Geologic Study Along Highway 45 From Tennessee Line to Meridian, Mississippi

DONALD M. KEADY

Prepared in cooperation with the Mississippi State Highway Department

BULLETIN 94

MISSISSIPPI GEOLOGICAL SURVEY
TRACY WALLACE LUSK
DIRECTOR AND STATE GEOLOGIST

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LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey

University, Mississippi

June 29, 1962

Hon. Henry N. Toler, Chairman, and
Members of the Geological Survey Board

Gentlemen:

Herewith is Mississippi Geological Survey Bulletin 94, Geologic Study Along Highway 45 From Tennessee Line to Meridian, Mississippi, by Donald M. Keady.

A pressing need for prompt information along the southernmost part of this study area was the deciding factor in the selection of a highway for geologic investigation. This series of reports began in the summer of 1959 and has continued each succeeding summer—this being the third published bulletin.

The author follows closely the pattern previously set, in that he describes in detail the geologic units that crop out along the route and points to specific locations for obtaining suitable topping material. He also describes the structural and geomorphic features exhibited.

The writer has properly acknowledged the personnel of the Mississippi State Highway Department for their cooperation, nevertheless, it is fitting that these men be recognized here—Mr. T. C. Robbins, Director of the Highway Department, Mr. H. O. Thompson, Chief Testing Engineer, and Mr. Clyde Clark, Highway Department Geologist.

Respectfully submitted,

Tracy W. Lusk
Director and State Geologist

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GEOLOGIC STUDY ALONG HIGHWAY 45 FROM TENNESSEE LINE TO MERIDIAN, MISSISSIPPI

DONALD M. KEADY

ABSTRACT

A geologic study along U. S. Highway 45 from the Tennessee Line to Meridian, Mississippi is presented for the benefit of the Highway engineer and the geologist. Geomorphology, stratigraphy, and structure are illustrated on geologic highway profiles for the 204 mile segment of highway. Many directional changes of the highway coupled with changes in dip and strike of the underlying beds provide an opportunity to show geologic conditions for strike-line, oblique-line, and dip-line highways.

Topographic subdivisions of the area involved are the Tennessee-Tombigbee Hills, the Black Prairies, the Flatwoods, and the North Central Hills.

Stratigraphic units crossed partially or completely include upper Cretaceous (Gulfian): upper Eutaw, upper Coffee, Mooreville, Demopolis, Ripley, and Prairie Bluff formations; Paleocene Midway: Clayton, Porters Creek, and Naheola formations; and Eocene Wilcox: Nanafalia, Tuscahoma, and lower Hatchetigbee formations. Quaternary deposits are not treated in detail, but those deposits that effectively mask bedrock are delineated approximately.

Structural attitude of bedrock units ranges from a strike of N 10° E and a dip of 30 feet per mile westerly in Alcorn County to a strike of N 45° W and dips of 30 to 45 feet per mile southwesterly in Lauderdale County. Four local structural anomalies are pointed out. Two of these suggest faulting, and the other two probably involve large-scale slump.

Geologic units offering sources for road-building materials are the Eutaw, Coffee, Naheola, Nanafalia, Tuscahoma, and Hatchetigbee formations, and Quaternary deposits. Foundation capabilities of certain units are assessed where highway stability can be related to bedrock.

INTRODUCTION

The geologic study along U. S. Highway 45 from the Tennessee line to Meridian, Mississippi is the third in a series of highway profile studies made possible by a cooperative agreement between the Mississippi Geological Survey and the Mississippi State Highway Department. This report is the result of investigations conducted along 204 miles of Highway 45. Throughout the length of the route, there are many variations between the direction of the Highway and the strike of the underlying beds, and a number of stratigraphic units are crossed —some several times. Also, there is considerable diversity of the surficial Quaternary deposits. These complexities have required a modification of the previously established manner of presentation and the introduction of new terminology. However, throughout the report the writer has made a special effort to present the geology in an acceptable form for use by both the geologist and the engineer.

Highway 45 is the principal north-south highway in eastern Mississippi, connecting Corinth, Booneville, Tupelo, Aberdeen, Columbus, Macon, Meridian, Quitman, and Waynesboro. A branch of the Highway, Highway 45-W, from Shannon (south of Tupelo) to Brooksville (north of Macon) provides a bypass around Aberdeen and Columbus and includes Okolona and West Point in the system. Highway 45-W was not studied during this investigation. Figure 1 shows the routes of Highways 45 and 45-W.

A large volume of traffic is carried by Highway 45, especially near the larger cities where it is considerably above normal. Segments of the route serve as a connecting link between Memphis, Tennessee and Mobile, Alabama; hence, at least part of the Highway carries a large load of heavy trucking. The demands on the Highway have exceeded its capacity along the older portions and in the areas of above normal traffic. Consequently, modernization is dictated along many parts of the route. It is hoped that the information contained in this report will be of considerable value to the highway engineer in planning new portions of the route.

PREVIOUS INVESTIGATIONS

Numerous geologic investigations have been published that deal with parts of northeastern Mississippi some of which include geology along segments of Highway 45. However, the references pertinent to this study were selected on the bases of the appli-

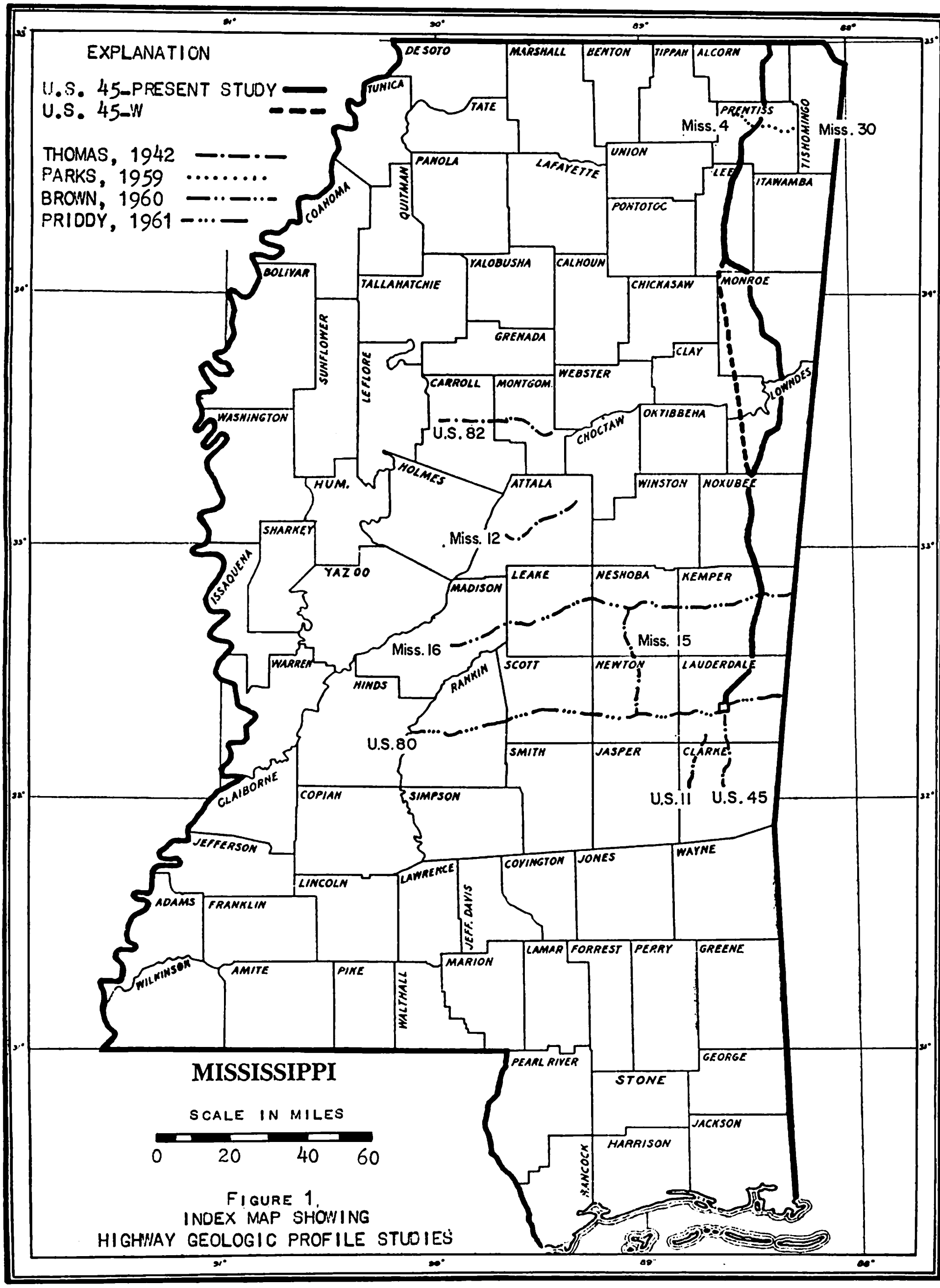

Figure 1,
INDEX MAP SHOWING
HIGHWAY GEOLOGIC PROFILE STUDIES

cability of the report to engineering studies, the usability of the report by the engineer, and the availability of the report. Each of the reports cited contains other references pertaining to the details of the area covered.

Figure 1, which shows the routes of Highways 45 and 45-W, also shows the location of other profile studies along Mississippi highways. The two previous geologic profile studies in this series — Mississippi Highway 16 from the Alabama line to Canton, Mississippi by Brown (1960) and U. S. Highway 80 from the Alabama line to Jackson, Mississippi by Priddy (1961) — have not only added to the existing knowledge of the surface geology of the State but have also developed methods and principles for presenting the results of geologic investigations along highways in a form suitable for highway engineering studies. Both reports were used as guides in the preparation of the present report. Mississippi Highway 16 crosses Highway 45 at Scooba, and Highway 80 crosses Highway 45 at Meridian. The intersection of Highway 45 with Highway 80 is used as the southern termination for this study.

The other profile studies shown on Figure 1 were used as illustrations in geologic reports. Thomas (1942) in his study of the Claiborne group in Mississippi included geologic profiles illustrating Claiborne beds that crop out along Highways 45, 11, 15, 12, and 82 — the first two profiles provide an extension to the present study south of Meridian. Parks (1960) in his study of the geology of Prentiss County made a geologic profile along parts of Mississippi Highways 4 and 30, which cross Highway 45 at Booneville.

Geologic reports for counties through which Highway 45 passes are available for Prentiss (Parks, 1960), Lee (Vestal, 1946), Monroe (Vestal and McCutcheon, 1943), Kemper (Hughes, 1958), and Lauderdale (Foster and McCutcheon, 1940). These reports contain details of the geology within each county and provide large scale geologic maps.

Regional reports include: (1) the study of the Upper Cretaceous deposits of Mississippi by Stephenson and Monroe (1940), which is a basic reference for the Cretaceous of Mississippi; (2) a study of Cretaceous shelf sediments by Mellen (1959), which is largely a subsurface study but deals with stratigraphic and nomenclatural problems in the Cretaceous of north Mississippi and presents the results of analyses of samples from the Demopolis and Coffee formations and an extensive bibliography of literature on the Cretaceous; and (3) a report by MacNeil (1946) concerning the Midway and Wilcox groups, which provides correlations between the Alabama type sections and the Mississippi deposits. Three publications of the Mississippi Geological Society that were used are: (1) the Geologic Map of Mississippi (1945); (2) Eighth Field Trip Guidebook, Cretaceous of Mississippi and South Tennessee (1950); and (3) Fourteenth Field Trip Guidebook, Upper Cretaceous of Northeast Mississippi and West Central Alabama (1959).

PURPOSE OF INVESTIGATION

The purpose of the investigation is to study the geology along Highway 45 in order to present the information in a manner suitable for use by the highway engineer. The highway geologic profile provides a base for studies designed to show the relationships between present highway conditions and the underlying geology. It also provides a guide for study in areas away from the right-of-way of the various geologic units which crop out along the highway. Such studies have value in helping to locate road-building materials and in planning new sections of Highway 45 or highways nearby.

A result of this study is the continued development of the techniques and the terminology for highway geologic studies begun by Brown (1960) and Priddy (1961). Each subsequent report should cumulate and refine the previous methods with the addition of new ideas. Eventually, standardization of profiling procedures may be accomplished.

This type of report provides an outlet for certain geologic findings that might not be published elsewhere. A large amount of data useful to the geologist may be found in the files of the Highway Department. Much of this information is valuable in preparing geologic reports. Data available include sedimentary analyses of select materials, soil borings along the profile center line, and bridge site borings. Other studies from which findings are utilized includes theses, special problems, and individual research projects. Most of these sources of information are not comprehensive enough to be published singly, but the material contained in them can be incorporated in other reports and are thus made available in published form.

This study adds to the geologic knowledge of the State, preserving valuable data which will be virtually lost when many of the numerous highway cuts are sodded. The geology of a number of areas through which Highway 45 passes has been studied by geologists in varying detail. The stratigraphy of the present report relies heavily on previous studies, but it is important as a continuous cross section of the geology along a 204 mile portion of the State.

METHODS

The highway geologic profile studies by Brown (1960) and Priddy (1961) have led to a more formalized manner of presentation of highway geologic reports. Prior to these studies highway profiles were used to illustrate geology along highways in cross-section or for elevation control in surface mapping, but none of the presentations dealt specifically with the geology along lengthy segments of a highway.

