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STRATIGRAPHY OF THE TUPELO TONGUE OF THE COFFEE SAND (UPPER CAMPANIAN), NORTHERN LEE COUNTY, MISSISSIPPI

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INTRODUCTION

The Coffee Sand (upper Campanian) is an updip terrigenous clastic facies of the Selma Chalk sequence (Campanian-Maastrichtian). The Coffee crops out in Mississippi in a belt extending from the Alcorn-Tishomingo County area southwestward to central Lee County, where the sand facies changes to argillaceous chalk (Stephenson and Monroe, 1940). In Tishomingo County, extreme northeastern Mississippi, the Coffee Sand is the basal unit of the Selma Group and rests above the Tombigbee Sand Member of the Eutaw Formation (a part of the Eutaw Group). There the Coffee Sand consists of massive and cross-bedded sands with occasional thin clay beds and some burrowed sand zones. The Tupelo Tongue of the Coffee Sand is a southward extension of the formation into southern Prentiss and Lee counties, Mississippi, where the formation is bounded below and above, respectively, by the Mooreville and Demopolis formations (chalks) of the Selma Group. Here the Coffee has a significant clay component, which increases in a south and westward direction, and the formation becomes more fossiliferous, especially in the lower half.

The present report is the result of test hole drilling to determine the position of a fossiliferous zone, informally referred to as the "Chapelville fossiliferous horizon," within the Coffee Sand sequence. Four test holes were drilled for the project (two of which were drilled at the same site) along a general east-west line in northern Lee County. Electric log characteristics of sand bodies within these test holes and in an additional well to the west (well number 1 of Figure 1) showed close correlation and indicated that these sand units are continuous over a distance of at least ten miles. Four major sand bodies were delineated in these logs and likely represent four episodes of sand transport onto the Selma marine shelf.

The sand intervals within the Coffee provide a useful source of ground water for residential wells in northern Lee County and surrounding areas. In Mississippi, fresh water occurs in the Coffee Sand in an area extending from the outcrop belt westward to a line extending from southwestern Lafayette County to northeastern DeSoto County (Boswell, 1979). However, the Coffee is utilized as an aquifer primarily in the area only as far west as Tippah and Union counties. There are large yield Coffee Sand wells at Ripley, Blue Mountain, Walnut,

