NOTES ON THE UPPER CRETACEOUS AND TERTIARY SUB-SURFACE STRATIGRAPHY OF WESTERN TENNESSEE[1]

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INTRODUCTION

The Tennessee River, in its northward swing across the state, approximately marks the boundary between two distinct geologic and physiographic provinces of Tennessee. To the east lies the Highland Rim area, a part of the Interior Low Plateaus, and to the west is the slope or plateau of western Tennessee, a part of the Gulf Coastal Plain province. It is with the latter division that the present paper is concerned.

Western Tennessee is situated along the eastern side of the Gulf Coastal Plain, commonly termed the Mississippi embayment, which extends some 250 miles up the valley of the Mississippi River. The Mississippi embayment is bordered on the north, east, and west by sedimentary rocks of Paleozoic age. Structurally the area is a down-warped trough of Paleozoic rocks which has been subsequently filled with essentially unconsolidated sands, marls, and clays of Upper Cretaceous, Tertiary, and Quaternary ages. In Tennessee these sediments dip to the west at a rate of about 20 to 40 feet per mile, roughly following the configuration of the underlying down-warped Paleozoic floor upon which they rest.

While our knowledge of the sub-surface conditions in western Tennessee is still very meager, the recent oil drilling operations in the south-central part of the area, from which cuttings were examined, and a detailed study of the well records of previous drillings justifies some interesting generalizations as to the post-Paleozoic geologic history of the Mississippi embayment.

STRATIGRAPHY

Paleozoic Rocks

Rocks ranging in age from the middle Ordovician (Mohawkian) to Recent outcrop in the region west of the Tennessee River, but Upper Cretaceous and Tertiary sediments have by far the greatest areal distribution. Outcrops of Paleozoic rocks are limited to the extreme eastern part of the area, in the Western Valley of the Ten-

[1]Revision of a paper read before the Reelfoot Lake meeting of the Tennessee Academy of Science, April 26, 1935. Published with the permission of Walter F. Pond, State Geologist. The writer acknowledges the aid and suggestions of Mr. Pond and Mr. T. E. Weirich of the Phillips Petroleum Company.

nessee River, where deep erosion and broad upwarps have exposed formations of Ordovician, Silurian, Devonian, and Mississippian ages. A few miles west of the Tennessee River these Paleozoic formations pass under the mantle of Upper Cretaceous sediments.

Ordovician System

The oldest formation exposed in the Western Valley region is the Hermitage formation of middle Ordovician age. The Hermitage is exposed in the southern part of the Western Valley and is composed of compact, bluish-gray limestone beds with many shale horizons. At no place in the general region is the base of Hermitage exposed, but the J. A. Montgomery well (No. 14)[2] drilled in southern Decatur County penetrated the Hermitage formation at a depth of 90 feet and, according to the insoluble residue studies made by Andrews (1932), the Hermitage is 115 feet thick in this well.

The Carters limestone of Lowville age underlies the Hermitage limestones and shales in the Western Valley region. In the Montgomery well (No. 14) the writer noted cuttings which were lithologically similar to the Carters of Middle Tennessee and in two samples fragments of the characteristic bentonitic clay were noted. The Carters is about 40 feet thick in this well. Miser (1921, pp. 31-35) recorded the presence of Carters limestone in two wells drilled in southern Wayne County.

Little definite information is available on the lower Ordovician rocks of the Western Valley region. Andrews (1932) correlated the cuttings below the Carters limestone in the Montgomery well (No. 14) and the Wyatt well (No. 12) as representative of the Stones River group. These, in turn, he believed were underlain by the Wells limestone of Canadian age, the equivalent of the upper part of the Knox dolomite of eastern Tennessee. The present writer has examined the cuttings from both of these wells and while some samples appear quite characteristic of certain Stones River horizons as exposed in central Tennessee, he hesitates in definitely assigning them to the Stones River group. However, both of these wells penetrated the Knox dolomite at a depth of approximately 800 feet.

Detailed work in several areas in the Western Valley region has shown that the higher Ordovician formations are absent. In central Tennessee some 500 feet of limestones of Ordovician age are known to overlie the Hermitage, but these apparently thin out towards the west. In Hardin County, Jewell (1931, p. 35) reported the Hermitage overlain unconformably by Silurian or younger strata, the post-Hermitage Ordovician formations (Bigby, Cannon, Catheys, and Leipers) being absent.

Silurian System

The Ordovician in the Western Valley area is succeeded by some 400 feet of Silurian limestones and shales, several formations of

[2]The numbers in parentheses refer to well locations given on the map, figure 1.

which are not known elsewhere in Tennessee (Table 1). The Silurian strata are generally characterized by pinkish, gray, and maroon crystalline limestones with many shale beds. The thicknesses of the individual formations vary greatly from place to place, but as a rule they thin out towards the east. The lower Silurian beds extend farthest to the east, the upper beds, if deposited, having been removed by post-Silurian erosion. No information is available on the westward extension of the Silurian, but it is possible that the beds thicken in that direction. The E. B. Sain (No. 16) well in Hardeman County, some 60 miles west of the outcrop of the Silurian, reported over 700 feet of bluish-gray, hard limestone, and some shales as Silurian in age.