The geology along Highway 45 was studied using geologic field methods, and the results of the study presented in "Cross Section" form on a profile of the highway. In the field, exposed stratigraphic sections were measured, described, and located on large scale plan-profiles of the highway. The plan-profiles, furnished by the Highway Department, were half normal size with a horizontal scale of 1″=200′ and a vertical scale of 1″=20′, a vertical exaggeration of 10. Because most of the exposed stratigraphic sections were found in road cuts or ditches, it was found advantageous to make notes directly on the plan-profiles. On each individual sheet there was ample room to plot the stratigraphy, to sketch outcrops on the profiles, and to make other notations on the blank facing page. Because of the large scale of the plan-profiles and the short segments of each highway project, it was necessary to transfer the data to smaller scale profiles so that gaps between geologic observations could be detected. In these cases, areas some distance from the right-of-way were studied, and the information obtained plotted on county road maps or topographic quadrangles, where available. These data were transferred to the small scale profile by projection. To supplement surface observations, twenty-one test holes were drilled with a power auger, furnished by the Highway Department. Considerable difficulty was experienced in drilling many of the holes. The presence of water-bearing strata was a particular hazzard, because the auger would not bring up samples below such beds. In such cases only the general lithology (sand or clay) could be estimated by the driller by the way the auger reacted. Another difficulty was that the auger could not penetrate "hard streaks", thus a limit was placed on the depth of some holes.

The final profiles were constructed following a procedure outlined by Priddy (1961). Each of the highway plan-profiles was redrafted with a horizontal scale of 1″=5,000′ and a vertical scale of 1″=50′, a vertical exaggeration of 100. The individual projects were then joined to form a continuous profile of the highway.

The horizontal scale was chosen for convenience in plotting on standard 10 x 10 cross-section paper. The horizontal distance between each solid line represents 5,000 feet and the small divisions 500 feet (very nearly 1″=1 mile). To show highway direction, a strip map is provided by using official county highway maps with a scale of 1″=1 mile. For each project the corresponding segment was cut from the highway map and centered over the project on the profile. The slight difference in scales causes the strip to be broken. In a few cases the direction of the highway was such that an individual part of the strip map is upside down, but for later comparison with a county map and in order to preserve continuity of the strip, these were left as is. Two horizontal scales are provided — one in feet and the other in miles. For each plan-profile the survey stations are shown at the beginning and at the end of the project, and multiples of 5,000 feet are shown between. The scale in miles is continuous along the profile, with zero starting points at the Tennessee line and at Meridian, Mississippi. Throughout the report mileage will refer to distance from the Tennessee line. Land marks along the highway are shown between the strip map and the profile for easy comparison with both.

The vertical scale was chosen to provide enough vertical space to plot stratigraphic units. The vertical distance between solid lines is 50 feet and each small division represents 5 feet.

Elevations above mean sea level are provided. The resulting vertical exaggeration of 100 is rather large, but relief is sharpened, and many subtle landforms become clear.

All geologic observations were plotted on the final profile form and interpretations were made to provide stratigraphic continuity. Nearly all the subsurface geology shown on the profiles was extended by projection, and much inference was required; therefore, the subsurface geology may be considerably in error where good control was lacking. The completed plates were reduced to approximately ¾ size for inclusion in the report.

Due to the extreme length of the complete profile along with the diversity of geology and the many directional changes in the highway, the final presentation is made in four segments, each with a central theme.

Plate 1 extends from the Tennessee Line to Verona, Mississippi. Highway 45 along this segment essentially follows the strike of the underlying beds and closely parallels the contact between the Coffee sand and the Demopolis formation. As a result of these conditions portions of only two bedrock units were observed. However, a facies change in the upper part of the Coffee sand (Tupelo tongue) and the Demopolis formation in the vicinity of Tupelo, Mississippi is shown in strike direction.

Plate 2 extends from Verona, Mississippi to Columbus, Mississippi and involves bedrock units of Cretaceous age, ranging from the upper part of the Eutaw formation to the lower part of the Demopolis formation, and Quaternary alluvium and terrace deposits associated with the Tombigbee River and its tributaries. Throughout most of the segment, the highway cuts across the bedrock units obliquely.

Plate 3 extends from Columbus, Mississippi to Kemper County and shows an unbroken sequence of Cretaceous beds from the upper Eutaw (Tombigbee sand member) through the Prairie Bluff formation. The highway crosses these beds obliquely in the northern part of the segment, but in the southern part the highway direction begins to coincide with the dip direction. Because of the repetition of stratigraphic units in Plates 2 and 3, the geology of the two profiles is treated singly. Some comparison can be made of the facies changes in the formations along strike.

Plate 4 extends from southern Noxubee County to Meridian, Mississippi and shows lower Tertiary deposits of the Midway and Wilcox groups. The direction of the highway very nearly coincides with the direction of dip of the underlying beds.

GEOLOGY AND HIGHWAY ENGINEERING

The growth of Engineering Geology and its subdivision, Highway Geologic Engineering has been ably summarized by George A. Kiersch, 1955, in a Quarterly of the Colorado School of Mines entitled "Engineering Geology, Historical Development, Scope, and Utilization." The development of Highway Engineering naturally followed the emphasis on better transportation routes as the automotive field advanced, but the use of geology in highway engineering practice lagged behind considerably.

The role of the geologist and the part that geology has played in modern highway engineering has been discussed at length by Woods (1942), Huntting (1943, 1944, 1945), Crosby, et al, (1944), Bean (1950), and Horner and McNeal (1950). Modern engineering geology textbooks treat in some detail the problems in which a knowledge of geology can aid the highway engineer.

Horner and McNeal (1950) in discussing the use of geology by the Kansas Highway Department suggest specific problems in which geology can be utilized by the engineer. These problems are grouped under specific functions of the geological department of the Highway Department and include: (1) location studies, (2) road design, (3) bridge design, and (4) location and study of road materials. Other functions listed include: (1) maintenance, (2) right-of-way and legal department, (3) soil mechanics, (4) research, and (5) special applications. The problems and functions will vary among different states, because the geology varies from state to state, nevertheless, many of the principles learned in one area may be readily applied to others.

The fact that highway engineering geology has come of age since World War II is evidenced by the number of publications in this field. Especially important is the series of symposiums on geology as applied to highway engineering, which have been held annually since 1950. Approximately 100 papers have been presented and many of these have been published as articles or abstracts in proceedings.

Nearly all discussions of the use of geology in highway engineering, whether written by engineer or geologist, stress the difference in training between the engineer and the geologist, and how the approach to a problem differs. Seldom does the geologist have the engineering training nor the engineer the geological training necessary to cope with all phases of problems that may arise; hence, close cooperation is suggested with each realizing the limitations and purposes of the other.

Throughout this report a number of problems of varying magnitude along the lines for research are suggested. Many of the problems require close coordination between engineer and geologist, whereas others lean heavily to one side or the other.

ACKNOWLEDGEMENTS

The writer is indebted to Tracy W. Lusk, Director of the Survey, for supervision, suggestions, and field conferences. Thanks are also due to Dr. R. R. Priddy, Millsaps College, for many helpful suggestions and field conferences. Also, Dr. B. W. Brown, University of Southern Mississippi, for discussions concerning geologic highway profile studies.

The writer is also indebted to many members of the Mississippi State Highway Department. Mr. H. O. Thompson, Chief Testing Engineer, and Mr. F. A. Lossing, Assistant Testing Engineer, were both highly cooperative in providing highway profiles, transportation, and numerous suggestions from the highway engineer's viewpoint. Thanks are due to Mr. W. E. Sneed, 5th District Testing Engineer, and Mr. L. G. Summerford, 1st District Testing Engineer, for helpful discussions and for making possible test hole drilling in their respective districts.

Finally, the writer wishes to express thanks to Mr. Ernest E. Russell, Mississippi State University, for many helpful suggestions and field conferences and to Mr. Ernest Boswell, U. S. Geological Survey, Grand-Water Branch, and Prof. R. J. Hughes, University of Mississippi, for discussions of certain problems in the Midway and Wilcox groups in Kemper and Lauderdale Counties.

GENERAL GEOLOGY

The general geology of northeast Mississippi has been well described, and only the major features of geomorphology, stratigraphy, and structure are presented in this section. From each branch certain principles which may be applied to highway engineering are pointed out.

GEOMORPHOLOGY

Geomorphology in this report refers primarily to the topographic surface that has been developed through geologic processes. The surface configuration of the earth is a product of (1) structure, which includes the type of underlying rocks and their attitude with respect to the surface, (2) process, which includes the geologic agents and processes that have modified structure, and (3) stage of development, which is a relative measure of the time through which the geologic agents and processes have acted. The present topographic surface is largely a product of Quaternary times, and the effects of Pleistocene glaciation have been very important even in areas far removed from direct glacial activity. Changes in sea level have occurred with resultant effect on base level, and stream regimens have changed greatly through variations in load and capacity.

Applied geomorphology has made notable advances in aiding the highway engineer. The study of topography and the causes for the development of relief in a region can help create an understanding of the landslide problem. Stable slopes may no longer be in equilibrium after deep cuts are made through them, and a study of slope stability will aid in planning cuts. The search for select materials can be more efficient if the relationship between desired material and the topographic expression of the material is analyzed. For instance, terrace deposits often yield satisfactory road-building material for a local area, and other similar deposits may be found in related terraces. Hence, the recognition of the individual terraces in the valley system can narrow the search considerably.

The gross aspects of the geomorphology of Mississippi have been described by many writers. Nearly all the state lies within the Gulf Coastal Plain Province, and within the state there are ten topographic divisions, each of which forms a more or less homogeneous region. Highway 45 from the Tennessee line to Meridian crosses four of these divisions — the Tennessee-Tombigbee Hills, the Black Prairie, the Flatwoods, and the North Central Hills.

The Tennessee-Tombigbee Hills is a maturely dissected highland in the northeastern part of the state. The region is underlain by sands, clays, and some gravels of the Tuscaloosa, Eutaw, and Coffee formations. A dissected cuesta system is developed with steep faces toward the north and east. Highway 45 follows the western edge of this division.

The Black Prairie borders the Tennessee-Tombigbee Hills on the west, and is underlain by chalks and marls of the Selma group. The terrane is undulating with low relief, broad valleys, and low broad divides. In northern Mississippi the chalk belt narrows and the topography formed on the chalk becomes somewhat sharper, and prairie features are less common. The highway follows the eastern edge of the Black Prairie to Shannon then crosses the lower part to Aberdeen. From Columbus to northern Kemper County the highway crosses the entire division.

Bordering the Black Prairie (along Highway 45) is a narrow, relatively low strip known as the Flatwoods, which is underlain by the Porters Creek clay. The region is characterized by little relief, broad stream valleys, and low poorly defined divides. Near the western edge of the Flatwoods the relief becomes greater, probably due to a change in the lithology of the Porters Creek to laminated sands and clays. Part of the greater relief may also be due to protective capping by overlying sands of the Naheola and Wilcox. The highway crosses the Flatwoods in Kemper County.

The North Central Hills border the Flatwoods on the south and west. These hills are a series of highly dissected cuestas. The underlying beds are chiefly sands and clays of the upper Midway, Wilcox, and Claiborne groups. Generally the clays erode to form flat, level surfaces; whereas the sands maintain considerable relief, and commonly the ridges are underlain by sand and the valleys are developed on clays. The highway enters the North Central Hills in southern Kemper County and remains in this division to Meridian, Lauderdale County.

Within each geomorphic division there are many local irregularities and deviations from the general description. Each stream adds its own development to the surface, and alluvial and terrace deposits modify greatly the surface that would be developed on bedrock alone. Furthermore, variations in lithology in the bedrock will produce local features not sufficiently distinctive to be classed as separate geomorphic divisions.

STRATIGRAPHY

Stratigraphy is the branch of geology which treats of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust; it is also the part of the descriptive geology of an area or district which pertains to the discrimination, character, thickness, sequence, age, and correlation of the rocks of the district. (AGI Glossary, 1960).

The stratigraphic report gives information concerning type of bedrock and distribution of stratigraphic units, generally presented on a geologic map. Most geologic maps are not sufficiently detailed for the engineer in planning phases of a project, but are of value in preliminary studies. Priddy (1962) lists some engineering applications of stratigraphy as follows:

1. Determination of causes of subgrade failure of existing roads.
2. Selection of fill material.
3. Calculation of cut depths and cut slopes.
4. Stepping of deep cuts.
5. Selection of bridge types.

