Geologic Study Along Highway 16 From Alabama Line to Canton, Mississippi

BAHNGRELL W. BROWN

Prepared in cooperation with the Mississippi State Highway Department

BULLETIN 89

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
May 23, 1960

Hon. James R. Park, Chairman, and
Members of the Geological Survey Board

Gentlemen:

Herewith is Mississippi Geological Survey Bulletin 89, Geologic Study Along Highway 16 From Alabama Line to Canton, Mississippi, by Bahngrell W. Brown.

The splendid cooperation of the Mississippi State Highway Department through Mr. H. O. Thompson, Chief Testing Engineer, and Mr. Clyde Clark, Highway Department Geologist, are very much appreciated. I sincerely hope that other such reports beneficial to both organizations can be prepared in the future.

The author points out the necessity of studying many more outcrops than those along the highway right-of-way. Even so the disadvantage of working a confining area is evident. In fairness to all, I must state here that the time limitation as well as the extremely small Survey staff did not permit the author to review carefully the regional geology nor was close supervision possible. In the main, the report is very good, nevertheless, it does not commit the State Geological Survey to all its conclusions. It should also be noted that the purpose of the report was well carried out.

This highway was particularly good for study due to the fact that it traversed a large part of the geologic column of Mississippi. The outcropping formations range from the Demopolis of the Selma Group to the Yazoo of the Jackson Group.

The dedicated manner in which Dr. B. W. Brown went about this task is hereby acknowledged.

Respectfully submitted,

Tracy W. Lusk

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GEOLOGIC STUDY ALONG HIGHWAY 16 FROM ALABAMA LINE TO CANTON, MISSISSIPPI

BAHNGRELL W. BROWN

ABSTRACT

A study of the geomorphology, stratigraphy, and structure along Mississippi Highway 16 from the Alabama line to Canton, Mississippi is presented in such a fashion as to benefit both the geologist and the highway engineer. The stratigraphy and geomorphology involves geologic units belonging to the Cretaceous and Tertiary systems.

Except for a hypothetical fault east of Philadelphia, the profile does not indicate any significant secondary structure.

The "Meridian" sand, a very important topping material, was not found to be clearly recognizable as a unit, especially questionable was the lower boundary. Also the overlap idea used by some workers is reviewed.

Two discrete beds, a lower "swashy" clay-breccia and an upper clay-ball conglomerate, were noted in Kemper and Neshoba Counties along the strike of the Wilcox beds. These were traced from Alabama to Tennessee; however, they were not found everywhere. It is concluded that these channel deposits should not be ignored in mapping. It is believed that they may be important clues to stratigraphy, especially as they seem to occupy stratigraphic positions with moderate channel relief.

Sands suitable for topping are thickest in the Kosciusko, Neshoba, "Meridian", and lower Nanafalia ("Fearn Springs") formations. Sands are also present in the lower Cockfield and Tuscahoma.

INTRODUCTION AND ACKNOWLEDGMENT

This Mississippi Highway 16 profile study was undertaken under a cooperative agreement between the Mississippi Highway Department and the Mississippi State Geological Survey. Field work was carried out during the summer of 1959 under the supervision of Mr. H. O. Thompson, Testing Engineer, Mississippi Highway Department, and Mr. Tracy W. Lusk, Director, Mississippi State Geological Survey. Drilling along the highway was made possible through the efforts of Mr. W. E. Sneed,

District Test Engineer, and Mr. J. L. Rees, District Engineer, for the Highway Department. The writer is also indebted to Mr. Clyde Clark, Geologist, and other personnel of the Highway Department for much kind consideration shown through-

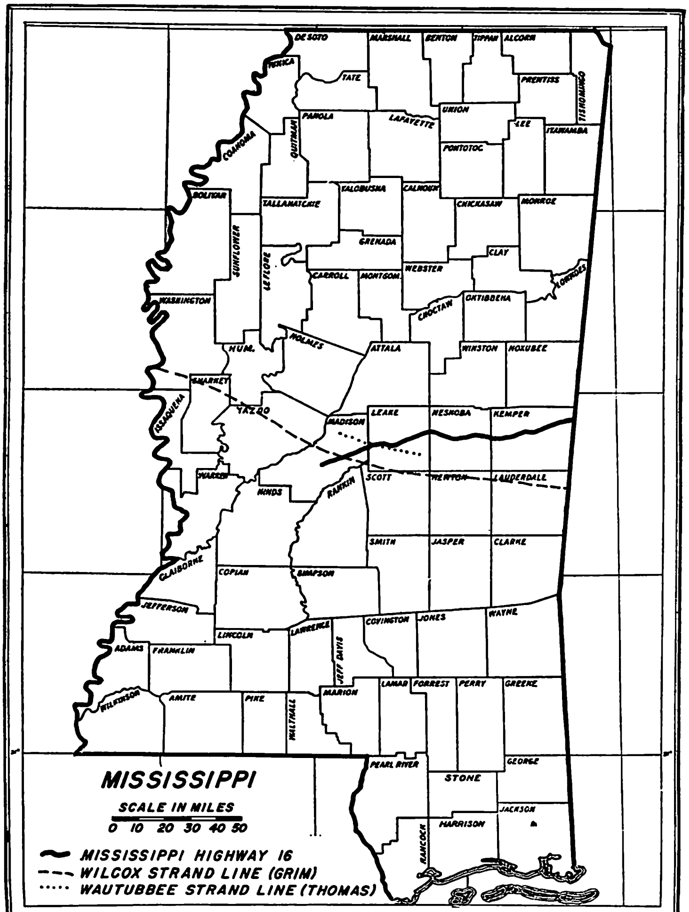

Figure 1

out the project. Dr. R. R. Priddy was in the field with the writer for several days, and special thanks are due him for revealing many exposures of the Cockfield formation in Madison County which proved to be keys to the stratigraphy along a portion of the highway. Mr. William S. Parks was very helpful in the study of Calhoun County clay ball structures.

The guiding principle throughout the project has been to seek out information concerning the geologic situation along route 16 and to present this in such fashion as would be of benefit to both supporting agencies. To accomplish this purpose it was necessary to leave the linear confines of the road many times, seeking a three dimensional perspective of the earth's crust along the route. Much of the geology is poorly exposed along the right of way and is better exposed at other places. It was on the basis of many lateral excursions from the highway that geologic "blind spots" in the profile were filled in with reasonable assurance of their lithology. Drilling also opened up some of these blind areas where road cuts did not adequately reveal the lithology.

In 1895 N. S. Shaler[15] stated briefly but strongly reasons for a closer alliance between the highway builder and the geological profession. *"All land transportation routes are, as regards their location, construction, and maintenance, profoundly affected by geological conditions, by the state of the earth over or through which they are made, by the character of the soil or the underlying rock, by the way in which the materials are affected by frost and rain and the pressure of wheels and of the feet of animals, and by the contours which the geological history of the region has impressed upon it. Only by knowing and considering these earth conditions is it possible to build and keep roads of good character at moderate expense. It therefore seems worth while to make some inquiry into the geological conditions of highways and to gather and set forth the knowledge which the earth science has to impart concerning them."*

Despite these glowing predictions, it must in all fairness be conceded that modern highway building is a highly specialized engineering art, which has become very successful in spite of too little geologic assistance. Experience has proven, however, and far-sighted engineers are very much aware, that there are degrees to this success, and that still better highways can be constructed and maintained more cheaply with more geological assistance.

Ways in which the geologist's special training can be utilized by the highway engineer have been reviewed by E. F. Bean.[3] Through this paper we can arrive at the heart of cooperation between two antipodal professions, geology and engineering. Engineering, on the one hand, is *"concerned with the behavior of that portion of the earth's crust which is at or near the surface"*[3] and has a practical use in view. On the other hand, the geologist is interested in the entire crust and its history. He often wishes that those surface materials which obscure his view were not there. The surface is of incidental interest as it fits his purpose. The only practical end in view normally disregards any ultimate use of earth materials unless specifically called for under the heading of economic geology. The geologist concentrates on the acquisition of pure knowledge to promote science.

In serving highway purposes the geologist must recognize that the average engineer has neither the opportunity nor the inclination to acquire adequate geological training. To better establish channels for communication there has been added, as an appendix to this report, a glossary of geologic terms for the highway engineer. Only terms used in this report have been included in the glossary.

ALABAMA TO PHILADELPHIA

GEOMORPHOLOGY

Once the decision to make a road is made and the general route is determined, four essentially geological engineering problems must be faced. These are: (1) The utilization or modification of the natural geomorphic gradients of topography by cut and fill in order to establish desired lines and grades over the exposed rock strata; (2) the character and structure of the road base or natural foundation supporting the road structure which will, of course, vary with the exposed geology and may as a result require corrective measures; (3) drainage and the effect of rock formations in the establishment of local and regional drainage systems and also on sub-grade drainage in the roadbed itself, and (4) the economic location of suitable materials of the earth's crust for construction purposed, such as asphalt, cement rock, sand, gravel, etc., with which to effect the road.

In all the above problems it may be noted that the engineer is mostly interested only in the surface and near surface of the landform. It is quite a common error to imagine the upper fifty feet or so of engineering interest to be a layer like soil having continuous lateral extent. Such a situation would exist where rocks maintain perfect horizontality, which is in few places. We can readily observe, for instance, that rock strata along Highway 16 do not parallel the surface in general but dip away, downward, and southwesterly. (Plates 1 and 2).

Frequent reference throughout this report will be made to Plates 1 and 2. At this point their construction should be explained. The profiles were designed with the dual reader in mind. For the engineer the survey reference system of his own use has been included. For instance, the Kemper-Neshoba county lines is designated F. A. P. 272-(2) 660 + 00 in accord with the Mississippi Highway Survey. For the geologist an automobile odometer reference mileage of 68.2 miles east from Canton is also given. The highway profile with a vertical exaggeration of 1/10 was the basis of these profiles. Plates 1 and 2 show a vertical exaggeration of 1/100, or ten times that used in highway work. The greater exaggeration was not a scale of convenience but was deliberately selected to bring about the exaggeration of rock dips to reveal any structural anomalies.