Devonian System

Overlying the Silurian formations in the Western Valley region are the Devonian limestones, cherts, and novaculites, which may have an aggregate thickness of nearly 500 feet, although the maximum exposed in any single section is about 150 feet (Dunbar, 1919, p. 26). In general the Devonian thickens towards the west, but the formations are soon lost to observation beneath the Upper Cretaceous sediments. To the east the Devonian thins very rapidly and in central Tennessee is represented by the Pegram limestone, which has an average thickness of only a few feet and which has a very limited areal distribution.

Mississippian System

The Mississippian, the youngest of the Paleozoic rocks of the Western Valley, is represented by the Chattanooga shale, the New Providence shales and limestones, and the Fort Payne chert. The St. Louis and Warsaw limestones of middle Mississippian age may be preserved in a few places capping the higher hills in the vicinity of the Tennessee River. The Chattanooga shale, which is considered upper Devonian in age by some geologists, is a definite horizon marker and has an average thickness of about 25 feet. About 100 feet of the New Providence formation overlies the Chattanooga shale in Hardin County, but this formation may be locally absent in the area under consideration. The Fort Payne chert has the greatest areal distribution of the Mississippian formations and along the Tennessee River approximates 200 feet in thickness.

A generalized section of the Paleozoic formations exposed in the Western Valley region is shown in Table 1.

Mesozoic Rocks

Cretaceous System

upper cretaceous series

Overlying the Paleozoic rocks in western Tennessee and outcropping in north-south trending belts are the gravels, sands, and clays of Upper Cretaceous age. During the late Paleozoic and early and middle Mesozoic time, western Tennessee is believed to have been a land mass. During this long geologic interval the land suffered

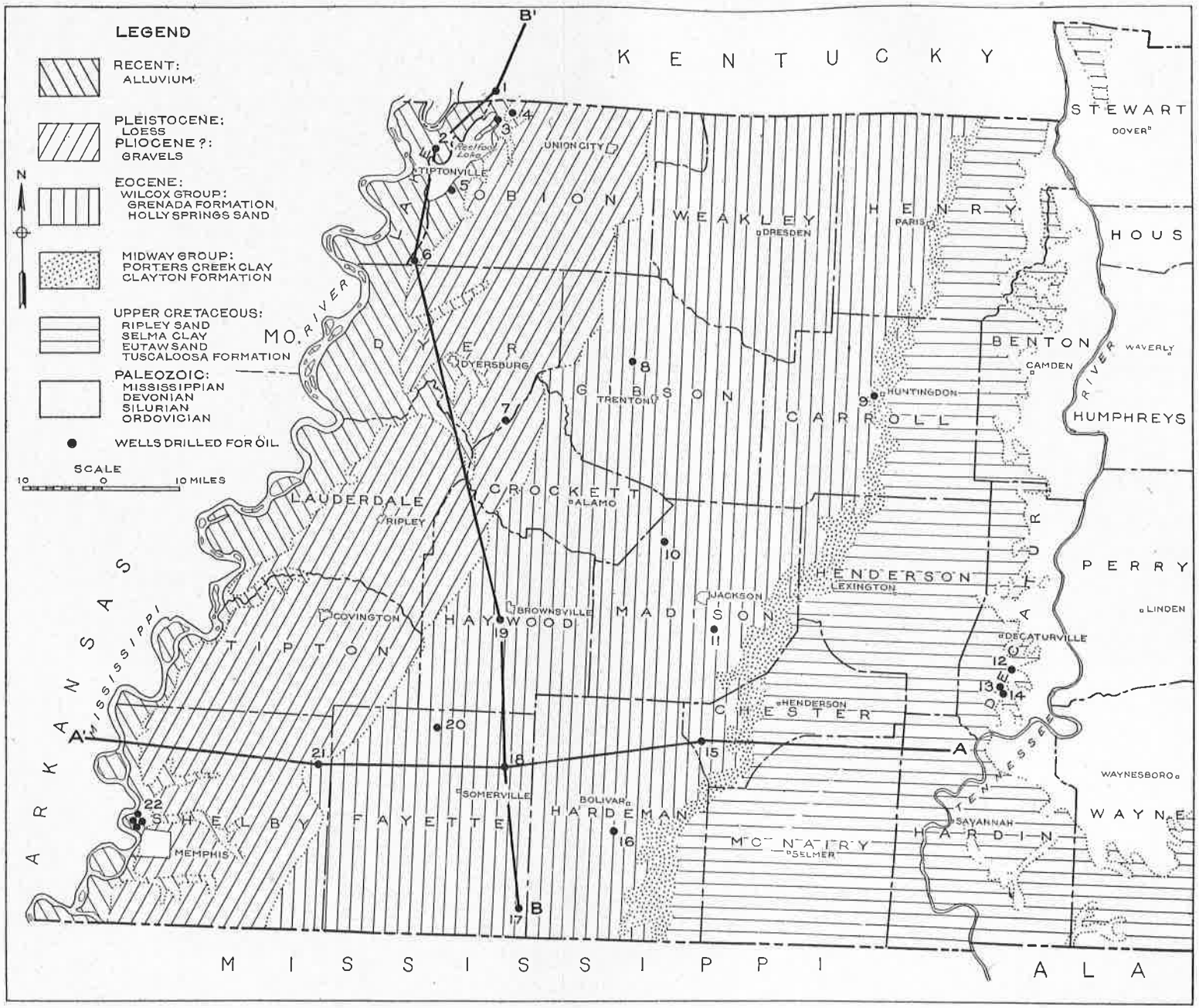

Fig. 1. Areal geologic map of Western Tennessee showing the location of wells drilled for oil. Lines A-A′ and B-B′ indicate the locations of the cross-sections given in figures 2 and 3 respectively.