The major stratigraphic units along Highway 45 include beds of upper Cretaceous, lower Tertiary, and Quaternary ages. The generalized stratigraphic column for the area is given in Figure 2, which shows stratigraphic relations, descriptions, and thicknesses of units. Presently accepted stratigraphic terminology is used, and discussions on various stratigraphic problems have been held to a minimum. Lithologic terminology has been kept as simple as possible and no ambiguous terms have been used, with the exception of the term marl. In this report, marl refers to a sedimentary rock, intermediate between a calcareous clay and chalk, containing from 25 to 75 percent calcium carbonate, with the remaining fraction composed of clay, silt, and sand in varying percentages — clay is dominant among the clastic portions. The term marl has also been used in previous reports to describe glauconitic sands containing fairly large amounts of calcium car-

Figure 2

Generalized Section of Geologic Units along U. S. Highway 45 From Tennessee Line to Meridian, Mississippi

Era	System	Series	Group	Stratigraphic Units	Lithologic Character	Thickness (feet)
Cenozoic	Quaternary	Recent		Alluvium	Variable deposits of sand, silt, clay, and some gravel.	0-60
				Silt-loam	Tan to reddish-brown silty clays—form mantle in Alcorn and northern Prentiss Counties. Thin loess (?).	0-25
		Pleistocene—?—		Terrace deposits	Variable deposits of sand, silt, clay, and some gravel. Remnants of older alluvial deposits.	0-35
	Tertiary	Eocene	Wilcox	Hatchetigbee Formation Bashi Member	Interbedded gray and tan clay and silt; bluish-gray, fossiliferous, glauconitic, fine-grained sand and greensand marl—locally indurated forming marlstone boulders.	45 incomplete
				Tuscahoma Formation	Bluish-gray, micaceous, fine-grained sand and light-gray clayey silt; dark-brown to black lignitic clay and lignite; gray, fine-grained sand, brown to gray lignitic clay, lignite; light-gray silt and silty clay.	230
				Nanafalia Formation	Interlensed and interbedded buff, cross-bedded, micaceous, fine-grained sand; gray plastic clay; lignite; laminated sand, silt, and clay.	230?
				Fearn Springs Member	Gray and tan, fine-grained sand, coarse grains at base; tan and gray, micaceous silt and clay.	65
		Paleocene	Midway	Naheola Formation	Bluish-gray, carbonaceous, laminated clay; tan, micaceous, cross-bedded, fine- to medium-grained sand; lignite.	75
				Matthews Landing Member	Green to dark-gray, clayey, fossiliferous greensand marl, weathers reddish-brown.	5-13
				Porters Creek Formation	Dark-gray to black, blocky clay, conchoidal fracture, weathers light-gray; base slightly calcareous; upper 30-40 feet laminated clay and sand, siderite nodules common.	515
				Clayton Formation	White to tan, sandy, fossiliferous, impure chalk; local sand and sandstone lenses at base.	27

Mesozoic	Cretaceous	Gulfian	Selma	Prairie Bluff Formation	Bluish-gray, dense, massive, sandy glauconitic, fossiliferous chalk, weathers white; contains marcasite concretions and phosphatic nodules.	40-60?
				Ripley Formation	Bluish-gray, sandy, glauconitic, fossiliferous marl and calcareous clay, weathers tan; irregular bedded appearance.	28
				Demopolis Formation: Bluffport Member	Bluish-gray fossiliferous marl, weathers buff to tan; oyster reefs common near base.	55
				Demopolis Formation	Bluish-gray, fossiliferous, dense, brittle chalk, weathers white; impure chalk and marl; oyster reefs numerous; joints common; lower portion grades northward into Tupelo tongue of Coffee formation.	392
				Tupelo Tongue, Coffee Formation	Gray, calcareous, glauconitic, micaceous, fossiliferous, fine- to medium-grained sand grading northward into tan and bluish-gray, glauconitic, fine- to medium-grained sand; dark-gray, micaceous silt; interbeds of dark-gray clay and lignitic clay.	50 incomplete
				Mooreville Formation: Arcola Member	Buff, dense limestone; several beds in some localities; not present in Coffee formation.	1+
				Mooreville Formation	Bluish-gray, sandy, fossiliferous marl and calcareous clay, weathers buff to tan; oyster reefs near base; grades northward into Coffee formation.	160-230
				Eutaw Formation: Tombigbee Member	Gray to greenish-gray, glauconitic, massive, fossiliferous, fine-grained sand, weathers light-gray and orange-red; oyster reefs near top; contains lignitized plant fragments.	100 (200?)
				Eutaw Formation	Gray to greenish-gray, glauconitic, micaceous, fine- to medium-grained sand, weathers to various shades of red; interbedded dark-gray clay.	incomplete

bonate, and in this report the terms greensand marl and greensand will be used for these sediments.

Throughout northeast Mississippi, the Cretaceous and Tertiary beds crop out in an arcuate pattern with a broad, belted, homoclinal arrangement. Further discussion of attitude follows in the chapter concerning general structure. The distribution of these beds is fairly predictable using principles of stratigraphy and structure. Such predictability can be used to advantage by the highway engineer.

Deposits of Quaternary age are represented by terrace deposits, loess (?), alluvium, colluvium, residuum, and soil. These Quaternary deposits are complex, requiring special methods of study, but are of importance to highway engineering studies, because these surficial sediments mantle most of the surface, often completely masking bedrock. In this study gross relationships of the Quaternary deposits are shown but with limited accuracy. These deposits require intensive local study, because of the wide variations.

STRUCTURE

Structural geology is the study of the structural (as opposed to the compositional) features of rocks, of the geographic distribution of the features and their causes. Structure is the sum total of the structural features of an area. (AGI Glossary, 1960).

The structural features of the Gulf Coastal Plain of particular importance to the highway engineer are dip and strike, thickness of beds, bedding, shape and size of beds, unconformities, jointing, faulting, and folding.

Jointing, faulting, and folding involve deformation of rocks by rupture or flexure. These structures are few in number along Highway 45; hence, they present few problems. Joints are common in the brittle chalks of the Demopolis formation, and in deep cuts may present a problem by slumpage of large blocks. The faults and folds along the highway are minor.

Unconformities, shape and size of beds, bedding, and thickness are customarily treated in the stratigraphic description of units. Thickness is of particular significance because it is a factor in determining the width of an outcrop belt.

Dip and strike are measurements that describe the attitude of a bed with respect to the surface. These measurements along with thickness and topography can be used to estimate the exposures of a unit at the surface. In cases where thickness and topography are not highly variable, dip and strike alone can be used to predict approximately the type of bedrock under a given segment of highway, and changes in bedrock that will be effected along the highway. Brown (1960) coined the terms Strike-Line Highway and Dip-Line Highway to describe the relationship between the direction of a highway and the dip and strike of the underlying beds. These terms are very useful for describing bedrock-highway directional relationship, but are somewhat restricted due to the fact that dip and strike are rigorously defined and seldom does the direction of the highway coincide with either dip or strike. Hence, terms are needed to describe general conditions.

The terms Strike-Line Highway and Dip-Line Highway are retained with slight modification of the original definition. Limits of an amount of deviation of the highway direction from either the dip or strike are used, thus broadening the terms. The term Oblique-Line Highway is proposed for the intermediate conditions. The three categories approximately describe the apparent dip of the beds beneath the highway.

A Strike-Line Highway is defined as a highway with a direction within 6 degrees of the direction of strike of the underlying beds, and a Dip-Line Highway is defined as a highway with a direction within 25 degrees of the direction of true dip. An Oblique-Line Highway is defined as a highway with a direction between the above limits. Based on the above definitions the apparent dip of beds beneath a strike-line highway is less than 10 percent (approximately) of the true dip; beds beneath a dip-line highway lie within 10 percent (approximately) of the true dip; apparent dip of beds under oblique-line highways vary between 10 percent and 90 percent of true dip.

Numerous examples and the use of these terms can be cited along Highway 45 due to the many variations in both highway direction and the dip and strike of the bed rock units crossed. The regional strike of beds crossed by Highway 45 is about N 10° E in Alcorn and northern Prentiss Counties; due North in southern Prentiss, Lee, and northern Monroe Counties; N 20° W in southern Monroe and northern Lowndes Counties; N 20° W in southern Lowndes County; N 30° W in Noxubee County; and N 45° W in Kemper and Lauderdale Counties. Corresponding dips of the beds range from approximately 30 feet per mile in the northern part of the area to approximately 45 feet per mile in the southern part in westerly and southwesterly directions. The variations in highway direction are shown in Figure 1.

PLATE 1, TENNESSEE LINE TO VERONA, MISSISSIPPI

The highway geologic profile shown on Plate 1 is unique in that the entire length of Highway 45 from the Tennessee line to Verona, Mississippi is nearly a strike-line highway. The profile demonstrates a number of characteristics of highway-geologic conditions along strike-line and low oblique-line highways. Although the underlying beds are not the oldest exposed along the highway, this segment is treated first because it is unique.

GEOMORPHOLOGY

The geomorphic features shown on Plate 1 include parts of the Tennessee-Tombigbee Hills and the Black Prairies, and the local topographic development of each along the highway. The profile shows most valley cross-profiles at or near right angles, so that interpretation of dissection by obsequent and resequent streams can be made—these would not be shown on a dip-line profile.

From the Tennessee line (mile 0.0) to Booneville (mile 24.8) the highway is in the drainage basin of the Tuscumbia River, one of the few major streams flowing northward out of Mississippi. The highway crosses the Tuscumbia River at mile 9.2. North of this point valley development of the tributaries is not shown well because from the Tennessee line to Corinth the highway follows a ridge between two tributaries, and south of Corinth the highway crosses only a small part of the north valley wall. The tributary valleys south of the intersection of the Tuscumbia and the highway are shown in cross-profile. Each stream flows easterly across the Black Prairie, and each has cut a wide asymmetrical valley. The streams migrate southerly creating a steep wall on the south side of the valley, generally expossing bedrock. The north side of the valley slopes gently and is usually covered by terrace deposits, which are remnants of alluvium from previous valley fillings. Each tributary steps up toward the divide at Booneville.

Maximum relief in the Tuscumbia drainage basin along Highway 45 is about 145 feet (difference in elevation between Booneville, 545 feet and the valley floor of the Tuscumbia, 400 feet) developed over a distance of 15.6 miles. Relief in the individual tributary valleys is about 70 feet, concentrated on the south valley walls. Throughout this area the valley development shown is in Demopolis chalk, floored by Coffee sands. In most valley bottoms the streams have cut into Coffee sand, but alluvium has formed an extensive cover over the sands.

South of Booneville the topographic features are mainly in the extreme western edge of the Tennessee-Tombigbee Hills. The streams are tributaries of the Tombigbee River system. Elevations decrease steadily from Booneville, 545 feet, to near Tupelo. Lowest elevations are north and south of Tupelo in Town (mile 51.4) and Kings (mile 54.3) Creeks, 265 feet (maximum relief 281 feet). Individual valley relief is from 50 feet to 70 feet and again a distinct tendency for the streams to migrate southward is evident.

In general, it appears that individual divides formed on the chalk are somewhat sharper than the divides formed on the sands. In places the dissection of the chalk appears serrate, but much of this appearance is due to the high vertical exaggeration of the profile.

STRATIGRAPHY

The strike-line nature of Highway 45 shown on Plate 1 is such that only two major bedrock units are exposed along the highway—the Coffee formation (containing the Tupelo tongue) and the Demopolis formation. The level of the highway is never more than about 75 feet above or 50 feet below the contact between the two units; thus only parts of the two formations can be observed along the highway.

SELMA GROUP

The Coffee and Demopolis formations are contained within the Selma group, but discussion of the Selma is deferred to the section explaining the stratigraphy of Plates 2 and 3, where an entire section of Selma is crossed by the highway. A number of stratigraphic problems are evident in northern Mississippi due to changes in facies of certain formations along strike. Equivalent formations in Alabama and in Tennessee when traced into Mississippi merge and change their lithologic character. The Coffee formation and its equivalents provide an excellent example. In Alabama and part of Mississippi the Selma group contains the Mooreville, Demopolis, Ripley, and Prairie Bluff formations, all characterized by carbonate facies—chalks and marls. Traced northward along strike in Mississippi the Mooreville and the lower part of the Demopolis merge into sand facies of the Coffee about the latitude of southern Lee County. The upper part of the Demopolis retains its carbonate character and can be traced into Tennessee.

COFFEE FORMATION

The Coffee formation is composed chiefly of sand, with subordinate amounts of silt and clay, and crops out in Alcorn, Prentiss, and Lee Counties. Highway 45 follows closely the western edge of the outcrop belt from the Tennessee line to Verona.

From the Tennessee line to Booneville the Coffee is the bedrock beneath the highway only in the deeper valleys. In these areas, however, the Coffee is covered by alluvium. Drill Holes 1, 2, 3, 4, and 5 were augered to determine the Demopolis-Coffee contact. The logs show the character of the upper part of the Coffee. In the drill holes, the uppermost part of the Coffee consists of fine- to medium-grained sands that are glauconitic, sparingly fossiliferous, gray to bluish-gray to brown in color, and are generally water-bearing. In most cases the exact break between the Demopolis and the Coffee is difficult to distinguish, inasmuch as the contact lies in a zone which is a sequence of marl, sandy marl, marly sand, and finally sand.

From Booneville to Frankstown (mile 31) the highway slopes into the upper 50 feet of the Coffee, but few unweathered outcrops are exposed. At mile 25.1 dark-gray to brown, lignitic clays are exposed in a gully east of the highway, and at mile 26.7 there is an exposure of fine- to medium-grained sand with interbeds of gray silt and dark-gray clay. Other exposures are deeply weathered. At mile 30.7 a road cut in the south valley wall of Twentymile Creek provides a section of Coffee and Demopolis;

however, this cut is old and is overgrown with kudzu. A photograph of the cut taken in 1936 has been published by Mellen (1958, p. 27). At that time the cut was fresh, and the photo shows prominent cross-bedding in the Coffee sands. In Frankstown the nature of the entire Coffee formation has been determined by Parks (1960, p. 95) who drilled a test hole at mile 31.1. The total thickness of the Coffee at this location is 288 feet, but only the upper part of his log is shown on the profile.