By way of further exaggeration all rock units have been projected upward and downward from the profile to reconstruct somewhat the situation prior to their erosion to the present profile elevations. This should serve as a reminder that the present land surface occupies a temporary position between a higher land surface of the distant past and a lower land surface that will surely be reached by erosion in some distant future. The topographic profile we enjoy today, because much of the road conforms to it, is the direct result of erosion acting through the last million years of the Pleistocene and Recent epochs upon the tilted stratified rock formations.

The highest point of Highway 16 is a "mountain" peak 620 feet high at 540 + 00 F. A. P. 272-(1). This is on a cuesta ridge certainly but may also be situated on the fault "scarp" of a hypothetical fault at 610 + 00 F. A. P. 272-(2) (see structure discussion).

Along this portion of Highway 16 considerable relief is to be found between miles 85 and 87. Here the basal sands of the Nanafalia, including "Fearn Springs", support a structural cuesta

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS IN FEET
			Unnamed Pleistocene	15-20
TERTIARY	EOCENE	JACKSON	Yazoo	Incomplete
			Moodys Branch	15
		CLAIBORNE	Cockfield	390
			Wautubbee	61
			Zilpha + Kosciusko	400
			Winona (restricted)	15
			Neshoba	70
			Tallahatta (restricted)	70
		WILCOX	Hatchetigbee + "Meridian"	300
			Tuscahoma	345
			Nanafalia	200
	PALEOCENE	MIDWAY	Naheola	65
			Porters Creek	475
			Clayton	30
CRETACEOUS	GULF	SELMA	Prairie Bluff	30
			Ripley	23
			Demopolis	Incomplete

Figure 2.—Stratigraphic Column from Alabama to Canton.

MISSISSIPPI GEOLOGICAL SURVEY
TRACY W. LUSK, DIRECTOR

GEOLOGIC PROFILE

Mississippi Highway 16 From Alabama to Philadelphia-1959

aided in part by the erosion resistance of a rather persistent horizon of pipey concretions and concretionary sandstone ledges. This ledge was traced southward in the county. A striking three-foot ledge of ferruginous quartzite crops out on the Moscow road.

One noteworthy characteristic of the Wilcox terrane along this right of way is its rugged topography. It is especially rugose where irregularly bedded sands and silty clays are juxtaposed in complex primary structures.

The Cretaceous terrane is rather uniformly rolling. The Prairie Bluff formation is topographically much more subdued than farther north in Mississippi. This may be due in part to its almost gradational lithology.

Other geomorphic relationships that could be noted are described in the general literature of Mississippi geology.

STRATIGRAPHY

The formations between the Mississippi-Alabama line and Philadelphia are the Demopolis, Ripley, Prairie Bluff, Clayton (?), Porters Creek, Naheola, Nanafalia, Tuscahoma, Hatchetigbee, and "Meridian". A mappable but as yet unnamed Pleistocene unit is also present. The Demopolis, Ripley, Prairie Bluff, and Clayton (?) formations are poorly exposed due to a thick cover of loamy soil. Even with the help of auger drilling, boundaries are difficultly discernable and the profile boundaries as marked may be in error as much as 5 feet in vertical direction.

DEMOPOLIS (MILES 99-101)

The best exposure of this material is by no means a good one at 240 + 00. The rock exposed is a gray, moderately glauconitic in part, slightly micaceous marl. One small specimen of *Exogyra cancellata* was found at this location, which greatly aided in finding the upper limit of these beds. A fine sandy clay loam obscures most of the formation.

Demopolis thickness is not maximum on the right of way. Hughes[8] assigns a thickness of approximately 260 feet to the Demopolis chalk of Kemper County.

RIPLEY (MILE 98)

Recognizable Ripley is not exposed on the right of way. For this interval the drill revealed calcareous, clayey, fine tan sand, and sandy clay. Thickness is approximately 23 feet.

PRAIRIE BLUFF (MILE 97)

Where exposed at 130 + 00 the chalk is gray, resistant, and sparsely fossiliferous. The hardness one might expect was not noted in drilling, and the interval was found to be an unfossiliferous but very calcareous, silty, micaceous, gray clay in the drill hole. The boundary between it and the overlying Clayton was taken at the change between slightly calcareous tan sandy clay and the very calcareous silty gray clay encountered in the drill hole (number 20). The thickness of Prairie Bluff beds is approximately 30 feet.

CLAYTON (?) (MILES 96-97)

Clayton beds were not recognizable along the right of way, due to soil cover. Soils were carefully examined for any residual Clayton fossils. None was found. The drilled interval which is thought to be Clayton was a tan, medium, clayey sand with some fine to medium sandy clay. The interval was somewhat calcareous, and the contact with the overlying Porters Creek, which is also calcareous at its base, may be gradational. A thickness of 30 feet was assigned to the "Clayton" interval.

PORTERS CREEK (MILES 87-96)

The Porters Creek is best exposed in the steep hills on the obsequent slope of the "Fearn Springs" (basal Nanafalia) cuesta between 120 + 00 and 380 + 00. Hughes has already detailed the road section between 130 + 00 and 150 + 00 (8,p.103, Figure 21). This treatment is essentially correct. The profile thickness is approximately 475 feet, which is also close to the stratigraphic thickness in Kemper County determined by Hughes (8, p. 100).

NAHEOLA (MILE 86)

Naheola stratigraphy is somewhat obscured by Pleistocene overlap. Its contact with the Porters Creek is well exposed, but its Nanafalia contact had to be verified by drilling. It is composed of micaceous, marcasitic (in drill cuttings only), somewhat lignitic silty clayey sand and silty micaceous clay. The basal portion is extremely muscovitic and carbonaceous, and has a sulphurous odor. Its thickness is 65 feet.

NANAFALIA (MILES 77-85)

The clays which ostensibly separate the Nanafalia sands from the Fearn Springs sands can be demonstrated to be lenticular, and for that reason the writer does not carry Fearn Springs as a mappable unit. There is some evidence that several sands mapped as "Fearn Springs" are channel. Since it is not mentioned by Hughes in Kemper County Geology[8], some mention should be made of the spectacular clay block conglomerate which is present north of the Highway. This is in an area (SW.¼, Sec.32, T.9 N., R.16 E. on Mississippi 39) mapped as "Fearn Springs." In this clearly channel deposit two sorts of clay are found as cobbles and boulders. Close to the contact are cobbles of plastic gray Naheola clay. Above them are large angular blocks, up to 10 feet across, of white non-plastic kaolin (?). The white clay suggests the Betheden aluminous clays and greatly resembles some found in the Betheden terrane. The writer has included Hughes' "Fearn Springs" in the basal sands of the Nanafalia.

The position of the upper contact of the Nanafalia formation is very much in question, partly due to an inconsistency in the literature on Kemper County. Hughes (8, p. 163) cites a location on Highway 16 (at 1110 + 00) for the "top of Nanafalia formation." There can be no doubt concerning his location inasmuch as he offers a photograph (his Figure 47) which is clearly recognizable in the present road condition. In the discussion of the lower Tuscahoma Hughes states (8,p.169) *"the base of the formation (Tuscahoma) locally . . . encloses large angular blocks of bedded silty clay."* Beds of this description are found at 1240 + 00 more than 100 feet stratigraphically below his Nanafalia-Tuscahoma boundary. This is obviously incongruent. Either the "blocky" conglomerate-"breccia" is well within Nanafalia beds, or Hughes is in error concerning the position of the Tuscahoma boundary.

The problem of the Nanafalia-Tuscahoma boundary involved the clay ball problem which is discussed under that separate heading. Correlation of Nanafalia and Tuscahoma boundary beds in Mississippi is dependent on the stratigraphic implications, if any, of the clay ball problem, and must await a more detailed study of the "breccias" and conglomerates of the Wilcox. Meanwhile, the writer has taken the conglomerate and "breccia" bed tentatively as the basal Tuscahoma contact zone.

In the light of the above remarks the Nanafalia formation is essentially medium to coarse red sand associated with lenticular bodies of silty gray clay and beds of very sandy clay. Thickness is approximately 200 feet. This is reasonably close to the thickness assigned by Hughes (230 feet) for Kemper County.

TUSCAHOMA (MILES 62-79)

Silty clays and lignitic clay are very common in Tuscahoma beds. Some medium grained clayey sands are present, also. At the base are coarse to medium cross-bedded sands in association with the "breccia"-conglomerates. In general, however, the sands of the Tuscahoma are finer than those of the Nanafalia. In most places they are gray to brownish tan on exposure, and interbedded with laminated silty gray clay. The lamination of these beds is apt to be penecontemporaneously deformed and somewhat swashy. As a rule the beds are violently contorted and swashy in the vicinity of the channels which carry clay ball "breccias" and conglomerates. In the vicinity of the Highway these contorted and brecciated beds are found only at the base and top of the Tuscahoma formation. Some thin beds of clayey lignite are contained in the lower portion. The top and bottom of the Tuscahoma can be traced for a considerable distance north and south of the Highway on the basis of unconformities marked by channel deposits containing swash "breccias" of silty Tuscahoma gray clays in a sand matrix, and clay cobble conglomerates. In much of Neshoba and Kemper Counties the writer found this stratigraphic relationship to hold. How reliable these marked beds will be found elsewhere in the State will depend upon the amount of channel relief there and the observer's ability to distinguish these contorted beds from other intraformational conglomerates and "breccias" at higher and lower horizons.

Thickness of the Tuscahoma is not greater than 510 feet. If the hypothetical fault (610 + 00) is a reality, then the thickness may be considerably less. How much less is not known, but a reasonable guess would give a thickness of 345 feet—a figure based on a risky lithologic correlation which yielded a stratigraphic throw of 165 feet in the vicinity of the "hypothetical" fault.