TABLE 1

Paleozoic formations exposed in the Western Valley of the Tennessee River

System	Formation	Thickness (feet)	Physical Character
Middle Mississippian	St. Louis and Warsaw limestones	0–100	Gray, cherty limestones, deeply weathered; Warsaw more pure of the two
Lower Mississippian	Fort Payne chert	0–200	Dark calcareous chert with limestone beds
	New Providence formation	0–100	Gray siliceous shale with many crinoidal limestone beds
	Chattanooga formation	0–30	Black, fissile, carbonaceous shale; Hardin sandstone usually at the base
Middle Devonian	Camden chert	0–240	White, brittle, fossiliferous chert; weathers to a buff rubble
Lower Devonian	Harriman chert	0–55	Chert and novaculite very similar to the Camden chert
	Quall limestone	0–10	Gray cherty limestone; limited areal distribution
	Linden group	0–286	Porous yellowish-gray chert (Decaturville); grayish-blue shale with some limestone beds (Birdsong); massive crystalline pink and gray cherty limestone Olive Hill group, which includes the Flat Gap, Bear Branch, and Ross limestones); greenish-gray calcareous shale (Rockhouse)
Middle Silurian	Decatur limestone	0–70	Light-gray, rather pure, thick-bedded limestone
	Brownsport formation	0–260	Thin-bedded shaly limestone (Lobelville); light-gray, coarsely crystalline limestone (Bob); greenish-gray to pink shale and cherty limestone (Beech River)
	Wayne formation	0–140	Earthy red limestone with shale (Dixon); pinkish crystalline limestone (Lego); light-gray shaly limestone (Waldron); massive reddish-pink limestone (Laurel); thin-bedded shaly limestone (Osgood)

TABLE 1—(*Continued*)

Paleozoic formations exposed in the Western Valley of the Tennessee River

System	Formation	Thickness (Feet)	Physical Characters
Lower Silurian	Brassfield limestone	0–25	Light-gray crystalline limestone with much chert
	Fernvale formation	0–35	Coarse-grained phosphatic limestone with shale beds
	Arnheim limestone	0–3	Coarse-grained phosphatic limestone with some chert
Middle Ordovician	Hermitage formation	0–70	Bluish-gray, compact limestone with many shaly beds

erosion and Wade (1914, p. 176) has suggested that the general area was a low-lying land. Sutton (1931, pp. 450-451) has pictured the pre-Tuscaloosa topography of western Kentucky as an irregular land surface in a mature stage of development. In the southwestern part of the western Highland Rim, Miser (1921, pp. 58-59) interpreted the topography at the beginning of Tuscaloosa time as an uneven surface on which sink-holes and underground channels were common.

Tuscaloosa Gravel. As the result of down-warping, the Upper Cretaceous was initiated in the Mississippi embayment region of Tennessee by a transgressing sea which rounded the Mississippian limestones and cherts with the formation of a water-worn gravel with some sand and clay. The eastern limit of the Tuscaloosa sea in Tennessee is not definitely known, but the present recognized distribution of these basal gravels on the western Highland Rim indicates that the sea encroached far upon the western flank of the Nashville arch (Born, 1935, pp. 221-230).

The areal distribution of the Tuscaloosa gravels west of the Tennessee River is very limited. In a few outcrops adjacent to the river the formation, consisting of well rounded, water-worn chert pebbles and sands, rests unconformably upon the Paleozoic rocks. The thickness of the Tuscaloosa is perhaps as much as 100 feet in some places, but the formation thins rapidly towards the north and west in Tennessee.

Eutaw Sand. The Eutaw, generally a red micaceous sand, normally overlies the Tuscaloosa gravels in the southeastern part of the region, but to the northwest these sands rest directly upon the Paleozoic rocks by overlap. Jewell (1931, p. 47) estimated some 300 feet of Eutaw sand in Hardin County and about 170 feet of sands referable to the Eutaw is present in the Scott well (No. 15) in western Chester County. In the Bailey Morrison well (No. 18), just north of Laconia in Fayette County, only 75 feet of Eutaw is present. Therefore, a

westward thinning of the Eutaw, like the Tuscaloosa, is indicated (Fig. 2).

Selma Clay. The Selma, consisting essentially of a chalky clay in Tennessee, extends into the area from northern Mississippi forming a belt whose surface outcrops decrease in width from 8 miles at the state line to a feather edge in central Henderson County. The Selma is a highly fossiliferous formation whose Foraminifera have been recently described by Cushman (1931). North of Henderson County the Selma is missing (Wells, 1933, p. 75). In southern McNairy County the Selma is 210 feet thick, but in the Scott well (No. 15), a few miles to the northwest, only 184 feet of Selma is represented. The Morrison well (No. 18) in Fayette County logged 119 feet of Selma clay. If the "chalky shale" indicated in the log of the Hunter No. 1 well in Crittenden County, Arkansas, is correlative with the Tennessee Selma, then only 50 feet of this formation is present in the vicinity of the present center of the Mississippi embayment (Spooner, 1935, pp. 311-313). This thinning towards the west is shown by the east-west cross-section in figure 2.

