prairie (Sec. 3, T. 15 S., R. 6 E.) at a depth of 241 feet, and in the well three quarters of a mile northwest of Strongs at a depth of 205 feet.

The southernmost observed exposure of the Arcola limestone is in a ditch at the southeast corner of a crossroad on Mississippi Highway 8, 1 1/2 miles east of Gibson (NW. cor. Sec. 27, T. 14 S., R. 6 E.).

SECTION IN DITCH 1 1/2 MILES EAST OF GIBSON

	Feet
Alluvium (Quaternary)	
Gray silty clay	10
Selma chalk	
Arcola limestone member composed of hard buff limestone	1
Soft argillaceous chalk	2
	13

Half a mile toward the west in the same ditch 6 feet of argillaceous chalk containing a 3-inch layer of phosphatic molds 3 feet above the base is overlain by 10 feet of residual clay. The phosphatic bed is probably about 10 feet above the Arcola limestone. Fossils (Coll. 17250) were collected from the phosphatic bed at this locality (middle of north edge of Sec. 28, T. 14 S., R. 6 E.), one mile east of Gibson on Mississippi Highway 8. This thin bed of phosphatic material probably represents a diastem, or time of very slow deposition of the chalk.

A section affording a good exposure of the Arcola limestone was observed on the slope overlooking a branch of Mattubby Creek about 8 1/2 miles north by east of Gibson (SE. 1/4, Sec. 10, T. 13 S., R. 6 E.).

SECTION ABOUT 8 1/2 MILES NORTH BY EAST OF GIBSON

Selma chalk	Feet
Residual silty clay underlain by light-brown argillaceous chalk; a few phosphatic molds of mollusks were found 5 feet above the base; to top of slope	22
Arcola limestone member: Hard light-buff limestone containing a few fossils (Coll. 17248)	1
Gray chalky clay; to flood plain	10
	33

The limestone is also exposed at other localities in northwestern Monroe: about 300 feet south of the Amory-Okolona road on the eastward-facing slope of Cowpen Creek Valley (NW. cor., Sec. 2, T. 13 S., R. 6 E.); at the top of the hill overlooking Old Town Creek on U. S. Highway 45 (SE. 1/4, Sec. 14, T. 12 S., R. 6 E.); and on the sides of the hills at the site of old Camargo (SE. 1/4, Sec. 3, T. 12 S., R. 6 E.).

Impure chalk containing *Diploschiza cretacea* Conrad and *Terebratulina filosa* Conrad is exposed in a bald spot on the westward-facing slope of Sakatonchee River Valley in the southwestern part of the county (NW. cor., SW. 1/4, Sec. 19, T. 15 S., R. 6 E.). A mile and a half farther north fossils, including *Diploschiza cretacea* (Coll. 17226), were collected from bald spots at the edge of the alluvial plain of Sakatonchee River at the south side of the road leading west from Prairie (NW. cor., Sec. 7, T. 15 S., R. 6 E.).

Diploschiza cretacea or *Terebratulina filosa* or both, and other fossils, were also observed at localities as follows: In a small bald spot at the east side of Mississippi Highway 8 (SW. Cor. Sec. 18, T.14 S., R.6 E.); at the top of the hills overlooking Mattubby Creek (0.15 mile north of the section line in the SE. 1/4, Sec. 18, T.13 S., R.6 E.); on the Amory-Okolona road 0.1 mile east of the Chickasaw County line, (NW. Cor., Sec. 31, T.12 S., R.6 E.); and in extensive bald spots overlooking Tallabinnela Creek on the county line 0.3 mile north of the southwest corner, Sec. 18, T.12 S., R.6 E.

CHICKASAW COUNTY

The Selma chalk crops out in the eastern two-fifths of Chickasaw County. In the eastern part of this area the formation consists of fairly pure hard white chalk giving rise to numerous bald spots. In the western part it is less pure and weathers to a mantle of brown and black slightly sandy clay in which bald spots are rare.

About the eastern third of the area of outcrop is within the zone characterized by the presence of *Exogyra ponderosa* Roemer; in the western two-thirds the chalk yields *Exogyra costata* Say and *Exogyra cancellata* Stephenson. Although *Diploschiza cretacea* Conrad has not been observed in Chickasaw County, the presence of the zone in the southeastern corner of the county is inferred, because it has been found just across the line in Monroe County.

The position of the dividing line between the *Exogyra ponderosa* zone and the *Exogyra costata* zone was determined rather closely near Okolona in the northeastern part of the county and near Pleasant Plain Church in the southeastern part of the county.

On the eastward-facing slope of a small branch of Chookatonkchie Creek on a new road near the southeast corner of the county (SE. Cor. SW. 1/4, Sec. 21, T.14 S., R.5 E.), bald spots north of the road show argillaceous chalk containing *Gryphaea convexa* (Say), *Gryphaea mutabilis* Morton and *Ostrea falcata* Morton—an assemblage from the *Exogyra ponderosa* zone. A bald spot a mile to the south-southwest (SW. 1/4, Sec. 28) exposes argillaceous chalk containing *Exogyra cancellata* Stephenson, *Anomia tellinoides* Morton and other fossils (Coll. 17224).

The chalk in a bald spot half a mile southwest of the Mobile & Ohio Railroad crossing on a local road (SE. 1/4, Sec. 33, T.12 S., R.5 E.), 2 miles southwest of Okolona, contains *Exogyra ponderosa erraticostata* Stephenson, *Gryphaea convexa* (Say), and *Ostrea plumosa* Morton. Three -tenths of a mile southwest of this exposure *Exogyra cancellata* Stephenson was observed in argillaceous chalk, thus approximately fixing the dividing line between the two major *Exogyra* zones.

Bald spots at the sides of Mississippi Highway 23 from 1 to 3 miles south of Okolona show hard fairly pure chalk containing large numbers of *Ostrea falcata* Morton, *Gryphaea convexa* (Say), and *G. mutabilis* Morton. Five feet of slightly argillaceous chalk in the upper part of the *Exogyra ponderosa* zone was observed in the bottom of Muttubby Creek on the Okolona-Van Vleet road (Sec. 27, T.12 S., R.5 E.), half a mile west of Mississippi Highway 23. Three feet above the base is a bed a foot thick containing large numbers of *Gryphaea convexa* (Say). A bald spot on this road 1 3/4 miles west of Mississippi Highway 23 (S. edge Sec. 28) shows fairly pure chalk containing *Exogyra cancellata* Stephenson and other common fossils.

LEE AND ITAWAMBA COUNTIES

An argillaceous facies of the Selma chalk, the Mooreville tongue, extends as a great tongue northward 20 or 25 miles from the main body of the formation through eastern Lee and western Itawamba counties, and interlocks with a corresponding body of sand, the Tupelo tongue, which extends southward a like distance from the main body of the Coffee sand through the central part of Lee County. In the area of outcrop this impure chalk produces waxy soils and subdued topography, such as are characteristic of similar argillaceous facies of the main body of the Selma.

The Mooreville tongue is traversed by U. S. Highway 78 for 5 to 12 miles east of Tupelo, Mooreville being situated a little west of the middle of the area. A good exposure of the chalky clay is in a road cut and deep gully, three-fourths of a mile west of Mooreville. Here the top of the hill is capped by about 8 feet of red weathered sand of the Tupelo tongue of the Coffee sand, beneath which is about 20 feet of dark shaly clay from which most of the lime has been leached, followed in a deep gully south of the road by about 20 feet of greenish-gray shaly chalky clay, containing small crystals of gypsum in the joint cracks.

In the banks of a small branch tributary to Long Creek just south of U. S. Highway 78, half a mile east of Mooreville, and 60 feet lower than the hill at Mooreville, a few fossils were collected from 2 feet of unweathered dark calcareous clay of the Mooreville tongue (Coll. 9521).

The contact of the Selma chalk with the underlying Tombigbee sand member of the Eutaw formation is well exposed at several places near Dorsey on U. S. Highway 78, 11 miles east of Tupelo (SE. Cor., Sec. 36, T.9 S., R.7 E.). In a gully a tenth of a mile west of Dorsey 5 feet of very calcareous, glauconitic massive sand (Tombigbee) is overlain by 21 feet of very argillaceous and sandy chalk (Mooreville tongue of Selma) containing fossils preserved in part as shells and in part as phosphatic molds (Coll. 17252).

The road leading southeast from Tupelo to Richmondlee crosses the waxy clay soil, derived from the chalky clay of the Mooreville tongue, from about 8 1/2 to 10 1/2 miles from Tupelo. Dark bluish-gray argillaceous, micaceous, glauconitic, sandy chalk, containing a few soft chalky fossils, is exposed in the bottom of Boguegaba Creek at Richmondlee (NE. 1/4, Sec. 28, T.10 S., R.7 E.). Two miles southeast by south of Richmondlee at the Itawamba County line fine ferruginous massive glauconitic sand (Tombigbee) is exposed in the bed of the same creek. The material at Richmondlee therefore is probably near the base of the Selma. There are numerous bald spots on the outcrop of the Mooreville tongue, consisting of gullies in very argillaceous and, at places, sandy chalk.

The tongue of chalky clay appears to lose its identity by merging or minor intertonguing with the Coffee sand in the northern part of T.8 S., R.7 E., north of which no outcrops of chalk have been observed.

The Arcola limestone member, 1 foot thick, is near the top of the Mooreville tongue and crops out at many places in the southeastern part of the county. The bed was traced as far north as the middle of the line between Secs. 8 and 9, T.10 S., R.7 E., but not far north toward Mooreville it loses its identity in the Tupelo tongue.

The Arcola limestone crops out in a local road in the SE. 1/4, Sec. 8, T.10 S., R.7 E., about 15 feet below red sand derived from the Tupelo tongue of the Coffee sand. Here the limestone is not a solid layer but a layer of round, cobble-like fragments. Associated with the limestone are a few worn phosphatic molds of pelecypods and a few phosphatic nodules. The limestone rises to the east and was noted in a road cut near the southwest corner of Sec. 16. The bed caps the top of the ridge trending southwest between Leeper and Carmichael creeks and was noted on Mississippi Highway 6 an the northwestward-facing slope of Carmichael Creek Valley. Several good exposures were noted on a local road half a mile north of Union Church (E. edge Sec. 35, T.10 S., R.6 E.).

Forty-five feet of brown micaceous, argillaceous very fine-grained sandy chalk of the Mooreville tongue is exposed on the westward-facing slope of Garrett Creek Valley, a mile east of Plantersville (east half of the line between Secs. 15 and 22, T.10 S., R.6 E.). The upper part of the section is purer than the lower part and contains *Exogyra ponderosa* Roemer and *Ostrea plumosa* Morton. The top of the exposure consists of red sand which may represent the Coffee sand or may be a terrace deposit of Old Town Creek.

The thickness of the Mooreville tongue is apparently between 150 and 250 feet. The Arcola limestone member, which lies at the top of the Mooreville, appears to be about 240 to 265 above the base of the Selma chalk in Noxubee and Lowndes counties, but in Lee County none of the logs of wells studied shows a thickness of the Mooreville tongue as great as 240 feet.

In 1927 and 1928 J. P. Evans drilled an oil-test well, Whiteside No. 1, about 2 miles north of Mooreville (Sec. 16, T.9 S., R.7 E.). According to the geologic map this well started in the lower part of the Tupelo tongue of the Coffee sand, probably not 20 feet above the top of the Mooreville tongue. The thickness of Mooreville penetrated in this well is 160 feet.

LOG OF WELL OF J. P. EVANS ET AL, WHITESIDE No. 1

(Altitude of derrick floor 411 feet above sea level. P. J. MacAlpine, drilling contractor)

	Thickness Feet	Depth Feet
Surface (Tupelo tongue of Coffee sand?)	30	30
Selma chalk (Mooreville tongue)		
Blue gumbo	130	160
Green slate	30	190
Eutaw formation		
Green sand, water-bearing	50	240
Gray sand	20	260
Green "creek" sand	163	423
Cherty gravel	21	444
Tuscaloosa formation		
Sandstone	15	459
Pink gumbo	8	467
Fine-grained sand	3	470
White sand and gravel	10	480
Red mud and gravel	7	487
White rock	6	493
Pink shelly rock	7	500
Red mud and gravel	5	505
Shelly rock and pink slate	5	510
Red mud and gravel, mixed	5	515
Pink shelly rock	3	518
Paleozoic rocks	2689	3207

The town well at Mooreville (48, p. 289) penetrated 155 feet of the Mooreville tongue, all except possibly the upper 20 or 30 feet of this unit.

In well No. 7 at the Tupelo Municipal Water and Light Plant the drill penetrated only 113 feet of materials that can be classified definitely as Mooreville.

LOG OF TUPELO MUNICIPAL WATER AND LIGHT PLANT WELL NO. 7

(Altitude about 280 feet above sea level. Drilled by J. W. Webb)

	Thickness Feet	Depth Feet
Top soil	20	20
Coffee sand (Tupelo tongue)		
Yellow sand	20	40
Rock	5	45
Rock, sand, and shells	23	68
Blue rock	12	80
Water-bearing sand	22	102
Selma chalk (Mooreville tongue)		
Hard rock (Arcola limestone?)	5	107
Soapstone	18	125
Blue rock	83	208
Hard rock	7	215
Eutaw formation		
Yellow sand, water-bearing	60	275
Soapstone	5	280
Rock	2	282
Yellow sand, water-bearing	170	452
White rock	53	505
Tuscaloosa formation		
Sand, gray fine crystals	4	509
Rock	11	520
Sand	4	524
Rock	10	534
Sand	4	538
Boulders, gravel, and pebbles	2	540
Chert gravel	16	556
Sand, water-bearing	2	558
Rock	2	560
Red gumbo	4	564
Sand	6	570
Paleozoic rocks (?)		
Hard rock	16	586
Fine sand	4	590
Coal (possibly with sand)	10	600
Fine sand showing oil	50	650
Very fine sand, greasy	5	655
Dark sand	23	678
Rock, very crystalline, hard	12	690

The logs of two wells at Tupelo that give different thickness figures for the Mooreville tongue of 130 feet and 215 feet are published in Water-Supply Paper 576 (48, p. 288).

SECTION A MILE AND THREE-QUARTERS EAST OF VERONA

	Feet
Terrace deposit (Pliocene or Pleistocene)	
Orange fine micaceous sand	25
Selma chalk	
Greenish-gray argillaceous, sandy, micaceous chalk becoming purer upward in the section; upper 30 or 40 feet consists of fine gray micaceous, sandy fossiliferous chalk (Coll. 6899); two phosphatic molds of gastropods were found within 5 feet of base	48
Arcola limestone member; "Bored" limestone	1
Sandy chalk mostly concealed to the flood plain of Old Town Creek	12
	86

The Tupelo tongue of the Coffee sand was not recognized in this section, although it was found 2 1/2 miles to the east. It seems likely that it merges into chalk down dip to the west as well as laterally along the strike to the south; in other words in Selma time the sand carried along the sea bottom by currents did not reach as far off shore at Verona as it did at Tupelo. This is shown by the merging of the sand into chalk from Tupelo south toward Verona.

The faunal zone, characterized by the presence of the mollusk, *Diploschiza cretacea* Conrad, and the brachiopod, *Terebratulina filosa* Conrad, was traced northward in Lee County as far as the site of old Clark School, 2 miles south by west of Tupelo.

Bald spots on the eastward-facing slope of Chiwapa Creek on the road from Shannon to Troy (N.1/2, Sec. 22, T.11 S., R.5 E.), reveal about 30 feet of argillaceous chalk, which contains *Diploschiza cretacea* Conrad, from the top down to the flood plain of the creek. *Exogyra ponderosa* Roemer and other common fossils were observed at this locality. On the slope down to Coonewar Creek, 6 miles south by west of Tupelo (Sec. 35, T.10 S., R.5 E.), 25 feet of chalk is exposed in a large bald spot. *Diploschiza cretacea* Conrad (in the upper 5 feet), *Gryphaea convexa* (Say), *G. mutabilis* Morton (very flat variety), and other fossils are present in the chalk.

The *Diploschiza cretacea* zone appears to thin markedly to the north for, as stated above, the zone on Chiwapa Creek is at least 30 feet thick, but to the north between Verona and Tupelo, *Diploschiza cretacea* Conrad and the associated brachiopod, *Terebratulina filosa*

Conrad, were found only in a bed about a foot thick, about a mile and a half north of Verona (NE.1/4, NW.1/4, NE.1/4, Sec. 13, T.10 S., R.5 E. (Colls. 6897 and 17216). *Diploschiza cretacea* was observed in blue argillaceous, sandy chalk a few inches below a semi-indurated 3-inch bed of sandy chalk that is overlain by weathered impure cream-colored chalk; other common fossils of the zone are also present

Figure 23.—Coffee sand overlain by Selma chalk, west side of U. S. Highway 45 a mile northwest of Saltillo, Lee County. The prominent bed of hard sandy chalk at the base of the Selma contains great numbers of Exogyra ponderosa Roemer and Gryphaea convexa (Say). Photo by W. H. Monroe.

here. A similar assemblage of fossils was observed in argillaceous chalk exposed in gullies a quarter of a mile to the northeast of the preceding locality, 100 feet east of a house at a bend in old U. S. Highway 45, 1100 feet north and 500 feet west of the southeast corner of Sec. 12. The species *Diploschiza cretacea* and *Terebratulina filosa* appear to be restricted to a very thin zone not more than 5 feet and probably not more than 2 feet thick.

The northernmost place at which fossils of this zone were found is in gullies about 300 feet south-southeast of the site of old Clark School (SE.1/4, NE.1/4, Sec. 12). The zone apparently passes into and is lost in the Tupelo tongue of the Coffee sand not far north of this locality, for the sandy chalk, about a mile and a half north of Verona (Coll. 6897) is similar to that which merges northward into the Coffee sand, and the strike of the zone apparently intersects the contact of the Selma and Coffee only a short distance north of the site of old Clark School.

From the north edge of Tupelo northward to the Tennessee line the contact of the Selma chalk and the Coffee sand appears to be at about the same stratigraphic position at all places where it was seen. At most outcrops in Lee County, where weathering has not reduced the Selma to a residual silt, the base of the Selma is marked by a hard ledge composed almost entirely of ostreid shells (Figure 23).

A sand pit east of the old route of U. S. Highway 45, about 3 miles southwest of Saltillo (Center Sec. 25, T.8 S., R.5 E.), exposes 6 feet of slightly glauconitic, yellow sand (Tupelo tongue of Coffee sand) overlain by slightly glauconitic, slightly sandy chalk (Selma), containing at the base a bed composed almost entirely of *Gryphaea convexa* (Say) and *Exogyra ponderosa erraticostata* Stephenson., The contact is very irregular but there is no evidence of an unconformity. The contact is well exposed at several places near Guntown and the shell bed is a prominent feature in the road cuts. On the new U. S. Highway 45, three quarters of a mile north of Guntown, the shell ledge is well exposed in a borrow pit east of the road. Locally in this pit the ledge has been completely dissolved away (Figure 24), so that residual silt from the Selma is resting directly on the Coffee sand.

SECTION IN PIT AT EAST SIDE OF U. S. HIGHWAY 45, SEC. 22, T.7 S., R.6 E.

	Feet
Selma chalk	
Dark-gray argillaceous, sandy chalk; lower 6 feet is a shell bed containing *Exogyra ponderosa* Roemer, *Gryphaea convexa* (Say) and other common fossils, and abundant phosphatic molds of fossils	14
Shell bed composed largely of *Exogyra ponderosa* Roemer and *Gryphaea convexa* (Say) in hard sandstone	1/2
Coffee sand	
Fine glauconitic sand	15
	29 1/2

Fossils were collected from the basal shell bed of the Selma on U. S. Highway 45 a mile west by north of Saltillo (Coll. 17803, Sec. 17, T.8 S., R.6 E.).

The contact of the Selma chalk on the Coffee sand is clearly exposed in a cut just north of the station at Guntown (See Coffee sand, Lee County). The Selma caps the divide between Twentymile Creek and Old Town Creek for about 2 miles east of Guntown. The shell beds exposed in the cut near the station outcrop at many places within 15 or 20 feet of the tops of the hills and large numbers of shells are weathered out from them. The marine sands of the Coffee appear in all the creek and branch valleys that cut below the fossil-bearing beds.

Figure 24.—Coffee sand overlain by Selma chalk, on U. S. Highway 45, in Sec. 22, T.7 S., R.6 E., Lee County. The contact lies immediately below the indurated bed, which is made up largely of the shells of Gryphaea convexa (Say) in a matrix of sand; in the right half of the photograph the Selma beds are weathered to residual clay. Photo by W. H. Monroe.

West of Guntown for 2 1/2 miles along the Blair road the soils are the waxy residual clays derived from the Selma chalk. Collections were made from bald spots exposing the chalk, at two localities (Colls. 6901 and 6902).

The hills at Baldwyn are mainly composed of the weathered products of the Coffee sand, but they are capped by isolated patches of Selma chalk, the limy subsoils of which can be seen in poor exposures along the western edge of town.

No exposures of the chalk appear along the New Albany road until the lower eastward-facing slope of Okeelala Creek Valley, 2 miles west of town is reached. Here 20 feet or more of bluish chalky limestone is exposed, in which were recognized: *Hamulus onyx* Morton, *Ostrea plumosa* Morton, *O. falcata* Morton, *Gryphaea mutabilis* Morton (large and numerous), *Gryphaeostrea vomer* (Morton), *Exogyra ponderosa* Roemer, and *Anomia argentaria* Morton. Bald spots were seen on this slope for a mile or more both to the north and south of the road.

Figure 25.—Selma chalk exposed in gullies in bald spots a quarter of a mile west of Bethany, northwestern Lee County; weathered from the chalk are many fossils, chiefly of Exogyra costata Say, Exogyra cancellata Stephenson, and Gryphaea mutabilis Morton. Photo by L. W. Stephenson.

The boundary between the *Exogyra ponderosa* zone and the *Exogyra costata* zone is relatively easy to trace through Lee County, for exposures containing faunas from the two zones are in rather close juxtaposition at a number of places through the county.

A bald spot at the top of the hill overlooking Chiwapa Creek Valley, about 5 miles west-northwest of Shannon (NE.1/4, Sec. 8, T.11 S., R.5 E.), shows hard chalk containing *Exogyra cancellata* Stephenson, *Ostrea plumosa* Morton, *Gryphaea mutabilis* Morton, and *Paranomia scabra* (Morton). A bald spot at the edge of the flood plain of the creek (SE. Cor., Sec. 5) shows hard chalk containing *Grypaea convexa* (Say), a form that, with rare exceptions, is restricted to the *Exogyra ponderosa* zone.

At the base of the *Exogyra cancellata* zone, hard chalk containing *Exogyra cancellata* Stephenson and other fossils is exposed on the road leading down from Belden to Old Town Creek.

Hard chalk containing three beds composed almost entirely of the shells of *Gryphaea convexa* (Say) forms a small cascade in the bed of a canal of Mud Creek, just north of the road east from Birmingham (S. edge, Sec. 2, T.8 S., R.5 E.). Nine-tenths of a mile farther west on this road gullies on the eastward-facing slope of Mud Creek Valley show hard chalk containing *Exogyra cancellata* Stephenson and other common fossils. The contact between the *Exogyra ponderosa* zone and the *Exogyra costata* zone thus intersects the surface between these two localities, probably at the base of the exposure on the hillside.

PONTOTOC COUNTY

The Selma chalk (*Exogyra cancellata* zone) crops out in Pontotoc County in a belt about 2 miles wide along the eastern side of the county. The chalk is somewhat impure giving rise to dark-brown and black sandy loam and clay loam.

In the northeast corner of the county the chalk crops out in numerous bald spots on the northeastward-facing slope of Town Branch Valley. A bald spot at the side of the Pontotoc-Sherman road half way down the hill to Town Branch (NW.1/4, Sec. 36, T.8 S., R.4 E.) exposes very sandy, micaceous, calcareous clay containing *Exogyra costata* (wide-ribbed variety), *Gryphaea mutabilis,* and *Paranomia scabra.* A quarter of a mile farther north *Exogyra cancellata* was found in a bald spot west of the road at the edge of the flood plain of Town Branch.

The well of C. Shaw, a mile west of Sherman, penetrated probably the entire thickness of the Selma chalk, for the base of the Ripley formation, which overlies the Selma, comes to the surface nearby.

LOG OF WELL OF C. SHAW, A MILE WEST OF SHERMAN

(Altitude of mouth of well about 375 feet above sea level. Adapted from description by J. W. Webb, driller)

	Thickness Feet	Depth Feet
Selma chalk (may include some beds of the Ripley formation in the uppermost part)		
Clay and rotten rock	45	45
White lime rock (chalk)	235	280
Coffee sand (Tupelo tongue)		
Sand, water-bearing	20	300

UNION COUNTY

The Selma chalk, all within the *Exogyra cancellata* zone, crops out in an irregular belt several miles wide in the eastern part of Union County, west of which it passes under the Ripley formation.

Two miles south of Graham (Sec. 21?, T.6 S., R.5 E.), on the road leading to Alpine (which is in Sec. 8?, T.7 S., R.5 E.), 4 feet of an argillaceous facies of chalk is exposed below the bridge in the bank of a small creek flowing out from the hills a short distance west of the road.

At the foot of the hills near Lenox (Sec. 1?, T.7 S., R.4 E.), 15 or 20 feet of greenish-gray calcareous, finely sandy and micaceous clay containing white concretionary nodules of calcium carbonate up to an inch in diameter, which represents the uppermost beds of the Selma chalk, is overlain by 20 feet or more of greenish-gray finely micaceous, noncalcareous sand of the Ripley formation. The base of the exposure is near the level of a small creek bottom.

Black micaceous, chalky clay weathering light gray (upper part of the Selma), is exposed in the bottom and left bank of Town Creek (E.1/2, Sec. 22, T.8 S., R.4 E.) 100 feet north of U. S. Highway 78. *Exogyra costata* Say (medium-ribbed variety) and other common fossils were noted.

Fossiliferous (Coll. 17262), very argillaceous, slightly sandy, black chalk weathering buff (approximately same bed as in Town Creek above) is exposed in the bed of Bridge Creek just below the bridge on the section line road (N. edge, Sec. 8, T.7 S., R.5 E.).

The thickness of the Selma chalk in southern Union County is probably about 300 feet as suggested by wells penetrating most of the Selma in Pontotoc County and in Alcorn County, but the log of the

Tupelo Oil and Ice Company well at Blue Springs (48, p. 465) appears to show 355 feet of Selma chalk, underlain by Coffee sand. Blue Springs is more than a mile west of the highest exposure of the Selma in a southeasterly trending valley in the Pontotoc hills, and the top of the Selma may be 50 feet or more below the surface, instead of 25 feet as shown in the log.

PRENTISS COUNTY

A cut of the Mobile & Ohio Railroad south of the station at Booneville exposes about 35 feet of light-gray compact argillaceous chalk, sandy at base, from which fossils were collected (Colls. 6455 and 6455b). The lower 15 or 20 feet of the chalk is below the level of the track and is seen in a deep ditch at the south end of the cut west of the track. The lowermost layer here is near the base of the Selma.

The contact of the Selma with the underlying Coffee sand crops out in the Geeville road, 2 1/2 miles southwest of Booneville, but it is poorly exposed.

For 3 1/2 miles northwest of Booneville, the Ripley road traverses an area the subsoils of which are finely sandy clays residual from the Selma chalk. A short distance from the Ripley road on a road which turns to the left, 3 1/2 miles from town, many fossils, chiefly Ostreidae, are weathered from the chalk in bald spots and gullies (Coll. 6456). The shells of Ostreidae (Figure 26) are weathered out in great numbers in similar bald spots near the Geeville road, 1 1/2 miles from Booneville (Coll. 6457).

Fifty feet of chalk is exposed on the northeastward-facing slope of Osborne Creek Valley (NE.1/4, Sec. 2, T.5 S., R.6 E.), on a road from Booneville to Walnut Grove School. The chalk is hard and argillaceous and in the upper part contains *Exogyra cancellata* Stephenson, *Anomia tellinoides* Morton, and other common fossils. East of Osborne Creek argillaceous chalk in a ditch at the side of the road contains *Exogyra ponderosa* Roemer, *Exogyra* sp., and *Paranomia scabra* (Morton).

The public road from a point about 2 1/2 miles east of Blackland, a small village 6 miles west by south of Booneville, is underlain by the Selma chalk to a point 1 1/2 miles west of the village. The chalk appears in a few bald spots near the road, and a few fossils from the *Exogyra ponderosa* zone and from the *Exogyra cancellata* zone were collected (Colls. 6871, 6908).

The Selma passes under the Ripley formation at the foot of the eastward-facing scrap of the Pontotoc Hills about 1 1/2 miles west of Blackland.

The contact of the Selma chalk with the overlying Ripley formation is poorly exposed on the Geeville-Dumas road about 100 feet south of the county line (NW.1/4, Sec. 1, T.6 S., R.5 E.). Twenty-seven feet of sandy, argillaceous chalk containing *Exogyra cancellata* Stephenson and *Exogyra costata* Say (wide-ribbed variety) is overlain at an altitude of about 490 feet by 10 feet of micaceous red and yellow sand.

Figure 26.—Selma chalk in bald spots and gullies near the Geeville road, 1 1/2 miles southwest of Booneville, Prentiss County. Photo by L. W. Stephenson.

ALCORN COUNTY

Over most of Alcorn County the Selma chalk is concealed by a heavy mantle, up to 20 feet thick, of silty residual clay; however, fresh exposures of the chalk appear in places.

The contact of the Selma chalk with the underlying Coffee sand is well exposed near Corinth, on the Southern Railway, 3 miles southeast of town (Coll. 6460); at Stevensons cut on the Illinois Central

Railroad, 2.5 miles southeast of town (Coll. 9496); and on the Mobile and Ohio Railroad, 3 miles south of town (Coll. 6913). The chalk in these cuts forms a thin capping on the ridge east of Bridge Creek, which has cut its bed some 50 feet or more below the base of the Selma into the underlying Coffee sand.

Corinth is near the eastern edge of the chalk as developed west of Bridge Creek. No outcrops were observed in the main part of town where, however, there is a rather deep covering of residual finely sandy clay. Four feet of chalk forming the upper part of the *Exogyra ponderosa* zone is exposed in the bed of Turners Creek, 50 feet south

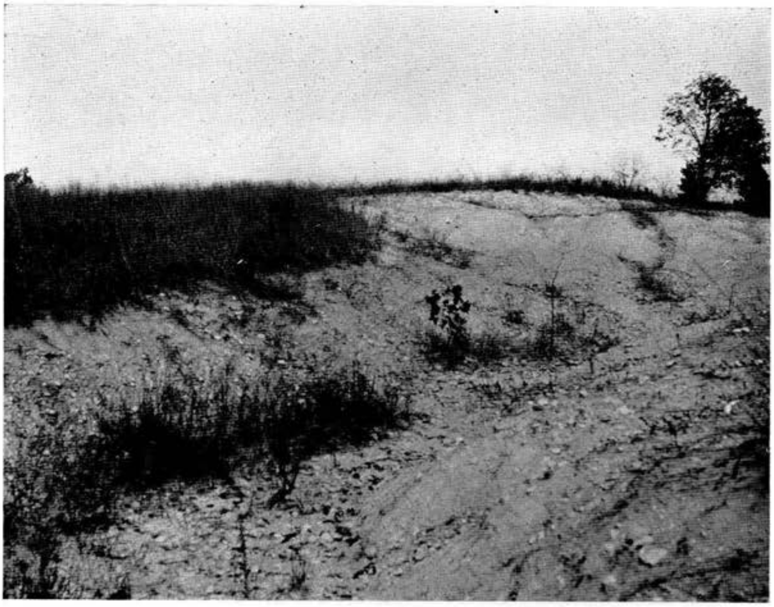

Figure 27.—Selma chalk in bald spot known as "bald knob," the Joseph Reynolds place, 3 miles west of Corinth, Alcorn County. Photo by L. W. Stephenson.

of the Smith Bridge road, 200 feet west of the Southern Railway at Corinth (center Sec. 2, T.2 S., R.7 E.). One foot above the base of the exposure of chalk is a bed a foot thick composed almost entirely of the shells of *Gryphaea convexa* (Say). Two-tenths of a mile west of this exposure on the slope up from the creek, light blue chalky clay containing an irregular variety of *Exogyra cancellata* Stephenson was observed. This is the base of the *Exogyra costata* zone.

A 30-foot cut of the Southern Railway, 2 3/4 miles northwest of Corinth, exposes massive dark-gray finely micaceous, chalky clay that weathers greenish-gray or greenish-yellow, the lower limit of weathering ranging from 3 to 20 feet below the surface. The material yielded *Exogyra cancellata* Stephenson, *Anomia tellinoides* Morton, and other common fossils of the *E. cancellata* zone (Coll. 6879). The chalk is exposed in other cuts farther toward the west, but the non-chalky sands and clays of the overlying Ripley formation begin to appear in cuts within a mile east of Wenasoga.

Figure 28.—Near view of the exposure at "bald knob" showing numerous shells of Exogyra cancellata Stephenson, Exogyra costata Say, and Gryphaea mutabilis Morton. Photo by L. W. Stephenson.

One of the best exposures of the Selma chalk in this region is in the "Blue Cut" on the Mobile & Ohio Railroad just north of the State line in Tennessee, 4 1/2 miles north of Corinth, where 35 or 40 feet of impure chalky clay, essentially like that in the cut of the Southern Railway 2 3/4 miles northwest of Corinth and containing a similar fauna, is revealed. This is near the western edge of the chalk belt, for weathered sand of the Ripley is poorly exposed in the upper 15 or

20 feet of the hill west of the cut, which rises 80 or 90 feet higher than the track. *Exogyra cancellata* Stephenson and *Anomia tellinoides* Morton are common here (Coll. 17221).

A hill locally known as the "bald knob" on the Joseph Reynolds place, 3 miles west of Corinth, is gullied on its upper slope in such a way as to reveal 25 or 30 feet of an impure finely sandy and argillaceous facies of chalk (Figures 27 and 28). Many fossils, belonging chiefly to the oyster family, have been weathered from the chalk (Colls. 6459a and 6459b).

The contact of the Selma chalk with the overlying Ripley formation is well exposed in a road on the northward-facing slope of McElroy Creek Valley (S.1/2, Sec. 35, T.2 S., R.6 E.), about 3/4 mile south by east of Kossuth.

SECTION THREE-FOURTHS OF A MILE SOUTH BY EAST OF KOSSUTH

	Feet
Ripley formation (Coon Creek tongue)	
Residuum—light reddish-brown and yellow silty, micaceous sand	12
Calcareous, micaceous, glauconitic fine sand becoming coarser in lower part, and merging into bed below; contains *Exogyra cancellata* Stephenson and other fossils	53
Selma chalk	
Slightly sandy and micaceous chalk	8
	73

A generalized section of materials penetrated in wells at Kossuth is published in Water-Supply Paper 576 (48, p. 72). In this section the Coffee sand is reported at a depth of 250 feet. The figure of 250 feet probably represents nearly the entire thickness of the Selma in Alcorn County.

COFFEE SAND

GENERAL FEATURES

NAME

The name Coffee sand was first used in 1864 by Safford (12, pp. 361-363) for the oldest Cretaceous group that he saw in Tennessee. He designated as the type locality a section at Coffee Landing on Tennessee River, Hardin County. Lithologically the Coffee sand of Tennessee is strikingly similar to the part of the Eutaw formation below the Tombigbee sand member, with which it was correlated by Safford.

In 1914 the senior author (30, pp. 14-15, 21) showed that the Coffee sand, though regarded by Safford as correlative with the Eutaw formation, is stratigraphically higher, and is in fact the age equivalent to the basal part of the typical Selma chalk. Inasmuch as the Coffee sand is the upward stratigraphic continuation of the Eutaw, from which in northern Mississippi and in Tennessee it is lithologically indistinguishable, the expansion of the application of the term Eutaw to include the Coffee sand as a member seemed a logical procedure at that time. However, as the Coffee sand is readily distinguishable in Mississippi from the underlying Tombigbee sand member of the Eutaw and is the age equivalent of the lower part of the Selma chalk, it has seemed better to consider it an independent unit and it has been so treated since 1936.

Hilgard (11, pp. 68-75) included the Coffee sand in his Tombigbee Sand Group, but stated that the tops of the hills were capped by deposits of so-called Orange sand, much of which is now known to have been derived by weathering from the underlying formation.

AREAL DISTRIBUTION

The Coffee sand crops out in Mississippi in a belt about 10 miles wide west of the Eutaw formation and east of the Selma chalk, except in central Lee County where it intertongues and merges with the lower part of the Selma chalk. Its area of outcrop includes the northeastern quarter of Lee, the middle third of Prentiss, and the eastern third of Alcorn County, and small adjacent areas in Itawamba and Tishomingo counties.

Dr. Bruce Wade (41, pp. 51-64) traced the formation to the north across Tennessee to the Kentucky State line where the area of outcrop is very narrow. The Coffee sand is not known east of Mississippi, being represented by the lower part of the Selma chalk in western Alabama and by nonchalky sands and clays in eastern Alabama and Georgia.

LITHOLOGIC CHARACTER AND THICKNESS

The Coffee sand at its type locality at Coffee Landing, in the northeastern part of Hardin County, Tenn. (13, pp. 411-414), although occupying a stratigraphically higher position, is lithologically similar to the typical Eutaw deposits in Alabama, except that it probably contains a greater percentage of comminuted plant fragments and scattered macerated pieces of lignite. It is characterized by its content of glauconite, by the presence of thin laminae and laminated layers of clay, and by the finely cross-bedded structure of the sands. The formation here probably includes all the deposits between the Paleozoic basement rocks and the overlying Selma chalk.

The deposits in Mississippi are, in general, like the typical materials except that from the Tennessee line southward the bedding in parts of the formation becomes more massive until in the valley of Old Town Creek in Lee County the Tupelo tongue of the formation, described below, presents a massive uniform structure similar to that of the Tombigbee sand member of the Eutaw. These more massive facies were deposited in deeper waters than the typical deposits, and in places yield marine fossils.

The materials of the Coffee sand are fine to medium in texture and, so far as known, contain no chert gravel such as is found in the Eutaw formation. Much of the surficial weathered material of the formation was referred by Hilgard to his "Orange sand" formation.

The Coffee sand probably averages about 200 feet in thickness in Prentiss and Alcorn counties. A well at Corinth, Alcorn County, entered the top of the Coffee sand at 35 feet and entered Paleozoic rock at 301 feet, making a total thickness of Coffee, Eutaw, and Tuscaloosa of only 266 feet. As the Tuscaloosa is very thin to the east, most of this thickness is probably Eutaw and Coffee.

TUPELO TONGUE

The Tupelo tongue of the Coffee sand is a body of dark-gray mostly massive calcareous, glauconitic sand extending southward from the Coffee sand of northern Lee County into the main body of the Selma chalk, being underlain by a corresponding tongue of the Selma chalk, the Mooreville tongue, which extends northward from the basal part of the Selma. The Mooreville tongue loses its identity by merging into and minor intertonguing with the Coffee sand in central and northern Lee County, whereas the Tupelo tongue loses its identity by merging into and minor intertonguing with the chalk in southern Lee County. These relations are graphically shown in Plate 2, Sections B-B and F-F. The exposure in an abandoned portion of the Fulton road, 1.5 miles east of Tupelo, is considered the type section.

The thickness of the Tupelo tongue, as shown by logs of wells at and near Tupelo, is approximately 100 feet.

STRATIGRAPHIC AND AGE RELATIONS

From Twentymile Creek in northwestern Itawamba County northward to the Tennessee State line the Coffee sand rests on the Tombigbee sand member of the Eutaw formation. Whether the contact is conformable or unconformable has not been determined, for it was seen at only a few places, where it is sharp and seemingly conformable.

The Tupelo tongue of the Coffee sand in Lee County represents a gradual southward spread of sand-forming conditions across an area in which impure chalk, the Mooreville tongue of the Selma chalk, had been accumulating. The change from the deposition of chalk to that of sand did not take place suddenly, so that the contact between the chalk and sand is not a sharp one, but is rather a zone of merging from chalk through sandy chalk to sand; the boundary as drawn on the map is therefore necessarily an arbitrary one. The southern tip of the Tupelo tongue is at a point several miles southeast of Plantersville, the point farthest to the south to which sand-forming conditions spread. Thereafter the sand-forming conditions retreated gradually to the northwest toward Tupelo, followed immediately by a northwestward spread of chalk-forming conditions. Here again the change is a gradual one, from the deposition of sand to the deposition of chalk, and the contact between the Tupelo tongue and the overlying main body of the Selma is not sharp, but is a zone of transition rising stratigraphically toward the northwest.

From Tupelo northward to the Tennessee State line the top of the Coffee sand is overlain, probably conformably, by the restricted body of Selma chalk of this area. At nearly all good exposures the base of the Selma is marked by a bed composed mainly of shells of the oyster family, especially *Gryphaea* and *Exogyra,* in a matrix of sandy chalk. Locally in Alcorn County the Coffee sand is overlain by a discontinuous blanket of brown loam, the eastward feather edge of the wind-blow loess.

A few miles south of Tupelo, the *Diploschiza cretacea* zone of the Selma loses its identity in the extreme top of the Tupelo tongue; thus the Coffee sand is equivalent in age to all of the Selma chalk south of Tupelo up to and including the *Diploschiza cretacea* zone.

A few miles south of Mooreville the Arcola limestone member of the Selma chalk is near the top of the Mooreville tongue of the Selma; in this latitude the Tupelo tongue, therefore, includes only beds equivalent in age to the Selma chalk between the Arcola member and the top of the *Diploschiza cretacea* zone.

The southern end of the Tupelo tongue merges into the Selma chalk not only along the strike but also down dip in the vicinity of Plantersville. The Arcola limestone member underlies the Tupelo tongue east and southeast of Plantersville, but on the Plantersville-Verona road the limestone is overlain only by impure, sandy chalk of the Selma.

The diastem or unconformity above the Arcola has not been recognized in the Coffee sand unless a few phosphatic molds of fossils and phosphatic nodules found at the same stratigraphic position at several places south of Twentymile Creek may represent the diastem.

PHYSIOGRAPHIC EXPRESSION

The topography in the area of outcrop of the formation is, in general, very much like that in the country to the east underlain by the Eutaw formation; it is hilly but is characterized by comparatively flat-topped ridges separated by deeply incised valleys. The general appearance of the country is that of a highly dissected plateau sloping gently to the west. This area forms the western part of the physiographic division to which the name Tombigbee and Tennessee River Hills is applied. Near Booneville the altitude of this upland is nearly 600 feet above sea level, and in Tishomingo County outliers of Coffee sand cap hills whose summits rise more than 800 feet above sea level. The stage of dissection represented by the topography is that of maturity, or the stage in which pronounced slopes prevail over flat or nearly flat surfaces.

The hills underlain by the Coffee sand contrast strongly with the subdued topography of the Black Prairie belt to the west, underlain by Selma chalk. There is little difference between the topography of the area underlain by the Eutaw formation and that underlain by the Coffee sand, except that the Tombigbee sand member along the western side of the Eutaw belt gives rise to rounded and more or less conical hills in contrast to the flat-topped ridges produced by the typical Eutaw and by the Coffee.

The Tupelo tongue of the Coffee sand finds a clear physiographic expression in the sand hills that form a belt 3 or 4 miles wide east of Old Town Creek in the area traversed by the Tupelo-Fulton road in Lee County. This hilly area contrasts strongly with the subdued topography of the area to the east underlain by the Mooreville tongue of the Selma chalk. This contrasting topography is well shown on the topographic sheet of the Tupelo Quadrangle.

FOSSIL CONTENT

The Coffee sand, especially the upper part and the Tupelo tongue, locally in northern Mississippi, contains fossiliferous strata in which the remains of marine mollusks are more or less plentiful in certain layers. Comminuted plant fragments are common. No mollusks have been reported from the typical Coffee sand of Hardin County, Tenn., but comminuted plant fragments and small pieces of lignite are present there in great abundance, and large pieces of lignite and logs of silicified wood are fairly common. An anterior wing, part of one antenna, and part of a leg of the insect *Dolophilus? praemissus* Cockrell (35, pp. 98-99) were found by Bruce Wade in fossil resin from Coffee Bluff, Tenn., the type locality of the formation. This is the first record of insects in American fossil resin. Two localities containing beautifully preserved fossil shells were discovered in the lower part of the Coffee in Mississippi, one in Lee County, the other in Prentiss County. These are sand facies assemblages similar in general aspect to the faunas of the stratigraphically higher Ripley formation (including the Coon Creek tongue) and the still higher Owl Creek formation. The faunas are listed in the accompanying table by stratigraphic position, counties (from south to north), and localities.

Fossil Localities in the Coffee sand

6453, 6900.—Abandoned cut of Tupelo-Fulton road on westward-facing slope of Old Town Creek Valley (Sec. 33, T.9 S., R.6 E.), 1 1/2 miles east of Tupelo, Lee County.

17260.—Cut on U. S. Highway 45 on northward-facing slope of Kings Creek Valley (Sec. 31, T.9 S., R.6 E.), half a mile south of St. Louis-San Francisco Railway at west edge of Tupelo, Lee County.

6907.—Bluff of small branch of Boyer Creek, 3/4 mile south of Booneville, Prentiss County.

6913.—Cut of Mobile and Ohio Railroad, 3 miles south of Corinth, Alcorn County. This collection includes fossils from both the top of the Coffee sand and the base of the Selma chalk.

6460b.—Cut of Southern Railway, 3 miles southeast of Corinth, Alcorn County.

9497.—Stevensons cut on Illinois Central Railroad, 2 1/2 miles southeast of the station at Corinth, Alcorn County. Bed 3 of section.

17254, 17809.—Road cut on northward-facing slope of Mantachie Creek Valley (S.1/2, Sec. 9, T.8 S., R.7 E.), 2 miles due west of Ratliff, Lee County.

17783.—Road cut on the northeastward-facing slope of Youngs Creek Valley (Sec. 9, T.6 S., R.8 E.), Prentiss County.

6454, 6909, 9501.—Six miles east of Booneville on road to Hare's old mill site, Prentiss County.

6458, 6910, 9502.—Hare's old mill site on Big Brown Creek, 9 miles east of Booneville, Prentiss County.

9498.—Cut on Illinois Central Railroad, 10 1/4 miles southeast of Corinth, Alcorn County.

6461.—Cut of Southern Railway, 2 miles northwest of Burnsville, Tishomingo County.