HATCHETIGBEE-"MERIDIAN" UNDIFFERENTIATED (MILES 56-61)

Most remarks have been made concerning these formations under the heading of the road from Philadelphia to Canton.

The lower Hatchetigbee beds exposed here are lignitic. "Meridian" sands cap hills west of "Mount" 540 + 00. Some of the orange-red sands east of this "mountain" may also be "Meridian," especially if the hypothetical fault (610 + 00) inference is correct.

PLEISTCENE-PLIOCENE (MILES 85-88)

Sands which overdrape the Nanafalia, Naheola, and Porters Creek beds are related here to Pleistocene time because of their conformity to post-Pliocene topography. These beds are thick enough and important enough to be assigned a formational name. A continuation of this surficial formation was also studied along Sucarnoochee Creek. The Pleistocene residuum is in places similar to the orange-red clayey sands of the lower Claiborne and also the basal Nanafalia. They are, nonetheless, definitely post-Pliocene.

STRUCTURE

It is very easy to find apparent secondary structure along Highway 16, and very difficult to have any confidence in any of the evidence. Diagonal, irregular, and contorted bedding is common in the Wilcox group. Channels, lenses, and pond deposits are numerous. In road exposures reverse dips bring the eager, petroleum-minded geologist to a screeching halt. Such evidence is most likely chimerical. Structural study on this portion of the Highway consisted mostly of weeding out unfit candidates.

The most plausible structure is in the Porters Creek at 145 + 00 F. A. S. 289A-(2). Here a hillside exposure clearly revealed confirmed dips up to 18 degrees and a slickensided fault plane. A detailed study of this section, however, showed a progressive flattening of the dip anomaly upward. It became clear then that since rotation was involved in the structure it had more the aspect of a Mohr's envelope fault belonging to a slump block. Rotational faults might be expected in Alpine structures but not in the normally faulted Gulf coastal plain area. Hughes (8, p.105) also thought this slumping.

Of all the anomalous dips in the Wilcox, one reverse dip at 610 + 00 F. A. P. 272-(2) in Tuscahoma beds attracted special attention. The topography for several miles east of that station is tilted eastward with the dip of the beds. The "mountain" to the west of the station is another feature that could be more easily explained by faulting. Lignitic clays and red clayey sands east of the station resemble as much "Meridian" and Hatchetigbee beds as they do Tuscahoma. Without some faulting the Wilcox would be thicker than could be expected. These and other more nebulous reasons led the writer to infer a hypothetical fault with an imagined stratigraphic throw of 165 feet. Only geophysical work could verify or disprove this.

The inflection between mile 61 and 62 is due to change in road bearing and is not structural. All other "structures" on this road section are thought to be primary structures and not of any special interest to the economic geologist.

PHILADELPHIA TO CANTON

GEOMORPHOLOGY

It was because of differences in erodability that the profile is now varied. For instance, the belt of Neshoba and Tallahatta formations has been dissected by erosion to give a cuesta "mountain" ridge. Similar "mountains" have been carved by untold millions of rains from similar strata where the new Mississippi Highway 19 east of Zama crosses the Neshoba-Tallahatta outcrop belt. By similar processes, a prairie type topography has been developed on the Yazoo clays of Madison county east of Canton that is a continuation of the Jackson Prairie. The relations of landform and scenery of Mississippi to the bedrock geology have been thoroughly discussed in early Bulletins of the Mississippi Geological Survey and so there is no reason to review the subject. The above examples of topographic-geologic relationship are sighted just to point out that geomorphic relationships are also to be found along the Philadelphia-Canton route.

An excellent example of the effect which geology has had upon the profile and related highway problems is found in the section bounded by the Pearl River Bridge on the west and the west corporate limit of Philadelphia on the east (F. A. P. 206 B—mile 43 to mile 54). Strata are dipping in the direction of the road westward from 20 to 25 feet per mile. True dip (see glossary) would be closer to 40 feet per mile and would be measured in a southwest direction and not road bearing. The road is somewhat diagonal to dip and strike lines here. A grade equivalent to 25 feet per mile is less than half of one percent. It will be noted that there can be no direct protractor scale reading of dip from this profile. Dips may be calculated from the angular reading, however. Many sorts of grade information can be obtained from the profile, as follow: (1) Road grades—highway profile; (2) landform grades—topographic profile; (3) geologic grade or attitude of strata—geologic profile; and (4) stream grades—represented mostly through elevation of stream cross sections at the various bridge crossings.

This section of the road represents the "mountainous" topography on the Tallahatta cuesta. It can be seen that the highway profile and the landform profile nearly coincide. Only the peaks of the "mountains" have been cut away for smoothing of sharp grade inflections in the natural profile. The engineer must always balance against cost of construction and necessity anything he might do by way of alteration of the natural profile. Therefore, the highway eastward from the bridge at 510 + 00 to the road at 230 + 00 N. R. H. 206 B, crosses a serrate topography, resembling in profile the jagged teeth of a timber saw, groups of shallow notches being separated by deeper notches (A, B, C, and D). In spite of this mature dissection which has left exposed very little of the dip slope of any one stratum, the trained geomorphologist has no difficulty in recognizing the original undissected cuesta form. It is apparent that the resistant "buhrstone" ledges of the Tallahatta formation have interrupted the entrenchment of the gullies between mile 44 and mile 49. From mile 49 to mile 55 is the steeply dissected back slope or obsequent side of the cuesta. Panther Creek and Kentawka Creek have cut well below the Tallahatta beds. Inasmuch as the hills at mile 49 represent the crest of the dissected cuesta, and because Kentawka Creek is cut more than 100 feet below the lowest Tallahatta beds, it would not be likely that materials of the Tallahatta and Neshoba formations would be encountered in place east of Kentawka Creek, and they are not. Many sands east of Kentawka Creek at first glance resemble Neshoba, but closer scrutiny reveals subtle differences.

West of the Pearl River crossing (206-A) the Tallahatta formation dips into the subsurface until it reaches at Canton a depth of approximately 1,000 feet. It may be seen that mile 42 and mile 53 represent the limits along this right of way for any possibility of encountering Tallahatta buhrstone at the depths of highway work. This example is cited not because the writer believes the Tallahatta beds offer usable highway materials, but because it illustrates what can be expected with precise stratigraphic information.

E, F, and G represent outliers of Tallahatta. Outlier E shows nearly a full thickness of Tallahatta. Outlier G has only residual float remaining and represents a wedge edge or "last bite" of the formation. Such truncation by erosion normally signifies that further material will not be found in the direction of thinning.

The principal physiographic features along Highway 16 from Canton to Philadelphia are the Jackson Prairie developed on the clays of the Yazoo formation, the wooded rolling sand and silt hills of the Cockfield and Kosciusko formations, the heavily forested "mountains" of the Neshoba and Winona red sands held high and airy on the Tallahatta cuesta, and the Hatchetigbee-Meridian bench on which is founded the city meaning brotherly love (Philadelphia).

STRATIGRAPHY

The formations between Philadelphia and Canton are the Hatchetigbee, "Meridian", Tallahatta, Neshoba, Winona, Zilpha (?), Kosciusko, Wautaubbee, Cockfield, Moodys Branch, and Yazoo. Some probable Pleistocene materials are also present. Although there is reason to think the Hatchetigbee and "Meridian" beds may be separable, they are not clearly differentiated in this area. As a unit distinct from the Kosciusko, the Zilpha is also a questionable formation here.

GEOLOGIC PROFILE
Mississippi Highway 16 From Philadelphia to Canton-1959

HATCHETIGBEE-"MERIDIAN" (MILES 50-55)

The Hatchetigbee formation includes tan to orange-red, cross-bedded medium sands, gray plastic silty clays, and gray to chocolate lignitic clays. In many respects it is indistinguishable in its general lithology from the underlying Tuscahoma.

The "Meridian" sand is a medium to coarse in part, tan, yellow to orange-red, washing white, sub-rounded, micaceous sand, in many places cross-bedded (but not everywhere), and varying in resistance and clay content. In places it contains lenses of Tallahatta olive-gray silty clay in the upper portion and also becomes more glauconitic and less micaceous where the Tallahatta is reached.

Toulmin[18] includes the "Meridian" sands in his Hatchetigbee of Choctaw County, Alabama. In Mississippi, heretofore, the "Meridian" has been considered by some to be a member of the Tallahatta formation. The alliance of the upper "Meridian" sands with the Tallahatta claystones is cogent. This is revealed by drilling along Highway 16 (drill holes 12, 13, and 14). South from 16 on Mississippi Highway 19, 9.9 miles, is an excellent highway exposure indicating clearly the intertonguing of Tallahatta and "Meridian" beds. Coarse gravelly cross-bedded lenses of "Meridian" type sand give way laterally to interdigitate beds of sands and shales with large marine borings. The problem is not one of the relationship of the "Meridian" sand member with the Tallahatta but of its relationship with the Hatchetigbee. Until some basis for clear delineation of that lower boundary is learned, one should not be too hasty in assigning the "Meridian" sand member *in its entirety* to the Tallahatta formation. Grim[4] found a transition zone between the "Grenada" (Hatchetigbee equivalent) beds and the Tallahatta-like claystone and questions Cook's[5] Claiborne overlap.

If, on the other hand, the "Meridian" has as much overlap as suggested by Vestal[19] in Marshall and Union Counties, where he presumably finds it on Naheola and Porters Creek, it is also unconformable on Hatchetigbee. However, if Vestal's "Meridian" beds have sufficient overlap in his area of study to extend beyond the entire Wilcox section, then the hiatus he has found raises serious questions for the overall stratigraphic picture of the region. In Alabama, for instance, the Meridian sands are all but absent but Wilcox beds continue in their marine facies. If there was a pre-Meridian erosion cycle in North Mississippi which resulted in stripping or non-deposition of the entire Wilcox section on strike line, where is there like evidence in Alabama or Texas on strike line? Where, also, are there deposits in the embayment corresponding to this interval of erosion. If one should go to the central Rocky mountains (a region of much relief and continental beds in Eocene times) we would find no support there for mid-Eocene stripping of early Eocene beds. Hiatus of the magnitude under discussion is usually referred to post-mid-Pliocene uplift. The possibility has already been recognized that some early Tertiary beds of Mississippi may in reality be Pleistocene in age.