Through southern Prentiss County and northern Lee County exposures of the Coffee are numerous, but are generally weathered deeply to a reddish-brown color. In some of the deeper road cuts and nearby sand pits less weathered Coffee can be observed. At mile 45.8, a sand pit just west of the highway exposes about 20 feet of sand, medium- to fine-grained, tan to buff, glauconitic, massive, slightly micaceous, containing lignite fragments, clay blebs, and fossils preserved as clay or prints in the sand. The fresh sand is overlain by reddish-brown, weathered Coffee sand.

In the northern outskirts of Tupelo, mile 51.5, deep road cuts were made into the Coffee, but these exposures are old, weathered, and covered by overgrowth. A photograph of the fresh cut is shown by Vestal (1946, p. 51).

Tupelo tongue.—Within the city of Tupelo, the sands of the Coffee begin to merge with impure chalks of the Demopolis formation, resulting in a distinctive lithology, which has been termed the Tupelo tongue. This facies change is well displayed in stratigraphic sections from Kings Creek (mile 54.3) southward to Verona. On the south valley wall of Kings Creek, the Tupelo tongue consists of gray to light-tan, fine- to medium-grained, calcareous, glauconitic, fossiliferous sand, with some indurated beds of calcareous sandstone. The sands merge with impure chalk rather abruptly at about mile 55.2. The facies change between the Coffee and the Demopolis is complex, and the dividing line shown on Plate 1 is highly generalized.

The Coffee sands apparently form a good highway foundation, and the many sand pits in the upper part of the Coffee attest to its value as a road-building material.

DEMOPOLIS FORMATION

Only a limited part of the Demopolis formation can be examined along Highway 45 from the Tennessee line to Verona, due in part to the strike-line nature of the highway, and in part to the fact that in northern Mississippi the lower part of the Demopolis chalk is replaced by the sand facies of the Coffee. Thus the base of the chalk shown on Plate 1 is considerably higher stratigraphically than the base of the chalk south of Tupelo.

From the Tennessee line to Booneville the Demopolis formation is the bedrock underlying the highway; however, outcrops are few because of extensive cover of residual material, designated silt-loam on the profile, and terrace deposits. In a railroad cut at mile 3.2 and in roadcuts at miles 11.3, 13.6, 16.7, and 19.2, exposures of the Demopolis, range in thickness from a few feet to 30 feet, all at about the same stratigraphic position. The formation in these cuts is composed of bluish-gray, argillaceous, micaceous, fossiliferous chalk and marl, which weathers to white and buff colors. Two fairly new cuts—just east of mile 0.9 and just west of mile 17.0—expose Demopolis chalks and show the development of the overlying residual materials.

From Booneville to Tupelo the highway cuts through the Demopolis-Coffee contact numerous times, and in many cuts only a thin residuum of the Demopolis remains. The base of the Demopolis is sandy, and weathering produces a clay-sand residuum resembling the weathered Coffee sands beneath. Throughout this segment of the highway, a fossil reef is commonly developed at the base of the Demopolis. The reef contains principally two large oysters—*Exogyra ponderosa* and *Gryphaea convexa.* Thickness of the reef varies from place to place, but in most exposures the lower foot or so is cemented, forming a resistant ledge.

South of Tupelo the change in facies between the Demopolis and Coffee extends the base of the Demopolis downward stratigraphically, increasing its thickness considerably. The highway road cuts expose chalk similar to that northward. Further discussion of the Demopolis follows in the next chapter.

QUATERNARY DEPOSITS

The major Quaternary deposits shown on Plate 1 are varied, consisting of silt-loam (residual), terrace deposits, and alluvium. Not all the Quaternary deposits are shown, but where such deposits are thick enough and extensive enough to be of significance in highway construction, an attempt is made to define them.

In Alcorn County and extending into northern Prentiss County, a blanket of surficial material covers the chalk—this is in part residual material weathered from the chalk and possibly contains some loess. A fresh road cut in a new highway east from mile 0.9 cuts through the blanket to the chalk. About 5 feet of relatively unweathered chalk are exposed at the base of the cut; this is overlain by about 5 feet of greenish-colored clays, which are weathered from the chalk below; and the cut is capped by approximately 13 feet of tan to reddish-brown, structureless, silty clay. Older cuts south of the Tuscumbia River show a similar sort of covering, but in these cuts the entire residual cover has weathered to a massive, featureless mantle. The mantle seems to be closely associated with the Tuscumbia River drainage basin.

Alluvial and terrace deposits are related in the individual valleys. The terrace deposits are older alluvial deposits which have been abandoned as the streams cut downward and southward, preserving the old alluvium on the north sides of the valleys. Present alluvial deposits occupy the lowest part of each valley and contain the present streams. Generally the extent of alluvium is directly related to the size of the stream and the size of the valley.

STRUCTURE

The structural geology along Highway 45 on Plate 1 is relatively simple. Only one contact between bedrock formations appears on the profile, and although the contact appears to undulate broadly, the beds are not structurally disturbed. The irregularities are due to changes in the direction of the highway and (or) changes in the direction of strike, resulting in a corresponding change in apparent dip on the cross-section.

The Coffee-Demopolis contact is very distinct in Lee and part of Prentiss Counties and is a fair mapping horizon. Vestal (1946, p. 64, 71) used the contact as a structural datum and concluded that there were no major structures associated in Lee County. From numerous measurements he determined the regional strike to be almost due north and the dip to be about 30 feet per mile due west. Parks (1959, pp. 74-75) also used the top of the Coffee as a mapping datum in Prentiss County. His structure map shows that the strike of the Coffee is about N 5° E in the southern part of the county and N 10° E in the northern part of the county, with dips of about 30 feet per mile westerly. In southern Alcorn County the Coffee-Demopolis contact was located at several points and a strike of N 10° E, and a dip of about 30 feet per mile westerly was determined.

PLATE 2, VERONA TO COLUMBUS, MISSISSIPPI AND PLATE 3, COLUMBUS TO NORTHERN KEMPER COUNTY, MISSISSIPPI

Plates 2 and 3 are treated together due to the repetition of stratigraphic units on the two. From north to south, the highway from Verona to Columbus crosses bedrock units in descending order; south of Columbus the highway crosses a complete sequence of the Selma group to northern Kemper County.

GEOMORPHOLOGY

From Verona to Aberdeen, Mississippi, Highway 45 crosses a part of the Black Prairies. Terrace deposits are extensively developed in the valleys in southern Lee and northern Monroe Counties, due to the close proximity of the Tombigbee River. The valley of Town Creek is crossed twice, and from mile 69.0 to mile 72.5 the development of its cross-profile is consistent with other valleys of the region. The south valley wall is steeper than the north valley wall, which is low and covered by terrace deposits. The south valley wall is held up in part by the thin but resistant Arcola limestone. Southward the surface slopes gently to Mattubby Creek (mile 84.3), and the highway crosses typical Black Prairie topography developed on marls on the Mooreville formation.

From Aberdeen to Columbus the highway crosses terrace deposits and alluvium of the Tombigbee River and closely associated tributaries. Elevations on the Tombigbee floodplain range from 190 feet near Aberdeen to 170 feet near Columbus. From mile 93.4 to mile 107.5 a low terrace surface at an elevation of about 220 feet is developed on terrace deposits of the Tombigbee River. This terrace system has been dissected and the resulting valleys alluviated by tributary streams in recent times.

Just north of Columbus between miles 111 and 112 a remnant of the Tennessee-Tombigbee Hills is preserved. These hills are underlain by the Tombigbee sand, and on an areal geologic map they have the appearance of an "island" surrounded by alluvium.

From Columbus to northern Kemper County (Plate 3) the Black Prairie is crossed in its entirety. Local topographic variations are evident, and the topographic development can be related to the lithology of the underlying beds. From mile 119.5 to mile 128.4 the Mooreville formation is crossed; the lithology is a marl which is deeply weathered forming the typical Black Prairie soils. Gently rolling hills and broad valleys are dominant. At mile 128.4 the highway crosses the Arcola limestone which is covered by the alluvium of Magowah Creek. On either side of the highway the low cuesta held up by the Arcola limestone may be observed. South of this locality a broad ridge is developed on chalks on the Demopolis formation. The ridge reaches a maximum elevation of 290 feet at mile 135.5, the highest elevation along this segment of the highway. Southward the surface drops toward the broad valley formed by the Noxubee River (miles 146.6-151.1), where the lowest elevation, about 165 feet, exists. Maximum relief as indicated by Plate 3 is 125 feet. From mile 151.1 to the end of this segment the highway crosses obliquely a low well-developed cuesta, which has resulted from erosion of a sequence of marls and chalks overlying the Demopolis chalks. The soft marls of the Bluffport and Ripley are easily undercut, and the chalks of the Prairie Bluff and Clayton tend to hold up the cuesta. Inconclusive evidence points to the fact that part of the topographic development along this cuesta may be due to faulting.

STRATIGRAPHY

Plates 2 and 3 show a broad cross-section of Cretaceous sediments ranging from the upper part of the Eutaw formation to the top of the Cretaceous. The highway from Verona to Columbus follows a winding route so that there are many changes in apparent dip, but in general the profile shows a descending order from the Demopolis through the Mooreville into the Eutaw. From Columbus southward to northern Kemper County (Plate 3) the highway crosses the bedrock units in normal order from the Tombigbee member of the Eutaw formation through the formations of the Selma group: Mooreville, Demopolis, Ripley, and Prairie Bluff.

EUTAW FORMATION

The Eutaw formation crops out in a belt nearly confined to the eastern tier of counties in northeastern Mississippi. Two stratigraphic divisions of the formation have been made. The lower unit is composed of fine- to medium-grained, micaceous, glauconitic sand, with interbedded clay, and commonly containing lignitized plant fragments. The upper 100 feet or so of the formation is a massive, fine-grained, glauconitic sand, which is fossiliferous at its top. This upper unit has been named the Tombigbee member, and is prominent in outcrops along the Tombigbee River in Lowndes, Clay, and Monroe Counties.

Although Highway 45 crosses the western part of the Eutaw outcrop belt for a long distance from Aberdeen to Columbus, the lower division of the Eutaw is not well exposed due to a thick cover of alluvium and terrace deposits associated with the Tombigbee River and its tributaries. However, the Tombigbee sand is well exposed at several localities along the highway.

At the Tombigbee River bridge on Highway 45 just south of Aberdeen (mile 90.6), the river has cut into lower Eutaw. Stephenson and Monroe (1940, p. 78) describe 6 feet of thin-bedded, gray sand and clay of the lower division of the Eutaw overlain by 12 feet of fine, glauconitic sand which they assign to the Tombigbee. From this locality southward the bedrock is lower Eutaw, but it is effectively covered, and the lithology shown on Plate 2 is highly generalized.

Tombigbee Member. — Important outcrops of the Tombigbee along Highway 45 are in the vicinity of Aberdeen where both the top and base of the member are exposed. The base of the member, mentioned previously, is at mile 90.6. The top few feet of the member can be observed in a road cut on the south valley wall of Mattubby Creek (mile 24.7). In this exposure the Tombigbee consists of fine-grained, bluish- to greenish-gray, glauconitic, micaceous sand, containing numerous fossils, chiefly *Exogyra ponderosa,* which form a reef near the contact between the Tombigbee and Mooreville. The thickness of the Tombigbee in the Aberdeen area appears to be about 200 feet, which is twice the normal thickness. Two methods were used to determine the thickness, projection along the profile, and calculation from an areal geologic map. On the areal geologic map the thickening appears as a bulge in the normal outcrop pattern. One possible explanation for the excessive thickness is faulting, but little other evidence is available to substantiate this.

North of Columbus the Tombigbee sands are exposed in hills isolated from the main outcrop area by floodplain deposits. The member in this area is similar to previous descriptions, except that the sands weather to a reddish-brown color. Drill Hole 9 was augered to examine the sand in the subsurface and to determine the contact with the lower division of the Eutaw. The latter was unsuccessful due to augering difficulties.

West of Columbus, the Tombigbee sands are covered by alluvium, and Drill Hole 10 was augered to locate the top of the member. The Mooreville-Tombigbee contact is difficult to determine in augering, apparently because of a blend of marl and sand at this contact. A prominent shell bed, which could be the reef containing a preponderance of *Exogyra ponderosa,* was chosen as the contact.

The sands of the Tombigbee member furnish good topping material, and apparently the sands form a good foundation for bridges.

SELMA GROUP

There is a considerable amount of confusion in stratigraphic terminology of the Cretaceous beds in Mississippi. As stratigraphic studies continue, the status of formation and member names change, and previous nomenclature becomes obsolete, although the stratigraphy of the beds remain the same. The term "Selma" was originally introduced as a formational term, and a number of members and tongues were named as parts of the formation. Subsequent studies showed that the members were equivalent to formations and should be raised to that rank, necessitating the elevation of the Selma to group rank.

The Selma was raised to group rank in 1945 as a result of geologic studies which culminated in a new geologic map for the State. The Selma group was defined to include all the upper Cretaceous formations above the Eutaw. Presently accepted units contained in the Selma group in ascending order are the Mooreville formation, with the Arcola member at its top; the Demopolis formation, with the Bluffport member at its top; the Ripley formation; and the Prairie Bluff formation. In northern Mississippi the Coffee formation is the equivalent of the Mooreville and the lower part of the Demopolis; the Ripley contains the thick Mc-

Nairy member, the Coon Creek tongue, and the Chiwapa member; and the Prairie Bluff merges into the Owl Creek formation.

