MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.
Director

BULLETIN 48

THE CLAIBORNE

By

EMIL PAUL THOMAS, Ph.D.

UNIVERSITY, MISSISSIPPI

1942

MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.
DIRECTOR

BULLETIN 48

THE CLAIBORNE

By

EMIL PAUL THOMAS, Ph.D.

UNIVERSITY, MISSISSIPPI
1942

MISSISSIPPI GEOLOGICAL SURVEY

COMMISSION

His Excellency, Paul Burney Johnson.....Governor

Hon. Joseph Sloan Vandiver.....State Superintendent of Education

Hon. Alfred Benjamin Butts.....Chancellor, University of Mississippi

Hon. Duke Humphrey.....President, Mississippi State College

Hon. William David McCain.....Director, Dept. of Archives and History

STAFF

William Clifford Morse, Ph.D.....Director

Calvin S. Brown, D.S., Ph.D.....Archeologist

Harlan Richard Bergquist, Ph.D.....Assistant Geologist

Thomas Edwin McCutcheon, B.S., Cer.Engr.....Ceramic Engineer

Laura Cameron Brown, B.A.....Secretary and Librarian

LETTER OF TRANSMITTAL

Office of Mississippi Geological Survey
University, Mississippi
June 19, 1942

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

Gentlemen:

Herewith is a report on "The Claiborne" in Mississippi from the Alabama line northwestward to northern Grenada County by Emil Paul Thomas who was generously granted permission by the Ohio Oil Company and Mr. C. L. Moody and Mr. W. B. Emery, members of the geologic staff, to use this much of the results of his 13 months of field investigations for the company for a thesis in fulfillment in part of the requirements for the degree of Doctor of Philosophy at Louisiana State University. It was most generously offered, without cost to the State, to the Mississippi Geological Survey for publication.

Because of the approval of the report by Louisiana State University and because of the generosity of its author, the company, and the staff, the Mississippi State Geological Survey felt impelled to print it in essentially its original form. Although "in general an unusually good report," its publication, nevertheless, does not commit the State Geological Survey or its staff to all its conclusions.

In fact one of its former geologists, Mr. Frederic F. Mellen, would divide the Claiborne into three formations:

3. Unnamed formation
   - Yegua member
   - Wautubbee member
   - Kosciusko member

2. Lisbon formation (?)
   - Zilpha member*
   - Winona member

1. Tallahatta formation
   - Basic member†
   - Meridian member

*Zilpha member to include the quartzite beds of the lower part of the present Kosciusko. Rather than the equivalent of the Wautubbee, the Shipps Creek is probably the equivalent of the Zilpha.
†Basic member to include the Neshoba as a facies.

He further questions the relative value of the stratigraphic breaks (unconformities) described in the report.

Neither do members of the State Geological Survey and the U. S. Geological Survey staffs nor the State Geologist agree in detail with the evaluation of the different geologic divisions of the report or with the evaluation of the different stratigraphic breaks.

Nevertheless, it is an excellent report whose publication will materially help in determining the true geology of Mississippi and help in the exploration for Oil and Gas in the State. Its publication will undoubtedly speed the day of more detailed knowledge of the geology of Mississippi and of a better basis for the nomenclature of its geologic divisions.

Although the published and unpublished maps of the various county reports are in much more detail than the geological map of the Claiborne

report, nevertheless the incorporation of this material would not be the work of the author.

Although the late State Geologist, Dr. E. N. Lowe, left a manuscript on the "Claiborne group," which was recently typed from his notes and which was received only within the last 12 months in the office of the Mississippi Geological Survey, it was being revised by him at the time of his death. The task was barely begun, leaving practically the whole of the manuscript to be revised which only he (the author) could do. To have published the original (unrevised) manuscript, which was not available to the author of Bulletin 48, would be an injustice to the memory of a great man.

Respectfully submitted,
William Clifford Morse,
State Geologist and Director

CONTENTS

GEOLOGY

ILLUSTRATIONS

FIGURES

PROFILES

PLATES

THE CLAIBORNE

EMIL PAUL THOMAS, PH.D.

INTRODUCTION

The Claiborne is one of four divisions which constitute the Eocene of southeastern United States. The beds which make up the Claiborne in Mississippi were studied and mapped, in the present investigation, from the Alabama line to the Bluffs of the Mississippi, as far north as northern Grenada County—as far north, in fact, as their distribution is shown on the Reconnaissance Geologic Map of Mississippi,[1] even though that limit is probably in error.

GENERAL FEATURES OF THE AREA MAPPED

The mapped area covers approximately 5,000 square miles and includes all or part of fifteen counties in the central part of the State of Mississippi. Its general outline and position are shown on the geological map (Plate 1). The area is a belt crossing the state from the Mississippi-Alabama state line on the southeast to the alluvial valley of the Mississippi River on the northwest. It averages about 20 miles in width at the Alabama line, gradually increases northwestward to a maximum width of 60 miles across Attala and Holmes Counties, and then decreases northward to about 20 miles in width in Grenada County. This area was mapped in a thirteen-month period beginning in the spring of 1940. All of it was covered by the writer except the Claiborne outcrop area of northern Madison County which is from a map by Mr. C. L. Moody and which is included in order to make the regional map complete.

The Claiborne outcrop pattern reflects the regional structure. The normal strike of the beds in the extreme southeastern part of the area is about 50 degrees west of north. The strike of the basal Claiborne contact gradually changes northwestward to about 10 degrees west of north in Grenada County, whereas the strike of the upper contact averages about 35 degrees west of

north all the way across the state. This difference in strike reflects a marked northwestward thickening of the Claiborne section from about 330 feet at the Mississippi-Alabama state line to more than 1200 feet at the edge of the alluvial valley of the Mississippi River. The normal dip is to the southwest and west. It ranges from 25 to 35 feet per mile, being steeper on the lower beds than on the upper.

PHYSIOGRAPHY

The Claiborne beds crop out in two physiographic regions. The greater portion of the outcrop lies in the area generally known as the North Central Hills, a well-dissected sand hills upland broken by several pronounced cuestas and escarpments which follow the strike of the beds. The local relief varies from 50 to 300 feet and is greater on the outcrop of the beds in the lower part of the Claiborne section than on those in the upper. The beds are well exposed throughout the area except along the western border where at many places an extensive blanket of brown silt obscures the outcrop. The only other superficial deposits are the Recent alluvium and Quaternary terrace materials along the streams.

The second physiographic region in which the Claiborne beds crop out is commonly called the Loess Hills, a region of rugged topography which forms a belt 5 to 12 miles wide along the western border of the Claiborne. The tertiary is covered by thick deposits of Quaternary sands and gravels and loess throughout the area. The Loess Hills adjoin the alluvial valley of the Mississippi River and are sharply defined on the west by a continuous series of bluffs which rise abruptly above the valley floor. The typical Loess Hills topography merges with typical sand hills topography eastward, and the eastern boundary is arbitrarily taken as the eastern limit of the Quaternary mantle deposits (Plate 1). Tertiary exposures are found only along the streams and in ravines along the bluffs in this region, but they include some of the best exposures in the state.

CLAIBORNE STRATIGRAPHY

INTRODUCTION

The term Claiborne[2] was first used by Conrad in 1847 for the "Claiborne sand" exposed at Claiborne Bluff, Alabama, from which he described a number of fossils. He assigned it to the "Lower or Older Eocene." Hilgard first identified the Claiborne in Mississippi in 1860 and divided it into an upper "Calcareous Claiborne group" and a lower "Siliceous Claiborne group." Seven years later he excluded the "Siliceous Claiborne or Buhrstone" from the Claiborne proper, a restriction followed until 1894 when Harris included the Buhrstone (Tallahatta formation of later reports) in his "Lower Claiborne stage." The United States Geological Survey has included the Tallahatta formation in the Claiborne since 1906.

As now generally accepted, the type Claiborne section is divided into three formations in the area around Claiborne Bluff, Alabama. They are:

Gosport fossiliferous sand
Lisbon sandy marl
Tallahatta formation or "Buhrstone."

The section is overlain by the Jackson formation (uppermost Eocene) and is underlain by the Wilcox sections (middle Eocene).

A tabular summary of the history of Claiborne nomenclature in Mississippi (Figure 1) shows that the more modern writers have divided the Claiborne into three formations corresponding to the three formations of the type section. They are:

Cockfield or Yegua formation
Lisbon formation
Talahatta formation

In this report the Lisbon formation of these authors is subdivided into four formations, because it is composed of four mappable units which can be traced across the state. The Claiborne, then, consists of six formations. They are:

Cockfield formation
Wautubbee formation
Kosciusko formation
Zilpha shale
Winona greensand
Tallahatta formation

The Cockfield formation of this report includes all beds above the predominantly marine Wautubbee formation and below the marine basal Jackson (the Moody Branch marl). The marine Wautubbee formation is subdivided into three new members in eastern Mississippi, is undifferentiated in central Mississippi, and is extended northwestward into the non-marine Shipps Creek shale member of this report. The Kosciusko formation includes all beds above the Zilpha shale and below the Wautubbee formation. The terms Zilpha and Winona are used as originally defined by Moore (1940) and Lowe (1919), respectively. The Tallahatta formation is divided into the Basic claystone member (Lowe, 1919) and a new member, the Neshoba sand. The Meridian sand, which has been considered basal Claiborne by the Mississippi Geological Survey, is excluded from the Claiborne.

These subdivisions are shown graphically on Plate 2, which is a composite diagram showing changes of facies and thicknesses of the different formations along strike from the Mississippi-Alabama state line to the western and northwestern limits of the area mapped. The plate is necessarily highly diagrammatic because it is impossible to show the true complexity of the section on a two dimensional figure. It is constructed from data obtained from highway profiles, measured sections, surface contours, well information, and reconnaissance mapping. The plane to which all data are referred is the Zilpha-Winona contact, the most persistent and reliable contact in the Claiborne section. Horizontal intervals on Plate 2 represent distances along the normal strike of the datum plane, whereas vertical intervals indicate thickness of section. The geologic section shown along any given vertical line is the approximate section which would be shown by a surface geological profile perpendicular to the normal strike of the datum plane from the point where the vertical line crosses that plane. The towns and villages and a few localities on the outcrop are shown beside vertical arrows which indicate the geological section exposed in and around each.

When properly interpreted, Plate 2 shows all of the essential elements of the Claiborne in the area mapped. A set of examples showing the use of the figure is taken from the area around the town of Newton, Newton County. The plate shows that the geological section exposed in and around the town ranges from the uppermost few feet of the Wautubbee to about 60 feet above

the base of the Cockfield. It indicates that the Wautubbee section near Newton is about 90 feet thick and is divisible into three facies or members and that along the strike northwestward the formation changes facies and becomes thinner. The figure also shows that, in the area between Newton and Decatur, the Wautubbee section and the upper half of the Kosciusko section are exposed, and that, between Decatur and Neshoba, the lower Kosciusko, a rather thick section of Zilpha shale with a greensand bed at the top, the Winona greensand, and the Neshoba sand are exposed.

Five selected surface geological profiles along main highways traversing the Claiborne outcrop belt are also included. Their primary purpose is for use in inspecting the Claiborne in the field. Nearly all of the essential features of the section are shown on these profiles.

TALLAHATTA FORMATION

INTRODUCTION

The name Tallahatta first appeared in print in an article by Dall.[3] It was suggested to him by E. A. Smith to take the place of the term "Buhrstone" which had a lithologic, rather than a geographic, connotation. The term Tallahatta has been in general use in Mississippi since its introduction by Johnson in 1905 to replace Hilgard's term "Siliceous Claiborne."

The typical Tallahatta "buhrstone" section, herein called the Basic claystone member, is well developed throughout eastern Mississippi, but in the central and western portions of its outcrop the typical facies is largely replaced by a sand section called the Neshoba sand member. In the extreme northern part of the area the entire section changes facies and is called undifferentiated Tallahatta formation in this report.

BASIC CLAYSTONE MEMBER

INTRODUCTION

The Basic claystone member is the stratigraphic and lithologic equivalent of the type section of the Tallahatta formation of Choctaw County, Alabama. The term Basic is used for this section in preference to Tallahatta because it was found necessary to set up another member in Mississippi and the two mem-

bers together logically constitute the Tallahatta formation. The name Basic is well established in Mississippi literature, having been proposed by Lowe[4] in 1919, and used since in several Mississippi Geological Survey bulletins. The type locality is a deep cut on the railroad just north of Basic City, a railroad station in northwestern Clarke County, Mississippi. As shown on Profile B, a full section 80 feet in thickness is exposed in this immediate vicinity. It overlies the micaceous, lignitic sands of the uppermost Wilcox (Meridian) and is overlain by the Winona greensand.

LITHOLOGY

The Basic member has the most distinctive lithology of any of the beds in the Claiborne section of Mississippi. It is composed chiefly of siliceous claystone with interbeds of siliceous siltstone and sandstone. These indurated rocks are the "buhrstone" of older authors. Buhrstone is any siliceous rock suitable for use as a millstone. Very little of the material in the Basic could be so used, and the term "buhrstone" has been so loosely applied that the tendency of the more recent authors has been to drop it from the literature.

The claystone of the Basic forms by surface induration from a dark greenish-gray somewhat micaceous silty clay that usually contains scattered plant fragments. The indurated material is a light-colored brittle rock which is remarkable for its low specific gravity and which breaks with a sub-conchoidal fracture. The contraction caused by the evaporation of the connate water shatters the claystone into angular blocks, the surfaces of which are usually stained yellow brown and which commonly exhibit a regular concentric banding extending to the center of the block. The claystone commonly contains small lenses, angular inclusions, and fucoidal structures of glauconitic silt which impart a heterogeneous texture to the sediment (Fig. 2).

The siltstone interbeds of the Basic member are formed by surface induration of a dark greenish-gray lignitic, argillaceous, glauconitic, micaceous coarse-grained silt. They are also light in color and commonly stained by iron oxide. The siltstones are usually irregularly indurated and have a characteristic knobby appearance on the outcrop. Inclusions of clay and sand similar to the inclusions in the claystone are abundant.

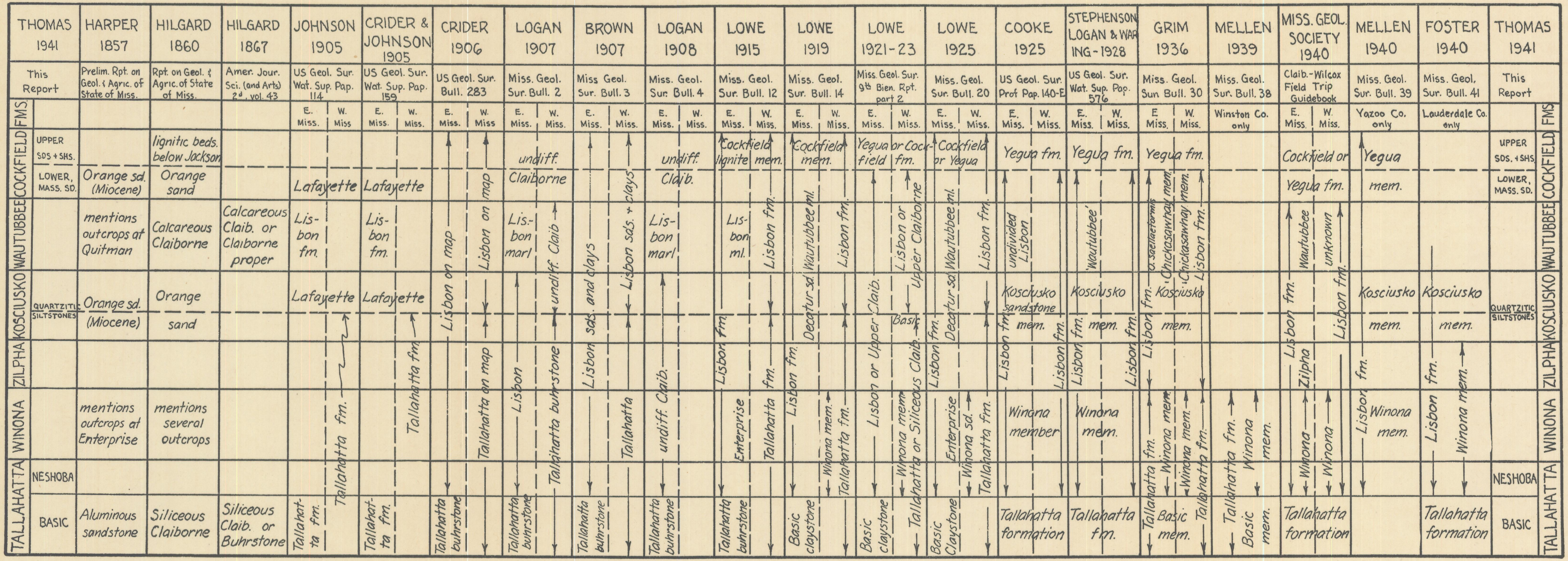


Figure 1.—Tabular Summary of the History of Claiborne Nomenclature in Mississippi.

Figure 2.—Fucoidal structures of siliceous claystone in a matrix of glauconitic siltstone in the Basic member. Cut on Highway U. S. 45, 1.1 miles south of Clarke-Lauderdale County line.

Sandstones are the least common of the indurated beds in the Basic. They are similar in general appearance to the siltstones and range from fine-grained to coarse-grained. They vary from highly glauconitic to non-glauconitic and from semi-indurated to quartzitic.

Shale or blocky clay, similar in lithology to the fresh clay from which the claystone arises but lacking the property of becoming indurated upon exposure, is abundant in the Basic. A few thin stringers of greensand* are found both at the top and at the bottom of the section.

Throughout eastern Mississippi the base of the Basic member is marked by a bed of coarse-grained poorly sorted light greenish-gray glauconitic sand having an abundance of white quartz granules and small rounded quartz pebbles. This basal sand of the Basic has a maximum thickness of 10 feet and grades upward through a glauconitic sandy clay or shale into the overlying indurated material.

* The term "greensand" is used in this report for a sand which contains over 15 per cent of glauconite grains. Glauconite-bearing sand containing less than that amount is called "glauconitic sand."

Figure 3.—Interbedded, thin-bedded shales, claystones, and siltstones of the Basic. Cut on Highway U. S. 45, 0.9 mile south of city limits of Meridian, Lauderdale County.

Figure 4.—Thirty-foot lens of non-glauconitic sand in upper part of the Basic. Boys are standing on a thin lens of Basic-type material which marks the top of the Tallahatta here. Cut on Highway 15, 3.5 miles south of its junction with Highway 16, southwest of Philadelphia, Neshoba County.

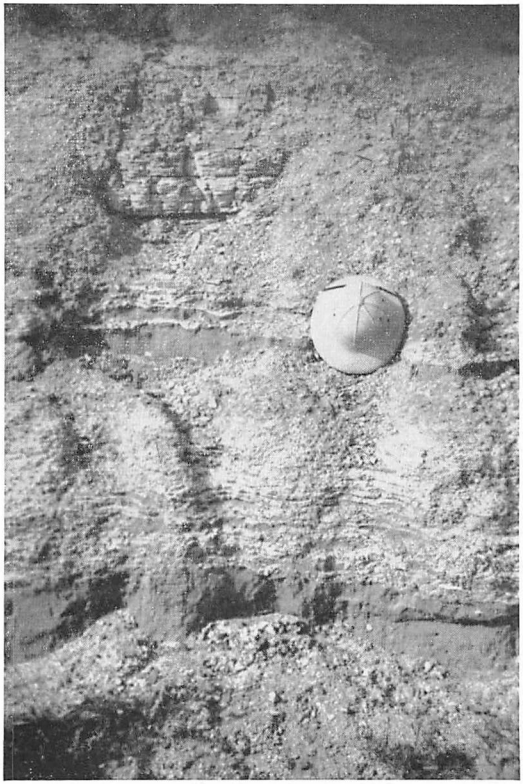


Figure 5.—Interbedded flaky shales and non-glauconitic sands in the Basic member. Cut on Highway U. S. 82, 1.65 miles northwest of five-way intersection at Kilmichael, Montgomery County.

The structure of the Basic member is even-bedded and thin-bedded to thick-bedded, the different facies being interbedded throughout the section (Fig. 3). The beds are extensively jointed on the outcrop and large vertical dike-like bodies of claystone cut across the individual beds at some exposures.

In Newton and Neshoba Counties lenses of non-glauconitic sand become abundant in the Basic (Fig. 4). This material is stained red, brown, yellow, pink, and purple on the outcrop and is fine-grained, micaceous, and well sorted. Its structure varies from massive to cross-bedded. Pellets, partings, and stringers of gray clay abound in this sand.

The characteristic indurated Basic materials become progressively thinner and more lenticular northwestward along the strike to northern Montgomery and Grenada Counties, where the only remnants are a few local developments of soft white glauconitic siltstone. Interbedded with this siltstone and lying both above and below it in Montgomery County is a distinctive black carbonaceous silty micaceous fissile shale which dries out into a very light-gray or white slightly indurated flaky shale. (Fig. 5). Associated with this flaky shale are partings, stringers, and interbeds of micaceous, sparingly glauconitic to non-glauconitic silt and sand. These flaky shales and associated beds reach a maximum thickness of 100 feet in the hills east of Grenada, Grenada County, and constitute at least part of Lowe's Grenada formation which was long considered to be of upper Wilcox age. This relationship was first pointed out by the authors of the Claiborne and Wilcox Field Trip Guidebook of the Mississippi Geological Society (March, 1940). If this shale section is persistent northward from Grenada County, the Grenada beds should be considered a member of the Tallahatta formation.

In Grenada County the flaky shales are overlain by 3 to 30 feet of light greenish-gray glauconitic sand or greensand which is characterized by an abundance of fucoidal structures and small clay inclusions.* These glauconitic beds should be given the rank of a new member in the Tallahatta formation if they are persistent northward. Until more detailed work is done between Grenada and the Mississippi-Tennessee state line, it is considered preferable to leave the Tallahatta section undifferentiated in Grenada County.