It will take a great deal more work than that involved in the scope of this report to solve the "Meridian"—Hatchetigbee problem. The writer feels that the answer may lie in Neshoba County but will not be forthcoming without a complete restudy of the geology of Winston County. Also, some brave geological soul should work out the details of Pleistocene-Pliocene history in Mississippi in order to eliminate any possibility of correlating late stratified sands with Tertiary beds.

"Meridian" exposures extend from 205 + 00 NRH 206 B to a poorly exposed contact just east of Philadelphia. "Meridian"-like outliers, which may be either Pleistocene or Eocene, are found as far as 30 miles east of Philadelphia.

The thickness of the "Meridian" and Hatchetigbee could not be determined separately. The total thickness of both is approximately 300 feet.

TALLAHATTA (MILES 49-52)

This formation consists of 65-70 feet of contiguous olive-drab, silty, micaceous, thin-bedded clays and silty shales, with intercalated thin ledges of lenticular arenaceous siltstone, and several prominent ledges up to 2 feet of buff-gray buhrstone (arenaceous lutite). Non-contiguous Tallahatta materials lie below the contiguous as lenses in "Meridian" sand. The restricted Tallahatta used in this report includes only the contiguous beds. So restricted, it probably does not represent the entire section of Alabama but only the "Basic" facies of Mississippi.

Grim[6] gives (pp.50-51) the log of a well in Leake County drilled by Pittsburg Oil Company (Stoll [sic, Stall ?] No. 1 well, Sec. 32, T.17 [sic, 12], R.7) in which, with the aid of samples, he made correlations with the Claiborne and Wilcox. Because this well location is only a few miles north of Highway 16 it is interesting to note that he does not include the soft sands of the "Meridian" in the basal Claiborne but in the upper Wilcox. Thomas[17] also preferred to omit the "Meridian" sands (his C profile), a situation similar to that at 130 + 00 NRH 206 B of Plate 1. His interpretation of this body as a *"small estuary on the Meridian deltaic plain"* may be in error. Grim[7] gave those sediments immediately below the Tallahatta (Meridian sands excluded by him from the Tallahatta) a lagoonal interpretation. Not only are Tallahatta clay and siltstone found in the "Meridian", but very coarse "Meridian" sand (at the locus cited south of Philadelphia) is found in the Tallahatta. These relationships are also on Highway 19 northwest of Arlington and on 429 west of House. The intercalation of marine clays and coarse, well sorted somewhat cross-bedded sand indicates nothing more nor less than periodic flooding of terrigenous sediment into a transgressive Tallahatta sea.

NESHOBA (MILES 40-50)

The Neshoba was first recognized as a mappable unit by Thomas[17] and named for the town of Neshoba (actual outcrops are nearer to Linwood). It is undoubtedly included in much of the Winona of earlier workers.

At Highway 16 it is about 70 feet thick with 15 to 20 feet of overlying Winona. It is mostly soft, medium, micaceous, gray, buff, tan to red, sub-rounded sand. It is orange-red and quite clayey at the top. Both the clay and color are thought to be eluvial from overlying Winona beds. In its mid section the Neshoba has a discontinuous body of Zilpha-like clay or clay and sand beds intercalated. This same horizon appears in exposures of Neshoba sand elsewhere in the county.

There is no reason to think Neshoba is not conformable along Highway 16. However, in an exposure on Mississippi 14, 20.5 miles west of Louisville, Neshoba sands rest with definite unconformity on Tallahatta clays.

It is thought that Priddy's[13] lower Winona is equivalent to Neshoba. Whereas the upper or shelly part of the Winona can be traced with more or less constant thickness (15-30 feet) from Tallahatchie County to Lauderdale County, the Neshoba and its equivalent in the unrestricted Winona thins from 70 feet to 0 feet southeastward along the same strike line. It would appear that the Neshoba bears the same relationship to the Winona shelly transgression that the upper "Meridian" bears to the Tallahatta transgression. In point of fact, the lithologic similarity of the two sands is sometimes confusing and one often thinks of them as pre- and post- Tallahatta sands. In view of this, certainly Lowe's[10] original error in correlating Winona (inclusive of Thomas' Neshoba) with "Meridian" is most understandable. Even though, as is now known, these formations are not time correlatives, they do represent similar sedimentary cycles. In the time sense it is doubtful whether the Neshoba should carry formational rank. It is an excellent mappable unit, however, and whether in its member status it belongs to the regressive Tallahatta phase, the transgressive Winona phase, or to both is after all academic. It is quite possible that the Neshoba and "Meridian" lithologic units are hemi-members and that time lines should not be drawn above or below, but through them.

WINONA (MILES 38-41)

Winona beds can be distinguished from the Neshoba formation, even though the contact is somewhat gradational, by means of their greater resistance, higher clay content, large amount of greensand giving weathered outcrops a red-brown appearance, and thin irregular ferruginous ledges. The upper part of the Winona is characterized by discontinuous, very glauconitic, in many places silicified, ledges containing fossil molds and casts. Though discontinuous, these ledges are easily traced for great distances north and south of the highway.

These beds, which are 15 to 20 feet thick, conformably overlie the Neshoba sand and are disconformably overlain by either Zilpha or Kosciusko. The lower contact with the softer, micaceous, tan, reddish and here and there washed-white Neshoba sand is in many places obscured by downward eluviation of red ferruginous clay into the upper Neshoba, so that upper Neshoba at a number of localities resembles Winona beds. The

Winona is thought to be one of the most reliable geologic horizons on this Highway.

ZILPHA (?) (MILES 37-38)

Unless the slightly glauconitic sands encountered in drill hole 9 are a phase of the Zilpha, this formation is discontinuous over the Winona. The presence of Zilpha-like clays higher in the Kosciusko is suggestive that the Zilpha may be a facies of the Kosciusko. Along Mississippi Highway 16 the "Zilpha" clays are gradational with Kosciusko sands. No measurable section of Zilpha could be found near the right of way. The Zilpha interval has been included in the measurement of the Kosciusko formation.

KOSCIUSKO (MILES 26-37)

Due to the confluence of the Pearl River and Lobutcha Creek drainages and floodplains, together with the obscuring factors of terrace deposits and the municipal area of Carthage, the Kosciusko formation is very poorly exposed along Highway 16.

The Kosciusko formation comprises a thickness (inclusive of any Zilpha beds which may underlie it) of approximately 400 feet. It is mostly a bedded to cross-bedded, medium, subangular to sub-rounded, tan to red, gray to buff sand with frequent lenses of coarser sand or flaky clay pellets and stringers. Within it are bodies of very clayey sand, sandy clay, and chocolate to gray plastic Zilpha-like clay. Toward the bottom is a striking horizon of vertical sandy clay and silty clay filled soft sand pipes. A similar lithology also belongs to the lower Cockfield (at 1315 + 00 F.A.P. 102 B-1) near its Wautubbee contact. For exposures of this unique lithology in the lower Kosciusko, reference is made to cuts occurring just north of the Highway at 175 + 00 F.A.P. 104-3, or exactly 0.2 mile northwest of 16 and on old 16. It is felt that these clay pipes represent shoaling and may have considerable stratigraphic significance. The reader is referred to the Wautubbee strand line (Figure 1) which has been reconstructed from notes by Thomas[17] principally with additions from Bergquist[4] and personal field observation in Neshoba and Scott Counties.

North of the Highway, toward Kosciusko, the sands are more cross-bedded, more micaceous, and the Zilpha, where exposed, is apparently definitely formational, with clear cut separation from the Kosciusko sands.

Thomas[17] states that the Kosciusko-Zilpha contact is *"conformable and gradational."* It certainly is gradational in the vicinity of this profile. Priddy[14], perhaps to account for the absence of Zilpha where expected, suggested, on the other hand, that the Kosciusko sand is distinctly *"nonconformable"* over the Zilpha. This lack of conformity may actually be intertonguing rather than non-conformity.

In unpublished notes in Survey files Vestal has raised the question which cast further doubt on the continuity of Zilpha beds, by wondering where the Zilpha beds were prior to 1940. Along the traverse of this right of way the Zilpha beds were hiding within the Kosciusko formation as "Sparta" clays.

WAUTUBBEE (MILES 24-26)

Thomas[17] has placed the top of the Wautubbee at the top of the carbonaceous shale section overlying the marls in the area of his study. This same shaly olive-gray to chocolate clay was recognized in the bottoms of drill holes 3 and 4 and the top of drill hole 5. It was also found exposed off the highway in the NW.¼, Sec. 18, T.10 N., R.7 E., and where a county road crosses Sec.33 and Sec.34 of T.11 N., R.7 E. Both locations are near the Highway. No marl was found at any of these locations, but a thin siliceous ledge where the clay is exposed on old Highway 16 as it enters the north half of Sec.16, T.10 N., R.7 E. yielded small worm tubes and one pelecypod print (*Venericardia* ?).

The Wautubbee section, interpreted mostly from drill hole data, is as follows:

30 feet	Sand, medium rounded to sub-rounded, olive-drab weathering red, clayey and glauconitic, very glauconitic towards the base
25 feet	Clay, gray to brown, carbonaceous, slightly micaceous, blocky to shaly
6 feet	Sand, medium to fine, tan, clayey
61 feet	Total

The profile dip near the Wautubbee-Cockfield contact is not due to any large structural disturbance but is mostly due to changes in the road course.

COCKFIELD (MILES 7-24)

The Cockfield and Wautubbee formations along this profile present a problem in themselves. The Wautubbee-Cockfield ecological boundary (Figure 1) is apparently gradational. A seemingly natural lithological break was found in the hills north of the junction of Highways 16 and 13 South, which is marked by a coarse ferruginous sand ledge. When projected to the profile, this lithologic boundary falls in the obscured Yockanookany-Pearl River floodplain. The boundary selected for this report is an arbitrarily chosen ecological boundary and not a formational contact.

