GEOLOGY OF OLIGOCENE, MIOCENE, AND YOUNGER DEPOSITS IN THE COASTAL AREA OF GEORGIA

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Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey

BULLETIN 131

Cover photograph:

Wind-sculpted Live Oak tree on a sand dune, Cumberland Island National Seashore, Camden County, Georgia. *Photograph by Alan M. Cressler.*

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Prepared in cooperation with the
U.S. GEOLOGICAL SURVEY

Atlanta, Georgia
2001

BULLETIN 131

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GEOLOGY OF OLIGOCENE, MIOCENE, AND YOUNGER DEPOSITS IN THE COASTAL AREA OF GEORGIA

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ABSTRACT

Analysis of cores and geophysical logs for ten coreholes and wells in the coastal area of Georgia has allowed a detailed synthesis and correlation of the Oligocene and Miocene strata across this area. A total of eighteen unconformity-bounded Oligocene and Miocene stratigraphic units can be recognized in the area. Erosion during the times represented by the intervening unconformities has produced cut and fill patterns that greatly complicate the stratigraphic and hydrologic patterns across the region. The Tiger Leap Member of the Parachucla Formation of Huddlestun and the Ebenezer Member of the Coosawhatchie Formation of Huddlestun are raised to formational rank. With these changes, the eighteen unconformity-bounded stratigraphic units can be clustered into seven lithologically distinctive formations. At the same time, however, these stratigraphic units also compose three hydrologic aquifers and their confining units. By integrating and clarifying the relations between stratigraphic units and hydrologic units, a more useful framework for both stratigraphers and hydrologists can be achieved than by basing the stratigraphic system on only one of these two concepts.

INTRODUCTION

Three aquifers have been recognized in Miocene and younger deposits in the 24-county coastal area of Georgia (McDowell and Steele, 1998; Clarke and others, 1990). These three aquifers, in descending order, are the surficial aquifer (in sediments of late Miocene age), and the upper and lower Brunswick aquifers (in sediments of latest Oligocene to middle Miocene age). Clarke and others (1990) conducted a preliminary evaluation of the hydrogeologic characteristics of these aquifers in coastal Georgia, but until now there has been no detailed lithologic description and stratigraphic synthesis of the geologic units that compose these aquifers and their confining units. Previously these aquifers and confining units were defined primarily by gamma log profiles of holes penetrating these units (Wait and Gregg, 1973). Four gamma markers labeled A, B, C, and D were used to recognize (in descending order) the top of the upper Brunswick aquifer (A), the top of the lower Brunswick aquifer (B), the approximate base of Miocene strata (C), and the top of the Ocala Limestone (D). While useful for recognizing important horizons in the subsurface, this approach offered only limited information concerning the age of the stratigraphic horizons of interest.

To better understand the distribution of permeable horizons within the Miocene strata of coastal Georgia and their stratigraphic framework, we present lithologic descriptions of eight new coreholes, correlate their stratigraphy with the standard Miocene dinoflagellate zonation of de Verteuil and Norris (1996), provide supplemental observations and dinoflagellate zonation horizons for the previously described Cumberland Island corehole (Clarke and others, 1990), and correlate all of these cores with the previously