Distribution of Coffee fossils

Species	Upper beds						Lower beds					
	Lee County		Prentiss County	Alcorn County			Lee County	Prentiss County			Alcorn County	Tishomingo County
	6453 etc. - Tupelo, 1 1/2 mi. E	17260 - Tupelo, 1/2 mi. S	6907 - Booneville, 3/4 mi. S	6913 - Corinth, 3 mi. S	6460b - Corinth, 3 mi. SE	9437 - Corinth, 2 1/2 mi. SE	17254 etc. - Ratliff, 2 mi. W	17783 - Booneville, 7 1/2 mi. SE	6454 etc. - Booneville, 6 mi. E	6458 etc. - Hare's old mill	9498 - Corinth, 10 1/4 mi. SE	6461 - Burnsville, 2 mi. NW
Coelenterata:												
Cliona? sp.						X						
Vermes:												
Serpula lineata (Weller)							X					
S. cretacea (Conrad)									X			
Hamulus onyx Morton							X					
H. squamosus Gabb var.						X						
Mollusca:												
Pelecypoda:												
Nucula aff. N. percrassa Conrad							X	X				
N. aff. N. stantoni Stephenson									X			
N. cf. N. perequalis Conrad									X			
Idonearca aff. I. carolinensis Gabb									X	X		X
I. antrosa (Morton)											X	
I. aff. I. wadei (Imlay)							X	X				
Gervilliopsis aff. G. ensiformis (Conrad)										X		
Ostrea plumosa Morton	X	X	X	X					X			
O. sloani Stephenson	X				X							
O. falcata Morton				X								
Gryphaea mutabilis Morton					X	X						
G. convexa (Say)	X	X			X	X						
Gryphaeostrea vomer (Morton)	X			X	X	X						
Exogyra ponderosa Roemer	X	X			X	X	X	X				
E. ponderosa erraticostata Stephenson							X					
E. aff. E. upatoiensis Stephenson										X		
Trigonia n. sp.								X	X	X	X	
Pecten (Camptonectes) aff. P. (C.) bellisculptus Conrad										X		
P. (C.) aff. P. (C.) berryi Stephenson							X					
Lima reticulata Forbes					X	X						
L. aff. L. reticulata Forbes		X										
Anomia argentaria Morton	X			X	X							
Paranomia scabra (Morton)		X		X	X	X	X	?				
Anatimya aff. A. anteradiata Conrad							X					
Cymella cf. C. ironensis Stephenson							X					
Veniella conradi (Morton)						X			X			X
Etea carolinensis Conrad						X			X	X		
E. aff. E. carolinensis Conrad							X					
Crassatella sp.							X	X	X	X	X	
Brachymeris carolinensis (Conrad)							X					
Cardium (Trachycardium) carolinense Conrad?			X									
C. (Granocardium) aff. C. (G.) alabamense (Gabb)							X		X			
C. (G.) aff. C. (G.) dumosum (Conrad)										X		
C. (Pachycardium) aff. C. (P.) spillmani Conrad			X									X
Aphrodina regia Conrad												X
Cyprimeria aff. C. alta Conrad							X	X	X			
Linearia aff. L. metastriata Conrad							X					
Corbula crassiplica Gabb							X		X			X
Panope aff. P. decisa Conrad										X		
Scaphopoda:												
Dentalium aff. D. ripleyanum Gabb							X					
Cadulus aff. C. obnutus (Conrad)									X			
Gastropoda:												
Acmaea cf. A. occidentalis (Hall and Meek)							X					
Polinices rectilabrum (Conrad)							X					
Gyrodes supraplicatus (Conrad)							X					
G. aff. G. abyssinus (Morton)								X				
G. aff. G. alveatus Conrad							X					
Laxispira sp.							X					
Turritella trilira Conrad							X	X		X		
T. quadrilira Johnson							X	X	X	X		
Anchura? aff. A.? lobata Wade							X					
Morea cf. M. cancellaria Conrad							X					
Drilluta? aff. D.? major Wade							X					
Pseudoliva? cf. P.? attenuata Wade							X					
Odontofusus sp.							X					
Haplovoluta sp.							X					
Cephalopoda:												
Eutrephoceras sp. (small)							X					
Baculites sp.									X			
Placenticeras aff. P. planum Hyatt										X		
Mortoniceras sp.										X		
Vertebrata:												
Shark teeth	X											

The numbers are the collection numbers of the U. S. Geological Survey; the collections are in the U. S. National Museum.

LOCAL DETAILS

LEE AND ITAWAMBA COUNTIES

The merging and intertonguing relationships of the Coffee sand in northeastern Lee County to the Selma chalk in the southeastern part of the county, have been described under Selma chalk. The type exposure of the Tupelo tongue is in an abandoned cut of the Fulton road on the westward-facing slope of Old Town Creek Valley (Sec. 33, T.9 S., R.6 E.) 1 1/2 miles east of Tupelo.

SECTION IN ABANDONED PORTION OF THE FULTON ROAD, 1 1/2 MILES EAST OF TUPELO

	Feet
Coffee sand (Tupelo tongue)	
Weathered massive reddish ferruginous marine sand, grading downward into yellowish-green massive slightly glauconitic sand	30
Massive gray more or less calcareous, glauconitic sand with several widely separated ledges of calcareous sandstone. *Gryphaea convexa* (Say) abundant in a layer 15 to 25 feet below the top, and *Exogyra ponderosa* Roemer and *Gryphaea convexa* (Say) fairly abundant in a layer 10 feet below the top (Colls. 6453 and 6900); base about 10 feet higher than the bottom lands of old Town Creek	50
	80

From the preceding locality eastward for 1 1/2 miles, to a point about 3 miles from Tupelo, the hills are composed of the glauconitic sands of the Tupelo tongue and their weathered products. From 5 to 12 miles east of Tupelo the road is over the calcareous clays composing the northward-extending Mooreville tongue of the Selma previously described; however, weathered sands of the Tupelo tongue cap a high hill 7 1/4 miles east of Tupelo on U. S. Highway 78, half a mile west of Mooreville (Center S 1/2, Sec. 29, T.9 S., R.7 E.).

SECTION HALF A MILE WEST OF MOOREVILLE

	Feet
Coffee sand (Tupelo tongue)	
Fine angular yellow and red massive sand; altitude at top about 440 feet above sea level	7
Dark-gray flaky clay breaking in paper-thin flakes; considerable sand in lower part	15
Selma chalk (Mooreville tongue)	
Sandy, argillaceous chalk containing soft chalky fossil shells; appears to merge upward into the overlying clay	27
	49

On the Saltillo-Mantachie road 100 feet west of the Itawamba County line (NE.1/4, Sec. 27, T.8 S., R.7 E.) 3 feet of dark-gray plastic micaceous clay (Mooreville tongue of Selma chalk) is overlain by 10 feet of micaceous red sand (Tupelo tongue of Coffee sand).

Reddish weathered marine sands of the Tupelo tongue are exposed in the Plantersville road from the point where it leaves the Fulton road, 1 1/2 miles east of Tupelo, to Plantersville, a distance of 5 miles. About 2 1/2 miles northwest of Plantersville a roadside exposure at the foot of a slope with base about level with the flat lands bordering Old Town Creek reveals 15 feet of massive gray calcareous, argillaceous sand (Tupelo tongue) containing *Exogyra ponderosa* Roemer, *Ostrea plumosa* Morton, and *Paranomia* sp. Similar sand, with *E. ponderosa* Roemer, appears in the same slope 35 to 45 feet above the base, above which, to the top of the hill 75 feet higher than the base, are weathered reddish sands.

Coffee sand not far above the Mooreville tongue is exposed on a northwestward-facing slope overlooking Tulip Creek on a local road a few hundred feet east of Mississippi Highway 6 (Sec. 10, T.10 S., R.6 E.), 1 1/2 miles north of Plantersville. Twenty-seven feet of fossiliferous, very calcareous dark-gray micaceous sand resembling impure chalk, containing *Exogyra ponderosa* Roemer and other common fossils, merges upward into fine angular-grained massive micaceous yellow sand containing some small grains of glauconite.

Farther east (Sec. 11, T.10 S., R.6 E.) on a road that goes to Tombigbee State Park, a layer of chalky, micaceous hard sandstone 3 to 5 feet thick is exposed at several places. Similar material at about the same stratigraphic position is exposed 5 miles to the north-northeast in a road cut (SW.1/4, Sec. 18, T.9 S., R.7 E.); it consists of 8 feet of soft yellow and gray fine micaceous, glauconitic, calcareous sandstone (almost a sandy, argillaceous chalk) and contains *Exogyra ponderosa* Roemer, *E. ponderosa erraticostata* Stephenson, and a few phosphatic molds of gastropods.

The road from Tupelo to Ratliff, for the first 7 miles, traverses hills of moderate relief (60 to 75 feet), composed chiefly of the glauconitic sands of the Tupelo tongue, as indicated by the dull-red and brownish residual products exposed in shallow road cuts. On a steep westward-facing slope, 6 7/8 miles from Tupelo, a ledge of fossiliferous gray calcareous, glauconitic sandstone a foot thick crops out in the midst of greenish-gray partly weathered sand, about 15 feet above the bottom land of a small creek; *Exogyra ponderosa* Roemer and a few other fossils were observed.

On the hill northeast of the preceding, waxy, sandy, calcareous clay, with *Exogyra ponderosa* Roemer, representing the northward-extending Mooreville tongue of the Selma, is poorly exposed in bald spots on the slopes about 40 feet above the creek bottom.

For the next mile the gradually ascending road is over the waxy clay. Eight miles northeast of Tupelo the upper part of a hill, whose summit is about 90 feet higher than the previously mentioned creek bottom, presents the following section:

SECTION IN RATLIFF ROAD, 8 MILES NORTHEAST OF TUPELO

	Feet
Greenish-gray argillaceous, more or less calcareous sand, with a discontinuous concretionary layer of calcareous sandstone 10 to 12 inches thick about midway of the layer	15
Greenish-gray waxy calcareous clay possibly representing a minor tongue of the Mooreville tongue	6
	21

In the next half mile to the northeast the upper parts of the hills, which rise somewhat higher than the preceding, are composed of the noncalcareous argillaceous sands and sandy clays of the Coffee sand. About 9 miles from Tupelo where the road descends a slope, the waxy calcareous layer noted in the preceding section is poorly exposed beneath about 40 feet of Coffee sand; the clay is about 20 feet thick and is in turn underlain by greenish-gray calcareous, argillaceous sand of Coffee aspect.

In the next 2 miles only the weathered sands and sandy clays of the Coffee were seen. A quarter of a mile northeast of the site of old Eggville, which is 11 miles from Tupelo, the road cuts near the crest of a high hill, which affords a view far to the eastward, reveal the following section:

SECTION IN RATLIFF ROAD, 11 1/4 MILES NORTHEAST OF TUPELO

	Feet
4. Massive greenish-gray argillaceous, glauconitic sand, with a discontinuous ledge of greenish-gray calcareous, micaceous sandstone 10 inches thick about 5 ft. above the base	35
3. Greenish-gray very argillaceous, calcareous sand containing *Ostrea plumosa* Morton	6
2. Very dark-gray compact argillaceous, slightly glauconitic sand containing near the base poorly preserved specimens of *Hamulus squamosus* Gabb and other common fossils	8
1. Lighter greenish-gray massive glauconitic, calcareous sand, containing a few fossil shells and internal molds	6
	55

Layer 3 of this section has the aspect of the greenish waxy clay of the Mooreville tongue of the Selma. The other layers are characteristic sands of the Coffee. Down the slope below the base of the section the road reveals weathered marine sand of Coffee aspect.

Within the next 3 miles to the northeast the road appears to be underlain chiefly by clays which become sticky in wet weather. Throughout the rest of the distance to Ratliff, which is 18 miles from Tupelo, the road bed is in general more sandy, but no good exposures were seen.

The facts noted in the preceding paragraphs seem to indicate that the Mooreville tongue of the Selma merges toward the north into the Coffee sand by a series of minor interlocking tongues of calcareous clay and glauconitic sand.

A bed of sand whose stratigraphic position is lower than that of the Arcola limestone member of the Selma chalk, is exposed in a road cut on the northward-facing slope of Mantachie Creek Valley (Center S.1/2, Sec. 9, T.8 S., R.7 E.) 2 miles due west of Ratliff (Itawamba County). Here 15 feet of dark-gray micaceous, argillaceous sand, rich in well preserved molluscan shells (Colls. 17254 and 17809), is overlain by about 45 feet of reddish-yellow and tan micaceous nonfossiliferous sand.

On the road from Saltillo to Mantachie all exposures are of Coffee sand as far as the flood plain of Puncheon Creek at the Lee-Itawamba County line. In a road cut at a crossroad about 4 miles east of Saltillo (SW.1/4, Sec. 18, T.8 S., R.7 E.), fine micaceous yellow sand is overlain by dark-gray argillaceous, micaceous sand. A quarter of a mile west of Walnut Grove church (SW. 1/4, Sec. 22, T. 8 S., R.7 E.), a cut reveals alternating beds of thin-bedded micaceous gray sandy clay and cross-bedded light reddish-brown micaceous fine sand.

The diastem above the Arcola limestone member of the Selma chalk may be represented at the base of bed 5 in the section exposed in a road cut on the northeastward-facing slope of Puncheon Creek Valley (Sec. 17, T.8 S., R.7 E.).

SECTION ON NORTHEASTWARD-FACING SLOPE OF PUNCHEON CREEK VALLEY

	Feet
Coffee sand	
9. Massive light-gray compact micaceous, sparingly glauconitic fine to very fine sand; contains a slightly indurated layer 21 feet above base; balls of iron pyrites common	45.0
8. Compact fine sand (like overlying bed) containing phosphatic nodules	0.5
7. Hard calcareous sandstone	0.5
6. Compact light-gray calcareous sand containing a few oysters and pebbles of phosphate	1.0
5. Compact calcareous sand containing abundant shells of *Exogyra ponderosa* Roemer. *Ostrea* sp., *Gryphaea* sp., phosphatic molds of mollusks, and a large piece of phosphatized bone	1.0
4. Compact light-gray sparingly glauconitic fine sand	3.0
3. Concealed by colluvium	5.0
(The part of the section described below is in a pit on east side of road at foot of hill)	
2. Stratified gray and brown, more or less ferruginous, highly glauconitic sand; bed 8 feet above base contains flakes of gray clay	20.0
1. Concealed to flood plain of Puncheon Creek	11.0
	87.0

About 4 1/2 miles east of Saltillo (SE.1/4 Sec. 18, T.8 S., R.7 E.), a six-inch bed composed of blocks and angular pebbles of bentonite is exposed in a ditch at the side of the road on an eastward-facing slope about 10 feet above the flood plain of Patch Creek. The altitude of this deposit is about 415 feet; that of the base of bed 5 in the preceding section is about 425 feet. Assuming a westward dip of 30 feet to the mile, the bentonite is, therefore, about 20 feet above the base of bed 5. This bentonite deposit appears to be at about the same stratigraphic position as that near Booneville. These correlations, although admittedly based on insufficient evidence, suggest that the bentonite near Booneville is stratigraphically a few feet above the horizon of the Arcola limestone.

South of Tupelo the Coffee sand appears to merge into chalk both toward the south and toward the west, for on the tops of the hills east of Plantersville red weathered sand, presumably derived from the Coffee sand, is exposed, whereas between Old Town Creek and Verona and for at least a mile and a half north of the latitude of Verona there is no break between chalk correlated with the Mooreville tongue and the main body of the chalk. The chalk in this area is not so pure as that higher in the section and undoubtedly was affected by the currents which were transporting and depositing sand to the east and north. Sandy chalk equivalent to the Tupelo tongue of the Coffee sand, is exposed from 1 1/2 to 1 3/4 miles east of Verona. As one passes northward from Verona (Center Sec. 18, T.10 S., R.6 E.), the chalk merges laterally into sand. About 1 mile north (Center west edge of Sec. 7), 12 feet of hard chalk is exposed, containing a bed of flaky calcareous sandstone 4 feet above the base. All of the chalk in this exposure is probably represented by sand in a cut on U. S. Highway 45 and in outcrops in the hills to the west of the road, on the northward-facing slope of Kings Creek Valley (Sec. 31, T.9 S., R.6 E.), half a mile south of the St. Louis-San Francisco Railway crossing.

SECTION ON NORTHWARD-FACING SLOPE OF KINGS CREEK VALLEY, U. S. HIGHWAY 45

	Feet
Selma chalk	
Very argillaceous, sandy, micaceous chalk; base not well exposed; contains *Exogyra ponderosa* Roemer, and other common fossils	15.0
Coffee sand (Tupelo tongue)	
Light-brown calcareous, argillaceous, glauconitic, sparingly micaceous sand containing a few small marcasite concretions (Coll. 17260)	20.0
Sandstone perforated by borings	0.5
Light-brown fossiliferous sand	6.0
Hard gray calcareous sandstone	3.0
Gray calcareous sand weathering into coffee-colored calcareous, micaceous, glauconitic sand	9.0
Hard calcareous brown sandstone	0.5
Weathered brown sand; to flood plain	10.0
	64.0

Half a mile southwest of the courthouse at Tupelo large numbers of fossils including *Hamulus onyx* Morton, *H. squamosus* Gabb, *Gryphaeostrea vomer* (Morton), many large specimens of *Exogyra ponderosa* Roemer, *Paranomia scabra* (Morton), *Legumen* sp. and *Xenophora* sp., are scattered on the surface soil of gray calcareous sand on a hill south of, and about 35 feet above, a creek bottom. The stratum from which the fossils weathered is near the top of the Tupelo tongue of the Coffee sand, for weathered reddish-brown Coffee sand is poorly exposed on the slopes below and clay characteristic of the Selma is exposed in gullies on the slopes a few hundred yards to the west.

On the Verona road about a mile south of Tupelo large specimens of *Exogyra ponderosa* Roemer were noted in a ledge of calcareous sandstone that crops out a few feet above the base of the eastward-facing slope of Old Town Creek Valley; this bed may correspond to the fossiliferous sandstone at the base of the Selma between Tupelo and Guntown (Figure 29).

From Tupelo northward the contact of the Coffee sand and the Selma chalk is marked by a hard ledge at the base of the Selma, composed almost entirely of the shells of *Gryphaea* and *Exogyra*. Several exposures are described in the section of this report treating of the Selma chalk in Lee County.

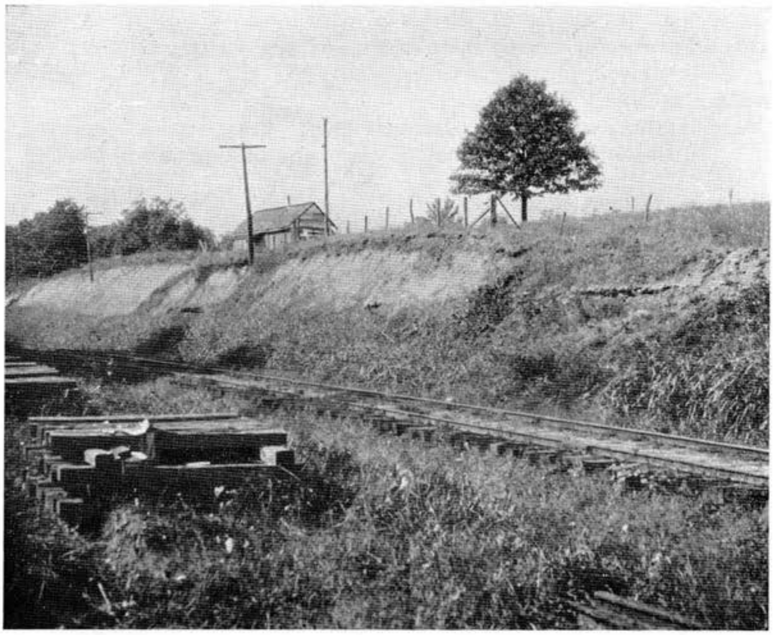

Figure 29.—Coffee sand overlain by Selma chalk; cut of Mobile & Ohio Railroad, north of the station at Guntown, Lee County. The prominent ledge of calcareous sandstone which marks the base of the Selma chalk contains great numbers of Gryphaea convexa (Say). Photo by L. W. Stephenson.

Between Tupelo and Guntown the Mobile & Ohio Railroad is east of the main body of the Selma chalk, but at the latter town, which is on the divide between Old Town and Twentymile creeks, the chalk extends eastward for about 2 miles beyond the railroad. The conformable contact between the Coffee and Selma is clearly exhibited in a cut just north of the station at Guntown (Figure 29).

SECTION IN CUT JUST NORTH OF GUNTOWN

	Feet
Selma chalk	
Residual yellow sandy, calcareous clay	7
Dark-gray finely sandy, calcareous, chalky clay full of shells (Coll. 6903)	5
Ledge of calcareous sandstone containing many shells (Coll. 6904) 1/2 to	1
Coffee sand	
Yellow rather loose calcareous sand	5
Gray massive argillaceous, micaceous sand	4
	22

The hills west of the railroad at Baldwyn are composed mainly of the weathered products of the Coffee sand, although patches of Selma chalk form thin cappings on their tops in the western edge of town. Within a mile west of town along the New Albany road are several cuts in which more or less weathered Coffee sand is well exposed, and in one of them the poorly preserved tubes of *Halymenites major* Lesquereux are abundant. The first exposure of the Selma chalk along this road is in the lower eastward-facing slope of Okeelala Creek, 2 miles west of town.

Weathered sands and clays of the Coffee sand are poorly exposed in the Kirkville road, about 1 1/2 miles east of Baldwyn, in an escarpment separating Twentymile Creek bottom from a Pleistocene terrace that lies about 30 feet higher. The Kirkville road traverses the terrace plain to a point about 6 miles southeast of town where, in a slope leading up from a shallow branch valley cutting the plain to the higher hills to the east, the following section is exposed:

SECTION IN KIRKVILLE ROAD, 6 MILES SOUTHEAST OF BALDWYN

	Feet
Coffee sand	
Mottled gray, yellowish and brownish harsh fine argillaceous sand	10
Fine pinkish, reddish, and yellowish sand, with fine clay films	8
Yellowish and brownish coarse loose sand, with interbedded lenses of gray sandy clay	7
Dark-gray compact argillaceous, glauconitic sand showing fine lamination where weathered; weathered to yellow in the upper two feet; contains prints of fossils	8
	33

Between this locality and the East Fork of Tombigbee River (via Kirkville), the surface presents smoothly rounded hills none of which rise more than 60 feet above the terrace plain mentioned above, nor more than 70 or 80 feet higher than the bottom lands of the river. The soils and subsoils are reddish weathered sands and yellowish and reddish clays derived from underlying marine sands and clays of the Coffee sand and of the Eutaw formation. Several localities are of interest.

Between 8 and 9 miles southeast of Baldwyn weathered greenish-gray clay was observed poorly exposed in the road ditches, and from here to Kirkville, which is 11 miles from Baldwyn, clay seems to predominate in the soils. This clay is probably in the transitional zone between the Coffee sand and the equivalent Mooreville tongue a few miles farther south.

Just east of Kirkville on the road leading to Spencer's store a cut reveals about 15 feet of massive greenish-gray fine glauconitic sand with a ferruginous layer showing faint lamination about midway of the section. Poorly preserved tubes of *Halymenites major* Lesquereux are abundant below the ferruginous layer. About 25 feet of similar glauconitic sand with *Halymenites major* was observed a mile east of Kirkville at the crest of the eastward-facing slope of Meadow Creek. These sands are probably the Tombigbee sand member of the Eutaw formation.

The logs of three wells at Tupelo (48, p. 288; this report under Selma chalk, Lee County) that penetrate the Tupelo tongue of the Coffee sand show the tongue to be about a hundred feet thick.

PRENTISS COUNTY

The Coffee sand crops out in a belt 8 to 10 miles wide extending approximately south-southwest across Prentiss County, the western edge of which is marked by the Mobile & Ohio Railroad. The eastern feather edge of the formation, resting on the Tombigbee sand member of the Eutaw formation, extends from near the northeastern corner of the county to the westward-facing slope of Donivan Creek at the south edge of the county.

The contact of the Eutaw formation and the Coffee sand is exposed in a road cut on the northeastward-facing slope of Youngs Creek Valley, Sec. 9, T.6 S., R.8 E.

SECTION ON NORTHEASTWARD-FACING SLOPE OF YOUNGS CREEK VALLEY

Coffee sand	Feet
Gray very finely glauconitic and micaceous very fine-grained sand weathering in upper part to streaked red, yellow, and gray sand; contains thin, lens-like partings of gray very finely sandy clay	18.0
Dark gray blocky, compact very finely sandy and micaceous shale-like silt containing prints of fossils; some parts contain abundant fine glauconitic sand and are rich in very soft fossil shells belonging to many genera; contains concretions of dark-gray sandy limestone, many of which have specimens of *Placenticeras* sp. in center; becomes coarser toward the base. About 10 feet above the base is a thin bed of phosphatic molds of mollusks and immediately below this bed is a zone rich in *Trigonia* sp. (Coll. 17783). The contact with the underlying Tombigbee sand is very indistinct; the only evidence of a break in deposition is the presence of the phosphatic molds, but the lower part of the Coffee sand contains species of fossils unknown in the Tombigbee sand	32.0
Eutaw formation (Tombigbee sand member)	
Massive gray highly glauconitic sand weathering light brown; this sand is somewhat lighter in color than the overlying Coffee	6.5
Hard calcareous, glauconitic fine-grained sandstone	1.5
Massive light-brown glauconitic sand (Coll. 17782)	8.0
	66.0

On the Baldwyn road about 2 miles southwest of Marietta approximately 30 feet of weathered greenish-gray finely sandy marine clay, near the base of the Coffee sand, appears in a roadside exposure.

On the road to Hare's old mill site on Big Brown Creek, 6 miles east of Booneville, the following section is exposed in a road cut (Figure 30):

SECTION IN PUBLIC ROAD 6 MILES EAST OF BOONEVILLE

Coffee sand	Feet
Weathered reddish, yellowish, and greenish, finely micaceous sand, residual from marine sand	20
Dark-gray compact finely micaceous, glauconitic sand, poorly exposed except in the lower 10 feet; well preserved, soft shells were collected in the lower 5 feet (Colls. 6454, 6909, 9501)	25
	45

At Hare's old mill site on Big Brown Creek, 9 miles east of Booneville, the upper 30 feet of the 80-foot exposure on the steep hill east of the creek is referred to the Coffee sand; the contact with the underlying Tombigbee sand was not observed. An 8-foot ferruginous layer with its base about 50 feet above the bed of the creek contains numerous internal and external molds of fossil shells, the sculpture of which is well preserved (Colls. 6458, 6910, 9502).

On the Iuka road (via Altitude) 13 miles east by north of Booneville, the westward-facing slope of a branch tributary to Big Brown Creek reveals the following section:

Figure 30.—Massive fossiliferous marine sand near the base of the Coffee sand; road to Hare's old mill site, 6 miles east of Booneville, Prentiss County. Photo by L. W. Stephenson.

SECTION IN IUKA ROAD, 13 MILES EAST BY NORTH OF BOONEVILLE

Coffee sand	Feet
Weathered reddish and brownish micaceous sand	10
Greenish-gray compact micaceous cross-bedded sand, with yellow and purple streaks, and with several thin layers of drab laminated clay; contains numerous crusts of ferruginous sandstone	15
Dark-gray compact argillaceous, micaceous sand	3
Partly weathered light greenish-gray massive, compact micaceous sand	8
Dark-gray compact very micaceous finely laminated sand	5
	41

Bay (57, pp. 28-31) has described three deposits of bentonite in the Coffee sand in Prentiss County. He states:

"Three deposits of bentonite were noted in Prentiss County—(1) on the farm of S. H. Wroten, in Sec. 36, T.5 S., R.7 E.; (2) in the NE.1/4, 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 deposits of bentonite in Prentiss County occupy a topographically high position and are within the upper half of the Coffee sand. A correlation with the Selma chalk above the Arcola limestone member is suggested in a local detail of Lee County.

The cut of the Mobile & Ohio Railroad south of the station at Booneville reveals only the Selma chalk, but the lowest bed in a deep ditch at a culvert just south of the cut is near the base of the formation, for the headwater branches of Boyer Creek have cut down into the underlying Coffee sand, a few hundred yards south of the cut. The best section examined is in the westward-facing bluff of a small branch about three-fourths of a mile south of the station.

SECTION IN BLUFF OF SMALL BRANCH THREE-QUARTERS OF A MILE SOUTH OF BOONEVILLE

Coffee sand	Feet
Brown sandy loam	2
Weathered brown slightly indurated sand	4
Stratified loose yellow glauconitic sand	5
Compact laminated dark-gray finely micaceous, glauconitic sand and clay, containing occasional small pieces of lignite	7
Dark-gray compact finely micaceous, slightly glauconitic sand, in part massive and in part finely laminated; poorly exposed in the lower 2 feet	16
Harder layer of massive greenish-gray finely micaceous, slightly glauconitic sand; forms the bed of the branch	1
	35

Several chunks of calcareous concretionary sandstone loose at the foot of the bluff were probably derived from the second layer above the base, and from these concretions were collected a few poorly preserved fossils (Coll. 6907).

Southwest of Booneville the Geeville road traverses the Selma chalk to a point 2 1/2 miles from town where, near the base of the westward-facing slope of a small branch, the basal layer of the Selma chalk, a calcareous sandstone about a foot thick, forms a poorly exposed ledge in the road ditch; the sandstone probably corresponds to the prominent fossiliferous ledge in the cut at Guntown (Figure 29). Beneath the sandstone appears 6 or 8 feet of rather loose light-colored sand, the upper part of the Coffee sand.

West of the preceding locality the Blackland road is over brownish weathered sands of the Coffee to a point about 3 3/4 miles from Booneville, where the stiff yellow residual clay of the Selma again appears.

South of Booneville in Prentiss County the Mobile and Ohio Railroad traverses the belt of outcrop of the Coffee sand, the eastern edge of the Selma being one-half to 3 miles west of the track. North of Booneville this railroad is also on the Coffee, but it is nearer the eastern margin of the Selma. The contact of the Coffee sand with residual material from the overlying Selma may be seen at several places along U. S. Highway 45 (SW.1/4, Sec. 27, T.4 S., R.7 E.) as on the northward-facing slope of a branch of Kings Creek.

SECTION ON U. S. HIGHWAY 45, 3 1/2 MILES NORTH OF BOONEVILLE

	Feet
Selma chalk (?)	
Light-tan sandy silt, questionably residual from chalk	10
Coffee sand	
Medium-grained sand containing clay balls	10
Fine sand containing tubes of *Halymenites major* Lesquereux	5
	25

The Coffee sand was found to be about 240 feet thick in a well at the old waterworks plant in Booneville (48, p. 402). Minor changes were made in the correlation of this log by the present writers, and it is now suggested that the well reached the Tombigbee sand member of the Eutaw formation at a depth of 312 feet.

ALCORN AND TISHOMINGO COUNTIES

The Coffee sand crops out in a belt about 10 miles wide in the eastern third of Alcorn County and in the extreme western part of Tishomingo County. The formation consists of cross-bedded sand and thin-bedded sand and clay.

Some of the best exposures of the Coffee sand are in cuts on the Southern Railway and on the Illinois Central Railroad, in Alcorn and Tishomingo counties.

Section in cut of Southern Railway, 2 miles northwest of Burnsville (Coll. 6461)

Coffee sand	Feet
Brown ferruginous sand	4
Light-gray massive compact finely micaceous sand mottled with yellow, with a row of fossiliferous concretionary masses of ironstone at intervals in a layer 4 feet below the top	18
Dark-gray massive, micaceous, argillaceous sand	8
	30

Although the description just given does not agree exactly with Hilgard's description of a fossiliferous locality at a place known as Bell's Contract (11, p. 70) in Tishomingo County (Sec. 33, T.2 S., R.9 E.), that locality may have been identical with this one.

Section in cut of Southern Railway, 3 1/3 miles northwest of Burnsville

Coffee sand	Feet
Reddish and brownish massive ferruginous sand	14
Light-gray massive fine micaceous sand, mottled with yellow	11
Dark-gray compact massive slightly glauconitic, very micaceous sand, very argillaceous in the lower part, becoming less so above; contains scattered marcasite concretions of small size; one soft mold of *Gyrodes* noted	18
	43

A section similar to the preceding is revealed in a cut about 3 5/6 miles northwest of Burnsville.

Cuts of the Southern Railway within about 4 miles northeast of Glen, Alcorn County, afford good exposures of sand and clay of the Coffee sand, and the contact of the Coffee sand with the overlying Selma chalk is revealed in a cut about 3 miles southeast of Corinth (Coll. 6460b). As the same strata are better exposed in cuts of the Illinois Central Railroad which parallels the Southern Railway on the south, the details will be omitted here.

On the Illinois Central Railroad between Leedy (13 1/4 miles southeast of Corinth) and Stevensons cut 2 1/2 miles southeast of Corinth the Coffee sand is exposed in many cuts. Glauconitic sands predominate, though subordinate beds of laminated clay are not uncommon and scattered thin laminae of clay are present at nearly all exposures. These sands and clays are of marine origin, but their cross-bedded structure and loose texture indicate deposition in water shallower than that in which the Tombigbee sand was laid down.

A 50-foot cut just northwest of Leedy station reveals chiefly finely current-bedded micaceous fine sand; gray prevails below, mottled, however, with pinks and purples, and pinks and purples prevail above, shading into brownish-red at top. Horizontal stratification lines characterize the bedding. On the north side of the cut a surficial formation is represented by a few pebbles in the soil and subsoil on the top and slopes. On the south side, however, is an old erosion valley occupying the central part of the cut, filled in its deepest

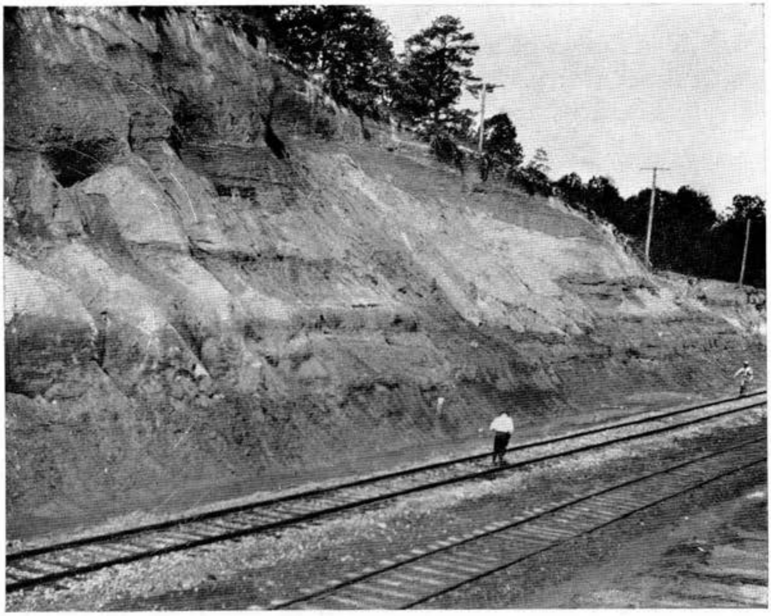

Figure 31.—Laminated sands and clays of the Coffee sand overlain (upper left hand corner) by surficial sand with pebbles and fragments of iron crust near base; cut of Illinois Central Railroad at Leedy, Tishomingo County. Photo by L. W. Stephenson.

part with harsh reddish-brown ferruginous sand containing a few pebbles and numerous fragments of ferruginous sandstone, especially in the lower few feet (Figure 31).

A cut at an overhead bridge 2 miles northwest of Leedy exposes about 25 feet of loose pinkish, yellowish, and reddish finely cross-bedded sand, with subordinate thin laminae and layers of clay; thin irregularly developed crusts of ferruginous sandstone are common in the upper part (Figure 32). *Halymenites major* Lesquereux preserved as limonitic tubes is common in some of the ferruginous layers. Near the bridge the Coffee sand is overlain by 15 to 20 feet of ferruginous surficial sand, with a basal pebble band 1 to 5 feet thick in which are numerous angular fragments of ferruginous sandstone mechanically derived from the underlying Coffee.

The loose grayish, yellowish, and brownish cross-bedded sands 10 3/4 miles southeast of Corinth exhibit a conspicuous development of ferruginous sandstone (Figure 33).

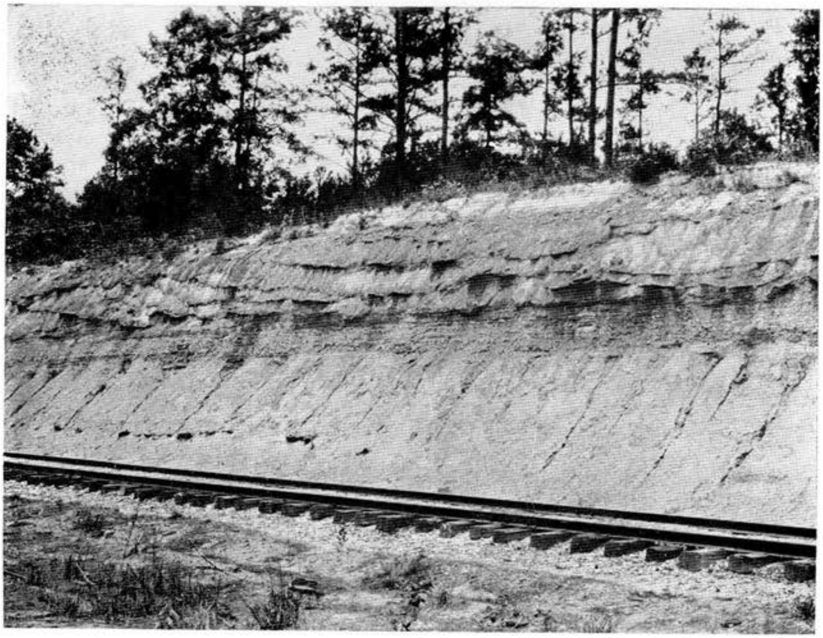

Figure 32.—Laminated sands and clays of the Coffee sand overlain by more massive sands with irregularly developed ferruginous sandstone plates; cut of Illinois central Railroad, 2 miles northwest of Leedy, in Alcorn County. Photo by E. W. Shaw.

A shallow cut 10 1/4 miles southeast of Corinth exposes 10 to 15 feet of reddish-brown massive ferruginous sand with an irregular concretionary layer of fossiliferous ferruginous sandstone about 8 feet above the base, overlain by 4 to 6 feet of pebbly surficial deposit. One tube of *Halymenites major* Lesquereux and a few fossil mollusks were collected from the sandstone (Coll. 9498).

SECTION IN CUT OF ILLINOIS CENTRAL RAILROAD 8 3/4 MILES SOUTHEAST OF CORINTH

Coffee sand	Feet
Weathered pinkish, yellowish, and brownish massive sand, about	15
Thinly laminated dark-gray clay, with thin interbedded layers of loose slightly glauconitic sand mottled with brown, yellow, and pink, containing some finely comminuted vegetable matter; clay predominates in the lower 10 feet (Figure 34)	25
	40

Figure 33.—Corrugated ferruginous sandstone of the Coffee sand; cut of Illinois Central Railroad, 10 3/4 miles southeast of Corinth, Alcorn County. Photo by L. W. Stephenson.

On the south side of the track a short distance northwest of the cut, a bed of compact, massive dark-gray finely micaceous, glauconitic sand, 5 feet thick, is exposed at the base of the bluff, the top of the layer being about 10 feet below the level of the track. A good spring emerges from above the sand.

About 8 1/2 miles southeast of Corinth a long cut, 35 feet deep, reveals fine loose finely current-bedded pinkish and yellowish slightly glauconitic sand, with numerous fine clay laminae, and with two conspicuous layers of laminated drab clay, one 4 or 5 feet thick near the base, and one 3 or 4 feet thick 10 to 14 feet above the base. The surficial deposit overlying the sand is 2 to 3 feet thick and contains a few scattered pebbles and numerous ferruginous concretions.

Thirty-five feet of loose gray and pinkish-tinted finely cross-bedded slightly glauconitic sand, with numerous thin laminae of gray clay, is exposed in a cut at an overhead bridge 7 3/4 miles southeast of Corinth; the surficial formation seems to be absent here.

Figure 34.—Laminated sands and clays of the Coffee sand; cut of Illinois Central Railroad, 8 3/4 miles southeast of Corinth, Alcorn County. Photo by L. W. Stephenson.

Between the bridge and Strickland (6 miles from Corinth) the glauconitic sands of the Coffee, with subordinate clay layers and laminae, appear in many cuts 10 to 25 feet deep, but the materials are for the most part weathered reddish and reddish-brown. In one cut 1 1/2 miles southeast of Strickland many tubes of *Halymenites major* Lesquereux are preserved in a friable sandy condition in a 2-foot layer just above the level of the track (Figure 35). In most of the cuts the Coffee is unconformably overlain by a few feet of the surficial deposit of the region, and several of the cuts within 2 miles of Strickland afford fine examples of old erosion hollows filled with this deposit (Figure 36).

Half a mile northwest of Strickland, a long cut, about 35 feet deep, reveals 25 or 30 feet of reddish-brown ferruginous sand having botryoidal ferruginous concretions and becoming laminated with thin streaks of clay at the base; in places where not so deeply weathered

Figure 35.—Cross sections of Halymenites major Lesquereux in the Coffee sand; cut of Illinois Central Railroad, 7 1/2 miles southeast of Corinth, Alcorn County. Photo by L. W. Stephenson.

the Coffee materials are light-gray. The sand is overlain by 6 to 8 feet of the surficial deposit. Similar weathered materials of the Coffee are in several other cuts between the one just described and Strickland, and good examples of the sand-filled cavities, described in subsequent paragraphs, are to be seen in places. A near view of one of the cavities, having a nest of pebbles in the bottom, is shown Figure 38.

A cut which is almost continuous from 3 3/4 to 4 1/2 miles southeast of the station at Corinth, exposes weathered facies of glauconitic Coffee sand in its lower 10 to 20 feet. At the southeast end of the cut the sand is underlain by a bed of dark-gray laminated clay, 5 or 6 feet thick, the top of which is about 2 feet above the level of the track. The clay is best seen in a ditch north of the track a short distance southeast of the cut. The sands of the Coffee are overlain by a few feet—a maximum of 15 feet—of the surficial deposit of the region

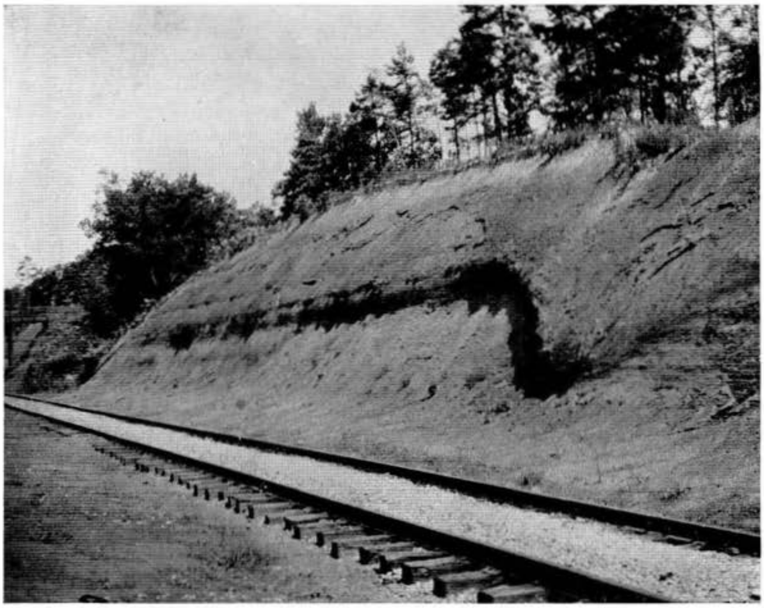

Figure 36.—Pliocene (?) erosion gully in the Coffee sand filled with surficial red ferruginous sand having an irregular band of gravel along the base; cut of Illinois Central Railroad, 7.3 miles southeast of Corinth, Alcorn County. Photo by L. W. Stephenson.

which, near the center of the cut, consists of mottled grayish, yellowish, and brownish argillaceous or loamy fine sand, becoming a dark loam at the top; at the base of the deposit are irregular accumulations of quartz and quartzite pebbles having a maximum thickness of 4 or 5 feet.

A phenomenon exhibited by the exposures in this cut (3 3/4 to 4 1/2 miles from Corinth station) is shown in Figure 37. Cavities 1/2 to 2 feet in diameter, some of which are branched, filled with leached gray sand, extend from the basal 2 or 3 feet of the surficial formation into the underlying glauconitic sand of the Coffee to a maximum depth of 6 or 7 feet. A few pebbles of quartz and quartzite are scattered through the gray sand, and in most of the cavities a number of pebbles are segregated at the bottom (Figure 38). As pebbles are wanting in the Coffee sand their source is the gravels of the surficial formation. Although some of the cavities decrease slightly in size with increasing depth most of them are of uniform diameter

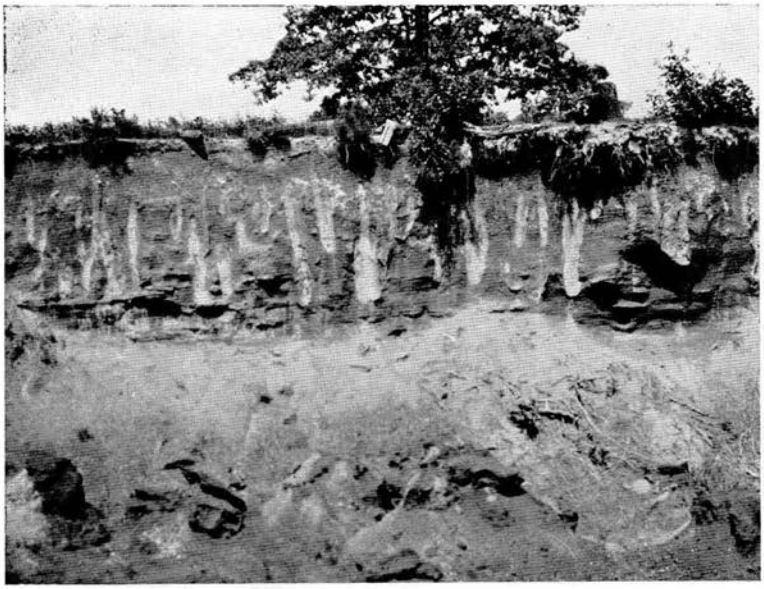

Figure 37.—Problematical filled pockets extending from surficial sands and gravels into underlying Coffee sand; cut of Illinois Central Railroad, 4 1/2 miles southeast of Corinth, Alcorn County. Photo by L. W. Stephenson.

to their lower bluntly rounded ends. Some are lined with a thin ferruginous crust; the walls are distinctly outlined in the basal part of the surficial deposit but become obscure above, nearer the surface, where they pass into the zone of deepest weathering. The sand-filled cavities are believed to have been produced by the roots of pine trees and subsequently filled by sand and pebbles falling in from above as the roots decayed or were burned out by forest fires. The bleaching of the sand may have been effected by the organic acids resulting from the decay of the wood.

In a cut 3 1/8 miles southeast of Corinth, 27 feet of weathered reddish-brown sand, with scattered thin laminae of clay of the Coffee sand, is overlain by 8 feet of surficial deposits consisting of fine reddish-brown loamy, rather harsh sand, with smoothly rounded quartz pebbles up to 2 1/2 inches in length, sparingly distributed in the lower 2 feet.