Keady[9] states, *"The contact between the Cockfield formation and the underlying Wautubbee formation is conformable and transitional. In eastern Mississippi, where the Cockfield formation rests on the Gordon Creek member, and in central Mississippi, the basal sands of the Cockfield formation grade down into the underlying shales forming an interbedded sand and shale zone."*

This writer feels Keady expressed very well the situation with respect to the lower Cockfield contact. On the other hand, the Cockfield and Moodys Branch contact is clearly defined. Here a normally gray, very silty and slightly micaceous clay has been stained (mottled) scarlet from its contact with overlying Moodys Branch beds. Clays and sands of the Cockfield formation crop out for about 18 miles of road from 490 + 00 F.A.P. 286 B-1 to 1400 + 00 F.A.P. 102 B-1. Good exposures are rare on the right of way and much of the section was pieced together from sideroad information and drilling data assembled as a jigsaw puzzle.

The uppermost 230 to 235 feet of Cockfield is clearly of non-marine origin and is dominantly clay, silt, silty clay, and very fine sand. There are some bands and lenses of red and gray medium sand, usually with flaky pellets of silty gray clay. Thin bands of lignite and lignitic clay are found within this part of the section.

The lower 155 to 160 feet of Cockfield is both marine and non-marine. Glauconitic clayey sand was encountered in the bottom of drill hole 2. This is separated from Wautubbee clay by a thick sequence of marine, questionably marine, and non-marine lignitic beds. The silty fine gray and tan sands, and gray clayey silts with gray sandy clays, which are found in the lower Cockfield bear a strong lithologic similarity to many beds of the upper Cockfield. The lower Cockfield boundary, if indeed there is one, should by all means include these Cockfield-like beds.

The writer visited "Yegua" and Wautubbee beds along Mississippi 19 north of Forest and along Mississippi 15 north of Newton and in-between areas in order to better appreciate the strike-line facies changes which have apparently taken place in the vicinity of Mississippi 16. It is well to remember that facies changes in this part of Mississippi are abrupt in both the dip and strike directions. Northwestward along the strike-line is toward the headlands of the Claiborne embayment and represents change toward a continental environment. The facies changes in the Wautubbee, both fossil and lithologic, bear this out (Figure 1). The vertical clay pipes, previously mentioned, may represent the same sort of strand line transition that exists in the lower Kosciusko beds.

MOODYS BRANCH (MILES 4-8)

This formation, which is about 15 feet thick, underlies the Jackson Prairie Cuesta and is exposed only where erosion has dissected it near the cuesta "scarp". It is made of reddish brown, formerly very glauconitic, clayey sand and sandy clay. Weathering has converted most of the glauconite to ferruginous clay and has apparently removed some of the iron and re-precipitated it as stain on underlying Cockfield clays. In Highway 16 exposures the Moodys Branch is unfossiliferous. Elsewhere in Madison County Lowe[11] has reported the marl beds to be fossiliferous. Lowe[11] also attributed unique road building properties to these materials. Unfortunately the thinness of the Moodys Branch would preclude its extensive use. (Lowe's remarks do suggest that the sandy marls in the topping poor Cretaceous-Midway belt may have some limited usefulness if mixed with imported sands).

YAZOO (MILES 0-7)

Exposure of an incomplete section of Yazoo formation is from Canton to 7 miles east of Mississippi Highway 43. From Club 16 eastward dissection has cut into and revealed the underlying Moodys Branch formation. The Yazoo clay is not well exposed but is well expressed in the tan sandy clay loams derived from it. These soils contrast both in lithology and agricultural use with the red-brown sandy clay loams of the Moodys Branch terrane. Where the clay is best exposed (415 + 00 to 430 + 00 F.A.P. B-1) it is tan to brown plastic.

The impervious clays, somewhat bentonitic, protect the resequent or dip slope of the Prairie cuesta.

PLEISTOCENE-PLIOCENE (MILES 0-55)

No good exposures of this age were found. Some loessic soils are present off the Highway in the vicinity of the Pearl and Yockanookany Rivers. Fragments of fossil wood are found as float or at the base of soils between Carthage and Canton. These may be geologically young. The river bottoms, of course, have relatively thick floodplain deposits of youthful age.

STRUCTURE

In the profile are two suggestions of structural changes, at mile 24 and mile 43. On closer examination these dip changes are seen to partly coincide with changes in road course toward a more nearly strike-line bearing. There may be a small fault in the lower Cockfield in the vicinity of the Yockanookany River. Geomorphology suggests some sort of structural disturbance in the area. However, until the lower Cockfield stratigraphy for this part of Mississippi is better known, it will be virtually impossible to make out any structure. The geologic profile inflection at the Leake-Neshoba line in the vicinity of the Pearl River is most likely due to road course changes.

In the early stages of the study it was thought there might be a structural disturbance in the Lobutcha Creek area (mile 34). This confusion was largely based on the strong wish to correlate the Zilpha-like clays in the Kosciusko (mile 32 to 33) with the "Zilpha" clays overlying the Winona in their normal position. However, drilling of holes 8 and 9 confirmed the continuity of the Winona in the subsurface.

Using the Tallahatta, the Winona, and the Moodys Branch as datum planes, the regional dip along this road is about 35 degrees to the southwest.

THE "MERIDIAN" PROBLEM

"Meridian" sand is an important road topping material and it would be of value to clearly understand the stratigraphic relationships of this member. The contact between "Meridian" beds and Tallahatta beds on Highway 16 and elsewhere in Neshoba County is clearly recognizable though in places beds are interwoven. The contact between sands of this type and lower beds is never clear. Outliers which may be "Meridian" are easily confused with similar sands in the Hatchetigbee and Tuscahoma. Some of the "Meridian" outliers may even be Pleistocene. A visit to the type locality in Lauderdale County did nothing for the writer to help clarify this lower boundary.

No discussion will be made here as to the age of "Meridian" beds, since they are generally conceded to be Claiborne. The writer thinks the problem of recognition is sufficiently complex without introducing the further question of correlation out of the State. The writer also feels that ground-water laterites have played too much a role in "Meridian" delineation in the type area and elsewhere. Ferruginous layers could be expected at almost any contact between a ferruginous sand and clay, even an intraformational contact.

Vestal, working in Marshall and Union Counties (19, pp. 19, 57) states Meridian "laps over" onto "Fearn Springs" and suggests it may lie on Naheola and even Porters Creek. This would mean that the entire thickness of Wilcox beds is in partial hiatus along the outcrop strike. This concept seems to be inconsistent with the fact that the Wilcox is well represented in west central Alabama and "Meridian" sands are in places only a few feet thick. A large hiatus could be rationalized in the more continental area of north Mississippi (see strand line positions, Figure 1) but not without extensive pre-Claiborne uplift. It seems to the writer that a Wilcox hiatus would introduce more problems than it would solve.

Attaya (1, p.21) also mentions "overlap" of Meridian beds on the Wilcox, but there is no indication (2, Plate 2) that his intention was an Ackerman-Meridian unconformity of anything like the magnitude Vestal has suggested. "Overlap" as used by Attaya appears to mean normal outlier deposits overlapping without hiatus.

A number of small "Meridian"-like outlier (?) deposits of orange-red sand were found along Highway 16 east of the normal "Meridian"-Hatchetigbee belt. These were for the most part too small to include in the profile. Orange-red sands which rest on Porters Creek along Sucarnoochie Creek can be definitely related to Pleistocene time (see discussion of stratigraphy) and are not Tertiary. Other draped sands which appear to be "Meridian" overlap may also be Pleistocene. "Meridian"-like sands are found east of the "hypothetical" fault (Plate 2). If these are "Meridian" then their anomalous position reinforces the probability of a fault occurrence. The sands in question may be down-faulted "Meridian", Tuscahoma, or even Pleistocene.

MASSIVE CLAY BALL CONGLOMERATES AND SWASH "BRECCIAS"

Two discrete strike-belts of unusual conglomerate beds cross Highway 16. The lower bed can be traced into Choctaw County, Alabama, where it is a basal Tuscahoma blocky conglomerate (18, p. 63). The upper bed can be traced to upper Tuscahoma clay ball conglomerates near Damascus in Kemper County (8, p.172, Figure 51).

The rather spectacular channel-like deposits of clay ball conglomerates and swashy "breccia" conglomerates presented a challenge the writer could not ignore. In view of the limited time for the study, it was decided that a general reconnaissance would be made to locate the more outstanding exposures. This reconnaissance was carried out by driving several thousand miles back and forth across the strike line. The best coverage was made in Neshoba and Kemper Counties. Locations are given in tabular form in Appendix C and the more striking deposits have been plotted (Figure 3).

The distribution of these deposits is such that Wilcox clay ball and "breccia" beds can be traced along the strike belt from Alabama to Tennessee. The position of Grim's[6] Wilcox strand line (Figure 1) apparently has no affect on the distribution. A brief survey of the literature indicates the belt continues in western Tennessee and west central Alabama.