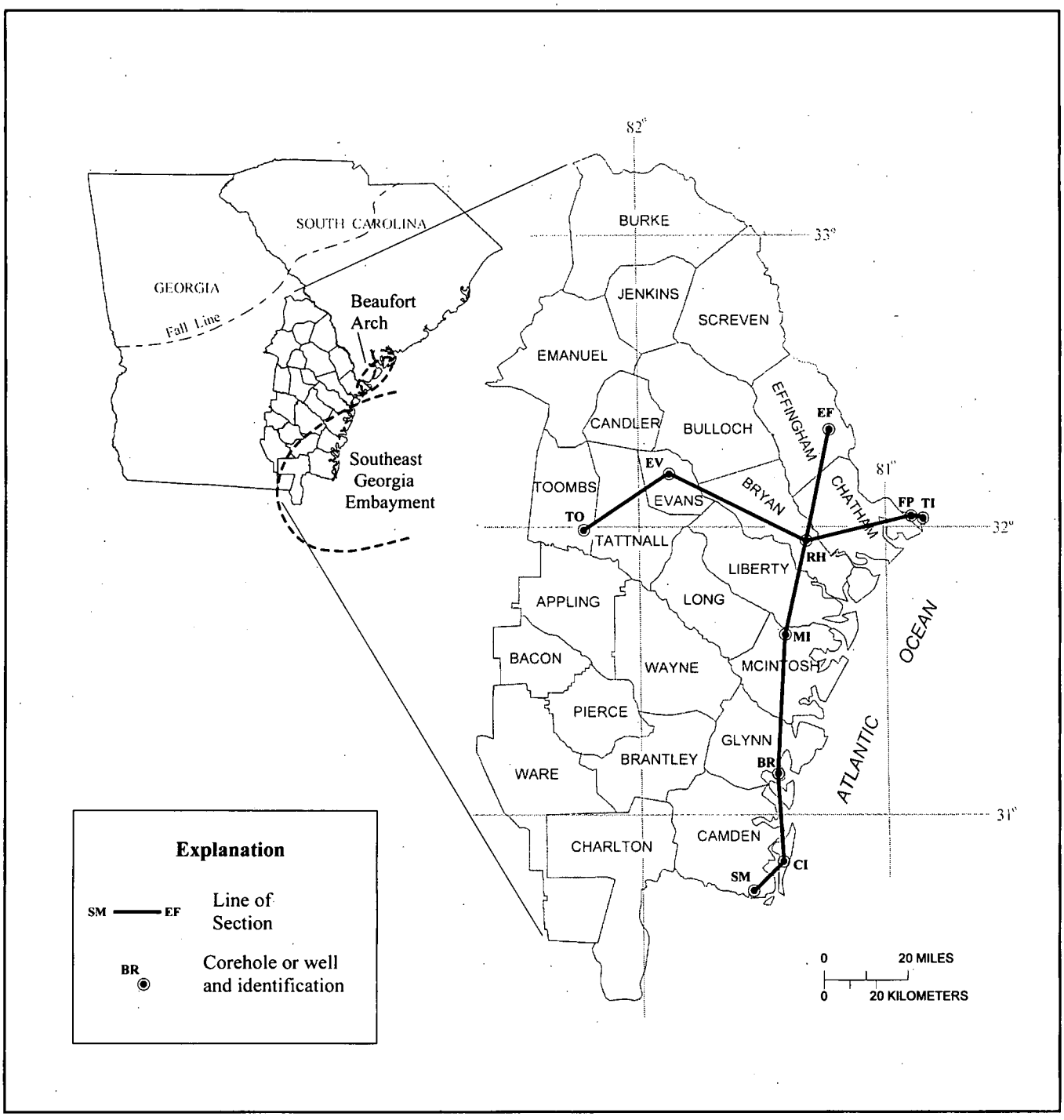

Figure 1. Extent of study area, location of wells and coreholes used to define the geology of the Miocene, and lines of geologic sections, coastal Georgia. BR = Brunwick Pulp and Paper well, CI = Cumberland Island Corehole, EF = Effingham County Corehole, EV = Evans County Corehole #1, FP = Fort Pulaski Corehole, MI = McIntosh County Corehole, RH = Richmond Hill Corehole, SM = St. Marys Corehole, TO = Toombs County Corehole #1, TI = Tybee Island Corehole.

established standard section for the Upper and Lower Brunswick aquifers in the Brunswick Test Well No. 1 (Clark and others, 1990). We also modify the stratigraphy established by Huddlestun (1988) for the Miocene of Georgia, so that his lithostratigraphic units better correlate with hydrologic units and so that major unconformities are better emphasized. These descriptions, correlations, and stratigraphic modifications provide, for the first time, a detailed integrated stratigraphic framework for the shallow subsurface stratigraphy and hydrology of the coastal area of Georgia.

Geologic Setting

The 24-county coastal area of Georgia lies in the easternmost part of the Georgia Coastal Plain physiographic province (fig. 1). Elevations range from sea level at the coast to about 175 feet in the western areas. Surface units across this area are Holocene, Pleistocene, and late Pliocene "terrace deposits," formed when sea level was higher than present. These deposits formed along what was then the Atlantic coast of Georgia. Pleistocene deposits (beneath terraces that are less than 100 feet in elevation) generally still preserve the landforms that were created when they accumulated, such as emergent barrier islands, partially infilled coastal lagoons, abandoned and filled meandering river channels, and planar bodies of well-sorted shallow shelf sand. Late Pliocene deposits (beneath terraces that lie above 100 feet elevation) generally are more deeply eroded so that their constructional geomorphology is difficult to discern.

Unconformably beneath these terrace deposits are Pliocene, Miocene, and Oligocene shallow marine shelf deposits. These deposits also formed at times when sea level was much higher than present. Between each episode of marine deposition, the sea withdrew from the study area and coastal rivers and streams eroded the deposited materials. These episodes of erosion varied from brief with slight erosion to prolonged with profound erosion. As a result, most of these deposits tend to be highly variable in thickness and, in some areas, to be entirely removed over large areas where they once must have been present. Early Pleistocene and Pliocene deposits have been most extensively eroded and removed, while Miocene and Oligocene deposits are relatively thicker and less discontinuous in their distribution. Even so, cut and fill patterns are a significant part of the stratigraphic story at all horizons. Below the Miocene and Oligocene units are Eocene strata. Their geology is only briefly considered in this report.

Regionally, Miocene deposits thicken and dip toward the south and southeast into the Southeast Georgia Embayment. In the vicinity of Savannah, a tectonically uplifted area known as the Beaufort arch causes Miocene units to thin or be entirely absent across that region. While these two tectonic elements profoundly affect the distribution of Miocene and Oligocene deposits, they do not seem to affect the distribution and thickness of Pliocene and Pleistocene deposits in any obvious way. This suggests that there has been only minor tectonic warping and tilting in the coastal area since the end of the Miocene.