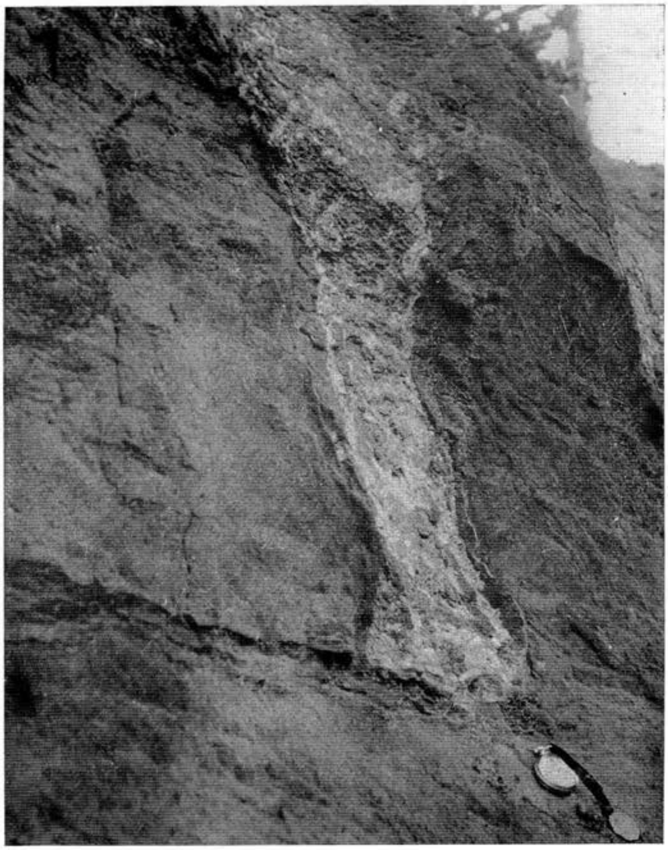

Figure 38.—Near view of a problematical pocket such as is shown in Figure 37, with pebbles segregated in the bottom; cut of Illinois Central Railroad, 6 miles southeast of Corinth (near Strickland), Alcorn County. Photo by L. W. Stephenson.

The uppermost beds of the Coffee sand and a few feet of the conformably overlying Selma formation are clearly revealed in Stevensons cut 2 1/4 to 2 3/4 miles southeast of Corinth station. The section is most complete near the middle of the cut where the succession of strata is as follows:

SECTION IN STEVENSONS CUT, ILLINOIS CENTRAL RAILROAD, 2 1/2 MILES SOUTHEAST OF THE STATION AT CORINTH

Selma chalk (impure facies)	Feet
5. Yellow finely arenaceous clay, mottled with gray, containing numerous small iron oxide concretions, and a few larger ferruginous masses of a concretionary nature, one foot or more in diameter; this layer is probably composed mainly of residuum resulting from the weathering of the underlying marl, but may include at the surface a foot or two of brown loam (loess); 10 to	20
4. Gray finely arenaceous, strongly calcareous clay (marl) becoming sandy and glauconitic toward the base, there being no sharp line separating it from the Coffee sand below; fossils are numerous in the marl (Coll. 9496); maximum exposed thickness	10
Coffee sand	
3. Reddish-brown partly indurated ferruginous, glauconitic sand, with corrugated ferruginous concretions along the base; fossils are numerous (Coll. 9497); the color is due to the oxidation of the glauconite; 6 to	9
2. Reddish-brown weathered glauconitic sand, with some clay, less indurated than the overlying bed and, where freshly exposed, mottled with gray and yellow; contains numerous irregular jutting masses of concretionary ferruginous sandstone	9
1. Massive compact dark-gray glauconitic sand with some streaks of clay, having an exposed thickness of 8 to	10

The description is based chiefly on the portion of the cut shown in the foreground in Figure 39. Toward the southeast from this place the basal portion of the residual clay (layer 5) merges into an indurated ferruginous band two feet thick, perforated with clay-filled vertical cavities 5 or 6 inches in diameter; this band which cuts diagonally across and bevels the unweathered marl of the Selma appears in Figure 39 and 40 as a distince broadly undulating slightly jutting ledge. The unweathered marl (layer 4) appears in the same picture as a light-gray band which pinches out toward the southeast between the overlying indurated layer and the underlying Coffee sand; the white spots on the gray band are fossil shells, chiefly *Gryphaea* and *Exogyra*. The Coffee strata in the same picture are gently and broadly flexed just beneath the southeast end of the gray band of unweathered marl of the Selma.

The contact between the Coffee and Selma, which is so well exposed on both the Illinois Central and Southern railroads, is also clearly exhibited on the Mobile and Ohio Railroad, 3 miles south of Corinth, where the railroad cuts the northward-facing scarp of Bridge Creek Valley.

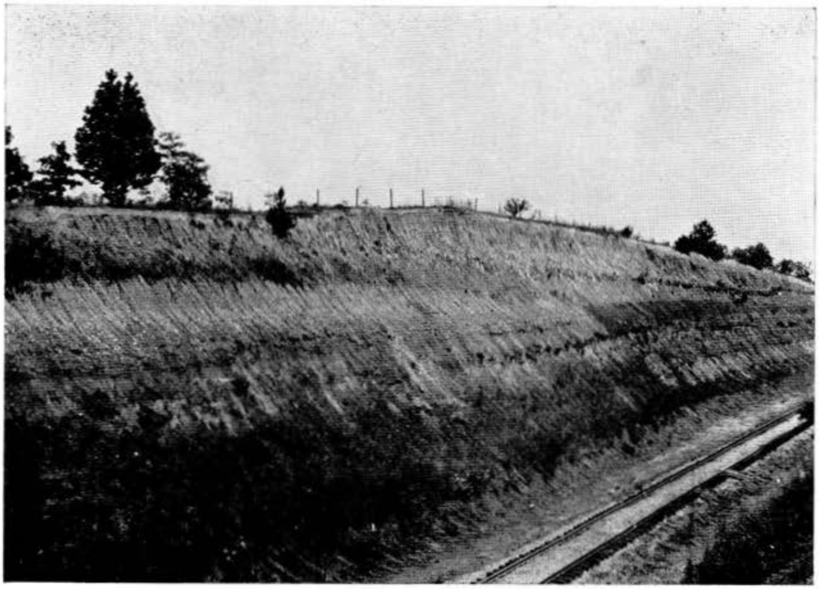

Figure 39.—Marine sand of the Coffee sand conformably overlain by Selma chalk, overlain in turn by residual clay and brown loam, the base of which is formed by the uppermost prominent indurated ferruginous ledge; Stevensons cut, Illinois Central Railroad, 2 1/2 miles southeast of Corinth, Alcorn County. The unweathered chalk appears on the left as a light-gray band above the midheight; it is dotted with white specks which are the shells chiefly of Exogyra ponderosa Roemer and Gryphaea sp.; to the right the chalk pinches out between the Coffee and the residual material. A slight flexure of the Coffee strata is clearly shown. Photo by L. W. Stephenson.

SECTION IN CUT OF MOBILE & OHIO RAILROAD, 3 MILES SOUTH OF CORINTH

	Feet
Selma chalk (impure facies)	
Yellow sandy loam with small ferruginous concretions, residual from the Selma	14
Gray sandy, calcareous clay, with fossil shells (Coll. 6913)	6
Coffee sand	
Coarse reddish-brown ferruginous, calcareous sand, partly indurated in the lower 2 feet; contains fossil shells (Coll. 6913)	4
Brown massive rather loose ferruginous sand	8
Dark greenish-gray massive argillaceous, glauconitic, slightly micaceous sand with occasional irregular ferruginous concretions produced by weathering	14
	46

There is no sharp line of demarcation between the Coffee and the Selma, the transition from the reddish sand to the calcareous clay being gradual; the line indicated is arbitrarily drawn.

Along the public road at Moores Park, 3 miles southeast of Corinth, strata of the Coffee, which underlie the uppermost massive beds of the formation, appear as described in the following section:

Figure 40.—General view of Stevensons cut, looking to the northwest. Photo by L. W. Stephenson.

SECTION AT MOORES PARK, 3 MILES SOUTHEAST OF CORINTH

Coffee sand	Feet
Yellow sandy clay containing numerous small round ferruginous concretions	15
Ledge of partly indurated ferruginous claystone	2
Weathered greenish-gray ferruginous clay, mottled with brown	8
Weathered dark-brown ferruginous sand with two partly indurated ledges near the base	15
Loose greenish-gray slightly glauconitic sand, with scattered thin laminae of drab clay	20
Dark-gray compact clay with some comminuted plant fragments, interbedded with greenish glauconitic sand laminae and pockets; base about 8 feet above the bottom land of a nearby creek	3
	63

At Corinth the combined thickness of the Coffee sand, the Eutaw formation, and the Tuscaloosa formation (if present) is only 300 feet or less as indicated by the logs of two wells (48, pp. 70, 71). The Tuscaloosa may be wanting there, as it is in parts of Tishomingo County where, especially in the north, the Eutaw formation is also much thinner than it is farther south.

RIPLEY FORMATION

GENERAL FEATURES

NAME

The name Ripley group was first used by Hilgard (11, pp. 83-95) and was intended to apply to all the strata in Mississippi included between the top of the "Rotten Limestone" (Selma chalk) and the base of the overlying Tertiary deposits. As described, however, the formation included at its top a few feet of limestone and overlying fossiliferous sand and clay now known to be the base of the Midway group (Paleocene) of the Tertiary; this error was corrected by Harris (16, pp. 18-25) in 1896. Thirty-five or 40 feet of argillaceous, glauconitic sand and sandy clay exposed in the bluffs of Owl Creek, 2 1/2 miles northeast of Ripley, were informally designated Owl Creek marl by Hilgard and were included by him in his Ripley group. These beds are now known to be separated from the beds below by an unconformity, and are treated as a separate geologic unit under the name Owl Creek formation (61, pp. 808-809). The name Ripley is now restricted to that part of Hilgard's Ripley group which lies between the Owl Creek formation above and the Selma chalk below. Exposures half a mile east of Troy, Pontotoc County, on the eastward-facing slope of Tallabinnela Creek Valley, are characteristic of the restricted Ripley formation, and there are excellent exposures in Chickasaw, Pontotoc, and Union counties.

The application of the name Ripley has been extended to include synchronous deposits in Tennessee, Kentucky, southern Illinois (30, pp. 17-19, 21) and Missouri (53, p. 1005). It is also used in Alabama and in western Georgia for a lithologically similar group of deposits which are essentially of the same age, but also includes deposits that are slightly older than any of the Ripley strata of Mississippi (63, pp. 1650-1651).

The name Ripley has also been applied to deposits in North Carolina, New Jersey, and Texas, that are in each case at least in part of Ripley age, but this wide application of the term has tended to looseness in correlation, and has not been sanctioned by subsequent usage.

AREAL DISTRIBUTION

The Ripley formation crops out in Mississippi in a belt extending from the Tennessee State line, where the width is nearly 17 miles, toward the south with decreasing width through parts of the counties of Alcorn, Tippah, Prentiss, Union, Pontotoc, Chickasaw, Clay, and Oktibbeha, finally ending as such in the northwestern part of Noxubee County. The area is bordered on the east by the Selma chalk and on the west in part by the Prairie Bluff chalk and in part by the Owl Creek formation (Plate 1A).

From Mississippi the area of outcrop extends toward the north as a belt 5 to 20 miles wide, through Tennessee and Kentucky, to the head of the Mississippi Embayment in the southern part of Illinois and in Crowleys Ridge in the southeastern part of Missouri. The deposits east of Mississippi, to which the name Ripley is applied, have their greatest width of outcrop (12 miles) on Chattahoochie River in Barbour County, Ala.

LITHOLOGIC CHARACTER AND THICKNESS

The Ripley formation is composed predominantly of marine sands and sandstones, though important beds of clay, more or less local in extent, are common, and some of the sandy beds are high enough in calcium carbonate to be termed sandy limestones. The maximum thickness of the formation has not been determined accurately, but in northern Tippah and Alcorn counties it is estimated to attain approximately 300 feet. The formation gradually becomes thinner toward the south until at its southern extremity in Noxubee County the thickness is probably about 50 feet. This thinning is probably due in part to a transgressive overlap of the Prairie Bluff chalk.

The sands and sandstones are fine to coarse, more or less micaceous, glauconitic, argillaceous, and calcareous, and range from loose sands through compact, partially indurated sands to hard sandstones; the latter as a rule calcareous in greater or less degree. In fresh exposures the colors range from white or light-gray to dark greenish- or bluish-gray. The strata range from thinly laminated to thick-bedded and the structure from finely cross-bedded to massive. The calcareous sands and sandstones are strongly developed in Chickasaw, Pontotoc, and Union counties, where they probably compose the bulk of the formation.

The clays are commonly laminated and are interbedded with partings and thin layers of micaceous sand. In fresh condition they range from light-gray or drab through dark greenish- or bluish-grays to nearly black. The laminated clays with their associated thin partings and laminae of fine micaceous sand have their greatest development in the base of the formation where they may be seen cropping out in the lower 40 or 50 feet of the eastern slope of the Pontotoc Hills. They appear to form a transition zone between the Selma chalk and the more typical Ripley sand and sandstone.

In eastern Tippah and in western Alcorn county the formation is partly represented by a great tongue of sand of shallow water origin, the southern extension of the McNairy sand member of the Ripley formation of Tennessee.

In general the Ripley strata weather reddish, brownish, and yellowish, the colors resulting chiefly from the oxidation of the iron which partly composes the mineral glauconite. Some of the iron dissolved in the zone of humic acids has been redeposited at lower levels within the limits of weathering, forming ferruginous concretions and platy ferruginous sandstones. The latter are not so conspicuously developed in the typical beds of the Ripley as they are in the Eutaw formation, but they are extensively developed in the McNairy sand member.

Marine fossils are common, and in places very abundant, in the typical beds of the formation, but are rare in the McNairy sand member, a subject more fully discussed below.

At the top of the Ripley in northern Chickasaw, Pontotoc, Union, and Tippah counties is a hard, cavernous bed of coarse sandy limestone from one to ten or more feet thick, that is a useful stratigraphic marker.

MCNAIRY SAND MEMBER

The McNairy sand member has its fullest development north of Mississippi in Tennessee, the type section being in the deep cut of the Southern Railway at the "Big Hill", 1 1/4 miles west of Cypress, McNairy County (30, pp. 17-18, 22). The member typically consists of irregularly bedded, noncalcareous, nonglauconitic sands, and subordinate clays, probably deposited chiefly in shallow marine waters within the range of strong waves and currents, though some of the materials were laid down in marginal swamps and some may have been deposited on low alluvial plains bordering the coast. The maximum thickness in Mississippi in northern Tippah County is estimated to be 225 or 250 feet.

The sands are coarse to fine, gray to varicolored, more or less micaceous, and range from finely to coarsely current-bedded. They

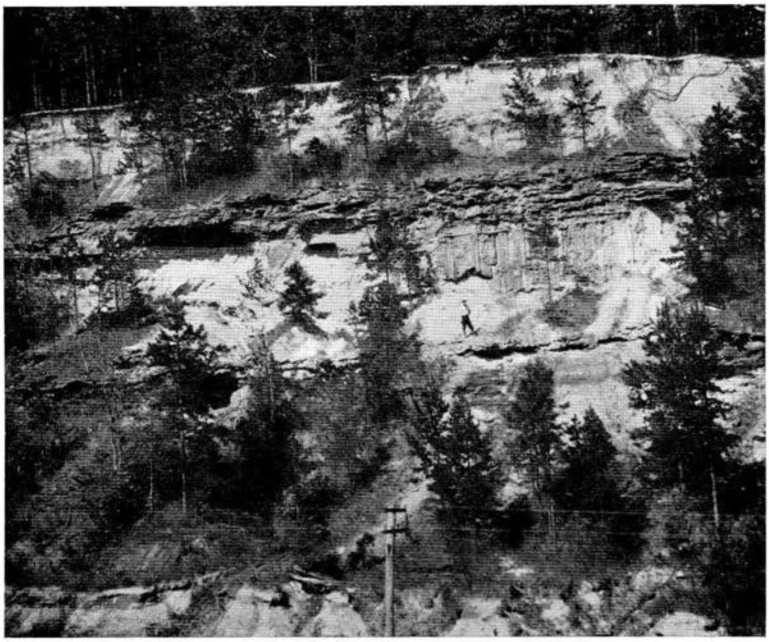

Figure 41.—Type locality of the McNairy sand member of the Ripley formation; cut of Southern Railway known as Big Hill, 1 1/4 miles west of Cypress, McNairy County. Shows two prominent layers of corrugated ferruginous sandstone. Photo by L. W. Stephenson.

are unconsolidated with the exception of more or less local ferruginous corrugated and tubular and platy sandstones, which are present at irregular intervals, but which constitute a diagnostic feature of the member in northern Mississippi and in McNairy County, Tenn.; one such ferruginous band 3 to 10 feet thick, is conspicuous in the type section (Figures 41 and 42). The locally developed lenses of clay are light or varicolored, or are dark-gray to black, due to their content of lignite or other carbonaceous matter. A short lens of black clay

8 or 10 feet thick with imperfect leaf impressions is intercalated in the sands at the base of the section toward the west end of the cut at the type locality.

In Mississippi the McNairy member forms a great wedge-shaped mass, the southern extremity of which tongues into the main body of the typical Ripley deposits in Tippah, Alcorn, and Union counties, where it is both underlain and overlain by northward extending

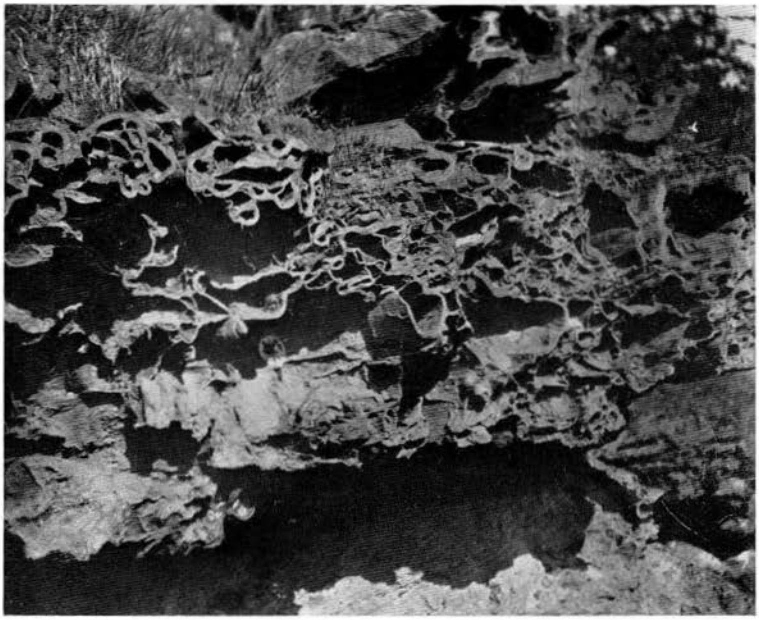

Figure 42.—Near view of a portion of the upper layer of ferruginous sandstone shown in Figure 41. Photo by L. W. Stephenson.

tongues of deeper marine invertebrate-bearing sands, clays, and marls. The lower or Coon Creek tongue extends toward the north through Tennessee nearly to the Kentucky line; the upper tongue (unnamed) thins toward the north and loses its identity by merging into the McNairy sand facies near the Tennessee State line.

STRATIGRAPHIC AND AGE RELATIONS

The Ripley formation in Mississippi and Tennessee rests with conformable relations on the Selma chalk. At most places in Mississippi where observations have been made the passage from the chalk to the overlying predominantly sandy deposits of the Ripley is marked by 40 or 50 feet of more or less sandy and calcareous laminated clay. The age of this transition band is nearly, though not quite, the same throughout its linear extent in the State. There is a slight upward transgression of the band across the geologic column from north to south in Alcorn County.

In Tippah County the Ripley formation is unconformably overlain by the Owl Creek formation. From the southern part of Tippah County southward the formation is unconformably overlain by the Prairie Bluff chalk which appears to be the exact age equivalent of the Owl Creek formation with which it intertongues. Toward the south the Ripley formation becomes more calcareous than in the northern part of the State and merges into the Selma chalk in the northern part of Noxubee County.

The McNairy sand member is conformably related to the typical beds of the formation.

The relations here described are graphically shown in Plate 2.

In Alcorn County small patches of brown loam were seen overlying the Ripley formation. These are remnants of the eastern feather edge of the great loess blanket that is extensively developed farther west.

PHYSIOGRAPHLC EXPRESSION

The predominantly sandy strata of the Ripley formation have produced a hilly topography, and the area of outcrop constitutes one of the most clearly defined physiographic divisions of the State. Different parts of the area have at different times, and more or less locally, been designated by different names, such as Hatchie Hills in Tippah and western Alcorn counties; Tippah Hills in Prentiss County; Buncombe Hills applied to a portion of east-central Union County, and Pontotoc Hills or Ridge applied to the area from Union County southward. In recent years the latter name, Pontotoc Hills, has come to be used for the whole area within the state, and this usage is followed in the present report. The belts of outcrop of the Owl Creek formation and of the Paleocene Clayton formation are included in the Pontotoc Hills. The elevations of the hills above sea level range from 350 feet in Oktibbeha County to nearly 800 feet in Alcorn, Tippah, Union, and Prentiss counties. The Pontotoc Hills are limited on the east by the Black Prairie belt underlain by the Selma chalk, which lies 50 to 400 feet lower than the crests of the ridges. Where the Prairie Bluff chalk is present it forms a narrow strip of prairie west of the Pontotoc Hills. Where this chalk is absent in

Union and Tippah counties the hills are bordered by the Flatwoods, which are underlain by the Porters Creek clay of the Midway; the Flatwoods range in elevation from 300 feet in Oktibbeha County to over 500 feet in Tippah County. In Union and Tippah counties the sandy strata of the Clayton and Owl Creek formations have caused a gradation in the topography from the lower plains of the Flatwoods on the west to the higher Pontotoc Hills on the east.

The Pontotoc Hills range in topographic aspect from hills of moderate relief (40 or 50 feet) with moderate slopes and broadly rounded crests, which prevail along the west side of the belt, to those of sharp outline and strong relief (150 to 250 feet) with steep slopes, narrow ridges, and narrow separating valleys, which are more characteristic of the eastern side of the belt. The latter have their maximum development in Union, Tippah, Prentiss, and Alcorn counties, particularly in the latter county in the area underlain by the McNairy sand member of the formation.

From northern Union County to northern Pontotoc County the Hills form the divide between the Tombigbee drainage system on the east and streams which flow to Mississippi River on the west. In Tippah and Alcorn counties the hills are drained chiefly by streams flowing north and forming the headwaters of Hatchie River, a tributary of the Mississippi in Tennessee. The southern end of the area is drained by tributaries of Tombigbee River.

FOSSIL CONTENT

The fossils of the Ripley formation are from the part of the *Exogyra costata* zone between the top of the *Exogyra cancellata* zone and the base of the Owl Creek formation and the Prairie Bluff chalk, except in northern Alcorn County where the base of the Ripley descends low enough to include the upper part of the *Exogyra cancellata* zone. The fossils are listed in the accompanying table by stratigraphic position, counties (from south to north), and localities. For the purpose of grouping the fossils in stratigraphic sequence the formation is divided roughly into lower, middle, upper, and topmost parts, although no sharp boundaries have been drawn between these parts. The topmost part is a hard sandy limestone.

The McNairy sand member of the formation has yielded fossil leaves in Tennessee (36, pp. 283-304) and is lignitic in places.

Both the typical Ripley deposits and the McNairy sand contain in some layers the peculiar tubes of *Halymenites major* Lesquereux, noted also in the Eutaw formation.

FOSSIL LOCALITIES IN THE RIPLEY FORMATION

17223.—Upper slope of hill in woods (SE. Cor., Sec. 13, T.12 S., R.3 E.), about 5 miles east of Houlka, Chickasaw County.

17201, 17256.—Quarry 450 feet southeast of crossing of the North Prong of Chiwapa Creek by the old Mississippi Highway 15 (NW.1/4, NW.1/4, Sec. 16, T.10 S., R.3 E.), 2 miles south of Pontotoc, Pontotoc County. Mary Neill and W. H. Monroe, collectors.

17799.—Road cut on L. T. Braddock's farm, southward-facing slope of Walnut Creek Valley (Sec. 16, T.3 S., R.4 E.), Tippah County.

6473.—Cut on eastward-facing slope of Houlka Creek Valley on Mississippi Highway 8 (SW.1/4, Sec. 2, T.14 S., R.3 E.), 2 miles east by south of Houston, Chickasaw County.

6469.—Bank of small stream at the south end of the wagon bridge on the Aberdeen road, 6 1/2 miles southeast of Pontotoc, Pontotoc County.

17276.—Roadside ditch on a local road on northeastward-facing slope of a branch of Browns Creek (NE.1/4, Sec. 21, T.7 S., R.4 E.), about 3 1/2 miles northeast of Wallerville, Union County.

6466a-g, 9522.—"The Caves" on the land of J. A. Roberts, 6 miles east by north of New Albany, Union County.

551.—Naber's Coal Bluff (Sec. 25, T.5 S., R.4 E.), near Dumas, Tippah County. L. C. Johnson, collector.

714.—Old Lander's (Medlin's) mill site on Cane Creek (S.1/2, Sec. 24, T.5 S., R.3 E.), 5 miles northwest of Molino and 9 miles south of Ripley, Tippah County. T. W. Stanton, collector.

544.—NE.1/4, Sec. 14, T.4 S., R.5 E., Tippah County, Miss. L. C. Johnson, collector.

6850.—Cut of Mobile and Ohio Railroad, 7 miles northeast of Houston, Chickasaw County.

17209.—Bob Miller Creek (?) at crossing of Mississippi Highway 6, 4 miles by road east of Pontotoc, Pontotoc County.

9508.—Cut in side of hill at bridge No. 5710 on St. Louis-San Francisco Railway over a branch of Cherry Creek, about 2 1/2 miles northwest of the station at Blue Springs, Union County.

18078.—Scraped area on north side of Pleasant Ridge Lake (NE.1/4, Sec. 11, T.6 S., R.4 E.), Union County. L. C. Conant, A. Brown, and W. H. Monroe, collectors.

6873, 17277.—Lee's old mill site on a headwater branch of Tallahatchie River (Sec. 17, T.6 S., R.4 E.), 1 1/2 miles northeast of Keownville, Union County.

712.—Bluff of small stream, 3 miles south of Molino, Union County. T. W. Stanton, collector.

711.—C. R. Hall's farm (Sec. 5, T.6 S., R.4 E.), near Molino, Union County. T. W. Stanton, collector.

709.—W. O'Kelly's farm, 2 1/2 miles south of Dumas, Tippah County. T. W. Stanton, collector.

Distribution of Ripley fossils

Species	Top: Chickasaw County, 17232 - Molino, 8 mi. S	Top: Pontotoc County, 17201 etc. - Pontotoc, 2 mi. S	Top: Tippah County, 17791 - Walnut Creek	Upper: Chickasaw County, 6377 - Houston, 3 mi. E	Upper: Pontotoc County, 6469 - Pontotoc, 4 1/2 mi. SE	Upper: Union County, 17778 - Wallerville, 5 1/2 mi. NE	Upper: Union County, 6464 etc. - New Albany, 8 mi. E	Upper: Tippah County, 561 - Dumas	Upper: Tippah County, 714 - Lowrey's mill	Upper: Tippah County, 544 - Ripley, 12 mi. E	Middle: Chickasaw County, 6152 - Houston, 7 mi. NE	Middle: Pontotoc County, 17102 - Pontotoc, 6 mi. E	Middle: Union County, 6608 - Blue Springs, 2 1/2 mi. NE	Middle: Union County, 18079 - [illegible] Ridge Lake	Middle: Union County, 6875 etc. - Lee's old mill	Middle: Union County, 712 - [illegible], 2 mi. W	Middle: Union County, 711 - [illegible]	Middle: Tippah County, 708 - Dumas, 2 1/2 mi. S	Middle: Tippah County, 544 etc. - [illegible] old mill	Lower: Oktibbeha County, 6008 - Starkville, 6 mi. SE	Lower: Pontotoc County, 6411 etc. - Troy	Lower: Tippah County, 6466 - Coon's old mill	Lower: Alcorn County, 6077 etc. - [illegible], 3/4 mi. NW
Coelenterata:																							
Micrabacia hilgardi Stephenson														X	X								
Echinodermata:																							
Hardouinia subquadrata (Conrad)		X	X					X															
H. porrecta (Clark)		X																					
Hemiaster [illegible] Lambert																					X		
Vermes:																							
Serpula lineata (Weller)														X									X
S. cretacea (Conrad)							X								X								
Hamulus onyx Morton														X	X		X	X	?		X	X	?
H. squamosus Gabb															X								
Mollusca:																							
Pelecypoda:																							
Nucula cuneifrons Conrad?																	X						
N. percrassa Conrad?																X	X		X				
N. percrassa Conrad var.														X	X								
Nuculana longifrons (Conrad)																	X	X	X			X	
Breviarca eufaulensis (Gabb)																X	X	X	X			X	
Glycymeris rotundata (Gabb)							?								?		X						
G. aff. G. rotundata (Gabb)									X						X	X			X				
Postligata crenata Wade														X	X								
Idonearca capax (Conrad)?															X								
I. littlei (Gabb)							X																
I. antrorsa (Morton)							X																
Limopsis cf. L. meeki Wade																							X
Pteria petrosa (Conrad)																							X
Ostrea plumosa Morton					X																		
O. tecticosta Gabb								X					X	X	X						X		
O. falcata Morton	X																						X
O. subspatulata Forbes?																		X					
Gryphaea mutabilis Morton					X						X										X		
Gryphaeostrea vomer (Morton)				X																X			
Exogyra costata Say (wide costae)				X																			X
E. costata Say (medium costae)				X			X				X			X						X			
E. costata Say (narrow costae)	X	X			X				X			X	X		X					X	X		
Trigonia eufaulensis Gabb							X								X	X							
T. cf. T. thoracica Morton						X																	
Pecten simplicius Conrad															X	X		X	X			X	
P. mississippiensis Conrad														X	X	X		X	X		X		X
P. (Camptonectes) sp.																	?		X				
P. sp. (with compound ribs)	X																						
Plicatula urticosa Morton				X																			
Lima acutilineata (Conrad)													X						X				
L. pelagica (Morton) var.															X						X		
L. reticulata Forbes															X	X			X	X	X		X
L. aff. L. reticulata Forbes																					X		
Anomia argentaria Morton					X		X						X	X	X	X	X		X	X	X	X	X
Paranomia scabra (Morton)																				X	X		
Crenella serica Conrad														X	X	X		X	X				X
Brachymodiola? tippana Conrad							X						X				X						
Liopistha protexta (Conrad)														X	X				X		X	X	
Cymella bella Conrad var.?																					X		
Veniella conradi (Morton)							X						X	X	X		X		?			X	X
Vetericardia crenalirata Conrad														X	X	X							X
V. cf. V. crenalirata Conrad																							X
Crassatella vadosa Morton						X								X	X								
C. pteropsis Conrad							X										X						
Cardium (Trachycardium) eufaulense Conrad							X		?					X	X		X		X				
C. (Granocardium) tippanum Conrad								X					?										
C. (G.) aff. C. (G.) kümmeli Weller							X							X	X				X				
C. (Pachycardium) spillmani Conrad							X		X				X				X		X		X		
Aphrodina tippana Conrad							X									X							
Cyprimeria alta Conrad													X										
C. depressa Conrad									X								X					X	
Legumen ellipticum Conrad							X								X		X	X	X				
Tenea parilis Conrad																	X		X		X		
Aenona eufaulensis Conrad															X	X	X	X	X			X	
Linearia metastriata Conrad?																							X
Leptosolen biplicatus Conrad							X										X	X	X			X	
Cymbophora appressa (Gabb)?																	X						
Corbula crassiplica Gabb														X	X			?					X
C. aff. C. crassiplica Gabb																X			X				
Scaphopoda:																							
Dentalium sp.														X	X								X
Cadulus sp.															X								X
Gastropoda:																							
Pseudomelania ripleyana Wade														X									
Calliomphalus americanus Wade														X									
Calliomphalus cf. C. argenteus Wade																							X
Urceolabrum sp.														X	X								
Discohelix? lapidosa Morton?																		X					
Hippocampoides? subplanus (Gabb)?																			X				
Creonella cf. C. triplicata Wade														X									X
Epitonium sillimani (Morton)?														X					X				
Rissoina? tennesseensis Wade														X									
Tuba? bella Conrad?															X								
Polinices rectilabrum (Conrad)														X	X		X	X	X				X
Gyrodes supraplicatus (Conrad)															X				X			X	
G. cf. G. spillmani Gabb													X						X				
Laxispira aff. L. lumbricalis Gabb																			X				X
Cerithiopsis meeki Wade																							X
Turritella vertebroides Morton						X									X							X	
T. tippana Conrad							X														?		
T. trilira Conrad							X	X	X					X	X		X	X	X				
Anchura abrupta Conrad															?				X				
Anchura? lobata Wade																			X				
A.? decemlirata (Conrad)?															X								
A.? aff. A.? decemlirata (Conrad)																X	X	X	X				
Pterocerella cf. P. tippana Conrad																		X					
Pugnellus densatus (Conrad)													?	X	X				X				
Pyropsis perlata Conrad?																		X					
Hercorhyncus tippanus (Conrad)														X	X								
Sargana stantoni (Weller)														X					X				
Morea cf. M. marylandica Gardner														X					X				
M. n. sp.																	X	X					
Seminola solida Wade														X									
Odontofusus curvicostatus Wade														X									
Pyrifusus subdensatus Conrad?															X			X	X	?			
Ornopsis cf. O. elevata Wade															X								
Liopeplum canalis (Conrad)?													X										
L. subjugosum (Gabb)?																	X						
L. leioderma (Conrad)																	X						
Drilluta ripleyana (Conrad)?																			X				
Drilluta? distans (Conrad)														X	X		X	X	?				
D.? laqueata (Conrad)																	X						
Paleopsephaea? pergracilis Wade														X									
"Mallia" melanopsis (Conrad)?															X				X				
Volutomorpha eufaulensis (Conrad)?																X			X				
V. turricula Dall																			X				
* V. dumasensis Dall															?	X			X				
Paladmete cancellaria (Conrad)															X			X	X				
P. cancellaria (Conrad), variety														X									
Ringicula pulchella Shumard														X	?		X						
R. aff. R. pulchella Shumard																		X	X				
Cephalopoda:																							
Eutrephoceras sp.					X								?						X				
Baculites tippahensis Conrad?																					X		
Nostoceras sp.																X	X						
Sphenodiscus lenticularis (Owen)							X																
S. lenticularis (Owen) var.			X																				
Belemnitella americana (Morton)										X			X								X		
Arthropoda (identified by Mary J. Rathbun):																							
Callianassa mortoni Pilsbry																					X		
Avitelmessus grapsoideus Rathbun					X													X	X			X	X
Rhachiosoma? n. sp.							X																
Vertebrata:																							
Shark teeth				X																			

The numbers are the collection numbers of the U. S. Geological survey; the collections are in the U. S. National Museum.

542, 708.—Bullock's old overshot mill (Sec. 36, T.5 S., R.4 E.), 2 miles south of Dumas, Tippah County. L. C. Johnson and T. W. Stanton, collectors.

6848.—Cut on Osborn road, 5 miles northeast of Starkville, Oktibbeha County.

6471, 17259.—Road cut on Shannon road, on eastward-facing slope of Tallabinnela Creek Valley, on section line between Secs. 15 and 22, T.11 S., R.4 E., 2/5 to 1/2 mile east of Troy, Pontotoc County.

6462.—Bluff on Hatchie River at Crum's old mill site, 16 1/2 miles northeast of Ripley at the Alcorn County line, Tippah County.

6877, 17234.—Cut of Southern Railway, about 3/4 mile northwest of Wenasoga and within 1/8 mile of Tennessee State line, Alcorn County.

LOCAL DETAILS

ALCORN COUNTY

The Ripley formation crops out over approximately the western half of Alcorn County. The lower typical marine beds (Coon Creek tongue) underlie an irregular belt 2 to 8 miles wide extending from west of the center of the southern boundary, north by east to the Tennessee line. The shallow marine beds of the McNairy sand member of the formation, which lie stratigraphically above the typical marine beds, appear at the surface throughout the remainder of the county to the west, forming a belt 6 to 9 miles wide.

A cut of the Southern Railway about three-quarters of a mile northwest of Wenasoga, and within about an eighth of a mile of the Tennessee State line exposes the following section:

SECTION IN CUT OF SOUTHERN RAILWAY, THREE-QUARTERS OF A MILE NORTHWEST OF WENASOGA

Ripley formation (Coon Creek tongue)	Feet
Residual yellow finely micaceous and sandy clay	5
Weathered light greenish-gray finely micaceous, calcareous clay with soft, poorly preserved shells, mostly small	21
Massive dark-gray finely micaceous, calcareous clay containing *Exogyra costata* Say, *Crenella serica* Conrad, *Corbula crassiplica* Gabb and other fossils (Colls. 6877 and 17234)	4
	30

Within 2 miles east of the preceding cut are several cuts 15 to 25 feet deep, which reveal fine greenish-gray micaceous, calcareous more or less weathered sands and clays of the Coon Creek tongue of the Ripley formation.

The localities just described in the vicinity of Wenasoga are near the base of the Ripley formation as developed in this area.

The characteristic rough hilly topography and strong relief produced by the McNairy sand member are well developed in a belt embracing a broad area east of Hatchie River and a narrower area west of it.

At Mathis High School, 6 miles southeast of Walnut (Tippah County), coarse corrugated ferruginous sandstone of this member, containing a few indistinct prints of fossil shells, crops out in the road in a steep slope 60 to 75 feet below the general upland level. Similar sandstone was observed at the crest of the westward-facing slope of a hill just east of Mathis Bridge over Hatchie River, 8 or 9 miles southeast of Walnut.

Between Mathis Bridge and a point (Sec. 7, T.2 S., R.6 E.), about three-fourths of a mile southwest of Theo, the road traverses a rough hilly region in which the highest hills rise probably 250 feet above the bottom lands of Hatchie River. Within 2 miles east of the bridge several poor exposures of the McNairy sand were observed. Materials thrown from a well 2 miles from the bridge consisted of yellow, white, and purple sands resembling the sands in the cut of the Southern Railway at the "Big Hill" west of Cypress, McNairy County, Tenn. In the next 6 or 7 miles toward the northeast evidences of the McNairy sand were seen at many places, though there were no fresh exposures. Ferruginous sandstones of the kind characteristic of the McNairy are common on the slopes and in places are present in great quantities; some of them are coarse-grained and some contain the prints of wood fragments.

The eastern edge of the McNairy belt is marked by an eastward-facing escarpment that, one-half to three-quarters of a mile southwest of Theo, is 150 or 175 feet high. Near the foot of this slope 15 feet of laminated gray clay interbedded with fine micaceous sand appears in a roadside exposure. This probably belongs to the more typical marine portion of the Ripley (Coon Creek tongue).

A section including the transition beds between the typical marine beds (Coon Creek tongue) and the McNairy sand member, half a mile south of Theo on the northward-facing slope of Tarebreeches Creek Valley (SW.1/4, SE.1/4, Sec. 8, T.2 S., R.6 E.) is described below:

SECTION ALONG ROAD HALF A MILE SOUTH-SOUTHEAST OF THEO

	Feet
Colluvium and residuum	
Buff micaceous sand containing small spherical ("buckshot") ferruginous concretions and large fragments of corrugated ironstone, to top of hill	24
Ripley formation	
McNairy sand member: Fine light reddish-brown cross-bedded micaceous sand containing white clay balls and numerous thick tubular and corrugated ironstone layers; lower part contains layers of white micaceous, slightly sandy kaolin	43
Coon Creek tongue: Thin-bedded light-gray clay and very fine micaceous light-gray sand separated by thin ironstone layers; contains prints of fossils in lower part	33
Concealed to flood plain of creek	15
	115

There are many exposures of the McNairy sand member in the northwestern part of the county; a characteristic section on the westward-facing slope of a small hill about a mile north of Theo (Center Sec. 5, T.2 S., R.6 E.) is described below:

SECTION ABOUT A MILE NORTH OF THEO (CENTER OF SEC. 5, T.2 S., R.6 E.)

	Feet
Ripley formation (McNairy sand member)	
Thinly laminated white argillaceous sand with pinkish cast; considerable flaky ironstone in upper part	8
Massive corrugated ironstone	2.5
Fine reddish-brown sand containing thin films of pure white clay	5
	15.5

At the top of a high hill about 3 miles northwest of Theo (SW. 1/4, Sec. 36, T.1 S., R.5 E.), is exposed a ledge 4 feet thick of coarse angular sand tightly cemented by iron oxide. This ledge or one at about the same stratigraphic position was noted over much of the northwestern part of the county. It protects the hills from erosion and gives rise to flat-topped, westward-sloping hills or small plateaus in a region of otherwise highly dissected topography. It is possible that this sandstone is the northern and eastern extension of the sandy limestone at the top of the Ripley formation exposed near Dumas, Tippah County, and to the south.

TIPPAH COUNTY

The Ripley formation crops out over the eastern third of Tippah County. In the southern part of the county the belt of outcrop of the McNairy sand member becomes narrower as the member tongues southward into the typical beds of the formation. Near Dumas characteristic marine sand of the Ripley is exposed under the Owl Creek formation and is underlain by McNairy sand, and a few miles to the east marine Ripley sand is exposed beneath the McNairy.

Ten feet of cavernous limestone with prints of fossils is poorly exposed at a place known as "The Caves," on land owned by W. L. Nabers, about a mile south of Dumas. At the base of the limestone, which is about 80 feet below the top of the hill to the west, a small stream emerges from a cavern in the limestone, and several small openings were noted in the rock above the base. The limestone is overlain by weathered brownish sand. This limestone forms a continuous bed at the top of the Ripley formation from the vicinity of Dumas far to the southward; the limestone is overlain by the Owl Creek formation in Tippah County and by the Prairie Bluff chalk in Union and Pontotoc counties.

On the opposite side of the ridge west of the locality just described, and south of a cemtery, ledges of poorly exposed limestone crop out in ravines in a vertical thickness of 40 to 50 feet. Echinoids (*Hardouinia*) were seen embedded in the rock, and numerous badly corroded specimens of *Exogyra costata* Say were noted loose on the slopes.

In an exposure on the headwaters of Tallahatchie River (NW.1/4 Sec. 4, T.5 S., R.4 E.), about 700 feet southwest of New York graveyard, the limestone at the top of the Ripley formation is 3 feet thick and is overlain by the Owl Creek formation. The rock is hard cavernous sandy and ferruginous and contains *Exogyra costata* Say and large numbers of echinoids. Overlying the limestone is 10 feet of light-brown and gray very fine sandy clay, light-blue and compact where fresh, belonging to the Owl Creek formation.

Echinoids were collected from hard calcareous sandstone at the top of the Ripley formation (Coll. 17799) on Walnut Creek about 3 1/2 miles southeast of Falkner (Sec. 16, T.3 S., R.4 E.).

The most northerly point at which this unnamed tongue of marine material has been observed is in the roadside ditch on the westward-facing slope of Muddy Creek (Sec. 26, T.1 S., R.4 E.), 2 1/2 miles south of the Tennessee line.

Dr. Stanton collected at a locality south of Ripley (Coll. 714) which he describes in his field notes as follows:

"At Landers mill on Cane Creek, 5 miles northwest of Molino and 9 miles south of Ripley, the exposures, which are small, consist of blue sandy marl forming the bed of the creek, overlain by 2 or 3 feet of very fossiliferous concretionary limestone. A *Trigonia* is especially numerous but the fossils are nearly all in the form of internal casts. Many sharks teeth and fragments of bone have been picked up in the bed of the stream. Above this limestone the beds are covered for 25 feet. Then comes 10 feet of limestone like No. 4 of the Dumas section and with similar fossils, followed by clay with *Exogyra costata.*"

The site of Landers mill (S.1/2, Sec. 24, T.5 S., R.3 E.), is now (1936) owned by Mr. Joe Medlin and the old mill site is better known as Medlin's mill. The exposures are small and the blue sandy marl at the base is now concealed by the alluvium of Cane Creek. The lower part of the section up to and including the uppermost limestone bed is here correlated with the Ripley formation. The "clay with *Exogyra costata*" is the Owl Creek formation. The hills east of Cane Creek are capped by red sand probably derived from the Clayton formation of the Midway.

The Coon Creek tongue of the Ripley formation is exposed on the lower slopes of the Hatchie Hills in the southeastern part of Tippah County. About 13 feet of black thin-bedded micaceous very fine sandy clay, gray and yellow micaceous fine sand, and very thin plates of ironstone are exposed at a small spring on the road from Dumas to Geeville, half a mile east of Hatchie River (Sec. 21, T.5 S., R.5 E.). Sediments of this kind are widespread below the McNairy sand, having been observed from central Union County north to about the middle of Alcorn County; they appear to form a transitional zone between the deeper-water sediments of the Coon Creek tongue and the McNairy sand which is of shallow water origin.

The site of an old mill, known as Bullock's mill, is on Hatchie River 4 miles northeast of Dumas, an eighth of a mile downstream from the crossing of the Booneville road. At a spring above Bullock's house 2 feet of dark-gray to black laminated clay is exposed, in which a few molds of fossils were observed. The hill on the west side of Hatchie Valley west of this old mill rises about 150 feet above the bottom lands; near its top were seen numerous masses of ferruginous sandstone which probably represent the southward extension of the McNairy sand member.

A bluff on Hatchie River at Crum's old mill site, 16 1/2 miles northeast of Ripley, at the Alcorn County line, reveals 25 or 30 feet of faintly laminated dark-gray compact micaceous, sandy clay with interbedded thin layers of sand 1 to 2 inches apart; the beds are in the southward extension of the Coon Creek tongue of the Ripley formation. Fragile fossil shells are abundant in a layer 2 feet thick at the base (Coll. 6462). The hills on the south side of Hatchie River valley near Crum's old mill rise 200 feet higher than the valley bottom. Near the crest of these hills, in and near the road leading to Ripley, are numerous large masses of ferruginous sandstone which probably represent the southward extension of the McNairy sand member. From here to within 3 or 4 miles of Ripley the road passes through a hilly country, the surface materials of which are weathered brownish ferruginous sands and clays residual from the underlying Ripley.

South of Dumas deep incisions of the headwaters of the Tallahatchie relative to the Hatchie drainage expose fossiliferous marine beds (Coon Creek tongue) below the McNairy sand.

The site of an old overshot mill, known as Bullock's mill, is on a small branch stream of Tallahatchie River 2 miles south of Dumas in Sec. 36, T.5 S., R.4 E. Fossils were collected here by Dr. T. W. Stanton and a small collection had previously been made by Mr. L. C. Johnson (Colls. 542 and 708). When the senior author visited the place in 1910 no exposure of the fossiliferous bed could be found, land creep and vegetation probably having concealed it. However, dark marine sands and clays of the formation crop out in small exposures in ravines in this neighborhood, and a few soft poorly preserved shells were seen in one of them. Dr. Stanton in his field notes states that the fossils were obtained from 8 or 10 feet of dark marl exposed just above water level of the creek.

PRENTISS COUNTY

The Ripley formation is present only in the western part of Prentiss County in the eastern part of the Pontotoc Hills. The irregular eastern boundary of the formation extends from the Union County line, 2 miles southwest of Geeville, in a north-northeasterly direction to Pisgah School near the Alcorn County line.

The higher peaks of the Pontotoc Hills are capped by heavy ledges of ferruginous sandstone of the McNairy sand member. One of these peaks is Lebanon Mountain (Sec. 12, T.6 S., R.5 E.—altitude

792 feet above sea level), the highest accurately measured point in the Pontotoc Hills (1936).

The lower part of the Ripley formation (Coon Creek tongue) is well exposed on a number of the roads crossing the ridge west of Blackland. The best exposures seen are on the road passing through Secs. 19 and 20, T.5 S., R.6 E.