Ripley Sand. Overlying the Selma clay in western Tennessee and west of the Selma outcrop area is a broad belt of sand and clay of the Ripley formation. This belt is about 18 miles wide along the southern boundary of the State, but narrows to less than one-half that width at the Kentucky line. In the more southern counties the Ripley has been divided into three members, the Owl Creek tongue, McNairy sand member, and the Coon Creek tongue. The formation has a maximum thickness of about 600 feet in southern McNairy County, but thins rapidly to the north to about one-half that thickness. Unlike the underlying Upper Cretaceous formations, the Ripley appears to thicken somewhat towards the west (Fig. 2). Some 700 feet of sands, which appear very typical of the Ripley, were logged in the Morrison well (No. 18) in eastern Fayette County. It is probable that between 800 and 1,000 feet of Ripley is present in the vicinity of Memphis.

Cenozoic Rocks

Tertiary System

The major portion of the surface of western Tennessee is covered by deposits of Tertiary and Quaternary ages. The Tertiary outcrop belt extends from Mississippi across Tennessee into Kentucky, southern Illinois, and southeastern Missouri. The belt is about 115 miles long in Tennessee, some 70 miles wide at the Mississippi line and about 60 miles in width at the Kentucky boundary.

Eocene Series

Only the lower and upper Eocene are present in western Tennessee, the middle Eocene (Claiborne) being absent (Roberts, 1928a, p. 436). The lower Eocene is composed of the Midway group (Clayton

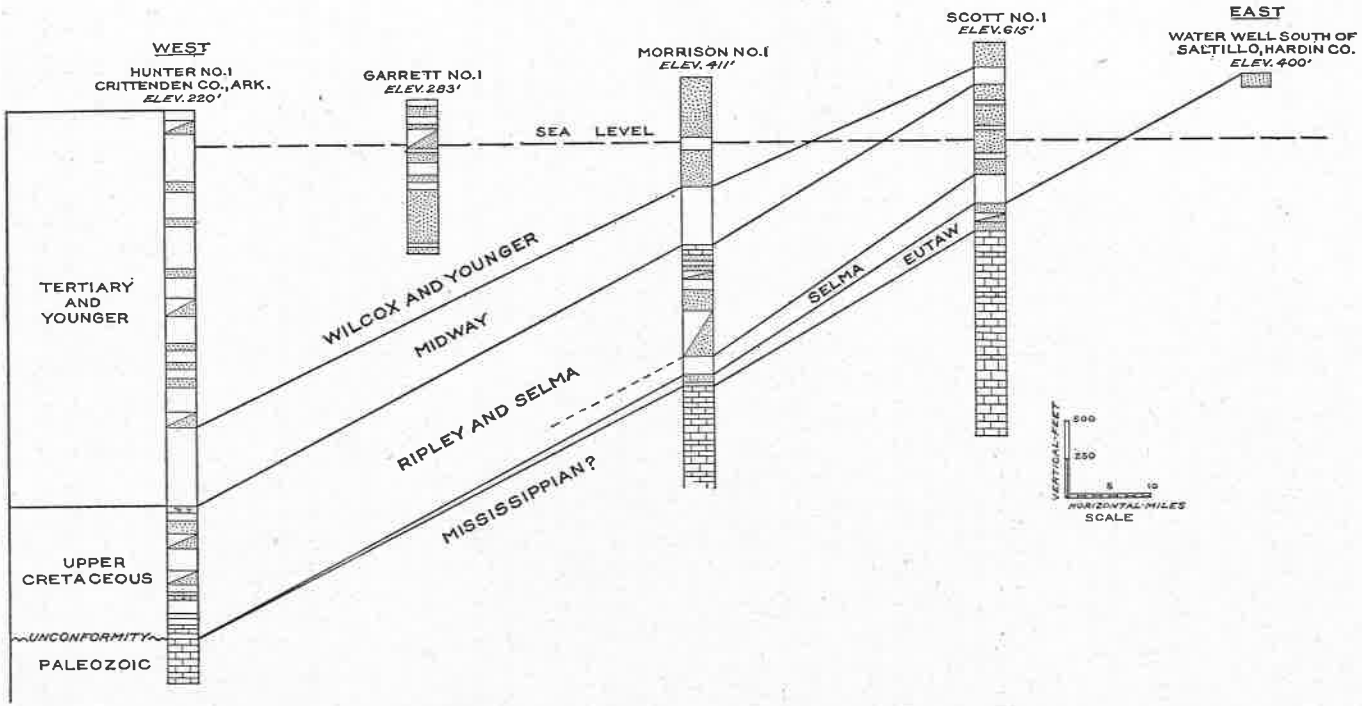

Fig. 2. East-west cross-section from near Saltillo, Hardin County, Tennessee, to the Hunter No. 1 well, Crittenden County, Arkansas.

formation and the Porters Creek clay) and the Wilcox group (Holly Springs sand and the Grenada formation). In northern Mississippi the basal Wilcox is represented by the Ackerman formation which has not been described in Tennessee, but which is believed by Whitlatch (personal communication) to outcrop in a few places in the southern part of the State. The Ackerman undoubtedly underlies the Holly Springs sand with which it has perhaps been included in the well records.