LOWER CONTACT

In this report the base of the Claiborne is placed at the base of the Basic member. The Mississippi Geological Survey, following Lowe,[5] places it at the base of the Meridian sand, a nonmarine sand section which underlies the Basic throughout the area. The Meridian sand is named from exposures near the city of Meridian, Lauderdale County, Mississippi, and was considered to be a member of the Tallahatta formation in state survey pub-

* Further details of each of the fifteen counties of this report is provided under the heading of "County details."

lications until Foster[6] recently raised it to formational rank. It is a massive to highly cross-bedded lignitic to non-lignitic sand which attains a maximum thickness of 125 feet and which contains a few lenses of glauconitic sand, greensand, glauconitic sandy shale, and lignitic silty shale in Clarke and Lauderdale Counties. The reasons for excluding the Meridian sand from the Claiborne are:

1. It is lithologically much more similar to the underlying non-marine Wilcox than to the overlying marine Tallahatta. It was deposited under conditions very similar to those which prevailed throughout most of Wilcox time in eastern Mississippi.

2. The marine Tallahatta section overlies the Meridian sand with distinct disconformity throughout eastern Mississippi and western Alabama.

3. The lower Meridian contact changes over short distances along the strike from conformable to locally disconformable (local erosional channels).

The lower contact of the Basic member is disconformable as far northwest as the Pearl River in Neshoba County. The details of the contact and lithology of the underlying and overlying beds indicate that it represents a small erosional and chronological break in which the uppermost few feet of the low-lying Meridian deltaic plain deposits were truncated by wave-erosion during the advance of the Tallahatta sea. The contact itself is sharply defined, the change from non-marine to marine facies taking place within 6 inches to 2 feet of section in which the two facies are intimately mixed (Fig. 6). Small blocks and fragments of lignitic shale and quartz pebbles from the underlying beds are found in the basal few feet of the marine section and branching fucoidal structures and filled borings from the beds above extend a foot or two down into the underlying non-marine sand. The basal pebble-bearing glauconitic sand of the Basic member in eastern Mississippi seemingly represents a beach deposit thrown up by the waves along an advancing shore-line. The continuity of this deposit indicates a strong unbroken advance throughout the area. Near Philadelphia, Neshoba County, there is a 10 foot lens of Basic material lying about 10 feet below the main body of the member (Profile C). This lens also has a

Figure 6.—Basal argillaceous pebble-bearing glauconitic sands of the Basic member overlying cross-bedded upper Wilcox (Meridian) sand. Cut (NE. ¼, NE. ½, Sec. 20, T. 5 N., R. 15 E.) on county road, 0.8 mile west of Savoy Station, Lauderdale County.

basal pebble-bearing sand and probably represents marine materials deposited in a small estuary on the Meridian deltaic plain ahead of the main advance of the Basic sea.

Northwestward from Pearl River the lower contact of the Basic member becomes gradational and shows little evidence of an erosional break. The basal pebble-bearing sand is not developed, the transition from non-marine to marine facies taking place within 5 to 20 feet of interbedded glauconitic sand, non-glauconitic sand, carbonaceous shale, and Basic-type clay. The marine advance was not so strong in this area, and this contact probably represents a gradual change from non-marine deposition to marine deposition. In the Montgomery-Grenada County area the lower Tallahatta contact is conformable. The flaky shales which lie at the base of the Tallahatta section grade downward into the underlying Meridian sand through an interbedded sand and shale transition facies having a maximum thickness of 10 feet. This contact represents an even more gradual change from non-marine to marine conditions.

THICKNESS

The Basic claystone member in eastern Mississippi ranges in thickness from 50 to 115 feet and averages 80 feet. These figures are comparable with the thickness of the Tallahatta formation in western Alabama where the average is 100 feet and the maximum is 125 feet. In the central portion of its outcrop the Basic member becomes thinner; the thickness varies greatly over short distances along the strike, ranging from 10 to 90 feet and averaging about 50 feet. Through southern and central Montgomery County the thickness varies from 5 to 30 feet. In the area around Grenada the thickness of the undifferentiated Tallahatta section reaches a maximum of about 200 feet.

FOSSILS

No detailed paleontological work has been done on the Basic member, but it contains a large fauna. Most of the finer grained rocks contain molds of thin-shelled molluscs, but no localities were found where fresh fossils could be collected. Many of the fossils in the claystone are opalized. Grim[7] records both diatoms and radiolaria in his thin sections.

TOPOGRAPHIC EXPRESSION

The Basic claystone member forms the strong Buhrstone Cuesta[8] in eastern Mississippi. Along the bajada or steep side of the cuesta is found some of the most rugged topography in the entire Coastal Plain Province, the local relief averaging about 175 feet and reaching a maximum of 300 feet. On the gentle slope of the cuesta, typical sand hills topography developed on the overlying Kosciusko sand is superimposed upon the more rugged claystone topography. The average local relief is about 75 feet. As the claystone becomes thinner, this cuesta becomes progressively less pronounced northwestward along the strike. In the northern part of the area mapped, it is absent or very weakly developed.

SOILS

The Basic claystone gives rise to fine sandy loam and stony clay soils of the Lauderdale series. They are among the poorest agricultural soils formed on the Claiborne outcrop.

DEPOSITIONAL CONDITIONS

In addition to the mineral glauconite and marine fossils, the persistence of the facies for more than 200 miles along the strike, the thin-bedded, even-bedded structure, and the abundance of fucoidal structures are evidences of marine deposition conditions for the Basic member.

The thin-bedded, interbedded nature of the main body of the Basic member indicates that it was deposited in quiet water so near the shore that slight changes in the grain side of the sediment introduced into the sea were recorded in the interbedding of the clays, silts, and sands. This depositional activity was interrupted in the central part of the outcrop area by the introduction of large quantities of sand now incorporated in the section as the Neshoba sand.

The undifferentiated Tallahatta section of Grenada County was deposited under nearer-shore conditions than the Basic. The flaky carbonaceous shales of the lower part of that section are probably coastal marsh deposits. The deposition of these materials was followed by an encroachment of the sea over the coastal marsh and the deposition of the overlying glauconitic sand and greensand.

The siliceous cement which binds the rocks of the Basic is apparently primary, since it is very uniformly distributed through 100 feet of sediments in eastern Mississippi. It was probably precipitated from the sea water under relatively quiet conditions.

NESHOBA SAND MEMBER

INTRODUCTION

Overlying the Basic claystone and underlying the Winona greensand throughout the central and northern portions of the area there is a section of non-glauconitic to sparingly glauconitic sand which has heretofore been considered to be lower Winona. This sand section, a useful mapping unit, is herein named the Neshoba sand from typical exposures in and around the village of Neshoba, Neshoba County. The type section is designated as that above the Basic claystone and below the Winona greensand (Profile C) along the present highway through Neshoba.

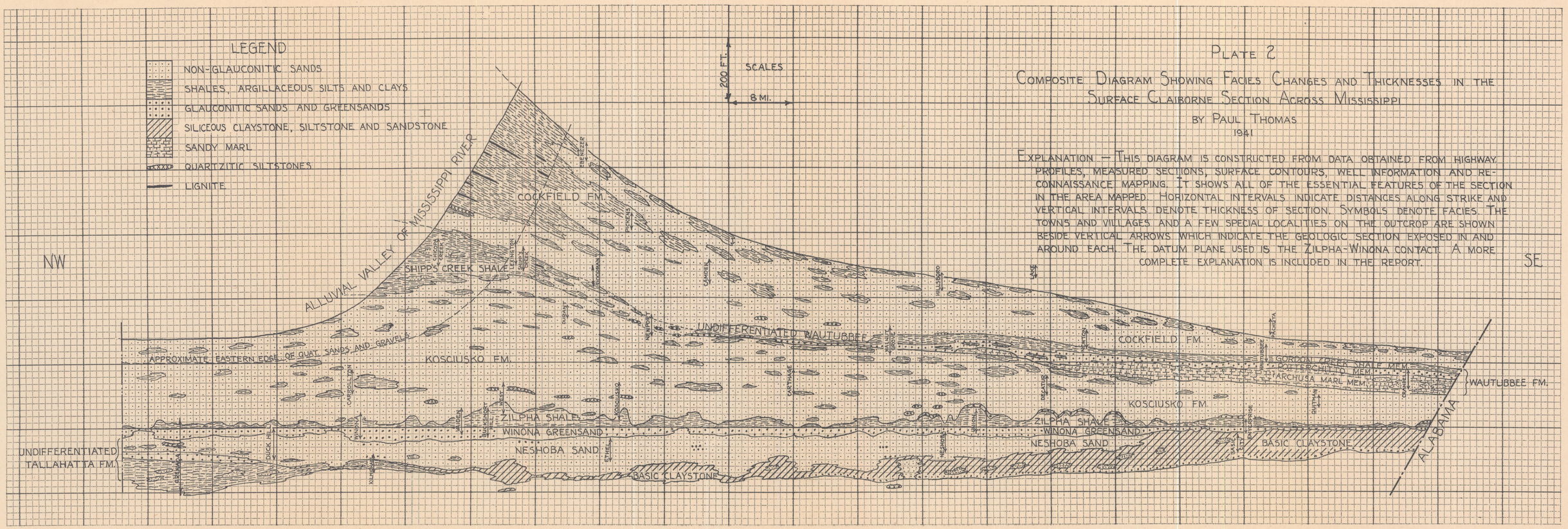
BULLETIN 48
PLATE 2

PLATE 2

COMPOSITE DIAGRAM SHOWING FACIES CHANGES AND THICKNESSES IN THE SURFACE CLAIBORNE SECTION ACROSS MISSISSIPPI

BY PAUL THOMAS
1941

EXPLANATION — THIS DIAGRAM IS CONSTRUCTED FROM DATA OBTAINED FROM HIGHWAY PROFILES, MEASURED SECTIONS, SURFACE CONTOURS, WELL INFORMATION AND RECONNAISSANCE MAPPING. IT SHOWS ALL OF THE ESSENTIAL FEATURES OF THE SECTION IN THE AREA MAPPED. HORIZONTAL INTERVALS INDICATE DISTANCES ALONG STRIKE AND VERTICAL INTERVALS DENOTE THICKNESS OF SECTION. SYMBOLS DENOTE FACIES. THE TOWNS AND VILLAGES AND A FEW SPECIAL LOCALITIES ON THE OUTCROP ARE SHOWN BESIDE VERTICAL ARROWS WHICH INDICATE THE GEOLOGIC SECTION EXPOSED IN AND AROUND EACH. THE DATUM PLANE USED IS THE ZILPHA-WINONA CONTACT. A MORE COMPLETE EXPLANATION IS INCLUDED IN THE REPORT.



MISSISSIPPI STATE GEOLOGICAL SURVEY
WILLIAM CLIFFORD MORSE, DIRECTOR

The Neshoba sand is considered to be a member of the Tallahatta formation because:

1. It is the stratigraphic equivalent of part of the type Basic claystone section in Mississippi and of part of the type Tallahatta section of Choctaw County, Alabama. This relationship is illustrated on Plate 2 where the overlying Winona greensand is shown maintaining a constant thickness and lithology across the area where the Neshoba lenses out into the Basic.

2. The Neshoba sand is overlain and underlain by typical Basic material in Newton and Lauderdale Counties.

3. The Neshoba and Basic facies are intimately interlensed over a wide area, and the thickness of the Neshoba fluctuates inversely with the thickness of the Basic.

LITHOLOGY

The Neshoba is composed of non-glauconitic to sparingly glauconitic non-fossiliferous marine sands which are typically well sorted, fine-grained, and micaceous, and which vary in structure from massive to irregularly bedded and to cross-bedded. When fresh, the sands are white, but on the outcrop they are usually stained red, brown, yellow, purple, and mottled (Fig. 7). The sands in the upper 5 to 15 feet of the member are normally very different in appearance from the sands in the remainder of the section. They are dark brick-red in color, highly argillaceous, medium-grained, and poorly sorted. Their high clay content and dark color are derived from the overlying weathered Winona greensand through the action of percolating ground-water. Greensands and glauconitic sands are found in the Neshoba at a few places. They are local concentrates of glauconite which grade laterally and vertically into non-glauconitic sands.

Gray clay is abundant in the Neshoba in the form of pellets, partings, stringers, and lenses in the sands. Impure bentonite and bentonitic clays are found at or near the top of the member in Attala and Grenada Counties. At the top of the member in northeastern Newton and northwestern Lauderdale Counties there are thin discontinuous lenses of typical greenish-gray Basic-type clay and shale. In northern Montgomery and Grenada

Figure 7.—Typical Winona-Neshoba contact. Contact is just below lowermost concretionary ledge. Cut on Highway 15, 0.7 mile north of Linwood School, Neshoba County.

Counties, the Neshoba section thins and shows a decided change of facies. Carbonaceous clays and shales become abundant as lenses and partings in the glauconitic to non-glauconitic micaceous sands and silts, and at a few localities discontinuous Basic-type siltstone ledges are found within the section. These sands and shales are included in the undifferentiated Tallahatta section of Grenada County.

LOWER CONTACT

The Neshoba sand lies conformably on the Basic claystone. Throughout the central part of the Tallahatta outcrop belt, the red sands of the Neshoba usually rest directly on typical Basic

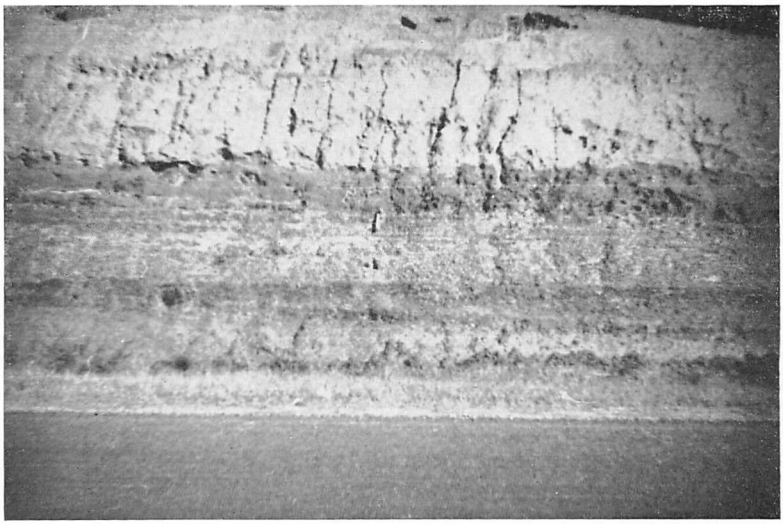


Figure 8.—Contact (hammer) of cross-bedded, non-glauconitic Neshoba sand above and Basic shale below. Cut on Highway 16, 0.5 mile east of Pearl River Indian School and about 8.0 miles west of Philadelphia, Neshoba County.

clay or shale, and in a few places they lie on siltstone or sandstone. The contact is normally sharply defined and without any interbedding of the two facies (Fig. 8). In the Montgomery-Grenada County area the contact is more gradational and is usually marked by an interbedding of the two facies.

DISTRIBUTION

The outcrop areas of the Basic claystone and Neshoba sand members are grouped together as the Tallahatta formation on the geological map (Plate 1), because of its small scale. In northeastern Clarke and southeastern Lauderdale Counties the Basic constitutes the entire Tallahatta formation, and the outcrop area is a very narrow and irregular belt with numerous topographic outliers which reflects the marked development of the Buhrstone Cuesta and the sharpness of the bajada in that area. Northwestward along the strike the Tallahatta outcrop widens to an average width of about 6 miles and becomes less irregular, and the Neshoba sand outcrop area becomes predominant over the Basic outcrop area.

TOPOGRAPHIC EXPRESSION

Throughout most of its outcrop the Neshoba sand gives rise to a rugged sand hills topography in which the local relief averages about 75 feet. Elevations on this outcrop are in general high, because the belt lies between the strong Buhrstone Cuesta on the east and the well-developed cuesta on the Winona greensand to the west.

SOILS

The Neshoba sand gives rise to loose light-gray or light-brown fine sandy loam and fine sand soils. The top-soil reaches 1 foot in thickness and the sub-soil, which is a reddish-brown or mottled clayey sand or sandy clay, reaches 6 feet in thickness. These soils are mapped as Ruston or some closely allied soil series, such as Greenville, Orangeburg, or Norfolk. They are fairly good soils for general agricultural purposes.

DEPOSITIONAL CONDITIONS

The manner in which the Neshoba sand is interlensed with the Basic claystone, the slightly glauconitic nature of the beds, and the conformable nature of the lower contact indicate a marine origin for the Neshoba. The irregular bedding and cross-bedding point to a near-shore site where currents were active.

During the time in which the upper Basic clays and silts were being deposited in eastern Mississippi, an abundance of sand was introduced in the sea in the central and northern parts of the area mapped and was incorporated in the section as the Neshoba. Either marine life was impoverished in the Neshoba sea, or conditions for its preservation were extremely unfavorable, because there is no fossil evidence of its existence.

WINONA GREENSAND

INTRODUCTION

The name Winona was proposed by Lowe[9] in 1919 for greensands which are well exposed near the town of Winona, Montgomery County. His original definition is:

"The Winona sand, as found in the western part of its outcrop, especially well developed around Winona, Vaiden, and east-

ward into adjacent counties, consists of highly glauconitic sands and clayey sands that weather to an intense Indian red color where exposed at the surface. This material is marine in origin and locally abundantly fossiliferous . . . .

"On the Southern Railroad, both east and west of Winona, are characteristic notable deposits of this material, that at Elliott, three miles east of Winona, being especially striking. From Winona southward on the Illinois Central Railroad frequent outcrops of the material are seen as far south as Vaiden and Beatty . . . .

"The thickness of this division of the Tallahatta in northwest Mississippi is estimated to be approximately 350 feet."

Although Lowe's estimated thickness is several times too high and the upper and lower limits of the Winona are not drawn, the description of the lithology and the localities mentioned satisfactorily delimit the formation.

Lowe erroneously considered the Winona to be the lower member of the Tallahatta formation and correlated it with the Meridian sand of eastern Mississippi. He[10] had previously applied the name Enterprise to a greensand exposed in the town of Enterprise, Clarke County, and had considered it to be the basal member of the Lisbon formation. Cooke[11] was the first to recognize that the greensands exposed at Winona and Enterprise are parts of the same formation, and he dropped the term Enterprise because it was preoccupied. Cooke and most later workers have considered the Winona to include all of the beds above the Basic member and below the Zilpha shale. In this report the term Winona is restricted to those greensands to which the name was originally applied and the underlying sands are included in the Neshoba.

Most authors have considered the Winona greensand to be a member of either the Tallahatta or Lisbon formations. It is raised to formational rank in this report, because it is a very distinctive lithological unit which has a wide areal distribution, it being the only formation in the Claiborne which extends all the way across the state without extensive facies changes.

Figure 9.—Irregular concretionary bodies in 10 feet of deeply weathered Winona greensand. Cut on Highway 15, 5.3 miles south of its junction with Highway 16 southwest of Philadelphia, Neshoba County.

LITHOLOGY

The Winona formation is composed of greensands and glauconitic sands which vary from light greenish-gray to dark green when fresh and which weather to a distinctive dark brick-red color. The glauconite content of the Winona sands ranges from 10 to 90 per cent. There is a noticeable tendency for the glauconite grains to be coarser than the quartz grains, and the sands are usually poorly sorted. These greensands and glauconitic sands are unusually coarse-grained for sands of this type, although the median grain size is rarely larger than medium sand size. The structure of the sands is commonly massive to poorly bedded and in a few places thin-bedded and even-bedded. High

angle cross-bedding is rarely seen. In eastern Mississippi the Winona becomes lenticular and thin, and at a few places it contains lenses of non-glauconitic massive to highly cross-bedded sand. Quartz pebbles are common in the greensands in this area. Clay is found in the Winona sands as formless inclusions and as thin lenses of black carbonaceous shale. The Winona sands are locally calcareous and commonly contain fossiliferous lenses; but surface localities where fresh fossils can be collected are rare.

Siderite is present in the Winona as thin beds outcropping as ledges and as isolated concretionary masses of dense light-brownish-gray material, but it is rarely seen in the fresh state on the surface, because it weathers readily to limonitic claystone or ironstone. It is particularly abundant near the top of the formation in the northern part of the area, and its first appearance in well samples can usually be taken as the top of the Winona. This fact is of particular value in the interpretation of old water well logs where siderite is logged as "rock."

The deeply weathered Winona outcrop is marked by an abundance of concretionary limonitic sandstone bodies which exhibit all shapes and sizes and degrees of induration (Fig. 9). They are very useful indicators of the weathered outcrop and of both the upper and lower contacts. The upper contact lies just above the uppermost concretionary ledge, and the basal contact is usually not far below the lowermost concretionary material.

LOWER CONTACT

The Winona-Tallahatta contact is conformable and sharply defined. The details of the contact differ somewhat with the nature of the underlying material. The contact between the Winona greensand and the Basic claystone in eastern Mississippi, where the Neshoba is absent, is slightly irregular, and the two facies are heterogeneously mixed at the contact proper, but the uniform thickness and persistence of the uppermost Basic beds in individual exposures disprove any significant truncation of Basic materials. Borings and pockets filled with material from above extend a few inches down into the underlying beds. On this evidence, several authors have considered this contact to be unconformable or disconformable, but such contacts are common between the different beds in many marine sequences, and they

apparently have little significance. At least seven such breaks are found in 140 feet of fairly homogeneous Lisbon sandy marl in the Little Stave Creek section near Jackson, Clarke County, Alabama. The homogeneity of this section precludes the existence of seven large depositional breaks during Lisbon time, and the contacts must represent minor breaks in sedimentation or diastems in which sub-marine erosion was active.

In the area where the Winona greensand overlies the Neshoba sand the contact shows more variation. At some exposures the two facies are intimately mixed through two or three feet of section, and small lenses of glauconitic material are found several feet below the main body of the greensand. The glauconite is abundant and irregularly distributed at and just below the contact and becomes increasingly rare downward. There is no reason to believe that this contact does not represent the same set of conditions as the Winona-Basic contact in eastern Mississippi. The differences in the details are probably due to the comparatively unconsolidated nature of the Neshoba sand as compared with the Basic clays. At other outcrops the transition from Winona to Neshoba facies is uniformly gradational through several feet of transition beds. This type of contact seemingly represents a gradual uniform change in the type of material being deposited.