SECTION ON ROAD ON SOUTHEASTWARD-FACING SLOPE ABOUT 8 1/2 MILES WEST BY SOUTH OF BOONEVILLE (SEC. 19, T.5 S., R.6 E.)

	Feet
Ripley formation	
Greenish-gray and light-brown argillaceous sand containing calcareous nodules	17.0
Hard calcareous sandstone	0.5
Finely cross-bedded medium-grained sparingly glauconitic white sand with yellow streaks; some parts are cemented with brown iron oxide	23.0
	40.5

The calcareous sandstone of this section forms a continuous bed that was observed at several places in these hills; it could be used as a key bed in mapping structure in this area, but it is doubtful if it could be traced many miles either to the north or the south.

UNION COUNTY

The Ripley formation is at the surface in the eastern half of Union County in a belt about 7 miles wide at the south and 13 miles wide at the north. The McNairy sand member, which forms an important part of the Ripley formation in Tippah County, extends southward into Union County in a belt 4 or 5 miles wide, but the member loses its identity a few miles to the south by merging into the typical marine beds of the formation; the shallow water beds merge into deeper water sediments toward the west, also, with the result that strata represented by McNairy sand in the northeastern part of the county are represented by more typical marine sand in the north central part; marine sand containing fossil shells lie both above and below the McNairy. The upper marine sand is part of an unnamed tongue that merges into the McNairy near the Tennessee State line.

The village of Blue Springs is in the valley of Town Branch about 2 miles west of the eastern edge of the Pontotoc Hills, whose tops here are about 40 feet above the level of the track of the St. Louis-San Francisco Railway. The lower part of the Ripley formation is well exposed at several places along the old Tupelo-New Albany highway near Blue Springs. The following section is exposed on the northward-facing slope of a small branch (Sec. 15, T.8 S., R.4 E.), a mile south of Blue Springs.

SECTION ABOUT A MILE SOUTH OF BLUE SPRINGS

	Feet
Ripley formation	
Cross-bedded glauconitic, highly micaceous fine sand, that weathers to massive red sand; to top of hill	11
Thin-bedded dark-gray very fine micaceous sand interbedded with yellow and brown coarser sand; merges with overlying and underlying beds; contains small lenses of siderite 1 inch thick	8
Black horizontally stratified, very fine micaceous, argillaceous sand containing poorly preserved mollusks; *Anomia argentaria* Morton recognied	8
Concealed to bottom of branch	20
	47

At Blue Springs the marine beds of the Ripley formation show evidence of merging northward into the McNairy sand member. A cut in the old New Albany highway at the school building at the north edge of town exposes very fine greenish-yellow highly micaceous highly cross-bedded sand containing tubes of *Halymenites major* Lesquereux, overlain by 4 feet of coarse red sand and fine gravel, also containing tubes of *H. major*. At the north end of this exposure some thin-bedded flaky shale is interstratified between the two sand beds. Half a mile to the north on the highway very fine black micaceous sand containing abundant soft friable molluscan shells is exposed about 8 feet stratigraphically higher than the cross-bedded sand to the south. Although the materials exposed in the vicinity of Blue Springs exhibit some of the characteristics of the McNairy sand member, they were mapped as typical marine Ripley because they were evidently deposited in deeper water than were the sediments of the McNairy farther north.

The first place near the St. Louis-San Francisco Railway northwest of Blue Springs where the Ripley strata are clearly exposed is at a bridge (No. 5710) over a headwater branch of Okonatie Creek, about 2 1/2 miles from the station. Here south of the track the creek has cut into the base of a steep hill which rises about 70 feet above the stream bed, exposing 10 or 12 feet of greenish-gray glauconitic fossiliferous sand with a partly indurated ledge a few feet above the base. Here, and in another exposure of the same bed at the base of the hill a few hundred yards toward the east, fossils were collected

(Coll. 9508). The fossils are numerous but are preserved chiefly as molds. Thorough collecting would doubtless bring to light many additional species. A cut of the railroad just south of the bridge reveals dark-gray compact argillaceous, micaceous, calcareous, glauconitic sand with a ledge of gray sandstone near the top, 30 to 45 feet above the bed of the stream. A few fossils were observed here.

Fossils in a fine state of preservation were found weathered out of their containing matrix at Lee's old mill site (Sec. 17, T.6 S., R.4 E.) on Tallahatchie River, 1 1/2 miles northeast of Keownville on the road to Molino (Figure 43).

Figure 43.—Ripley formation at Lee's old mill site on the Molino road, 1 1/2 miles northeast of Keownville, Union County; the numerous white specks are the shells of mollusks weathered from the sand. Photo by L. W. Stephenson.

SECTION AT LEE'S OLD MILL SITE, 1 1/2 MILES NORTHEAST OF KEOWNVILLE

	Feet
Ripley formation	
Poorly exposed yellowish-brown ferruginous sand	15
Laminated gray finely micaceous sand and clay	10
Gray massive finely micaceous, calcareous sand, out of which weather many perfectly preserved shells (Colls. 6873 and 17277)	10
	35

Ferruginous sand of the McNairy sand member is exposed above the fossiliferous strata on the hill to the south.

In 1889 Dr. T. W. Stanton collected fossils in the vicinity of Molino which he described in his field notes as quoted below (No. 1 of his section is the basal bed):

"There are numerous outcrops of fossiliferous clay marl in this neighborhood. The most extensive and fossiliferous is on C. R. Hall's farm (Sec. 5, T.6 S., R.4 E.) where for a quarter of a mile along a little creek there is an almost continuous exposure of dark clay marl, 10 or 15 feet thick [Coll. 711]. The assemblage of fossils is about the same as at Bullock's old mill with some additional species.

"About 3 miles south of Molino the following section is exposed in a bluff:

	Feet
1. Blue clay marl in bed of a little stream	-
2. Pure white and yellow unconsolidated sand with thin layers of clay	10
3. Blue clay marl with many fossils like those at Bullock's old mill, but most of them not well preserved [Coll. 712]	40
	50"

A prolific fossil locality was recently discovered by Messrs. L. C. Conant and A. Brown along the north side of Pleasant Ridge Lake about 4 miles south of Dumas (Tippah County) (NE.1/4, Sec. 11, T.6 S., R.4 E.—Coll. 18078). The soil at this place was scraped off by Works Progress Administration laborers for use as the core of the dam. More than 10 feet of fossiliferous sand, overlain by red sandy clay soil, is exposed in the freshly scraped area. On higher slopes of the hills to the northeast and east cross-bedded sand of the McNairy sand member is exposed. A detailed description of this locality will be included in a forthcoming bulletin of the Mississippi Geological Survey on the Geology and Mineral Resources of Union County. The collection includes elements relating the fauna to that from Coon Creek, McNairy County, Tennessee, and to that of the Nacatoch sand of Texas. The list given in the table of distribution does not include several as yet undescribed genera and species of mollusks. Conant has shown that this bed occupies about the same stratigraphic position as the fossiliferous strata at Lee's old mill.

SECTION OF NORTHEASTWARD-FACING SLOPE OF BRANCH OF BROWNS CREEK ABOUT 3 1/2 MILES EAST-NORTHEAST OF WALLERVILLE (NE.1/4, SEC. 21, T.7 S., R.4 E.).

Ripley formation	Feet
Hard cavernous crystalline, sandy limestone; surface consists of a mass of molds of fossil shells etched out by weathering away of the limestone; this bed is of great linear extent at the top of the Ripley formation immediately beneath the Owl Creek formation in Tippah County, and beneath the Prairie Bluff chalk in Union and Pontotoc counties	2+
Very fine highly micaceous sand containing *Halymenites major* Lesquereux; 5 feet above base are two large concretionary masses of very hard crystalline limestone, originally a coquina, containing great numbers of mollusks on surface	29
Fossiliferous calcareous very fine sandstone	6
Very fine micaceous sand	10
Calcareous sandstone	1
Partly indurated glauconitic, micaceous fossiliferous very fine sand; at base a 3-inch bed of well-rounded, waterworn (?) concretions and one slightly indurated tube of *Halymenites major* Lesquereux (Coll. 17276)	12
Local unconformity	
Thin-bedded very fine, highly micaceous sand containing fossils and some indurated layers of calcareous sandstone; fossils not so well preserved as those in overlying bed; to bottom of small branch on road	45
Concealed to bottom of large branch north of road	20+
	125+

COMPOSITE SECTION ON MISSISSIPPI STATE HIGHWAY 30, 5 1/2 TO 7 MILES EAST-NORTHEAST OF NEW ALBANY (SECS. 30, 31, T.6 S., R.4 E.)

Prairie Bluff chalk	Feet
11. Red sandy clay soil	8.0
10. Light-brown fine sandy, chalky silt containing *Exogyra costata* Say (narrow-ribbed variety) and abundant phosphatic molds of mollusks; this material is an impure facies of the Prairie Bluff chalk	11.0
Unconformity	
Ripley formation	
9. Hard brown ferruginous coarse and fine sandy limestone containing abundant molds of fossils; also contains shells of *Exogyra costata* Say (narrow- and medium-ribbed varieties)	11.0
8. Fine micaceous brown sand, probably residual from limestone	8.0
7. Very hard cavernous sandy limestone containing *Exogyra costata* Say (medium-ribbed variety) and one large echinoid; contains many small crystals of calcite	3.0

(The parts of the section above and below this contact are exposed about half a mile apart; the immediately overlying limestone is exposed at several places in this interval and the lower part of the section is measured from the base of the limestone).

6. Light-brown very fine sandy clay, probably residual from limestone; contains some coarse ferruginous sand	14.0
5. Greenish-yellow very fine glauconitic, micaceous sand containing numerous well-preserved prints of fossil mollusks and abundant tubes of *Halymenites major* Lesquereux; in the basal 1 foot are many small blocks of sand eroded from the underlying bed	32.0
Unconformity (probably local)	
4. Light bluish-gray and tan very fine highly micaceous compact sand containing prints of fossils; many borings into this bed are filled with sand like that composing the overlying bed	3.0
Concealed by talus	10.0
3. Light-gray and tan very fine micaceous, argillaceous sand, in part indurated and containing *Exogyra costata* Say and many small mollusks; lower part contains many tubes of *Halymenites major* Lesquereux	39.0
2. Dark-brown argillaceous sand containing abundant prints of mollusks	0.5
1. Dark-tan argillaceous sand containing borings; passes downward into dark blue-gray argillaceous sand containing many very friable fossil shells	2.5
Concealed to flood plain of Willhite Creek	5.0
	147.0

Bed 1 in the preceding section is probably the top of the bed exposed at Lee's old mill site on Tallahatchie River. The McNairy sand was not recognized in this section, but the stratigraphic position of at least a part of it is in beds 3, 4, and 5.

The limestone at the top of the Ripley formation is exposed in a ravine at a place known as "The Caves" on the land of J. A. Roberts, a few rods north of the public road, half a mile east of Baker's store, and 6 miles east by north of New Albany.

Section at "The Caves," 6 miles east by north of New Albany

Ripley formation	Feet
Poorly exposed residual materials	20
Hard sandy cavernous fossiliferous limestone	27
Dark-gray compact massive very glauconitic, finely micaceous sand; recognized *Sphenodiscus* sp. (Colls. 6466a-g and 9522)	11
Hard limestone with prints and molds of fossils	1
Dark compact calcareous greensand	3
Calcareous sandstone containing many molds of fossils (Colls. 6466a-g and 9522)	2
Dark-gray partially indurated calcareous, glauconitic sand containing molds of fossils (Colls. 6466a-g and 9522)	15
	79

A cavern in the limestone in the upper part of this section is 12 to 15 feet wide and about 5 feet high at the opening and extends through a narrow ridge to an opening on the opposite slope. There are several sinks on the ridge in the immediate vicinity.

PONTOTOC COUNTY

The Ripley formation crops out in Pontotoc County in a north-south belt 4 to 7 miles wide, the western edge of which lies about 3 miles east of Pontotoc. The unweathered beds of the formation, which consist chiefly of gray sandy limestone, calcareous sandstone, unconsolidated marine sand, and some clay, are overlain by a few feet to 50 feet or more of reddish and reddish-brown ferruginous sands and sandy loams derived by weathering from the beds below.

Twenty-seven feet of alternating hard and soft layers of calcareous, micaceous, glauconitic sand of the Ripley formation crops out on the eastward-facing slope of Tallabinnela Creek Valley about 3 miles north of Troy (E.1/2 Sec. 4, T.11 S., R.4 E.). Fossils observed included *Exogyra costata* Say (varieties with narrow and medium costae), *Ostrea falcata* Morton, *Anomia argentaria* Morton, and *Paranomia scabra* (Morton).

The lower part of the Ripley formation crops out on Mississippi Highway 6 from Furrs (NE.1/4, Sec. 10, T.10 S., R.4 E.) westward to the hills west of Bob Miller Creek. Half a mile west of Furrs 1 foot of dark-gray micaceous, calcareous, argillaceous, very fine sand of the Ripley, containing *Ostrea falcata* Morton and a fragment of *Exogyra costata* Say (medium-ribbed variety), is overlain by 10 feet of buff fine sand, probably a terrace deposit of Muddy Creek. The hill west of Muddy Creek (Sec. 9, T.10 S., R.4 E.) is composed of plastic light brown micaceous, calcareous clay containing prints of fossils. This material is very much like an impure facies of the Selma chalk and may belong to that formation. If so the sand east of the creek is probably a small tongue of Ripley extending southward into the Selma. Both deposits were mapped as Ripley. Three-quarters of a mile farther west in the northeast corner of Sec. 8, on the westward-facing slope of a branch of Bob Miller Creek, bedded dark brownish-gray micaceous clay, darker and showing more stratification than that described above, crops out in a ditch at the south side of the highway; this material is definitely Ripley. Gray argillaceous, calcareous sand containing *Exogyra costata* Say (narrow-ribbed variety) forms the bed of Bob Miller Creek.

SECTION IN BANK OF CREEK AT THE SOUTH END OF WAGON BRIDGE ON THE ABERDEEN ROAD, 6 1/2 MILES SOUTHEAST OF PONTOTOC

Ripley formation	Feet
Red ferruginous sand grading downward into yellow sandy clay, poorly exposed at base	20
Gray argillaceous, micaceous, calcareous sandstone containing fossils (Coll. 6469)	15
	35

Figure 44.—Cavernous limestone at the top of the Ripley formation, in Sec. 30, T.8 S., R.4 E., Pontotoc County. Photo by W. H. Monroe.

The upper part of the Ripley formation is well exposed in cuts on Mississippi Highway 41 between Troy and the Middle Prong of Chiwapa Creek. Beds of the Ripley in a cut in a local road, a tenth of a mile southwest of the highway (SW.1/4, Sec. 26, T.10 S., R.3 E.) include 6 feet of fine calcareous, micaceous sand, indurated in irregular ledges about a foot apart, containing *Exogyra costata* Say and other fossils, and 5 feet of overlying fine micaceous red sand.

The top of the Ripley is marked throughout Pontotoc County by a ledge or several ledges of hard cavernous sandy limestone. This limestone, as it appears at several localities in the county, is described briefly in the part of this report treating of the Prairie Bluff chalk. The limestone is particularly well exposed about 4 miles west of Sherman in the northern part of the county (Secs. 29 and 30, T.8 S., R.4 E.) where 10 feet of the cavernous limestone is overlain by about 40 feet of Prairie Bluff chalk (Figure 44). The contact is well exposed in a quarry 2 miles south of Pontotoc where fossils were obtained from the limestone (Colls. 17201 and 17256).

Mellen and Vestal (59, pp. 34, 35) in 1936 found a deposit of bentonite northeast of Pontotoc that is reported to be interbedded with this limestone.

CHICKASAW COUNTY

The Ripley formation crops out in Chickasaw County in a belt from 2 to 5 miles wide in the southern extension of the Pontotoc Hills. The formation consists of fossiliferous glauconitic, micaceous, more or less calcareous sand and sandstone. The formation weathers to dark reddish-brown argillaceous sand and ferruginous sandstone. The road cuts on Mississippi Highway 8 through the Pontotoc Hills exhibit several good sections. The highway enters the hills from the east just west of Long Creek. The following section, 3 miles west of Buena Vista (S.1/2, Sec. 4, T.14 S., R.4 E.), is on the east slope of the Pontotoc Hills. Blue micaceous, argillaceous chalk is exposed in the bed of Long Creek, 37 feet below the base of the section.

SECTION ON MISSISSIPPI HIGHWAY 8, 3 MILES WEST OF BUENA VISTA

Age indeterminate	Feet
Glauconitic fine to medium sand weathering to brick-red sand containing many ferruginous plates and small concretions	15
Prairie Bluff chalk	
Gray calcareous, glauconitic sand containing some beds that look like sandy chalk. (Coll. 17251)	7
Unconformity	
Ripley formation	
Light-colored calcareous sand	1
Concealed	7
Very fine light-brown highly micaceous sand, slightly indurated in lower part	15
Similar material, but light-gray, with numerous thin interbedded, slightly indurated layers; a few concretions cemented by lime, up to 4 inches in diameter	28
Concealed	5
Brown and gray micaceous sand and clay	15
Selma chalk (?)	
Dark-gray micaceous, slightly sandy clay, apparently containing blocks of hard slightly sandy chalk; to flood plain of Long Creek	25
	118

A mile and a half farther west on the westward-facing slope of a small branch (SE.1/4 Sec. 6, T.14 S., R.4 E.) the following section is exposed:

SECTION ON MISSISSIPPI HIGHWAY 8, 4 1/2 MILES WEST OF BUENA VISTA

	Feet
Age indeterminate	
Medium to coarse brown argillaceous sand	55
Prairie Bluff chalk	
Coarsely glauconitic and phosphatic, slightly sandy compact chalk; contains *Exogyra costata* Say, *Gryphaea mutabilis* Morton, and a few phosphatic molds and phosphatic concretions, particularly at base	13
Unconformity	
Ripley formation	
Very hard sandy limestone containing abundant specimens of *Exogyra costata* Say	7
Dark blue-gray (weathering to white) argillaceous, glauconitic, chalky sand containing *Exogyra costata* Say and other fossils; becomes less chalky near base; bottom 2 feet contains small clay balls and pebbles of siderite weathering to iron oxide	40
Stratified light-gray fine glauconitic, micaceous, calcareous sand containing thin films and balls of gray clay	31
Concealed to flood plain	15
	161

The eastward-facing slope of Houlka Creek Valley 2 miles east by south of Houston on Mississippi Highway 8 (SW.1/4, Sec. 2, T.14 S., R.3 E.) shows the section described below:

SECTION ON MISSISSIPPI HIGHWAY 8, 2 MILES EAST BY SOUTH OF HOUSTON

	Feet
Ripley formation (?)	
4. Light-brown and gray medium-grained sandy silt; much iron has been leached out and redeposited as oxide in vertical tubes and at the base; this may be in part residual silt from Prairie Bluff chalk	25
Ripley formation	
3. Compact coarse gray argillaceous, calcareous sand indurated into irregular, nodular beds of calcareous sandstone (Coll. 6473)	16
2. Darker gray glauconitic, more argillaceous, very fossiliferous coarse sand containing phosphatic nodules (Coll. 6473)	13
1. Fine dark-gray and white glauconitic, slightly sandy, chalky clay. Many shells of *Gryphaea mutabilis* Morton and a few of *Exogyra costata* Say	46
Concealed to flood plain of Houlka Creek	13
	113

SECTION IN CUT OF ABANDONED MOBILE & OHIO RAILROAD, 7 MILES NORTHEAST OF HOUSTON

	Feet
Ripley formation	
Weathered red ferruginous, argillaceous sand	8
Coarse gray calcareous, argillaceous sandstone containing *Exogyra costata* Say and numerous large shells of *Gryphaea mutabilis* Morton (Coll. 6850)	5
	13

Within the next eighth of a mile gray calcareous sandstone with many shells of *Exogyra costata* Say and *Gryphaea mutabilis* Morton crops out near the railroad from 10 feet above to 12 feet below the track level.

About 7 miles east-northeast of Houlka (NW.1/4, Sec. 5, T.12 S., R.4 E.) are several exposures of cream-colored argillaceous sand, that was at first thought to be Prairie Bluff chalk. This sand contains *Exogyra costata* Say (narrow- and medium-ribbed varieties) and other fossils. This is apparently the same bed as that on Highway 8, 4.5 miles west of Buena Vista (Sec. 6, T.14 S., R.4 E.) described on a preceding page.

Southeast of Houston the eastern Starkville road passes for half a mile or more over yellow clay roads, beyond which to a point 7 miles southeast of town the character of the weathered soils and subsoils apparently indicates their derivation from the marine sands and clays of the Ripley formation. The best exposure examined was in a road cut about 6 miles from Houston.

SECTION ON THE EASTERN STARKVILLE ROAD, ABOUT 6 MILES SOUTHEAST OF HOUSTON

	Feet
Ripley formation	
Weathered yellow sandy clay, somewhat ferruginous	4
Greenish-gray and brown ferruginous, sandy clay, most ferruginous and partly indurated in the upper 2 feet	4
Brown ferruginous stratified sand with numerous thin clay laminae	8
	16

The cavernous sandy limestone that marks the top of the Ripley formation in Pontotoc County was observed in the northern part of Chickasaw County about 5 miles east of Houlka (SE. Cor. Sec. 13, T.12 S., R.3 E.), from which fossils were collected (Coll. 17223). A tenth of a mile farther south and up the hill (Sec. 24) slightly sandy, micaceous chalk of the Prairie Bluff is overlain by Paleocene red sand.

In the southern part of the county about 4 miles west by north of McCondy (Sec. 20, T.14 S., R.4 E.) thin-bedded flaky micaceous black clay and fine gray sand of the Ripley formation are exposed in the ditch at the corner where a road turns south from the Houston-Trebloc road.

CLAY COUNTY

The Ripley formation crops out in Clay County in the Pontotoc Hills in a belt 2 1/2 to 4 1/2 miles wide, trending south by east from Houlka Creek in the northwest corner of the county to Cedar Bluff and Wadell in the southern part. In the north the formation, about 140 feet thick (aneroid measurement), consists of gray and brown fine micaceous, argillaceous sand that weathers to red micaceous fine sand. Much of the belt north of Line Creek Valley is sharply dissected, presenting narrow ridges and deep narrow valleys, the hills probably rising 150 feet or more above Line Creek bottom, and the local relief being 100 feet or more. In the southern portion of the belt the topography is much more subdued owing to terracing and a more advanced stage of erosion in proximity to Line Creek.

Observations were made along the public road leading from Montpelier northeastward to Caradine store (NW.1/4, Sec. 14, T.15 S., R.4 E.) distant about 6 1/2 miles. About 3 miles northeast of town, where the road ascends the steep westward-facing slope of one of the eastern branches of Standing Reed Creek, 30 feet of massive dark greenish-gray argillaceous, glauconitic, micaceous sand is exposed. Overlying this sand to the top of the hill is 30 feet of weathered light greenish-gray to reddish residual sand. About 100 yards farther to the east and corresponding to the upper 20 to 25 feet of the preceding section, less weathered massive, compact calcareous, glauconitic sand, which contains numerous shells of *Exogyra costata* Say, scattered phosphatic molds of gastropods and pelecypods, and other fossils, is interpreted to be the basal part of the Prairie Bluff chalk. For the next 3 miles no good exposures were seen, but the soils and subsoils are composed chiefly of reddish ferruginous sands making sandy roads.

Six miles northeast of Montpelier, where the road descends a steep eastward-facing slope to a small branch 125 feet lower than the top of the hill to the west, the lower part of the slope reveals 40 feet of gray compact calcareous clay containing *Exogyra costata* Say and other common fossils; the clay is overlain by 30 or 40 feet of weathered greenish-gray sandy, micaceous clay. The calcareous clay at the base probably forms a transition zone between the Ripley formation and the underlying Selma chalk. In a hill just east of the branch the calcareous clay is overlain by only 10 or 15 feet of the noncalcareous clay, beyond which to the east the road descends to the gently rolling country underlain by the Selma chalk; here the general level is about 125 feet lower than the hills of the Ripley belt.

The Selma chalk is exposed on the west side of Line Creek about a mile east of Cedar Bluff. Within half a mile northwest of Cedar Bluff the Montpelier road ascends an eastward-facing slope to a hilly upland, the general level of which is about 50 feet higher than the plain on which the town is situated. For the next 3 miles poor exposures along the road reveal weathered brownish, reddish, and yellowish argillaceous sands and sandy clays, and at intervals less weathered greenish-gray argillaceous sands and finely sandy clays, belonging to the Ripley formation. A little farther to the northwest the Prairie Bluff chalk caps the hills.

In exposures in the bank of Line Creek and in the Montpelier road just south of the creek, 5 1/2 miles northwest of Cedar Bluff, in a topographic position such as to place it stratigraphically below the Prairie Bluff chalk, the following section is revealed:

SECTION IN AND NEAR THE MONTPELIER ROAD, 5 1/2 MILES NORTHWEST OF CEDAR BLUFF

Ripley formation	Feet
Weathered yellowish argillaceous sand	10
Greenish-gray argillaceous, calcareous sandstone, containing *Exogyra costata* Say; base at level of creek bed	25
	35

OKTIBBEHA COUNTY

In Oktibbeha County the belt of outcrop of the Ripley formation has narrowed down to a strip 1 to 3 miles wide, which extends from a little east of the center of the northern boundary south-southeast to near the southeastern corner of the county. The formation consists of fine calcareous, argillaceous sand. At many places the content of lime is so high that it resembles the Selma chalk into which it is merging toward the south.

Starkville is situated at the eastern edge of the area of outcrop of the Porters Creek clay (Paleocene) and is partly on the outcrop of the Prairie Bluff chalk. A section on the Mayhew road 1 3/4 miles east of Starkville shows the chalk underlain by sand of the Ripley formation.

Northeast of Starkville the Osborn road traverses the Prairie Bluff chalk for 1 1/2 miles, beyond which for 2 1/2 miles it traverses a sandy and decidedly hilly belt underlain by the Ripley formation. In a road cut about 5 miles from town a few feet of greenish-gray calcareous fossiliferous sand grades upward into reddish residual sand from which *Exogyra costata* Say and other fossils were collected (Coll. 6848).

Half a mile north of Rocky Hill church (Sec. 11, T.19 N., R.14 E.), a local road forks northwest from the Muldrow road. Coarse calcareous sandstone crops out just below the road at the fork. Twenty feet below the Muldrow road is exposed fine to medium calcareous sandstone which weathers to whitish bald spots and contains *Exogyra costata* Say and other fossils. Fifty feet below the road the sandstone is dark-gray and fine. In all the exposures the sand is locally indurated to hard ledges about a foot thick and 5 to 10 feet apart. Seventy feet below the road the Selma chalk is exposed.

The entire thickness of the Ripley formation is exposed in a section on the northward-facing slope of Catalpa Creek Valley, half a mile northeast of Salem Church (NE.1/4, Sec. 32, T.18 N., R.15 E.).

SECTION HALF A MILE NORTHEAST OF SALEM CHURCH

	Feet
Prairie Bluff chalk	
Impure sandy, argillaceous chalk containing *Diploschiza melleni* Stephenson, *Exogyra costata* Say and many phosphatic molds of mollusks, about	5
Unconformity	
Ripley formation	
Fine to medium highly calcareous, micaceous sand, some layers indurated to slightly projecting ledges; contains *Exogyra costata* Say and other fossils; dark-gray chalky, micaceous sand at base	70
Selma chalk	
Blue-gray, weathering to cream, very compact slightly sandy, micaceous, argillaceous chalk; contains *Exogyra cancellata* Stephenson and *E. costata* Say	20
	95

NOXUBEE COUNTY

The Ripley formation is recognized only in the northern part of Noxubee County. The belt of outcrop of the formation in the northwest, is about 1 1/2 miles wide. Toward the south the formation merges into that part of the Selma chalk that lies above the zone of *Exogyra cancellata*. The formation is composed of fine very calcareous or chalky, argillaceous, micaceous sand, and is probably not over 50 feet thick.

Fairport, a small village near the Oktibbeha County line, and 5 miles west by south of Crawford (Lowndes County), is situated on a low sandy ridge that represents the Ripley. The crest of this ridge is estimated to be about 80 feet higher than Noxubee River bottom and about 60 feet higher than the bottom land of Shotbag Creek, a mile east of Fairport.

The southernmost point at which material definitely referred to the Ripley was observed is on the Cranford Bridge road, 5 1/2 miles northwest of the railroad station at Macon, on the westward-facing slope of West Water Creek Valley (Sec. 11, T.15 N., R.16 E.), where 45 feet of gray chalky, micaceous, glauconitic fine sand of the Ripley formation, containing *Exogyra costata* Say and other fossils, is overlain by 15 feet of red and yellow medium-grained sand, a Pleistocene (?) terrace deposit of Noxubee River.

PRAIRIE BLUFF CHALK

GENERAL FEATURES

NAME

The name Prairie Bluff limestone was first used by Winchell (7, pp. 84, 90) in 1857 for the uppermost formation of the Cretaceous of Alabama, which crops out in the upper part of the section at Prairie Bluff on Alabama River. Smith, Johnson, and Langdon (15, pp. 267-268) abandoned the name Prairie Bluff limestone treating the entire section at Prairie Bluff as part of the Ripley formation. Stephenson (37, p. 250) in 1917 revived Winchell's name and treated the chalk unit as a tongue of the Selma chalk extending eastward from the main body of the Selma in Sumter County, Alabama. In Mississippi Stephenson named a corresponding body of chalk, extending northward above the Ripley from the main body of the chalk in Noxubee County to northern Chickasaw County, the Oktibbeha tongue of the Selma chalk. He recognized an unconformity between the Prairie Bluff tongue and the underlying Ripley formation at Prairie Bluff, but not elsewhere. The field work of 1936 and 1938 showed that this unconformity is not a local one, but is present beneath beds of Prairie Bluff age, both chalky and nonchalky, throughout the eastern Gulf region. It is present beneath the chalk unit formerly considered as forming the uppermost part of the Selma chalk in Sumter County, Ala., and Noxubee County, Miss.; it is present beneath the so-called Oktibbeha tongue of the Selma chalk in Mississippi, and beneath the unit now known as the Owl Creek formation in northern Mississippi; the eastern extension of the unconformity is also present beneath the Providence sand of the Chattahoochee region and Georgia. Recognizing the wide geographic extent of the unconformity, and for other reasons stated on a subsequent page, Stephenson and Monroe in 1937 (61, pp. 806-809) raised the Prairie Bluff unit to the rank of formation and extended the application of the name to include the upper phosphatic zone in west-central Alabama and east-central Mississippi, previously considered a part of the Selma chalk, and the unit in Mississippi formerly called the Oktibbeha tongue of the Selma. Priority of usage (Winchell, 1857) determined the selection of the name Prairie Bluff for this chalk unit.

AREAL DISTRIBUTION

The Prairie Bluff chalk extends into Mississippi from Alabama in east-central Kemper County as a belt about 2 to 3 miles wide and extends northwestward and northward through Noxubee, Oktibbeha, Clay, and Chickasaw counties. In Pontotoc and Union counties the chalk merges northward into the nonchalky marine sand of the Owl Creek formation, as explained on a following page. The belt of outcrop of the Prairie Bluff chalk varies in width from a maximum of about 5 miles near Starkville, Oktibbeha County, and Houston, Chickasaw County, to a feather edge in the northern part of Union County.

In Alabama the formation has been traced eastward as far as the vicinity of Perote in southern Bullock County. At many places, however, it is concealed by overlapping beds of the Paleocene Midway series. In eastern Alabama the formation merges into the Providence sand (63, pp. 1651-1652)—a formation typically composed of unfossiliferous shallow water sediments, but including some highly fossiliferous sandy clay and sand.

LITHOLOGIC CHARACTER AND THICKNESS

In the southern part of its area of outcrop in Mississippi the Prairie Bluff unit is a hard, brittle chalk characterized in its lower part by abundant phosphatic internal molds of fossil shells. In contrast the extreme upper part is nearly barren of fossils other than those of microscopic size. In Oktibbeha County the lower part of the formation contains abundant scattered grains of coarse angular sand. Farther north, especially in Pontotoc and Union counties, the formation becomes increasingly sandy and argillaceous to an extent such that it might appropriately be called calcareous sand or chalky clay; phosphatic molds of fossils are present in the basal beds throughout this northern extension of the formation. Analyses of several samples of Prairie Bluff chalk are given in the following table. Comparison of these analyses with those of the Selma chalk shows a general similarity in the composition of the chalks of the two formations.

ANALYSES OF PRAIRIE BLUFF CHALK FROM MISSISSIPPI

	1	2	3	4	5
Silica (SiO_2)	10.60	16.48	20.00	29.98	18.82
Alumina (Al_2O_3)	5.90	6.97	8.92	5.45	.23
Iron oxide (Fe_2O_3)				5.60	2.80
Lime (CaO)	46.21	41.64	38.61	31.62	40.02
Magnesia (MgO)	Trace	.33	Trace	.14	.96
Carbon dioxide (CO_2)	36.26	33.04	30.30	24.50	34.02
Sulphur trioxide (SO_3)	......	......	......	.21	2.53
Water (H_2O)	.82	.67	1.03	1.50	1.15
Calcium carbonate ($CaCO_3$) equivalent [a]	82.47	74.31	68.90	56.43	71.42

a The figures given for calcium carbonate ($CaCO_3$) may be slightly too high as a small part of the lime (CaO) may be present as a silicate. The figures were obtained by calculating the total CaO to carbonate.

1. Sample from Fox Prairie road at crossing of Bodea (Bodka?) Creek, about 6 miles southeast of Scooba and 2 miles west of the Alabama line in Kemper County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 211, 1905.
2. Sample from west bank of creek, 2 1/2 miles east of Scooba, Kemper County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 210, 1905.
3. Sample from bed of Wahalak Creek, about 1 1/2 miles south of Wahalak, Kemper County. W. S. McNeil, U. S. Geol. Survey, analyst. U. S. Geol. Survey Bull. 243, p. 212, 1905.
4. Sample from campus of Mississippi State College near Starkville, Oktibbeha County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 50, 1907.
5. Sample from the Mayhew road, a mile east of Mississippi State College, Oktibbeha County. Analyst unknown. Mississippi Geol. Survey Bull. 1, p. 50, 1907.

The thickness of the Prairie Bluff chalk varies in measured sections from only 12 feet at the type locality on Alabama River to more than 70 feet near Livingston, Sumter County, Alabama. So far as known the formation does not much exceed 70 feet in thickness in its belt of outcrop. As the formation is overlapped to greater or less extent by Paleocene deposits, it probably increases in thickness in its buried extension down the dip.

STRATIGRAPHIC AND AGE RELATIONS

The Prairie Bluff chalk rests unconformably on the Selma chalk in Kemper and Noxubee counties, and on the Ripley formation, the nonchalky sandy equivalent of the Selma from the northern part of Noxubee County to the southern part of Tippah County. In Alabama the Prairie Bluff rests unconformably on the Selma chalk in the western part of Sumter County and on the Ripley formation in the eastern part of Sumter and in the counties to the east. The Prairie Bluff chalk is overlain unconformably, and is either partly or entirely overlapped, by deposits of the Paleocene Midway series, except in Pontotoc and Union counties, Miss., where the formation is conformably overlain by a southward extending tongue of the Owl Creek formation. This long thin tongue of the Owl Creek has been recognized as far south as Pontotoc, and the corresponding underlying thin tongue of the Prairie Bluff has been recognized as far north as the southern boundary of Tippah County. On account of the smallness of the scale it has not been practicable to show these tongues on the geological map (Plate 1A), and the Prairie Bluff is arbitrarily represented as merging into the Owl Creek at a selected place near New Albany, in Union County. This merging of chalky into nonchalky beds begins at the top of the Prairie Bluff in southern Pontotoc County and affects lower and lower beds of the chalk toward the north, until in southern Tippah County the whole of the chalk has merged into the nonchalky beds of the Owl Creek formation.

The studies of the senior author have shown a close faunal relationship between the lower part of the Prairie Bluff chalk and its equivalent, the Owl Creek formation, on the one hand, and the Corsicana marl of Texas on the other. The Corsicana marl, a formation of the Navarro group, is a chalky marl lithologically similar to the Prairie Bluff chalk, and it carries a similar fauna with many identical species; it is phosphatic in its basal porton and rests with transgressing unconformable relations on the Nacatoch sand, Neylandville marl, and Taylor marl. If the correlation suggested is correct, it appears that the unconformities at the base of the Corsicana marl and the Prairie Bluff chalk are synchronous and mark an episode of emergence and erosion of Gulf-wide extent, followed by submergence in a shallow, clear sea. According to J. A. Cushman and Helen Jeanne Plummer (oral communications) foraminifera found in the upper part of the chalk suggest synchroneity with the Kemp clay of Texas, which overlies the Corsicana.

PHYSIOGRAPHIC EXPRESSION

The topography of the belt of outcrop of the Prairie Bluff chalk is in general gently rolling. The low hills together with those produced by the sandy strata of the overlying Clayton formation (Paleocene), where it is present, form the western border of the Pontotoc Hills. The topography of this bordering belt, though subdued, is in contrast to the featureless Flatwoods (underlain by the Porters Creek clay, Paleocene) which parallels the Pontotoc Hills on the west. In Pontotoc and Union counties the relatively thin chalk crops out low on the slopes and in the bottoms of valleys, and has but little effect on the topography, which is determined mainly by the sandy strata of both the underlying Ripley formation and the overlying Clayton formation.

In Noxubee and Kemper counties the topography produced by the Prairie Bluff chalk forms a narrow but integral part of the Black Prairies, whose major extent coincides with the outcrop of the adjacent Selma chalk.

The altitude of the Prairie Bluff belt ranges from about 200 feet in Kemper and Noxubee counties to nearly 500 feet in Pontotoc County. Drainage of the belt is accomplished by streams that flow parallel to the Pontotoc Hills for short distances and then either cut through the hills to join the Tombigbee River system on the east, or flow westward to the Mississippi. North of central Pontotoc County the belt is drained by Tallahatchie River and its tributaries; south of central Pontotoc it is drained by tributaries of Tombigbee River, including Sakatonchee River, Houlka, Line, Trim Cane, and Catalpa Creeks, Noxubee River, and Bodka Creek.

FOSSIL CONTENT

The Prairie Bluff chalk is the uppermost formation included in the *Exogyra costata* zone in Mississippi. The fossils are listed in the accompanying table by counties (from south to north) and localities.

FOSSIL LOCALITIES IN THE PRAIRIE BLUFF CHALK

6835.—Road cut (Sec. 2, T.11 N., R.18 E.), 3 miles east of Scooba on the Giles road, Kemper County.

6480.—Old U. S. Highway 45 near top of northward-facing slope of Wahalak Creek Valley (Sec. 9, T.12 N., R.18 E.), about 6 miles north of Scooba, Kemper County.

6838.—Bald spots in field west of the road about a mile north of Shuqualak, Noxubee County.

6837.—Bank of Running Water Creek at crossing of the DeKalb road, 7 1/2 miles south of Macon, Noxubee County.

6836.—Bald spot on the southward-facing slope of a small branch of Running Water Creek (NW.1/4, Sec. 36, T.14 N., R.16 E.), DeKalb road, about 7 miles south of Macon, Noxubee County.

6479, 6839, 17210, 17485, 17802.—U. S. Highway 45 on northward-facing slope of Running Water Creek Valley (Sec. 28, T.14 N., R.17 E.), 5 miles south of Noxubee River Bridge at Macon, Noxubee County. L. W. Stephenson, W. H. Monroe, and P. A. Bethany, collectors.

17242, 17484.—Bald spots on northward-facing slope of Dry Creek Valley (Sec. 13, T.14 N., R.16 E.), 4 miles southwest of Macon, Noxubee County. W. H. Monroe and P. A. Bethany, collectors.

17241.—Right bank of Noxubee River (Sec. 16, T.15 N., R.16 E.), 6 1/2 miles west-northwest of the railroad station at Macon, Noxubee County.

17240.—Roadside ditch (S. edge, Sec. 14, T.16 N., R.15 E.), 3/4 mile east of Popes Chapel, Noxubee County.

6842.—Right bank of Noxubee River at Edmonds Bridge (Sec. 12, T.16 N., R.15 E.), Noxubee County.

17232.—Roadside exposure (NW.1/4, NW.1/4, Sec. 19, T.17 N., R.15 E.), 10 miles south by west of Starkville, Oktibbeha County.

17204.—Cut of Illinois Central Railroad at overhead bridge at east edge of the business section of Starkville, Oktibbeha County.

3186, 6843, 6844.—Gullies on the campus of Mississippi State College, near Starkville, Oktibbeha County. A. F. Crider, W. N. Logan, and L. W. Stephenson, collectors.

6845.—Aiken farm, 2 1/2 miles north of Starkville, Oktibbeha County.

6846.—Gullies east of the Rocky Hill Church road, 3 miles north of Starkville, Oktibbeha County.

6847.—Lee Pearson's farm near the Houston road (Sec. 16, T.19 N., R.14 E.), 3 miles northwest of Starkville, Oktibbeha County.

17225.—Roadside exposure on Mississippi Highway 10 (Sec. 23, T.20 N., R.13 E.), 2 1/2 miles east of Pheba, Clay County.

6861.—Roadside ditch a few hundred yards north of the Montpelier road (Sec. 12, T.20 N., R.13 E.), 4 miles northwest of Cedar Bluff, Clay County.

17228.—Bald spot on top of Pontotoc Ridge (SE.1/4, SW.1/4, Sec. 8, T.15 S., R.4 E.), 5 miles north-northeast of Montpelier, Clay County.

17235, 17253.—Bald spot in field at roadside and cut on the Houston road (Sec. 10, T.15 S., R.3 E.), 1 1/4 miles north of Sparta, Chickasaw County.

17233.—Bald spot at foot of northward-facing slope of Cane Creek Valley (Sec. 10, T.15 S., R.3 E.), 1 1/2 miles north of Sparta on the Houston road, Chickasaw County.

Distribution of Prairie Bluff fossils

Species	Kemper County		Noxubee County								Oktibbeha County						Clay County			Chickasaw County											Pontotoc County											Union County
	6835 - Scooba, 1 mi. E	6480 - Scooba, 6 mi. E	6838 - Shuqualak, 1 mi. N	6837 - Macon, 7 1/2 mi. S	6836 - Macon, 7 mi. S	6479 etc. - Macon, 5 mi. S	17242 etc. - Macon, 4 mi. SW	17241 - Macon, 6 1/2 mi. WNW	17240 - Popes Chapel, 3/4 mi. E.	6842 - Edmonds Bridge	17232 - Starkville, 10 mi. S	17204 - Starkville	3186 etc. - State College	6845 - Starkville, 2 1/2 mi. N	6846 - Starkville, 3 mi. E	6847 - Starkville, 3 mi. NW	17225 - Pheba, 2 1/2 mi. N	6861 - Cedar Bluff, 4 mi. SW	17228 - Montpelier, 5 mi. NNE	17233 etc. - Sparta, 1 1/4 mi. N	17253 - Sparta, 1 1/2 mi. W	17231 - Houston, 5 3/4 mi. S	6474 - Houston, 1 1/2 mi. S	17251 - Buena Vista, 3 1/2 mi. W	6849 - Houston, 1 1/4 mi. NE	17230 - Houston, 4 1/2 mi. NE	17258 - Houston, 5 mi. W	17215 - Houston, 5 1/2 mi. NNE	6851 - Houston, 4 3/4 mi. NE	17227 - Houlka, 3 mi. NNE	17261 - Troy, 4 mi. SW	17257 - Pontotoc, 2mi. S	11562 - Pontotoc, 1 1/4 mi. S	6473 - Pontotoc, 1/2 to 3/4 mi. S	6853 etc. - Pontotoc	6852 - Pontotoc	6855 - Pontotoc, 1 mi. N	6856 - Pontotoc, 2 mi. N	17255 etc. - Pontotoc, 2 3/4 mi. N	6857 - Pontotoc, 5 mi. N	6858 - Pontotoc, 2 1/2 mi. NW	9604 - Wallerville
Coelenterata:																																										
Cliona aff. C. cretacica Fenton and Fenton						X													X																							
Cliona sp.						X	X						X								X						X					X							X			
Dasmosmilia reesidei Wells						X	X						X																													
Micrabacia sp.																				X																						
Gorgonian coral?																				X																						
Echinodermata:																																										
A new genus and species of crinoid (aff. Mesocrinus)																				X																						
Catopygus sp.																													X													
Hardouinia subquadrata (Conrad)																															?						?				X	
Hemiaster slocumi Lambert						X							X													X	X	X	X	X	X				X	X	X	X	X	X		X
Linthia variabilis Slocum																														X			X		X	X	X					X
Micraster (Plesiaster) sp.																												X														
Vermes:																																										
Serpula sp.							?		?										X	X										X									X			
Hamulus onyx Morton																		X																X					X			X
H. squamosus Gabb																															X								X			
Molluscoidea:																																										
Bryozoan remains																				X								X														
Terebratulina floridana (Morton)													X					X																								
Mollusca:																																										
Pelecypoda:																																										
Nucula percrassa Conrad		X				X	X						X	X									?					X											X			
Nuculana longifrons (Conrad)						X																																				
Postligata? sp.																																										X
Idonearca capax (Conrad)		?				X	X						X				X		X		X							X											X			
Pinna laqueata Conrad																																						X				
Gervilliopsis ensiformis (Conrad)																																			X							
Inoceramus argenteus Conrad																															X				X	X						X
Ostrea plumosa Morton		X	X			?			?				X	X	X			X				?	X		X											X	X				X	
O. tecticosta Gabb	X								X					X	X				X				X		X	X		X		X	X			X	X	X	X	X	X	X		X
O. falcata Morton (and varieties)						X										X																										
O. mesenterica Morton							X	X												?			?																			
Gryphaea mutabilis Morton		X				X					X		X	X				X						X	X															X		
G. convexa (Say)													X																													
Gryphaeostrea vomer (Morton)			X				X							X			X						X		X		X			X	X	X			X			X				
Exogyra costata Say (wide costae)													X																													
E. costata Say (medium costae)			X										X						X																							
E. costata Say (narrow costae)	X	?				X	X						X	X			X	X	X		X		X		X	X	X	X		X	X	X		X	X			X	X	X	X	?
Trigonia angulicostata Gabb?																																			X							
Pecten simplicius Conrad?																						X																				
P. mississippiensis Conrad?															X																											
P. venustus Morton	X		X	X		X	X			X	X	X	X	X	X	X		X	X	X	X	X			X														X			
P. (Camptonectes) sp.																										X				X												
Plicatula urticosa Morton						X							X	X				X																								
P. mullicaensis Weller?							X																																			
Diploschiza melleni Stephenson	X					X							X		X	X			X		X			X																		
Lima acutilineata (Conrad)																										X					X				X				X			
L. reticulata Forbes		?											X					X			X													X	?					X		
Anomia argentaria Morton		X					X						X	X	X			X	X		X	X	X		X		X	X		X	X			X	X			X	X	X		
Paranomia scabra (Morton)		X				X							X		X	X			X																							
Crenella serica Conrad	X									X	X			X																										X		
Liopistha protexta (Conrad)						X							X												X		X					X		X				X				X
Cuspidaria aff. C. jerseyensis Weller						X							X	X																												
Veniella conradi (Morton)		X				X							X		X	X		X	X																				X			
Crassatella vadosa Morton						?	X												X									X											X			
Titanosarcolites? sp.													X					X																								
Sauvagesia? sp.														X																												
Unicardium concentricum (Conrad)?		X																																								
Cardium (Pachycardium) spillmani Conrad																X																										
Cyprimeria alta Conrad?		X				X																																		X		
Legumen ellipticum Conrad													X	X		X																										
Tenea parilis Conrad																															X											
Pholas? pectorosa Conrad																							?								X											
Gastropoda:																																										
Epitonium sillimani (Morton)	X												X					X																								
Capulus spangleri Henderson?		X																																								
Gyrodes petrosus (Morton)		X				X	X						X	X	X	X		X					X																			
G. abyssinus (Morton)		X				X	X	X					X	X	X		?								X																	
Xenophora leprosa (Morton)						X	X						X	X		X			X																							
Turritella cf. T. vertebroides Morton							X																																			
T. tippana Conrad																																X		?		?						?
Anchura abrupta Conrad?						X		X					X																													
A. aff. A. abrupta Conrad							X																																			
Pugnellus densatus Conrad?													X																													
"Perissolax" octolirata (Conrad)		?				X							X																													
Cephalopoda:																																										
Eutrephoceras perlatus (Morton)	X					X	X	?					X				?	X									X					X		?					X			
Baculites tippaensis Conrad					X	X							X			X							X		X													X				
B. columna Morton													X														X															
B. carinatus Morton		X			X								X												X																	
Parapachydiscus cf. P. gollevillensis (D'Orbigny)						X																																				
Discoscaphites conradi (Morton) (several varieties)							X						X																													
D. iris Conrad?																																				X						
D. petechialis (Morton)							X																																			
Sphenodiscus lobatus (Tuomey)?							X																																			
S. cf. S. lobatus (Tuomey)?							X																																			
S. lenticularis mississippiensis Hyatt?																																							X			
S. aff. S. pleurisepta (Conrad)													X																													
Belemnitella americana (Morton)		X				X							X		X	X																										
Arthropoda (identified by Mary J. Rathbun):																																										
Callianassa sp.														X																												
Avitelmessus n. sp.																								X																		
Prehepatus n. sp.																															X											
Raninoides ovalis Rathbun																				X																						
A genus of family Portunidae, akin to Charybdis																																					X					
Crab claws						X	X															X																				
Vertebrata:																																										
Fish vertebrae																				X																						
Shark teeth	X																	X					X																			
Bone fragments							X	X																																		

The numbers are the collection numbers of the U. S. Geological Survey; the collections are in the U. S. National Museum.