Midway Group. The Midway group is composed of a lower formation, the Clayton, about which little is definitely known in Tennessee, since it has been the practice to term all sediments between the top of the Ripley and the base of Wilcox as "Porters Creek." Near Trim's Mill, in southeastern Hardeman County, a limestone phase of the Clayton has been noted (Roberts, 1928b). At this place the limestone is overlain by some 30 feet of greensand. Towards the north the limestone phase grades into a loose, medium-grained, glauconitic sand, which may be locally absent. The formation probably does not exceed 60 feet in thickness in Tennessee.

The Porters Creek is a dark-gray, tough, sticky clay commonly called "gumbo" or "soapstone" by the drillers. At the outcrop the formation reaches a thickness of about 100 feet, but well logs indicate a rapid thickening towards the west (Fig. 2). In the Scott well (No. 15) the Midway is only 105 feet thick, but in the Morrison well (No. 18) it has increased to 364 feet. Spooner (1935, p. 312) logged 490 feet of Midway clay in the Hunter No. 1 well in Crittenden County, Arkansas. Wells (1933, p. 282) believed the Midway at Memphis to be some 350 feet in thickness although the logs of the Shelby County wells do not allow definite correlation.

Wilcox Group. Both the Grenada formation and the underlying Holly Springs are sands with many clay lenses. Since they are so lithologically similar, no precise correlation of well cuttings can be made and the group term, Wilcox, has been used in plotting the data from well logs. The Wilcox, like the underlying Midway, becomes thicker towards the center of the Mississippi embayment (Fig. 2).

Jackson Formation. The Jackson formation of upper Eocene age is a sandy clay with some lignite beds and in some places the formation is a calcareous sandstone. The Jackson is known to outcrop at a number of places along the bluffs of the Mississippi River and the formation undoubtedly underlies most of the loess and gravels in the region immediately east of the river bluffs.

PLIOCENE (?) SERIES

Gravels. In the uplands adjacent to the Mississippi and Tennessee Rivers sands and gravels occur, the definite age of which is not known. Some of these gravels are related to present streams while others occur as a thick mantle over the Tertiary and Upper Cretaceous sediments. Roberts (1928) considered these gravels as Pliocene-Pleistocene in age.

TABLE 2

Mesozoic and Cenozoic formations exposed in Western Tennessee

System	Series	Subdivisions		Thickness (feet)	Physical Character
Quaternary	Recent	Alluvium		0–150	Gravels, sands, and muds of the present streams
	Pleistocene	Loess		0–100	Yellowish-brown silty clay; exposed in Mississippi River bluffs
Tertiary	Pliocene ?	Gravels		0–50	Gravels and sands; includes terrace and "Lafayette" gravels; some may be as young as Pleistocene
	Eocene	Jackson formation		0–120	Fine sand and clay, with some lignite and sandstone beds
		Wilcox	Grenada formation	600–1900	Cross-bedded fine sands with clay lenses
			Holly Springs formation		Fine to coarse sands with clay; very similar to the Grenada
			Ackerman formation		Lignitic clay with some sand; not exposed but probably present on the sub-surface in southern part
		Midway	Porters Creek clay	30–100	Dark-gray, sticky, tough clay; "gumbo" of drillers
			Clayton formation	0–60	Glauconitic clay and sand; some limestone in southern part
Cretaceous	Upper Cretaceous	Ripley	Owl Creek tongue	350–600	Micaceous sandy marl
			McNairy sand member		Highly-colored, cross-bedded sand with some clay
			Coon Creek tongue		Greenish, glauconitic, ferruginous sandy marl
		Selma clay		0–210	Grayish-white chalky clay or marl
		Eutaw	Coffee sand member	0–530	Red, cross-bedded, micaceous sand
			Tombigbee sand member		Glauconitic, cross-bedded fine sand

TABLE 2—(*Continued*)

Mesozoic and Cenozoic formations exposed in Western Tennessee

System	Series	Subdivisions	Thickness (Feet)	Physical Characters
Cretaceous	Upper Cretaceous	Tuscaloosa gravel	0–100	Well-rounded, water-worn chert pebbles; only locally present

Quaternary System

Pleistocene Series

Loess. In the bluffs of the Mississippi River and overlying the Pliocene-Pleistocene sands and gravels is the loess of Pleistocene age, which ranges in thickness from about 50 to nearly 100 feet. The loess thins towards the east to a feather edge, but it mantles the area just east of the river bluffs to depths approximating 100 feet.

Recent Series

Alluvium. The youngest rocks exposed in western Tennessee are the present-day stream deposits, consisting of gravels, sands, and muds, and referred to as alluvium. The depth of the alluvium varies considerably from valley to valley, but as much as 150 feet is present in certain portions of the Mississippi River flood plain.

A generalized section of the Mesozoic and Cenozoic rocks of western Tennessee is shown in Table 2.