Any stratigraphic implications for the swash "breccia" and conglomerates must be very carefully weighed. Since channel

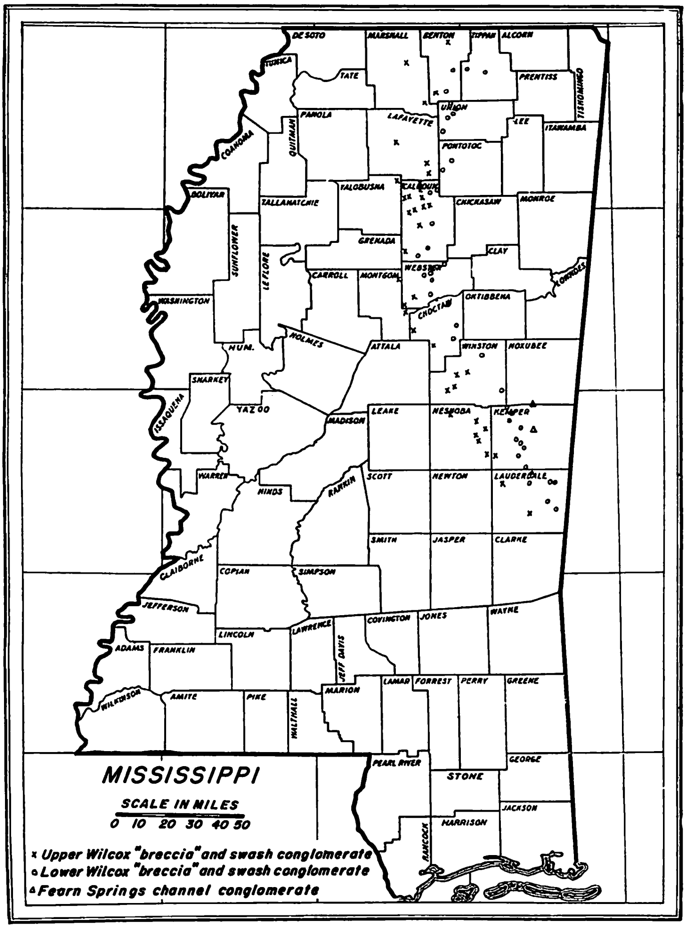

Figure 3.

deposits (and that is their assumed origin) have no precise stratigraphic horizon they must be used with extreme caution. Their stratigraphic value will depend on the depth of channel relief. On the face of things it appears that the unconformities above and below the Tuscahoma formation are characterized by discontinuous channels of conglomerate and swash "breccia", at least as far north as Choctaw County.

The stratigraphic picture is further complicated by the fact that conglomerate channels are found in other formations. Massive clay ball beds have been found in the "Meridian" formation and in the Betheden formation (12, pp. 14, 15). These, of course, could very readily be mistaken for similar conglomerates in the Wilcox formations.

The writer does not wish to seem overly optimistic about the stratigraphic usefulness of the conglomerate beds. The swashy "breccias" and contorted silt beds of the Tuscahoma may have limited stratigraphic usefulness, however, for carrying Alabama nomemclature into northern Mississippi Ackerman terrane. Whether or not upper and lower Tuscahoma swash beds can be differentiated remains to be learned.

Conglomerates and "breccias" are especially abundant in Calhoun County. In that area they apparently do not exist in discrete trends. It is possible that a major structure in northern Calhoun County has brought the upper and lower Wilcox beds closer together and so confused discrete belts of conglomerate.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Topping pits along Mississippi Highway 16 are at many stratigraphic positions. The materials in most cases are medium sub-angular to sub-rounded quartz sands with varying amounts of clay. A clayey orange-red sand finds widespread use as topping material. Sands of this sort are thickest in the Kosciusko, Neshoba, "Meridian", and lower Nanafalia ("Fearn Springs") formations, but are also present in the lower Cockfield and Tuscahoma. Large sand pits in this region could be most likely developed wherever there is a full thickness of either Neshoba or "Fearn Springs" formation. A full thickness is not to be expected near exposures of the lower contact of any formation in Mississippi, but only near the upper contact.

A region offering little prospect for the development of sand is from Sucarnoochee Creek to Alabama. Mixtures of coarse imported sand with local fine sandy marls of the Cretaceous belt may possibly offer a solution. Synthetic aggregate from Porters Creek clay is another possibility, but unless higher, more vitreous temperatures are reached than were used for previous Porters Creek aggregate firing, it is doubtful that the product would be satisfactory.

Inasmuch as geologic work is a highly interpretative learning process, no geologic report should be considered final. If further drilling is done along the right of way, undoubtedly refinements of this report will be suggested. As a state of knowledge the paper does represent a careful reporting of what the writer has learned from his brief study.

As time goes on it is hoped that additional highways will be profiled, especially the geologically meaningful dip-line roads.

The conglomerate problem is deferred to the petroleum geologist. The "Meridian" problem is one which should be of continuing interest to the highway geologist because it involves topping sands.

A profile of the sort which accompanies this report should find many highway uses, the least of which would be the search for materials. If factors of road performance which are related to bedrock lithology and stratigraphy could be isolated, better roads might be designed and troublesome areas anticipated.

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APPENDIX A

GLOSSARY OF GEOLOGIC TERMS USED IN THIS REPORT (FOR HIGHWAY USE)

Consequent — See *cuesta*

Cuesta — A gently sloping land form on gently dipping rock formations. It usually presents two sloping surfaces which face away from a strike-line ridge. The longer more gentle slope, called *consequent* (or *resequent*), follows the dip-slope of the strata away from the ridge. The shorter steeper slope, called *obsequent,* is opposed to the dip direction and cuts across strata.

Dip — The angle of inclination or "lay" of strata from the horizontal, measured at right angles to strike (q.v.).

Dip-Line Highway — See *strike-line highway*

Formation — A recognizable and mappable lithologic unit composed of one or more beds of one or more rock types. It must be readily distinguishable for mapping purposes and must have sufficient lateral extent to admit of its being mapped over a sizable area. Formations are basic geologic map units. A formation may represent a unit of time of any magnitude, and have any thickness. One of the most persistent formations (Sylamore) is only 4 inches thick and represents a geologic period of time. Other formations hundreds of feet thick represent only a brief epoch. Features such as odd-shaped ledges, balanced rocks, mountains, etc. are NOT geologic formations, though often referred to as such in popular parlance.

Geomorphology — A subdivision of geologic science devoted to the interrelationship of geology and the landform. Inasmuch as most of the landform changes have been in the Pleistocene, it deals mostly with the effect of the Pleistocene on the earth's surface.

Glauconite — An amorphous iron silicate of complex chemistry and as yet undetermined origin, which is abundant in marine sediments of the Gulf Coast region, commonly as rounded or flattened greenish grains.

Greensand — A sand (normally quartz) containing a high proportion of glauconite (q.v.) giving it a green color. In highway cuts, especially those of long standing, oxidation ("rusting") has made greensand formations RED rather than green. Downdip in the subsurface the red sand would be green.

Obsequent — See *cuesta*

Rock — Any part of the earth's crust. Rocks are both hard and soft. Hard rocks are easily recognized as rock by reason of their hardness. Most of the rock exposed in Mississippi is soft and could be mistaken for soil (q.v.). Nature has transformed many soft rocks into harder rocks by two complex processes termed *diagenesis* and *metamorphism*. These processes have not been very active in Mississippi by reason of its location.

Soil — Strictly speaking, soil is a relatively thin, tenuous, and in some places discontinuous layer mantling the rocks of the earth's crust, and must be capable of supporting vegetation. Geologists and soil scientists alike use *soil* in this meaning. It is probably equivalent to "top-soil" of the civil engineer and should not be confused with the soft rocks which are exposed in most of the roadcuts of the state.

Strata — Distinguishable rock layers. Strata as a rule represent bedding. However, because many of the formations of this report exhibit some cross-bedding, one should not think of stratification and bedding as synonymous.

Stratigraphy — The science of study of rock strata. It is based largely on the principle that older rocks, because deposited first, will underlie younger rocks, if not disturbed.

Strike — The direction or bearing of a horizontal line in the plane of an inclined stratum.

Strike-Line Highway — This is a term which the writer has coined for specific highway use. It refers to the direction of right of way bearing with relation to direction of strike and dip. If a road parallels the strike of a formation it may be termed *strike-line,* and if it is opposed to strike, it may be called *dip-line.* The significance of this reference is to be found in the fact that strike-line highways (Mississippi 341 at Vardaman in Porters Creek formation) may remain in an unfavorable material for long distances, whereas a dip-line highway (Mississippi 16, mostly transverse to the strike of strata) may be in and out of a favorable topping material such as Moodys Branch (miles 5 to 7) in a very few miles.

APPENDIX B

DRILLING DATA ALONG MISSISSIPPI HIGHWAY 16

Drill Hole 1—660 + 00 F. A. P. 286B-(1)

Thickness Feet	Depth Feet	Description
5	5	Loam
3	8	Clay, brown, silty
8	16	Clay, red plastic
9	25	Clay, olive-brown to gray
3	28	Clay, chocolate-gray
10	38	Clay, brown
6	44	Sand, medium, gray, clayey, micaceous
6	50	Clay, brown "limonitic"
5	55	Hang up, probably clay, olive-gray to charcoal-gray and sand, silty, clayey, fine to medium. Water

Drill Hole 2—1050 + 90 F. A. P. 286B-(1)

Thickness Feet	Depth Feet	Description
5	5	Loam, silty
4	9	Clay, brownish, plastic
1	10	Clay, gray and red, plastic
7	17	Clay, red, sandy
9	26	Clay, tan, sandy
14	40	Sand, gray, medium, clayey. Water

Drill Hole 3—1345 + 00 F. A. P. 102B-(1) (International Paper Company Park)

Thickness Feet	Depth Feet	Description
4	4	No sample
5	9	Clay, brick red, sandy
3	12	Clay, ochrous, plastic
12	24	Sand, yellow-brown, clayey
6	30	Sand, light milk chocolate, medium, very clayey
5	35	No sample, probably sand. Water
5	40	Sand, dark-tan, clayey, medium, some glauconite
5	45	Sand, olive-drab, clayey, glauconitic
10	55	Sand, greenish, glaucontic
5	60	Clay, hard, olive-gray to chocolate-gray, slightly micaceous

Drill Hole 4—1385 + 00 F. A. P. 102B-(1)

Thickness Feet	Depth Feet	Description
3	3	Loam
8	11	Sand, tan, medium, clayey
4	15	Sand, pinkish, fine, clayey, micaceous

17	32	Sand, fine, buff-gray, clayey. Water
8	40	Clay, hard, chocolate-gray, sticky

Drill Hole 5—1490 + 00 F. A. P. 102B-(1)