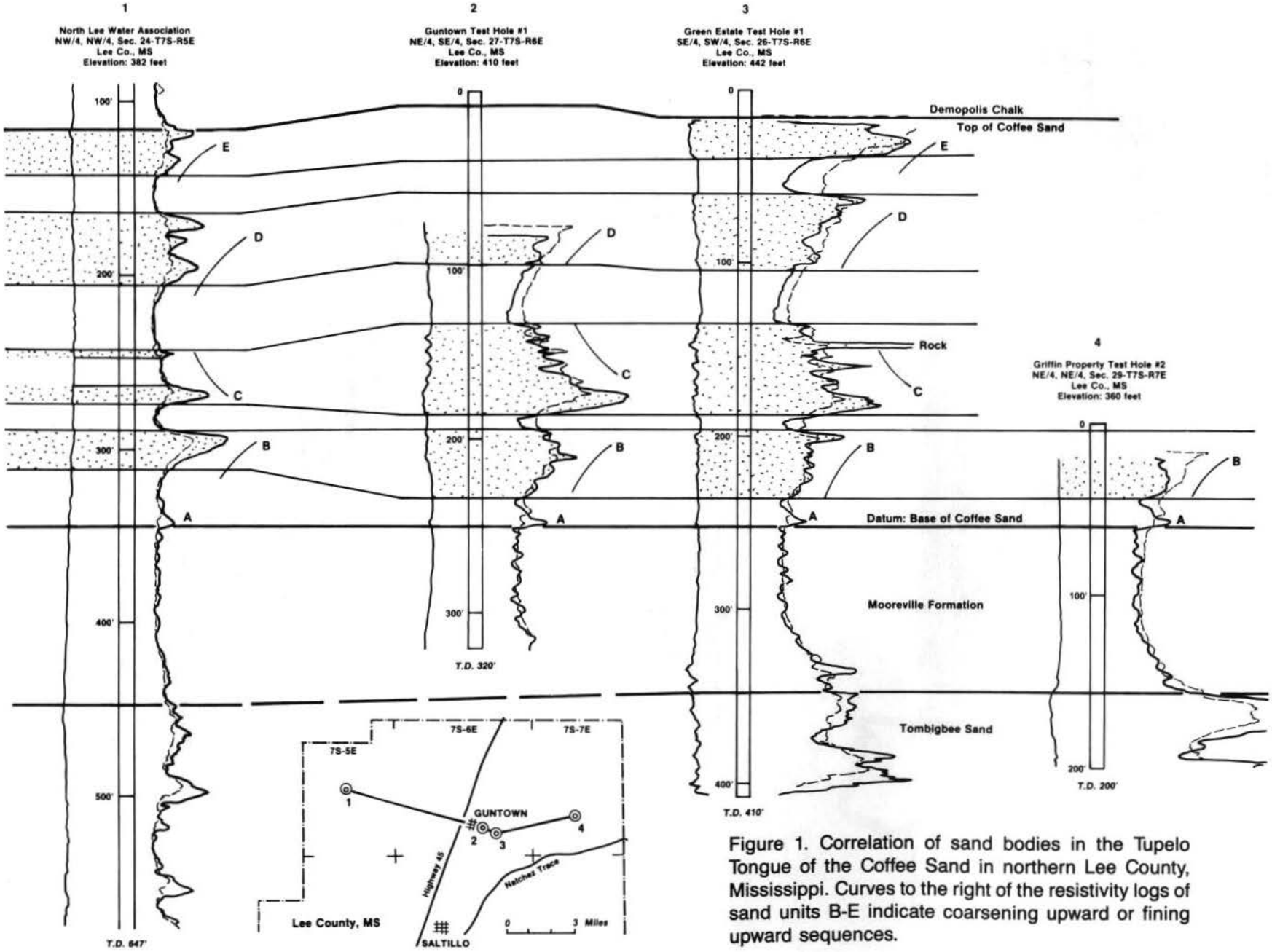

Figure 1. Correlation of sand bodies in the Tupelo Tongue of the Coffee Sand in northern Lee County, Mississippi. Curves to the right of the resistivity logs of sand units B-E indicate coarsening upward or fining upward sequences.

Mitchell, Kossuth, Chalybeate, and Keownville. Regional structural dip is to the west at approximately 30-35 feet per mile, and the regional potentiometric surface of the Coffee aquifer dips to the west-southwest (Darden, 1985). Description of the Coffee Sand stratigraphy is pertinent to understanding the depositional history of the area and in delineating this significant aquifer.

INVERTEBRATE MARINE FAUNA OF THE COFFEE SAND

Sohl (1964) described the gastropods of the Coffee Sand in Mississippi and included a list of mollusks from 12 localities. Localities 1-7 were cited as from the lower part of the Coffee Sand whereas localities 8-12 were from the upper part. Most of the molluscan occurrences were from the lower half of the formation, and the vast majority of these were cited from a single locality. This locality (locality 6) was a roadcut on the north-facing slope of the Mantachie Creek valley in section 9, T.8S., R.7E., Lee County, Mississippi. Presently the fossiliferous interval of this locality is covered. While a diverse molluscan assemblage was cited for the Mantachie Creek locality, Sohl (personal communication), who collected from it in 1955 and 1956, stated that fossils were not abundant there.

The Mississippi Bureau of Geology was contacted in May of 1976 concerning the find of numerous large ammonites (*Placenteras*) in concretions along the excavation route for the Natchez Trace Parkway in the vicinity of Twenty Mile Creek near the community of Chapelville in northeastern Lee County. The roadcuts were in the lower part of the Tupelo Tongue of the Coffee Sand and were found to be moderately fossiliferous. An additional roadcut adjacent to the Natchez Trace was noted to contain an abundance of marine fossils at a particular stratigraphic horizon. This roadcut has a section of moderately fossiliferous, argillaceous sand at the base similar to (but not necessarily correlative with) that noticed along the Natchez Trace roadcut. Overlying this argillaceous sand is a very fossiliferous, concretion-bearing sand unit which grades upward into a fossiliferous clay. This fossiliferous sequence, here informally called the Chapelville horizon, terminates abruptly at a shell-rich layer containing the large bivalves *Exogyra erraticostata* Stephenson, *Cucullaea (Idonearca) vulgaris* Morton, *Cyprimeria alta* Conrad, and *Pachycardium stantoni* (Wade), as well as fragments of *Placenteras*. Overlying the fossiliferous horizon are non-fossiliferous clays.