Distribution of Prairie Bluff fossils

Species	Kemper County		Noxubee County								Oktibbeha County						Clay County			Chickasaw County											Pontotoc County											Union County
	6835 - Scooba, 3 mi. E	6850 - Scooba, 6 mi. N	6838 - Shuqualak, 1 mi. N	6837 - Macon, 7 1/2 mi. S	6836 - Macon, 7 mi. S	6479 etc. - Macon, 5 mi. S	17242 etc. - Macon, 4 mi. SW	17241 - Macon, 6 1/2 mi. WNW	17240 - Popes Chapel, 3/4 mi. E.	6842 - Edmonds Bridge	17232 - Starkville, 10 mi. S	17204 - Starkville	3186 etc. - State College	6845 - Starkville, 2 1/2 mi. N	6846 - Starkville, 3 mi. E	6847 - Starkville, 3 mi. NW	17225 - Phaba, 2 1/2 mi. E	6861 - Cedar Bluff, 4 mi. SW	17228 - Montpelier, 5 mi. NNE	17235 etc. - Sparta, 1 1/4 mi. N	17233 - Sparta, 1 1/2 mi. W	17231 - Houston, 5 3/4 mi. S	6474 - Houston, 1 1/2 mi. S	17251 - Buena Vista, 3 1/2 mi. W	6849 - Houston, 1 1/4 mi. NE	17230 - Houston, 4 1/2 mi. NE	17258 - Houston, 5 mi. W	17215 - Houston, 5 1/2 mi. NNE	6851 - Houston, 4 3/4 mi. NE	17227 - Houlka, 3 mi. NNW	17261 - Troy, 4 mi. SW	17257 - Pontotoc, 2mi. S	11952 - Pontotoc, 1 1/4 mi. S	6473 - Pontotoc, 1/2 to 3/4 mi. S	6853 etc. - Pontotoc	6852 - Pontotoc	6855 - Pontotoc, 1 mi. N	6856 - Pontotoc, 2 mi. N	17255 etc. - Pontotoc, 2 3/4 mi. N	6857 - Pontotoc, 5 mi. N	6858 - Pontotoc, 2 1/2 mi. NW	9604 - Wallerville
Coelenterata:																																										
Cliona aff. C. cretacica Fenton and Fenton						X													X																							
Cliona sp.						X	X						X								X						X					X							X			
Datmosmilia reesidei Wells						X	X						X																													
Micrabacia sp.																				X																						
Gorgonian coral?																				X																						
Echinodermata:																																										
A new genus and species of crinoid (aff. Mesocrinus)																				X																						
Catopygus sp.																													X													
Hardouinia subquadrata (Conrad)																															?						?				X	
Hemiaster slocumi Lambert						X							X													X	X	X	X	X	X				X	X	X	X	X	X		X
Linthia variabilis Slocum																														X			X		X	X	X					X
Micraster (Plesiaster) sp.																												X														
Vermes:																																										
Serpula sp.							?		?										X	X										X									X			
Hamulus onyx Morton																		X																X					X			X
H. squamosus Gabb																															X								X			
Molluscoidea:																																										
Bryozoan remains																				X								X														
Terebratulina floridana (Morton)													X					X																								
Mollusca:																																										
Pelecypoda:																																										
Nucula percrassa Conrad		X				X	X						X	X									?					X											X			
Nuculana longifrons (Conrad)						X																																				
Postligata? sp.																																										X
Idonearca capax (Conrad)		?				X	X						X				X		X		X							X											X			
Pinna laqueata Conrad																																						X				
Gervilliopsis ensiformis (Conrad)																																			X							
Inoceramus argenteus Conrad																															X				X	X						X
Ostrea plumosa Morton		X	X			?			?				X	X	X			X				?	X		X											X	X				X	
O. tecticrata Gabb	X								X					X	X				X				X		X	X		X		X	X			X	X	X	X	X	X	X		X
O. falcata Morton (and varieties)						X										X																										
O. mesenterica Morton							X	X												X			?																			
Gryphaea mutabilis Morton		X				X					X		X	X				X						X	X															X		
G. convexa (Say)													X																													
Gryphaeostrea vomer (Morton)			X				X							X			X						X		X		X			X	X	X			X			X				
Exogyra costata Say (wide costae)													X																													
E. costata Say (medium costae)			X										X						X																							
E. costata Say (narrow costae)	X	?				X	X						X	X			X	X	X		X		X		X	X	X	X		X	X	X		X	X			X	X	X	X	?
Trigonia angulicostata Gabb?																																			X							
Pecten simplicius Conrad?																						X																				
P. mississippiensis Conrad?															X																											
P. venustus Morton	X		X	X		X	X			X	X	X	X	X	X	X		X	X	X	X	X			X														X			
P. (Camptonectes) sp.																										X				X												
Plicatula mullicaensis Morton						X							X	X				X																								
P. mullicaensis Weller?							X																																			
Diploschiza melleni Stephenson	X					X							X		X	X			X		X			X																	
Lima acutilineata (Conrad)																										X					X				X				X			
L. reticulata Forbes		?											X					X			X													X	?					X		
Anomia argentaria Morton		X					X						X	X	X			X	X		X	X	X		X		X	X		X	X			X	X			X	X	X		
Paranomia scabra (Morton)		X				X							X		X	X			X																							
Crenella serica Conrad	X									X	X			X																										X		
Liopistha protexta (Conrad)						X							X												X		X					X		X				X				X
Cuspidaria aff. C. jerseyensis Weller						X							X	X																												
Veniella conradi (Morton)		X				X							X		X	X		X	X																				X			
Crassatella vadosa Morton						?	X												X									X											X			
Titanosarcolites? sp.													X					X																								
Sauvagesia? sp.														X																												
Unicardium concentricum (Conrad)?		X																																								
Cardium (Pachycardium) spillmani Conrad																X																										
Cyprimeria alta Conrad?		X				X																																		X		
Legumen ellipticum Conrad													X	X		X																										
Tenea parilis Conrad																															X											
Pholas? pectorosa Conrad																							?								X											
Gastropoda:																																										
Epitonium sillimani (Morton)	X												X					X																								
Capulus spangleri Henderson?		X																																								
Gyrodes petrosus (Morton)		X				X	X						X	X	X	X		X					X																			
G. abyssinus (Morton)		X				X	X	X					X	X	X		?								X																	
Xenophora leprosa (Morton)						X	X						X	X		X			X																							
Turritella cf. T. vertebroides Morton							X																																			
T. tippana Conrad																																X		?		?						?
Anchura abrupta Conrad?						X		X					X																													
A. aff. A. abrupta Conrad							X																																			
Pugnellus densatus Conrad?													X																													
"Periscolax" octolirata (Conrad)		?				X							X																													
Cephalopoda:																																										
Eutrephoceras perlatus (Morton)	X					X	X	?					X				?	X									X					X		?					X			
Baculites tippaensis Conrad					X	X							X			X							X		X													X				
B. columna Morton													X														X															
B. carinatus Morton		X			X								X												X																	
Parapachydiscus cf. P. gollevillensis (D'Orbigny)						X																																				
Discoscaphites conradi (Morton) (several varieties)							X						X																													
D. iris Conrad?																																				X						
D. petechialis (Morton)							X																																			
Sphenodiscus lobatus (Tuomey)?							X																																			
S. cf. S. lobatus (Tuomey)?							X																																			
S. lenticularis mississippiensis Hyatt?																																							X			
S. aff. S. pleurisepta (Conrad)													X																													
Belemnitella americana (Morton)		X				X							X		X	X																										
Arthropoda (identified by Mary J. Rathbun):																																										
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A genus of family Portunidae, akin to Charybdis																																					X					
Crab claws						X	X															X																				
Vertebrata:																																										
Fish vertebrae																				X																						
Shark teeth	X																	X					X																			
Bone fragments							X	X																																		

The numbers are the collection numbers of the U. S. Geological Survey; the collections are in the U. S. National Museum.

17231.—Road cut (S. edge, Sec. 32, T.14 S., R.3 E.), on the northward-facing slope of Chewawah Creek, Chickasaw County.

6474.—Cut on Mississippi Highway 15, 1 1/2 miles south of Houston, Chickasaw County.

17251.—Road cut on Mississippi Highway 8 at the top of eastward-facing slope of Pontotoc Hills (S.1/2, Sec. 4, T.14 S., R.4 E.), about 3 1/2 miles west of Buena Vista, Chickasaw County.

6849.—Gullies and washes in a field northwest of the Mobile and Ohio Railroad, 1 1/4 miles northeast of Houston, Chickasaw County.

17230.—Ditch at side of Houston-Van Vleet road (SE. cor., NE. 1/4, Sec. 14, T.13 S., R.3 E.), 1 1/4 miles northeast of the Mobile and Ohio Railroad crossing, Chickasaw County.

17258.—Eastward-facing slope of Soctahoma Creek (SE. cor., Sec. 4, T.13 S., R.3 E.), 1/4 mile east of Mississippi Highway 15, Chickasaw County.

17215.—Roadside exposure (SE. Cor., Sec. 3, T.13 S., R.3 E.), 1 1/2 miles east of Mississippi Highway 15, Chickasaw County.

6851.—Bank of branch stream northeast of a cut of the abandoned Mobile & Ohio Railroad, 4 3/4 miles northeast of Houston, Chickasaw County.

17227.—Upper part of northward-facing slope of Chookatonkchie Creek Valley (SE.1/4, Sec. 10, T.12 S., R.3 E.), 3 miles east-northeast of Houlka station, Chickasaw County.

17261.—Bald spots on both sides of a local road (NE. 1/4, Sec. 35, T. 11 S., R. 3 E.), Pontotoc County.

17257.—Quarry 450 feet southeast of old Mississippi Highway 15 at the crossing of the North Prong of Chiwapa Creek (NW.1/4, NW.1/4, Sec. 16, T.10 S., R.3 E.), 2 miles south of Pontotoc, Pontotoc County.

11652.—1.2 miles south of Pontotoc, Pontotoc County. L. W. Stephenson and C. W. Cooke, collectors.

6470.—Roadside exposure 1/2 to 3/4 mile south of Pontotoc, Pontotoc County.

6853, 17206.—Street exposure just east of an underpass of the Gulf, Mobile & Northern Railroad, several blocks south of the station, Pontotoc, Pontotoc County.

6852.—Right bank of small stream 1/8 to 1/4 mile south of the Gulf, Mobile & Northern Railroad station, Pontotoc, Pontotoc County.

6855.—A mile east of Pontotoc on the abandoned Tupelo road, Pontotoc County.

6856.—The abandoned Tupelo road, 2 miles east of Pontotoc, Pontotoc County.

17255, 17808.—Side road to a rock quarry 50 feet north of Mississippi Highway 6 (NW.1/4, Sec. 35, T.9 S., R.3 E.), 2 3/4 miles by road east of Pontotoc, Pontotoc County.

6857.—Old Tupelo road, on eastward-facing slope of Bob Miller Creek Valley, 5 miles east of Pontotoc, Pontotoc County. These fossils may be from the Ripley formation.

6858.—Floor of abandoned ballast pit east of the Gulf, Mobile & Northern Railroad, 2 1/2 miles northwest of Pontotoc, Pontotoc County.

9604.—Cut of the St. Louis-San Francisco Railway, a few hundred yards northwest of the station at Wallerville, Union County. The fossils may be from the Owl Creek formation.

LOCAL DETAILS

KEMPER COUNTY

The Prairie Bluff chalk crops out in a belt 2 to 4 miles wide from the Noxubee County line near Wahalak to the junction of Bodka and Scooba Creeks near the Alabama line. It consists of hard, brittle chalk containing phosphatic molds of mollusks in the lower part.

The southernmost exposure of Cretaceous strata that has been observed in Mississippi is on the eastward-facing slope of a branch of Bodka Creek, 7 miles by road east of Sucarnoochee (Sec. 5, T.10 N. R.19 E.).

SECTION 7 MILES EAST OF SUCARNOOCHEE

	Feet
Porters Creek clay (Paleocene)	
Dark-gray and brown sandy clay	3
Soft sandy chalk	2
Unconformity	
Prairie Bluff chalk (Upper Cretaceous)	
Hard blue slightly sandy massive chalk	6
	11

The town of Scooba is underlain by the Porters Creek clay of the Paleocene. Several poor exposures of greenish clays were observed in the streets and along the roads in the vicinity of the town, and a poor exposure of similar clay was noted along the Mobile & Ohio Railroad, a mile north of town. Clay overlain by 5 to 10 feet of sand of undetermined age (probably Paleocene) was observed at intervals along the Giles road for a distance of 2 1/2 miles east of Scooba.

On the Giles road 3 miles east of Scooba, where the road descends into a small valley (Sec. 2, T.11 N., R.18 E.), 6 feet of compact gray fossiliferous chalk (Coll. 6835) belonging to the Prairie Bluff appears in the road bed and is overlain by 6 feet of residual sandy clay derived from the Porters Creek clay of the Paleocene.

From Scooba northward along the old U. S. Highway 45 which joins the Wahalak-Binnsville road in Wahalak Creek Valley about 6 miles from Scooba, numerous exposures of greenish clay (Porters Creek) of the Midway and a few exposures of Prairie Bluff chalk were observed to the crest of the steep slope overlooking Wahalak Creek Valley (Secs. 4 and 9, T.12 N., R.18 E.).

SECTION ON THE OLD U. S. HIGHWAY 45 SOUTH OF WAHALAK CREEK

Porters Creek clay (Paleocene)	Feet
Brown sandy clay containing abundant phosphatic molds of fossils at base	9
Unconformity	
Prairie Bluff chalk	
Hard blue-gray slightly sandy chalk; contains phosphatic molds of fossils 8 feet below top and phosphatic material and *Diploschiza melleni* Stephenson in basal 6 feet. (Coll. 6480)	30
Unconformity	
Selma chalk equivalent in the upper part to Ripley formation	
Very argillaceous, micaceous, sandy chalk passing downward into fine sandy, micaceous hard chalk; the lower 15 feet contains *Exogyra cancellata* Stephenson. (Coll. 6480f)	85
	124

Much of the chalk in this section is shattered apparently by faulting, and the relations are not clear.

The Minnie Portis Spring is a quarter of a mile north of the post office at Wahalak in a small branch which has cut its valley 25 or 30 feet below the upland level. The surface materials at the spring and in the immediate vicinity are the greenish clays belonging to the Porters Creek clay. In the basal layer of a 21-foot dug well in a small branch valley a few hundred yards east of the spring, *Hamulus onyx* Morton, a Cretaceous fossil, was found associated with *Ostrea pulaskensis* Harris, indicating that the Prairie Bluff chalk closely underlies the Paleocene and that this Cretaceous fossil was mechanically intermingled with the Paleocene oysters.

Crider (20, pp. 18, 79) noted the chalk along the bed of Wahalak Creek in the vicinity of Wahalak. Although on the map Crider represents Scooba as situated in the Cretaceous area, in his text he states that the town is in the Flatwoods area which is underlain by the Midway. This and other statements in Crider's text show that, with the exception of his reference of the relatively thin calcareous and sandy basal beds of the Midway to the Ripley formation, his interpretation of the stratigraphy of the area was correct.

The following section is exposed on the northward-facing slope of Mossy Creek on the old Wahalak-Shuqualak highway (Sec. 2, T.12 N., R.17 E.) just south of the Noxubee County line:

SECTION SOUTH OF MOSSY CREEK

	Feet
Soil	
Reddish-yellow fine sand containing small ferruginous concretions	7
Porters Creek clay	
Chocolate-colored clay containing at base phosphatic molds of *Ostrea pulaskensis* Harris and other fossils	26
Unconformity (?)	
Clayton formation	
Light-gray sandy, glauconitic marl becoming somewhat indurated in basal one foot; contains phosphatic molds of *Ostrea pulaskensis* Harris in upper one foot and phosphatic molds of *Idonearca saffordi* (Gabb) and other fossils in the lower part	12
Unconformity	
Prairie Bluff chalk	
Hard massive brittle chalk to water level of lake (March 25, 1938)	11.5
	56.5

NOXUBEE COUNTY

The Prairie Bluff chalk appears at the surface in Noxubee County in a belt 2 to 3 miles wide from the northwest corner of the county in a south-southeasterly direction through Shuqualak to the Kemper County line. The formation consists of chalk of differing degrees of purity and is characterized by the presence of many phosphatic molds of mollusks at the base.

The Flatwoods, which is underlain by the Porters Creek clay of the Midway, is well developed immediately west of Shuqualak. North of the town several poor exposures of Prairie Bluff chalk were observed in the Macon road, and in a field west of the road a mile north of town the chalk is fairly well exposed in several bald spots; here were found the characteristic Upper Cretaceous fossils *Ostrea plumosa* Morton, *Gryphaeostrea vomer* (Morton), *Exogyra costata* Say, and *Pecten venustus* Morton (Coll. 6838). The town of Shuqualak is therefore situated approximately on the boundary between the Cretaceous and the Paleocene.

The Cretaceous-Paleocene contact was observed in the Macon-DeKalb road about half a mile north of the crossing of Running Water Creek and about 4 miles northwest of Shuqualak in a bald spot on the southward-facing slope of a small branch (NW.1/4, Sec. 36, T. 14 N., R.16 E.). (Figure 45.)

SECTION IN MACON-DE KALB ROAD, ABOUT 7 MILES SOUTH OF MACON, AND HALF A MILE NORTH OF THE CROSSING OF RUNNING WATER CREEK

Midway (Paleocene)	Feet
3. Dark greenish-gray compact calcareous clay containing *Foraminifera* and in the lower 3 to 5 feet large numbers of *Ostrea pulaskensis* Harris, identified by C. W. Cooke	8
2. Moderately hard bluish-gray somewhat sandy and argillaceous limestone. The upper 2 feet is a little harder than the lower portion and contains the following Paleocene (Midway) species: *Idonearca saffordi* (Gabb)?, *Venericardia alticostata* Conrad, *Turritella mortoni* Conrad, identified by C. W. Cooke; the basal portion weathers soft and a little shaly and contains *Gryphaeostrea vomer* (Morton)?, probably derived mechanically from the underlying Prairie Bluff chalk	6
Unconformity (indicated by some reworking of layer 1 in layer 2 and by borings in layer 1 filled by the darker materials of layer 2)	
Prairie Bluff chalk	
1. Gray very hard slightly sandy and argillaceous massive chalky limestone; *Baculities carinatus* Morton and *B. tippaensis* Conrad (Coll. 6836) were found loose on the surface near the upper part of this bed	4
	18

On the northward-facing slope of Dry Creek Valley (Sec. 18, T.14 N., R.17 E. and Sec. 13, T.14 N., R.16 E.), 4 miles southwest of Macon, are many bald spots of Prairie Bluff chalk containing abundant phosphatic molds of mollusks. Fossils were collected with the help of Mr. P. A. Bethany of Macon (Colls. 17242 and 17484). The contact of the Prairie Bluff chalk and Selma chalk is well exposed in a road cut at this locality. Fifteen feet of Selma is overlain by 25 feet of Prairie Bluff which is characterized by abundant glauconite, whereas the Selma has very little of this mineral. The unconformity is characterized by reworked fragments of Selma in the basal part of the Prairie Bluff and by borings as deep as 3 1/2 feet in the Selma, filled with glauconitic chalk of the Prairie Bluff. In two borings were found shells of *Diploschiza melleni* Stephenson, which had undoubtedly fallen in at the time the borings became filled with the calcareous ooze formed on the bottom of the Prairie Bluff sea.

SECTION HALF A MILE SOUTH OF POPES CHAPEL (E EDGE, SEC. 22, T.16 N., R.15 E.), NORTHWARD-FACING SLOPE OF LYNN CREEK VALLEY

	Feet
Midway (Paleocene)	
Very argillaceous, glauconitic chalk, containing some phosphatic molds of fossils; coarsely glauconitic in a layer about 5 feet below top; a layer 5 feet above base contains many shells of *Ostrea pulaskensis* Harris; to top of hill	28.0
Fine argillaceous, coarsely glauconitic, calcareous sand, indurated at top into a very hard ledge	2.5
Unconformity (very irregular surface)	
Prairie Bluff chalk	
Very hard light blue-gray chalk	12.0
	42.5

Figure 45.—Unconformity between the Prairie Bluff chalk of the Upper Cretaceous and the Clayton (?) formation of the Paleocene, in hill north of Running Water Creek, Sec. 36, T.14 N., R.16 E., Noxubee County. Note conglomerate of chalk pebbles, and borings into chalk filled with overlying marl. Photo by W. H. Monroe.

The position of the Cretaceous-Paleocene contact was approximately determined in an exposure on Horse Creek (Sec. 35, T.16 N., R.15 E.), a quarter of a mile north of Benjamin Taylor's store, and 13 miles northwest of Macon. The creek bank reveals 20 feet of massive, compact argillaceous, slightly siliceous, chalky limestone belonging to the Prairie Bluff chalk. The upper 2 feet of the rock is perforated with borings filled with gray calcareous clay. Weathered out in the soil on the slope just above the exposed beds of the Prairie Bluff were found the following Paleocene (Midway) fossils (identified by C. Wythe Cooke): An unidentified coral, *Idonearca saffordi* (Gabb), *Ostrea pulaskensis* Harris, *Turritella* sp., *Natica* (2 species), *Xenophora* sp., *Cylichna?* (mold), and *Pleurotoma?* (mold). The perforated portion of the chalk was doubtless immediately below the contact with the overlying Midway, the clay filling the borings having been derived from the sediments on the bottom of the transgressing Midway sea.

OKTIBBEHA COUNTY

The Prairie Bluff chalk crops out in Oktibbeha County in a belt 2 to 5 miles wide within which are Starkville and State College. The formation consists of more or less sandy chalk and fairly pure chalk and is characterized by many phosphatic molds of mollusks in the lower 10 feet.

The unconformity between the chalk and the overlying Midway (Paleocene) is well exposed at several places in the county.

SECTION ON U. S. HIGHWAY 82, WEST OF STARKVILLE (NW. COR., SEC. 4, T.18 N., R.14 E.)

	Feet
Midway (Paleocene)	
Glauconitic, argillaceous sand, containing *Idonearca saffordi* (Gabb)	5
Yellow glauconitic, calcareous sandstone; at base a conglomerate 6 inches thick made up of chalk fragments; contains *Ostrea pulaskensis* Harris	3
Unconformity	
Prairie Bluff chalk	
Light blue-gray chalk containing phosphate nodules and phosphatic molds of fossils, including *Baculites* sp., and *Ostrea tecticosta* Gabb	5
	13

On the left bank of Noxubee River 100 feet north of the bridge (S. edge Sec. 26, T.17 N., R.14 E.) near the southern edge of the county is exposed 5 1/2 feet of light-gray, fine sandy chalk of the Prairie Bluff, unconformably overlain by medium-grained glauconitic sand containing *Ostrea pulaskensis* Harris, of the Midway. At the south end of the exposure is a fault, with light-blue micaceous sand of the Midway faulted down to the east against the chalk. The fault strikes south 25° west and dips 70° to the east.

The Prairie Bluff chalk exposed in gullies on the campus of Mississippi State College, near Starkville, has yielded many species of fossils (Colls. 3186, 6843, and 6844).

SECTION IN MAYHEW ROAD NORTH OF STATE COLLEGE CAMPUS

	Feet
Prairie Bluff chalk	
3. Moderately sandy and argillaceous, chalky limestone, with many fossils	26
Unconformity	
Ripley formation	
2. Gray finely micaceous, somewhat calcareous sand, with a few slightly indurated ledges	20
1. Moderately sandy, very calcareous clay	4
	50

W. N. Logan (17, pp. 21-30) correctly referred layer 2 of the preceding section to the Ripley formation, but he regarded this sand as overlying the limestone (layer 3) and as constituting an outlier of the Ripley.

Starkville is located on the Cretaceous-Paleocene contact, as shown by the observations recorded below. The following succession of strata appears in a cut a quarter of a mile southwest of the station:

SECTION IN CUT OF ILLINOIS CENTRAL RAILROAD A QUARTER OF A MILE SOUTHWEST OF THE STATION AT STARKVILLE

	Feet
Midway (Paleocene)	
Weathered brown finely micaceous, sandy clay	5
Thinly stratified fine gray micaceous sand with yellow and brown streaks	7
Concealed	2
Greenish-gray to olive-green tough clay	1
	15

The beds in this section were mistakenly referred by Logan to the "Lafayette formation," but they constitute the eastward feather edge of the Midway, the main outcrop of which begins within less than 1.5 miles southwest of Starkville along this railroad.

From the cut toward the southwest the railroad track descends a rather steep grade, and half a mile from the station 6 feet of massive chalky limestone (Prairie Bluff chalk), overlain by 2 feet of yellow residual clay, is exposed in a shallow cut. A cut 1 1/2 miles southwest of the station reveals 4 or 5 feet of grayish to greenish-gray hard sandy residual clay, a weathered facies of the Porters Creek clay of the Midway (Paleocene). The exact contact between the Cretaceous and Paleocene was not observed in this vicinity.

The following section is exposed on the northward-facing slope of Trim Cane Creek Valley (SW.1/4, Sec. 16, T.19 N., R.14 E.):

SECTION 3 1/2 MILES NORTH-NORTHWEST OF STARKVILLE

	Feet
Prairie Bluff chalk	
Chalk containing many phosphatic molds of fossils and shells of *Diploschiza melleni* Stephenson and *Exogyra costata* Say (Coll. 6847)	8
Unconformity	
Ripley formation	
Fine chalky sand containing no phosphatic molds; contains *Exogyra costata* Say	47
Concealed to flood plain of Trim Cane Creek	8
	63

SECTION IN A WESTWARD-FACING SLOPE OF A ROAD CUT 3 MILES NORTHWEST OF STARKVILLE (SEC. 21, T.19 N., R.14 E.)

	Feet
Prairie Bluff chalk	
Impure, very glauconitic chalk containing many phosphatic molds of fossils; at the base is an indurated bed of sandy, glauconitic chalk; *Diploschiza melleni* Stephenson was observed only in the lower 10 feet of this bed; other fossils include *Ostrea falcata* Morton, *Pecten venustus* Morton, and *Paranomia scabra* (Morton)	50
Unconformity	
Ripley formation	
Dark-gray compact glauconitic, micaceous, calcareous fine sand	6
Concealed	22
	78

CLAY COUNTY

The Prairie Bluff chalk crops out in Clay County in a belt 1 to 4 miles wide trending north by west from Waddell to Montpelier. The formation consists of chalk of different degrees of purity, containing considerable coarse sand and phosphatic molds of mollusks in the lower part. The chalk is not conspicuous in the county for it is concealed in large part by alluvium and terrace deposits of Line Creek and its tributaries.

The unconformity between the Prairie Bluff chalk and the overlying Midway (Paleocene) strata is well exposed 3 miles north of Pheba on the northward-facing slope of Johnson Creek Valley (Sec. 4, T.20 N., R.13 E.). Porters Creek clay is exposed on the next hill to the south.

SECTION 3 MILES NORTH OF PHEBA

Midway (Paleocene)	Feet
Dark-brown glauconitic, argillaceous sand	15
Fine sandy chalk containing *Ostrea pulaskensis* Harris, and *Idonearca saffordi* (Gabb)?; the base contains reworked blocks of the underlying chalk	3
Unconformity	
Prairie Bluff chalk	
Massive blue-gray and white chalk containing *Ostrea tecticosta* Gabb and a small flat oyster; the upper part contains borings filled with the overlying sandy chalk	18
	36

The unconformity is also exposed in road cuts 2 miles due north of Montpelier (Center Sec. 25, T.15 S., R.3 E.).

One mile west of Montpelier on the low eastward-facing slope of Little Cane Creek Valley (Sec. 3, T.16 S., R.3 E.) is exposed 5 feet of chalk containing *Exogyra costata* Say, overlain by about a foot of very hard sandy limestone containing crinoid remains, probably the same bed as that observed 1 1/4 miles north of Sparta (Sec. 10, T.15 S., R.3 E.) in Chickasaw County.

SECTION IN ROAD CUT ON TOP OF PONTOTOC RIDGE 5 MILES NORTH-NORTHEAST OF MONTPELIER (SE.1/4, SW.1/4, SEC. 8, T.15 S., R.4 E.)

Prairie Bluff chalk	Feet
Brown sandy clay (residual from chalk)	11
Fine sandy, argillaceous chalk containing many phosphatic molds of mollusks; the chalk becomes much more sandy near the base where phosphatic molds are especially abundant (Coll. 17228)	13
Unconformity (sharp change in lithology)	
Ripley formation	
Highly cross-bedded very micaceous fine to medium sand	33
	57

CHICKASAW COUNTY

The Prairie Bluff chalk crops out in a narrow north-south belt a little west of the middle of Chickasaw County. It consists of argillaceous and sandy chalk in the lower part, overlain in the northern part of the county by more sandy beds. Characteristic features of the basal 10 feet or so of the formation are the large number of phosphatic molds of mollusks and, at least in the southern part of the county, the presence of *Diploschiza melleni* Stephenson.

The chalk contains one of the few crinoid-bearing beds in the Coastal Plain. Bald spots in fields and a cut in the Houston road on the slope down to the flood plain of Cane Creek (S.1/2 Sec. 10, T.15 S., R.3 E.), 1 1/4 miles north of Sparta, expose the section described below.

SECTION ON HOUSTON ROAD, 1 1/4 MILES NORTH OF SPARTA

Prairie Bluff chalk	Feet
Light-brown chalky clay passing upward into reddish-brown residual clay; to top of hill	6
Thin-bedded calcareous, micaceous sand containing fossils (Colls. 17235 and 17253); at base a hard ledge (1 inch thick) of calcareous sandstone containing many fragments of crinoid stems	1
Very glauconitic, argillaceous chalk passing downward into dark-gray highly and coarsely glauconitic, sandy, argillaceous chalk containing no phosphatic material; contains *Exogyra costata* Say and *Anomia argentaria* Morton	27
Similar material containing *Diploschiza melleni* Stephenson and phosphatic molds of mollusks (Coll. 17233)	33

There is a strong north dip at this place that was not taken into account in measuring the thickness of the two lower beds. Accordingly the thickness recorded represents the difference in altitude of the base and top of each bed rather than its actual thickness. Bald spots 150 feet southwest of the hill and 22 feet below its crest show impure argillaceous, glauconitic chalk containing phosphatic molds of mollusks. The same bed about 1000 feet north of the hill is 56 feet below the crest, making a total north dip of 34 feet in about 1000 feet, or roughly 175 feet to the mile. The highest exposure of the crinoid bed is 6 feet below the top of the hill near the south end of the section, but at the northernmost exposure the bed is 25 feet below the same datum. Locally this bed dips north at a rate of 11°. Such a strong north dip is probably caused by faulting of some magnitude for this area. Minor faulting was observed in the bald spots southwest of the section, and a sharp reversal in dip was observed at the edge of the flood plain of Cane Creek.

The Prairie Bluff chalk appears in numerous small exposures in the vicinity of Houston, some of which are described in following paragraphs.

SECTION IN CUT OF ABANDONED MOBILE & OHIO RAILROAD AT HOUSTON

	Feet
Midway (Paleocene)	
Residual yellow sandy, ferruginous clay	7
Gray massive, compact calcareous, glauconitic, somewhat argillaceous, finely micaceous sand	5
Loose yellow ferruginous sand with scattered white grains of kaolin (?), poorly exposed	4
Unconformity (sharp contact)	
Prairie Bluff chalk	
Gray massive chalky, glauconitic, finely sandy clay	2
	18

SECTION IN THE OLD HOULKA ROAD, 1 1/2 MILES NORTH OF HOUSTON

	Feet
Midway (Paleocene)	
Yellowish hard calcareous, glauconitic sandstone	7
Dark-gray compact argillaceous, glauconitic, calcareous sand, containing *Ostrea pulaskensis* Harris	3
Greenish-gray calcareous sandstone	0.5
Compact red and yellow fine micaceous sand	1
Reddish rather coarse sandstone	0.2
Yellow rather fine stratified mealy sand	1
Unconformity (sharp contact)	
Prairie Bluff chalk	
Compact gray argillaceous limestone	1
	13.7

On Mississippi Highway 15 leading south from Houston, about a mile from town, the following section is exposed in a northward-facing slope of one of the headwater branches of Chico Creek:

SECTION IN ROAD A MILE SOUTH OF HOUSTON

	Feet
Midway (Paleocene)	
Yellow sandy weathered clay	6
Red coarse ferruginous sand slightly indurated	3
Red ferruginous clay	0.5
Unconformity	
Prairie Bluff chalk	
Tough argillaceous chalk with few fossils; *Baculites* sp. observed; base at creek bed	25
	34.5

The weathered representatives of the Paleocene (Midway) sands and clays unconformably overlying the Prairie Bluff chalk cap the hills for a distance of 2 miles east of Houston.

An interesting section including both Paleocene and Cretaceous strata, is exposed 2 1/2 miles northeast of Houlka in cuts on a local road on the northeastward-facing slope of Chookatonkchie Creek Valley (NW.1/4 Sec. 4, T.12 S., R.3 E).

SECTION 2 1/2 MILES NORTHEAST OF HOULKA

	Feet
Midway (Paleocene)	
Dark greenish-gray coarsely glauconitic, sandy clay weathering brick-red, with a bed, 1 foot thick, of waterworn clay balls in sand, at base; *Ostrea pulaskensis* Harris is abundant in the upper 15 feet	40
Cross-bedded glauconitic, highly micaceous fine ferruginous sand containing numerous clay balls; the base of this layer is undulating	5
Thin-bedded highly ferruginous clay and sand indurated in thin layers; both the top and bottom surfaces of this bed are undulating and east of the place where the section was measured the bed increases in thickness to 5 feet, and contains numerous thin beds of gray clay	2
Light-gray micaceous coarse argillaceous sand, locally indurated to concretionary masses, one of which is 5 feet in diameter; contains broken shell fragments, of which one mold of *Baculites* sp. was identified; this bed is similar to that exposed in the Gulf, Mobile, & Northern Railroad cut at Pontotoc, and many of the shells are preserved as clay replacements; the bed thins toward the east nearly pinching out within 25 feet allowing the overlying bed to descend almost to the chalk	12
Unconformity (poorly exposed)	
Prairie Bluff chalk	
Dark-gray, weathering to light-tan very argillaceous, slightly sandy chalk; contains *Exogyra costata* Say and *Baculites* sp.	28
	87

The bed of sand, containing reworked Cretaceous shells, at the base of the Paleocene, is remarkably persistent from this place north through Pontotoc County.

PONTOTOC COUNTY

The Prairie Bluff chalk crops out a little to the east of the middle of Pontotoc County in a narrow irregular north-south belt at the western edge of which is the city of Pontotoc. The formation consists in general of argillaceous and sandy chalk. The chalk rests unconformably on beds of hard sandy limestone which form the upper part of the Ripley formation in this county. The base of the chalk contains many phosphatic molds of mollusks. The chalk is overlain in all but the southernmost part of the county by a bed of ferruginous sand that is considered a southward-extending tongue of the Owl Creek formation, which is too thin to be shown on the small scale geologic map (Plate 1A).

Bald spots on both sides of a local road in the southern part of the county (NE. 1/4, Sec. 35, T. 11 S., R. 3 E.) show 4 feet of hard cavernous, sandy limestone of the Ripley formation, making a shelf 20 feet wide. It is overlain by 23 feet of sandy, argillaceous chalk of the Prairie Bluff that contains abundant phosphatic molds of mollusks (Coll. 17261).

The contact of the Ripley and the Prairie Bluff is well exposed in a quarry 450 feet southeast of old Mississippi Highway 15 at the crossing of the North Prong of Chiwapa Creek (NW.1/4,NW.1/4, Sec. 16, T.10 S., R.3 E.), 2 miles south of Pontotoc.

SECTION IN QUARRY 2 MILES SOUTH OF PONTOTOC

	Feet
Prairie Bluff chalk	
Calcareous, sandy clay containing phosphatic molds of mollusks (Coll. 17257); merges with soil above	15
Unconformity	
Ripley formation	
Hard calcareous coarse sandstone (Colls. 17201 and 17256)	6
Concealed to floodplain	7
	28

At this quarry there is a small fault with a 10-foot downthrow to the west. Adjacent to the quarry, the sandstone at the top of the Ripley formation crops out at road level on the northwest side of Mississippi Highway 15.

The Prairie Bluff is exposed on Mississippi Highway 6 (Tupelo road) at the top of the hill above the westernmost branch of Bob Miller Creek, 2 3/4 miles by road east of Pontotoc (NW.1/4, Sec. 35, T.9 S., R.3 E.).

SECTION ON SIDE ROAD NEAR MISSISSIPPI HIGHWAY 6, 2 3/4 MILES EAST OF PONTOTOC

	Feet
Prairie Bluff chalk	
Highly weathered slightly sandy, argillaceous chalk containing abundant phosphatic molds of mollusks (Colls. 17255 and 17808)	28
Unconformity	
Ripley formation	
Hard slightly ferruginous medium-grained sandstone containing *Exogyra costata* Say (narrow-ribbed variety)	3
	31

The sandy limestone of the Ripley formation and the overlying impure Prairie Bluff chalk are well exposed at many places in the northern part of the county (Sec. 25, T.8 S., R.3 E., and Secs. 29, 30, and 31, T.8 S., R.4 E.). (See Figure 44.)

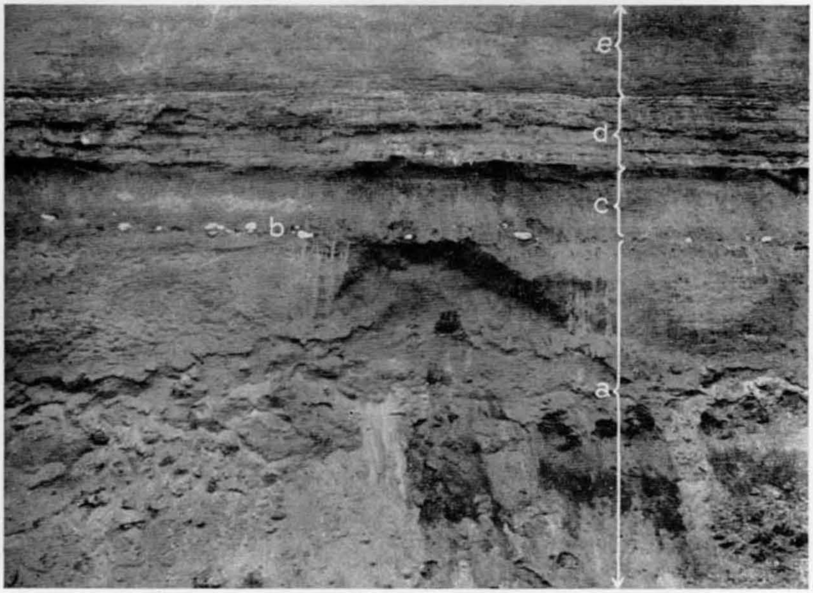

Figure 46.—Cretaceous-Paleocene contact in cut of Gulf, Mobile, & Northern Railroad, half a mile south by west of Pontotoc, Pontotoc County. a. Glauconitic sand of the Owl Creek formation. b. Cretaceous-Paleocene contact marked by a row of light-gray pebbles. c. Basal sand of Clayton formation (Paleocene), containing mechanically included Owl Creek fossils preserved as clay replacements. d. Laminated sand and clay of the Clayton formation. e. Weathered sand of the Clayton formation.

Near Pontotoc the uppermost part of the Prairie Bluff chalk merges into sandy beds here considered to be a southward-extending tongue of the Owl Creek formation, a tongue that could not be shown on the small scale geologic map (Plate 1A). The relations of these formations are shown in a deep cut of the Gulf, Mobile and Northern Railroad, a half mile south by west of the station, and in small outcrops of Cretaceous rock in the lower slopes of the small branch between the station and the cut (Figure 46).

SECTION IN A CUT OF THE GULF, MOBILE & NORTHERN RAILROAD, HALF A MILE SOUTH BY WEST OF PONTOTOC

Clayton formation (Paleocene)	Feet
5. Weathered deep-red ferruginous sand becoming brownish below, and grading into the grayish sand of the underlying bed; fossils, probably from this sand, are enumerated in the text below	25
4. Laminated sand and clay, the sand predominating, forming a slightly projecting ledge	4
3. Coarse yellowish glauconitic sand with numerous extremely soft shells preserved as clay replacements (64, pp. 96-99; 65, pp. 393-397), interpreted to have been mechanically drived from the underlying Owl Creek formation, though they show only slight indication of having been water-worn; the following were recognized: *Glycymeris* sp., *Crassatella ripleyana* Conrad?, *Cardium tippanum* Conrad, *Turritella* (n. sp. with two spiral ribs), *Pugnellus densatus* Conrad?, and *Liopeplum canalis* (Conrad). In the lower foot are numeous mechanically derived chunks of gray argillaceous sand and sandy clay, probably representing a basal Paleocene conglomerate (Figure 46)	3.5
Unconformity (obscured by weathering and marked only by the line of clay boulders).	
Owl Creek formation	
2. Mottled grayish to purplish massive glauconitic sand containing poorly preserved tubes of *Halymenites major* Lesquereux; about midway of this layer in the middle of the cut several feet of the sand, poorly exposed, is indurated to calcareous fossiliferous sandstone, containing *Ostrea tecticosta* Gabb, *Exogyra costata* Say, *Gryphaeostrea vomer* (Morton), and *Pecten simplicius* Conrad	25
Prairie Bluff chalk (sandy facies)	
1. Gray calcareous glauconitic sandstone, the top exposed at one place in the north end of the cut, but appearing in several places in the lower slopes of the branch valley north of the cut; contains many specimens of echinoids of several species, and other fossils	10
	67.5

Layer 5 of the section is largely concealed on the adjacent hill slopes by residuum and creep materials having a maximum thickness of 8 feet or more, which on account of weathering can be separated only with difficulty from the Paleocene sand in place. The following Midway (Paleocene) fossils, identified by C. W. Cooke, were found in gullies west of the south end of the cut in such position that it was difficult to determine whether they were in place in the weathered sand of layer 5, or were in the residuum, but it is reasonably safe to assume that, if not actually in place, they were derived from layer 5: *Idonearca* cf. *I. saffordi* (Gabb)?, *Venericardia* sp. cf.

V. smithi Aldrich, *Turritella* sp., *Mesalia pumila* Gabb?, and *Enclimatoceras* sp.

Fossils were collected from the gray sandstone, layer 1, at two localities between the cut and the Gulf, Mobile and Northern Railroad station at Pontotoc: from right bank of small stream, an eighth to a quarter of a mile south of the station (Coll. 6852), and from a street exposure just east of an underpass several blocks south of the station (Colls. 6853 and 17206).

SECTION IN GULLIES NEAR THE ABANDONED PONTOTOC-TUPELO ROAD, 2 MILES EAST OF PONTOTOC (SW.1/4, SW.1/4, SEC. 35, T.9 S., R.3 E.)

	Feet
Reddish-brown clay soil	11
Prairie Bluff chalk	
Gray chalky, argillaceous very fine sand weathering to cream-colored sandy, chalky clay; makes large bald spot; phosphatic molds of mollusks in lower 6 feet	44
Unconformity	
Ripley formation	
Partly indurated calcareous, glauconitic sand	4
Concealed to branch	5
	64

About 5 miles east of Pontotoc on the old Tupelo road (Sec. 6, T.10 S., R.4 E.) on the slope overlooking Bob Miller Creek Valley, a section is exposed that may include some prairie Bluff chalk. About 15 feet above the flood plain of the creek on a hill north of the road, hard limestone of the Ripley formation is exposed. On the road from 25 feet to 60 feet above the flood plain, compact glauconitic, calcareous, sandy clay is exposed, containing *Hemiaster slocumi* Lambert, *Belemnitella americana* (Morton), phosphatic molds of *Gyrodes petrosus* (Morton) and other fossils common in the Prairie Bluff chalk (Coll. 6857). This material is overlain by 30 feet of weathered red ferruginous sand.

If the material questionably referred to the Prairie Bluff actually belongs in that formation, it is probably faulted down, for the Prairie Bluff-Ripley contact has been seen high on the hills several miles to the west.

UNION COUNTY

The Prairie Bluff chalk is represented in Union County by chalky sand and calcareous clay that contain numerous phosphatic molds of mollusks. This impure chalk unconformably overlies hard sandy limestone of the Ripley formation. The Prairie Bluff is conformably overlain by the Owl Creek formation and merges into it toward the north. No exact boundary can be drawn between the Owl Creek and the Prairie Bluff, as the feather edge of Prairie Bluff in the northern part of the county is too thin to be shown separately on the small scale map (Plate 1A).

The contact of the Prairie Bluff chalk and the Ripley formation is exposed on the westward-facing slope of Cane Creek Valley near the northern edge of the county (Sec. 11, T.6 S., R.3 E.).