Thickness Feet	Depth Feet	Description
5	5	No sample
3	8	Clay, brown
5	13	Sand, tan to orange, medium, clayey
14	27	Sand, loose, pinkish to tan. Water
7	34	Sand, ochrous, medium, slightly clayey
11	45	Sand, olive-drab, medium, some clay

Drill Hole 6—1545 + 00 F. A. P. 102B-(1) (Mississippi Power Station)

Thickness Feet	Depth Feet	Description
6	6	Loam
2	8	Clay, dark-tan, sandy
6	14	Sand, red-brown, medium, clayey
3	17	Sand, tan, medium, clayey
9	26	Clay, dark-tan, ochrous, sandy
4	30	Clay, light-tan, plastic
5	35	Sand, buff, clayey. Water

Drill Hole 7—135 + 00 F. A. P. 104-(3) (TVA Power Station)

Thickness Feet	Depth Feet	Description
4	4	No sample
3	7	Sand, red-brown, medium, very clayey
5	12	Clay, silty, light-brown, sticky wet
3	15	Clay, tan, sandy
12	27	Sand, tan, loose, medium
13	40	Sand, light-tan, fairly clean. Water

Drill Hole 8—300 + 00 F. A. P. 104-(3)

Thickness Feet	Depth Feet	Description
8	8	No sample
4	12	Sand, gray, silty, fine, clayey
6	18	Sand, tan, medium, slightly clayey. Water
2	20	Clay, blue-gray
5	25	Sand, olive-gray, glauconitic, medium to coarse
3	28	Clay, blue-gray
19	47	Sand, dark-gray, medium to coarse, glauconitic
6	53	Sand and clay, alternating glauconitic sand and clay
2	55	Sand, blue-green, marly, very glaucontic, shell fragments

Drill Hole 9—375 + 00 F. A. P. 104-(3)

Thickness Feet	Depth Feet	Description
8	8	No sample
7	15	Clay, gray, silty
5	20	Sand, tan, somewhat clayey
5	25	Sand, blue-gray, medium, glauconitic
7	32	Sand, tan, medium, clayey. Water
3	35	Marl, sandy, green, glauconitic, shell fragments

Drill Hole 10—460 + 00 F. A. P. 104-(3)

Thickness Feet	Depth Feet	Description
4	4	No sample
4	8	Clay, fine sandy, olive-gray, plastic
10	18	Sand, fine to very fine, silty, gray to tan, clayey
2	20	Sand, fine to medium, tan, glauconitic. Water
5	25	Clay, gray-chocolate
15	40	No sample
25	65	Sand, olive-drab, medium, glauconitic
5	70	Sand, medium, micaceous, slightly glauconitic

Drill Hole 11—545 + 00 F. A. P. 104-(3)

Thickness Feet	Depth Feet	Description
3	3	No sample
10	13	Clay, gray to tan, silty, plastic
5	18	Clay, sandy, brown, glauconitic
17	35	Clay, brown, sticky
5	40	Clay, marly, glauconitic
5	45	Sand, tan to brown, medium to coarse, glauconitic
15	60	Sand, glauconitic. Water

Drill Hole 12—175 + 00 N. R. H. 206-B

Thickness Feet	Depth Feet	Description
5	5	No sample
5	10	Sand, orange-red, loose, medium
5	15	Sand, tan, loose, slightly clayey, medium
5	20	Sand, tan, very clayey, medium
5	25	Sand, olive-drab, clayey
3	28	Sand, gray, clayey
2	30	Clay, gray, carbonaceous, tough
1	31	No sample, heavy flow, probably sand. Water
7	38	Clay, gray, carbonaceous, tough
15	53	No sample, heavy flow, probably sand. Water
17	70	Clay and sand, alternating layers of sandy gray carbonaceous clay and gray clayey sand

Drill Hole 13—162 + 00 N. R. H. 206-B

Thickness Feet	Depth Feet	Description
3	3	No sample
7	10	Sand, orange-red, medium, clayey
3	13	Sand, dark-tan, medium, clayey
10	23	Clay, olive-gray, silty, plastic
5	28	Clay, blue-gray, somewhat silty
2	30	Clay, dark-gray, carbonaceous

Drill Hole 17—1055 + 00 F. A. P. F-272-(2)

Thickness Feet	Depth Feet	Description
5	5	Clay, buff, silty
7	12	Clay, tan, fine sandy
1	13	Sand, tan, fine, clayey
7	20	Clay, buff-gray, micaceous, silty
3	23	Clay, and fine sand, buff, sticky
2	25	Clay, hard, ochrous (contact)
5	30	Lignite, clayey, dark-brown

Drill Hole 18—65 + 00 F. A. S. 289A-(2)

Thickness Feet	Depth Feet	Description
5	5	No sample
10	15	Sand, orange-red, slightly clayey, quartz and feldspar
15	30	Sand, olive-drab, sub-rounded, medium to coarse
5	35	Sand, dark-olive, lignitic
35	70	Sand, olive-gray, sub-rounded, medium to coarse, clayey, marcasitic, and lignitic

Drill Hole 14—67 + 00 N. R. H. 206-B

Thickness Feet	Depth Feet	Description
5	5	No sample
5	10	Sand, red to brown, very clayey, medium
6	16	Sand, orange-red, micaceous, somewhat clayey
54	70	Sand, tan, loose, medium, micaceous
0	70	Clay (?)

Drill Hole 15—0 + 15 N. R. H. 206-B

Thickness Feet	Depth Feet	Description
5	5	No sample
1	6	Sand, brown, very clayey and silty
5	11	Clay, red and gray, plastic
4	15	Clay, gray-brown, lignitic

Drill Hole 16—110 + 00 F. A. P. 272-(1)

Thickness Feet	Depth Feet	Description
4	4	No sample
1	5	Sand, red, very clayey
2	7	Clay, red and gray, sandy
3	10	Clay, ochrous, tan, plastic, micaceous
2	12	Clay, slightly lignitic
8	20	Clay, sticky, silty

Drill Hole 19—0 + 05 W. O. 2929

Thickness Feet	Depth Feet	Description
3	3	No sample
18	21	Clay, olive-gray, silty, stiff
4	25	Clay, gray, brownish, stiff
15	40	Clay, charcoal-gray, stiff, slightly calcareous
18	58	Clay, light-gray, very calcareous, shell fragments

Drill Hole 20—70 + 00 W. O. 2929

Thickness Feet	Depth Feet	Description
5	5	No sample
10	15	Sand, medium, tan, very clayey
25	40	Mud, tan
15	55	No sample, tan muck
10	65	Clay, light-gray, silty, micaceous, very calcareous

Drill Hole 21—180 + 00 W. O. 2929

Thickness Feet	Depth Feet	Description
5	5	No sample
10	15	Sand, tan, fine to medium, clayey
3	18	Clay, light-tan, fine sandy, micaceous, calcareous
2	20	Marl, calcareous greensand

APPENDIX C

CONGLOMERATE AND "BRECCIA" IN THE WILCOX

Location	Stratigraphic position	Description	Reference
Mississippi			
Benton County			
T.5 S., R.1 W.			
Sec.12, NW.¼	"Meridian"	Clay Balls	Mississippi Geol. Survey Bull. 80
T.2 S., R.1 E.			
Sec.11, NE.¼	"Meridian"	Clay Balls	Mississippi Geol. Survey Bull. 80
T.5 S., R.1 E.			
Sec.15, SE.¼	Ackerman	Swash "Breccia"	Observation
T.4, S., R.2 E.			
Sec.6	Ackerman	Clay Conglomerate	Observation
Calhoun County			
T.11 S., R.2 W.			
Sec.14-15	Tuscahoma (?)	Clay Balls & Block	Observation
T.11 S., R.2 W.			
Sec.13-14	Tuscahoma (?)	Clay Balls	Observation
T.22 N., R.9 E.			
Sec.4, NE.¼	Ackerman	Swash	Observation
T.22 N., R.8 E.			
Sec.24	Ackerman	Clay Conglomerate	Observation
T.12 S., R.2 W.			
Sec.28, S.½	Ackerman	Swash "Breccia"	Observation
T.12 S., R.2 W.			
Sec.10	Ackerman	Swash "Breccia"	Observation

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
T.12 S., R.2 W. Sec.14, NE.¼	Ackerman	Swash "Breccia"	Observation
T.12 S., R.2 W. Sec.13, S.½	Ackerman	Swash "Breccia"	Observation
T.11 S., R.1 W. Sec.31, NW.¼	Ackerman	Clay Boulder Breccia	Observation
T.11 S., R.1 W. Sec.30, SE.¼	Ackerman	Clay Boulder Breccia	Observation
T.11 S., R.3 W. Sec.9	Ackerman	Swash "Breccia"	Observation
T.11 S., R.2 W. Sec.34, NW.¼	Ackerman	Swash "Breccia"	Observation
T.11 S., R.3 W. Sec.36, SE.¼	Ackerman	Swash "Breccia"	Observation
T.11 S., R.3 W. Sec.35, SE.¼	Ackerman	Swash "Breccia"	Observation
T.22 N., R.8 E. Sec.16, NW.¼	(?)	"Clay Breccia"	Oral
T.12 S., R.2 W. Sec.29, N.½	(?)	"Clay Breccia"	Oral
T.13 S., R.1 W. Sec.10, S.½	Ackerman	Conglomerate	Stacy Thesis
T.11 S., R.1 W. Sec.13, W.½	Lower Ackerman	Clay "Breccia"	Observation