Highway 45 crosses a complete section of the Selma group from Columbus to northern Kemper County (Plate 3), but from Aberdeen northward to the Tennessee line the highway crosses only few of the formations—Eutaw, Mooreville, lower and middle Demopolis, and upper Coffee. In the southern part of the outcrop belt the formations of the Selma are closely related, consisting of carbonate facies—chalk, marl, calcareous clay, and sandy chalk; in the northern part of the belt, sand and clay facies are dominant.

The chalks and marls of the Selma group are fossiliferous, and major faunal zones have been established. The *Exogyra ponderosa* zone extends from within the Tombigbee to about 100 feet below the top of the Demopolis. The *Exogyra costata* zone ranges from the top of the *E. ponderosa* zone to the top of the Cretaceous. Within the basal 100 feet of the *E. costata* zone lies the *Exogyra cancellata* subzone. Although the characterizing fossil for each zone is wide ranging, it commonly is most abundant near lithologic changes, where reef-like accumulations exist. The prominent reef at the Coffee-Demopolis contact has been pointed out on Plate 1; other horizons are noted at the Tombigbee-Mooreville contact and the contact between the chalky facies of the Demopolis and the Bluffport marl.

A thin but important zone in the Demopolis is the *Diploschiza cretacea* zone, which is shown on Plate 3, where the thickness of the zone is about 45 feet. Traced northward this zone thins and disappears south of Tupelo, apparently affected by the change in facies to Coffee sand.

During this study a very thin reef-like accumulation of *Gryphaea convexa* was found at mile 134.7, Plate 3. *Gryphaea* and *Exogyra* appear to have a close relationship and commonly are together in reefs. The occurrence of reefs of *G. convexa* has been pointed out by Mellen (1958) in Lee County, and Parks (1960) in Prentiss County; in these areas there are numerous reef-like accumulations in the Demopolis. The single bed found in Noxubee County was traced through Lowndes and Oktibbeha Counties and is a mappable bed in the chalk. Such mappable beds are of value in dividing the thick chalk and marl beds into smaller workable units.

Other reefs mentioned in the literature include those containing principally the genus *Ostrea*. Much further work is needed in the study of these oyster reefs, for perhaps the answer to unravelling the stratigraphy of the Cretaceous beds lies therein.

MOOREVILLE FORMATION

The Mooreville formation, the basal unit of the Selma group, consists of marl, sandy marl, calcareous clay, and a thin limestone at the top. The Mooreville varies in composition along strike, becoming less marly northward where it merges with sands and clays of the Coffee. Most of this change takes place in eastern Lee County.

The route of Highway 45 is such that the Mooreville is crossed three times—once partically, and twice completely. The exposures along the highway are generally rather poor, due to the fact that the marls weather deeply to clay, forming a thick soil cover. In deep cuts the marl is generally exposed near the base of the cuts and in ditches.

On Plate 2, the top portion of the Mooreville forms the bedrock from mile 65.9 to mile 72.5. Most of the bedrock is covered by alluvium and terrace deposits, but the south valley wall of Town Creek (mile 72.5) exposes a good section of the upper half of the formation. Here the marls of the Mooreville are interbedded with calcareous clays and thin streaks of sand.

From mile 75.5 to mile 83.0 the highway crosses the Mooreville from top to base, but throughout the length, the formation is mantled by residuum. The base of the formation and the contact with the underlying Tombigbee are well exposed at mile 83.0. About 40 feet of basal Mooreville marl can be observed in the cut, and at this locality a complete gradation from relatively unweathered marl to blocky, montmorillonitic clay to residuum is present.

On Plate 3, the Mooreville is crossed from miles 119.7 to 128.5, but the exposures are poor. Neither the base nor the top of the formation are exposed, and Drill Holes 10 and 11 were augered to determine these contacts. Although the Mooreville is poorly exposed along the highway, there are two complete stratigraphic sections along streams nearby. One of these streams, Cedar Creek, heads near the highway at mile 130.5 and flows easterly across the Mooreville outcrop belt, exposing a complete section. Dinkins (1960) studied the section and provided insoluble residue analyses for 18 samples ranging from the top of the Tombigbee, through the Mooreville, into the Demopolis. His findings show that the Mooreville is chiefly a marl, but that there are thin beds of bentonite within the formation. Another complete section is found along Tibbee Creek, which forms part of the boundary between Lowndes and Clay Counties. This section was studied in detail by O'Quinn (1961), who presented insoluble residue analyses and a study of the foraminifera. These two stratigraphic studies provide a good base for further work on the Mooreville in this area. Apparent thickness of the Mooreville ranges from 230 feet as indicated on Plate 3 to 160 feet as indicated on Plate 2.

Arcola Member. — The Arcola member of the Mooreville formation consists of one or more beds of nearly pure limestone, each about one foot thick, at the top of the Mooreville. At mile 65.9 a fair exposure is in a ditch along a side road. At mile 72.5 the Arcola is well exposed in a road cut and may also be found along a number of local roads in the vicinity. Here the Arcola contains at least two limestone beds, separated by about five feet of marl. The lower bed is cobbly, whereas the upper bed is dense and bored. At mile 128.5 the Arcola is covered by alluvium, but along a side road east (mile 128.2), there are a number of good exposures of a single bed of limestone.

The Mooreville presents a problem to the highway engineer. The marls contain considerable amounts of clay intimately mixed with calcium carbonate, but during weathering the calcium carbonate is leached out leaving a soil or residuum enriched in clay, which contains montmorillonite as its chief clay mineral. These clays are active and highly susceptible to moisture changes, which causes them to swell and contract. Further research is needed to determine the extent of these conditions and the seriousness of the problem in highway construction.

DEMOPOLIS FORMATION

The Demopolis formation is a thick unit composed chiefly of chalk and impure chalk, and some marl. A portion of the unit was discussed under Stratigraphy of Plate 1. As shown on Plate 2 the Demopolis is crossed from Verona, mile 58.3 to mile 65.9, and the basal few feet are crossed from miles 72.5 to 75.0. Plate 3 illustrates a complete section of the Demopolis along the highway from miles 128.5 to 151.3, a distance of 22.8 miles.

The lithology of the Demopolis is not as homogeneous as might be concluded at a glance, and the formation can be divided into informal units, based partly on fossil zones and partly on lithology. These divisions are best displayed on Plate 3.

The basal unit ranges from the bottom of the Demopolis to the *Diploschiza cretacea* zone (miles 128.5 to 129.6) and is about 105 feet thick. The litology consists of impure chalk and marl, which weather deeply to form an extensive cover of Black Prairie soil. It has been suggested by Mellen (1958, p. 36, Fig. 21) that this part of the Demopolis is probably the continental slope depositional equivalent of the Coffee sand.

The *Diploschiza cretacea* zone (miles 128.5 to 131.9) consists of about 45 feet of impure chalk and marl that is characterized by the presence of two small fossils, *Diploschiza cretacea* and *Terebratulina filosa*. The unit is not well exposed along the highway due to a thick soil cover, but there is an excellent outcrop about a mile west of the highway along a side road at mile 129.8.

Above the *Diploschiza cretacea* zone is a thick unit composed chiefly of chalk (miles 131.9 to 151.2) with a thickness of about 242 feet. This thick unit can be traced northward to the Mississippi-Tennessee line, and throughout the outcrop belt it is characterized by nearly pure chalk. The State Lime Plant pit at mile 144.8 obtains chalk containing over 80 percent calcium carbonate from this unit. Some aspects of the lithology of this unit and part of the *Diploschiza cretacea* zone are presented by Carson (1961) in a study of the Demopolis in the Artesia quadrangle, which the highway crosses in the southeastern part. Samples were taken at 10-foot intervals and insoluble residue studies were made. He found that the average chalk contains 81.6 percent calcium carbonate, 17.0 percent clay, and 1.4 percent sand and silt. However, the average seems to be influenced by at least two distinct types of chalk: one is dense, hard, light-gray to white, and contains from 80 to 90 percent calcium carbonate; the other is softer, darker, and contains from 73 to 79 percent calcium carbonate. The dominant clay minerals in the insoluble residue are montmorillonite, illite, and kaolinite in order of abundance.

Bluffport Member. — Overlying the chalk unit is about 55 feet of marl, which has been formally designated the Bluffport member of the Demopolis (miles 151.2 to 151.3). Along the highway a nearly complete section can be seen in road cuts and gullies on the south wall of the Noxubee River valley. The section along the highway and ten other stratigraphic sections of the Bluffport in Noxubee County were studied by Harper (1959), who showed that the average carbonate content of the Bluffport marl varies from 70 percent near the base to 45 percent at the top. He also mentions a reef containing *Exogyra cancellata* and *Gryphaea mutabilis* at the chalk-marl contact at a number of localities. The base of the Bluffport is not exposed at the locality on Highway 45, and Drill Hole 12 was augered at the bottom of the bluff to attempt to locate the reef, but apparently it is weathered. East along the bluff the reef is prominent where the base is exposed. The top of the Bluffport grades into the overlying Ripley.

The total apparent thickness of the Demopolis formation along Highway 45 shown on Plate 3 is about 447 feet.

The engineering properties of the Demopolis are varied. Many of the marls weather in a similar manner to the Mooreville marls and cause foundation difficulties due to the high content of montmorillonite. An example of these conditions is along Mississippi Highway 14 east of Macon. Near the Alabama line the underlying bedrock is marl of the lower part of the Demopolis, that is deeply weathered forming an active soil mantle. In recent repair programs and reconstruction, the soil has been treated with hydrated lime to stabilize the active clays. Highway failure along other parts of the marl belts may be a result of similar conditions.

The chalk of the Demopolis does not present many problems to the engineer; on the contrary its properties are such that so few problems arise that little is known of the engineering characteristics. A study by Vodrazka (1962) presents some engineering data on chalk that may be considered typical: Failure under unconfined compression ranges from 28.9 to 89.2 tons per square foot, with most test results in the range from 50 to 60 TSF; failure at low values is attributed to the presence of large shells in the test specimen. Failure under tension averaged 9.5 TSF. Cohesion is 11.2 TSF and the angle of internal friction is 43 degrees. Modulus of elasticity ranges from 27,000 to 30,000 PSI, and consolidation tests show that the chalk is virtually incompressible up to 20 TSF. Permeability is low—coefficient of permeability was found to be 4.46 x 10^{-8} cm. per second using a falling head permeameter; and porosity is high—calculated to be 30 percent. Unit dry weight ranges from 96 to 106 pounds per cubic foot with moisture content ranging from 19.5 to 24 percent. From the engineering data Vodrazka concludes that there are no special problems with foundations or embankments. One problem in road cuts is that the exposed chalk "gullies" badly, and it is difficult to grow a cover on the bare chalk. This condition may be combatted by expensive sodding, or the less expensive emulsion spray to protect the bank until grass can be established.

RIPLEY FORMATION

The Ripley formation is crossed only once by Highway 45 and is shown on Plate 3 from mile 151.3 to mile 155.9. The Ripley in this area is composed of marl and calcareous clay somewhat similar to the underlying Bluffport, but contains more sand, abundant mica, and a different fossil assemblage. In weathered exposures the Ripley has a "bedded" appearance.

A complete section of Ripley is exposed along the highway and in nearby gullies at mile 151.6. The base of the Ripley is gradational with the Bluffport, and the top of the Ripley is some what gradational with the Prairie Bluff; however, the top of the Ripley can be determined fairly closely due to the contrast in lithology above and below the contact zone.

A thickness of 28 feet is assigned to the Ripley; however, the lower contact is difficult to determine with any precision and the thickness shown may be too small. Hughes (1958, p. 62) gives an average thickness of 40 feet for the Ripley in nearby Kemper County, but he further states that the thickness is variable.

From mile 151.6 to mile 155.9 the highway descends along a part of the dip slope of the Ripley, which is capped in several places by Prairie Bluff and terrace deposits. Exposures of Ripley are poor along this segment. Drill Hole 13 was augered to locate the Ripley-Bluffport contact downdip, but the auger samples showed little variation through the contact zone. At mile 155.9 the Ripley-Prairie Bluff contact is covered by alluvium, and the contact shown is projected.

The engineering properties of the Ripley are similar to those of the Bluffport marl.

PRAIRIE BLUFF FORMATION

The Prairie Bluff, uppermost formation of the Selma group, is shown on Plate 3 (and in the overlap on Plate 4). The base of the formation is exposed at mile 151.7; a nearly complete section is exposed at mile 156.0 in the south valley wall of Shuqualak Creek; and the upper seven feet are exposed at mile 163.0 in the south valley wall of Wahalak Creek.

The Prairie Bluff is composed chiefly of bluish-gray, massive, glauconitic, very fossiliferous, sandy chalk, which weathers white. Marcasite concretions, phosphatic nodules and molds of fossils, and calcareous concretions and nodules are common. Joints are common in the brittle chalk.

The contact relationship of the Prairie Bluff and the overlying Clayton (Midway) are well shown in the exposures at miles 156.0 and 163.0. The stratigraphic sections at these two localities were studied in detail by Hughes (1958, pp. 71-75). The Prairie Bluff is exposed in steep bluffs causing a short span; along the dip slope from mile 156.2 to Wahalak Creek valley, the Prairie Bluff is mostly covered by the Clayton (Midway).

The thickness of the Prairie Bluff shown on Plate 3 is about 60 feet; however, the base of the formation was determined by projection, and there is a possibility of faulting in Shuqualak Creek valley, which could reduce the thickness to about 40 feet. Hughes (1958, p. 71) states that the thickness of the Prairie Bluff in Kemper County is about 30 feet, but that elsewhere the thickness varies from 12 to 70 feet due to overlap by formations of the Midway group.