A second locality for the Chapelville fossiliferous horizon was later found in a borrow pit near Chapelville. Both localities contain a diverse, well preserved, invertebrate marine fauna. The Tupelo Tongue is moderately fossiliferous through most of its sequence, but fossils within this unit are often poorly preserved. The Chapelville horizon is an acme zone for well-preserved fossil mollusks within the Tupelo Tongue. It is ten feet thick at the Natchez Trace Parkway locality and eight feet thick at the borrow pit locality. Collections from these localities at the Mississippi Bureau of Geology contain about three hundred species of mollusks, many of which are new. Although most of these mollusks are open marine types, one taxon, *Gymnentome*, is a brackish water gastropod indicative of an estuarine environment associated with a river mouth (Sohl, 1987). Description of the molluscan fauna of the Tupelo Tongue is to be published in upcoming issues of the Bureau's bulletin series.

TEST HOLES

The two very fossiliferous exposures of the Tupelo Tongue in the vicinity of Chapelville are believed to be within the same stratigraphic horizon at the base of a ten to fifteen foot thick clay bed. Two test holes were drilled on March 12 and 13, 1987, to determine the position of the Chapelville fossiliferous horizon within the Tupelo Tongue sequence. The first of these, the Guntown Test Hole #1, began in the Demopolis Chalk and entered the Coffee Sand at 9 feet. A prominent oyster biostrome at the base of the Demopolis constitutes an excellent marker bed for the Demopolis-Tupelo Tongue contact in northern Lee County. This test hole penetrated 241 feet of the Tupelo Tongue and reached total depth in the Mooreville at 320 feet. Cutting samples were taken at ten-foot intervals. The first fossil fragments noted in cuttings from the Tupelo Tongue were at 155 feet, and a Shelby tube core was taken of a sparsely fossiliferous sand at 158-160 feet. Although an electric log was run in the hole, the upper 80 feet were not logged due to a malfunction in the logging unit.

The Griffin Property Test Hole #1 was drilled the following day on March 13. This test hole began one foot above the Chapelville fossiliferous horizon and reached a total depth of 190 feet in the Tombigbee Sand Member of the Eutaw Formation. The top eleven feet of the section, including the Chapelville horizon, were continuously cored using Shelby tubes. However, a malfunction of the electric logging unit, similar to that of the previous day, prevented the upper 80 feet of the hole from being logged.

Cutting samples taken during drilling were not useful in determining the lower contact of the Tupelo Tongue with the Mooreville Formation. Clays in the lower part of the Tupelo Tongue and the upper Mooreville were

similar in the test hole cuttings. These clays thickened the drilling fluid, making the fine-grained sands difficult to sample. For this reason, the character of the sands within the lower Tupelo Tongue are best recorded by electric logs.

Two additional test holes were drilled on May 17 and 18, 1988, and were successfully logged with both multipoint electric and natural gamma radiation logging tools. These logs provided the means for determining the stratigraphic position of the Chapelville horizon within the Tupelo Tongue sequence as shown in Figure 2. The first hole drilled, the Griffin Property Test Hole #2 (Figure 3), began three feet above the Chapelville fossiliferous horizon and reached total depth in the Tombigbee Sand at 200 feet. The second hole, the Green Estate Test Hole #1, began in the Demopolis Chalk 15 feet above the Demopolis-Tupelo Tongue contact and reached total depth in the Tombigbee Sand at 410 feet.

CORRELATION OF UNITS WITHIN THE TUPELO TONGUE

Test holes through the Coffee Sand sequence in northern Lee County showed the formation to rest above the Mooreville "Chalk" rather than the Tombigbee Sand, thus technically placing the sequence in the Tupelo Tongue. In both the Green Estate Test Hole #1 and the Griffin Property Test I 'ole #2 (Figure 2), 96 feet of the Mooreville Formation underlies the Tupelo Tongue. The Mooreville Formation or "Chalk" is a gray, calcareous clay where it occurs below the Tupelo Tongue of the Coffee Sand. It is increasingly sandy toward its lower contact with the Tombigbee Sand. The resistivity log for the Green Estate Test Hole #1 suggests a prominent sand unit in the lower Mooreville at 332-338 feet. Though this sand could be mistaken for the top of the Tombigbee, the drilling characteristics indicate the first Tombigbee Sand at 350 feet, which is very close to the electric log pick at 348 feet as shown in Figure 2. Unlike the Tupelo Tongue-Mooreville contact, the Mooreville-Tombigee contact is easily recognized during drilling operations. The drilling rate increases significantly across this contact and an abundance of glauconite is noted in the drilling mud. In addition, the gamma ray logs for both of these test holes (Figure 2) indicate a clay interval at the base of the Mooreville at the same horizon the resistivity logs indicate sand. One possible explanation of these apparently contrasting log measurements is that the lower Mooreville sands are in a clay matrix.