THICKNESS

The thickness of the Winona greensand reaches a maximum of 50 feet in the general vicinity of the type locality. Over most of the area it is consistently about 25 feet, and variations of more than 10 feet from this amount are rare. The formation is thin and poorly developed in Clarke and Lauderdale Counties. In that area its average thickness is about 10 feet. In places it is absent; elsewhere it reaches a maximum of 20 feet. The few places where it is absent seem to be cases of simple non-deposition of the facies.

FOSSILS

The Winona greensand contains two excellent index fossils, *Ostrea sellaeformis* var. *lisbonensis* and *Proscutella mississippiensis*. The formation has a rather large and varied fauna which includes pelecypods, gastropods, echinoids, crabs, shark teeth,

PROFILE A

GEOLOGIC PROFILE ALONG HIGHWAY US 45 FROM MERIDIAN TO QUITMAN, CLARKE AND LAUDERDALE COS., MISS.

BY PAUL THOMAS FEB. 1941

VERTICAL SCALE 50' FT.
HORIZONTAL " 1 MILE

NOTE - SYMBOLS REPRESENT FACIES, NOT NECESSARILY FORMATIONS. SEE LEGEND ON PLATE TWO

——— CENTER-LINE PROFILE OF HIGHWAY
- - - - APPROXIMATE PROFILE OF GROUND

SOUTH

NORTH

ELEVATIONS ABOVE SEA LEVEL

650
500
400
300

TYPICAL TALAHATTA HILLS TOPOGRAPHY ON BOTH SIDES OF HIGHWAY

SAND HILLS TOPOGRAPHY SUPERIMPOSED ON GENTLE SLOPE OF CUESTA

TYPICAL SAND HILLS TOPOGRAPHY

BASIC CLAYSTONE

MERIDIAN SAND

HATCHETIGBEE FM.

KOSCIUSKO FM.

ZILPHA SHALE

WINONA GREENSD.

CLARKE COUNTY

LAUDERDALE COUNTY

MILES SOUTH OF STARTING POINT

24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

QUITMAN

BLACKTOP | CONCRETE SLAB

COURTHOUSE
COLLEGE CREEK
ROAD NW
ROAD NW
ROAD NW JUNCTION CORP. LIMIT
ROAD SE
ROAD NW
COLE CREEK
ROAD NW
ROAD EAST
T.H. PENNEL CREEK
ROAD NW
ROAD SW
ROAD EAST
CROSS ROAD
ROAD NE
ROAD SE
ROAD NE
ROAD SE
ROAD SW
ROAD NW
ROAD SW
CROSS ROAD
New Hope Church
CROSS ROAD
Mt Gilfrin's Store
ROAD SE
T.H. A. Jones Store
ROAD WEST
ROAD EAST
ROAD SOUTH
ROAD WEST
ROAD EAST
Mt. Olive Church
ROAD WEST
ROAD SW
ROAD NW
CHURCH
ROAD EAST
ROAD EAST
MERIDIAN CITY LIMIT

PROFILE A

MISSISSIPPI STATE GEOLOGICAL SURVEY
WILLIAM CLIFFORD MORSE, DIRECTOR

foraminifera, and ostracods, but there are very few localities in the state where fresh material can be collected. The best localities are in and around the town of Enterprise, Clarke County. Foster[12] lists 42 species of macrofossils, identified by Cooke, from several localities in this vicinity.

TOPOGRAPHIC EXPRESSION

The Winona greensand has little or no topographic expression in eastern Mississippi where it overlies the Basic, because it is poorly developed and its influence is overshadowed by that of the Basic claystone. In the central part of the area the Winona forms a secondary cuesta lying to the west of the stronger Buhrstone Cuesta, but northwestward along the strike the cuesta developed on the Winona becomes more marked as the Buhrstone Cuesta grows weaker, and, in the northern part of the area, the Winona cuesta is the dominant topographic feature.

SOILS

The Winona greensand gives rise to a very distinctive light-brown to gray sandy loam soil of considerable fertility. The top-soil is thin, having a maximum thickness of 8 inches, whereas the sub-soil is from 18 to 24 inches in thickness and is a red to reddish-brown friable sandy clay which usually contains fragments of sandstone concretions. This soil is known as the Nacogdoches or some closely allied series.

DEPOSITIONAL CONDITIONS

The oysters, echinoids, and crabs present as fossils in the Winona greensand indicate a shallow-water near-shore environment for its deposition. Such an environment would have currents capable of handling such coarse-grained material. Winona deposition represented a time of shallow-water conditions which closed the cycle of marine deposition initiated by the advance of the Tallahatta sea.

ZILPHA SHALE

INTRODUCTION

The term Zilpha first appeared in print in the guidebook for the Claiborne and Wilcox field trip of the Mississippi Geological Society (March, 1940). The original definition (page 3) is: "A

workable bed of gray-white and chocolate-brown clay, having a thickness of about 60 feet, was found to lie between the Winona and the Kosciusko in North Central Mississippi in Carroll, Grenada, and Attala Counties. Mr. Raymond Moore, formerly with the Arkansas Fuel Oil Company, found this to be a good key horizon, and suggested the name of Zilpha, from Zilpha River in Attala County."

Although the term has never been formally defined by its author, the conditions are such that there can be little confusion regarding the beds to which it was first applied. The name Zilpha is in common use in Mississippi at the present time and is used in this report as defined in the guidebook. The Zilpha shale does not outcrop on Zilpha Creek (or River) proper, but these beds reach their maximum development in this general area. The best exposure of the shale in the vicinity of Zilpha Creek is along the county road at Bucksnort Hill, and this locality is herein set up as the type locality of the Zilpha shale in order to avoid any confusion in the future. The type section is described under Lithology.

The Zilpha shale is given formational rank in this report because:

1. It is a distinctive lithological unit which can be traced without serious interruption across the State of Mississippi.

2. Giving it the ranks of a member along with the Winona or Kosciusko would necessitate the introduction of a new formational name, since both of those terms are restricted to other divisions and should not be expanded to include the Zilpha section.

LITHOLOGY

The characteristic lithology of the Zilpha shale may be seen at the exposure herein selected as the type locality which is along the county road at Bucksnort Hill, one and a half miles north of Zilpha Creek and near the center of Sec. 8, T. 16 N., R. 6 E., extreme northwestern Attala County, Mississippi.

SECTION AT BUCKSNORT HILL

	Feet	Feet
Zilpha shale, upper contact not exposed, total		54.0
Carbonaceous shale, chocolate-brown to light-gray to dark-red; abundant partings of light-gray silt and many pockets, stringers and interbeds of highly glauconitic material to within 4 feet of the top; few thin stringers of soft white glauconitic siltstone; plant fragments common in the chocolate material; grading down into the next interval	29.0	
Carbonaceous shale, similar to above but non-glauconitic; upper 14 feet badly weathered and slumped; grading down into the next interval	22.5	
Glauconitic sandy clay, chocolate to light-gray; glauconite and quartz sand concentrated in pockets and stringers near base and becoming rare toward top; few thin irregular concretionary ledges of limonitic claystone; scattered molds of fossils; this bed is really the transition section between typical Zilpha and Winona facies	2.5	
Contact conformable		
Winona greensand, total		35.0
Limonitic sandstone, heavy concretionary ledge of, developed on weathered greensand; most prominent bed in section	4.0	
Fossiliferous greensand, light greenish-gray to yellow-brown to dark brick-red; massive to irregularly bedded; fossils abundant as molds concentrated in small lenses; upper 4 to 8 feet of this section very irregularly indurated; disoriented pellets; tubes and inclusions of gray clay common; much of glauconite of coarse sand size; grading down into the next interval	19.0	
Glauconitic sand or greensand, similar to above but less glauconitic and less fossiliferous	5.0	
Carbonaceous clay, chocolate to gray; sandy and honey-combed with sand-filled borings and pockets; pinches out in cut	0.5	
Glauconitic sand or greensand, light greenish-gray to yellow-brown and red; upper half thin-bedded and banded; lower half contains an abundance of disoriented pellets and filled tubes of gray clay; beds irregularly stained black by manganese oxide (?)	6.5	
Base of section at floodplain level of Big Black River Elevation 285 (altimeter).		

As indicated by the section, the Zilpha formation is composed chiefly of carbonaceous shale and clay. When fresh, this material is black, but it is readily oxidized to a chocolate-brown or gray color and is usually found in that condition on the surface. It ultimately weathers to a dark brick-red clay (Fig. 10). The lower part of the section is typically a nearly-pure blocky clay, whereas the upper portion is much more silty and shaly. Partings, stringers, and lenses of micaceous silt and sand, many of which exhibit

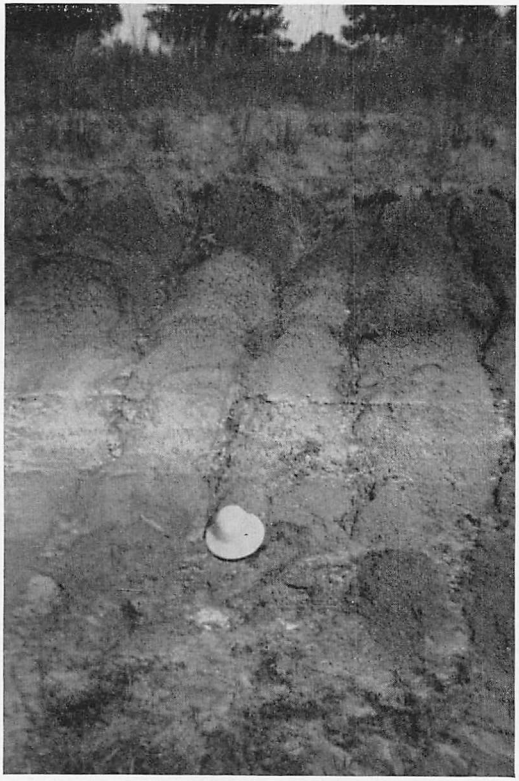


Figure 10.—Typical weathering profile in the Zilpha shale. Cut on west side of Highway U. S. 51, 1.5 miles south of Beatty Station, Carroll County.

high angle cross-bedding, are the most common associates of the chocolate shales. Plant fragments are found throughout the section, but they tend to be much more abundant in the upper shaly facies.

The lowermost few feet of the Zilpha are glauconitic and sandy, these two materials being abundant and irregularly distributed near the basal contact and becoming increasingly rare above. Glauconite also is present in small lenses and pockets which are found all the way to the top of the formation. In northwestern Attala County where the Zilpha reaches its maximum development, the shales of the upper part of the section are

commonly highly glauconitic. Several glauconitic beds can be recognized at some outcrops in this area.

Throughout the southeastern part of the Zilpha outcrop, there is a discontinuous greensand bed at the top of the formation. It is a dark greenish-gray fine-grained argillaceous, lignitic greensand which is sparingly fossiliferous at a few localities. It reaches a maximum thickness of 15 feet in the area west of Union, Newton County. This greensand is separated from the overlying basal Kosciusko sand by a few feet of sparingly glauconitic silt. In southern Neshoba County are several lenses of glauconitic sand and greensand which lie from 20 to 30 feet above the main body of the Zilpha. These lenses were mapped as part of the Zilpha in order to include as much marine material as possible in this formation rather than in the overlying nonmarine Kosciusko formation.

Some of the concretions in the Zilpha are very useful in identifying the deeply weathered outcrop. By far the most abundant type found is a soft flaky yellow-brown limonitic siltstone which is formed along the silty partings of the shale by the deposition of iron oxide from circulating ground-water. A similar type of claystone commonly forms as ledges of dense hard material at the top of the shale section. In the northern and southeastern parts of the area these ledges are strong and persistent and serve as good markers for the top of the formation.

Throughout north-central Attala County, where the Zilpha is best developed, rounded yellow-brown limonitic claystone or ironstone concretions are commonly found. These concretions are hollow or spongy in the interior and have a characteristic shelly or concentric structure. They are present at definite horizons as weak ledges and are derived from weathered siderite.

LOWER CONTACT

The lower Zilpha-Winona contact is conformable and sharply defined. The material at the contact proper is a heterogeneous mixture of carbonaceous clay, glauconite, and quartz sand. Below this horizon the clay diminishes and disappears, whereas above it the glauconite and quartz sand gradually do likewise. The actual transition from one facies to the other takes place within

one-half foot to three feet of section, except in a few places in Attala County where the two facies are found interbedded at the contact. The lithology of the overlying and underlying beds and the sharpness of the contact indicate that this contact represents a rapid change from shallow marine to marsh conditions. The heterogeneity of the material at the contact was probably caused by wave agitation during the change of conditions.

This contact is the sharpest and most reliable one in the Claiborne section in Mississippi and it is the only one which persists across the state without extensive facies changes. For these reasons it was used as the datum plane upon which Plate 2 was constructed.

THICKNESS

The thickness of the Zilpha shale varies widely over short distances (Plate 2). The formation is thin and absent at a few localities in Clarke and Lauderdale Counties, averaging about 15 feet and reaching a maximum thickness of 35 feet. It becomes thicker through the central part of its outcrop, averaging about 25 feet and reaching a maximum of 60 feet and being absent at a few localities in eastern Leake County. The maximum development is found in Attala and Holmes Counties where the average thickness is about 40 feet and the maximum of 75 feet is attained. North of this area the average thickness decreases to about 15 feet, and in numerous localities the formation is thin to absent.

FOSSILS

In places where the Zilpha overlies fossiliferous Winona material, the basal few feet of the shale usually contain fossil molds, but fresh fossils are very rare in the formation. Both *Ostrea sellaeformis* var. *Lisbonensis* and *Proscutella mississippinesis* are present in this basal part of the formation. Neither the macrofauna nor the microfauna of the Zilpha has been studied in detail.

DISTRIBUTION

Although the Zilpha and Winona outcrop belts are combined on the small scale map (Plate 1), the relative areal distribution of the two formations can be obtained by studying the Geologic

Map in conjunction with the Composite Diagram. The outcrop of the Zilpha and Winona formations in eastern Mississippi is a thin and very irregular belt which follows the Tallahatta outcrop closely and has but a few topographic outliers and inliers. In the central part of the area this belt expands to an average width of about two miles, and its irregularity and the numerous topographic outliers reflect the strength of the Winona Cuesta. In northeastern Carroll, northern Montgomery, and Grenada Counties the outcrop is an irregular belt averaging about half a mile in width and having several topographic outliers and inliers.

TOPOGRAPHIC EXPRESSION

The Zilpha shale has a weak topographic expression. The outcrop is usually marked by a topographic flat or bench which is often of considerable aid in mapping operations.

SOILS

The Zilpha shale gives rise to a gray or brownish-gray very fine sandy loam soil. The top-soil reaches 8 inches in thickness, the sub-soil is 14 to 20 inches of brown to red heavy plastic silt clay or clay. The sub-soil is usually underlain by a mottled gray and red heavy plastic clay, and in places the top-soil rests directly on this material. These soils, generally regarded as poor agricultural soils, are known as the Boswell or Susquehanna or some closely allied series. They are distinctive and of considerable help in mapping.

DEPOSITIONAL CONDITIONS

The nature of the overlying and underlying materials indicates that the Zilpha shale was deposited during a time of change from marine to non-marine conditions. The formation has the characteristics of both types of deposits. Its lithology suggests that, following the deposition of the Winona, the shore line retreated in the face of accelerated non-marine sedimentation. The first indication of a change in conditions is the clay which was deposited in very shallow water where wave action mixed it thoroughly with the underlying greensands. As the shore line retreated farther seaward, this clay was covered by silty clays, silts, and sands deposited on the tidal flats and in the coastal

marsh. The high angle cross-bedding in the silt interbeds in the upper shaly portion of the Zilpha indicates depositional conditions in which currents played an important part. The probable site of deposition of this material was in lakes and bays in the coastal marsh where the waves and bottom currents winnowed the silts out of the marsh deposits.

The greensand bed at the top of the Zilpha in eastern Mississippi, the glauconitic sand lenses above the main body of the Zilpha in southern Neshoba County, and the several glauconitic beds in the formation in Attala County were all deposited during local minor advances of the sea.

The contact relationships indicate that the absence of the Zilpha shale at a few localities in the state is due to simple non-deposition of the facies rather than unconformable overlap.

The thinness of the lower transition facies, rarity of a repetition of facies at the contact, and the general thinness of the Zilpha section across the state indicate that the change from marine to non-marine conditions occurred rapidly over a wide area.

KOSCIUSKO FORMATION

INTRODUCTION

The term Kosciusko was proposed by Cooke[13] to replace Lowe's term "Decatur" which was preoccupied. Cooke's original definition of the Kosciusko is: "The name Kosciusko sandstone member is here proposed as a designation for the ledges of saccharoidal to quartzitic sandstone exposed in the vicinity of Kosciusko, the county seat of Attala County, Mississippi, and for the unconsolidated sands of the same age in Mississippi."

The beds specified by Cooke lie near the base of a thick section of non-marine sands and shales which have not been satisfactorily subdivided, so the term Kosciusko is redefined in this report to include all beds above the Zilpha shale and below the Wautubbee formation.

Most workers since Cooke have considered the Kosciusko to be a member of the Lisbon formation. It is herein raised to the rank of a formation, because it is a lithologic unit having definable upper and lower boundaries and a wide areal distribution.

SSW

PROFILE B

GEOLOGIC PROFILE ALONG HIGHWAY US11 FROM BASIC CITY TO PACHUTA, CLARKE AND LAUDERDALE COS., MISS.

BY PAUL THOMAS — MARCH 1941

VERTICAL SCALE 50 FEET
HORIZONTAL " 1 MILE

NOTE—SYMBOLS REPRESENT FACIES, NOT NECESSARILY FORMATIONS. SEE LEGEND ON PLATE TWO.

— CENTER-LINE PROFILE OF HIGHWAY
-- APPROXIMATE PROFILE OF GROUND
A EXPOSED CONTACT - LETTER INDICATES QUALITY

ELEVATION ABOVE SEA LEVEL

400
300
200

MOODY'S BRANCH
weathered glauconitic fossilif. sandy marl
Qt
Qal
lignitic carb. beds
silt or silty shale
lens of platy opaline siltstone
50-60' massive to K-bd, iron-stained, sand with stringers and interbeds of shale, abundant pebbles in some outcrops
20' chocolate shale or clay - basal 5' sandy and glauconitic
15' interbedded greensand and glauconitic sand with weak concretionary ledges; sparingly fossiliferous; weathered marl interbeds
52' highly fossiliferous, glauconitic, calcareous sand or sandy marl with discontinuous limestone ledge near center - Ostrea sellaeformis abundant
COCKFIELD FM.
GORDON CREEK SHALE - TYPE SECTION
POTTERCHITTO MEMBER
ARCHUSA MARL
130' massive to K-bd, ironstained sand with blebs and stringers of clay and
KOSCIUSKO FM.
3'-14' clay to chocolate clay
15'-20' fossiliferous, glauconitic to non-glauconitic sandy
greensand
ZILPHA SHALE
WINONA GREENSAND
80' interbedded clay to clayey, siliceous siltstone and sandy, fossiliferous and glauconitic
BASIC CLAY-STONE - TYPE SECTION
basal pebbly glauconitic sand
lignitic sd.
Qal
CLARKE
LAUDERDALE
COUNTY
NON-GLAUCONITIC SAND WITH QUARTZ PEBBLES 50 YDS. WEST
MERIDIAN
SD.

PACHUTA
WAUTUBBEE STATION 0.1 MI. WEST
WEST ENTERPRISE
BASIC CITY 0.2 MI. E.

RAILROAD STATION
SOUNDOVEY CREEK
CROSS ROAD
ROAD NE
ROAD E.EXT
GORDON CR.
CROSS ROAD
RAILROAD OVERPASS
CROSS ROAD
SOUTH CORP. LIMIT ROAD SE
MAIN CROSS ROAD
NORTH CORP. LIMIT ROAD SE
ROAD NW
ROAD WEST
CHUNKY RIVER
ROAD NORTH
ROAD NE
CROSS ROAD
ROAD SE TO BASIC
BROWN'S CREEK

17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

MILES SOUTH OF STARTING POINT

NNE

PROFILE B

START 8.75 MI. SOUTH OF JUNCTION OF U.S. HIGHWAYS 11 AND 80 IN WESTERN OUTSKIRTS OF MERIDIAN

MISSISSIPPI STATE GEOLOGICAL SURVEY
WILLIAM CLIFFORD MORSE, DIRECTOR

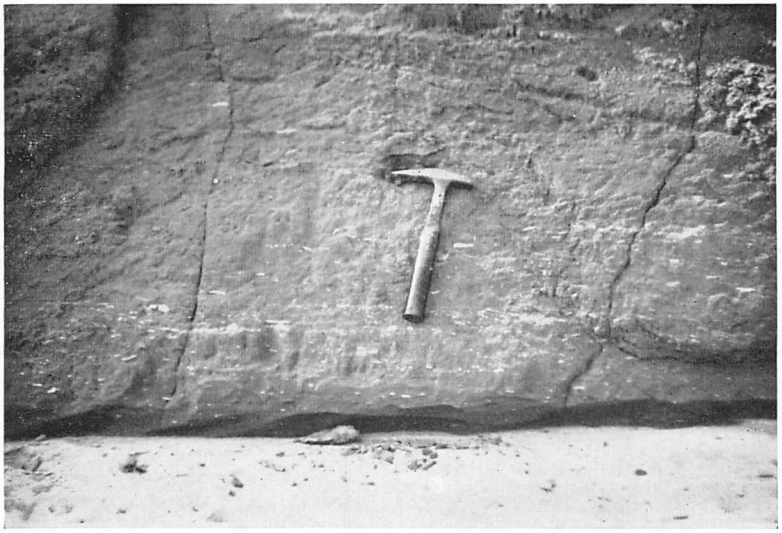


Figure 11.—Poorly oriented clay pellets in argillaceous sands of the Kosciusko. Cut of five-way cross-roads, 1.0 mile southwest of depot at Vaiden, Carroll County.