The engineering aspects of the Prairie Bluff in this area seem to be similar to those of the chalks of the Demopolis, which they resemble in some outcrops. Some difference is to be expected because of the higher sand content of the chalk of the Prairie Bluff.

QUATERNARY DEPOSITS

On Plate 2 the profile shows extensive tracts of alluvium and terrace deposits. From Coonewah Creek valley, mile 60.5, in southern Lee County to Town Creek valley, mile 71.7, in northern Monroe County, the bedrock is covered by alluvium and terrace deposits which are a result of the confluence of a number of streams. Drill Holes 6 and 7 were augered through terrace deposits into bedrock, and an estimated thickness for the terrace deposits in this area is 20 to 25 feet. Bridge borings at mile 70.7 indicate that the maximum thickness of the alluvium in Town Creek valley in this area is about 20 feet.

From Aberdeen to Columbus, with the exception of an "island" of Tombigbee sand, the surface is entirely alluvial or terrace deposits. A rather complete set of terrace deposits is preserved on the east valley wall of the Tombigbee River, but little detailed work has been done to unravel the geology. Surface studies are difficult due to lack of good consistent exposures; however, topographic interpretation of the surface can aid greatly in deciphering the series of events that led to the development of the terrace system. The recent publication of two topographic quadrangles, the Columbus and Caledonia 15-minute quadrangles, covers an area north and south of Columbus and provides excellent control for study of the terrace system. Cross-sections show clearly the terrace development, and from gravel pit locations shown on the quadrangles, terrace deposits can be roughly outlined. Stephenson and Monroe (1940, p. 259) describe briefly the events leading to the present development. They recognize five abandoned floodplains belonging to the Tombigbee River. Each of these became terrace deposits as the river cut downward and migrated westward. No accurate time correlation has been made, but is suggested that the events are largely Quaternary.

The highway crosses one of the youngest terraces from mile 93.4 to mile 107.5. The approximate elevation along the top of the terrace deposits is 220 feet, and in profile it is shown dissected by younger streams which have subsequently alluviated their valleys. Thicknesses of the terrace deposits and alluvium are variable. Drill Hole 8 shows a thickness of 23 feet for the alluvium A number of seismograph drill records near New Hamilton were examined, and most of these showed thicknesses of about 35 feet for terrace deposits and about the same for alluvial deposits, except for a few holes which showed alluvium as thick as 60 feet. In all the logs the description is simply sand and gravel, so that no quantitative interpretation could be made.

Time did not permit a detailed study of the Tombigbee terrace and alluvial deposits, and most of the Quaternary geology shown on Plate 2 is highly generalized.

On Plate 3 the Quaternary deposits are not so prominent. The western edge of the Tombigbee alluvial plain is shown from mile 116.8 to mile 119.5, and other prominent alluviated valleys include those of Gilmer Creek (mile 125.0), Magowah Creek (mile 127.6), Horse Hunter Creek (mile 142.7), Noxubee River (mile 146.6 to mile 151.1) and Wahalak Creek (mile 161.6). A few of the plan-profiles show depth to bedrock from bridge borings, and thickness of alluvium in the valleys ranges from 15 to 20 feet at a maximum.

STRUCTURE

The many "apparent" structures along the profile shown on Plate 2, are a result of changes in apparent dip due to numerous changes in highway direction between Verona and Columbus. The strike of the underlying beds is due North throughout most of Plate 2, but in southern Monroe County the strike swings to about N 10° W, then in Lowndes County the strike swings to about N 20° W. The dip is westerly and ranges from 30 feet per mile in Lee and northern Monroe Counties to about 40 feet per mile in southern Monroe and Lowndes Counties.

In the vicinity of Aberdeen a structure is suggested by the abnormal thickness of the Tombigbee. The thickness was determined by two methods, and both gave values of about 200 feet, which is twice normal. This abnormality has been mapped areally by Stephenson and Monroe (1940) and Vestal (1943), and on both maps the outcrop pattern for the Tombigbee is shown as a bulge. Due to extensive cover of the bedrock involved and the lack of key beds in the strata, no evidence was found to account for the abnormal thickness.

Along the profile shown on Plate 3 the strike of the underlying beds changes from about N 20° W in Lowndes County to N 30° W in Noxubee County, and to N 45° W in the extreme southern part of Noxubee County and through Kemper County. The dip of the beds is 40 to 45 feet per mile in west-southwesterly and southwesterly directions.

Some faulting is indicated south of Macon, but good evidence is meager. The south valley walls of Noxubee River, Shuqualak

Creek, and Wahalak Creek are all steep bluffs, resembling fault scarps. However, there is a natural tendency for stream valleys in northeast Mississippi to develop in this manner, and the scarps could be purely erosional.

Few adequate control points on key horizons could be established along the highway; however, sufficient control is available near Wahalak Creek to suggest strongly the displacement of beds by faulting. From mile 155.2 to the end of the profile, mile 163.6 the direction of the highway is constant, so that the apparent dip of the underlying beds should be the same, if strike and dip do not change. The top of the Prairie Bluff and the base of the Clayton can be followed along the dip slope from mile 156.2 to Wahalak Creek, mile 161.6, where Prairie Bluff chalk is exposed in the creek banks. The apparent dip thus established should continue under the valley, but at mile 163.0 the Prairie Bluff and the Clayton are exposed in the south valley wall at an elevation some 50 feet higher than that predicted by projection. If the displacement is caused by faulting, the fault (or faults) are concealed by alluvium.

PLATE 4, SOUTHERN NOXUBEE COUNTY TO MERIDIAN, MISSISSIPPI

Plate 4 shows the geologic profile along Highway 45 from southern Noxubee County to Meridian, Mississippi. Along this segment of the highway the underlying beds are chiefly lower Tertiary (Midway and Wilcox groups) in age. An overlap from Plate 3, which includes upper beds of the Cretaceous is necessary to show "outliers" of Midway. Variations exist between the direction of the highway and the direction of dip of the underlying beds, and the profile contains both oblique-line and dip-line sections.

GEOMORPHOLOGY

The physiographic units shown on Plate 4 are the western edge of the Black Prairie, the Flatwoods, and part of the North Central Hills. Valleys with prominent flood plain and terrace deposits are formed by Wahalak Creek, Sucarnoochee Creek, Blackwater Creek, Ponta Creek and Sowashee Creek.

The Flatwoods, one of the major physiographic regions of Mississippi, is a lowland with little relief developed on a relatively homogeneous body of clay—the Porters Creek formation. The belt extends from mile 163.5 to mile 180.7. The lowest elevation along this segment is 170 feet, the highest is 270 feet, a maximum relief of 100 feet, which is measured over a span of about 7 miles. Local relief varies from a few feet in the northeastern part of the area near mile 164 to as much as 85 feet in the southeastern part near mile 179. Maximum relief is found close to the boundary between the Flatwoods and the North Central Hills. Here the upper part of the Porters Creek is more resistant to erosion, and the overlying sands of the Naheola provide a protective capping.

The North Central Hills, a rugged upland belt in Mississippi, dominates the southern part of the profile. Lowest elevations along the highway are about 200 feet, and the highest elevation is 450 feet, providing a maximum relief of about 250 feet, which is developed over a distance of about 9 miles. Local relief is generally about 100 feet, but away from the right-of-way relief may be as great as 200 feet. Three dissected cuestas reflect the nature and attitude of the underlying beds. The first of these cuestas is very prominent at mile 181 where the Flatwoods give way rather abruptly to the North Central Hills. Foster (1940, p. 10) named this feature the Ackerman cuesta, but it is more commonly referred to as the Wilcox escarpment throughout northeastern Mississippi. The backslope is hilly and relief is considerable. South of Lauderdale (mile 188.5) a second cuesta, the Holly Springs cuesta of Foster (1940, p. 11) is developed. The face of this cuesta is dissected and rises in a series of "steps" to an elevation of 450 feet at mile 195.3. The backslope of the cuesta is gentle; however, the slope as shown on the profile is influenced partly by the flood plain of Sowashee Creek, which the highway parallels. Near the southern end of the profile a third cuesta, the Bashi-Hatchetigbee cuesta of Foster (1940, p. 11) is only partially shown.

STRATIGRAPHY

Plate 4 shows principally a cross-section through bedrock of Paleocene and lower Eocene ages. Two major groups are represented: the Midway (Paleocene) and much of the Wilcox (lower Eocene). Not all geologists are in agreement with the stratigraphic nomenclature used within the groups, especially the Wilcox, and there is also some disagreement on boundaries.

The interpretation shown on the profile is based on comparison of findings along the highway with the most consistent interpretations made by geologists in other areas. Little time was available for extensive regional study of the stratigraphic units along strike. The most useful publications concerning Midway and Wilcox stratigraphy in this area are "Summary of the Midway and Wilcox Stratigraphy of Alabama and Mississippi", by F. S. MacNeil (1946) and "Kemper County Geology", by R. J. Hughes, Jr. (1958).

MIDWAY GROUP

The Midway group along Highway 45 contains the following units, in ascending order: the Clayton formation; the Porters Creek formation, with the Matthews Landing member at its top; and the Naheola formation.

CLAYTON FORMATION

The Clayton formation, a relatively thin unit that forms the base of the Midway, consists chiefly of white to tan, silty, sandy, fossiliferous chalk. Locally at its base there are thin beds and lenses of sand and sandstone. A small oyster, *Ostrea pulaskensis,* is in large numbers in the formation and is considered a marker fossil.

Along the highway the base of the Clayton is exposed at mile 156.2, where its unconformable contact relationship with the underlying Prairie Bluff is well exposed. Southward from this point a small exposure at mile 157.6 yields abundant *O. pulaskensis,* and in ditches and cuts along the highway on either side of a small valley at mile 159.5 there are poor exposures of Clayton. In this area the Clayton is overlain by Porters Creek clays, but weathering has obscured the contact and reduced the Porters Creek to a residuum.

A complete section of Clayton is exposed between miles 163.0 and 163.5 on the south valley wall of Wahalak Creek. This exposure shows the Clayton-Prairie Bluff contact, contains abundant *O. pulaskensis,* and near the top shows the gradation of the Clayton into the overlying Porters Creek. The cut has been described in numerous publications dealing with the geology of this area, and is a "must stop" for field trips along Highway 45. Thickness for the Clayton at this point is about 27 feet, which includes one to two feet of sandstone at the base.

The Clayton has little engineering significance in this area due to its limited span along the highway.

PORTERS CREEK FORMATION

The Porters Creek formation is chiefly a very thick body of clay and makes up the bulk of the Midway group. It overlies the Clayton formation with apparent conformity and is overlain disconformably by the Naheola formation.

Through northeast Mississippi the Porters Creek crops out in a belt varying in width from 3 miles near the Tennessee line to 12 miles in Kemper County. Highway 45 crosses the formation obliquely and traverses about 17 miles. Exposures of the formation are rather poor, because the clays erode to form a fairly flat surface, and few road cuts are deep enough to expose more than a few feet of the formation.

In Kemper County the Porters Creek may be divided into four lithologic units for convenience in descriptions.

A thin basal unit, consisting of slightly calcareous clays, is poorly exposed from mile 163.5 to about mile 166.0. This unit is about 20 to 30 feet thick and possibly represents a gradation between the calcareous Clayton and the non-calcareous Porters Creek clays.

Overlying the basal calcareous clays is a thick unit containing dark-gray to black, massive clay, that weathers light-gray. The clay is generally blocky in exposures and breaks with a conchoidal fracture. This unit makes up a large part of the formation and is often considered the "typical" facies. A few good outcrops of the unit are found at miles 167.9, 169.3, 172.5, 174.2, 175.5, 176.8, 178.7, and 180.4; numerous other exposures between the above mileages show weathered clay, which in most cases is reduced to a reddish-brown residuum. Thickness of the "typical" clay facies is about 450 feet.

The thick massive clay grades up into the third unit, about 30 to 40 feet thick, composed of laminated clay and sand, characterized by large numbers of siderite nodules and thin limonite partings that form in the more sandy facies. This laminated phase is exposed in the south valley wall of Blackwater Creek (mile 180.6). Foster (1940, p. 26) describes this section, and apparently studied the section when the cuts were much fresher.

Most of the cuts are now covered by vegetation or are slumped, especially those in the clay, but the part of the zone containing siderite nodules is still exposed.

Matthews Landing Member. — The uppermost lithologic unit of the Porters Creek formation in Kemper County is a clayey, fossiliferous, greensand marl, called the Matthews Landing member. About 6 feet of this marl was described by Foster (1940, p. 26) along Highway 45, but this exposure is now covered. Drill Hole 14 at mile 180.8 penetrated about 8 feet of greensand marl, but the auger could not drill through a hard streak at the base, which is interpreted as a hard pan formed between the marl and the clays below. A local road east from mile 181.1 exposes about 13 feet of Matthews Landing marl, which is highly weathered to a reddish-brown, ferruginous sand, but still contains scattered grains of glauconite and molds and prints of fossils.

Total thickness for the Porters Creek formation determined from the profile is about 525 feet.

The clays contained in the Porters Creek create a number of problems for the highway engineer, chief of which are foundation problems. Little details of the engineering properties of the Porters Creek clays have been published; however, the chief clay mineral is montmorillonite, an active clay, which swells when wetted and shrinks when dried, causing a wide variation in its strength properties. Most of the pavement along Highway 45 underlain by Porters Creek has buckled and warped due to differential movements. This condition is common for roads built on active clays that are not stabilized. In many respects the Porters Creek clay shows a similarity to the Yazoo clay, discussed by Priddy (1961, pp. 46-48) along Highway 80.