Five laterally extensive sand units were noted in the Tupelo Tongue of northern Lee County. The first of these is labeled A in Figure 1 and is a thin sand unit that forms a prominent local marker bed for the base of the Tupelo Tongue. The other four units, labeled B-E, are sand bodies with significant thicknesses. These units are separated by clay intervals and probably represent specific episodes of sand transport onto the Selma marine shelf. Sand units B, D, and E coarsen upward as indicated by the "inverted Christmas tree" log curves in Figure 1, whereas unit C fines upward as indicated by the "Christmas tree" curve. The Chapelville fossiliferous horizon occurs in the upper sand of unit B and in the base of the clay interval separating units B and C (see also Figure 2). Unit E, the uppermost sand unit of the Tupelo Tongue, can be observed at various localities in the Guntown-Baldwyn area below a basal oyster biostrome of the Demopolis Chalk. In this area it is a massive to cross-bedded, nonfossiliferous, brown sand. Preliminary correlations of the sand units indicate that the uppermost units at least can be mapped as discrete sand bodies as far south as the west Tupelo area and as far west as eastern Union County.

DEPOSITIONAL ENVIRONMENTS OF THE TUPELO TONGUE

Russell (1975) attributed the Coffee Sand in western Tennessee to shelf deposition associated with barrier bars and sandy lagoons. Webb (1984) gave a similar depositional model for the Coffee Sand in the subsurface of the Desha Basin area of western Mississippi. There Webb mapped sand trends that ran parallel to the ancient shoreline and recognized shallow shelf environments consisting of lagoons, barrier islands, offshore bars, and surge channel deposits.

The fossiliferous nature of much of the Tupelo Tongue (especially the lower half) in northern Lee County suggests shallow shelf depositional environments similar to those interpreted by Russell and Webb. However, the sand units illustrated in Figure 1 continue down depositional slope (to the south) as well as along depositional strike (east-west). The coarsening upward of units B, D, and E indicates cycles of increasing proximity to the sand source and/or increasing energy regime during deposition. These units exhibit electric log characteristics similar to those of a prograding deltaic sequence. It is probable that units B, D, and E were deposited either in destructional deltaic sequences (Fisher et al., 1969), probably of the wave-dominated type, or as shelf sands deposited in front of advancing deltaic systems. Units D and E were not noted to be fossiliferous in test hole cuttings and show the strongest deltaic influences. Clay intervals underlying these sand units are shelf and prodelta mud facies of the prograding deltas.