SECTION ON WESTWARD-FACING SLOPE OF CANE CREEK VALLEY

	Feet
Owl Creek formation (?)	
Red clay soil	16
Prairie Bluff chalk (impure facies)	
Tan and gray chalky, silty clay containing *Exogyra costata* Say (narrow-ribbed variety) and abundant phosphatic molds of pelecypods and gastropods	22
Unconformity	
Ripley formation	
Hard cavernous limestone	4
Cross-bedded red and yellow sand containing tubes of *Halymenites major* Lesquereux; may be in part residual from limestone and calcareous sandstone; to flood plain of creek about	52
	94

OWL CREEK FORMATION

GENERAL FEATURES

NAME

The name Owl Creek tongue of the Ripley formation was proposed in 1926 by Wade (46, pp. 3, 7, 9) who applied it to marine sediments that overlie the McNairy sand member of the Ripley formation from southern Tippah County, Mississippi, northward into Hardeman County, Tennessee; the type section is on Owl Creek 2.5 miles northeast of Ripley, Tippah County. Wade (38, pp. 73-101) had previously used the name Owl Creek horizon for the same lithologic unit.

Hilgard (11, pp. 85-92) in his classic report on the geology of Mississippi, published in 1860, repeatedly referred to the fossiliferous marl on Owl Creek as the Owl Creek marl which he included in his Ripley group, but he did not formally define the marl as a subordinate unit of that group. He did not designate a type locality of the group as a whole.

Although Conrad (9, p. 324) had in 1858 suggested that the name Ripley group might properly be applied to the beds exposed on Owl Creek, Hilgard used the name in a much broader sense to include all the beds between the Selma chalk below and the Paleocene above, thus making its application coextensive with the physiographic belt known as the Pontotoc Hills. He actually included some Paleocene strata in the Ripley. Hilgard's usage was subsequently generally followed until the present authors in 1937 (61, pp. 806-809) proposed to raise the so-called Owl Creek tongue to the rank of formation, thus restricting the Ripley formation to the beds between the Owl Creek above and the Selma below. The reason for this reclassification was that the Owl Creek is separated from the underlying beds by an important unconformity, and should therefore be treated as an independent formation. As thus classified the old historic names, Ripley and Owl Creek, are retained with equal rank in current usage.

The Owl Creek tongue, as defined by Wade, included some marine beds in Tippah County and in northern Union County, which intervene between the McNairy sand member of the Ripley formation below and the Owl Creek formation above, as here defined, and which in reality constitute an unnamed northward extending marine tongue of the Ripley formation (Plate 1A).

AREAL DISTRIBUTION

In Mississippi the Owl Creek formation comes to the surface in a narrow irregular north-south belt toward the western border of the Pontotoc Hills; the belt ranges from less than a half mile wide in central and northern Pontotoc County, to 8 miles wide in Tippah County. Because the formation is relatively thin (50 feet or less) and the topography hilly, the boundaries separating it from the Ripley formation below and the Clayton formation (Paleocene) above are exceedingly irregular.

The formation extends northward into Tennessee for about 18 miles, cropping out in southwestern McNairy and southeastern Hardeman counties, beyond which point it is overlapped by the Midway series (Paleocene). The formation does not terminate, however, in Tennessee, but continues northward under cover of the transgressing Midway sediments and reappears at the head of the Mississippi embayment in Crowleys Ridge in southeastern Missouri (53, pp. 1003-1009; 58, pp. 1-35).

In Union and Pontotoc counties, Mississippi, the Owl Creek formation merges laterally southward into impure chalk of the Prairie Bluff chalk.

LITHOLOGIC CHARACTER AND THICKNESS

The Owl Creek formation consists of argillaceous, glauconitic, fine sand and sandy clay, calcareous in places. In the northern part of its belt of outcrop it is less calcareous than in its southern part, where it merges imperceptibly into an impure facies of the Prairie Bluff chalk. At the type locality on Owl Creek, 2 1/2 miles northeast of Ripley, Tippah County, the formation consists of fine dark greenish-gray compact, tough massive micaceous, calcareous, argillaceous, slightly glauconitic sand. A foot or so of hard sandy limestone has been noted in the formation at a few places.

The exposed part of the formation is thickest in the southern part of its area of outcrop in Union County, where it measures about 50 feet. Toward the north the formation becomes progressively thinner, owing to the transgression of the Midway already described; in northern Tippah County only the lower 20 feet of the formation is exposed.

STRATIGRAPHIC AND AGE RELATIONS

The Owl Creek formation rests unconformably on the Ripley formation in Tippah County and conformably on a northward extending tongue of the Prairie Bluff chalk in Union and Pontotoc counties. At most places the unconformity is obscured by weathering, but in fresh exposures it is marked by a sharp change in lithology, and in the southern part of its area of outcrop by the presence of large numbers of phosphatic molds of invertebrate fossils in the base of the Owl Creek. In Tennessee the Owl Creek formation rests on the McNairy sand member of the Ripley formation; farther south in Tippah County in the western part of its area of outcrop it rests on a tongue of marine sand, clay, and sandy limestone that extends northward from the upper part of the Ripley formation above the southward extending tongue of the McNairy sand. Toward the east this northward extending tongue of marine material merges into the McNairy sand, so that the Owl Creek rests directly on the McNairy.

The Owl Creek merges laterally southward into the Prairie Bluff chalk in Union and Pontotoc counties by a progressive decrease in sand and an increase in chalk. The lower part of Owl Creek formation merges into the Prairie Bluff chalk near the Tippah-Union County line. Toward the south successively higher parts of the formation merge into chalk, until in southern Pontotoc County the entire unit is represented by the Prairie Bluff chalk.

The Owl Creek is overlain unconformably by the Clayton formation of the Paleocene. The unconformity is well exposed at several places in Tippah, Union and Pontotoc counties.

The studies of the senior author have shown a close faunal relationship between the Owl Creek formation and its equivalent, the Prairie Bluff chalk, on the one hand, and the Corsicana marl of Texas, on the other. These relationships are discussed in the section of this report on the Prairie Bluff chalk.

PHYSIOGRAPHIC EXPRESSION

The belt of outcrop of the Owl Creek formation is so narrow that its topographic expression is masked by that of the underlying sandy Ripley formation and the overlying sandy Clayton formation, both of which give rise to more or less hilly topography. Along the western side of the belt the formation crops out mainly in the sides and bottoms of the stream valleys; eastward up dip it rises to the tops of the hills and ridges where it appears as residual silt and sandy clay underlain by the Ripley formation.

FOSSIL CONTENT

Fossils have been collected from the Owl Creek formation in two counties, Union and Tippah, and are listed in the accompanying table.

Fossil localities in the Owl Creek formation

17805.—Cut of Mississippi Highway 15 on northward-facing slope of Kings Creek Valley (Sec. 29, T.7 S., R.3 E.), 3 1/4 miles south of New Albany, Union County.

6468c.—Cut of Pontotoc road on northward-facing slope of Kings Creek Valley, 3 miles south of New Albany, Union County. May be same locality as 17805.

6872.—Northward-facing slope of Kings Creek Valley on the first north-south road east of the Pontotoc road, 3 miles south of New Albany, Union County.

9509.—Gullies near St. Louis-San Francisco Railway, a few hundred yards northwest of the station at Wallerville, Union County.

9510.—Cut at an overhead bridge on St. Louis-San Francisco Railway, 4 miles southeast of New Albany, Union County. Bed 3 of section.

9512.—Cut at an overhead bridge on St. Louis-San Francisco Railway, 4 miles southeast of New Albany, Union County. Bed 1 of section.

6868.—Foot of the northward-facing slope of Kings Creek Valley on Wallerville road, 2 miles southeast of New Albany, Union County.

17278.—Roadside exposure (Sec. 24, T.5 S., R.4 E.), 3/4 mile south of Dumas, Tippah County.

75, 541, 546, 707, 6464a-c.—Bluff on Owl Creek, land of William Hill (Sec. 7, T.4 S., R.4 E.), 2 1/2 miles northeast of the court house at Ripley, Tippah County. L. C. Johnson, T. W. Stanton, and L. W. Stephenson, collectors.

6463.—Yancey Hill, 3 1/2 miles east of Ripley on the Corinth road, Tippah County. Near base of section.

6463b.—Yancey Hill, 3 1/2 miles east of Ripley on the Corinth road, Tippah County. Ten feet below top of Owl Creek formation.

6875.—Bluff on south side of White Oak Creek Valley on the Erastus Blackwell place, 5 1/2 miles northeast of Ripley, Tippah County.

713.—Walnut Creek, Braddock's farm, 7 miles northeast of Ripley, Tippah County. T. W. Stanton, collector.

9516.—Chalybeate Spring, 2 miles southeast of Walnut, Tippah County.

Distribution of Owl Creek fossils

Species	Union County							Tippah County						
	17805 - New Albany, 3 1/4 mi. S	6468c - New Albany, 3 mi. S	6872 - New Albany, 3 mi. S	9509 - Wallerville	9510 - New Albany, 4 mi. SE	9512 - New Albany, 4 mi. SE	6868 - New Albany, 2 mi. SE	17278 - Dumas 3/4 mi. S	75 etc - Owl Creek	6463 - Yancey Hill, near base	6403b - Yancey Hill, near top	6675 - White Oak Creek	713 - Walnut Creek	9518 - Chalybeate Spring
Coelenterata:														
Micrabacia hilgardi Stephenson									X					
Echinodermata:														
Hemiaster sloeumi Lambert			X											
Linthia variabilis Slocum	X								?					
Vermes:														
Serpula lineata (Weller)									X			X		
S. cretacea (Conrad)									X					
Hamulus onyx Morton					X		X		X					
Mollusca:														
Pelecypoda:														
Nucula cuneifrons Conrad?									X				X	
N. percrassa Conrad			?						X			X	X	
Nuculana longifrons (Conrad)									X					
Nemodon eufaulensis (Gabb)			X						X					
Glycymeris cf. G. rotundata (Gabb)									X					
Postligata aff. P. wordeni Gardner												X	X	
Idonearca capax (Conrad)			X			X	X		X	X		X	X	
Pinna laqueata Conrad			X						X	X	X	X	X	
Gervilliopsis ensiformis (Conrad)									X			X	X	
Inoceramus argenteus Conrad			X						X			X	X	X
Ostrea plumosa Morton									X			X		X
O. tecticosta Gabb						X	X		X			X		
Gryphaeostrea vomer (Morton)							X							
Exogyra costata Say (medium costae)										X				
E. costata Say (narrow costae)		X			X	X	X	X	X			X	X	
Trigonia angulicostata Gabb							X		X			X	X	
T. eufaulensis Gabb							X		X					
Pecten simplicius Conrad					X				X					X
P. venustus Morton							X							
Pecten (Camptonectes) sp.			X		X		X	X	X			X	X	
Lima acutilineata (Conrad)			X	X			X		X	X		X		X
L. reticulata Forbes			X		X				X	X				
Anomia argentaria Morton							X	X	X					
Pulvinites argenteus Conrad									X			X		
Crenella serica Conrad					X									
C. aff. C. elegantula Meek and Hayden									X					
Dreissensia tippana Conrad									X					
Pholadomya conradi Gardner?								X	X			X		
Anatimya anteradiata (Conrad)									X					
A. postsulcata (Conrad)									X					
Periploma? applicata (Conrad)?									X					
Liopistha protexta (Conrad)		X			X	X	X		X			X		X
Veniella conradi (Morton)			X						X	X		X	X	
Crassatella vadosa ripleyana (Conrad)									X			X	X	
Scambula perplana Conrad			X											
Unicardium concentricum (Conrad)									X					
Cardium (Trachycardium) eufaulense Conrad									X					
C. (Granocardium) tippanum Conrad									X					
C. (G.) kümmeli Weller?									X					
C. (Pachycardium) spillmani Conrad									X	X	X			
Aphrodina tippana Conrad									X			X		
Cyprimeria alta Conrad									X	X		X	X	
C. depressa Conrad									X	X		X	X	X
Legumen ellipticum Conrad									X			X		X
Tenea parilis Conrad									X			X		
Aenona eufaulensis Conrad									X					X
Linearia metastriata Conrad?									X					
Leptosolen biplicatus Conrad									X			X		X
Cymbophora lintea (Conrad)									X					
Corbula aff. C. crassiplica Gabb									X					
Pholas? pectorosa Conrad							X		X	X				X
Scaphopoda:														
Dentalium sp.									X					
Cadulus sp.									X					
Gastropoda:														
Hippocampoides? subplanus (Gabb)?									X					
Polinices rectilabrum (Conrad)									X			X		
Gyrodes supraplicatus (Conrad)									X					
G. petrosus (Morton)							X							
G. aff. G. spillmani Gabb									X					
Turritella vertebroides Morton									X			X		
T. tippana Conrad				X					X			X		
T. trilira Conrad									X	X				
Anchura abrupta Conrad?									X					
A.? cf. A.? lobata Wade									X					
A.? aff. A.? decemlirata (Conrad)									X					
Pterocerella tippana Conrad									X					
Pugnellus densatus (Conrad)?									X			X		
Pyropsis perlata Conrad?									X					
"Perissolax" octolirata (Conrad)									X	X				
Morea cf. M. marylandica Gardner									X					
Strepsidura? interrupta (Conrad)?									X					
Fusus? novemcostatus (Conrad)									X					
F.? tippanus Conrad									X					
F.? novemliratus Conrad									X					
Pyrifusus? bellaliratus (Conrad)?									X					
Pyrifusus subdensatus Conrad									X					
Liopeplum cretaceum (Conrad)									X					
L. canalis (Conrad)									X				X	
L. subjugosum (Gabb)?									X			X	X	
Drilluta ripleyana (Conrad)									X					
D.? distans (Conrad)?									X					
Volutomorpha aspera Dall									X					
Volutoderma protracta Dall									X					
Parafusus cretacensis Conrad									X					
Paladmete cancellaria (Conrad)									X				X	
"Actaeonina" lintea (Conrad)									X					
Ringicula aff. R. pulchella Shumard									X					
Bullopsis cretacea Conrad									X					X
Bullaria macrostoma (Gabb)									X					
Cephalopoda:														
Eutrephoceras sp. (small)									X					
Baculites tippaensis Conrad		?		X					X			X		X
B. carinatus Morton									X					
Discoscaphites iris (Conrad)	X	X					?		X			X	X	
Sphenodiscus lenticularis mississippiensis Hyatt									X					
S. aff. S. pleuriseptus (Conrad)									X			X		
S. beecheri Hyatt									X					
Vertebrata:														
Shark teeth							X							

The numbers are the collection numbers of the U. S. Geological Survey; the collections are in the U. S. National Museum.

LOCAL DETAILS

TIPPAH COUNTY

The Owl Creek formation crops out in Tippah County in a belt trending south by west half a mile to 8 miles wide (including outliers).

The uppermost strata of the formation appear in the bluff along the right side of Owl Creek, one of the small headwater streams of West Hatchie Creek, northeast of Ripley. Though the exposures are

Figure 47.—Owl Creek formation at the classic Owl Creek locality, 2 1/2 miles northeast of Ripley, Tippah County. Photo by L. W. Stephenson.

insignificant in extent, owing to the growth of vegetation on the slopes, they are highly important, for they have yielded the bulk of the fossil material contained in the earlier collections from the formation. The best locality on Owl Creek examined by the writers is on land owned by the William Hill estate (Sec. 7, T.4 S., R.4 E.) about 2 1/2 miles northeast of the court house at Ripley (2.7 miles by road); at a spring near the dwelling, the following section is exposed (Figure 47):

SECTION IN BLUFF ON OWL CREEK, LAND OF WILLIAM HILL ESTATE, 2 1/2 MILES NORTHEAST OF RIPLEY

	Feet
Slope concealed by vegetation	8
Clayton formation (Paleocene)	
Weathered red ferruginous, sandy clay	4
Greenish-gray micaceous, sandy clay weathered yellow and red in places	3
Weathered brown and red more or less argillaceous marine sand	8
Hard fossiliferous sandy limestone	8
Unconformity (sharp contact)	
Owl Creek formation	
Dark greenish-gray fine compact tough massive micaceous, calcareous, argillaceous, slightly glauconitic sand containing large numbers of well preserved shells, including many genera and species	16
	47

A section an eighth of a mile down stream and east of the preceding locality, shows the variation in the character of the overlying basal beds of the Paleocene.

SECTION IN BLUFF OF OWL CREEK, AN EIGHTH OF A MILE BELOW THE SPRING NEAR THE WILLIAM HILL HOUSE

Clayton formation (Paleocene)	Feet
Weathered brown argillaceous sand	12
Stratified yellow sandy clay	1
Unconformity (sharp contact)	
Owl Creek formation	
Dark greenish-gray marly, argillaceous sand like that in the preceding section	22
	35

The absence of the bed of limestone described in the section at the spring is probably due to removal by solution.

Small, poor exposures of the Owl Creek were noted in the bluff from an eighth of a mile below to an eighth of a mile above the spring, and at several places limestone of the Clayton formation was observed, either as a ledge above the Owl Creek or as boulders that had rolled to the foot of the bluff. Fossils have been obtained by different collectors from the exposures along Owl Creek, chiefly by T. W. Stanton in 1889, supplemented, however, by the less complete collections of L. C. Johnson and the senior author (Colls. 75, 541, 546, 707 and 6464a-c.).

SECTION AT YANCEY HILL, CORINTH ROAD, 3 1/2 MILES EAST OF RIPLEY

	Feet
Clayton formation (Paleocene)	
Weathered ferruginous sand with a yellow ferruginous band of clay along the base	15
Unconformity (obscured by weathering)	
Owl Creek formation	
Dark-gray micaceous marine sand in various stages of weathering; in a layer 10 feet below the top are numerous fossils preserved as ferruginous molds (Coll. 6463-b); the lower 10 feet of the section is also fossiliferous (Coll. 6463), the fossils being preserved as more or less decomposed shells; a layer 10 feet above the base contains numerous large specimens of *Exogyra costata* Say (variety with narrow costae)	40
	55

The full thickness of the Owl Creek formation is exposed on Walnut Creek on the farm of Mr. L. T. Braddock, (SE 1/4 Sec. 16, T. 3 S., R. 4 E.). The section described below is exposed in a road cut on the southward-facing slope of the creek valley. The contact of the Owl Creek and the Midway group is better exposed on the northward-facing slope, about half a mile to the southwest along the same road.

SECTION ON ROAD ON SOUTHWARD-FACING SLOPE OF WALNUT CREEK VALLEY

	Feet
Clayton formation (Paleocene)	
Fine to medium glauconitic, ferruginous sand; a fine line of pebbles composed of the underlying light-brown very fine sand, at the base	24
Unconformity	
Owl Creek formation	
Light-brown very fine micaceous sand	5
Light blue-gray calcareous, micaceous, argillaceous sand, rich in fossils	9
Yellow sandy, calcareous clay	1.5
Limestone	0.5
Yellow sandy, calcareous clay	0.5
Blue-gray calcareous, argillaceous very fine sand containing abund-and fossil shells; basal foot contains numerous pebbles of concretionary origin that appear to be waterworn	9
Unconformity	
Ripley formation	
Hard nodular ferruginous, calcareous sandstone, containing echinoids (Coll. 17799)	2
Reddish-brown fine to coarse sand containing small brown pellets and abundant tubes of *Halymenites major* Lesquereux	6
	57.5

Dr. Stanton collected fossils from 20 feet of blue clay marl on Walnut Creek near this road cut (Coll. 713).

SECTION ALONG ROAD ON THE NORTHWARD-FACING SLOPE OF BRIDGE CREEK VALLEY
SEC. 2, T.3 S., R.4 E.

	Feet
Clayton formation (Paleocene)	
Fine brick-red sand containing some ferruginous sandstone	22
Concealed	11
Owl Creek formation	
Light-gray and yellow very fine micaceous sand containing prints of mollusks	20
Unconformity	
Ripley formation (McNairy sand member)	
Coarse ferruginous sand and fine gravel, containing many tubes of *Halymenites major* Lesquereux; a bed of tubular ironstone at base	9
Coarse red sand containing abundant tubes of *Halymenites major* preserved as white clay; to flood plain	55
	117

A high ridge a mile and a half north-northwest of Dumas on the Ripley road is capped by 25 feet of coarse red argillaceous, micaceous sand probably residual from the Clayton formation of the Midway. At a slightly lower altitude east of this ridge highly weathered marine sand of the Owl Creek formation is exposed.

Dr. Stanton who collected fossils in this neighborhood in 1889 says in his original field notes:

"On the farm of Rev. W. M. Nabers (Sec. 23, T. 5 S., R. 4 E.) there is a Cretaceous section thus described by Hilgard. In descending order:

	Ft.	in.
5. Yellowish-gray calcareous clay with veins of lime—*Exogyra costata*	20	
4. Bored limestone * * * [fossiliferous]	20	
3. Coarse glauconitic sand	-	10
2. Black laminated clay	2	
1. Soft ferruginous limestone	20	
	62	10

"The thin beds of Nos. 2 and 3 are now probably covered as they were not recognized.

"No. 5 contains numerous fossils of the same species as those at Owl Creek, with some that are different, but they are so poorly preserved that they cannot be collected satisfactorily. *Pinna laqueata?*, *Dalliconcha ensiformis*, and Owl Creek species of *Inoceramus*, *Cras-*

satella, Pholadomya, Turritella, and *Scaphites* were recognized. Numerous specimens of *Exogyra costata* are left on the surface by the disintegration of this bed.

"No. 4 yielded a number of echinoids, probably all of one species.

"The soft ferruginous limestone of No. 1 is frequently very sandy with calcite crystals."

Beds 1 to 4 of Hilgard's section belong to the Ripley formation and bed 5 to the Owl Creek formation, as here interpreted. Fossils of the Owl Creek formation were obtained from this locality by Dr. Stanton and the junior author (Colls. 710 and 17278).

The contact between the Owl Creek formation and the overlying Paleocene is well exhibited at Chalybeate Springs, 2 miles southeast of Walnut.

SECTION AT CHALYBEATE SPRINGS

	Feet
Clayton formation (Paleocene)	
Deeply weathered ferruginous sands and clays	48
Hard glauconitic, very fossiliferous limestone with brown phosphatic (?) grains larger than the grains of glauconite; small chunks of greensand from the underlying Owl Creek reworked in the base of the limestone; recognized *Venericardia* sp. and *Turritella* sp.	2
Unconformity (contact irregular in detail)	
Owl Creek formation	
Tough, compact micaceous, argillaceous sand, with marly glauconitic pockets; many fossil species (Coll. 9516)	6
	56

The Cretaceous-Paleocene contact in the preceding section is about 50 feet below the crest of the hill on which the village stands, and about 15 feet (?) higher than Muddy Creek bottom. According to the aneroid the contact is about 25 feet lower than the level of the railroad track at Walnut station.

The following section, somewhat more complete than that at Chalybeate Spring, is exposed at the side of a road three quarters of a mile northwest of Chalybeate on the southwestward-facing slope of a hill overlooking Muddy Creek (Sec. 3, T.2 S., R.4 E.):

SECTION THREE-QUARTERS OF A MILE NORTHWEST OF CHALYBEATE

	Feet
Clayton formation (Paleocene)	
Gray highly glauconitic medium sand, filled with borings; merges downward into coarse sand; at base is a three-inch bed of small pebbles composed of the underlying micaceous sand; weathers to brick-red color	28

Unconformity

Owl Creek formation

Very fine dark-gray micaceous sand containing abundant very friable fossils; weathers to gray and yellow argillaceous sand; the upper two feet contains borings filled with Paleocene coarse glauconitic sand; to flood plain of creek 22

50

UNION COUNTY

The Owl Creek formation crops out in Union County in a narrow belt half a mile to 2 miles wide.

The Cretaceous-Paleocene contact is poorly exposed on Mississippi Highway 30 about 3 miles east by north of New Albany (Sec. 2, T. 7 S., R. 3 E.), where the following section is exposed on the slope down to a small branch valley:

Section 3 miles east by north of New Albany

Clayton formation (Paleocene) Feet

Finely sandy brick-red clay containing many small ferruginous concretions about 5 feet below the top, extending downward into highly glauconitic medium-grained red and brown sand; the lower 3 feet contains prints of fossils 23.0

Unconformity

Owl Creek formation

Light-gray and yellow micaceous, argillaceous very fine sand containing many impressions of pelecypods 4.5

27.5

Section in cut of St. Louis-San Francisco Railway northwest of Wallerville

Feet

Owl Creek formation

Deeply weathered red and reddish-brown sand with a discontinuous layer of iron concretions 6 to 8 feet below the top; poorly preserved tubes of *Halymenites major* Lesquereux? are common; poorly exposed in lower 2 or 3 feet 20

Residual yellowish-green sand with faint impressions of shells; *Liopistha protexta* Conrad recognized; in the sand are scattered chunks of gray unweathered rock like that composing the next layer below 1

Prairie Bluff chalk (?)

Dark-gray massive soft, very sandy limestone containing fossils (Coll. 9604) 8

29

The lower limit of weathering is here marked by an undulating line at the top of the impure limestone, which simulates an unconformable contact, and the erroneous impression that it marks a structural break is further strengthened by the presence of the unweathered gray chunks in the yellow sand, which appear to have been mechanically included therein. The Cretaceous-Paleocene contact is, however, poorly exposed about a hundred yards east of the cut in the ditch of the road leading to Wallerville.

In a layer of deely weathered sand exposed in gullies on the slopes both north and south of the cut just described, and 25 or 30 feet above the track, the following fossils, preserved as ferruginous molds, were collected: *Idonearca* sp., *Lima acutilineata* (Conrad), *Crassatella* sp., *Turritella tippana* Conrad, and *Baculites tippaensis* Conrad (Coll. 9509).

At an overhead bridge 4 miles southeast of New Albany on old U. S. Highway 78 a cut reveals a section similar in its general character and relations to the one just described.

Section in cut of St. Louis-San Francisco Railway, 4 miles southeast of New Albany

	Feet
Clayton formation (Paleocene)	
7. Weathered deep-red sand; in small masses of gray sandstone 15 feet below the top were recognized *Hamulus onyx* Morton and *Lima reticulata* Forbes; *Halymenites major* Lesquereux noted in the basal portion	20
Unconformity	
Owl Creek formation	
6. Greenish to yellowish-gray soft glauconitic sand containing *Halymenites major?*	4
5. Concealed by talus	8
4. Yellowish-green loose sand containing masses of grayish to greenish partially weathered sandstone	1
3. Greenish-yellow calcareous, very nodular sandstone or sandy limestone with irregular patches and pockets of unindurated sand; contains *Exogyra costata* Say and other fossils (Coll. 9510)	3.5
2. Compact, yellowish to greenish-yellow sand, probably a weathered facies of the underlying bed	2
1. Dark-gray compact calcareous, somewhat micaceous sandstone or sandy limestone; contains fossils (Coll. 9512)	5
	43.5

Here as elsewhere in the vicinity Cretaceous fossils have been reworked into the basal bed of the Midway.

The exact contact of the Cretaceous and Paleocene is well exhibited in a cut of the St. Louis-San Francisco Railway 1 1/4 miles southeast of New Albany (Figure 48).

Figure 48.—Unconformity between the Owl Creek formation and the Paleocene in a cut of the St. Louis-San Francisco Railway, 1 1/4 miles southeast of New Albany, Union County. Photo by F. F. Mellen.

SECTION IN CUT OF ST. LOUIS-SAN FRANCISCO RAILWAY

	Feet
Clayton formation (Paleocene)	
Deeply weathered red and brownish-red sand, with numerous small iron concretions	28
Yellow, very hard, very fossiliferous sandy limestone; fossils poorly preserved; recognized the following Paleocene fossils: *Ostrea pulaskensis* Harris, *Venericardia* sp. and *Turritella mortoni* Conrad; Cretaceous fossils mechanically included in the low 5 or 6 inches were *Glycymeris rotundata* Gabb?, *Idonearca littlei* Gabb, *Trigonia* sp., *Pecten simplicius* Conrad, *P.* (*Camptonectes*) sp., *Crassatella* sp., *Cardium* (*Granocardium*) *tippanum* Conrad, *Baculites carinatus* (Morton)	6
Yellow ferruginous sand containing *Exogyra costata* Say 1/2 to	1

Unconformity (contact undulating in detail; observed several borings half an inch to three quarters of an inch in diameter, filled with the material from above, and extending down 4 or 5 inches into the underlying bed.)

Owl Creek formation

Dark-gray compact, slightly micaceous, argillaceous sand; recognized *Pecten* (*Camptonectes*) sp., 2 1/2 to	3

The contact between the Cretaceous and Paleocene is exposed in the Pontotoc road, on the northward-facing slope of King Creek Valley, 3 1/4 miles south of New Albany.

SECTION IN MISSISSIPPI HIGHWAY 15, 3 1/4 MILES SOUTH OF NEW AIBANY

Clayton formation (Paleocene)	Feet
Weathered red argillaceous, ferruginous sand	29
Yellow nodular limestone, containing small brown ferruginous oolites	5
Greenish-gray sandy coquina-like, abundantly fossiliferous limestone, slightly glauconitic and containing a large percentage of yellow and brown polished limonitic oolites; the basal 2 to 6 inches is unconsolidated; contains many fossils reworked from the underlying Owl Creek formation, including *Exogyra costata* Say (with narrow costae), *Trigonia angulicostata* Gabb, *Crenella serica* Conrad, *Turritella* n. sp. (with 2 spiral lirae), and many others, 2 to	3
Unconformity (contact sharp and gently wavy)	
Owl Creek formation	
Gray massive argillaceous, sparingly fossiliferous sand containing small brown ferruginous oolites; recognized *Scaphites* sp. and a small echinoid (Coll. 17805); base 26 feet above King Creek bottom	18

The basal bed of the Clayton formation in the preceding section occupies the same stratigraphic position as the bed containing reworked Owl Creek fossils preserved as clay replacements in the section in the railroad cut half a mile south by west of Pontotoc (64, pp. 96-99). In the section south of New Albany most of the reworked fossils are preserved as calcium carbonate, but here and there among them the calcium carbonate has been incompletely replaced by clay, indicating the operation of the same replacement process.

The Cretaceous-Paleocene contact is well exposed in a section in the first road cut on Mississippi Highway 15 south of Okonatie Creek (Sec. 18, T.8 S., R.3 E.).

SECTION IN ROAD CUT SOUTH OF OKONATIE CREEK

Clayton formation (Paleocene)	Feet
Light-brown glauconitic, very argillaceous sand; in the lower 1 foot are reworked Cretaceous fossils, notably *Baculites* sp.	8
Unconformity (sharp undulating contact)	
Owl Creek formation	
Dark-gray argillaceous, calcareous sand, which dries and weathers white like chalk; *Exogyra costata* Say (narrow-ribbed variety), *Ostrea tecticosta* Gabb, *Anomia argentaria* Morton, *Ostrea* sp. (small), and abundant fossils preserved as phosphatic molds, including *Baculites* (2 species), *Scaphites* sp., pelecypods, and gastropods	10
	18

PONTOTOC COUNTY

The Owl Creek formation is represented in Pontotoc County by a thin bed of glauconitic sand conformably overlying the Prairie Bluff chalk. In the southern part of the county this bed of sand merges into the higher beds of the Prairie Bluff chalk.

The unconformity between the Owl Creek formation and the overlying deposits of the Clayton formation (Paleocene) is obscure in most exposures in Pontotoc County, because of the similarity of the materials above and below the contact; however, the contact may be seen in a cut of the Gulf, Mobile and Northern Railroad south of Pontotoc and at several places along Mississippi Highway 15 south of Pontotoc. A section on the southward-facing slope of a small branch of the Middle Prong of Chiwapa Creek (SE.1/4, Sec. 17, T.10 S., R.3 E.) reveals the following section:

SECTION 2 1/2 MILES SOUTH BY WEST OF PONTOTOC

	Feet
Clayton formation (Paleocene)	
Medium ferruginous sand, flaky ironstone at base; to top of hill	15
Coarse brick-red ferruginous sand containing in upper part a layer of mechanically reworked Cretaceous pelecypods and gastopods preserved as clay replacements; many fragments of ironstone	3
Unconformity (undulating surface, sharp contact)	
Owl Creek formation	
Fine brick-red sand	8
Concealed to branch	28
	54

SIGNIFICANCE OF THE FOSSILS

No invertebrate fossils have been recorded from either the Tuscaloosa formation or the lower typical beds of the Eutaw formation in Mississippi. These units are, therefore, not represented in the tables of distribution and range. A few poor prints of the shallow marine or brackish water forms, *Ostrea* and *Volsella*, have been found at one locality in the Tuscaloosa formation in Alabama, and the prints of a few marine mollusks have been observed at several localities in the typical beds of the Eutaw in that State. Although fossil plants, mainly leaves, are abundant in clay lenses at several known localities in the Tuscaloosa formation in Alabama, no plant species have been identified from that formation in Mississippi. On the evidence afforded by the fossil plants Berry (40, pp. 40-41) has correlated the Tuscaloosa formation in Alabama with the Woodbine formation of Texas, at least in part with the Raritan formation of New Jersey, and with the Cenomanian of Europe. The following plant species have been recorded by Berry (40, p. 14) from basal beds of the Eutaw formation (formerly considered to be Tuscaloosa) in a railroad cut 1 5/8 miles east of Iuka, Tishomingo County: *Andromeda wardiana* Lesquereux, *Androvettia carolinensis* Berry, *Phyllites pistiaeformis* Berry, and *Sequoia reichenbachi* (Geinitz). Elsewhere in the typical beds of the Eutaw comminuted plant fragments are common, especially in the clays and in the sand partings, but as yet have yielded no identifiable genera or species.

Fossil marine invertebrates, chiefly mollusks, made their first appearance in the Mississippi Upper Cretaceous in the upper part of the Tombigbee sand member of the Eutaw formation, and are present in greater or less numbers in all the formations and members between the Tombigbee and the base of the overlying Paleocene, except in the McNairy sand member of the Ripley formation. The ranges of the fossil species, as given in the accompanying table, indicate the existence of a definite faunal relationship throughout this succession of fossiliferous beds. At least 4 species range from the Tombigbee sand to the top of the Cretaceous, and the percentage of common species becomes progressively greater in the successively higher formations. Many of the species in the higher units are doubtless the evolutionary successors of closely related species in lower units. However, faunal zones carrying distinctive restricted species have been differentiated, and where the faunas are not too meager it is generally possible to determine their approximate stratigraphic position from paleontologic evidence. Two major faunal zones are recognized. The *Exogyra ponderosa* zone includes the Tombigbee sand, about the lower two-thirds of the Selma chalk, and the Coffee sand (equivalent to about the lower half of the Selma chalk). The *Exogyra costata* zone includes (1) the upper third of the Selma chalk, the partly equivalent Ripley formation, and (2) the Prairie Bluff chalk and the equivalent Owl Creek formation.

Twenty-four invertebrate species are listed from the Tombigbee sand. Of these forms 10 have not been reported above that member in Mississippi, but of the 10 only 4 are considered to have narrow zonal implications, as at present known. The ammonite genus *Muniericeras* is recorded from the Coniacian and Santonian of Europe. The floating crinoid, *Marsupites americanus* has a close analogue in *M. testudinarius* Schlotheim, a narrowly restricted zone species in the Cretaceous of Europe, and it, together with *Muniericeras,* is believed to indicate the Santonian age of the Tombigbee. *Placenticeras guadalupae* and *Mortoniceras texanum* are species of the upper part of the Austin chalk of Texas, and the closely related forms in the Tombigbee sand are accepted as indicating its upper Austin age. Of the remaining 14 species 4, as already stated, range to the top of the Cretaceous, and 10 range to different intermediate stratigraphic positions.

Thirty species of invertebrates, 7 of them more or less questionably identified, are listed from the lower two-thirds of the Selma chalk, or that part of the chalk which lies within the *Exogyra ponderosa* zone. Of these forms, 10 are long ranging in Mississippi or elsewhere and have no value in close correlation. The name *Exogyra ponderosa* is used in a broad sense to include a series of large smooth Exogyras that might appropriately be subdivided into several varietal forms. This species is present in the Tombigbee sand below, but does not range above the zone bearing its name. Of the genera and species listed the following appear to be everywhere restricted to beds below the top of the *E. ponderosa* zone:

Micrabacia cribraria (a small coral)
Echinocorys sp. (a small fragment only)
Hamulus major (a worm tube)
Terebratulina filosa (a brachiopod)
Ostrea whitei
Ostrea sloani
Exogyra ponderosa
Pecten (Neithea) casteeli
Diploschiza cretacea
Liopistha alternata
Etea carolinensis
Durania austinensis
Baculites asper
Mortoniceras sp.

The presence of the genus *Mortoniceras* in only the lower part of the Selma chalk and in the Tombigbee sand is consistent with its known restriction to the lower part of the *E. ponderosa* zone elsewhere in the Coastal Plain. *Baculites asper* in the chalk above the Arcola limestone member is near the top of its known range in the Gulf region. *Diploschiza cretacea,* the principal index fossil of the zone bearing its name, is accompanied by the brachiopod species *Terebratulina filosa.* These two species appear to be indigenous to a limy sea bottom, for this narrow zone, which is readily traceable for 200 miles through the *chalk* in Mississippi and Alabama, has not been recognized in either the equivalent upper beds of the Coffee *sand* in northern Mississippi or in the Cusseta *sand* of eastern Alabama; both of these species are present in the equivalent Pecan Gap *chalk* member of the Taylor marl of Texas. The basal beds of the Selma chalk in Mississippi and Alabama are believed to be as old as the uppermost beds of the Austin chalk in Texas; the part of the Selma that lies between these basal beds and the base of the *Exogyra costata* zone correspond in age to the Taylor marl of Texas, to the upper half or more of the Blufftown formation and the Cusseta sand of the Chattahoochee region, to the Black Creek formation of the Carolinas, and to the Matawan group of the North Atlantic Coastal Plain.

The Coffee sand in northern Mississippi, a formation equivalent to about the lower half of the Selma chalk, carries a facies fauna similar in general aspect to the faunas of the sandy Ripley and Owl Creek formations. This fauna has been only superficially studied. As listed it consists of about 54 species, some of which belong to well known species, and many of which are indicated as related to known species elsewhere. Several new undescribed species are omitted from the list. Among the invertebrate species and genera listed, the following are not known to range above the *Exogyra ponderosa* zone:

Nucula aff. N. stantoni
Idonearca carolinensis
Ostrea sloani
Gryphaea sp (of the G. wratheri type)
Exogyra ponderosa
Exogyra aff. E. upatoiensis
Pecten (Camptonectes) bellisculptus
Pecten (Camptonectes) berryi
Pecten (Neithea) casteeli
Trigonia n. sp. (well preserved shells)
Cymella ironensis
Etea carolinensis
Brachymeris carolinensis
Aphrodina regia
Turritella quadrilira
Placenticeras planum
Mortoniceras sp.

The *Exogyra cancellata* zone, which in Mississippi lies within the Selma chalk and is coincident with the lower part of the *Exogyra costata* zone, has yielded a relatively small fauna in this state, most species of which are long ranging in the Upper Cretaceous series; however, two species, *Exogyra cancellata* and *Anomia tellinoides*, are restricted to the zone, and indeed are thus narrowly restricted throughout the length of the Atlantic and Gulf Coastal Plain. North of Mississippi in McNairy County, Tennessee, the base of the sandy Coon Creek tongue of the Ripley formation has descended to a stratigraphic position such that it includes about the upper half of the *Exogyra cancellata* zone. In Texas the zone is coincident with the Neylandville marl, the basal formation of the Navarro group; in the Chattahootchee region (Alabama-Georgia) the zone forms the uppermost beds of the Cusseta sand and the lower part of the Ripley formation; in North Carolina, it forms the basal part of the Peedee formation; in Delaware and New Jersey it is coincident with the Mount Laurel sand.

In east-central Mississippi (Noxubee and Kemper counties) the upper sandy facies of the Selma chalk is proportionately thin, in places not exceeding 50 feet, probably due in part at least to a transgressive overlap of the overlying Prairie Bluff chalk, which cuts out the uppermost beds. The fauna contained in this sandy facies is relatively meager and consists chiefly of long ranging common species in the families Ostreidae, Limidae, and Anomiidae. Most of the shells of *Exogyra costata* belong to the variety having costae of medium width, although this feature is individually rather widely variable.

Toward the north the upper sandy facies of the Selma chalk merges into a prevailingly sandy facies, the Ripley formation, the thickness of which increases from south to north. Some of the beds of the Ripley in Mississippi are richly fossiliferous but their faunas have never been systematically studied. The provisional list of genera, species, and varieties in the tables of distribution and range shows how prolific are the fossil marine organisms, particularly the pelecypods and gastropods. A critical study of these organisms would result in the recognition of many new species. The fauna as listed includes 2 corals, 4 echinoids, 4 worms, about 55 pelecypods, 2 scaphopods, about 40 gastropods, 6 cephalopods, and 4 arthropods. At least 22 of the species are long ranging in the Upper Cretaceous series and are of no value in exact correlation. Of the species listed, the following, as at present known, appear to be restricted to the Ripley formation and to beds of Ripley age:

Hardouinia porrecta
Glycymeris rotundata
Ostrea subspatulata
Hercorhynchus tippanus
Sargana stantoni
Liopeplum leiodermum
Volutomorpha eufaulensis
Volutomorpha dumasensis
Volutomorpha turricula
Ringicula pulchella
Sphenodiscus lenticularis

The following species have not been recorded in beds stratigraphically lower than the Ripley, but range upward into the Owl Creek formation or beds of that age:

Hardouinia subquadrata
Hemiaster slocumi
Nucula cuneifrons
Nucula percrassa
Idonearca littlei
Nemodon eufaulensis
Postligata wordeni
Trigonia eufaulensis
Trigonia thoracica
Pecten venustus
Lima acutilineata
Crenella serica
Dreissensia tippana
Vetericardia crenalirata
Crassatella vadosa
Cardium (Trachycardium) eufaulense
Cardium (Granocardium) tippanum
Cardium (Granocardium) kuemmeli
Aphrodina tippana
Cyprimeria alta
Turritella vertebroides
Turritella tippana
Anchura abrupta
Pugnellus densatus
Pyropsis perlata
Morea marylandica
Liopeplum canalis
Liopeplum subjugosum
Drilluta ripleyana
Paladmete cancellaria
Baculites tippaensis

The two preceding lists are tentative and subject to change, but they are sufficient to show that many new species make their appearance in the sediments of the Ripley formation. Doubtless many of them are the descendents of species in sediments of earlier date in the Gulf region.

The Ripley fauna of Mississippi includes at least 30 species, (chiefly mollusks) that are common to the Nacatoch sand of Texas and Arkansas, some of which are restricted in range, and the approximate age equivalency of the two formations is well established. However, the lower part of the Coon Creek tongue of the Ripley, which carries *Exogyra cancellata,* must lie stratigraphically as low as the upper part of the Neylandville marl of Texas. The Ripley formation of Mississippi and Tennessee, including the Coon Creek tongue, corresponds to the Ripley formation of the Chattahoochee region (Alabama-Georgia) as now restricted (63, pp. 1648-1652). All but the uppermost part of the Peedee formation of the Carolinas is of Ripley age, as is also the Monmouth formation of Maryland. The Monmouth group of New Jersey, exclusive of the Red Bank sand at the top, falls within the time limits of the Ripley.

In terms of the European Upper Cretaceous section the Ripley is believed to fall within the limits of the Maestrichtian division (upper Senonian), with the possible exception of the Coon Creek tongue which may be as old as upper Campanian. This correlation is based on the common occurrence of the ammonite genus *Sphenodiscus,* the presence in the Ripley of *Belemnitella americana,* which has a close analogue in *B. mucronata* Schlotheim in Europe, and on the general similarity of the molluscan faunas, which have many genera, but few species, in common. This age assignment is not in harmony with the opinion of Berry (45, p. 23), based on a very meager fossil flora from the McNairy sand member of the Ripley formation in Tennessee, that the Ripley is of Emscherian age (lower Senonian). The typical Emscherian of Germany is of Coniacian (lower Senonian) age, although some European geologists include both the Coniacian and the Santonian in the Emscherian. Evidence has been given on a previous page that the Tombigbee sand member of the Eutaw formation is of Santonian age; the lower typical beds of the Eutaw may therefore be considered as approximately equivalent to the typical Emscherian.

The Owl Creek formation is similar in its lithologic facies to the Ripley formation and is comparable to that unit in the character of its fauna and in the number of its contained species. It was from the classic locality on Owl Creek, 2 1/2 miles northeast of Ripley, Tippah County, that Conrad in 1858 described 56 new species, mainly mollusks. Many additional described, and as yet undescribed, species have since been found in the formation. The provisional list of species includes 1 coral, 2 echinoids, 3 worms, 50 pelecypods, 2 scaphopods, 35 gastropods, and 6 cephalopods. That this fauna is largely made up of species descended from ancestral Ripley species is shown by the presence in the two formations of no less than 65 common species, several of which, however, are questionably identified. As shown in the table of ranges the following species are not found stratigraphically lower than the Owl Creek formation, but future critical study of the fauna may show that some of them range downward into the Ripley formation:

Micrabacia mississippiensis
Linthia variabilis
Pinna laqueata
Inoceramus argenteus
Trigonia angulicostata
Pholadomya conradi
Anatimya anteradiata
Anatimya postsulcata
Periploma? applicata
Crassatella vadosa ripleyana
Strepsidura interrupta
Fusus? novemcostatus
Fusus? tippanus
Liopeplum cretaceum
Volutomorpha aspera
Volutoderma protracta
Parafusus cretacensis
Actaeonina lintea
Bullopsis cretacea
Bullaria macrostoma
Baculites carinatus
Discoscaphites iris
Sphenodiscus lenticularis mississippiensis
Sphenodiscus pleurisepta
Sphenodiscus beecheri

Of particular value as index species are *Linthia variabilis* (an echinoid), *Trigonia angulicostata* (a pelecypod), and the ammonites *Baculites carinatus, Discoscaphites iris, Sphenodiscus lenticularis, S. pleurisepta,* and *S. beecheri.*

The Prairie Bluff chalk, as at present known, is more prolific in species of marine organisms than the Selma chalk, but less prolific than either the Ripley or Owl Creek formations. Although it carries many species in common with those of the Ripley and Owl Creek it also includes certain faunal elements indicative of the different ecologic conditions existing on a limy sea bottom, as opposed to a sandy one. The list shows 2 poriferans (sponges), 3 anthozoans (corals), 5 echinoderms (echinoids and a crinoid), 3 worms, 1 brachiopod, 40 pelecypods, 10 gastropods, 13 cephalopods, and 4 arthropods. The gastropods are not fairly represented in the list because many genera and species are preserved as imperfect phosphatic internal molds that are indeterminate both generically and specifically. The same is true of the pelecypods, though in lesser degree. The following species may be mentioned as particularly diagnotic of the Prairie Bluff chalk, or of beds not older than that unit.

A new genus and species of crinoid (aff. Mesocrinus)
Linthia variabilis
Micraster (Plesiaster) sp.
Terebratulina floridana
Inoceramus argenteus
Diploschiza melleni
Pholas pectorosa
Baculites columna
Baculites carinatus
Parapachydiscus cf. P. gollevillensis
Discoscaphites conradi (several varieties)
Discoscaphites petechialis
Sphenodiscus lobatus
Sphenodiscus pleurisepta

Species that are common in the Prairie Bluff chalk, but are occasionally found also at lower stratigraphic positions, are *Hemiaster slocumi, Idonearca capax, Pecten venustus, Crenella serica,* and *Liopistha protexta.*

Several species in the above list indicate the correlation of the Prairie Bluff chalk with the Corsicana marl of Texas; several elements in the fauna of the Prairie Bluff suggest its age equivalency with the Providence sand (marine facies) of the Chattahoochee region, with the upper part of the Peedee formation of the Carolinas, and with the Red Bank sand of New Jersey.