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
T.13 S., R.1 W.			Stacy Thesis
Sec.11, NE.¼, NW.¼	Lower Ackerman	Swash "Breccia"	Observation
T.13 S., R.2 W.			
Sec.26, E.½	Ackerman	"Breccia" Conglomerate	Observation
Choctaw County			
T.19 N., R.11 E.			Mississippi Geol. Survey Bull. 52
Sec.18, W.½	Lower Tuscahoma	"Chaotic Bedding" Swash	Observation
T.17 N., R.11 E.			Mississippi Geol. Survey Bull. 38
Secs.21, 28	Lower Tuscahoma	"Clay Boulders"	Mississippi Geol. Survey Bull. 52 (Photo)
T.16 N., R.11 E.			
Sec.15, SW.¼	Lower Tuscahoma	"Clabber" Zone	Mississippi Geol. Survey Bull. 52
T.16 N., R.10 E.			
Sec.8	Upper Tuscahoma	Swash "Breccia"	Observation
T.17 N., R.8 E.			
Sec.15	"Holly Springs"	Swash "Breccia"	Observation
Kemper County			
T.9 N., R.16 E.			Observation
Sec.32, SW.¼	Upper Nanafalia	"Silty Clay Blocks"	Mississippi Geol. Survey Bull. 84 (Photo)
T.11 N., R.16 E.			
Sec.4, N.½	"Fearn Springs"	Clay Blocks	Observation
No location	"Fearn Springs"	"Clay Ball Conglomerate"	Mississippi Geol. Survey Bull. 84
T.12 N., R.15 E.			
Sec.16, SW.¼	Upper Nanafalia	Clay "Breccia"	Observation

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
T.12 N., R.15 E. Sec.6, SW.¼	Upper Nanafalia	Clay "Breccia"	Observation
T.11 N., R.15 E. Sec.5, S.½	Upper Nanafalia	Clay Ball Conglomerate	Observation
T.11 N., R.15 E. Sec.24, SW.¼	Upper Nanafalia	Swash Conglomerate	Observation
T.11 N., R.15 E. Sec.35, NE.¼	Upper Nanafalia	Swash "Breccia"	Observation
T.10 N., R.14 E. Sec.27, SW.¼	Upper Tuscahoma	Clay Balls	Mississippi Geol. Survey Bull. 84
T.10 N., R.15 E. Sec.1, W.½	Upper Nanafalia	Clay Ball Conglomerate	Observation
T.10 N., R.16 E. Sec.7, NW.¼	Upper Nanafalia	Clay Ball Conglomerate	Observation
T.10 N., R.15 E. Sec.26, SE.¼	Upper Nanafalia	Clay Ball Conglomerate	Observation
Lafayette County			
Near Oxford	"Holly Springs"	"Clabber"	Mississippi Geol. Survey Bull. 25
3 miles South of Oxford	"Holly Springs"	Clay Conglomerate	Observation
?	"Kosciusko"	"White Clay Breccia"	Mississippi Geol. Survey Bull. 71
?	"Meridian"	Clay Balls	Mississippi Geol. Survey Bull 71
T.10 S., R.2 W. Sec.24	"Holly Springs"	Clay "Breccia"	Observation

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
T.9 S., R.2 W. Sec.36, S.½	"Holly Springs"	Swash "Breccia"	Observation
Lauderdale County			
T.8 N., R.16 E. Sec.9, SE.¼	Upper Nanafalia	Swash	Observation
T.8 N., R.14 E. Sec.35	Hatchetigbee	Clay Ball "Breccia"	Observation
T.8 N., R.16 E. Sec.29, E.½	Lower Tuscahoma	"Basal Conglomerate"	Mississippi Geol. Survey Bull. 41
T.8 N., R.17 E. Sec.28	Lower Tuscahoma	"Clay Fragments"	Observation Mississippi Geol. Survey Bull. 41
T.8 N., R.17 E. Sec.27	Lower Tuscahoma	"Sand-clay Conglomerate"	Observation Mississippi Geol. Survey Bull. 41
"3 mi. NW. Topton"	Lower Tuscahoma	"Sand-clay Conglomerate"	Mississippi Geol. Survey Bull. 41
T.6 N., R.16 E. Sec.15, NW.¼	"Meridian"	Clay Ball Conglomerate	Observation
T.6 N., R.17 E. Sec.11, SE.¼	Lower Tuscahoma	Swash "Breccia"	Observation
T.7 N., R.17 E. Sec.32	Upper Nanafalia	Contorted Beds	Observation
T.6 N., R.15 E. Sec.21, SW.¼	"Meridian"	"Intraformational Conglomerate"	Guides to Southeastern Geology, Geol. Soc. Am.
T.6 N., R.15 E. Sec.20, SW.¼	"Meridian"	"Basal Conglomerate"	Mississippi Geol. Survey Bull. 41

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
Marshall County			
T.3 S., R.2 W.			
Sec.20, SE.¼	"Holly Springs"	"Angular Clay Masses"	Mississippi Geol. Survey Bull. 78
T.6 S., R.1 W.			
Sec.5, SW.¼	Ackerman	Swash Conglomerate	Observation
Montgomery County			
T.18 N., R.8 E.			Mississippi Geol. Survey Bull. 51
Sec.5, SE.¼	"Holly Springs"	"Breccia"	Mississippi Geol. Survey Bull. 75
T.21 N., R.7 E.			
Sec.36, SE.¼	"Holly Springs"	"Coarse Breccia"	Mississippi Geol. Survey Bull. 51 (Photo)
T.20 N., R.5 E.			
Sec.34, NE.¼	"Kosciusko"	"Breccia" Lenses	Mississippi Geol. Survey Bull. 51
Neshoba County			
T.10 N., R.13 E.			
Sec.26	Upper Tuscahoma	Clay Ball Conglomerate	Observation
T.10 N., R.12 E.			
Sec.2	Upper Tuscahoma	Clay Ball Conglomerate	Observation
T.11 N., R.12 E.			
Sec.34, NE.¼	Upper Tuscahoma	Swash "Breccia"	Observation
T.11 N., R.13 E.			
Sec.19	Upper Tuscahoma	Clay Ball Conglomerate	Observation
T.11 N., R.12 E.			
Sec.3, SE.¼	Upper Tuscahoma	Clay Ball Conglomerate	Observation
T.12 N., R.11 E.			
Sec.17, SE.¼	Hatchetigbee ?	Swash "Breccia"	Observation

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
Noxubee County			
T.13 N., R.16 E.			
Sec.34, S.½	"Fearn Springs"	Clay Blocks	Observation
Pontotoc County			
T.10 S., R.1 E.			Mississippi Geol. Survey Bull. 54
Sec.20, SW.¼	Lower Ackerman	"Breccia"	(Photo)
T.10 S., R.1 E.			
Sec.2	Ackerman	Swash "Breccia"	Observation
East of Toccopola	Lower Ackerman	"Breccia"	Mississippi Geol. Survey Bull. 54 (Photo)
Tippah County			
T.3 S., R.2 E.			
Sec.35	Lower Wilcox	Clay Ball "Breccia"	Mississippi Geol. Survey Bull. 42
T.3 S., R.3 E.			
Sec.35, SE.¼	Lower Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 42
T.4 S., R.3 E.			
Sec.15, NW.¼	Lower Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 42 (Photo)
Union County			
T.6 S., R.1 E.			
Sec.11, NE.¼	Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 45
T.6 S., R.1 E.			
Sec.13, N.½	Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 45
T.6 S., R.1 E.			
Sec.34	Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 45

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
T.7 S., R.1 E. Sec.32, SE.¼	Wilcox	"Breccia"	Mississippi Geol. Survey Bull. 45
Webster County			
T.21 N., R.9 E. Sec.23	Ackerman	Clay Pebble Conglomerate	Observation
T.19 N., R.8 E. Sec.31, NW.¼	"Holly Springs"	Clay Cobbles	Mississippi Geol. Survey Bull. 51 Mississippi Geol. Survey Bull. 75
T.21 N., R.10 E. Sec.9, NE.¼	Lower Ackerman	Mosaic Sand and Clay	Mississippi Geol. Survey Bull. 75
T.21 N., R.10 E. Sec.8, NE.¼	Lower Ackerman	Haphazard Blocks	Mississippi Geol. Survey Bull. 75
T.21 N., R.10 E. Sec.2	Lower Ackerman	Chaotic Mosaic	Mississippi Geol. Survey Bull. 75
T.21 N., R.10 E. Sec.19, SW.¼	Lower Ackerman	"Breccia"	Mississippi Geol. Survey Bull. 75
T.21 N., R.10 E. Sec.17, NE.¼	Ackerman	Mosaic	Mississippi Geol. Survey Bull. 75
T.20 N., R.10 E. Sec.6, N.½	Ackerman	Clay "Breccia"	Mississippi Geol. Survey Bull. 75
T.20 N., R.8 E. Sec.36, NE.¼	"Holly Springs"	Clay "Breccia"	Mississippi Geol. Survey Bull. 75
T.20 N., R.9 E. Sec.31	"Holly Springs"	"Clay Inclusions"	Mississippi Geol. Survey Bull. 75

Appendix C—(Continued)

Location	Stratigraphic position	Description	Reference
Winston County			
T.13 N., R.14 E. Sec.3	Nanafalia	Clay Block Conglomerate	Observation
T.16 N., R.13 E. Sec.29	Upper Nanafalia	Swash "Breccia"	Observation
T.13 N., R.11 E. Sec.6	"Holly Springs"	Swash Conglomerate	Observation
T.14 N., R.11 E. Sec.27	"Holly Springs"	Clay Ball Conglomerate	Observation
T.15 N., R.12 E. Sec.32	"Holly Springs"	Clay Ball Conglomerate	Observation
T.14 N., R.11 E. Sec.4	"Holly Springs"	Clay Block "Breccia"	Observation
Yalobusha County			
?	"Meridian"	Clay "Breccia"	Mississippi Geol. Survey Bull. 76
?	?	Clay Boulders	Mississippi Geol. Survey Bull. 6
T.10 S., R.3 W. Sec.33	"Holly Springs"	Swash "Breccia"	Observation
T.25 N., R.7 E. Sec.4	"Holly Springs"	Swash	Observation
Alabama			
West Central Alabama	Lower Tuscahoma	Clayey Silt Boulders	Guides to Southeastern Geology, Geol. Soc. Am.
Tennessee			
West Tennessee	Wilcox	Silt and Clay Ball Conglomerate	Guides to Southeastern Geology, Geol. Soc. Am.