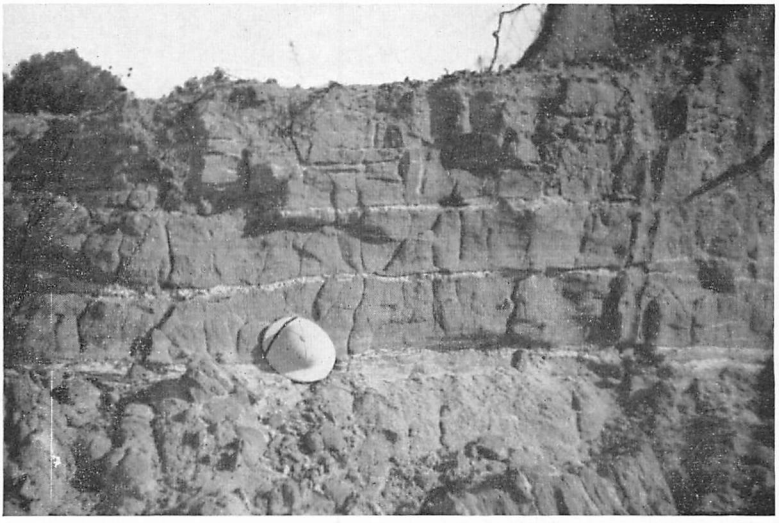


Figure 12.—Stringers of gray and purple sandy clay in irregularly bedded sand of the lower Kosciusko. Cut at five-way cross-roads about 1.0 mile southwest of depot at Vaiden, Carroll County.

LITHOLOGY

The Kosciusko formation is a heterogeneous highly lenticular non-marine section in which sands and shales are the dominant facies. The basal interval of 50 to 200 feet of the formation is typically composed of massive to highly cross-bedded sands which are colored red, brown, yellow, purple, pink, violet, gray, and white on the outcrop. This vivid coloration is a surface effect, since the sands are invariably light colored in well samples. These samples also show that some of the sands are sparingly lignitic. The sands are predominantly fine-grained and fairly well sorted, but they exhibit all variations in grain size and degree of sorting. The individual grains are usually coated with a thin film of iron oxide.

Clay is found in the sand as pellets, balls, irregular inclusions, partings, and stringers (Figs. 11 and 12). In a few places these inclusions become abundant enough to form clay-ball conglomerates. The clay is a light-gray sandy or silty material which becomes mottled pink or purple when slightly weathered.

Shales increase in abundance above the basal sand until they usually predominate over the sand in the upper part of the section. In the Kosciusko there are three types of shale. The light-gray to mottled purple and gray silty clay, which is found as stringers and pellets in the sands, is also present as lenses of shale throughout the formation. Black to chocolate-brown carbonaceous shales identical to the carbonaceous shales of the Zilpha and other Claiborne formations are common as lenses in the Kosciusko throughout the central and western part of its outcrop. The third type is a dark-gray to greenish-gray (fresh) to light-gray or brownish-gray (weathered) lignitic silty shale which grades into the carbonaceous shales on one hand and into argillaceous silts on the other. These silty shales vary in structure from even-bedded and laminated to highly cross-bedded. Plant fragments are abundant, and well preserved fossil leaves are found at a few localities. Weathered remains of siderite concretions, one foot in largest diameter, are common. These shales are particularly abundant in the Kosciusko in Carroll County and are well exposed along the highway between Winona and Carrollton (Profile E).

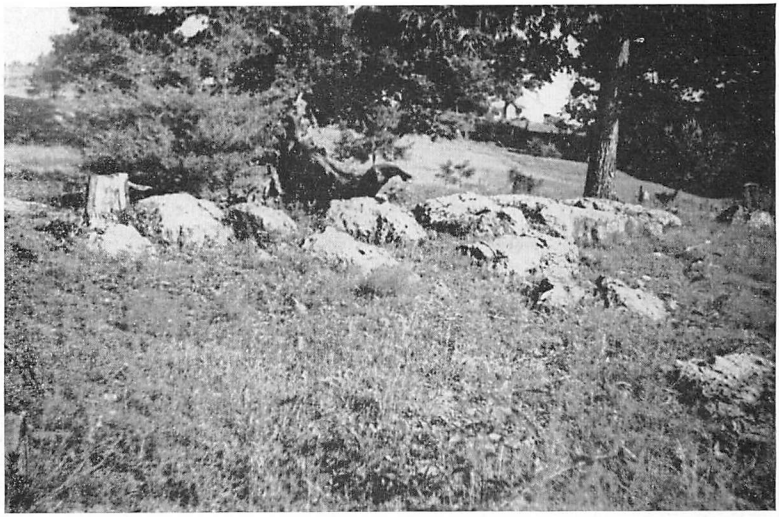


Figure 13.—Typical exposure of the quartzitic siltstones of the Kosciusko. Northwestern outskirts of West Station, Holmes County.

The ledges of quartzitic sandstone, mentioned by Cooke in his original definition of the Kosciusko are the most distinctive feature of the formation (Fig. 13). They are light-gray siliceous coarse siltstones which form by surface induration from light-gray compact argillaceous silt lenses in the massive Kosciusko sands and which appear on the outcrop as quartzitic boulders and ledges. They are best developed in Attala and Holmes Counties where they form discontinuous ledges which occupy a stratigraphic horizon 50 to 75 feet above the top of the Zilpha. They are also present in Grenada, Carroll, Leake, and Neshoba Counties, but they are only locally developed in these counties. Most of the older authors mistook these ledges in Attala and Holmes Counties for Tallahatta material and considered the Claiborne section below them to be of Tallahatta age. Cooke[14] was the first to recognize their true stratigraphic position.

Petrified wood and lignite are very rare in the Kosciusko formation. These factors serve to differentiate the formation from Wilcox and Cockfield beds. Also, the sands of the Kosciusko are rarely micaceous, a fact which helps to differentiate them from the lower Claiborne sands.

Limonitic sandstone, siltstone, and claystone are the common concretionary materials in the Kosciusko. Each has its characteristic lithology and position. All are produced by the deposition of limonite by circulating ground-water and are surface phenomena. Limonitic sandstone forms as irregular ledges or inclusions in the iron-stained sands and in a few places has a fluted or tubular structure. It varies from yellow brown and somewhat indurated to dark brown and very hard. In some places these bodies form on top of clay stringers where ground-water circulation has been impeded. Elsewhere they form in massive sands without apparent reason for their location. This material is abundant throughout the Kosciusko and all similar sands in the Claiborne in Mississippi. Limonitic siltstones, as flaky yellow-brown concretions, form along the silty partings in the shales of the Kosciusko and shaly facies of other formations. Limonitic claystone is the least abundant of the three types. At a few places it forms at the top of chocolate-brown shale lenses in the formation. The siderite concretions in the silty shales weather to shelly or concentric-structured limonitic claystone or ironstone bodies.

LOWER CONTACT

The Kosciusko-Zilpha contact is conformable and gradational. The gradation takes place from the basal Kosciusko sand through an interbedded sand and shale section into the typical Zilpha shale (Fig. 14). The thickness of the transition section varies from a few inches to 30 feet and may change markedly over short distances. In eastern Mississippi where the top of the Zilpha is marked by a greensand bed, the transition takes place through a thin section of sparingly glauconitic silt, and a similar situation exists in the few places where the Kosciusko lies directly on the Winona greensand.

THICKNESS

The thickness of the Kosciusko formation gradually increases northwestward along the strike from 85 feet at the Alabama line to a maximum of 400 feet in Attala, Holmes, and Carroll Counties. The thicknesses in the eastern part of the state were measured directly on the outcrop, those in the central part were derived from profiles, and those in the western part

Figure 14.—Typical gradational Zilpha-Kosciusko contact. Cut on Highway U. S. 82, 3.0 miles east of Winona, Montgomery County.

were based on projections of surface dips combined with water well and oil well data.

FOSSILS

Fossil leaves are found in the silty shales in Carroll County, but the flora has not been studied.

DISTRIBUTION

In eastern Clarke County the Kosciusko outcrop forms an irregular belt averaging about 8 miles in width. Northwestward across the state this belt increases in width to a maximum of 20 miles in Attala and Holmes Counties (Plate 1).

TOPOGRAPHIC EXPRESSION

The basal sands of the Kosciusko support a comparatively rugged sand hills topography. In eastern Mississippi this sand hills topography is superimposed upon the gentle slope of the Buhrstone Cuesta, and throughout the remainder of the area it is superimposed upon the gentle slope of the cuesta developed on the Winona. In the areas where the Zilpha formation is well

developed, these sands form an escarpment overlooking the topographic flat developed on the outcrop of the shale. The average local relief in the sand hills is about 75 feet, whereas the maximum is about 150 feet. The upper more shaly portion of the formation supports a more rolling type of topography in which the local relief averages about 50 feet.

The quartzitic siltstone ledges in the Kosciusko in Attala and Holmes Counties exert a strong influence on the topography. They support a bold escarpment along which the most rugged topography in the Kosciusko outcrop belt is found.

SOILS

The sands of the Kosciusko give rise to fine sandy loam and fine sand soils known as Ruston, Greenville, Orangeburg, or Norfolk or some closely allied series. They have been described under the soils of the Neshoba sand.

The sand and shale sections of the Kosciusko give rise to a similar fine sandy loam which has more clay in the sub-soil. This is the Shubuta fine sandy loam or some closely allied type.

In eastern Attala, eastern Leake, and southwestern Neshoba Counties the sandy soils of the Kosciusko contain abnormal quantities of silt and grade into silty loam soils. This silt is residual from a thin blanket of brown silt which once covered the area. In the area bordering the Loess Hills region on the west, the Kosciusko is covered by a mantle of brown silt which gives rise to silt loam soils.

DEPOSITIONAL CONDITIONS

Many features indicate that the Kosciusko is a non-marine deposit. Its heterogeneity and lenticularity and the lignitic nature of its finer grained materials all point to this conclusion. It lacks the marine fossils, glauconite, and lime so characteristic of marine Tertiary deposits. The extensive cross-bedding of its sands and silty shales and the presence of clay-ball conglomerates and local erosional channels in the sands indicate a stream-laid origin. Its rather consistent thickness over a wide area precludes a flood plain site of deposition. All of these facts indicate that the formation was laid down on the coastal or deltaic plain by a number of small streams. The presence of an abundance of

Zilpha-type carbonaceous shale lenses through the section indicates conditions not greatly different from the marshy conditions at or near sea-level under which the Zilpha was deposited. Only along a subsiding coast line could as much as 400 feet of such near-sea-level materials be deposited.

The lithology of the Kosciusko suggests that, following the deposition of the Zilpha, the coastal marsh was flooded by stream-borne sands while the finer grained materials were carried farther out and deposited in the coastal marsh or incorporated in the marine deposits. The general thinness of the transition facies between the Zilpha and Kosciusko formations indicates that this change took place rapidly. During middle and upper Kosciusko time the gradients of the streams on the deltaic plain were diminished, and much of the finer grained material was dropped on the coastal plain where it now appears as silts and shales.

There is little positive evidence regarding the conditions under which the quartzitic siltstones of the Kosciusko were deposited. They are derived from lenses of silt which are overlain and underlain by fine-grained non-marine sands. Although the ledges are discontinuous, their main development is found at approximately the same stratigraphic horizon. The facts that they arise from a distinctive type of compact silt and that the overlying and underlying materials are not silicified suggest that the siliceous cement may be primary. A possible site of deposition for these beds was in fresh-water lakes on the deltaic plain in which quantities of opal were precipitated.

WAUTUBBEE FORMATION

INTRODUCTION

The term Wautubbee was introduced by Lowe in 1919,[15] the name being taken from Wautubbee Station on the Southern Railroad in northwestern Clarke County. In the original definition he states:

"The Wautubbee marls constitute the most extensive division of the Lisbon, since other members of the formation have unimportant outcrops. The Wautubbee beds are all marine, consisting of highly calcareous and fossiliferous marls, of gray to

almost white color, or of darker bluish and greenish tints, due to the presence of glauconite. In the vicinity of Newton and a few other localities these marls pass vertically into clays or sands which are often lignitic and fossiliferous.

"The Wautubbee marls are locally rich in marine fossils, exhibiting a very characteristic fauna. The large saddle-shaped oyster, *Ostrea sellaeformis,* is especially abundant.

"These beds in southeast Mississippi have a thickness of about 100 feet, and dip southward at a rate of 23 to 25 feet to the mile. The thickness in west Mississippi is perhaps as great, though not so evident."

Since the term Wautubbee is satisfactorily defined and is well established in the literature, it is used in this report in preference to "Lisbon", "Lisbon marl", or "typical Lisbon", because, although the Wautubbee section includes beds which are lithologically and faunally identical with the Lisbon formation at its type locality, these beds constitute a minor part of the section which has been called Lisbon formation in nearly all of the later Mississippi reports, and it would be confusing to restrict such a well established term.

The term Wautubbee is used in this report essentially as applied by Lowe. It includes all of the marine section above the Kosciusko and below the Cockfield in eastern and central Mississippi and its non-marine equivalent, the Shipps Creek shale, in western Mississippi. The upper contact is placed at the top of the carbonaceous shale section overlying the marls (Gordon Creek shale member of this report) rather than at the top of the marls themselves, because these shales exhibit many marine characteristics and logically belong in the marine section.

Most workers in Mississippi have considered the Wautubbee beds to be a member of the Lisbon formation. The Wautubbee is considered to be a formation by the author, because it can be subdivided into several lithologic units which are logically members and, because it has a wide areal distribution.

In eastern Mississippi the Wautubbee section is divisible

Bulletin 48
Profile C

Mississippi State Geological Survey
William Clifford Morse, Director

into three distinctive and persistent lithologic units which are named and given the rank of members in this report. They are:

Gordon Creek shale member (top)
Potterchitto member
Archusa marl member (bottom)

This subdividing becomes impracticable in central Newton County and the formation is mapped as undifferentiated Wautubbee as far northwest as the Yockahockany River in northwestern Leake County. Beyond that point the section becomes highly lenticular and in southwestern Attala County the marine material disappears, interfingering along the strike with nonmarine beds. In western Holmes and Carroll Counties there is a thick tongue of carbonaceous shale lying at the stratigraphic horizon of the marine Wautubbee. It is named the Shipps Creek shale member in this report and is considered to be the nonmarine extension of the Wautubbee formation. As shown on Plate 2, the Wautubbee contacts are arbitrarily drawn across the gap between the northwesternmost exposure of the marine Wautubbee and the type locality of the Shipps Creek shale.

ARCHUSA MARL MEMBER

INTRODUCTION

The name Archusa is taken from Archusa Springs, a well-known locality and former health resort on the Chickasawhay River south of the town of Quitman, Clarke County, Mississippi. This member has the same lithology as the Lisbon formation at Lisbon Bluff and Claiborne Bluff, Alabama. It constitutes the major part of Lowe's Wautubbee marl and has been called "Calcareous Claiborne" by Hilgard and "Lisbon marl" and "typical Lisbon" by other authors.

LITHOLOGY

Characteristic Archusa lithology is well exposed at the locality selected as the type, which is a bluff beneath the south end of the bridge across the Chickasawhay River on Highway U. S. 45 two miles south of Quitman. (SW., SE., Sec. 14, T.2 N., R.15 E.). The top of the measured section is 1.0 foot below the road level, Elevation 222 feet.

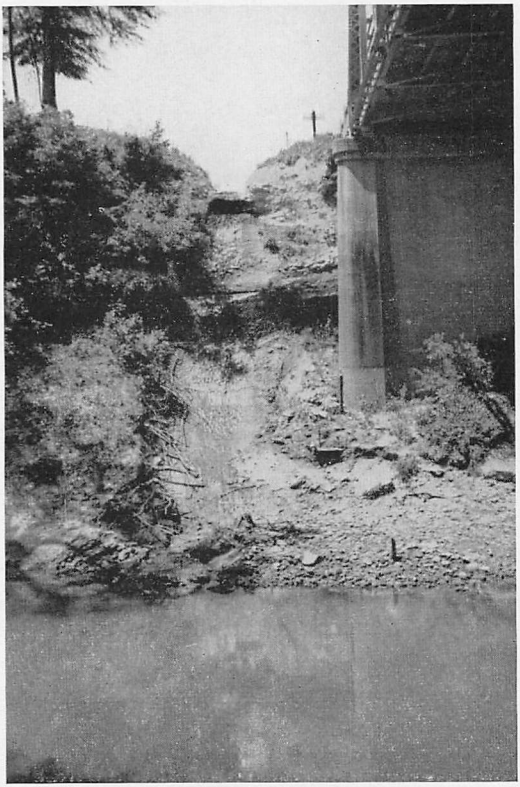


Figure 15.—Archusa marl member at type locality. South end of bridge across Chickasawhay River, 2.0 miles south of Quitman, Clarke County.

SECTION AT TYPE LOCALITY OF ARCHUSA MEMBER

	Feet	Feet
Archusa marl member of Wautubbee formation, neither contact exposed		48.0
Marl or soft limestone, light-gray to white fossiliferous sandy and glauconitic	1.5	
Marl, light-gray to white fossiliferous sandy and sparingly glauconitic; abundant irregular clay inclusions; less indurated than bed above; scattered weathered pyritiferous concretions; abundant *Ostrea sellaeformis* and other fossils in basal foot	3.5	
Limestone, light-gray sandy glauconitic and fossiliferous; forms lip of small falls	1.5	
Marl, similar to 3.5-foot bed above; *Ostrea sellaeformis* and many other forms	10.5	

Oyster bed, dark-green medium-grained greensand with an abundance of *Ostrea sellaeformis* and communited shells	1.0
Marl, similar to 10.5-foot bed above	8.0
Limestone, discontinuous ledge of material similar to that above and below but slightly more indurated	1.0
Marl, similar to 10.5-foot bed above	21.0
Base of section—low water level of Chickasawhay River.	

In the area around Crandall in eastern Clarke County, the Archusa becomes very lenticular and contains bodies of non-glauconitic sand, but elsewhere it is a persistent homogeneous unit. On the weathered outcrop the lime is leached from the sandy marls, and the residual material is a dark-red sparingly glauconitic sand having an abundance of irregular clay inclusions. Where deeply weathered, the marl closely resembles some of the weathered non-marine Claiborne sands.

The basal few feet of the Archusa are typically more sandy than the remainder of the member. This part of the section is a fine to medium grained sparingly glauconitic, calcareous sand. It bears the same relationship to the Archusa as the pebble-bearing glauconitic sand at the base of the Basic bears to that member. The uppermost few feet of the marl contain angular fragments and irregular inclusions of tan bentonite at a few localities in Newton County.

LOWER CONTACT

The Archusa-Kosciusko contact is disconformable and sharply defined (Fig. 16). It closely resembles the Basic-Meridian contact in the eastern Mississippi area and undoubtedly represents the same sequence of events. The transition from marine to non-marine facies is represented by a 0.5 to 3.0-foot section in which the two facies are mixed in a heterogeneous fashion. The basal portion of the Archusa contains small blocks and inclusions of material from the beds below, and small lenses and pockets of marl are found in the uppermost few feet of the Kosciusko. Marl-filled borings extend a few feet or so down into the non-marine beds, and disseminated glauconite is found as much as 15.0 feet below the contact in some places. The uppermost Kosciusko beds on which the Archusa rests change lithologically over short distances along the strike from sands to carbonaceous

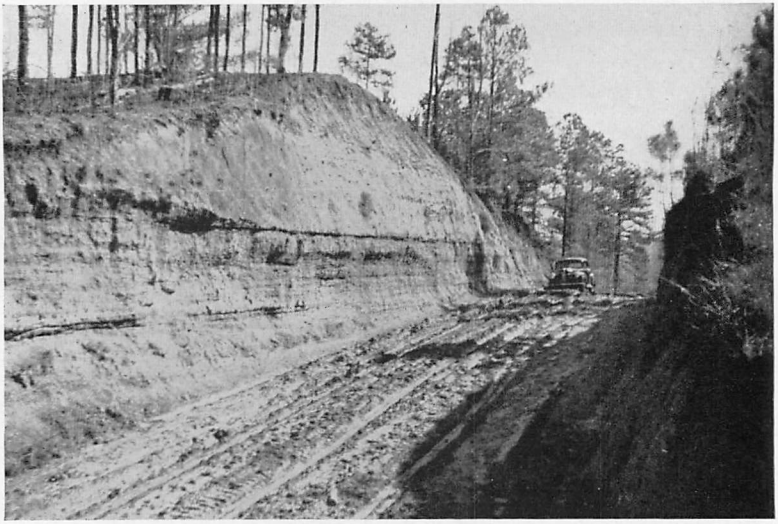


Figure 16.—Wautubbee-Kosciusko contact (SW. 1/4, SE. 1/4, Sec. 2, T. 5 N., R. 12 E.) slightly above top of car—massive Archusa marl over lignitic shales of uppermost Kosciusko. County road, 1.0 mile southwest of Hickory, Newton County.

shales, to lignitic silty shales. This is the condition which would logically be expected after truncation of the uppermost beds of the deltaic plain by wave-erosion along an advancing shore line.

This contact is a reliable mapping horizon, but is often difficult to identify on the deeply weathered outcrop.

THICKNESS

The Archusa maintains a thickness of 45 to 60 feet in Clarke, Jasper, and southeastern Newton Counties. It lenses out in central Newton County, but reappears as a 15-foot lens in northeastern Scott and northwestern Newton Counties.

FOSSILS

The Archusa marl constitutes part of the *Ostrea sellaeformis* zone of Mississippi. It also contains a large fauna very closely related to that of the middle and upper Lisbon at Lisbon Bluff and Claiborne Bluff, Alabama.

Figure 17.—Potterchitto-Archusa contact (hammer) at the type locality of Potterchitto member.

POTTERCHITTO MEMBER

INTRODUCTION

The Potterchitto member is named for an outcrop near Potterchitto Creek in south-central Newton County, Mississippi. The member is lithologically the most heterogeneous of the three members of the Wautubbee formation of eastern Mississippi, but certain features make it one of the most easily identified on the weathered outcrop.