NAHEOLA FORMATION

The Naheola formation is the uppermost formation of the Midway group, but extends into Mississippi only a short distance. It has been mapped through Kemper County, but pinches out northward due probably to overlap by Wilcox beds.

Along Highway 45 the Naheola consists of bluish-gray, thinly laminated, carbonaceous, micaceous clay with silt and sand partings, and beds of tan, fine- to medium-grained, cross-bedded, micaceous sands. Lignite is common, especially near the top of the formation.

Sands below the carbonaceous clay unit seem to be widespread, and are exposed at miles 180.8 and 181.5. Drill Hole 14, mile 180.8, penetrated 23 feet of fine-grained, micaceous sand above the Matthews Landing greensand, and Drill Hole 15, mile 187.4, bottomed in sand below the clay unit.

The carbonaceous clays are well exposed at mile 181.8 and in a number of cuts between miles 183 and 184. This unit seems to be persistent. At mile 187.4 Drill Hole 15 was augered through the unit, which is about 30 feet thick.

Sands overlying the clay unit appear to be more local. It is probable that in many areas these sands were eroded, and sands of the lower Wilcox deposited in their place. The upper sands are exposed between miles 182 and 183, but at mile 184.5 and in Drill Hole 15 the sands overlying the Naheola clays are interpreted as basal Wilcox.

Thickness of the Naheola is variable, but a maximum of about 75 feet was determined from the profile.

Lithologically the Naheola is similar to the Wilcox, and engineering problems discussed under the Wilcox group also apply to beds in the Naheola.

WILCOX GROUP

The stratigraphy of the Wilcox is perhaps more complex and confused than any other group in Mississippi. Most of the difficulty lies in subdivisions of the group and nomenclature. Type formations were established by early geologists in both Alabama and Mississippi, two areas in which Wilcox beds are lithologically dissimilar. Most of the formations of the Wilcox in Alabama contain marine beds, which have diagnostic fossils, whereas the formations in Mississippi are composed largely of non-marine beds, which lack diagnostic fossils. The marine and non-marine facies merge in Kemper and Lauderdale Counties, Mississippi. In a report by Foster (1940) marine beds in Lauderdale County were assigned Alabama names; non-marine beds were assigned formational names carried southward from north Mississippi. In a later study Hughes (1958) used Alabama terminology almost exclusively in Kemper County. Priddy (1961) used informal "zones" in the Wilcox along Highway 80 in Lauderdale County.

In this report names for the units within the Wilcox group are those used by Hughes.

The Wilcox along Highway 45 contains the following units in ascending order: the Nanafalia formation, with the Fearn Springs member at its base; the Tuscahoma formation; and the Hatchetigbee formation, with the Bashi member at its base.

NANAFALIA FORMATION

The Nanafalia formation as defined in Mississippi consists chiefly of deltaic, fluviatile, and paludal deposits of sand, silt, clay, and some lignite, and through Lauderdale and Kemper Counties the formation also contains a few marine beds that are recognized by fossils which appear as prints or clay molds. The formation is variable along strike.

Along Highway 45 the base of the formation is exposed as "outliers" on hill tops in the vicinity of miles 182.5 and 184.5, and a nearly complete sequence of beds above the basal unit is exposed in cuts and gullies between miles 189.6 and 192.8. Ponta Creek valley separates the main section from the "outliers".

A three-fold lithologic subdivision of the Nanafalia was worked out in Kemper County by Hughes (1958, p. 157). A basal unit, the Fearn Springs member, consists of thick channel sands and bedded clay and sand; the middle unit contains recognizable marine beds; and the upper unit consists of blocky clay and silt. A somewhat similar subdivision is suggested along the highway.

Fearn Springs Member. — The Fearn Springs member is discontinuous along the strike belt and has been interpreted as a series of channel-fill deposits. Channels cut into older beds were first filled with sand, coarse and usually conglomeratic at the base grading upward to medium and fine sands. These sands may be overlain by bedded clay and sand, which may also overlie older beds adjacent to the channels. In this case, the stratigraphic sections would vary considerably in thickness and lithology from locality to locality. A possible example of these conditions is shown in the two localities near miles 182.5 and 184.5. The first locality was studied in detail and stratigraphic interpretation was made by Hughes (1958, pp. 156-157); the second locality was studied by Foster (1940, pp. 40-41) when the cuts were much fresher. Although the nomenclature differs between the two lithologic sections, there is a strong suggestion of Fearn Springs-type deposition. South of the Kemper-Lauderdale line the Fearn Springs sands are colluviated, but coarse sand and some "pea gravel" were found in a few cuts on the backslope. In Drill Hole 15, mile 187.4, coarse sand overlies the carbonaceous clay unit of the Naheola. Drill Hole 16, mile 189.6, was augered to examine the upper part of the Fearn Springs, but water-bearing sands prevented the recovery of good samples.

From mile 189.6 to mile 192.8 beds assigned to the middle division of the Nanafalia are exposed. These beds consist of buff, cross-bedded, micaceous, fine-grained sand; gray, plastic clay; lignitic clays and lignite; and laminated sand, silt, and clay. The beds are interlensed and intertongued, and a definite stratigraphic sequence is indeterminable because few of the beds can be correlated from outcrop to outcrop. In the vicinity of mile 192.5 exposures in ditches and cuts show light-gray, limonite stained, micaceous, fine-grained sand interbedded with gray, plastic clay, which are lithologically similar to marine beds that have yielded fossil prints and molds elsewhere in Lauderdale County. No fossils were found at this locality.

At mile 192.8 poor exposures show about 15 feet of gray, plastic to semi-plastic silty clays, which resemble that described as the upper division of the Nanafalia. Sands overlying these clays contain large cobbles of clay—referred to as clay-ball conglomerate. The Nanafalia-Tuscahoma contact was picked at the top of the clay unit.

Total thickness of the Nanafalia measured from the profile is 295 feet, of which about 65 feet is Fearn Springs. The thickness is greater than that determined by Hughes (1958, p. 148) who gives a maximum of 230 feet for Kemper County and by Brown (1960, p. 16) who estimated 200 feet along Mississippi Highway 16 in Kemper County. The thickness determined from the profile may be too great due to possible flattening of regional dip, repetitious measurement of beds in fault or slump blocks, or choice of upper and lower contacts for the formation.

Sands from the Nanafalia furnish abundant topping material. The highway across the Nanafalia is old and badly in need of repair, and these conditions make it difficult to appraise the foundation capabilities of the formation. Water trouble with perched water bodies and water-bearing lignite is possible locally in the formation.

TUSCAHOMA FORMATION

The Tuscahoma formation, which crops out through Lauderdale and Kemper Counties in a broad belt southeast of the Nanafalia, is composed chiefly of deltaic, fluviatile, and paludal sediments—a continuation of deposition similar to that of the Nanafalia. However, marine beds are absent in the Tuscahoma in Mississippi, with possible exceptions in the extreme eastern part of Lauderdale County.

Highway 45 spans the Tuscahoma from mile 192.8 to about mile 202.3. The formation in this area can be divided informally into three divisions. The basal division, exposed in cuts from mile 192.8 to mile 194.4, consists of gray, fine-grained sand; brown and gray lignitic clay; and light-gray silt and silty clay. Basal sands of this unit contain clay-ball conglomerate, which is common but not always present at the base of the Tuscahoma in other areas. Clay-ball conglomerates are also present in other formations of the Wilcox. Brown (1960, pp. 31-33) discusses possible stratigraphic implications of these clay-ball conglomerates, but he recognizes that caution is necessary in using them as criteria for formational boundaries.

From mile 194.4 to about mile 197 the middle division of the Tuscahoma is crossed. This unit is composed of approximately 50 feet of dark-brown to black lignitic clay and lignite. The clay weathers light-brown and light-gray. An excellent exposure of a bed of lignite about 2 to 3 feet thick is in a cut at mile 194.4. Drill Hole 17, augered at mile 197.1, penetrated nearly 40 feet of lignitic clay below alluvium, showing continuity down dip. In Drill Hole 18 at mile 199.0 the lower ten feet of the log shows lignitic clay.

From mile 195.7 to mile 202.8 the highway parallels the western edge of Sowashee Creek valley, and the underlying bedrock is largely covered by alluvium and terrace deposits. Drill Holes 17, 18, 19, 20, and 21 were augered to provide subsurface information. From samples, the upper division of the Tuscahoma was determined to be composed of bluish-gray, micaceous, fine-grained sand; light-gray, micaceous, fine-grained sand; light-gray, clayey silt; and tan and blue, plastic clay, in some holes lignitic.

Total thickness of the Tuscahoma determined by measurements from the profile is about 230 feet. Hughes (1958, p. 169) gives a thickness of approximately 300 feet in southern Kemper County, and Brown (1960, pp. 16-17) estimates 345 feet along Mississippi Highway 16 in Kemper County. Combined thicknesses of both the Tuscahoma and Nanafalia are 525 feet in this study, 530 feet by Hughes, and 545 feet by Brown. The close agreement of combined thicknesses suggests that perhaps the variations in the formational thickness is due to choice of boundaries.

Sands suitable for topping material are present in the Tuscahoma, but many of these are silty or laminated with clay. Foundation conditions are difficult to assess, but the thick lignitic clay bed may create some trouble. The problems concerning lignite and the highly acid waters contained in them have been discussed by Priddy (1961, pp. 22-23). The lignites are spongy and act as reservoirs for water which may flow for long periods of time after a road cut is made through them. Further, the low pH is detrimental to the growth of many grasses used in sodding the cuts.

HATCHETIGBEE FORMATION

The Hatchetigbee formation, the uppermost formation of the Wilcox group, is the youngest bedrock unit shown on Plate 4. In Lauderdale County the Hatchetigbee consists chiefly of lenses and tongues of sand, silt, clay, silty clay, carbonaceous clay, and lignite. Near its base the Hatchetigbee contains greensand marl beds, the Bashi member, which separate it from the underlying Tuscahoma. Priddy (1960) discovered that there are four greensand marl beds along Highway 80, each separated by normal Hatchetigbee lithology, and that the greensands form only a small part of the Bashi. Locally the greensand marl is cemented to form large concretionary boulders (marlstone boulders).

Bashi Member. — Along Highway 45 the Bashi crops out within the city limits of Meridian. The best outcrop is located in a small branch at mile 203.1. The bottom of the creek exposes marlstone boulders overlain by about 14 feet of fossiliferous greensand marl and thin clay beds. Above the greensand unit the section is composed of plastic, blue, lignitic clay with silt partings grading upward into alternating beds of light-gray clay and tan, medium-grained sand. Drill Holes 20 and 21 were augered north of this outcrop, but neither penetrated any well-defined greensand marl beds, and the base of the Bashi (Hatchetigbee) was chosen at the base of the marlstone boulders.

Only some 45 feet of Hatchetigbee is shown on Plate 4, probably all Bashi.

QUATERNARY DEPOSITS

Major Quaternary deposits shown on Plate 4 include alluvial and terrace deposits of the major streams. Colluvium is common on the slopes of hills underlain by sands, but its relationship to bedrock can still be ascertained, and these are not shown.

A terrace deposit at mile 177.2 south of Sucarnoochee Creek is significant in that it contains sand, in an area largely devoid of sandy deposits. It is possible that other terrace deposits of streams flowing through the Porters Creek clay belt may contain sand, providing topping material for local use.

Previously mentioned are the floodplain and terrace deposits of Sowashee Creek, which cover the upper Tuscahoma beds from mile 195.7 to mile 202.8. The highway follows the western edge of the valley floor and crosses a number of floodplains of tributaries. Through this segment the highway is in poor condition, but this is attributed more to excessive traffic and load than to foundation conditions.

Priddy (1961) delineated many high terrace deposits capping hill tops in Lauderdale County. These are difficult to recognize along Highway 45, and some of the sand on high hills assigned to the Wilcox may be terrace deposits.

STRUCTURE

There are few secondary structures along Highway 45 from the fault zone at mile 162 to Meridian. Two anomalous areas suggest faulting. North of Blackwater Creek, Hughes (1958) mapped a small capping of Naheola on the prominent "peak" at mile 179.0; however, as shown by projection this is considerably lower than the normal position of the Naheola. In other areas along this same belt, the Wilcox escarpment, large scale slumping is evidenced. Hughes (1958, p. 105) and Brown (1960, pp. 17-18) note a structure of this type along Mississippi Highway 16 just east of DeKalb, Kemper County.

In Ponta Creek valley, Foster (1940, pp. 91-92) describes a structural area with faults paralleling Ponta Creek. In numerous outcrops small-scale faults can be seen in areas adjacent to the highway, but the absence of key beds makes it impossible to determine accurately the exact nature of the structures. The physiographic setting is nearly the same as along the Wilcox escarpment, and many of the faults could be the result of slump. The above normal thickness of the Nanafalia formation could be due in part to repetition of beds by large-scale slump.

The strike of the underlying beds is about N 45° W throughout the profile length, and the true dip varies from 45 feet per mile in the northern part to about 30 feet per mile in the southern part of the area.

CONCLUSIONS

The length of Highway 45 studied and the many diverse highway-geologic relationships provide an opportunity to examine most aspects of highway geologic profiles. Strike-line highways exhibit a limited stratigraphic range of units along outcrop belts, and only portions of thick units will be exposed along the route. In dip-line studies the formations are traversed completely, but the formation can only be illustrated once. Oblique-line highways are an intermediate case.