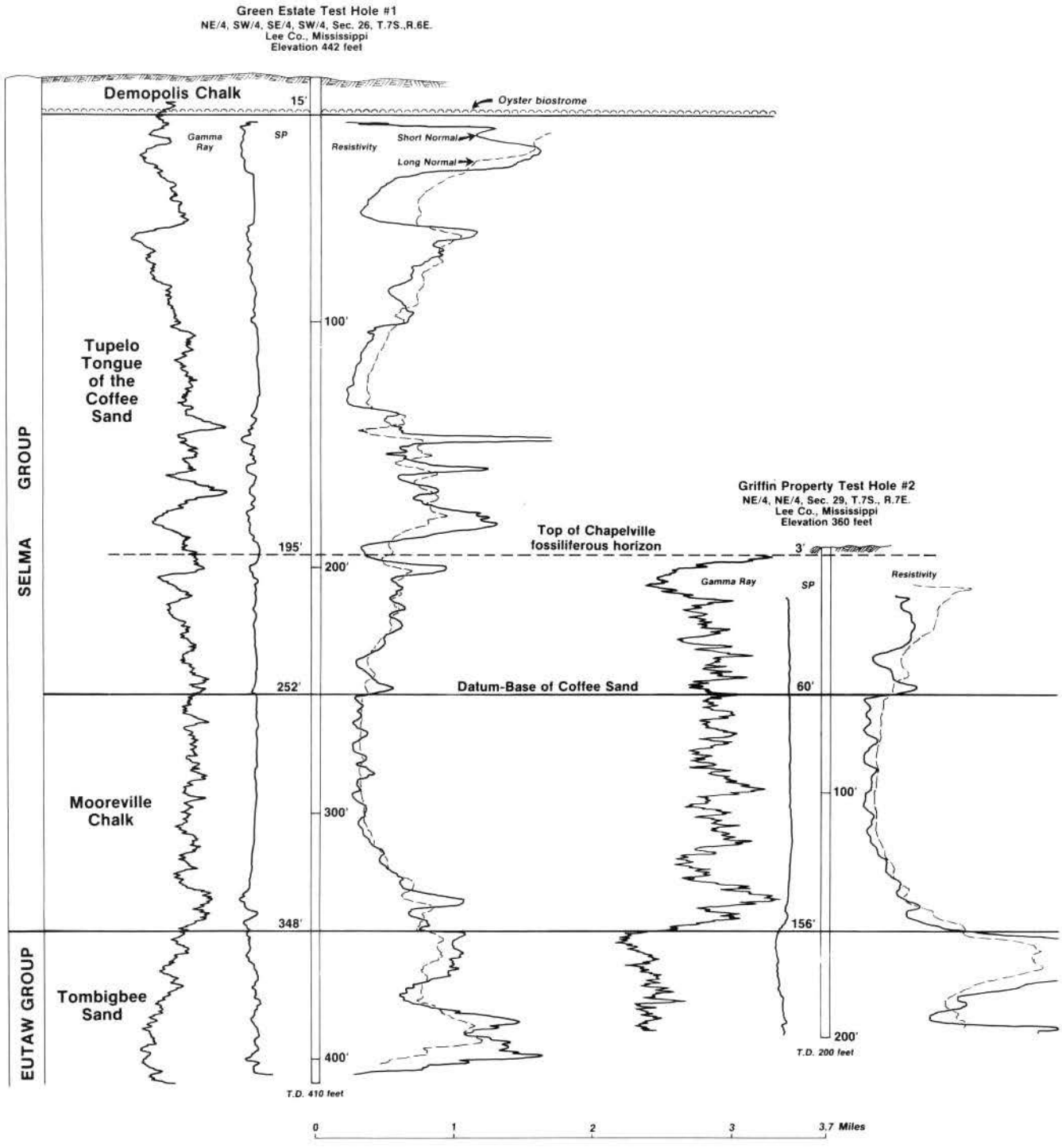

Figure 2. Position of the Chapelville fossiliferous horizon within the Tupelo Tongue sequence. The top of this horizon occurs at the base of a clay bed separating sand units B and C as shown in Figure 1.

Unit C differs from the other sand units in that it fines upward and has a massive basal sand in sharp contact with the underlying clay. This contact can be seen in the borrow pit on the Griffin property where the test holes were drilled (Figure 3). Neither the basal sand nor the upper part of the underlying clay are fossiliferous at this locality. The basal sand of unit C may represent a delta front sand immediately overlying a prodelta mud facies. The fining upward sequence would represent shelf sands in front of the delta as it retreated.

The Chapelville fossiliferous horizon probably represents a return to open marine conditions following abandonment and retreat of the deltaic sand sources for unit B. Occurrences of the brackish water gastropod *Gymnentome* within this horizon are indicative of proximity to a retreating river mouth. The Chapelville fauna continued to inhabit the shelf as the seafloor sediment changed from sand to mud. Shells within the mud layer were concentrated in one or more thin beds during current-related events (possibly storm currents). The abrupt absence of fossils immediately above the Chapelville horizon indicates a relatively rapid change in environments from open marine to estuarine conditions. This change occurred as prodelta muds were deposited above shelly shelf muds in front of the prograding delta complex of unit C.

CONCLUSIONS

Sand units in the Tupelo Tongue of the Coffee Sand in northern Lee County, Mississippi, demonstrate a cyclical sedimentation pattern related to four periods of delta progradation and abandonment. Each successive period shows stronger deltaic influences and thus increased deltaic progradation onto the Selma marine shelf. Overlying the first deltaic sequence are shelf sands and clays of the Chapelville fossiliferous horizon.

Figure 3. Drill site for the Griffin Property Test Hole #2. Stadia pole at left is resting on the base of sand unit C. Fossil shells from the top of the Chapelville fossiliferous horizon are scattered on the slope below the pickup truck at left.

This horizon formed seaward of a retreating delta system and terminated with the introduction of prodelta muds from a subsequent period of delta progradation. Marine shelf and prodelta clays (muds) separate the four deltaic sand units and form confining beds that subdivide the Tupelo Tongue into multiple aquifers.

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"It is an advantage or disadvantage of mathematical shorthand, depending on the point of view, that things can be said in equations, impressively, even arrogantly, which are so nonsensical that they would embarrass even the author if spelled out in words."

J. Hoover Mackin
1963

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