LITHOLOGY

Characteristic lithology of the Potterchitto member is well exposed at the type locality in a series of road cuts along the Newton-Decatur highway (State Highway 15) on the south valley wall of the creek about 2 miles northeast of the town of Newton (NE.1/4, Sec. 26 and SE.1/4, SE.1/4, Sec. 23, T.6 N., R.11 E.) (Profile C) (Fig. 17).

SECTION POTTERCHITTO MEMBER AS THE TYPE LOCALITY

	Feet	Feet
Cockfield formation		12.0
Sand and shale interbeds—sand red and red-brown; shale, gray	12.0	
Contact conformable and irregularly slumped		
Wautubbee formation, total 66.5		
Gordon Creek shale member		12.0
Carbonaceous shale to blocky clay, chocolate-brown to light yellowish-gray to red; basal 2.0 feet sandy and glauconitic and heterogeneous; 2.0 feet above base is a thin ledge of white sparingly glauconitic, siliceous siltstone which is a typical feature of the member in this area	12.0	
Contact conformable		
Potterchitto member—type section		36.0
Glauconitic sand, dark greenish-gray to light greenish-gray to red; argillaceous and lignitic; 1.0 foot below top of this bed is a weakly developed concretionary ledge with molds of fossils; bed locally indurated into soft white siliceous sandstone concretionary bodies of irregular shape; basal 2.0 feet contain abundant molds of fossils	6.0	
Clay, chocolate brown; sandy and glauconitic; heterogeneous; many molds of fossils	1.5	
Greensand, light greenish-gray to brown; argillaceous; abundant molds of fossils; near top are many irregular concentric-structured limonitic claystone or ironstone concretions, some of which contain a core of light brownish-gray siderite; 4.0 feet below top is an oyster bed which contains an abundance of *Ostrea sellaeformis* and many other forms	6.0	
Base of exposed section		
Missing section	3.0	
Section continued, starting at top of cut directly south of Potterchitto Creek bridge		
Glauconitic sand, light greenish-gray to brown; argillaceous; few molds of fossils; really a deeply weathered sandy marl or calcareous sand	5.0	
Clay, medium gray; blocky and lignitic; grading down into	1.5	
Clay, light greenish-gray; sandy and glauconitic; heterogeneous; sparingly fossiliferous; scattered weathered siderite concretions near center	1.5	
Glauconitic sand, light greenish-gray to yellow; very fine grained; calcareous and very fossiliferous containing *Ostrea sellaeformis* and many other forms; abundant small calcareous concretions	3.0	
Oyster bed—greensand loaded with *Ostrea sellaeformis* and many other forms; light greenish-gray to yellow-brown; loose to slightly indurated; most prominent bed in section	3.5	
Glauconitic sand or greensand, light greenish-gray to yellow-brown; banded appearance; brown bands are indurated and contain earthy siderite; few thin stringers of fossiliferous greensand; six-inch dark-green medium-grained fossiliferous greensand stringer one foot above base	5.0	

Contact conformable

Archusa marl member 18.5

Sandy marl, medium greenish-blue to gray and yellow-gray; argillaceous, sparingly glauconitic and highly fossiliferous; lens containing abundant *Ostrea sellaeformis* near middle; two discontinuous 6-inch to 8-inch ledges of white to light-gray sandy limestone near base; about 3.0 feet below the top is a bentonitic section in which irregular inclusions of bentonite and bentonitic clay are imbedded in a matrix of fossiliferous marl..... 18.5

Base of section at road level at base of cut—elevation 359 feet.

A nearly complete Potterchitto section similar to the type section is exposed in a cut on the county road on the south side of Potterchitto Creek 0.4 mile west of the type locality (NE.1/4, SW.1/4, Sec. 23, T.6 N., R.11 E.). The section at this place is less fossiliferous, and the thicknesses and sequence of beds are slightly different. The total thickness as measured by hand level is 36.0 feet. This section may be considered an alternative type section in case the other one is destroyed.

As shown in the described section, the lithology of the Potterchitto varies considerable. All gradations from greensand to non-glauconitic sand are found. These sands vary from calcareous and marly to non-calcareous and from highly fossiliferous to non-fossiliferous. They contain pellets, partings, interbeds, and lenses of carbonaceous clay and shale. Some of the clay inclusions are tubular and filled with matrix material. The different materials are usually interbedded and poorly bedded. In a few places they are even-bedded and thin-bedded and, in a very few, they are cross-bedded. None of the individual beds can be traced any distance along the strike. The glauconite of the Potterchitto is both light-green and dark-green in color and is much finer grained than the Winona glauconite.

Bentonite and bentonitic clay, similar in appearance to the bentonite in the Archusa, are found in the Potterchitto at a few localities. Earthy siderite is common in the member. Where fresh, it is a light brownish-gray color and contains considerable clay, but it weathers so readily that the unaltered material is rarely seen on the outcrop.

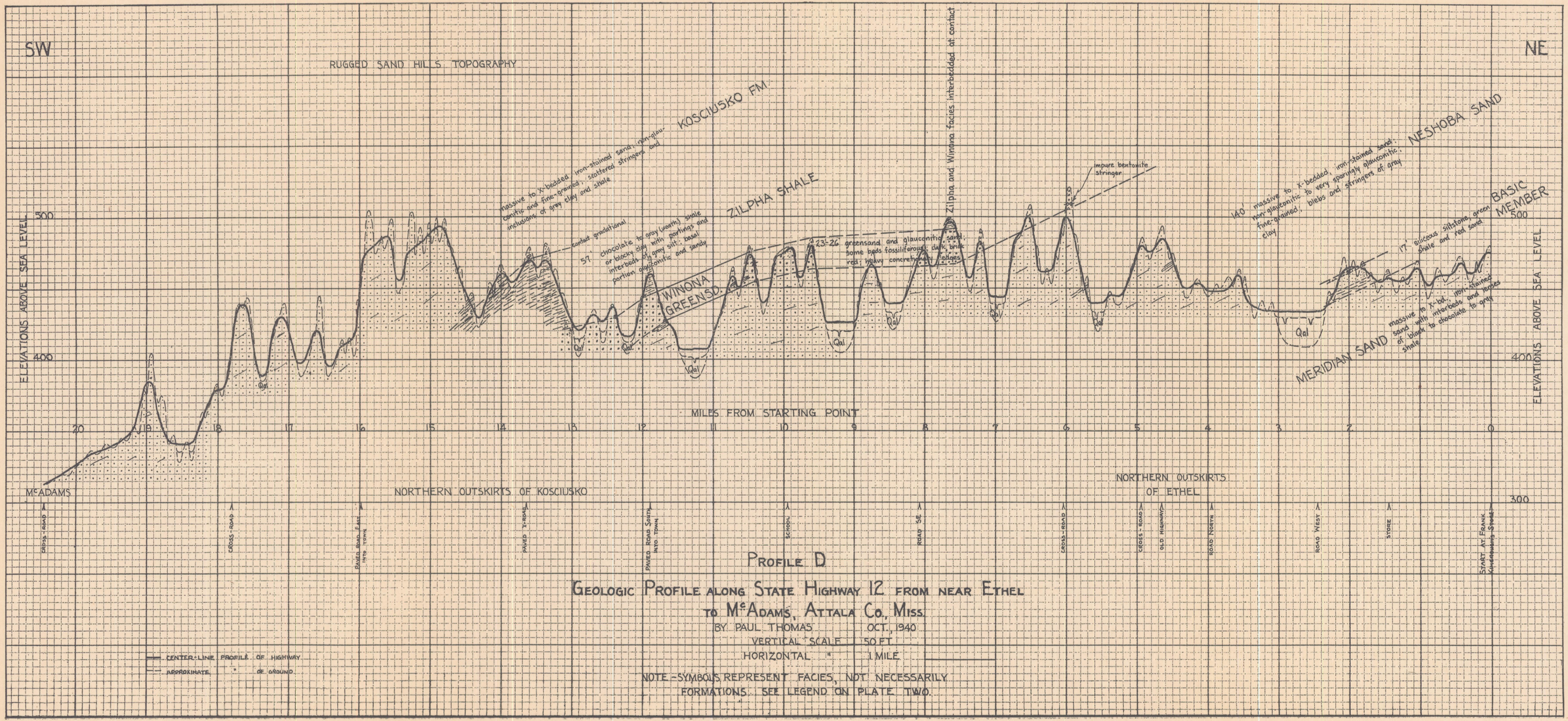
The weathered Potterchitto outcrop is everywhere marked by weak concretionary ledges most of which are of brown limonitic sandstone developed on the weathered greensand and

Figure 18.—Weak concretionary sandstone development in weathered exposure of the Potterchitto member. Cut on Highway U. S. 11, 1.2 miles north of railroad overpass near Wautubbee Station, Clarke County.

glauconitic sand beds (Fig. 18). They resemble the concretionary bodies in the Winona, but they are nowhere so well developed. Some of the ledges are of brown limonitic claystone or ironstone derived from weathered siderite. At many places concretionary bodies contain molds of fossils and weathered grains of glauconite which greatly aid in identifying the Potterchitto on the deeply weathered outcrop.

LOWER CONTACT

The Potterchitto-Archusa contact is conformable and gradational. In mapping the Potterchitto it was found most satisfactory arbitrarily to include as much as possible of the Potterchitto-type material in that member even if this procedure involved placing lenses of Archusa-type marl in the Potterchitto. The position of the contact at the Potterchitto type locality was established on that basis. The thickness relationships show that the type Potterchitto section is at least in part contemporaneous with the upper Archusa in Jasper and Clarke Counties (Plate 2).



PROFILE D

GEOLOGIC PROFILE ALONG STATE HIGHWAY 12 FROM NEAR ETHEL TO McADAMS, ATTALA CO., MISS.

BY PAUL THOMAS OCT., 1940

VERTICAL SCALE 50 FT.

HORIZONTAL " 1 MILE

NOTE - SYMBOLS REPRESENT FACIES, NOT NECESSARILY FORMATIONS. SEE LEGEND ON PLATE TWO.

MISSISSIPPI STATE GEOLOGICAL SURVEY
WILLIAM CLIFFORD MORSE, DIRECTOR

This contact represents a change of conditions similar to that represented by the Winona-Basic contact in eastern Mississippi.

THICKNESS

The thickness of the Potterchitto member ranges between 12 and 30 feet in Clarke, Jasper, and southeastern Newton Counties. It reaches a maximum of 36 feet at the type locality and becomes lenticular and loses its identity in northwestern Newton County.

FOSSILS

The index fossil *Ostrea sellaeformis* ranges throughout the Potterchitto member. In addition, the Potterchitto contains a large fauna which is closely related to that of the Archusa, but localities where fresh fossils can be collected are few. The type locality is the best fossil locality of this member as well as one of the best Wautubbee localities in the state.

GORDON CREEK SHALE MEMBER

INTRODUCTION

The name Gordon Creek is taken from a small creek which flows through Wautubbee Station and which is crossed by the Laurel-Meridian highway (U. S. 11) a short distance south of the station. The type section is designated as that shown on the profile along the highway (Profile B). All the important features of the lithology of the member are well exposed along this highway.

LITHOLOGY

The Gordon Creek member has the same lithology and stratigraphic relationships as the Zilpha shale. It is predominantly a carbonaceous shale which varies in color from black to chocolate-brown to gray to red, depending on the stage of weathering. Glauconite and quartz sand are abundant and irregularly distributed in the basal few feet, and small pockets and lenses of this material are found well up in the section in a few places. The lower portion is characteristically a nearly pure blocky clay, whereas the upper part is more silty and shaly. Plant fragments are found throughout the section, but they are more

Figure 19.—Cross-bedded Cockfield sands over lignitic, silty shales of Gordon Creek member. Cut on Highway U. S. 11, 0.1 mile east of Wautubbee Station, Clarke County.

abundant in the upper shaly portion. Thin irregular partings and interbeds of gray lignitic micaceous silt are abundant in the upper part of the section. This typical lithology is best exposed on the type profile in a cut along the old highway immediately east of the present highway location at a point 1.0 mile north of the highway overpass near Wautubbee Station and also at the type locality of the Potterchitto member.

The second facies of the Gordon Creek exposed along the type profile is that of a dark greenish-gray (fresh) to light-gray (weathered) lignitic, argillaceous, sparingly glauconitic silt or silty shale (Fig. 19). This facies is well exposed in the cut beneath the overpass near Wautubbee Station and in cuts along the highway for several miles south of that point. It is a comparatively rare facies of the member.

Thin beds of light-gray to white platy sparingly glauconitic, siliceous siltstone having a superficial resemblance to some of the Basic siltstones are common in the Gordon Creek in Newton, Jasper, and northwestern Clarke Counties. The best develop-

ment of these beds is found in the area west of Decatur, Newton County, where a five-foot section lies at the top of the member. Elsewhere they are developed as two or three thin beds near the base of the section.

A six-inch stringer of tan bentonite is found at the base of the Gordon Creek in Jasper County, and small quantities of light green bentonite or bentonitic clay are found at the same horizon at several localities in Clarke County.

LOWER CONTACT

The Gordon Creek-Potterchitto contact is conformable and sharply defined. It is very similar in details to the Zilpha-Winona contact and represents the same sequence of events. The material at the contact proper is a heterogeneous mixture of carbonaceous clay, glauconite, and quartz sand. Downward from this horizon, the carbonaceous clay becomes increasingly rare, whereas upward the quartz sand and glauconite become rare and disappear.

This contact is a good one for use in detailed field work. It normally comes a foot or two above the uppermost concretionary material of the Potterchitto and can readily be picked on the outcrop.

THICKNESS

In contrast to the wide variations in thickness of the Zilpha, the Gordon Creek member maintains a consistent thickness between 15 and 25 feet throughout its extent.

FOSSILS

Ostrea sellaeformis ranges up into the basal few feet of the Gordon Creek. In a few places molds of fossils are found in the basal glauconitic portion of the member, but no localities were found where fresh material could be collected. No check has been made on these shales for microfossils.

UNDIFFERENTIATED WAUTUBBEE OF CENTRAL MISSISSIPPI

INTRODUCTION

The three-fold subdivision of the Wautubbee formation of eastern Mississippi can be satisfactorily extended northwest to central Newton County (T.7 N., R.11 E.). Beyond that place the different facies become so lenticular that satisfactory sub-

division of the section is impractical, and the formation is undifferentiated. This undifferentiated marine sequence extends unbroken along the strike to the Yockahockany River in northwestern Leake County. Northwest of that river the marine materials are developed only as discontinuous lenses which lie near the same stratigraphic horizon and which can be traced into the area around the village of Newport, southwestern Attala County, without much difficulty. Northwest of Newport the stratigraphic equivalent of the marine Wautubbee is a highly lenticular section of non-marine sands and carbonaceous shales.

LITHOLOGY

The Wautubbee of central Mississippi is composed of carbonaceous shales, fossiliferous to non-fossiliferous green sands and glauconitic sands, non-glauconitic sands, and fossiliferous sandy marls. The section is essentially a highly interlensed mass of the three eastern Mississippi facies of the formation. The lower part is typically composed of greensands, glauconitic sands, and marls, and the upper portion, of carbonaceous shales; but in local areas the shales extend to the base of the section, and in others the sands, to the top. In central Leake County there are two 5.0-foot to 15.0-foot lenses of shaly glauconitic sand which lie well above the main body of the Wautubbee and are separated from it by non-marine sands. These lenses seem to be deposits which were laid down during local minor advances of the sea, and they are included in the Wautubbee in order to keep all marine materials in that formation.

LOWER CONTACT

The lower contact of the Wautubbee of central Mississippi is disconformable as far northwest as the Yockahockany River. The contact in the area southeast of the river is very similar in detail to the Archusa-Kosciusko contact in eastern Mississippi. It forms a valuable mapping horizon which is usually marked by weak concretionary ledges (Fig. 20).

THICKNESS

The thickness of the Wautubbee section in northwestern Newton and northeastern Scott Counties ranges from 45 to 75

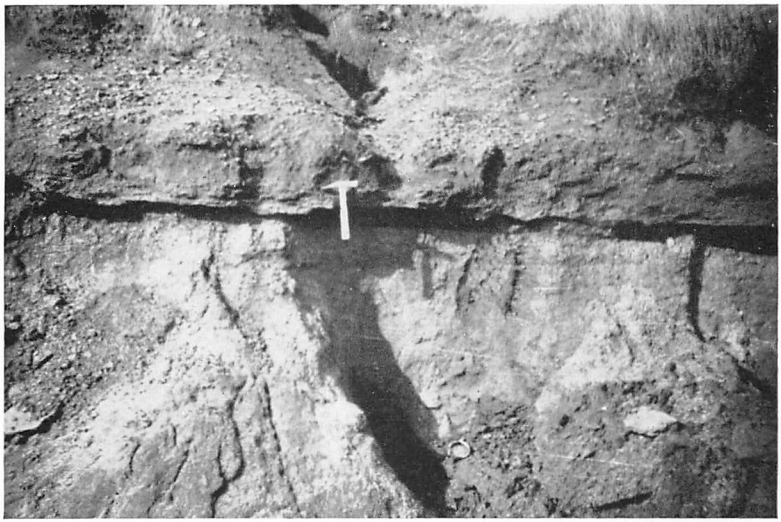


Figure 20.—Typical concretionary sandstone development marking the base of the Wautubbee formation. Cut on highway in northern outskirts of Walnut Grove, Leake County.

feet. Northwestward along strike the thickness varies somewhat but gradually diminishes to 12 feet at the Yockahockany River. The inclusion of the two marine lenses lying above the main body of the formation increases the thickness to a maximum of 75 feet in central Leake County. Elevations of the lenses of marine material in the section northwest of the Yockahockany River show that they lie at slightly different horizons, the maximum vertical difference between these horizons being about 40 feet.

FOSSILS

The Wautubbee beds of central Mississippi are locally highly fossiliferous, but there are few localities in the area where satisfactory collecting is possible. As in the case of the Potterchitto, most of the fossiliferous beds are porous sands which are deeply leached. The fossil molds are found as far northwest as the marine lenses extend. The best fossil localities in the central Mississippi area are in the marls at the base of the formation in northeastern Scott and northwestern Newton Counties. The beds at these localities contain about the same fauna as the Archusa.

Ostrea sellaeformis is found as far northwest as fossils are present in the formation.

SHIPPS CREEK SHALE MEMBER

INTRODUCTION

Beneath the Quaternary sands and gravels in northwestern Holmes and southwestern Carroll Counties, there crops out a thick section of carbonaceous shales which constitutes a distinctive lithologic unit. There is very little similar material in the 450 feet of overlying non-marine Cockfield beds, and the section below is predominantly a non-marine sand section which has lenses of carbonaceous shale and lignitic silty shale. This thick section of carbonaceous shale is herein named the Shipps Creek shale, the name being taken from Shipps Creek, a tributary to Black Creek in east-central Holmes County, Mississippi.

The Shipps Creek shale in part at least is the stratigraphic equivalent of the marine Wautubbee of central Mississippi, because it lies at the same stratigraphic horizon in an area in which non-marine sedimentation was continuous throughout upper and middle Claiborne time. The Shipps Creek occupies a position in the middle of the section between the top of the Winona and the top of the Claiborne. The marine Wautubbee occupies the same position in the section on the outcrop in central Mississippi and in the subsurface section in Yazoo County. The Shipps Creek outcrop also lies along the projection of the normal strike of the marine Wautubbee.

LITHOLOGY

Lithology typical of the Shipps Creek may be seen along practically every stream in the Loess Hills region of northwestern Holmes and southwestern Carroll Counties. The best exposures are found on a series of bluffs on Chicopa Creek and its tributary Jordans Branch (Phillips Creek) in extreme northwestern Holmes County, where 80 to 100 feet of the section can be seen in the fresh state. These outcrops are relatively inaccessible; accordingly an exposure in a cut along the county road just south of the iron bridge across Shipps Creek (SE.1/4, NE.1/4, Sec. 28, T.15 N., R.3 E.) about 4 miles (airline) east-northeast of Lexington, Holmes County, was selected as the type.

SECTION SOUTH OF SHIPPS CREEK IRON BRIDGE

	Feet	Feet
Cockfield formation		23.0
Sand, iron-stained; irregularly bedded to massive; abundant slab-like pieces of dark-brown limonitic sandstone; brown silt mantle	23.0	
Wautubbee formation		
Shipps Creek shale member—type section		43.0
Carbonaceous shale, chocolate-brown to light-gray laminated; irregular partings and thin interbeds of light-gray coarse silt; fresh material highly lignitic, bearing a few fossil leaves; flaky yellow-brown siltstone concretions along silty partings; at the top is a thin limonitic sandstone ledge of the type commonly formed on the top of shale sections by circulating ground-water	14.0	
Sand, gray to yellow to brown; very fine grained and loose; few partings of gray shale; grading down into	1.5	
Sand, similar to above but more partings and stringers of gray to chocolate shale and abundant flaky siltstone concretions in the more weathered material	3.5	
Carbonaceous shale, chocolate brown	2.0	
Covered	6.0	
Section continued beneath bridge		
Carbonaceous shale, black to chocolate-brown; laminated; whole mass regularly bedded, but individual laminae extremely irregular and lenticular; partings, interbeds, and pockets of coarse silt; abundant fragments of plants and a few fossil leaves; base of member not exposed	16.0	
Water level of Shipps Creek—elevation 234 ft. (altimeter)		

The Shipps Creek member is extremely lenticular—much more so than could possibly be illustrated on Plate 2. The carbonaceous shales are interbedded and interlensed with silts and sands in an extremely complex manner, a fact best illustrated by comparing the type section with the section exposed at a bluff on the south side of Shipps Creek on the Chuck Swinney place about half a mile above the type locality (Center Sec. 27, T.15 N., R.3 E.).