The several species of the Ammonite genus *Sphenodiscus,* the species *Parapachydiscus* cf. *P. gollevillensis,* and the species *Belemnitella americana* are interpreted to indicate the Maestrichtian age of the Prairie Bluff chalk and its equivalent, the Owl Creek formation.

GEOLOGIC HISTORY

ANCIENT GEOLOGIC EPISODES

The Upper Cretaceous sediments of Northeastern Mississippi are underlain by a great series of rocks of Paleozoic age. Although these rocks record a long succession of interesting geologic episodes, their story is difficult to read because they are concealed by the covering of Cretaceous sediments in all but relatively small, narrow areas in a few of the deeper valleys in Tishomingo County. For the purposes of this report the surface of the Paleozoic basement rocks will be taken as the starting point for the succession of events that transpired during the Cretaceous period.

PRE-CRETACEOUS EROSION INTERVAL

The youngest of the Paleozoic basement rocks under cover in northeastern Mississippi were formed in late Carboniferous (Pennsylvanian) time. During the exceedingly long interval that elapsed between the Pennsylvanian and the Upper Cretaceous epoch, ambracing the Permian, the Triassic, and Jurassic periods, and the Lower Cretaceous epoch, northeastern Mississippi is believed to have been continuously above sea level and subject to all the processes of erosion that tend to reduce a land surface to a plain. It is not necessary to assume that during all this great lapse of time the land was at a standstill with reference to sea level, for doubtless there were many oscillations, the surface being higher above sea level at one time than

Range of Upper Cretaceous fossils

Species										
Coelenterata:										
[illegible]										
Echinodermata:										
[illegible]										
Vermes:										
[illegible]										
Molluscoidea:										
[illegible]										
Mollusca:										
Pelecypoda:										
[illegible]										
Gastropoda:										
[illegible]										
Cephalopoda:										
[illegible]										
Arthropoda:										
[illegible]										
Vertebrata:										
[illegible]										

at another. But the record of such changes has been almost if not entirely destroyed by the erosion that finally, prior to the beginning of the Upper Cretaceous epoch, reduced the surface to an approximate peneplain. The rocks that cropped out in this pre-Upper Cretaceous peneplained land area belonged in part to the Devonian and in part to the Carboniferous system of the Paleozoic.

A POSSIBLE LOWER CRETACEOUS SUBMERGENCE IN SOUTHERN MISSISSIPPI

At the beginning of Cretaceous time northern Mississippi and adjacent areas were a country of low relief and of topographically monotonous aspect. Somewhere to the south of the area in which the Upper Cretaceous rocks now crop out this early Cretaceous land was bordered by an ocean or an ancient Gulf of Mexico. The commencement of the downwarping, which initiated the formation of the Mississippi Embayment, has not been definitely determined, but records of recent drilling in the Coastal Plain have shown a much greater thickness of sediments above the old basement rocks than had previously been suspected. Doctor Lowe, the former State Geologist, was of the opinion that some of these are of Lower Cretaceous age. Beds of Lower Cretaceous and Jurassic age have been penetrated in wells in northwestern Louisiana and in central Mississippi, but it seems likely that the innermost edge of these deposits is not far north of Jackson, and that the Lower Cretaceous sea never covered northeastern Mississippi. However, the sea must have extended northward along the axis of the Mississippi embayment area during Lower Cretaceous time, and whatever sediments were laid down in that sea are now completely overlapped and concealed by sediments of Upper Cretaceous age.

TUSCALOOSA SUBMERGENCE AND DEPOSITION

Early in the Upper Cretaceous epoch northeastern Mississippi and adjacent areas formed part of an extensive low-lying plain bordered somewhere to the south by an ocean, an arm or bay of which may have extended part way up the center of the present embayment area. Shortly after the beginning of Upper Cretaceous time this plain was tilted in a manner such as to cause a downwarp south of the axis of movement and an uplift north of it. The sea advanced across the downwarped portion pushing its shore northward, while the streams entering the sea from the uplifted area to the north, because of their increased capacity to erode and transport material, began bringing large amounts of gravel, sand, and clay, and depositing them on the flood plains of the streams where they crossed the bordering coastal plain, in the deltas at the mouths of the streams, and in the shallow sea waters. These sediments make up the basal part of the Tuscaloosa formation.

As the area undergoing submergence was not an absolutely even surface but was gently undulating to hilly, the higher portions probably remained above water level for longer or shorter periods, forming peninsulas and islands. Swamps existed locally along the shores of the mainland and the islands, and in these peat and carbonaceous clays and sands accumulated. As the waters were shallow the distribution of the sands and clays brought in by the streams was affected by the waves and currents, producing irregularity of bedding and a marked development of cross bedding in the sands. Fossil leaves, including many species, were buried in the sediments of these early Tuscaloosa seas, and have been discovered at several localities in Alabama. These leaves have been described and figured by E. W. Berry (40), and they afford a fair conception of the composition of the flora of the time.

As the downwarping continued the resulting submergence spread toward the north covering southern and central Alabama, all of Mississippi, and probably reaching well toward the head of the present Mississippi Embayment. The deposition of sands and clays continued with sufficient rapidity to keep the sea nearly filled with sediments, so that it remained very shallow. Near the close of Tuscaloosa time the accumulation of sediments in west-central Alabama had reached an estimated maximum thickness of more than 1,000 feet. In Tishomingo County a notable amount of chert gravel was deposited, reaching a maximum thickness of 150 to 200 feet, the deposit probably marking the place where one or more large streams entered the sea.

TUSCALOOSA-EUTAW EROSION INTERVAL

The close of Tuscaloosa time was marked by a relative lowering of sea level that exposed the Tuscaloosa sediments to erosion. The thickness of the sediments removed from the newly uncovered land surface during this period can only be conjectured. The evidence indicates that the interval was geologically very long, long enough indeed to permit the deposition of the Eagle Ford shale (400 feet) in the western Gulf region, for no sediments equivalent in age to the Eagle Ford are present in the section in the belt of outcrop of the

Cretaceous in Mississippi. Such sediments, if present, would have intervened between the Tuscaloosa and Eutaw sediments. The thickness of the sediments removed by erosion was probably greater in northeastern Mississippi than farther south in Mississippi and Alabama, for there is reason to believe that the gravel deposits in Tishomingo County represent only the basal part of the Tuscaloosa.

At the beginning of Eutaw time the level of the sea again rose, or the land was depressed, and the sea transgressed the eroded surface of the Tuscaloosa formation.

POST-TUSCALOOSA MARINE DEPOSITION

During the greater part of the time that elapsed between the transgression of the Eutaw sea across the eroded surface of the Tuscaloosa sediments and the close of the Upper Cretaceous epoch northeastern Mississippi was submerged beneath a sea, on the bottom of which was gradually accumulated great beds of sand, chalky mud, and clay, aggregating a thickness of 1300 or 1400 feet. There were, however, several periods of erosion or nondeposition of greater or less length, as indicated on following pages. The sands and clays are the detrital materials brought in suspension by the streams entering the sea from the northeast, and dropped as a result of the checking of their currents. The chalks originated in part from the calcareous remains of coccolithophores (minute plant organisms), foraminifers, and other marine organisms, in part from lime chemically precipitated from the sea water, and in part from clay and fine sand brought from the land by the streams. The prevalence of one or the other of these types of deposits over certain areas of sea bottom, and for greater or less periods of time, resulted in the building up of the divisions classed as formations and members in this report. (See geologic map, Plate 1A and sections, Plate 2).

DEPOSITION OF THE EUTAW SEDIMENTS

EARLY EUTAW DEPOSITS

At the beginning of Eutaw time the sea was shallow and the principal material contributed by the streams was first fine chert gravel mixed with sand, followed by sand, with subordinate amounts of clay and fine chert gravel. These materials were distributed by the waves and currents in such a manner as to form masses exhibiting cross bedding, ranging from the coarse plunge and flow structure produced by strong currents in very shallow water to the fine structure resulting from the gentle to and fro swing of the deeper water near the lower limit of wave action (Figures 15 to 20). Contemporaneous with the accumulation of the sand and gravel, greater or less amounts of clay were deposited in the form of thin laminae or laminated layers involved in the cross bedding, but locally layers up to several feet in thickness, in which the clay predominates, were formed.

Distributed through the sands in greater or less amounts, and forming a characteristic component of them, are many small dark-green grains of glauconite, a potassium-iron silicate mineral, which apparently was formed on the sea bottom contemporaneous with the deposition of the sands, though the exact manner of the origin of glauconite has never been satisfactorily determined.

Some vegetation was floated into the sea while the sands and clays were accumulating and, becoming waterlogged, sank to the bottom; most of it was ground to bits by the beating of surf along beaches, by the whipping of white-capped waves, or by dragging on the bottom, and now appears as comminuted lignitized plant fragments; larger pieces and even logs now either lignitized or, rarely, silicified, escaped comminution.

The sea bottom gradually sank about as fast as these materials accumulated, so that there was not much change in the depth of the water while the lower part of the Eutaw, which is 100 to 300 feet thick, was being formed.

Little has been learned of the character of the marine life during this time for, though no reason is known for their nonexistence, the conditions seem to have been unfavorable for the preservation of the remains of mollusks and other marine organisms.

DEPOSITION OF THE TOMBIGBEE SAND MEMBER OF THE EUTAW FORMATION

The conditions just outlined were followed by a somewhat more rapid sinking of the sea bottom in northeastern Mississippi and central Alabama, and consequent deepening of the water, with, however, a continued deposition of sand accompanied by the formation of grains of the mineral glauconite. In general the sand grains reached the bottom in water deep enough to be only slightly or not at all affected by waves and currents, a condition indicated by the prevailing massive, homogenous character of the strata composing the Tombigbee sand member of the Eutaw formation. Marine animals in fairly large variety lived in these waters, for their remains are abundant in certain layers, particularly in the upper part of the member, though some beds of considerable thickness apparently contain no traces of animal life.

EUTAW-SELMA EROSION INTERVAL

Deposition of the Tombigbee sand member of the Eutaw formation was interrupted by a period of emergence and erosion. Neither the length of this period nor the thickness of the sediments removed is known, but paleontologic evidence suggests that the interval was not very long as geologic time is measured. The eroded surface of the Tombigbee sand was a fairly even plain with, however, minor irregularities; apparently it was never very high above sea level and was therefore not subjected to deep stream erosion. This period of erosion was brought to a close by a tilting movement that permitted the sea to again spread rather quickly inland across the low-lying plain.

DEPOSITION OF THE SELMA CHALK AND EQUIVALENT FORMATIONS

THE EARLY SEDIMENTS OF THE CHALK

The water in the early Selma sea must have been deep enough from the start to permit the sediments to settle to the bottom without much disturbance from the action of waves or currents, for they exhibit little or no cross bedding. The first of the accumulating sediments, mainly sand, were probably derived in large part from the reworking of the underlying Tombigbee sand; these were followed shortly by limy muds that later consolidated to form impure, clayey chalk.

The prevalence of the relatively clear seas in which the chalks were forming resulted from the physiographic conditions on the adjacent land to the northeast in the present area of outcrop of the Paleozoic rocks in Alabama. There, the land surface was a broad low-lying plain limited on the southwest by the broad crescentic shoreline of the Selma sea. Drainage appears to have been effected mainly by streams flowing to the southeast and to the northwest. For a distance of fully 250 miles in Mississippi and Alabama no major streams carrying coarse sediments flowed to the southwest into the Selma sea. The finer clay sediments that form an important percentage of the lower beds of the Selma may have been transported in part by small streams flowing directly into the sea, or may have been brought from greater distances by alongshore currents. Tiny, microscopic organisms (coccolithophores) swarmed in the clear warm-temperate or subtropical waters and their calcareous skeletal remains, dropping to the sea bottom in vast quantities and mixing with the fine transported clay, produced the chalky texture of the accumulating sediments. Conditions favorable to the deposition of impure chalk continued in east-central Mississippi and to the eastward well across Alabama until a thickness of about 300 feet of this kind of sediment had accumulated. No chalks were deposited at any time in eastern Alabama and Georgia, where the sediments of Selma age are sands, clays, and marls.

DEPOSITION OF THE ARCOLA LIMESTONE MEMBER

Following the deposition of the impure chalky sediments the waters became temporarily clearer and almost entirely free from transported clay sediments, and at the same time for some reason became unfavorable to the existence of the coccolithophores. Limy sediments, perhaps produced by chemical precipitation from the sea water, accumulated on the sea bottom, and their consolidation resulted in the formation of a thin nearly pure limestone, the Arcola limestone member of the Selma chalk. It appears that this consolidation took place at least in part almost contemporaneously with deposition, for the rock was hard enough to preserve the numerous borings of some organism, perhaps a crustacean, that lived on the immediately succeeding sea bottom. These borings became filled with softer chalky mud that is easily weathered and eroded out of the harder limestone, producing a perforated appearance that accounts for the locally applied name of "bored rock." In Alabama the Arcola is made up of several layers of limestone with intervening layers of chalk, indicating an alternation of limestone- and chalk-forming conditions there. Following the formation of the Arcola limestone in Mississippi the coccolithophores returned to the sea waters and more chalky sediments were deposited.

A MINOR STRATIGRAPHIC BREAK ABOVE THE ARCOLA LIMESTONE MEMBER

A few feet above the Arcola limestone a sharp line of contact between purer chalk below and a thin phosphate-bearing bed above is believed to indicate a minor stratigraphic break in the deposition of the Selma chalk. Either there was a brief period of emergence and erosion or the sea was so shallow that the waves and currents prevented deposition by carrying the limy sediments away to deeper waters. This contact is irregular in detail but occupies a remarkably uniform position above the Arcola limestone from Lee County, Mississippi, to Bullock County, Alabama, a distance of 250 miles; eastward from Bullock County the break becomes an erosional and overlapping unconformity of considerable magnitude.

DEPOSITION OF THE MIDDLE AND UPPER CHALK SEDIMENTS

The time of the stratigraphic break above the Arcola limestone was immediately followed by a resumption of chalk-forming conditions that continued without interruption until in east-central Mississippi and west-central Alabama a maximum of nearly 900 feet of chalk had accumulated. Here the middle third of the chalky body as a whole is purer and more typical chalk than either the lower third below the stratigraphic break or the uppermost third. Toward the latter part of Selma time there was an influx of sand into the sea which produced a sandy chalk facies having a thickness of about 100 feet in Noxubee County.

DEPOSITION OF THE COFFEE SAND

During the time that this great thickness of chalk was being formed in east-central Mississippi and west-central Alabama a more varied succession of sediments was being deposited in northern Mississippi. At times the streams flowing to the northwest from the Paleozoic land area of northern Alabama carried important quantities of sand into the sea. As the first of the chalk beds began to form at the south sand was being deposited from northern Lee County northward into Tennessee. Sand with subordinate amounts of clay accumulated to a thickness of 250 or 300 feet to form the body of sediments called Coffee sand, and during the time of this accumulation the sand-forming conditions spread southward past Tupelo to form the Tupelo tongue of the Coffee sand. This tongue overlies a northward extending tongue of chalky marl, the Mooreville tongue of the Selma chalk.

The Coffee sand is the time equivalent of about the lower half of the Selma chalk. The sea in which the Coffee sand was deposited was shallow enough during much of the time to allow the waves and currents to disturb the sandy sediments, as evidenced by their prevailing rather fine cross-bedded structure. However toward the close of Coffee deposition the sea became somewhat deeper and the deposited sediments more massive.

DEPOSITION OF THE SELMA CHALK OF NORTHERN MISSISSIPPI AND TENNESSEE

The deposition of the Coffee sand from Lee County northward to the Tennessee boundary and beyond was brought to a close as a result of the failure of the streams and currents to transport a supply of sandy material to this part of the sea bottom, so that in this clearer sea chalk-forming conditions spread rapidly northward to and beyond the Tennessee State line. The chalk continued to accumulate until it had reached a thickness of 250 to 350 feet and thus there was a considerable portion of middle Selma time during which chalk-forming conditions prevailed entirely across the State from the Alabama line in Noxubee County to the Tennessee line in Alcorn County. As the chalk strata are thick-bedded to massive the sea must have been too deep to permit the formation of cross-bedded structure.

DEPOSITION OF THE RIPLEY FORMATION

The formation of the Selma chalk of northern Mississippi and Tennessee was followed by a period during which nonchalky materials, at first chiefly sandy clays, were deposited, marking the beginning of the Ripley type of sedimentation. The change took place first in Tennessee, but spread rapidly southward through Mississippi to northern Noxubee County, south of which sandy chalk continued to form. Except in its lower 40 or 50 feet, which is chiefly sandy clay, the Ripley formation is predominantly composed of sand. The deposits were probably formed as a result of an uplift of the land adjacent to the Cretaceous sea to the east of northern Mississippi, which caused renewed activity of the streams and the transportation of greater amounts of clastic sediments to the sea.

The sea in which the typical Ripley deposits were laid down was perhaps on the average a little deeper than that in which the Coffee sand accumulated, for massive homogenous sands and sandstones, for the most part more or less calcareous, compose an important part of the formation. However, cross-bedded sands are not lacking, and give evidence of the prevalence of relatively shallow waters. This is further evidenced by the contained abundant remains of marine molluscan life belonging to types that do not live in very deep water. In general it may be said that during Ripley time the sea bottom in northern Mississippi was either within the lower limit of wave action or only a little below it.

In Alcorn County, Miss., and to the north in Tennessee, after the deposition of 100 or 125 feet typical Ripley materials (Coon Creek tongue), there was a slight uplift which caused a decided shallowing of the sea, probably accompanied by a nearer approach of the adjacent shore line from the east. Large amounts of sand were carried into these shallow waters and deposited under the influence of active waves and currents, which produced great irregularity in the larger features of the bedding and coarse current-bedded structure. Under these conditions was accumulated a great body of sediments, chiefly sand with subordinate amounts of clay, which form the entire upper part of the Ripley formation north of McNairy County, Tenn., and the extreme terminus of which extends southward as a great tongue or lens into the main body of the typical Ripley strata in northern Mississippi. This body of shallow water deposits has been called the McNairy sand member of this formation. (Geologic map, Plate 1A, and section FF, Plate 2.)

A POST-SELMA, POST-RIPLEY, EROSION INTERVAL

At the close of Selma and Ripley time there was a general uplift of the Gulf region that raised the newly deposited Selma chalk and Ripley formation above sea level and subjected them to erosion. The available evidence indicates that the effect of this uplift was widespread in the Gulf region. Thus there is an erosional unconformity between the Ripley formation and the overlying Owl Creek formation in northern Mississippi, between the Ripley and the Prairie Bluff chalk farther south in Mississippi, between the Selma chalk and the Prairie Bluff chalk in east-central Mississippi and central and west-central Alabama, and between the Ripley formation and the Providence sand in the Chattahoochie region; even in the western Gulf region there is a good stratigraphic break between the Nacatoch sand (of Ripley and upper Selma age) and the overlying Corsicana marl (of Prairie Bluff and Owl Creek age).

The amount of material removed during this period of land conditions differed considerably in different parts of the region. Thus in east-central Mississippi (Noxubee County) and west-central Alabama, the thickness of the eroded strata may have amounted to as much as 200 feet, for in places no more than 50 feet of chalk intervenes between the *Exogyra cancellata* zone and the Prairie Bluff chalk, whereas in northern Mississippi fully 250 feet of Ripley strata are present in the interval between this zone and the Owl Creek formation (of Prairie Bluff age); likewise in the Chattahoochie region several hundred feet of Ripley strata intervene between the *Exogyra cancellata* zone and the Providence sand (of Prairie Bluff age).

DEPOSITION OF THE PRAIRIE BLUFF CHALK AND OWL CREEK FORMATION

The widespread post-Selma erosion interval was brought to a close by downtilting that again caused the ocean waters to spread inland. From the vicinity of Pontotoc, Mississippi, to the longitude of Troy, Alabama, a distance of 300 miles, the waters were clear and nearly free from clastic sediments, a condition favorable to the deposition of chalky oozes that later consolidated to form the Prairie Bluff chalk—a chalk now nowhere more than about 80 feet thick. In northern Mississippi the sea of this time was not so clear as it was farther south, and nonchalky sediments composed of clayey sand accumulated to form the Owl Creek formation. The Prairie Bluff chalk passes northward into the Owl Creek formation by merging and intertonguing. Similarly in eastern Alabama and Georgia nonchalky sediments accumulated to form the Providence sand.

CRETACEOUS-PALEOCENE EROSION INTERVAL

Upper Cretaceous sedimentation was finally brought to a close by an earth movement that raised the whole of northeastern Mississippi and central Alabama out of the water and caused the strandline to retreat far to the south. Immediately the processes of erosion became active and before the sea again transgressed across the area in early Paleocene time, a considerable thickness of Cretaceous sediments had been removed, the outcropping edges of the Cretaceous formation had been beveled off, and the surface had been reduced to an approximate peneplain. The length of time that elapsed between the retreat of the sea and its return again in early Paleocene time cannot of course be determined in years, but even in terms of geologic time, which is measured in ten and hundreds of thousands of years, the period was long, for the returning sea brought with it a greatly changed and largely new assemblage of marine life. Many Cretaceous genera had become extinct. Those that were still living were practically all represented by new species that were the evolutionary descendents of the Cretaceous species previously inhabiting the area. New genera and species had migrated in from other regions.

The Midway sea was the last of the marine inundations to reach as far inland as northeastern Mississippi. Since its retreat in early

Tertiary time the area of outcrop of the Cretaceous formations has been continuously above sea level and subject to erosion.

LATE TERTIARY AND QUATERNARY EVENTS

Shaw (39, pp. 149-153) has shown that in early Pliocene or perhaps in late Miocene time northern Mississippi was a part of a great plain whose altitude was about 100 feet higher than the present crest of the Pontotoc Hills. Remnants of this plain are still preserved in Tennessee where it is known as the Highland Rim peneplain.

A later uplift of the land relative to sea level caused the streams and rivers of the region to cut valleys into this plain, and the highest terrace deposits of Tennessee and Tombigbee rivers were laid down in their flood-plains. Successive elevations of the land caused deeper and deeper channels to be cut and left the older floodplains as terrace deposits at the sides of the valleys (Plate 1B).

Tombigbee River successively abandoned five floodplains, each time cutting a new channel to the west of the old and leaving its former floodplains as terrace deposits to the east. As erosion cut back the edge of the relatively resistant Selma chalk on the west the newly exposed Tombigbee sand offered less resistance to down-cutting than the gravel deposits of the former flood plain. Thus the river kept shifting its course westward. At the time the lowest of the five terraces was formed, Tombigbee River flowed east of Pleasant Ridge on the southern tip of which is the site of Columbus. Tibbee River, flowing west of Pleasant Ridge, apparently joined the Tombigbee south of the site of Columbus. By some means not yet entirely understood Tombigbee abandoned its former course and assumed that of Town Creek and Tibbee River. It may be that a meander of the Tombigbee cut through the narrow divide between Tombigbee River Valley on the east and Town Creek Valley on the west, after which the flood waters of the Tombigbee followed this shorter route south rapidly carving out a channel in the relatively soft Tombigbee sand. Whatever the cause, the present flood plain of the Tombigbee is west of Pleasant Ridge and this ridge is the only area east of Tombigbee River near Columbus that is not covered by terrace gravel.

The great continental glaciers that covered central North America during parts of the Pleistocene epoch (ice age) did not extend as far south as Mississippi, but during the melting stages the waters of the Mississippi River of that time carried in suspension great quantities of very fine sediment ("rock flour") that had resulted from the grinding and scraping of the ice over their rock floors. As the flood waters spread out over the bottom lands of the river in its lower course their currents were checked and much of the sediment was deposited as fine mud. Deposition was rapid and floods were so frequent that during the intermediate low stages of the river, vegetation had little opportunity to take root. But these stages were long enough to premit the mud flats to dry out, and strong west winds lifted clouds of dust from the flats and carried them eastward over much of Mississippi and other states to the north. The dust settled on the upland immediately east of the river valley forming the thick mantle of material known as loess; and farther east, as a thinner deposit, where it is mixed with other soil materials to form brown loam. Only the eastern feather edge of the brown loam mantle is still preserved over parts of the Cretaceous area treated in this report. In the area (Black Prairies) underlain by the Selma chalk most of the thin mantle of brown loam has been removed by erosion in Recent time.

The surface of Mississippi as it is seen today, with its hills and plains, its prairies and stream terraces, is the final result of the long period of erosion that succeeded the last invasion of the sea in early Tertiary time.

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PLATES

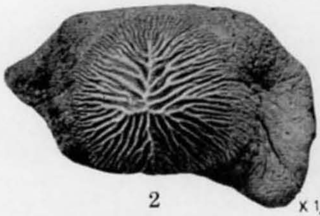
PLATE 3

Fossils from the Tombigbee sand member of Eutaw formation

Figure 1. *Mortoniceras* aff. *M. texanum* (Roemer). From the bench-making indurated layer at Plymouth Bluff, Tombigbee River, Lowndes County, Miss. (U.S.N.M. Cat. No. 76253.)

2. *Hemiptychodus* cf. *H. mortoni* (Mantell). From the upper part of the member in a field about 3 miles northwest of Selma, Ala. (U.S.N.M. Cat. No. 11908.)

3. *Hemiptychodus* cf. *H. mortoni* (Mantell). From the upper part of the member at Choctaw Bluff, Warrior River, Greene County, Ala. (U.S.N.M. Cat. No. 11907.)



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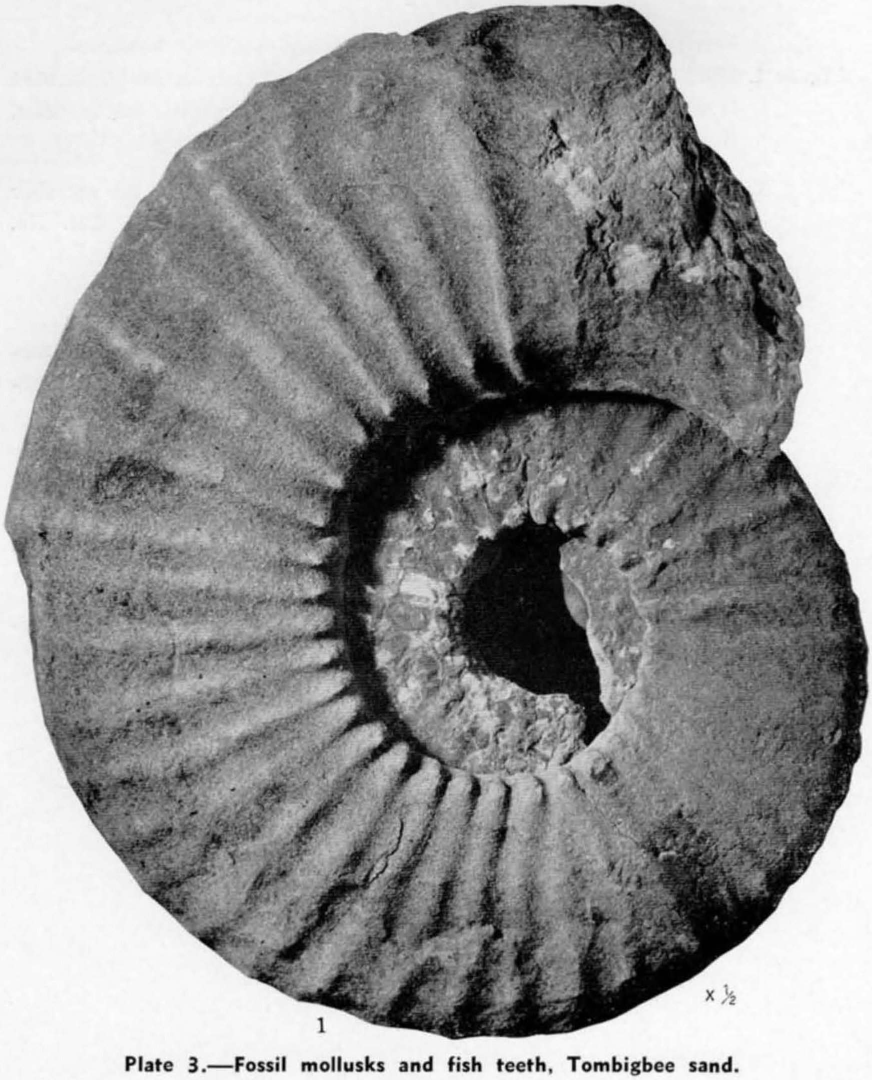

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1

Plate 3.—Fossil mollusks and fish teeth, Tombigbee sand.

PLATE 4

Fossils from the Tombigbee sand member of Eutaw formation

Figure 1. *Marsupites americanus* Springer. From the bench-making indurated layer at Plymouth Bluff, Tombigbee River, Lowndes County, Miss. Reproduction of Springer's original drawing of the type.

2. *Exogyra ponderosa* Roemer. From the upper part of the member at Plymouth Bluff, Lowndes County, Miss. (U.S.N.M. Cat. No. 31224.)

Fossils from the Coffee sand

3. *Idonearca* aff. *I. carolinensis* Gabb. From the lower part of the formation on the road to Hare's old mill site 5 1/2 miles east of Booneville, Prentiss County, Miss. (U.S.N.M. Cat. No. 76241.)

4. Interior view of the specimen shown in Figure 3.

5. *Etea carolinensis* Conrad. From the lower part of the formation on the northeastward-facing slope of Youngs Creek Valley, in Sec. 8, T. 6 S., R. 8 E., Prentiss County, Miss. (U.S.N.M. Cat. No. 76242.)

6. *Turritella quadrilira* Johnson. From the same locality as the preceding. (U.S.N.M. Cat. No. 76243.)

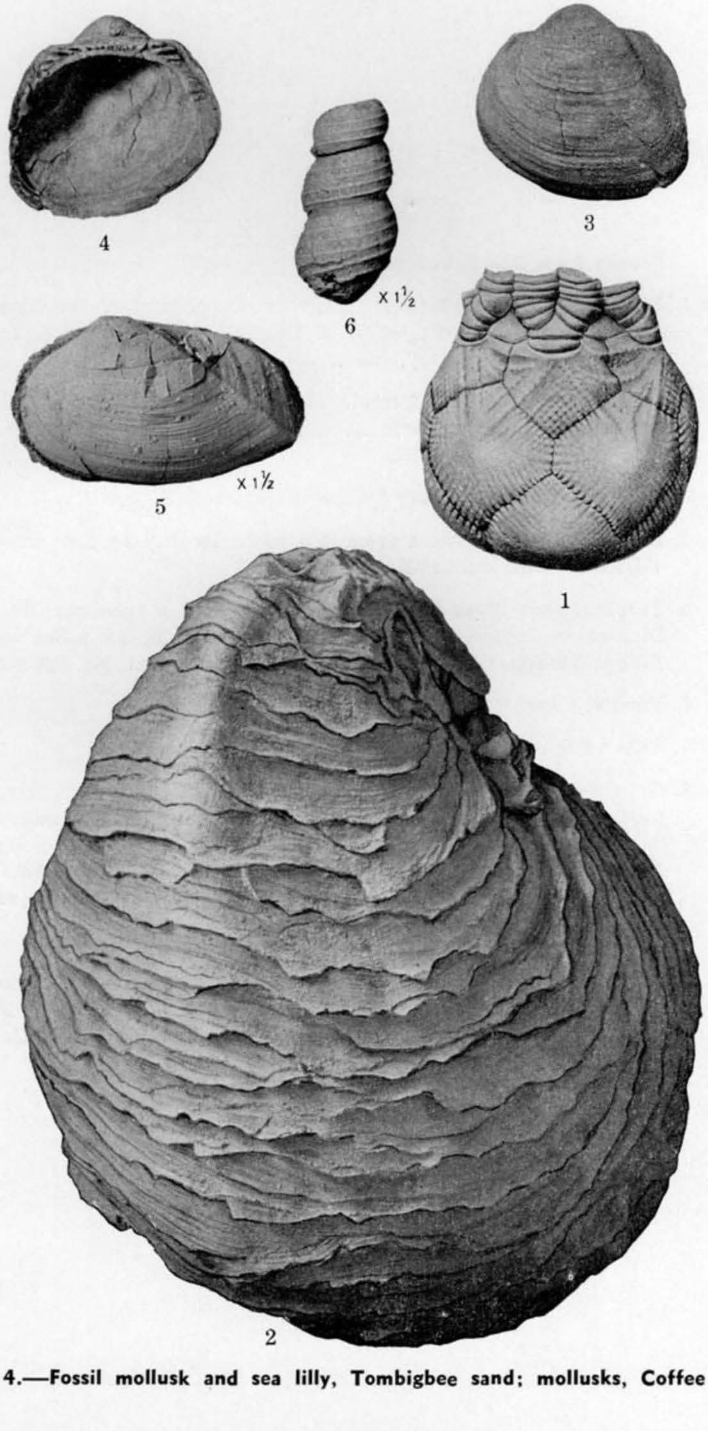

Plate 4.—Fossil mollusk and sea lilly, Tombigbee sand; mollusks, Coffee sand.

PLATE 5

Fossils from the Selma chalk

Figure 1. *Liopistha alternata* Weller. From the lower part of the formation on the southward-facing slope of Mattubby Creek in Sec. 2, T. 14 S., R. 6 E., Monroe County, Miss. (U.S.N.M. Cat. No. 76244.)

2. *Diploschiza cretacea* Conrad. Right valve, a neotype, from the *Diploschiza cretacea* zone in the river bluff at Demopolis, Ala. (U.S.N.M. Cat. No. 75105.)

3. An enlarged view of the specimen shown in Figure 2.

4. Interior of a left valve from the same locality as the preceding. (U.S.N.M. Cat. No. 75106.)

5. *Terebratulina filosa* Conrad. Dorsal view of a specimen from the *Diploschiza cretacea* zone on State Highway 25, 1.8 miles west of Tibbee Station, Clay County, Miss. (U.S.N.M. Cat. No. 76245.)

6. Ventral view of the specimen shown in Figure 5.

7. Side view of the same specimen.

8. *Gryphaea convexa* (Say). Left or convex valve of a nearly complete shell, the gift of Mr. John G. Foster, from near the base of the Selma chalk of northern Mississippi on U. S. Highway 45 south of Biggersville, Alcorn County, Miss. (U.S.N.M. Cat. No. 76246.); this species is recorded also from the upper part of the Coffee sand.

9. Right or concave valve of the shell shown in Figure 8.

10. *Gryphaea convexa* (Say). Left valve of a specimen from the base of the Selma chalk of northern Mississippi, in a cut of the Mobile & Ohio Railroad at Guntown, Lee County, Miss. (U.S.N.M. Cat. No. 76247.)

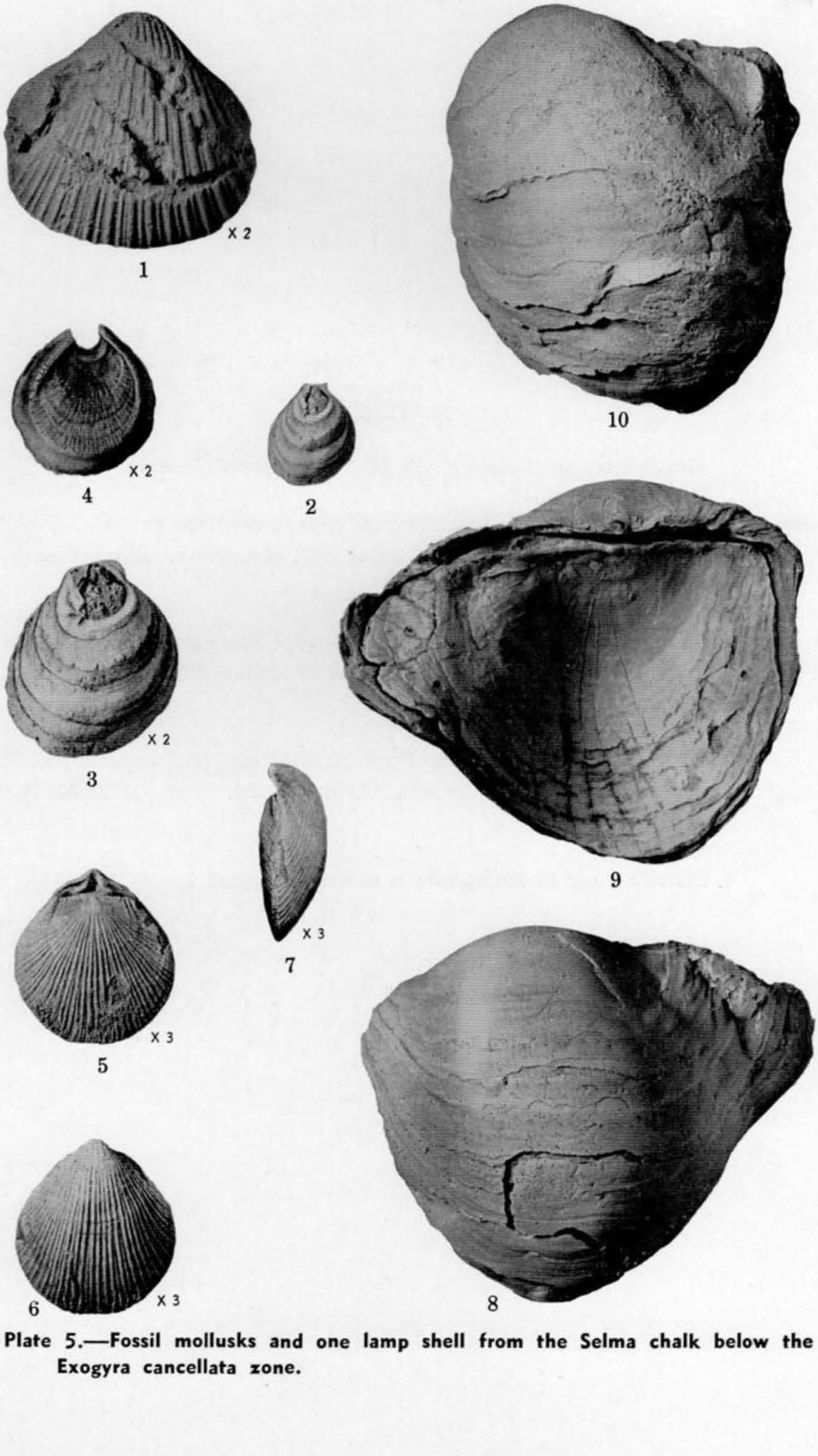

Plate 5.—Fossil mollusks and one lamp shell from the Selma chalk below the Exogyra cancellata zone.

PLATE 6

Fossils from the Selma chalk (*Exogyra cancellata* zone)

Figure 1. *Exogyra costata Say* (variety with wide costae). From "Bald Knob" on Joseph Reynold's place 3 miles west of Corinth, Alcorn County, Miss. (U.S.N.M. Cat. No. 31229.)

2. *Exogyra cancellata* Stephenson. The type specimen, from the West Point-Cedar Bluff road 1 mile east of Cedar Bluff, Clay County, Miss. (U.S.N.M. Cat. No. 31235.)

3. *Anomia tellinoides* Morton. From "Bald Knob" on Joseph Reynold's place 3 miles west of Corinth, Alcorn County, Miss. (U.S.N.M. Cat. No. 76248.)

4. Interior view of the specimen shown in Figure 3.

2

3

4

1

Plate 6.—Fossil mollusks, Selma chalk (Exogyra cancellata zone).

PLATE 7

Fossil from the Selma chalk (upper part)

Exogyra costata Say (variety with costae of medium width). From the upper part of the formation (of Ripley age) above the *Exogyra cancellata* zone, on the westward-facing slope of Wahalak Creek Valley, 6 miles north of Scooba, Kemper County, Miss.; this is the largest shell of this common species yet discovered. (U.S.N.M. Cat. No. 31230.)

Plate 7.—Largest known shell of Exogyra costata Say, Selma chalk.

PLATE 8

Fossil from the Ripley formation

Figure 1. *Hardouinia porrecta* (Clark). From the upper part of the formation, east of State Highway 15, about 1 1/2 miles south of Pontotoc, Miss.; this specimen is the gift of its dicoverer, Miss Mary Neill of Oxford, Miss., and is the only representative of the species on record from Mississippi. (U.S.N.M. Cat. No. 76249.)

2. Lower surface of the specimen shown in Figure 1.

1

2

Plate 8.—Large fossil sea urchin from the Ripley formation.

PLATE 9

Fossils from the Ripley formation

Figure 1. *Hardouinia subquadrata* (Conrad). From the upper part of the formation on the southward-facing slope of Walnut Creek Valley, south of Mr. L. T. Braddock's house, in the SE 1/4, Sec. 16, T. 3 S., R. 4 E., Tippah County, Miss. (U.S.N.M. Cat. No. 76250.)

2. Lower surface of the specimen shown in Figure 1.

3. Rear end view of the same specimen.

4. *Crassatella pteropsis* Conrad. From C. R. Hall's farm in Sec. 5, T. 6 S., R. 4 E., Union County, Miss. (U.S.N.M. Cat. No. 20845.)

5. Dorsal view of the specimen shown in Figure 4.

6. *Sargana stantoni* (Weller). From Bullock's old mill site 2 miles south of Dumas, Tippah County, Miss. (U.S.N.M. Cat. No. 20548.)

7. Front view of the specimen shown in Figure 6.

8. Top view of the same specimen.

9. *Liopeplum leiodermum* (Conrad). From C. R. Hall's farm in Sec. 5, T. 6 S., R. 4 E., Union County, Miss. (U.S.N.M. Cat. No. 20471.)

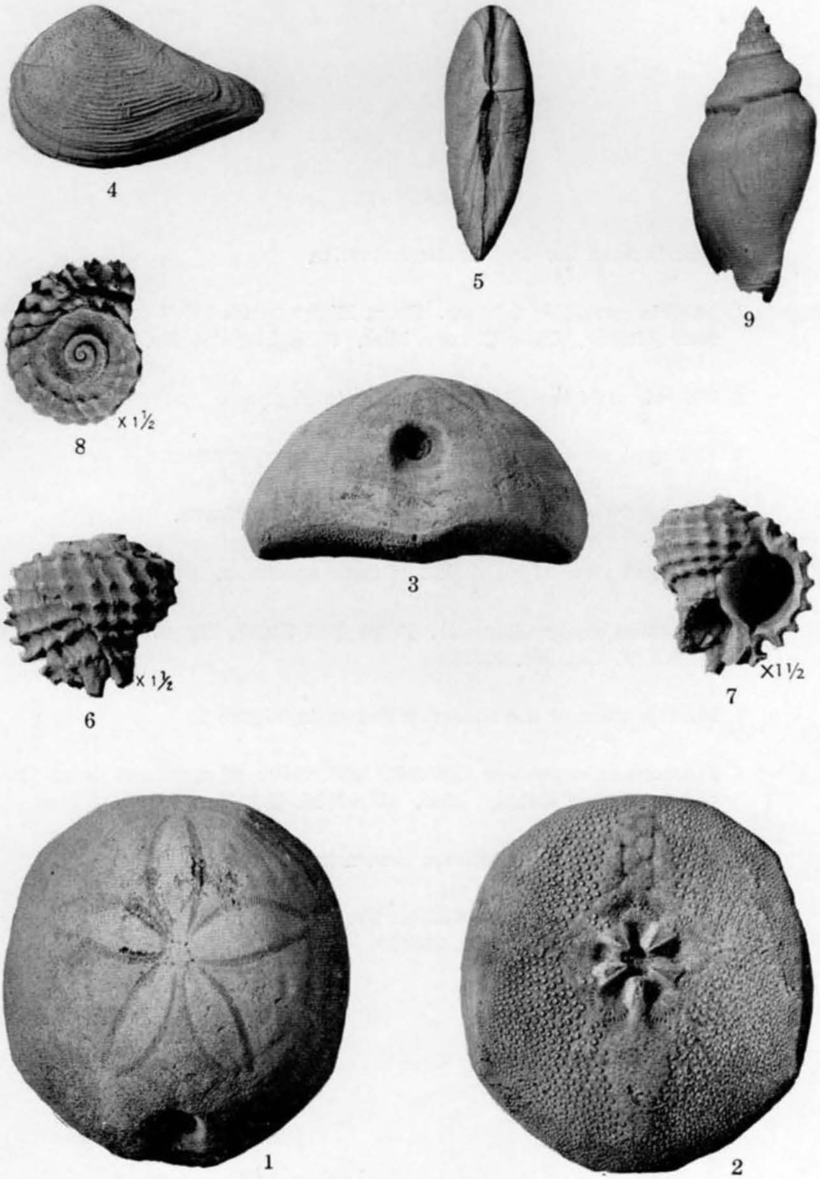

Plate 9.—Fossil mollusks and one sea urchin, Ripley formation.

PLATE 10

Fossils from the Owl Creek formation

Figure 1. *Linthia variabilis* Slocum. From Highway 15, 3 1/4 miles south of New Albany, Union County, Miss. (U.S.N.M. Cat. No. 76251.)

2. Side view of the specimen shown in Figure 1.

3. Enlarged view of upper surface of same specimen.

4. Enlarged view of lower surface of same specimen.

5. Enlarged view of right side of same specimen.

6. *Idonearca capax* (Conrad). From Owl Creek, Tippah County, Miss. (U.S.N.M. Cat. No. 20721.)

7. Interior view of the specimen shown in Figure 6.

8. *Inoceramus argenteus* Conrad. Left valve of specimen from Owl Creek, Tippah County, Miss. (U.S.N.M. Cat. No. 20661.)

9. Right valve of the specimen shown in Figure 8.

10. *Trigonia angulicostata* Gabb. From Owl Creek, Tippah County, Miss. (U.S.N.M. Cat. No. 20666.)