POST-PALEOZOIC GEOLOGIC HISTORY

Upper Cretaceous

Since the Upper Cretaceous and lower Eocene sediments of western Tennessee represent deposition by a trangressing sea over an eroded land surface, it must be definitely kept in mind that these formations of the Mississippi embayment represent lithologic rather than chronologic units. These seas invaded the area from the south and southwest and the formations, therefore, become progressively younger towards the north. As the writer (Born, 1935, p. 229) has previously pointed out, the Tuscaloosa gravels, representing the basal deposition of the Upper Cretaceous sea, are younger in the western Highland Rim region than the Tuscaloosa gravels in northwestern Alabama and northeastern Mississippi, and the Tuscaloosa between the Cumberland and Tennessee Rivers in western Kentucky may be the age equivalent of the Eutaw or even younger formations to the south.

The absence of the Tuscaloosa in wells drilled in western Tennessee strongly suggests that these deposits represent off-shore gravels deposited by the advancing Upper Cretaceous sea. The western extension of these gravels is not known, but the Scott well (No. 15) failed

to penetrate any gravels immediately above the Paleozoic floor.[3] The presence of both Tuscaloosa and Eutaw sediments in western Kentucky (Roberts, 1929, pp. 281-326) and the absence of the formations to the northwest in Tennessee would seem to indicate that the initial Upper Cretaceous sea may have entered western Tennessee farther to the east than has been previously considered. This idea is further substantiated by the eastern occurrences of the Tuscaloosa on the western Highland Rim, which have been recently described by the writer (Born, 1935, pp. 225-227).

During both Tuscaloosa and Eutaw time western Tennessee was never deeply submerged, a condition which is reflected by the type of sediments. It has been previously stated that an inspection of well records definitely indicates that the Eutaw as a sand thins towards the west. This would suggest a post-Tuscaloosa shift of the center of deposition towards the west. It is interesting to note that a westward shift of the axis of the Mississippi embayment has been suggested by Dane (1929, p. 169).

Probably due to continued down-warping, deeper marine conditions prevailed during Selma time, with the deposition of a chalky clay in which *Inoceramus* and *Exogyra* were common. The Selma outcrops just west of the Eutaw exposures and the thinning of the formation to the west would seem to indicate a farther westward migration of the axis in post-Eutaw time.

The Upper Cretaceous sea in Tennessee reached its maximum development during Ripley time. The Ripley sands underlie all of the younger formations west of the outcrop belt and extend to the north into southern Illinois and southeastern Missouri. Unlike the underlying Upper Cretaceous formations, the Ripley thickens towards the west (Fig. 2). It seems probable that during Ripley time the axis of the Mississippi embayment had shifted to about its present position where it has since remained.

It has long been recognized that the sediments of the Mississippi embayment thin towards the north. This decrease in thickness is due to progressive overlap by successively younger formations and not to the thinning of each individual formation in the upper part of the Mississippi embayment area. This relationship may be shown by a north-south cross-section from southern Tennessee to Wickliffe, Kentucky, near the head of the embayment (Fig. 3). In the Beasley No. 1 well (No. 17) nearly 200 feet of Eutaw sand overlies the Paleozoic floor.[4] In the Morrison well (No. 18), some 15 miles to the north, the Eutaw has thinned to 75 feet and in the Jarrett No. 2 well (No. 19) only 47 feet of sand correlated as the Eutaw is present. The writer believes that the Eutaw thins out completely between the Jarrett test and the Reelfoot Lake region.

[3]In the P. R. Beasley No. 2 well, recently abandoned in southeastern Fayette County, about 9 feet of small pebbles and sand was encountered at the base of the Upper Cretaceous. This gravel and sand may represent the Tuscaloosa.

[4]The Beasley No. 2 well, located about 50 feet from the No. 1 well, logged about 9 feet of gravels and sands above the Paleozoic floor, which probably represents the Tuscaloosa.