SECTION OF THE BLUFF ON THE CHUCK SWINNEY PLACE

	Feet	Feet
Shipps Creek shale member of the Wautubbee formation		42.0
Sand, light-gray, white, and yellow-brown; very fine grained and micaceous; partings, stringers, and interbeds of carbonaceous shale; this bed changes laterally into a carbonaceous shale section at the lower end of the bluff, within a hundred yards	20.0	

Carbonaceous shale, black to chocolate-brown; irregular partings of medium-gray lignitic micaceous coarse silt and a few thin stringers of black lignite; shale nearly pure clay and contains an abundance of plant fragments. 6.0 to 8.0

Sand, white to yellow-brown; bands and partings of black lignitic concentrates and brown lignitic clay; micaceous; individual beds lenticular and cross-bedded.....3.0 to 5.0

Shale or clay, dark-gray to black; silty and lignitic; yellowish efflourescence on slightly oxidized surface; lenses of light-gray silt; extremely irregular structure; this bed truncates underlying bed 1.5

Coarse silt, medium-gray to brown; micaceous; yellowish efflourescence on slightly oxidized surface; few irregular partings and oriented blebs of gray lignitic clay..... 2.5

Silty shale or interlaminated silt and clay, medium-gray to brown; lignitic and micaceous; structure of whole even-bedded and of individual laminae highly irregular and lenticular 5.0

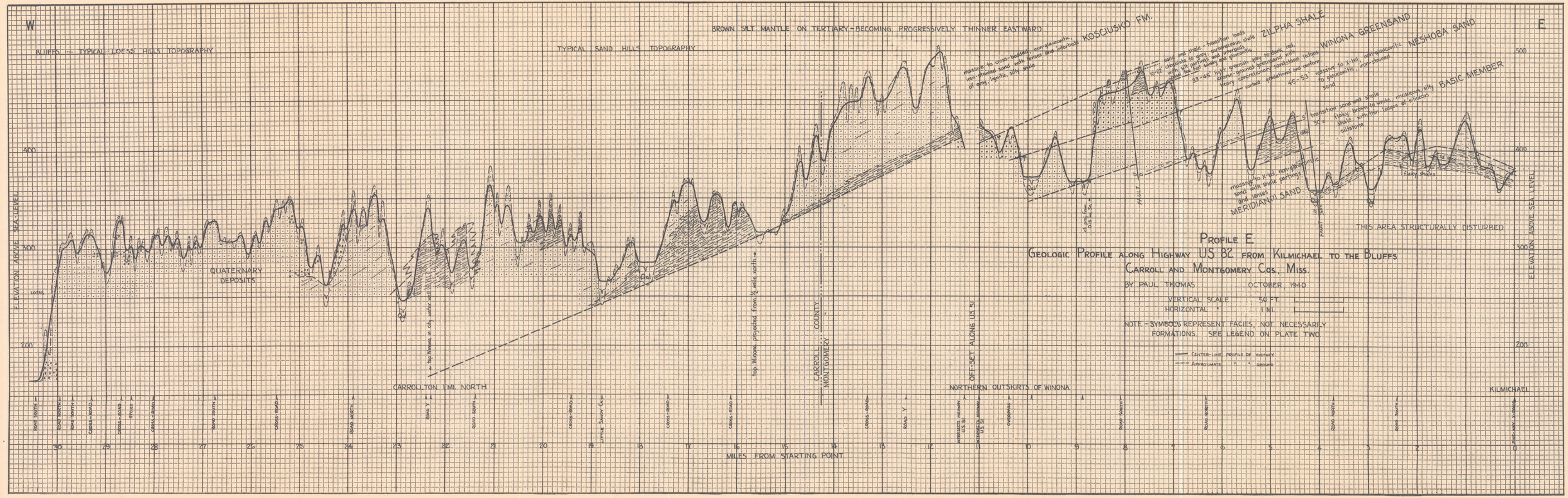
Water level of Shipps Creek—elevation 240 ft. (altimeter)

In addition to the carbonaceous shales and more or less lignitic silts and sands, the Shipps Creek member contains a few thin interbeds of black impure lignite.

CONTACTS

The lower contact of the Shipps Creek is conformable and highly transitional. It is arbitrarily drawn at the base of the section in which carbonaceous shales are the predominant facies in southwestern Carroll and northwestern Holmes Counties. As shown on Plate 2, the section in the eastern Holmes-southwestern Attala County area is a lenticular mass of carbonaceous shales and non-glauconitic sands which cannot be satisfactorily subdivided, and so the basal contact is arbitrarily projected through this area on convenient carbonaceous shale lenses in order to join the basal contact of the marine Wautubbee.

The upper contact is also conformable. It varies from sharply defined to transitional, but it is a much more definite horizon than the lower contact, for the reason that little carbonaceous shale is present in the Cockfield section in Holmes and Yazoo Counties. This contact is projected across southwestern Attala County on carbonaceous shale lenses to join the upper marine Wautubbee contact. Both the upper and lower contacts are dashed on Plate 1 throughout the area northwest of the Yockahockany River, because of their arbitrary nature in that area.



PROFILE E

GEOLOGIC PROFILE ALONG HIGHWAY US 82 FROM KILMICHAEL TO THE BLUFFS CARROLL AND MONTGOMERY COS., MISS.

BY PAUL THOMAS OCTOBER, 1940

VERTICAL SCALE . . . 50 FT.
HORIZONTAL " . . . 1 MI.

NOTE—SYMBOLS REPRESENT FACIES, NOT NECESSARILY FORMATIONS. SEE LEGEND ON PLATE TWO.

— CENTER-LINE PROFILE OF HIGHWAY
---- APPROXIMATE " " " GROUND

BULLETIN 48
PROFILE E

MISSISSIPPI STATE GEOLOGICAL SURVEY
WILLIAM CLIFFORD MORSE, DIRECTOR

THICKNESS

The thickness of the Shipps Creek in the type area is only about 65 feet. The maximum development is reached along the bluffs which border the alluvial valley of the Mississippi River. The thickness of the member in this area is about 200 feet, as derived from subsurface contours on top the Winona. The arbitrarily defined section included in the Shipps Creek across eastern Holmes and southwestern Attala Counties averages about 40 feet in thickness.

FOSSILS

Fossil leaves are present throughout the Shipps Creek, but they are nowhere abundant. They have not been studied in detail.

GENERAL FEATURES OF THE WAUTUBBEE FORMATION

DISTRIBUTION

The Wautubbee outcrop forms an irregular belt, ranging from one-half to six miles wide and averaging about two miles, which extends from the Alabama-Mississippi state line near Crandell, Clarke County, northwest across the state to the bluffs in northwestern Holmes and southwestern Carroll Counties (Plate 2).

TOPOGRAPHIC EXPRESSION

The weak carbonaceous shales which constitute the Gordon Creek member in eastern Mississippi and the upper portion of the undifferentiated Wautubbee of central Mississippi give rise to a distinctive topographic flat or bench which greatly aids in mapping the formation (Fig. 21). The other beds of the section have no distinctive topographic influence and their outcrop is a continuation of the sand hills topography of the Cockfield and Kosciusko formations.

SOILS

The materials of the Wautubbee give rise to a number of different soils. The sparingly glauconitic to non-glauconitic sands give rise to fine sandy loams or fine sands of the Ruston, Greenville, Orangeburg, and Norfolk series which have been described under the soils of the Neshoba sand. The green sands

Figure 21.—Topographic bench developed on Gordon Creek shale outcrop with escarpment developed on basal Cockfield sand in the background. Along county road at Newton-Jasper County line in Sec. 36, T. 5 N., R. 12 E.

and highly glauconitic sands give rise to fine sandy loams of the Nacogdoches and allied series, described under soils of the Winona; and the carbonaceous shales give rise to the distinctive Boswell and Susquehanna very fine sandy or silty loams, described under soils of the Zilpha.

DEPOSITIONAL CONDITIONS

An advance of the sea over the Kosciusko deltaic plain initiated the deposition of the Wautubbee. The maximum northern extent of this advance was to the latitude of southwestern Attala County. That this advance probably did not occur simultaneously throughout the area, but was initiated in eastern Mississippi and gradually extended northward to its maximum advance is indicated by the decreasing thickness and lithologic changes of the formation along strike. If so, the upper part of the Kosciusko and the lower part of the Cockfield formations of western Mississippi are the time equivalents of part of the Wautubbee section in eastern Mississippi.

The absence of the marine Wautubbee section in southwestern Attala County is not due to overlap or truncation of the marine section. This is evidenced by:

1. The marine lenses in southwestern Attala County do not lie at the same stratigraphic horizon as they would if they were remnants of a formerly continuous section.

2. The carbonaceous shales and marine sands of the Wautubbee exhibit a normal and conformable relationship in the area where the marine section lenses out. The carbonaceous shales which normally overlie the marine beds are present throughout. They would be absent had truncation occurred.

3. The Wautubbee beds become progressively more shallow-water deposits northwestward along strike.

This lensing out of a marine section is an example of what probably happens to all marine sections in the Tertiary of the Gulf Coastal Plain in the area of maximum marine advance. In such an area non-marine sedimentation takes place on the deltaic plain simultaneously with marine sedimentation just off-shore, and minor retreats and advances of the sea produce an interlensing of the two facies.

The abundance of the large oyster, *Ostrea sellaeformis,* and other shallow-water forms, the clay inclusions, and the sandy nature of the Archusa marl indicate that the marl was deposited fairly near shore in clear shallow waters in which lime was being precipitated. The lack of bedding and lithologic breaks and the homogeneity of the materials indicate uniform conditions throughout its deposition. The irregular bedding and lenticular nature of the beds of the Potterchitto indicate that it was deposited in an environment of strong current action nearer shore than was the Archusa. This shallowing of the sea corresponded closely to conditions during Winona time. The green sands and glauconitic sands of the undifferentiated Wautubbee of central Mississippi were deposited under the same conditions as the Potterchitto.

Marine conditions were brought to a close by an advance of the deltaic plain over the shallow marine deposits in the same manner that the deposition of the Zilpha ended the Tallahatta-

Winona marine epoch. The deposits which were laid down during this change from marine to non-marine conditions were incorporated in the section as the Gordon Creek shale and the carbonaceous shales of the upper Wautubbee of central Mississippi. The sharp nature of the Gordon Creek-Potterchitto contact indicates that this change was very rapid in eastern Mississippi, but the lenses of green sand and glauconitic sand in the carbonaceous shales throughout central Mississippi and above the main body of the formation in central Leake County point to many minor localized advances of the sea in that area.

The thick non-marine section between the top of the Zilpha and the top of the Cockfield in western Mississippi indicates unbroken deltaic plain depositional conditions throughout Kosciusko, Wautubbee, and Cockfield times in that area. During Shipps Creek time the shore line seemingly drew near the northwestern Holmes-southwestern Carroll County area, and marshy conditions probably existed while that member was deposited.

COCKFIELD FORMATION

INTRODUCTION

The beds in Mississippi which are called Cockfield in this report were first noted by Hilgard[16] in 1860, but were first given a formal name by Lowe[17] who called them the Cockfield Lignite member of the Lisbon formation. Later authors have called them both Cockfield and Yegua. Most of these writers have restricted the Cockfield or Yegua to the upper more shaly portion of the section herein called Cockfield. In this report the formation is expanded to include all beds below the Moodys Branch of the basal Jackson and above the Wautubbee. This usage is in agreement with the usage of the term Cockfield in Louisiana where the type section is located and gives the formation a definite basal contact rather than an arbitrary and highly transitional one.

Stenzel[18] has summarized the history of the names Yegua and Cockfield. He points out that the type locality of the Yegua is in reality a part of the marine Crockett formation, and that the term Lufkin has priority over the term Yegua. The only point in favor of retention of the term Yegua is its common usage. On the other hand the type section of the Cockfield is representative of the lithology of the formation and is situated near the middle

of the Cockfield section. The term Cockfield does not have priority over either Yegua or Lufkin, but is well established in Louisiana literature and is preferred over Yegua in this report.

The name Cockfield was proposed by Vaughn[19] in 1895. He called the section the "Cocksfield Ferry beds" after a locality in Grant Parish, Louisiana. Veatch[20] later changed the spelling slightly and abbreviated the name to Cockfield.

The Cockfield of Mississippi has been considered both a member of the Lisbon formation and a separate formation. The tendency in later reports has been to give it formational rank, and that procedure is followed in this report, because the section is a well-defined lithologic unit which has a wide areal distribution.

LITHOLOGY

The lithology of the Cockfield beds is essentially the same as that of the Kosciusko section. The basal 25 to 125 feet of the formation are composed of massive to highly cross-bedded iron-stained sands. Upward in the section lenses of shale become more and more abundant and usually predominate over the sands in the uppermost part of the formation. The shales are of both the carbonaceous and lignitic silty types described under the lithology of the Kosciusko. The transition from the basal sandy portion to the upper sand and shale part of the section is so gradual that no logical separation of these two facies can be made in the field.

As shown on Plate 2, a marked lithologic change takes place in the Cockfield section in western Mississippi. On the bluffs in western Holmes and northwestern Yazoo Counties the upper 300-foot interval of the formation consists of dark greenish-gray (fresh) to light-gray (weathered) lignitic argillaceous silt and silty shale with irregular partings and interbeds of lighter colored silt. Lenses of gray lignitic leaf-bearing clay and lignitic to non-lignitic sands are interspersed in the silts. The sands vary from black to gray in color, depending on the lignitic content, and from massive to cross-bedded. Carbonaceous shales are very rare in this sequence.

Lignite is abundant as beds as much as 5.0 feet thick in the finer grained Cockfield sediments. The lignites are typically

black and impure. Some of them show roots extending down into the underlying materials and have obviously formed in place, whereas others seem to be composed of material transported to the site of deposition. The best exposures of the lignites are found along the bluffs where the outcrops are fresh. They are rarely seen on the surface in central and eastern Mississippi, because of the deep weathering in this area. These beds contain an abundance of well preserved fossil leaves and other plant fragments.

A thin stringer of tan bentonite which lies near the top of the formation is found at a few exposures in extreme southwestern Holmes County. Along the bluffs east of Tchula, Holmes County, a thick bed of quartzitic siltstone similar to the ledges in the Kosciusko is found.

The most common concretionary materials in the Cockfield are the familiar limonitic sandstones and siltstones formed by circulating ground-waters. The lignitic argillaceous silts and silty shales contain both pyrite and siderite concretions. The pyrite concretions are small cylindrical bodies which are formed in vertical silt-filled pipes in the argillaceous silts. The pyrite binds the silt into an indurated pyritiferous siltstone. The siderite forms rounded to spheroidal to flattened boulders which are as much as 5.0 feet in largest diameter and which are abundant in northwestern Yazoo and southwestern Holmes Counties (Fig. 22). At a few localities the argillaceous silts contain rounded calcareous siltstone concretions, 8 inches in maximum diameter.

LOWER CONTACT

The Cockfield-Wautubbee contact is conformable and transitional. It is similar in its details to the Kosciusko-Zilpha contact and represents the same sequence of events. Throughout central and eastern Mississippi the basal Cockfield sand grades down into the underlying carbonaceous shale through an interbedded sand and shale section which ranges from a few inches to 10 feet in thickness. Scattered lenses of carbonaceous shale are found in the basal Cockfield sand. At some outcrops in Leake County the Cockfield rests directly on greensands and glauconitic sands, and the basal few feet of the Cockfield contain glauconite which gradually disappears upward in the section. A similar condition

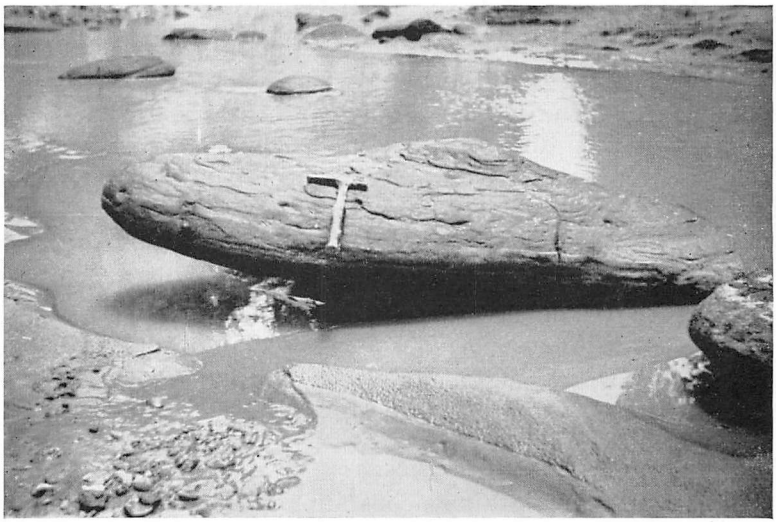


Figure 22.—Siderite concretion from the lignitic, argillaceous silts of uppermost Cockfield—Techewa Creek bridge near Eden, Yazoo County.

exists in the vicinity of Wautubbee Station where the Cockfield overlies the sparingly glauconitic silts of the Gordon Creek member.

The lower contact is easily identified on the outcrop and makes a satisfactory mapping horizon as far northwest as the Yockahockany River. The details of the contact between the Cockfield and the Shipps Creek shale have already been discussed under the contacts of the Shipps Creek.

UPPER CONTACT

The contact between the Moodys Branch (basal Jackson) and the Cockfield is disconformable. The Moodys Branch is composed of fossiliferous greensands and glauconitic sands which become more marly near the top of the section and which are overlain conformably by the marine Yazoo clay. The Moodys Branch is a basal sandy concentrate which bears the same relationship to the overlying marine Jackson section that the basal pebble-bearing glauconitic sand bears to the main body of the Basic claystone, and that the basal sandy portion of the Wautubbee bears to the overlying marine section.

The contact resembles the lower Wautubbee and lower Basic contacts in its details and represents a similar sequence of events. The transition between the two facies is a 1.0-foot to 10.0-foot section in which the Moodys Branch and Cockfield materials are intimately and heterogeneously mixed. The basal few feet of the marine section contain small blocks and other inclusions of material from below, and the uppermost part of the Cockfield contains small pockets and filled borings and lenses of fossiliferous material from the bed above, as well as disseminated glauconite.

The Moodys Branch-Cockfield contact is a good one on which to base detailed mapping, but it is seldom used because the Moodys Branch is thin and its upper contact is one of the best in the Tertiary section of Mississippi.

THICKNESS

The Cockfield maintains a constant thickness of about 50 feet across Clarke County and gradually thickens northwestward from this area to a maximum thickness of about 450 feet in Holmes and Yazoo Counties. Thicknesses under 75 feet were measured directly on the outcrop; those in the central part of the area were obtained by a projection of dips on surface contours, and those in the western part, by reference to sub-surface contours on top the Winona.

FOSSILS

A number of good fossil leaf localities are found in the lignites and leaf-bearing clays of the Cockfield along the bluffs. The remainder of the outcrop is so badly weathered that such localities are very rare. This flora has not been studied in detail.

DISTRIBUTION

The Cockfield outcrop (Plate 1) forms a belt with irregular boundaries which trends about 45 degrees west of north across the state. This belt is very sinuous in Clarke County and ranges from 0.5 to 7.0 miles in width. Northwestward from this area it gradually increases in width to an average of about 15.0 miles in western Mississippi.

TOPOGRAPHIC EXPRESSION

The basal sands of the Cockfield support a rugged sand hills topography and form a marked escarpment overlooking the

topographic bench formed on the weak shales of the upper Wautubbee throughout central and eastern Mississippi. The average local relief throughout this belt is about 75 feet and the maximum is about 125 feet. The upper more shaly portion of the Cockfield supports a more rolling sand hills topography in which the average local relief is about 50 feet. These rolling sand hills merge with the very gently rolling Jackson or Yazoo Prairie region to the southwest.

SOILS

The Cockfield sediments give rise to soils very similar to those found on the Kosciusko outcrop. The massive sands form fine sandy loams and fine sands of the Ruston and allied series, whereas the sands and shales give rise to fine sandy loams of the Shubuta and allied series. These soils have been described under the soils of the Kosciusko and Neshoba.

As in the case of the Kosciusko, the soils of the Cockfield in western Mississippi contain abnormal amounts of silt and in western Madison, northeastern Yazoo, and southeastern Holmes Counties the outcrop is covered by a mantle of brown silt which gives rise to silt loam soils. In Leake, Scott, and Newton Counties the soils of the Cockfield commonly contain an abundance of small white quartz pebbles which are residual from a younger Pliocene or Pleistocene (Citronelle) blanket which once covered that area.

DEPOSITIONAL CONDITIONS

The conditions under which the Cockfield sediments were deposited were the same as those under which the Kosciusko beds were laid down. The nature of the lower contact shows that the deposition was initiated by a rapid flooding of the coastal marsh by a thick section of stream-deposited sands. The gradients of the streams on the deltaic plain gradually diminished, and during upper Cockfield time considerably more fine grained material was deposited. Conditions were probably much more marshy and swampy in the southwestern Holmes-northeastern Yazoo County area during middle and upper Cockfield time than elsewhere in the outcrop area, and a thick section of fine-grained lignitic material was laid down in these counties.

Non-marine Cockfield depositional conditions were ended by the concerted advance of the Jackson sea.