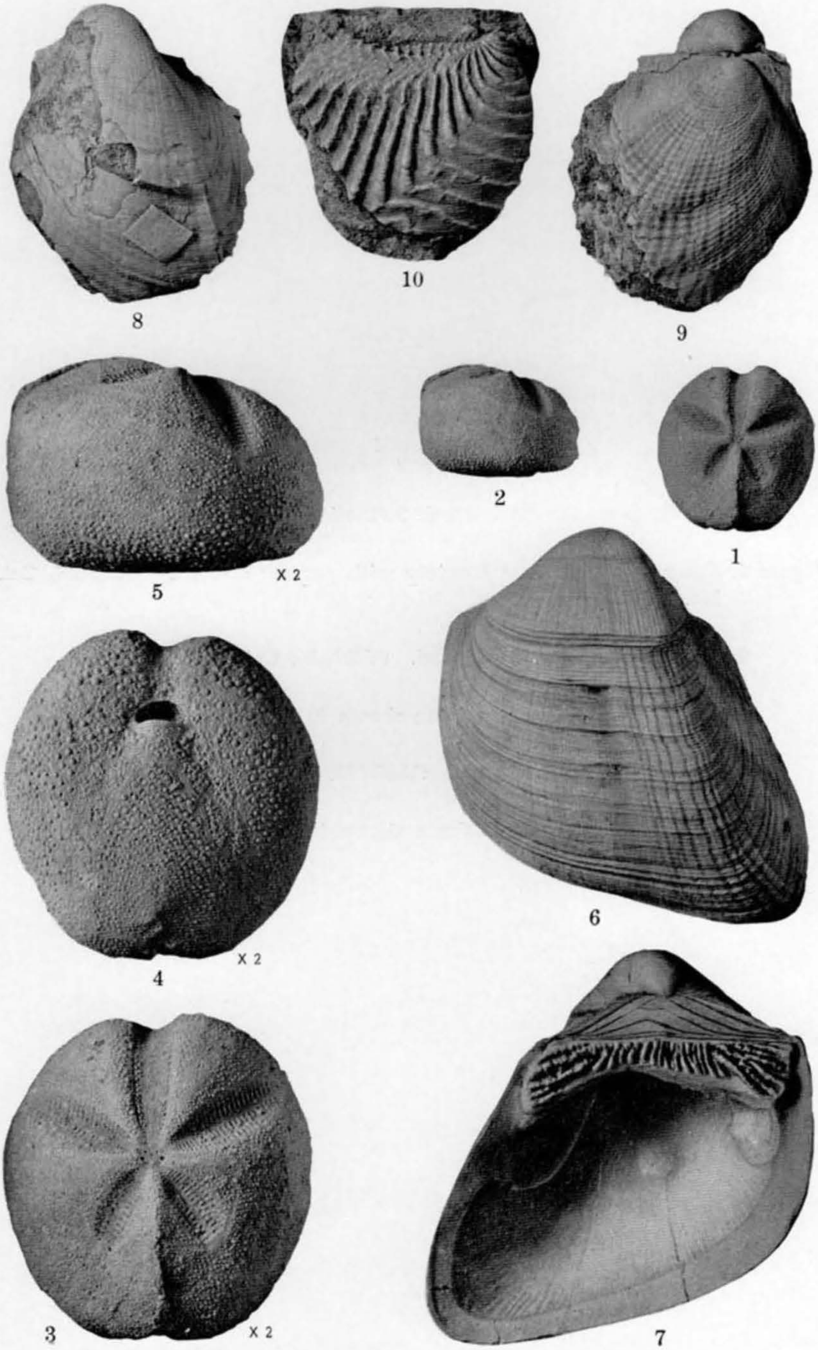

Plate 10.—Fossil mollusks and one sea urchin, Owl Creek formation.

PLATE 11

Fossils from the Owl Creek formation, Tippah County

Figure 1. *Exogyra costata* Say (variety with narrow costae). (U.S.N.M. Cat. No. 31233.)

2. *Pholadomya tippana* Conrad. (U.S.N.M. Cat. No. 20716.)

3. Dorsal view of the specimen shown in Figure 2.

4. *Pholas? pectorosa* Conrad. (U.S.N.M. Cat. No. 20715.)

5. Dorsal view of the specimen shown in Figure 4.

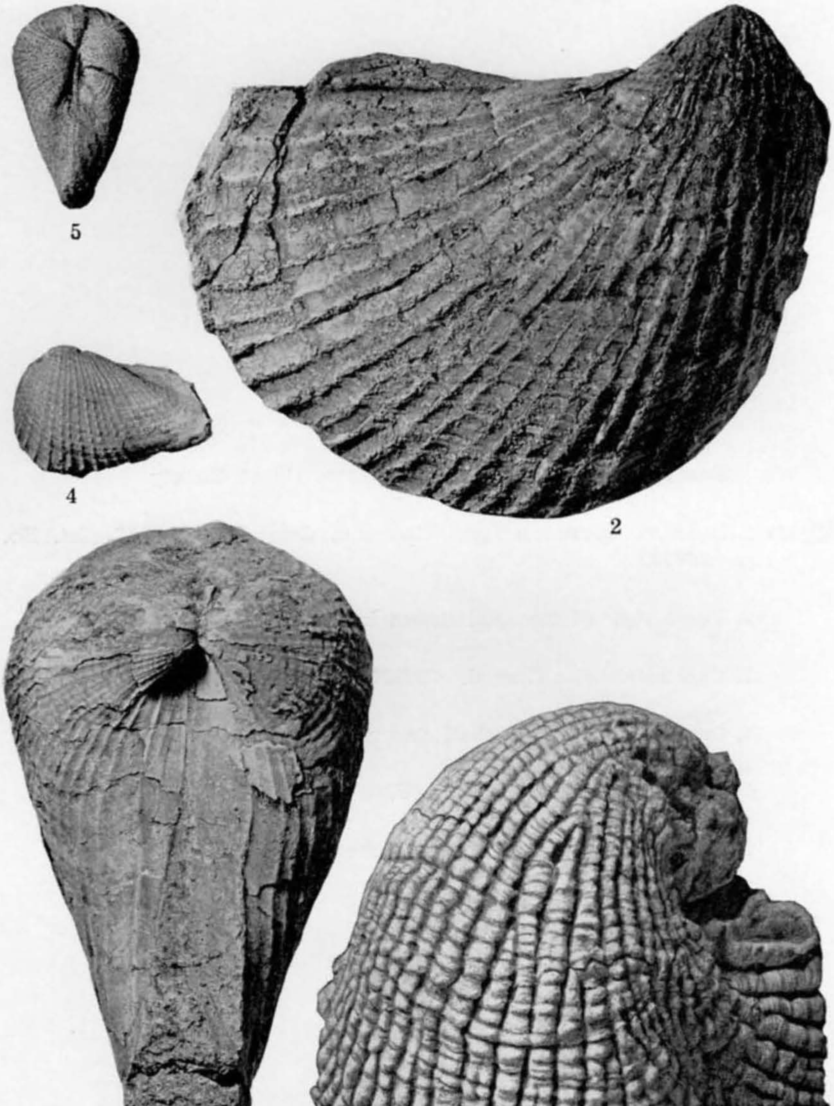

Plate 11.—Fossil mollusks, Owl Creek formation.

PLATE 12

Fossils from the Owl Creek formation, Tippah County

Figure 1. *Cardium (Granocardium) tippanum* Conrad. (U.S.N.M. Cat. No. 20853.)

2. Front view of the shell shown in Figure 1.

3. *Cyprimeria alta* Conrad. (U.S.N.M. Cat. No. 20695.)

4. Interior view of the shell shown in Figure 3.

5. *Aphrodina tippana* Conrad. (U.S.N.M. Cat. No. 20690.)

6. View of the hinge of the shell shown in Figure 5.

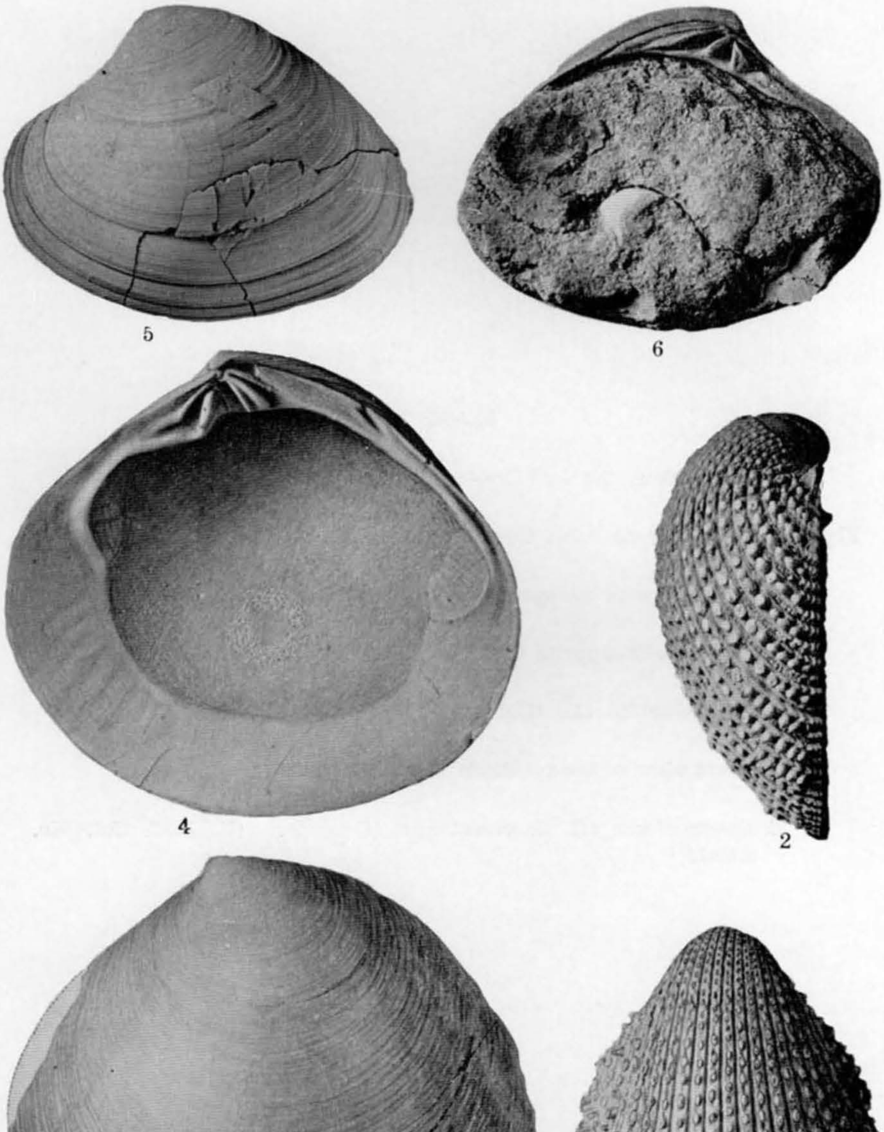

Plate 12.—Fossil mollusks, Owl Creek formation.

PLATE 13

Fossils from the Owl Creek formation, Tippah County

Figure 1. *Pugnellus densatus* Conrad. (U.S.N.M. Cat. No. 20433.)

2. Front view of the specimen shown in Figure 1.

3. *Pterocerella tippana* Conrad. (U.S.N.M. Cat. No. 20435.)

4. *Liopeplum canalis* (Conrad). (U.S.N.M. Cat. No. 20437.)

5. Front view of the specimen shown in Figure 4.

6. *Sphenodiscus* aff. *S. pleurisepta* (Conrad). (U.S.N.M. Cat. No. 20863.)

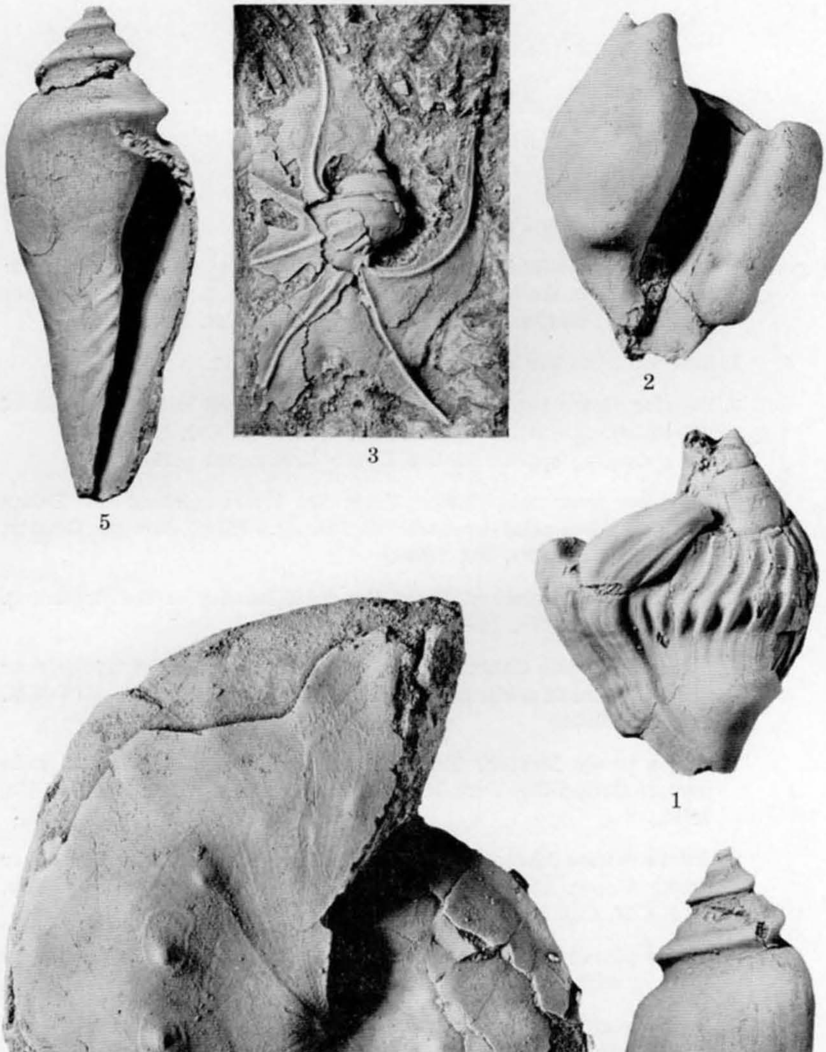

Plate 13.—Fossil mollusks, Owl Creek formation.

PLATE 14

Fossils from the Prairie Bluff chalk

Figure 1. *Diploschiza melleni* Stephenson. Right valve of the holotype, from a bald spot in the old Coatopa road, about 2 1/2 miles southeast of Livingston, Sumter County, Ala. (U.S.N.M. Cat. No. 75484.)

2. Left valve of the holotype, shown in Figure 1.

3. Interior view of one of the paratypes from 0.35 mile northwest of the courthouse at Livingston, Ala. (U.S.N.M. Cat. No. 75486.)
Long-ranging species in the Upper Cretaceous series

4. *Hamulus squamosus* Gabb. From the lower part of the Selma chalk, 2 miles west by north of Pleasant Ridge, Greene County, Ala. (U.S.N.M. Cat. No. 73645.)

5. *Hamulus onyx* Morton. From the same locality as the preceding. (U.S.N.M. Cat. No. 73644.)

6. *Ostrea tecticosta* Gabb. From the Ripley formation at bridge over Chewalla Creek north of Eufaula, Barbour County, Ala. (U.S.N.M. Cat. No. 73624.)

7. *Ostrea panda* Morton. From the base of the Selma chalk 1 mile west of Cotton Gin Port, Monroe County, Miss. (U.S.N.M. Cat. No. 76252.)

8. *Ostrea falcata* Morton. From the Ripley formation at bridge over Snake Creek, Carlowville-Snow Hill road, Dallas County, Ala. (U.S.N.M. Cat. No. 73623.)

9. *Ostrea plumosa* Morton . From an unknown locality in the Selma chalk of Alabama. (U.S.N.M. Cat. No. 73621.)

10. *Gryphaeostrea vomer* (Morton). A left valve from the Prairie Bluff chalk at Old Canton Landing, Alabama River, Wilcox County, Ala. (U.S.N.M. Cat. No. 73646.)

11. *Gryphaeostrea vomer* (Morton). A right valve from the same locality as the preceding. (U.S.N.M. Cat. No. 73646.)

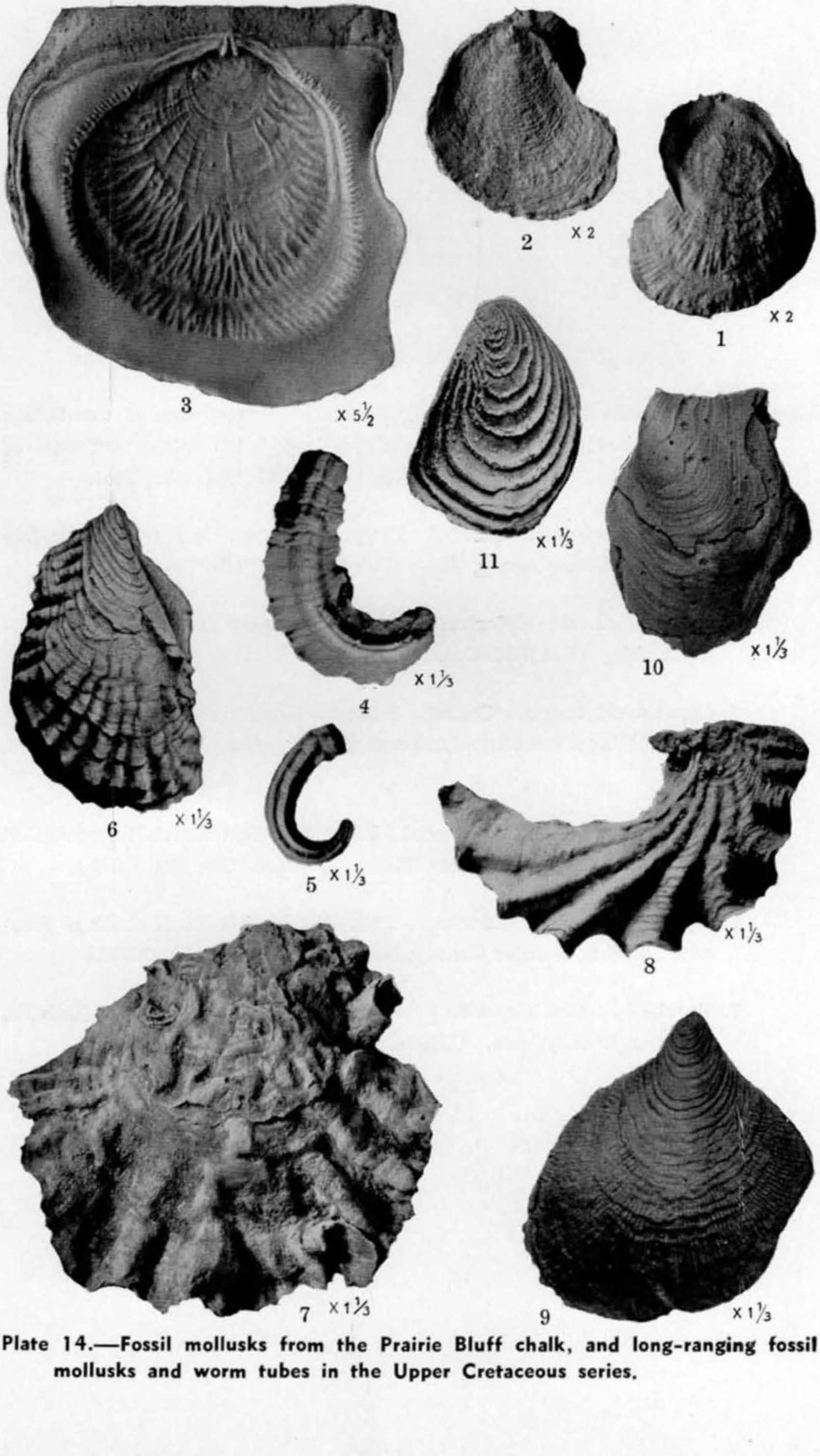

Plate 14.—Fossil mollusks from the Prairie Bluff chalk, and long-ranging fossil mollusks and worm tubes in the Upper Cretaceous series.

PLATE 15

Long-ranging fossils in the Upper Cretaceous series

Figure 1. *Paranomia scabra* (Morton). From the upper part of the Selma chalk (sandy facies), on the Epes road 4 1/4 miles northeast of Livingston, Sumter County, Ala. (U.S.N.M. Cat. No. 73641.)

2. *Anomia argentaria* Morton. From the Ripley formation near Eufaula, Barbour County, Ala. (U.S.N.M. Cat. No. 73640.)

3. *Veniella conradi* (Morton). From the Ripley formation, near Eufaula, Ala. (U.S.N.M. Cat. No. 73636.)

4. *Cyprimeria depressa* Conrad. From the Cusseta sand (marine facies) at Woolridge Landing, Barbour County, Ala. (U.S.N.M. Cat. No. 73632.)

5. *Leptosolen biplicatus* Conrad. From the Owl Creek formation at Owl Creek, Tippah County, Miss. (U.S.N.M. Cat. No. 21678.)

6. *Gyrodes abyssinus* (Morton). From the Prairie Bluff chalk at Moscow Landing, Sumter County, Ala. (U.S.N.M. Cat. No. 73638.)

7. *Turritella trilira* Conrad. From the Ripley formation near Eufaula, Barbour County, Ala. (U.S.N.M. Cat. No. 73637.)

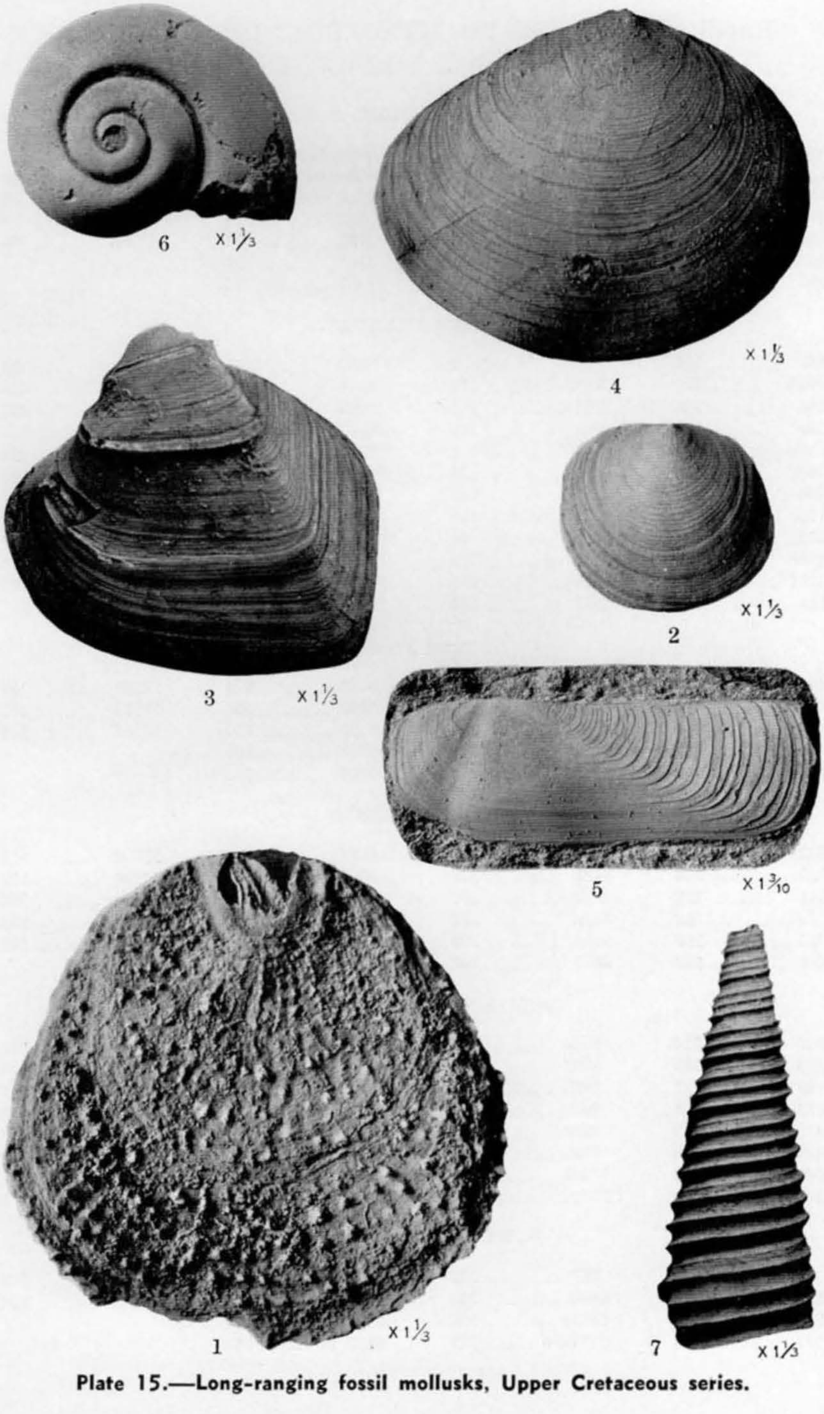

Plate 15.—Long-ranging fossil mollusks, Upper Cretaceous series.

PAGE REFERENCES TO LITHOLOGIC DESCRIPTIONS OF FOSSIL LOCALITIES

EUTAW (TOMBIGBEE) FOSSILS

Collection number	Page	Collection number	Page	Collection number	Page	Collection number	Page
6448	76	6914	73	6922	79	17245	75
6449	76	6915	73	6923	79	17247	73
6450	74	6916	73	6925	79	17782	159
6458b	87	6918	73	9517	87		
6887	81	6921	74	17202	73		

SELMA FOSSILS

6455	138	6860	123	6903	157	17226	125
6455b	138	6862	123	6904	157	17243	116
6456	138	6871	138	6908	138	17244	117
6457	138	6879	141	6913	173	17248	125
6459a	142	6880	113	6919	73	17249	124
6459b	142	6882	121	6920	117	17250	124
6460	139	6883	121	9496	172	17252	127
6475	114	6885	120	9521	127	17262	137
6479b	115	6886	81	17207	81	17800	115
6479c	115	6897	132	17216	132	17803	133
6480f	211	6899	131	17221	142	17804	117
6859	123	6901	134	17224	126		

COFFEE FOSSILS

6453	150	6900	150	9497	172	17260	155
6454	159	6907	161	9498	165	17783	159
6458	160	6909	159	9501	159	17809	153
6460b	163	6910	160	9502	160		
6461	163	6913	173	17254	153		

RIPLEY FOSSILS

542	188	6466a-g	194	6877	183	17256	222
708	188	6469	196	9508	190	17276	193
711	192	6473	198	9522	194	17277	191
712	192	6848	202	17201	222	17799	233
714	186	6850	199	17223	199	18078	192
6462	188	6873	191	17234	183		

PRAIRIE BLUFF FOSSILS

3186	216	6844	216	17228	218	17261	222
6479	115	6847	217	17233	219	17484	213
6480	211	6852	225	17235	219	17485	115
6835	210	6853	225	17242	213	17802	115
6836	213	6857	225	17251	197	17808	222
6838	212	9604	236	17253	219		
6839	115	17206	225	17255	222		
6843	216	17210	115	17257	222		

OWL CREEK FOSSILS

75	232	713	233	9509	237	17278	235
541	232	6463	233	9510	237	17805	239
546	232	6463b	233	9512	237		
707	232	6464a-c	232	9516	235		

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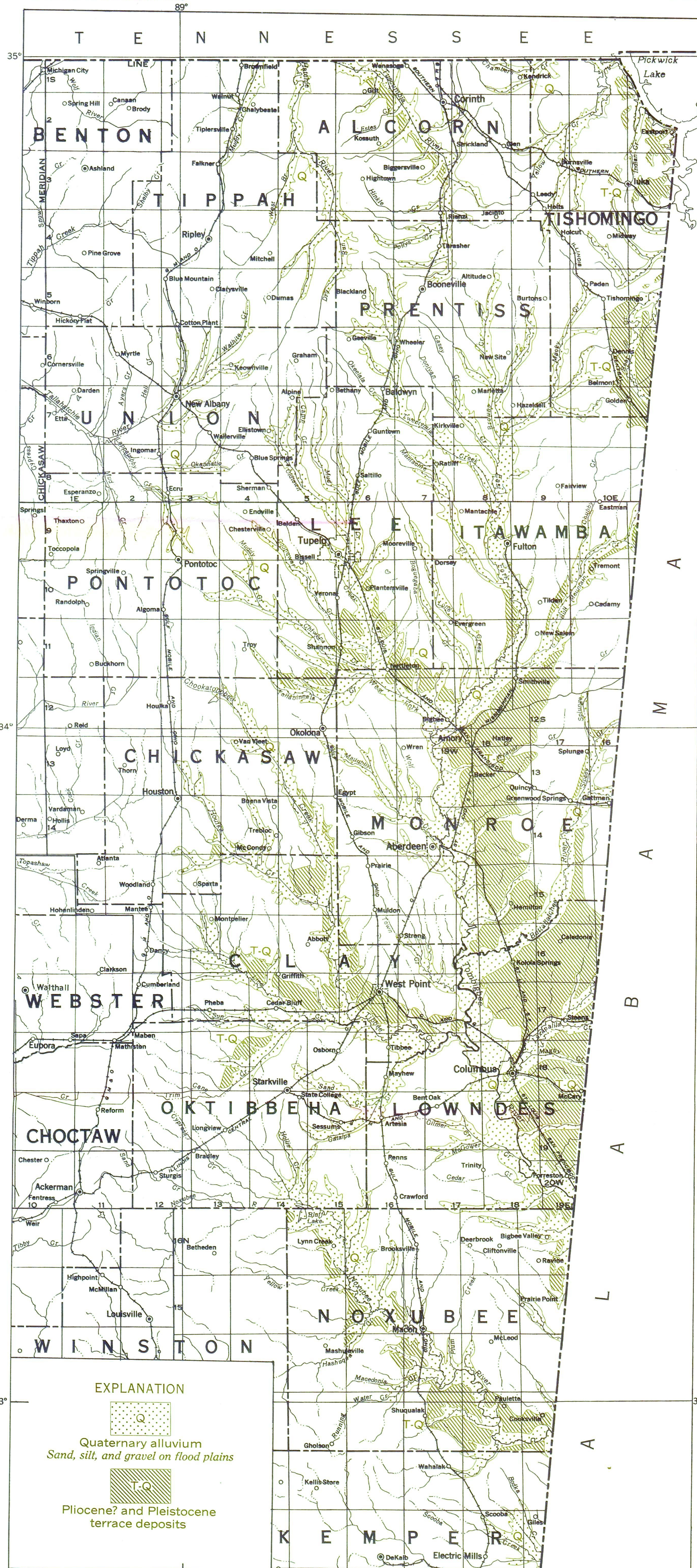
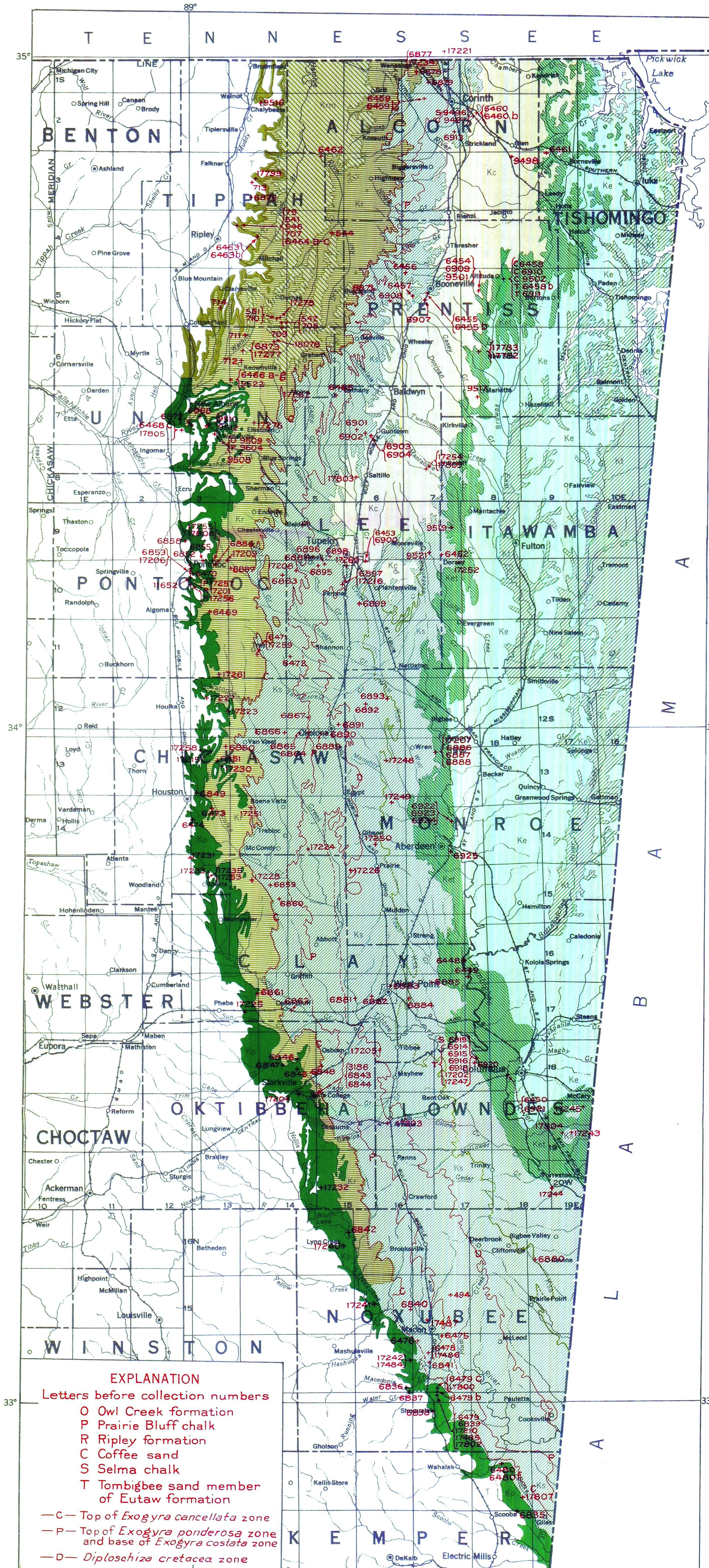


GEOLOGIC MAP SHOWING THE LARGER BODIES OF SURFICIAL DEPOSITS WITHIN THE AREA OF OUTCROP OF THE UPPER CRETACEOUS SERIES

5 0 5 10 20 30 MILES



GEOLOGIC MAP OF THE AREA OF OUTCROP OF THE UPPER CRETACEOUS SERIES IN NORTHEASTERN MISSISSIPPI

THE NUMBERS ARE THE COLLECTION NUMBERS OF THE U. S. GEOLOGICAL SURVEY

5 0 5 10 20 30 MILES

LEGEND

T
Tertiary rocks
(Marine sand, clay, marl, and limestone)

UNCONFORMITY

Kp
Prairie Bluff chalk
(Chalky limestone containing many phosphatic molds of fossils at base; as mapped includes at top a narrow tongue of the Owl Creek formation extending southward beyond Pontotoc)

Ko
Owl Creek formation
(Tough blue fine glauconitic sandy clay; as mapped includes at base a narrow tongue of Prairie Bluff chalk extending northward to southern Tippah County)

UNCONFORMITY

Krm
Kr
Ripley formation
(Gray to greenish-gray fine glauconitic sand, clay, and sandy limestone; Krm, *McNairy sand member, red and white cross-bedded micaceous sand and white sandy clay)*

Ks
Ksa
Ks
Selma chalk
(Chalky limestone containing more or less sand and clay; Ksa, *Arcola limestone member, hard buff-colored limestone)*

Kc
Coffee sand
(Light-gray cross-bedded glauconitic sand and sandy clay and calcareous sandstone)

UNCONFORMITY

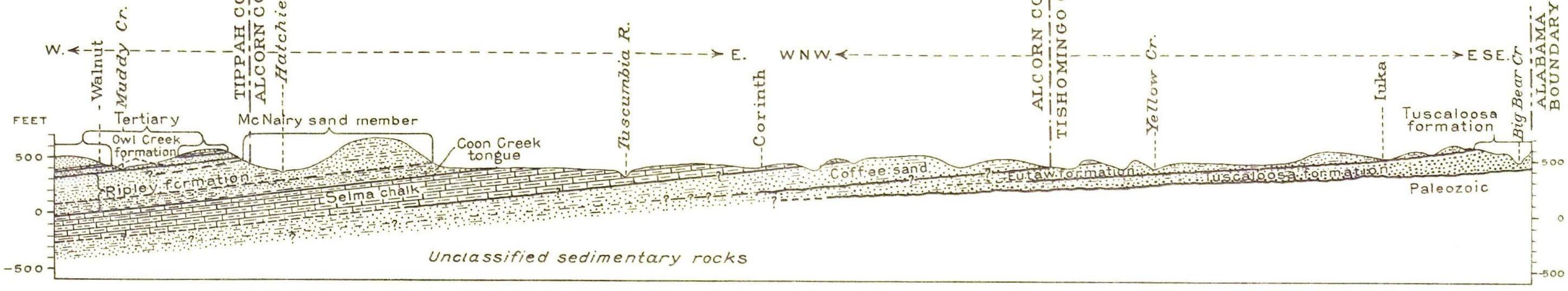
Ket
Ke
Eutaw formation
(More or less cross-bedded and thinly laminated glauconitic sand and clay; Ket, *Tombigbee sand member, massive fine glauconitic sand)*

UNCONFORMITY

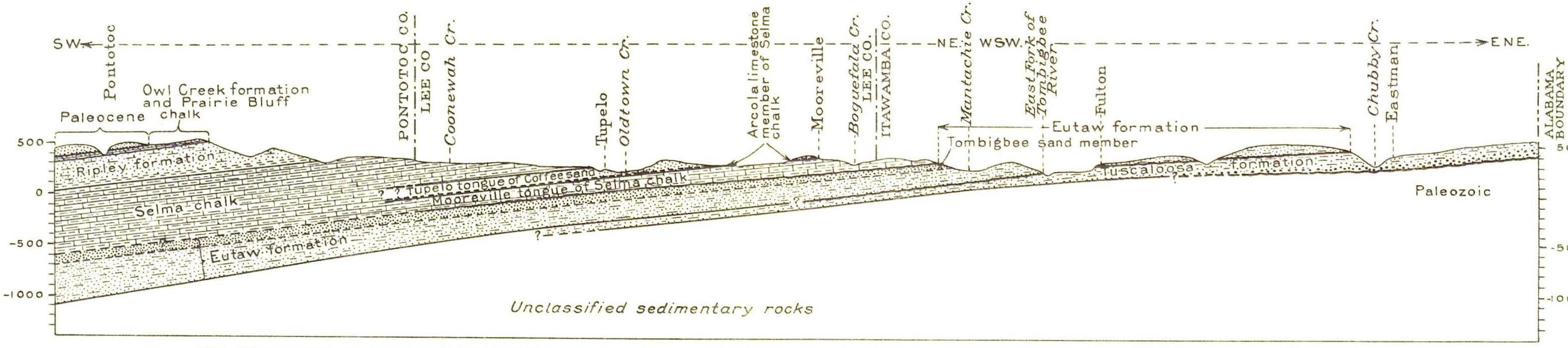
Kt
Tuscaloosa formation
(Light and vari-colored irregularly bedded sand, clay, and gravel; gravel is mostly in lower portion)

UNCONFORMITY

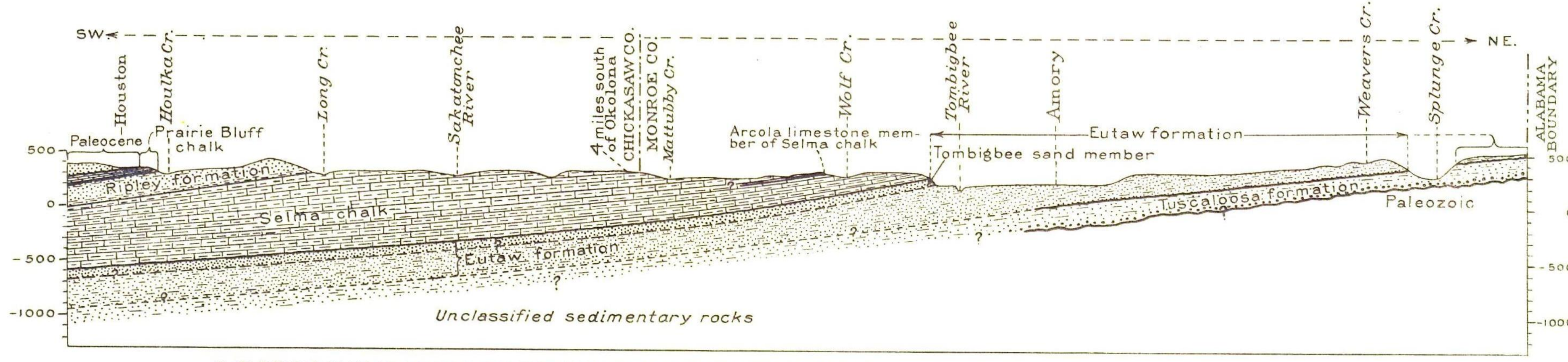
P
Paleozoic rocks
(Shale, sandstone, limestone, and chert, of Devonian and Mississippian age)



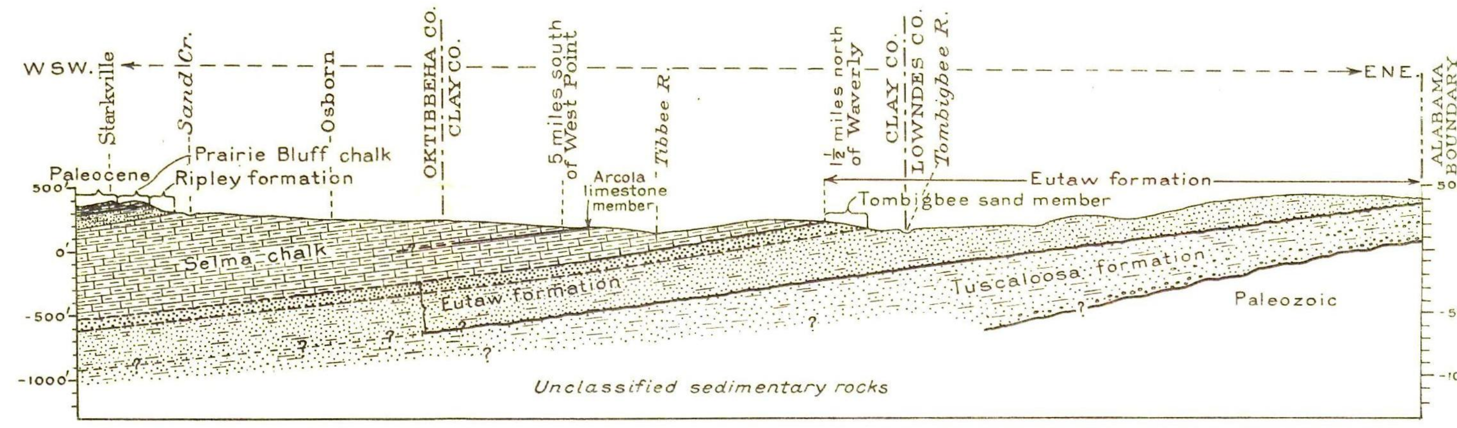
A-A' FROM THE ALABAMA BOUNDARY SOUTHEAST OF IUKA, TISHOMINGO CO., VIA CORINTH TO WALNUT, TIPPAH CO.



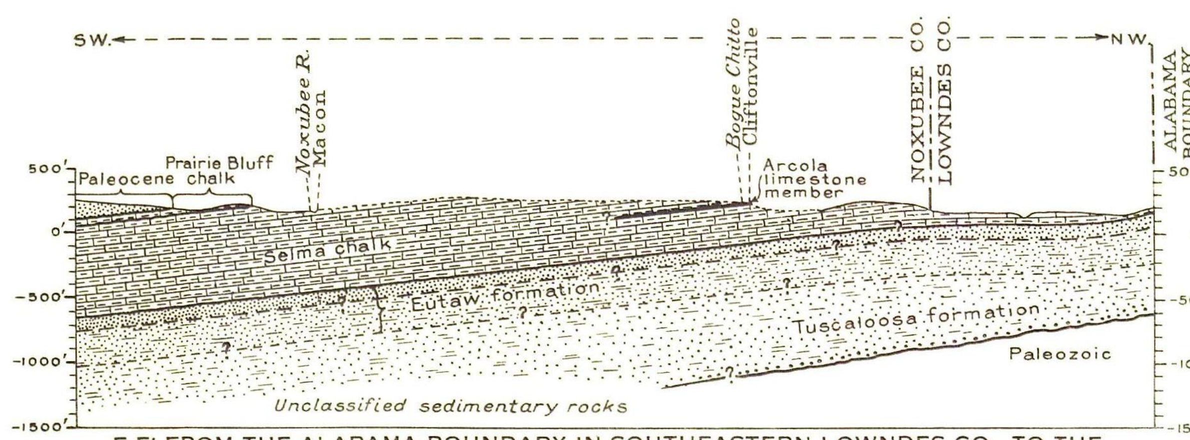
B-B' FROM THE ALABAMA BOUNDARY NORTHEAST OF EASTMAN, ITAWAMBA CO., VIA FULTON TO PONTOTOC, PONTOTOC CO.



C-C' FROM THE ALABAMA BOUNDARY IN NORTHEASTERN MONROE COUNTY TO HOUSTON, CHICKASAW COUNTY

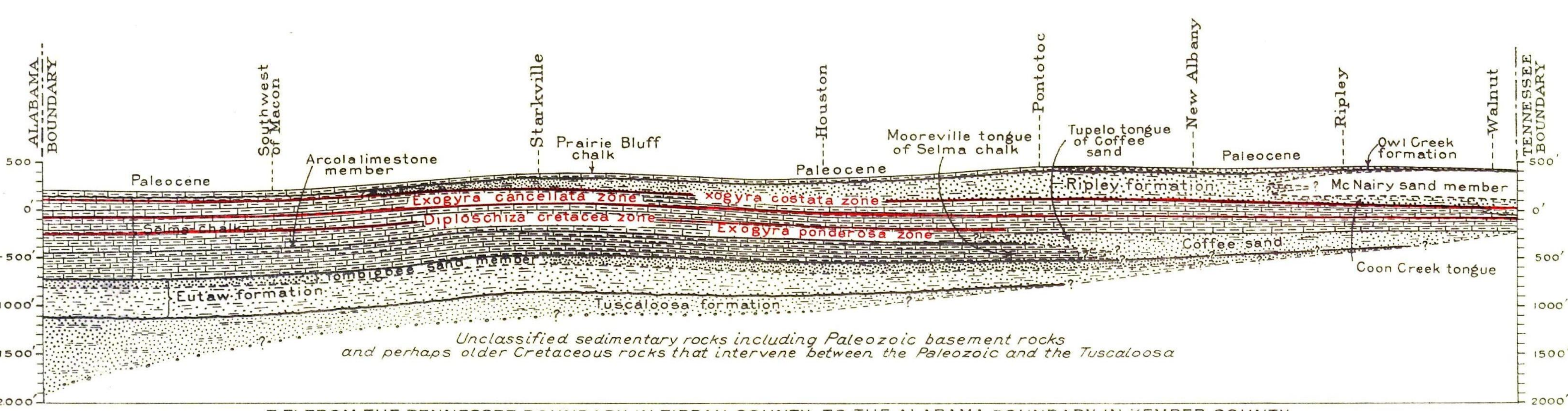


D-D' FROM THE ALABAMA BOUNDARY IN NORTHEASTERN LOWNDES CO., TO STARKVILLE, OKTIBBEHA CO.



E-E' FROM THE ALABAMA BOUNDARY IN SOUTHEASTERN LOWNDES CO., TO THE CRETACEOUS-PALEOCENE CONTACT SOUTHWEST OF MACON, NOXUBEE CO.

Horizontal scale
0 5 10 Miles



F-F' FROM THE TENNESSEE BOUNDARY IN TIPPAH COUNTY, TO THE ALABAMA BOUNDARY IN KEMPER COUNTY, SHOWING THE RELATION OF THE UPPER CRETACEOUS LITHOLOGIC UNITS TO THE FAUNAL ZONES

Horizontal scale
10 0 10 20 Miles

GEOLOGIC CROSS SECTIONS SHOWING THE STRUCTURE AND THE STRATIGRAPHIC AND ZONAL RELATIONS OF THE UPPER CRETACEOUS DEPOSITS OF MISSISSIPPI