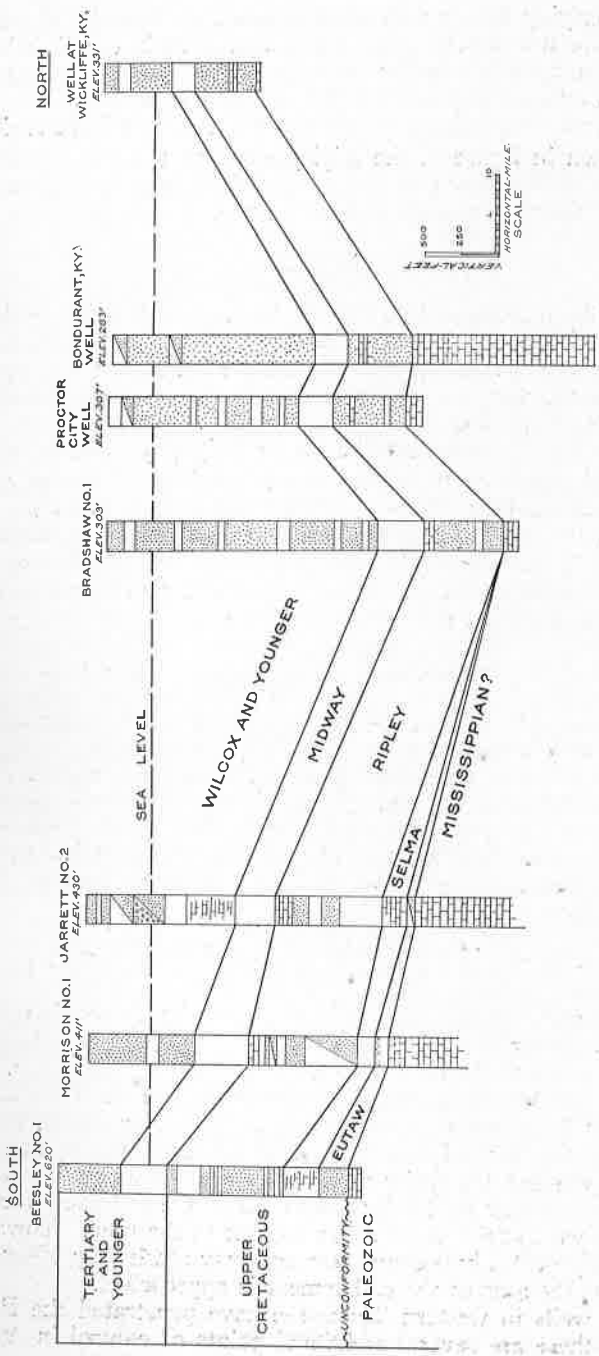

Fig. 3. North-south cross-section from the Beasley No. 1 well, southeastern Fayette County, Tennessee, to Wickliffe, Kentucky.

The overlying Selma clay, which has a thickness of 238 feet in the Beasley No. 1 well (No. 17), is 119 feet thick in the Morrison well (No. 18) and thins to about 55 feet in the Jarrett No. 2 well (No. 19). With the possible exception of the S. J. Bradshaw well (No. 6), the Selma clay is absent in the wells of the Reelfoot Lake region.

As shown in figure 3, the Ripley overlaps the underlying Upper Cretaceous formations and in the northern part of the embayment area rests directly upon the Paleozoic floor.

Eocene

The widespread unconformity at the top of the Ripley indicates elevation of the upper Mississippi embayment at the close of the Upper Cretaceous. In lower Eocene time the region was again submerged as far north as southern Illinois and southeastern Missouri. The Midway sea deposited a thin limestone (Clayton) in southern Tennessee, but the sedimentation was chiefly clays with some sand.

The withdrawal of the Midway sea is evidenced by the clay conglomerate at the base of the Holly Springs formation of the Wilcox group. Very shallow water conditions existed during Wilcox time and the Holly Springs and Grenada sands show the influence of near shore and estuarine facies. The swampy and continental deposits of the Jackson followed the recession of the Wilcox seas.

Pliocene (?) and Quaternary

During the late Tertiary, western Tennessee was a low-lying land area upon which sluggish streams deposited blanket and terrace gravels. The definite age of these gravels is not known, but they are usually assigned to the late Pliocene. The Pleistocene history consists of the deposition of the wind-blown loess upon the gravels. During comparatively recent time a slight elevation of the area has intrenched the streams with the deposition of the present-day alluvium.

THE PALEOZOIC FLOOR

Structure

In western Tennessee the regional dip of the Paleozoic rocks is to the west and southwest and the slope of the younger beds is naturally that of the Paleozoic floor upon which they were deposited. Glenn (1906, p. 10) has compared the configuration of the Paleozoic floor underlying the embayment sediments to that of a spoon whose tip extends to the north into southern Illinois and whose eastern half underlies western Kentucky and Tennessee. Near their outcrop, in the Western Valley of the Tennessee River, the Paleozoic formations dip to the west at a rate of 30 to 40 feet to the mile. Towards the west the dip probably becomes less and may reach only 10 or 15 feet per mile as the axis of the embayment is approached.

Eleven wells in western Tennessee have penetrated the Paleozoic floor and there are several additional points of control in Arkansas,