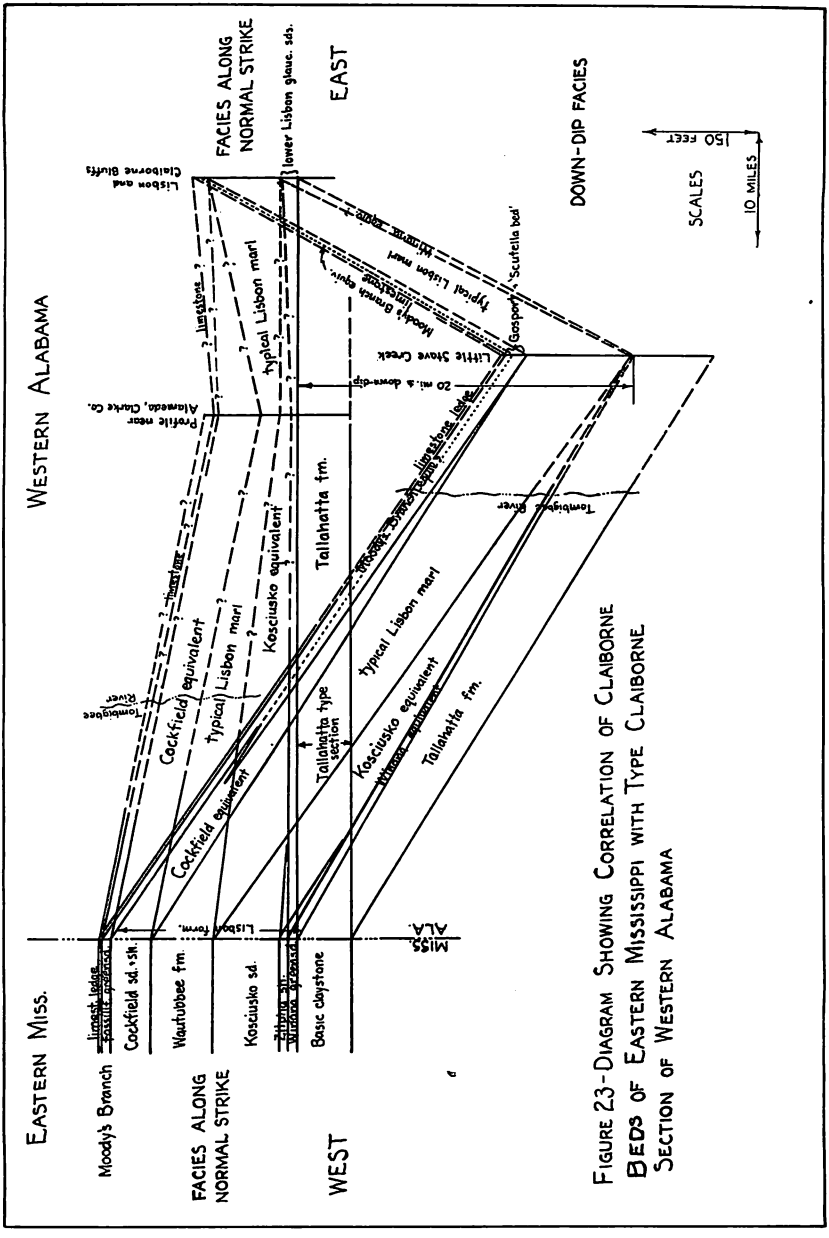


FIGURE 23-DIAGRAM SHOWING CORRELATION OF CLAIBORNE BEDS OF EASTERN MISSISSIPPI WITH TYPE CLAIBORNE SECTION OF WESTERN ALABAMA

CORRELATION OF THE CLAIBORNE OF MISSISSIPPI WITH THE TYPE CLAIBORNE SECTION

INTRODUCTION

As generally accepted, the type Claiborne section of western Alabama consists of three formations:

Gosport fossiliferous sand
Lisbon sandy marl
Tallahatta formation or "buhrstone"

This section is entirely marine and is very different from the alternating marine and non-marine Claiborne sequence of eastern Mississippi. The transition from one section to the other takes place in Clarke, southern Choctaw, and northeastern Washington Counties, Alabama. In this area two large structural uplifts, the Hatchetigbee anticline and the Jackson fault, shoved Claiborne beds to the surface that would normally be far beneath the surface 20 to 30 miles down-dip from the normal outcrop. Marked changes take place in the Claiborne section both along the normal outcrop and down-dip on the structure. The author's interpretation of the stratigraphic relationships of the Claiborne in eastern Mississippi and western Alabama is shown in the following diagram (Fig. 23). It shows only the general features of the correlation, because the problem is, in reality, very complex and the data incomplete in many instances. The largest and most important gap in the data is along the normal strike of the Claiborne across Clarke County, Alabama.

TALLAHATTA FORMATION

The Tallahatta formation takes its name from the Tallahatta Hills in southeastern Choctaw County, Alabama, where the beds are well exposed. The type section is the lithologic and stratigraphic counterpart of the Basic claystone of eastern Mississippi. The Tallahatta persists throughout western Alabama, averaging about 100 feet in thickness and reaching a maximum thickness of 125 feet. Most Alabama reports give this thickness as about 300 feet after Smith and Johnson,[21] but this is a carefully preserved error. The basal pebble-bearing glauconitic sand is persistent throughout western Alabama.

LISBON AND GOSPORT FORMATIONS

INTRODUCTION

The type middle and upper Claiborne section at Lisbon Bluff and Claiborne Bluff on the Alabama River in Clarke and Munroe

Counties, Alabama, and about 65 miles along the normal strike east-southeast of the Mississippi-Alabama state line has been described by Smith and Johnson[22] and copied in most later Alabama reports.

GENERALIZED SECTION OF THE LOWER JACKSON AND CLAIBORNE AT THE TYPE LOCALITY, ALABAMA

Present Name	Beds	Thick.
Jackson	White limestone	45.0
Gosport *	"Scutella bed"	3.0
	Coarse glauconitic sand	6.0
	Sparingly glauconitic sand loaded with shells 15.0 to	17.0
Lisbon	Interbedded glauconitic sandy marls, calcareous clays, and calcareous sands	92.0
	Glauconitic sands	23.0
Tallahatta	Bluish-black clay, only partly exposed	13.0

* The original definition of the Gosport includes all beds below the white limestone ("St. Stephens limestone") and above the Lisbon.

A very similar Gosport-Lisbon section is exposed down-dip along the Jackson fault on Little Stave Creek about 3 miles north of Jackson, Clarke County, Alabama.

EQUIVALENT SECTION IN EASTERN MISSISSIPPI

	Formation	Beds	Thick.
JACKSON	Moodys	Sandy sparingly glauconitic limestone 1.0 to	3.0
	Branch	Fossiliferous greensand 5.0 to	10.0
	Cockfield	Non-marine sands and shales	50.0
CLAIBORNE	Wautubbee	Sandy marls and glauconitic sands with 20 feet of carbonaceous shale at top	80.0
	Kosciusko	Non-marine sands	85.0
	Zilpha	Carbonaceous shales	10.0
	Winona	Coarse-grained fossiliferous greensands	10.0

Each of these eastern Mississippi formations has a lithologic equivalent in western Alabama.

WINONA EQUIVALENT

Coarse-grained greensands of typical Winona aspect and containing both *Proscutella mississippiensis* and *Ostrea sellaeformis* var. *lisbonensis* are found overlying the Tallahatta throughout most of western Alabama. They are absent to poorly developed along the crest of the escarpment formed on the normal Tallahatta outcrop, but they become progressively thicker and more marine in aspect down-dip on the Hatchetigbee anticline. Both the upper and lower contacts of this section are conformable, indicating that this is a simple up-dip lensing out of a marine section rather than an unconformable overlap.

The Winona equivalent is mappable around the Hatchetigbee anticline and consists of a 2.0-foot section on Little Stave Creek. The extent of its development along the normal outcrop through Clarke County is unknown, but it is present as 6 feet of cross-bedded glauconitic sand with coarse-grained glauconite and quartz pebbles along Highway U. S. 43 near Alameda, Clarke County, Alabama, and it can probably be traced into Lisbon Bluff where its probable equivalent is at least part of the 23-foot glauconitic sand section which overlies the Tallahatta. The distinctive lithology and persistence of these beds throughout western Alabama warrant their recognition as a member of the Lisbon formation.

ZILPHA EQUIVALENT

The carbonaceous shales which overlie the Winona throughout Mississippi are very poorly developed in western Alabama. They are found only at isolated outcrops and have little value as a mapping unit.

KOSCIUSKO EQUIVALENT

The massive to cross-bedded non-glauconitic sands of the Kosciusko of eastern Mississippi can be traced well into western Alabama. This section averages about 65 feet in thickness along the normal outcrop in Choctaw County, Alabama, and it is exposed over a wide area on the gentle slope of the Buhrstone Cuesta. The extent of the development of these sands along the normal outcrop belt through Clarke County, Alabama, is not known, but they can be recognized as 14 feet of medium-grained to coarse-grained pebble-bearing non-glauconitic sand along

Highway U. S. 43 near Alameda. The sand seems to lens out into the lower part of the type Lisbon section in eastern Clarke County, Alabama. These beds can be traced around the southwestern flank of the Hatchetigbee anticline. They become progressively thinner down-dip and lens out near the Tombigbee River in northeastern Washington County. These sands form a mappable unit over a considerable area in western Alabama and should be recognized as a member of the Lisbon formation in this area.

WAUTUBBEE EQUIVALENT OR TYPICAL LISBON FACIES

The Archusa member of the Wautubbee formation of eastern Mississippi is in reality a tongue of the marine Lisbon section developed at Lisbon Bluff and Claiborne Bluff, Alabama. The Potterchitto member contains essentially the same fauna, but it has a slightly different facies from any of the type upper Lisbon beds, whereas the Gordon Creek shale is a facies developed only where the marine Wautubbee section is overlain by non-marine beds and is absent at Claiborne Bluff. The three-fold subdivision of the Wautubbee section of eastern Mississippi can be made at some localities, but the facies are not persistent enough to warrant subdivision of the section.

The typical Lisbon marl facies or Wautubbee equivalent of Choctaw County, Alabama, is very similar to the Wautubbee section of eastern Clarke County, Mississippi. It is very lenticular, but it can be traced without much interruption around the southwestern flank of the Hatchetigbee anticline into the down-dip Lisbon marl section on Little Stave Creek where it reaches 140 feet in thickness. The basal contact shows less and less evidence of being disconformable, and the upper contact becomes more and more gradational southeastward from the state line.

The extent of development and the relationships of this typical Lisbon marl section along the normal outcrop belt in Clarke County, Alabama, are not known. The stratigraphic relationships in this area are probably exceedingly complex, because only an interval of 25 feet of fossiliferous silty clay, which might be considered to be of typical Lisbon facies, is found overlying the Kosciusko equivalent along Highway U. S. 43 between Alameda

and Fulton. Along the normal strike this section is only 20 miles from Claiborne Bluff and Lisbon Bluff where the marl and clay section is 92 feet thick.

COCKFIELD EQUIVALENT

The Gosport sand has long been considered to be the correlative of the Cockfield formation, although the evidence for this correlation has never been adequately presented. Cooke[23] and Gardner[24] have recently presented stratigraphic and paleontological evidence in companion papers to show that the Gosport sand is at least in part the equivalent of the Moodys Branch of Mississippi. Stenzel[25] disagrees with this correlation on the basis of both stratigraphic and faunal evidence. Blanpied and Hazzard,[26] after detailed field work in western Alabama, say: "It is the writers' opinion that the lithologic change from marine Gosport sands of southwestern Alabama to the non-marine Cockfield of eastern Mississippi represents a lateral and gradational interfingering of marine fossiliferous greensands with lacustrine non-fossiliferous sands and carbonaceous clays."

The present writer's conclusions regarding the stratigraphic relationships of the Gosport, Moodys Branch, and Cockfield are:

1. The uppermost few feet of the Gosport, as originally defined, are probably the stratigraphic equivalent of the middle and lower Moodys Branch of eastern Mississippi. The Moodys Branch of Clarke County, Mississippi, consists of an upper interval of 1 to 3 feet of sandy glauconitic limestone and a lower interval of 5 to 15 feet of fossiliferous greensands. The upper Moodys Branch is tentatively correlated with the limestone overlying the "Scutella bed" on Little Stave Creek on the basis of its field relationships and lithology. If this correlation is correct, the upper part of the fossiliferous greensand section underlying the limestone on Little Stave Creek is the stratigraphic equivalent of the lower fossiliferous greensands of the Moodys Branch of Clarke County, Mississippi. Since the Gosport sections at Claiborne Bluff and Little Stave Creek are very similar, the same correlation probably holds at Claiborne Bluff.

2. The lower part of the Gosport interfingers with upper Cockfield shales and is of upper Cockfield age. Blanpied and Hazzard[27] record from 24 to 37 feet of Gosport in a series of

core holes in northeastern Washington County, Alabama. The upper interval of 10 feet or so of this section is the stratigraphic equivalent of the Moodys Branch of eastern Mississippi, whereas the lower part of this section can be seen interfingering with upper Cockfield shales on the surface at the well-known Willow Branch locality, a few miles northwest along strike from the core-holes area.

3. The lower part of the Cockfield section of eastern Mississippi is older than Gosport. This lower Cockfield section can be traced around the southwestern flank of the Hatchetigbee anticline as far as the Tombigbee River where it lenses out between the Gosport and typical Lisbon marl. Blanpied and Hazzard[28] record from 20 to 44 feet of "typical Cockfield" underlying the full Gosport section in their core holes in northeastern Washington County, but this "typical Cockfield" section is absent across the Tombigbee River on Little Stave Creek. The full section of overlying Gosport across this area and the thickening of the Lisbon marl section with the thinning of the lower part of the Cockfield equivalent indicate an upper Lisbon age for the lower Cockfield.

CYCLIC DEPOSITIONAL PATTERN

Several geologists working in various parts of the Gulf Coastal Plain have recognized that the Tertiary beds were deposited in definite cyclic patterns which are of fundamental importance in a logical interpretation of the stratigraphy and dispositional history in the area. The Claiborne section of eastern and central Mississippi exhibits such a cyclic depositional pattern. It is:

Disconformity
Non-marine sands and shales (top)
Conformity
Carbonaceous shales or transitional facies
Conformity
Marine facies (bottom)
Disconformity

The contacts between the different lithologic units in this pattern are very similar in many of their details, and radically different interpretations of their significance have been presented by different geologists who have worked on the Claiborne

of Mississippi. These contacts which are considered disconformable in this report are horizons at which it can be established that an erosional break of some importance occurred. The lines of evidence used to establish this relationship are listed below in order of decreasing significance.

1. The lithologic nature of the underlying and overlying materials—A sharp transition from non-marine to marine beds, such as that at the base of both of the marine sequences in the Claiborne of eastern and central Mississippi, could only be brought about by a strong marine advance accompanied by wave-erosion.

2. The presence of a basal concentrate—The basal sandy portion of the marine sequence is apparently a beach deposit thrown up along the shore line as it advanced onto the deltaic plain. It usually contains small fragments and inclusions of material eroded from the bed below and incorporated in the beach deposit. Similar features are found in some places at conformable contacts, but they can be logically explained by submarine erosion, and it can often be proved by the persistence and constant thickness of the bed immediately below the contact that little or no truncation occurred.

3. The nature of the uppermost portion of the underlying section—In most cases where a marine section lies on a non-marine section, the lithology of the uppermost part of the non-marine sequence changes over short distances from sand to shale to silt. This is exactly the condition which would be produced by truncation of the uppermost portion of the deltaic plain during a marine advance.

4. Irregular line of contact—This is perhaps the least reliable criterion for determining the existence of a disconformity. The irregularities must be of considerable magnitude before they have any significance, since slight irregularities are present along most conformable contacts and along many minor breaks or diastems within marine sequences.

The filled borings at disconformable contacts in the Claiborne of Mississippi have little or no significance in the interpretation of the contact, since they are common within the marine beds and at conformable contacts within marine sequences.

The contacts which are considered conformable in this report are horizons at which no significant break in sedimentation occurred. The lines of evidence used to establish this relationship are listed below in order of decreasing significance.

1. An interbedding of the two facies at the contact.

2. Persistent lithology and constant thickness of the uppermost bed of the section just below the contact.

3. The lithology of the section involved—If the beds above and below the contact were deposited under essentially the same environment, the contact is normally conformable. Also, the presence of a carbonaceous shale section or transition facies indicates a change of depositional conditions during which there was continuous sedimentation.

The field evidence indicates that the sequence of events which caused the formation of the depositional pattern in the Claiborne section of Mississippi was:

1. A strong advance of the sea over a low-lying deltaic plain.

2. Deposition of the main body of the marine section under off-shore shallow water conditions.

3. Shoaling of the sea.

4. A rapid advance of the coastal marsh over the marine sediments.

5. Flooding of the marsh by stream-deposited sands.

6. Gradual replacement of stream deposition by more marshy conditions.

7. Another advance of the sea over the deltaic plain.

Fisk,[29] in a discussion of the causes of similar events in central Louisiana during Oligocene and Eocene time, attributed them to subsidence under sedimentary loading with the shifting of the centers of deposition accounting for the advances and retreats of the shore line. Subsidence under load has probably been a major factor in the sedimentary history of the Claiborne section of Mississippi, because the presence of a thick section of beds which have accumulated at or near sea level can most logically be explained in that manner, but there is some reason

to believe that other factors may also have played a part in causing the transgressions and regressions of the Claiborne sea. The indications of this are:

1. The rapidity of the widespread marine advances—The field evidence indicates that the Tallahatta and Moodys Branch marine advances occurred rapidly and covered wide areas. In all probability they took place in the face of non-marine sedimentation. There are no large nearby deltas of contemporaneous age which would promote lateral downdragging sufficient to permit such advances and the Claiborne beds are predominantly sands which would undergo little compaction.

2. The rapidity of the change from marine to non-marine depositional conditions—The field evidence indicates that a sudden acceleration of the rate of sedimentation caused a rapid advance of the land into the sea over a wide area during each change from marine to non-marine conditions. Also the absence of any large Claiborne deltaic mass nearby precludes the possibility of a shift of a center of deposition which could account for such a widespread acceleration of the rate of sedimentation. The most logical explanation is that the gradients of a number of smaller streams were suddenly increased.

3. Large overlaps exist in the Eocene section along the Atlantic Coastal Plain and there is no reason to believe that the factors which caused them did not operate elsewhere in the Coastal Plain Province.

In the writer's opinion, these points indicate that epeirogenic movements probably played an important role in causing the oscillations of strand-line in Mississippi during Claiborne time.

COUNTY DETAILS

This part of the report is intended to supplement the general discussion of the Claiborne with additional details which amplify some of the more unusual features. These details are presented under county headings which are arranged in alphabetical order. All locations are taken from the new series of inch to the mile county base maps published by the Planning Division of the Mississippi Highway Commission.

ATTALA COUNTY

WINONA GREENSAND

Molds of fossils are abundant in the Winona in Attala County. In fact the best surface locality noted in western Mississippi is on the J. C. Goyne place about 4 miles east of Kosciusko (NE. ¼, NW. ¼, SW. ¼, Sec. 19, T.14 N., R.8 E.), where an abundance of *Ostrea sellaeformis* var. *lisbonensis* and other forms are found along with some unusually large gastropods. Two general areas hold considerable promise of additional fossil localities on detailed investigation. One of these areas is in the general vicinity of Kosciusko where fresh fossils have been encountered in many water wells. The other area is in the extreme northwestern corner of the county and across the Big Black River in Carroll County. A poor surface locality was noted on the bluffs overlooking the river just north of the point where Zilpha Creek flows onto the river bottom and on the Will Oakes place about 6 miles south of Vaiden (NW. ¼, SW. ¼, Sec. 17, T.16N., R.6E.).

WAUTUBBEE FORMATION

The marine Wautubbee lenses out into non-marine sands and shales in southwestern Attala County. In this area it is in reality a number of thin discontinuous lenses of marine material. A typical exposure of one of these lenses may be seen just north of the road intersection in the village of Newport. The westernmost exposure of this marine material was found at a place (SW. ¼, NE. ¼, Sec. 20, T.13 N., R.5 E.) about halfway between Newport and the Big Black River.

CARROLL COUNTY

WINONA GREENSAND

Poorly preserved Winona fossils, including both *Ostrea sallaeformis* var. *lisbonensis* and *Proscutella mississippiensis,* are found in a cut on the west side of Highway U. S. 51, 3.7 miles south of the depot at Vaiden and 0.85 mile north of Beatty Station. This fossiliferous lens lies about 25 feet below the top of the formation. Some of the fossils are beautifully opalized.

KOSCIUSKO FORMATION

The lignitic, silty shales of the Kosciusko of Carroll County contain an abundance of fossil leaves, but good collecting localities are comparatively rare. The three best localities noted are:

1. At a bluff on the left bank of Little Teoc Creek just above the ford (NE. ¼, Sec. 32, T. 20 N., R. 3 E.) about 6 miles northwest of Carrollton.

2. At a low bluff on the right bank of Seawood Branch a short distance below the bridge (NE. ¼, Sec. 20., T. 19 N., R.3E.) about 5 miles west of Carollton.

3. In a cut at the crest of a hill on Highway U. S. 82, 2.45 miles east of the Carrollton turn-off.

WAUTUBBEE FORMATION

The black shales of the Shipps Creek are found along the bluffs bordering the alluvial valley of the Mississippi River for a distance of six miles north of the Carroll-Holmes County line and also along Abiacha and Coila Creeks and their tributaries. The elevations and regional dips in southwestern Carroll County are such that these shales should normally be exposed east of the Quaternary belt, but considerable difficulty is encountered in identifying them in this area, because of a noticeable up-dip sanding-up of the shales and because of the deep weathering and mantle of brown silt.

Five feet of black shaly lignite belonging in the Shipps Creek section is exposed at a spring on the bluffs (NW.¼, NE.¼, Sec. 1, T. 17 N., R. 1 E.) about 2 miles north of Pine Bluff.

CLARKE COUNTY

WINONA GREENSAND

In addition to the well-known fossil localities in the stream beds in and around Enterprise, one other locality where fresh Winona fossils can be collected was noted. It is in a road cut (SW. ¼, SW. ¼, Sec. 28, T. 3 N., R. 18 E.) about half a mile southwest of Pine Ridge Church.

KOSCIUSKO FORMATION

The Kosciusko is composed almost entirely of massive and cross-bedded iron-stained sands in Clarke and Lauderdale Counties, the upper shaly phase not being developed. Small white quartz pebbles and granules are common in the sands, particularly near the base of the formation. The basal contact is marked by a persistent concretionary limonitic sandstone ledge throughout the southern Lauderdale-Clarke County area.

WAUTUBBEE FORMATION

Extensive lithologic differences are noted in the Wautubbee section in the Bucatunna Creek drainage basin in southeastern Clarke County. The Archusa marl is thinner and contains abundant lenses of non-glauconitic sand, the Potterchitto member is less highly glauconitic, and the Gordon Creek shale is sandy in places. However, in the area around Theadville near the state line, the normal section is found.

There are many excellent Archusa marl fossil localities in Clarke County in addition to the type locality. The best of these are:

1. At Kings Bluff (NE. ¼, NE. ¼, Sec. 16, T. 2 N., R. 15 E.) on the south bank of Souinlovey Creek about 2 miles southwest of Quitman.