The greatest difference between highway profile studies and areal geologic studies is that individual lithology is plotted on the profile, whereas on geologic maps only contacts between lithologic units are plotted. Exposures along a highway are rarely sufficient to provide good stratigraphic continuity, and a considerable amount of inference by the geologist is required. Greater accuracy could be obtained by an extensive drilling program. It should be emphasized that the geology depicted on the profile is not as accurate nor as detailed as the engineer desires. The profiles may be compared to regional lithologic mapping, and they serve as a base for detailed studies in limited areas.

The successful use of geology in highway engineering depends to a great extent on the highway engineer. Also, he is in the best position to offer criticism of the work already done. The engineer should offer specific suggestions which the geologist can use as guides in planning future studies. It would be advantageous to team geologists and engineers in various projects so that each could benefit from the knowledge of the other.

DRILL HOLE RECORDS

Drill Hole 1—2460+00 N.R.H. 215C, Plate 1, Alcorn County.
Elevation: 420 ft.

Thickness Feet	Depth Feet	Description
		Quaternary Terrace
9	9	Clay, orange, silty
6	15	Sand, red-brown, fine-grained, clayey.
		Coffee
4	19	Sand, gray, fine-grained, very clayey, water-bearing
10	29	Sand, blue-gray, fine-grained, glauconitic, water-bearing.

Drill Hole 2—2259+00 P.W.S. 1043-R-67, Plate 1, Alcorn County.
Elevation: 427 ft.

Thickness Feet	Depth Feet	Description
4	4	Fill
		Demopolis
5	9	Clay, dark-gray, sandy
10	19	Clay, tan, calcareous
11	30	Marl, blue-gray, fossiliferous, sandy near base
1	31	Sandstone—possibly fossil bed—returns poor, cemented nodules on auger.
		Coffee
3	34	Sand, brown, fine-grained, slightly glauconitic
5	39	Sand, blue-gray, fine-grained, glauconitic, fossiliferous.

Drill Hole 3—1975+00 P.W.S. 1043-R-67, Plate 1, Alcorn County.
Elevation: 450 ft.

Thickness Feet	Depth Feet	Description
4	4	Fill
		Demopolis (?) or *Quaternary*
10	14	Clay, dark-brown, silty
10	24	Clay, dark-brown, lignitic, gray streaks.
		Coffee
10	34	Sand, brown, medium-grained, slightly glauconitic, water-bearing
10	44	Sand, blue-green, medium-grained, glauconitic, water-bearing
1	45	Clay, brown, lignitic, plastic.

Drill Hole 4—1836+50 N.R.H. 215B, Plate 1, Prentiss County.
Elevation: 455 ft.

Thickness Feet	Depth Feet	Description
4	4	Sand fill
		Coffee
5	9	Sand, tan, fine- to medium-grained, glauconitic (?)
5	14	Sand, brown, fine- to medium-grained, glauconitic (?), water in last 2 feet.

Drill Hole 5—1672+50 N.R.H. 215B, Plate 1, Prentiss County.
Elevation: 495 ft.

Thickness Feet	Depth Feet	Description
6	6	Clay, orange and gray mottled, weathered Demopolis?
		Demopolis
10	16	Marl, blue, micaceous, fossiliferous
1	17	Shell bed
7	24	Marl, blue, sandy, micaceous, fossiliferous.
		Coffee
12	36	Sand, marly, water-bearing
3	39	Sand, gray, medium-grained, water-bearing.

Drill Hole 6—168+00 F.A.P. 233D, Plate 2, Lee County.
Elevation: 267 ft.

Thickness Feet	Depth Feet	Description
4	4	Fill
		Quaternary Terrace
13	17	Sand, orange and gray, fine-grained, clayey, water-bearing.
		Demopolis
7	24	Clay, tan, calcareous, highly weathered, samples poor.
		Mooreville
10	34	Marl, blue, micaceous. Arcola member not recognized in augering.

Drill Hole 7—19+00 F.A.P. 253D, Plate 2, Lee County.
Elevation: 243 ft.

Thickness Feet	Depth Feet	Description
		Quaternary Terrace
16	16	Sand, orange and gray, fine-grained, clayey, water-bearing.
		Mooreville
3	19	Marl, blue-gray, micaceous.

Drill Hole 8—520+00 DA-WC 7-(1), Plate 2, Lowndes County.
Elevation: 200 ft.

Thickness Feet	Depth Feet	Description
		Quaternary alluvium
12	12	Clay, gray and tan, silty, slightly sandy
9	21	Sand, gray, fine-grained, micaceous, water-bearing
2	23	Gravel, (poor sample).
		Eutaw
1	24	Sand, gray-green, fine-grained, glauconitic, micaceous, clayey.

Drill Hole 9—576+00 DA-WC 7-(1), Plate 2, Lowndes County.
Elevation: 230 ft.

Thickness Feet	Depth Feet	Description
		Tombigbee
24	24	Sand, red-brown, fine-grained, clayey, weathered
10	34	Sand, gray-green, fine-grained, glauconitic, micaceous.

Drill Hole 10—1016+00 SP 82-1172(1), Plate 3, Lowndes County.
Elevation: 181 ft.

Thickness Feet	Depth Feet	Description
4	4	Fill
		Mooreville
26	30	Marl, blue-gray, fossiliferous, micaceous, sandy at base.
		Tombigbee
1	31	Shell bed
3	34	Sand, blue-gray, fine-grained, glauconitic, marly.

Drill Hole 11—909+00 F.A.P. 301-B (2), Plate 3, Lowndes County.
Elevation: 194 ft.

Thickness Feet	Depth Feet	Description
4	4	Fill
		Demopolis
5	9	Clay, highly weathered, tan, calcareous
7	16	Marl, tan, silty, slightly micaceous, fossiliferous.
		Arcola?
1	17	Soft limestone.
		Mooreville
2	19	Marl, blue-gray, silty, fossiliferous, slightly micaceous.

Drill Hole 12—208+00 P.W.S. 1043-R-113, Plate 3, Noxubee County. Elevation: 173 ft.

Thickness Feet	Depth Feet	Description
		Bluffport (?)
7	7	Clay, tan, calcareous, sandy, weathered.
		Demopolis
5	12	Clay, dark-tan, silty, slightly micaceous, weathered
8	20	Clay, olive, calcareous, fragments of chalk
30	50	Chalk, white to tan and gray, dense.

Drill Hole 13—85+00 P.W.S. 1043-R-107-F, Plate 3, Noxubee County. Elevation: 210 ft.

Thickness Feet	Depth Feet	Description
		Quaternary Terrace
7	7	Clay, orange-brown, silty, calcareous at base.
		Ripley and Bluffport
8	15	Marl, light-tan, micaceous
35	50	Marl, light-blue-gray, fossiliferous, micaceous.

Drill Hole 14—353+00 F.A.P. 107-A Re-opened, Plate 4, Kemper County. Elevation: 310 ft.

Thickness Feet	Depth Feet	Description
		Naheola
22	22	Sand, red-orange, fine-grained, micaceous, clayey in streaks.
		Matthews Landing
8	30	Greensand marl, dark-gray to green, clayey, slightly fossiliferous. Hard streak at 30′ auger could not penetrate.

Drill Hole 15—5+25 F.A.P. 110 Re-opened, Plate 4, Lauderdale County. Elevation: 227 ft.

Thickness Feet	Depth Feet	Description
		Nanafalia? Fearn Springs?
17	17	Clay, tan to gray, silty, streaks of lignite, streaks of fine-grained sand and some coarse sand.
		Naheola
30	47	Clay, blue-gray, highly micaceous, considerable amounts of sand, fine-grained, angular; some lignite. Clay and sand alternate
3	50	Sand, tan, fine- to medium-grained, micaceous.

Drill Hole 16—760+00 N.R.H. 30, Plate 4, Lauderdale County.
Elevation: 245 ft.

Thickness Feet	Depth Feet	Description
		Nanafalia
14	14	Sand, orange-red, fine- to medium-grained, slightly micaceous
10	24	Silt, gray-brown with streaks of bluish-gray clay, micaceous
17	41	No returns—water with lignite stain
8	49	No returns—augered like clay.
		Fearn Springs?
15	64	No returns—augered like sand.

Drill Hole 17—350+00 F.A.P. 107-C, Plate 4, Lauderdale County.
Elevation: 390 ft.

Thickness Feet	Depth Feet	Description
		Quaternary Terrace
9	9	Sand, orange, fine-grained, water-bearing.
		Tuscahoma
5	14	Water—no returns
5	19	Lignite and clay—poor returns
18	37	Clay, plastic, dark-brown to black, lignitic
2	39	Streaks of sand
10	49	Clay, dark-brown to black, lignitic.

Drill Hole 18—248+00 F.A.P. 107-C, Plate 4, Lauderdale County.
Elevation: 370 ft.

Thickness Feet	Depth Feet	Description
		Quaternary alluvium
9	9	Clay, silty, tan, and gray and orange mottled silt.
		Tuscahoma
5	14	Sand, light-gray, fine-grained, slightly micaceous
5	19	Sand, light-gray, medium-grained, water-bearing, lignite at base
5	24	Clay, bluish-green, plastic
15	39	No returns—augered like sand with clay streaks
10	49	Clay, dark-gray to brown, lignitic, slightly sandy and micaceous.

Drill Hole 19—152+00 F.A.P. 107-C, Plate 4, Lauderdale County.
Elevation: 345 ft.

Thickness Feet	Depth Feet	Description
		Quaternary alluvium
12	12	Clay, tan, silty.
		Tuscahoma
17	29	Poor returns—silt, tan and light-gray, water-bearing
10	39	Clay, gray to brown, plastc, lignitic, slightly micaceous
10	49	Clay, bluish-green and brown, plastic, lignitic, sandy.

Drill Hole 20—109+00 F.A.P. 107-C, Plate 4, Lauderdale County.
Elevation: 360 ft.

Thickness Feet	Depth Feet	Description
		Quaternary alluvium
14	14	Silt, red-orange, clayey, sandy.
		Tuscahoma
5	19	No returns
5	24	Clay, tan, plastic, silty, micaceous
10	34	Silt, tan
10	44	Silt, bluish-gray
5	49	Sand, bluish-gray, fine-grained, micaceous.

Drill Hole 21—72+50 F.A.P. 107-D, Plate 4, Lauderdale County.
Elevation: 343 ft.

Thickness Feet	Depth Feet	Description
14	14	Fill and alluvial clay.
		Tuscahoma
15	29	Clay, bluish-gray, plastic, micaceous
5	34	Sand, bluish-gray, fine-grained, hard streak at base.

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LEGEND

Profile After Mississippi State Highway Department

Geology By Donald M. Keady

GENERAL SYMBOLS

Highway profile

Definite unit contact

Topographic profile

Indefinite unit contact

5

Drill hole

Contact between bedrock and prominent surficial deposits

BASIC LITHOLOGIC SYMBOLS

Gravel

Sand, coarse-grained

Sand, medium-grained

Sand, fine-grained

Silt

Clay

Limestone

Chalk

Marl

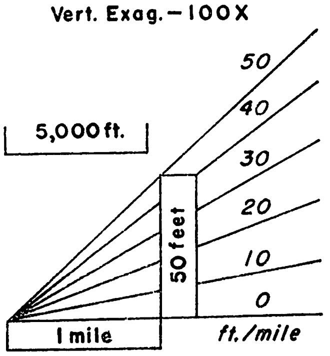
Fossil "Reef"

Glauconite

Lignite

SCALE & RATE OF DIP

Vert. Exag.—100X



GEOLOGIC PROFILE ALONG U.S. HIGHWAY 45 FROM TENNESSEE LINE TO VERONA, MISSISSIPPI

GEOLOGIC PROFILE ALONG U.S. HIGHWAY 45 FROM VERONA TO COLUMBUS, MISSISSIPPI


GEOLOGIC PROFILE ALONG U.S. HIGHWAY 45 FROM COLUMBUS, MISSISSIPPI TO NORTHERN KEMPER COUNTY
STRIP MAP ON PLATE 4
OVERLAP FROM PLATE 4
KEMPER COUNTY
NOXUBEE COUNTY
LOWNDES COUNTY
Shuqualak
Macon
Brooksville
PORTERS CREEK Clay
CLAYTON Formation
PRAIRIE BLUFF Formation
RIPLEY FORMATION
BLUFFPORT Marl Member
DEMOPOLIS Formation
MOOREVILLE Formation
EUTAW Formation
alluvium
terrace deposits
INFERRED FAULT or FAULT ZONE
LEGEND
Profile After Mississippi State Highway Department
Geology By Donald M. Keady
GENERAL SYMBOLS
Highway profile
Topographic profile
Drill hole
Definite unit contact
Indefinite unit contact
Contact between bedrock and prominent surficial deposits
BASIC LITHOLOGIC SYMBOLS
Gravel
Sand, coarse-grained
Sand, medium-grained
Sand, fine-grained
Silt
Clay
Limestone
Chalk
Marl
Fossil "Reef"
Glauconite
Lignite
SCALE & RATE OF DIP
Vert. Exag.—100X
5,000 ft.
1 mile
50 feet
ft./mile

GEOLOGIC PROFILE ALONG U.S. HIGHWAY 45 FROM SOUTHERN NOXUBEE COUNTY TO MERIDIAN, MISSISSIPPI