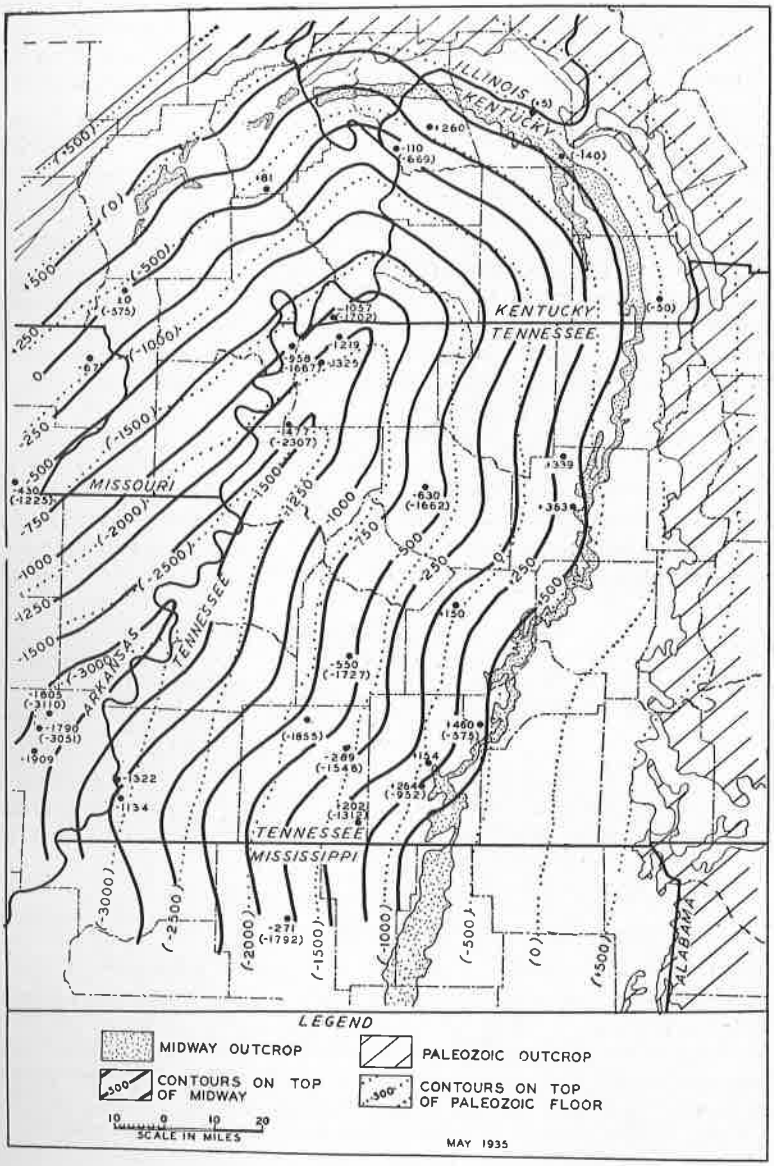

Fig. 4. Structural contour map on top of the Paleozoic floor and the top of the Porters Creek clay in Western Tennessee. Paleozoic contour interval is 500 feet. Midway contour interval is 250 feet.

Mississippi, and Kentucky. The logs of these wells indicate a regional dip towards the center of the embayment, whose axis, according to present data, lies a little west of the Mississippi River near Memphis, and trends in a general northeastern direction across the river into northwestern Tennessee (Fig. 4). The axis pitches to the southwest. It is interesting to note that the structural contours on top of the Midway (Porters Creek clay) closely follow the configuration of the Paleozoic floor.

In the Western Valley of the Tennessee River, Dunbar (1919, p. 13) has noted several open folds in the Paleozoic rocks whose dips may reach a maximum of about 10 degrees. These folds trend generally east-west and are exposed at various places along the Tennessee River from northern Benton County to southern Hardin County. The westward extension of these structures under the Upper Cretaceous and Tertiary sediments is unknown, but it would seem probable that some of the larger folds extend a considerable distance in that direction.

With the exception of the Reelfoot Lake region and the southern half of the Western Valley area, there is little evidence of faulting in the Mississippi embayment region of Tennessee. Some small faults, such as the one just east of Hornsby in Hardeman County, in the Porters Creek clay, have been observed, the displacement along which does not exceed a few feet. The New Madrid disturbance of 1811-1812 undoubtedly was associated with lines of structural weakness in the underlying Paleozoic rocks, but the extension of this faulting into adjacent parts of Tennessee and the upper Mississippi embayment area is unknown.

Age

The lack of numerous cuttings from wells which have penetrated the Paleozoic floor in western Tennessee makes the assignment of an age to these rocks somewhat speculative. Based upon our present data, the Paleozoic rocks, underlying most of the embayment sediments in this region, are considered Mississippian in age. The Sain well (No. 16) and the Scott well (No. 15) reported Chattanooga shale some 300 to 400 feet below the top of the Paleozoics. The Jarrett No. 2 well (No. 19) recently penetrated the Chattanooga black shale, but there is some question as to the accurate depth from which this sample came. Cuttings from the Beasley No. 1 well (No. 17), which drilled about 75 feet into Paleozoic rocks, are very hard, cherty, white limestones quite similar in lithology to the middle Mississippian limestones and cherts of middle Tennessee.

In the Reelfoot Lake region Glenn (1933, p. 10) has suggested that the Paleozoic floor may be Ordovician or even older in age. In 1921 a well (No. 1) was drilled deeper than 3100 feet in Fulton County, Kentucky, just north of Reelfoot Lake. Unfortunately, only a few cuttings are available from this test. However, H. S. McQueen, in a recent letter to the writer (1935), reported that an insoluble residue study of some of the samples from this well indicated that

this test was deep in the Ordovician between 3100 and 3183 feet. Since the top of the Paleozoics was logged at 1985 feet in this well, the presence of lower Ordovician rocks at 3100 feet points towards an older age for the Paleozoic rock floor in this region than farther to the south.

SUMMARY

A detailed study of the available cuttings and logs of wells drilled in western Tennessee indicates that:

1. The Tuscaloosa, Eutaw, and Selma formations of Upper Cretaceous age thin definitely towards the west, suggesting a gradual shifting of centers of deposition to the west during a part of Upper Cretaceous time. A westward shift of the axis of the Mississippi embayment would explain this thinning.

2. The Ripley sand thickens to the west, probably indicating that the axis of the embayment had reached about its present position during Ripley time.

3. The Midway and Wilcox groups of the lower Eocene rapidly thicken towards the center of the embayment.

4. The Mississippi embayment sediments thin to the north towards the head of the embayment. This thinning is due to progressive overlap, with the Ripley sand resting directly upon the Paleozoic floor in the northern part of the embayment area.

5. According to present data, the axis of the Mississippi embayment lies a little west of the Mississippi River at Memphis and trends in a general northeastern direction into northwestern Tennessee. The configuration of the top of the Midway clay closely approximates that of the underlying Paleozoic floor.

6. Based upon present information, the Paleozoic rocks underlying the embayment sediments are considered Mississippian in age, with the possibility that older rocks form the floor in the Reelfoot Lake region.

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