2. Along the banks of the Chickasawhay River below the bridge about 1 mile east of the town of De Soto.

3. Along Highway U. S. 11 in the northwestern part of the county (Profile B).

GRENADA COUNTY

TALLAHATTA FORMATION

The most instructive exposure of the Undifferentiated Tallahatta of Grenada County is found in a cut (near middle south line Sec. 10, T. 22 N., R. 4 E.) along the county road on the west side of Howards Creek about 3 miles (airline) east of Dubard and a similar distance west of Grenada.

SECTION OF COUNTY ROAD CUT ON THE WEST SIDE OF HOWARD CREEK

	Feet	Feet
Kosciusko formation		15.0
Sand, red, brown, and white; massive and cross-bedded; argillaceous; abundant irregular brown limonitic sandstone concretionary bodies; in the gully this sand contains petrified logs—very rare feature of the Kosciusko	15.0	
Zilpha shale		6.0
Concretionary claystone ledge, dark-brown and yellow-brown; this ledge is a persistent and characteristic feature of the Kosciusko-Zilpha contact in Grenada and Montgomery Counties. From 0.5 to	2.0	
Carbonaceous shale, light-gray and red; abundant glauconite in small lenses and pockets	2.0	

Glauconitic clay, light greenish gray; really a heterogeneous mixture of glauconite, quartz sand, and clay; typical Zilpha-Winona transition facies. From 1.0 to..... 2.0

Winona greensand 22.5

Concretionary sandstone ledge, brown limonitic, argillaceous, and glauconitic; discontinuous and extremely irregular in structure with a tendency toward concentric structure; typical of uppermost Winona throughout Grenada and Montgomery Counties. From 0.5 to..... 1.5

Greensand or glauconitic sand, light greenish gray to dark, brick-red; abundant disoriented clay inclusions, many of which are tubular and filled with glauconitic sand..... 21.0

Undifferentiated Tallahatta 37.0

Position of siliceous siltstone in gully

Shaly sand, white, yellow, and red; very fine-grained; heterogeneous, with abundant partings and interbeds of flaky carbonaceous shale; whole mass appears to be even-bedded and thin-bedded, but individual beds are extremely irregular due to small-scale interlensing; some of the sands are glauconitic; this section is the stratigraphic equivalent of the upper part of the Neshoba of Montgomery County.... 14.0

Greensand, light greenish gray, yellow, and dark red; loose to slightly indurated; abundant disoriented inclusions of clay which impart a distinctive heterogeneous appearance; most prominent bed in section; this greensand is persistent throughout Grenada County 17.0

Sand and shale; the sand is white, yellow, and red and glauconitic to non-glauconitic; the shale is carbonaceous and flaky; structure of whole highly lenticular..... 6.0

Foot of hill—elevation 220 feet (altimeter)

A gully one-fourth mile southwest of the road cut on the west side of Howard Creek and in front of a tenant house on the Lake Travis place 3 miles east of Dubard furnishes a supplementary exposure.

SECTION IN THE GULLY

Winona greensand 14.0

Greensand or glauconitic sand, similar in lithology to the 21.0-foot bed in road cut..... 14.0

Tallahatta, undifferentiated 3.0

Siliceous siltstone, white and yellow; indurated; argillaceous, glauconitic, micaceous, and sparingly fossiliferous; abundant disoriented inclusions of white clay imparting a heterogeneous appearance similar to much of the Basic siltstone; marks top of the Undifferentiated Tallahatta section (Figure 24) 2.5

Carbonaceous shale 0.5

Figure 24.—Siliceous siltstone bed marking top of undifferentiated Tallahatta section in the gully on the Lake Travis place, 3.0 miles east of Dubard, Grenada County.

HOLMES COUNTY

WAUTUBBEE FORMATION

The black shales of the Shipps Creek member are well exposed at many places in northwestern Holmes County. In addition to the bluffs along Chicopa Creek, there are good exposures along Fannegusha Creek and its tributaries. Excellent outcrops are also found along Torreys Creek for a distance of two miles above the bridge across that creek (NE.1/4, NE.1/4, Sec. 5, T.14 N., R.3 E.) about three miles east-southeast of Lexington. The shales upon which the Wautubbee contact is projected through eastern Holmes County are best exposed along Highway U. S. 51 about two miles north of Goodman.

Lignite is found in the Shipps Creek member at two localities. At one, a four-foot bed forms a small falls in a branch just south of Highway 12 at a point (NW.1/4, NE.1/4, Sec. 2, T.14 N., R.3 E.), 0.6 mile east of the take-off of the Owens Wells road and about half way between Durant and Lexington. The other is in the bed of the creek at McMillan Station (NE.1/4, NW.1/4, Sec. 36, T.15 N., R.3 E.), about one mile east-northeast of the first exposure.

COCKFIELD FORMATION

The lignitic, argillaceous silts, and silty shales of the Cockfield are well exposed in nearly all of the spring branches along the bluffs in southwestern Holmes County. Good lignite exposures are found at the following localities:

1. In the bed of Whitehead Branch (S.1/2, Sec. 32, T.15 N., R.2 E.) about half a mile above the bridge on the road to a gravel pit and 1.5 miles southeast of Jones Crossing.

2. In the bed of a small unnamed branch (NW.1/4, SW.1/4, Sec. 17, T.14 N., R.1 E.) about 5 miles south-southwest of Howard. There are at least two lignite beds here.

3. In a bluff on the right bank of Harland Creek (near center Sec. 27, T.14 N., R.1 E.) about half a mile above the bridge across that creek on the road from Euology to Taylorsville.

Well-preserved fossil leaves are found in these lignites. Two additional fossil leaf localities were noted:

1. In a bluff on the left bank of an unnamed creek (NW.1/4, SW.1/4, Sec. 17, T.13 N., R.1 E.) about 2.0 miles south-southwest of Coxburg.

2. In the ditch beside the county road (SE.1/4, SW.1/4, Sec. 27, T.15 N., R.1 E.) leading down to the west bank of a small stream flowing into Black Creek and about 1 mile south-southeast of Howard.

A thick quartzitic siltstone development, similar to the quartzitic siltstone of the Kosciusko, is found on the bluffs (NE. ¼, Sec. 3, T.15N., R.1E.), 2.5 miles east-northeast of Tchula and on the south bank of Fannegusha Creek (SE.1/4, Sec. 2, T.15 N., R.1 E.) about 1 mile farther east.

JASPER COUNTY

WAUTUBBEE FORMATION

The Wautubbee retains its tri-partite facies through northeastern Jasper County. The only unusual feature noted is the presence of a six-inch stringer of tan bentonite near the base of the Gordon Creek shale member. This bentonite is well exposed along the county road (SE.1/4, Sec. 27, T.4 N., R.13 E.) about 3 miles east-northeast of the village of Rose Hill.

Good exposures of the Wautubbee beds and good fossil localities for the Archusa marl member are found at the following places.

1. Along the county road (NE.1/4, NW.1/4, Sec. 1, T.4 N., R.12 E.) about 6 miles north-northwest of Rose Hill.

2. Along the county road (NW.1/4, SW.1/4, Sec. 5, T.4 N., R.13 E.) about 5 miles north of Rose Hill.

3. Along the county road (SE.1/4, SE.1/4, Sec. 23, T.4 N., R.13 E.) about 4 miles northeast of Rose Hill.

COCKFIELD FORMATION

Much of the Cockfield outcrop of Jasper County is covered with a veneer of sands containing small lenses of gravels most of which is probably residual after a high-level Citronelle (?) terrace deposit which once covered the area.

LAUDERDALE COUNTY

The Claiborne stratigraphy of Lauderdale County has been covered in some detail by V. M. Foster in Mississippi Geological Survey Bulletin 41. That bulletin should be consulted for described sections and a more detailed map.

TALLAHATTA FORMATION

The Neshoba sand lenses out between the Winona and Basic in the area north of Highway U. S. 80 between Meridian and Chunky. Additional evidence that this member is the stratigraphic equivalent of the upper part of the Basic may be seen at the following localities where stringers of Basic-type shale are found in the Neshoba sand:

1. Along the county road (NW.1/4, SW.1/4, Sec. 26, T.7 N., R.14 E.) about 2 miles south-southwest of Suqualena.

2. Along the county road (NE.1/4, SE.1/4, Sec. 34, T.7 N., R.14 E.) about 3 miles south-southwest of Suqualena.

WINONA GREENSAND

An excellent illustration of the lenticularity of the Winona in eastern Mississippi is shown along Highway U. S. 45 south of Meridian (Profile A). At the crest of the Basic escarpment,

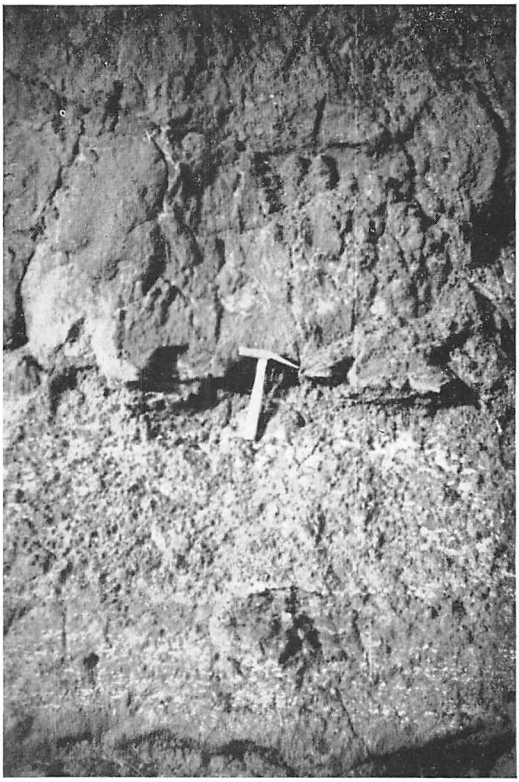


Figure 25.—Massive basal Cockfield sand overlying a lens of shaly glauconitic uppermost Wautubbee sand. Cut on Highway 35, 0.7 mile southeast of Estes Mill, Leake County.

the Winona is composed of 12.5 feet of coarse-grained greensand, whereas down a county road 0.1 mile west of the highway at a point 1.6 miles south, the Winona is composed of 1.0 foot of glauconitic sand at the top underlain by 13.0 feet of cross-bedded iron-stained non-glauconitic sand with clay stringers.

LEAKE COUNTY

WINONA GREENSAND

Fresh Winona fossils were noted in a hard calcareous greensand bed in a cut on the county road (NE.1/4, NE.1/4, Sec. 34, T.11 N., R.9 E.), 2.7 miles south-southwest of the Pearl River bridge at Edinburg.

WAUTUBBEE FORMATION

The best exposure of one of the lenses of marine material lying well above the main body of the Wautubbee is found along highway 35 (Center Sec. 10, T.9 N., R.8 E.) 0.7 mile southeast of Estes Mill. Here a massive sand, basal cockfield, overlies about ten feet of shaly glauconitic sand, uppermost Wautubbee (Figure 25).

COCKFIELD FORMATION

Much of the Cockfield outcrop of southwestern Leake County is covered by a thin veneer of sands and gravels which appear to be residual after a Citronelle (?) blanket which once covered the area.

MADISON COUNTY

Madison County was mapped for the Ohio Oil Company by C. L. Moody and his contacts were transferred to the regional map. A brief reconnaissance in the area by the author revealed no unusual features.

MONTGOMERY COUNTY

Montgomery County has been studied in some detail for the State Geological Survey by Richard R. Priddy and will be covered in a forthcoming bulletin.

NESHOBA COUNTY

TALLAHATTA FORMATION

The type locality of the Neshoba sand member is in southern Neshoba County in a series of road cuts along the highway through the village of Neshoba. In case these cuts are obscured in the future, an alternate type locality may be considered to be along the county road about 1.5 miles southeast of McDonald Station (NE.1/4, NE.1/4, Sec. 12, T.9 N., R.11 E.). Here a full section of 64.0 feet (altimeter) of this sand is exposed.

ZILPHA SHALE

The Zilpha shale exhibits some unusual features in Neshoba County. The discontinuous greensand bed found at the top of the section in central and eastern Mississippi is particularly well

developed in the southern part of the county. Its best exposure is beneath the wooden railroad overpass (NE.1/4, SE.1/4, Sec. 34, T.9 N., R.11 E.) about 2 miles northwest of Union. Here ten to twelve feet of dark greenish gray, lignitic greensand overlies five feet of black blocky clay. In the area around Dixon, several lenses of greensand and glaconitic sand are found well above the main body of the Zilpha. One of these lenses may be seen in the cut (NW.1/4, SE.1/4, Sec. 36, T.10 N., R.10 E.) along the county road 0.5 mile north of the school house at Dixon.

NEWTON COUNTY

TALLAHATTA FORMATION

An unusual feature of the uppermost Wilcox is exposed along the county road (NE.1/4, SW.1/4, Sec. 26, T.8 N., R.13 E.) about 1.5 miles northwest of Duffee. Here the basal pebble-bearing glauconitic sand of the Basic member rests directly on a lens of lignitic, silty shale in the Meridian sand.

There are several good exposures of Basic-type shale stringers in the Neshoba sand in Newton County. In addition to the one shown on Profile C, they are:

1. Along the county road (NW.1/4, SE.1/4, Sec. 21, T.8 N., R.12 E.) about 2.5 miles west of Little Rock. Here two feet of Basic-type shale is found at the top of the Neshoba and is underlain by several feet of glauconitic sand.

2. Along the county road 0.6 mile west of Little Rock.

3. Along the county road (NE.1/4, SE.1/4, Sec. 9, T.7 N., R.13 E.) about 8 miles east-northeast of Decatur. At this locality two stringers of Basic-type shale are found in the Neshoba. One is situated at the top and one is 35.0 feet below the top, the member being 45.0 feet thick (altimeter).

ZILPHA SHALE

The discontinuous greensand bed at the top of the Zilpha may be seen along Highway U. S. 80, 2.3 miles east of the school building at Hickory. The bed is fossiliferous at this locality.

WAUTUBBEE FORMATION

The Gordon Creek shale member contains thin siliceous siltstone beds at many exposures in Newton County. The best de-

Figure 26.—Siliceous siltstones in the uppermost Wautubbee along the county road (NW. 1/4, Sec. 16, T. 7 N., R. 11 E.) near Crossroads Church about 4.0 miles west of Decatur, Newton County.

velopment may be seen along the county road near Crossroads Church (NW.1/4, Sec. 16, T.7 N., R.11 E.) 4 miles west-northwest of Decatur where a five-foot lens of this material is found at the top of the member (Figure 26).

There are numerous good Archusa marl fossil localities in Newton County, the best being:

1. Along the county road (NW.1/4, NW.1/4, Sec. 16, T.5 N., R.13 E.) about 3 miles southeast of Hickory.

2. Along the county road (NE.1/4, NE.1/4, Sec. 16, T.5 N., R.13 E.) about 4 miles southeast of the same place.

3. Along the county road (NW.1/4, SE.1/4, Sec. 2, T.5 N., R.13 E.) about 1.5 miles south-southwest of Chunky.

4. Along the county road (SE.1/4, NW.1/4, Sec. 32, T.5 N., R.13 E.) 6 miles south-southeast of Hickory.

5. Along the county road (SE.1/4, NW.1/4, Sec. 18, T.5 N., R.13 E.) about 3 miles south-southeast of Hickory.

6. Along the county road (NE.1/4, SE.1/4, Sec. 11, T.5 N., R.12 E.) about 2 miles south of Hickory.

COCKFIELD FORMATION

Much of the Cockfield outcrop in Newton County is covered by a veneer of sand and gravel which appear to be residual after a Citronelle (?) blanket which once covered the area.

SCOTT COUNTY

The geology of Scott County has been studied in considerable detail by Harlan R. Bergquist for the State Geological Survey and will be covered in a forthcoming bulletin.

WINSTON COUNTY

The Claiborne beds of Winston County have been described in some detail by Frederic F. Mellen in State Geological Survey Bulletin 38.

YAZOO COUNTY

The geology of Yazoo County has also been covered by State Geological Survey Bulletin 39, by Frederic F. Mellen.

ACKNOWLEDGMENTS

This report, based on field work for the Ohio Oil Company, is made possible through the generosity of the company and the kind interest of Mr. C. L. Moody and Mr. W. B. Emery of its geological staff. Dr. H. N. Fisk has been particularly helpful in checking the field work and criticizing the manuscript. Drs. W. C. Morse, H. V. Howe, R. J. Russell, R. D. Russell, C. J. Roy, and J. M. McGuirt, and Mr. C. L. Moody have all given constructive criticism. Miss Jane Roulston Huggins has ably edited the manuscript.

REFERENCES

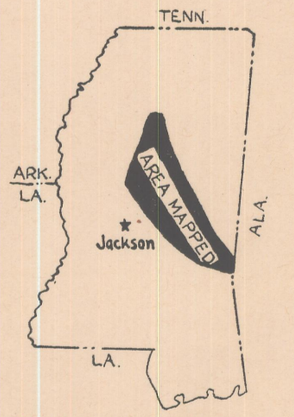
1. Stephenson, L. W., Logan, W. N., and Waring, G. A., The Ground-Water Resources of Mississippi: U. S. Geol. Survey Water-Supply Paper 576, Plate 2, 1928.
2. Wilmarth, M. Grace, Lexicon of geologic names of the United States (including Alaska): U. S. Geol. Survey Bull. 896, pp. 448, 449, 1938.
3. Dall, W. H., A Table of the North American Tertiary horizons, correlated with one another and with those of Western Europe, with annotations: U. S. Geol. Survey 18th Ann. Rept. pt. 2, p. 344, 1898.
4. Lowe, E. N., Mississippi, Its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 14, pp. 74, 75, 1919.
5. Lowe, E. N., Midway and Wilcox groups in Coastal Plain Stratigraphy of Mississippi: Mississippi Geol. Survey Bull. 25, p. 1 and pp. 106-108, 1933.
6. Foster, V. M., Lauderdale County Mineral Resources: Mississippi Geol. Survey Bull. 41, p. 68. 1940.
7. Grim, R. E., The Eocene sediments of Mississippi: Mississippi Geol. Survey Bull. 30, pp. 152, 153, 1936.
8. Fenneman, N. M., Physiography of the Eastern United States, p. 75, 1938.
9. Lowe, E. N., Mississippi, Its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 14, p. 73, 1919.
10. Lowe, E. N., Mississippi, Its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 12, p. 76, 1915.
11. Cooke, C. Wythe, Correlation of the Eocene formations of Mississippi and Alabama: U. S. Geol. Survey Prof. Paper 140-E, p. 135, 1925.
12. Foster, V. M., op. cit., pp. 82-84.
13. Cooke, C. Wythe, op. cit., pp. 135, 136.
14. Loc. cit.
15. Lowe, E. N., Mississippi, Its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 14, pp. 75, 76, 1919.
16. Hilgard, E. W., Report on the Geology and Agriculture of the State of Mississippi: pp. 127, 128, 1860.
17. Lowe, E. N., Mississippi, Its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 12, p. 77, 1915.
18. Stenzel, H. B., The Yegua Problem: Texas Bureau Econ. Geol. Bull. 3945, pp. 847-910, 1939.
19. Vaughn, T. W., The Stratigraphy of Northwestern Louisiana: Amer. Geologist, Vol. 15, p. 220, 1895.
20. Veatch, A. C., The Underground Waters of Northern Louisiana and Southern Arkansas: Louisiana Geol. Survey Bull. 1, pt. 2, p. 89, 1905.
21. Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama Rivers: U. S. Geol. Survey Bull. 43, p. 35, 1887.
22. Op. cit., pp. 29, 30.
23. Cooke, C. Wythe, Equivalence of the Gosport sand to the Moodys marl: Jour. Paleontology, Vol. 13, pp. 337-340, May, 1939.
24. Gardner, Julia, Recent collections of upper Eocene Mollusca from Alabama and Mississippi: Jour. Paleontology, Vol. 13, pp. 340-343, 1939.
25. Stenzel, H. B., The Yegua Problem: Texas Bureau Econ. Geol. Bull. 3945, p. 892, 1939.
26. Blanpied, B. W., and Hazzard, R. T., Correlation of Cockfield and Gosport formations, Eastern Mississippi and Western Alabama: Bull. Amer. Assoc. Petrol. Geol., Vol. 22, p. 310, 1938.
27. Blanpied, B. W., and Hazzard, R. T., op. cit., p. 313.
28. Loc. cit.
29. Fisk, H. N., The Geology of Rapides and Western Avoyelles Parishes: Louisiana Dept. Cons. Geol. Bull. 18, pp. 126, 127, 1940.

LEGEND

TERTIARY – EOCENE
CLAIBORNE

- QUATERNARY DEPOSITS – sand, gravel and loess
- COCKFIELD FM. – 50 to 500 ft. of non-marine sands, silts, shales and clays with lignite, siderite, bentonite, etc.; heterogeneous
- WAUTUBBEE FM. – 5 to 200 ft. of fossiliferous marls, greensands, glauconitic sands and limestones with associated carbonaceous shales, non-glauconitic sands, bentonite, etc.; becomes non-marine northwest of the Yockahockany River
- KOSCIUSKO FM. – 75 to 450 ft. of non-marine sands, silts, shales and clays with quartzitic siltstones, etc.; heterogeneous
- ZILPHA SHALE – 0 to 75 ft. of carbonaceous shale and blocky clay with silt, sand, glauconite, greensand, etc.
- WINONA GREENSAND – 0 to 50 ft. of medium to coarse-grained greensand with fossils, siderite, non-glauconitic sand, etc.
- TALLAHATTA FM. – 50 to 175 ft. of siliceous claystone, siltstone and sandstone, shale, clay, greensand, glauconitic sand, non-glauconitic sand, etc.

— Definite contact
-- Indefinite contact



SKETCH SHOWING REGIONAL POSITION OF AREA MAPPED

PLATE I - GEOLOGICAL MAP OF THE CLAIBORNE OF MISSISSIPPI AS FAR NORTH AS GRENADA COUNTY

GEOLOGY BY PAUL THOMAS

1941

0 8 16
MILES