Biostratigraphic Framework and Microfossil Sampling Technique

The biostratigraphic framework for this report is based primarily upon dinoflagellates that are moderately common to common throughout the deposits studied here. The dinoflagellate zonation of de Verteuil and Norris (1996), which includes ten dinoflagellate zones within the Miocene of the northern Atlantic Coastal Plain, can be applied, with only slight modification, to the Miocene sediments of the Georgia Coastal Plain. The relation of this zonation to the Miocene stratigraphy of the coastal region of Georgia is shown in fig. 2.

Sections of core, typically 0.2 feet long, were removed in Georgia and brought back to the palynological laboratory at the U.S. Geological Survey in Reston, VA for processing. All samples were treated with hydrochloric and hydrofluoric acid. For some samples, organic material was separated by using nitric acid. For most samples, a series of soap washes or a swirling technique was used to concentrate palynomorphs. Material was stained with Bismark brown, sieved to collect the 10-200 micrometer (μm) fraction, and mounted for light microscope observation using glycerin jelly. Where material was sufficient, samples were sieved through a 20 μm mesh and the >20 μm material was mounted and studied.

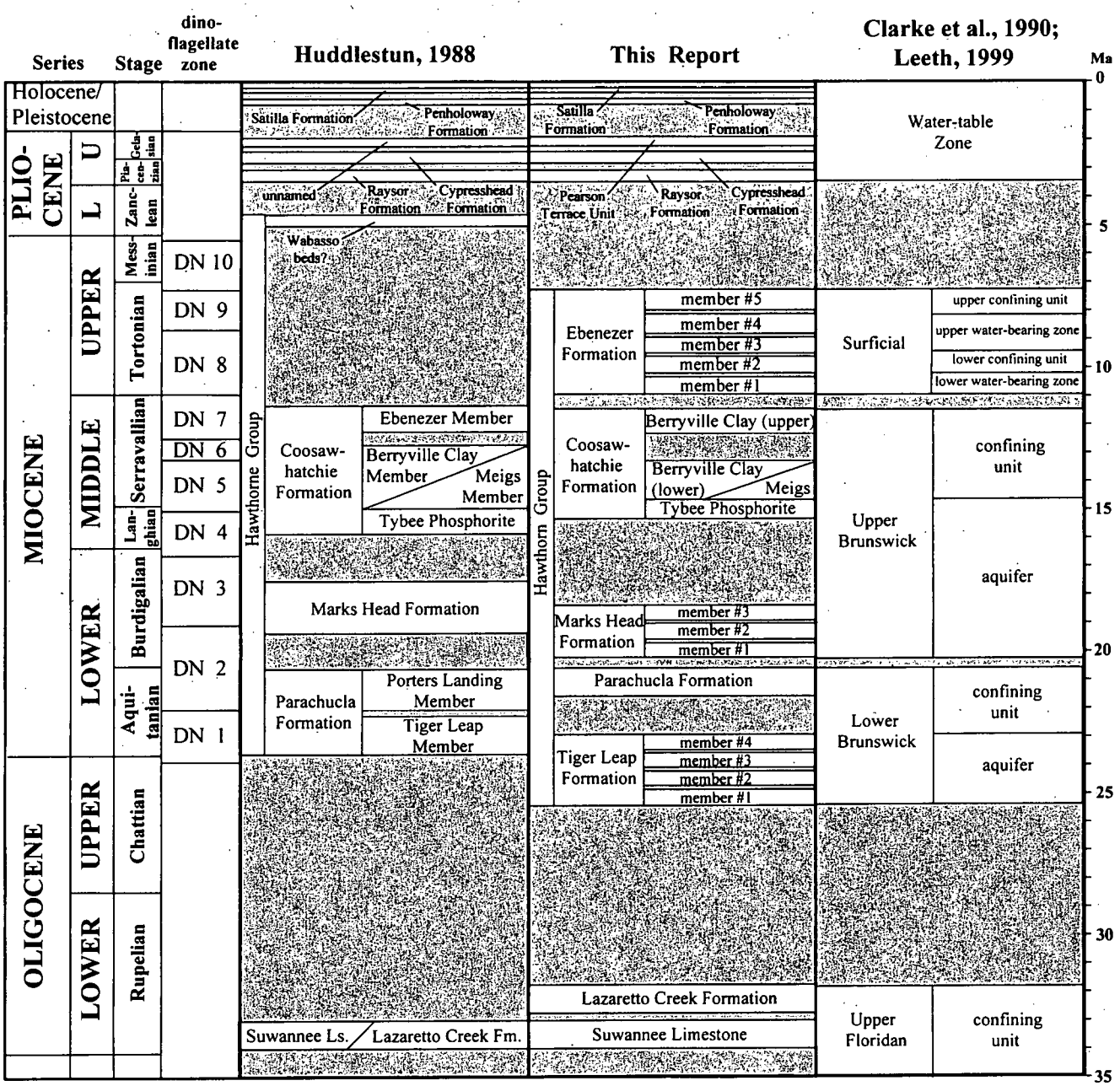

Figure 2. Oligocene through Pleistocene geology of coastal Georgia, showing ages, series, dinoflagellate zonation, formations, and hydrogeologic units. Dinoflagellate zonation and time scale adapted from deVerteuil and Norris (1996).

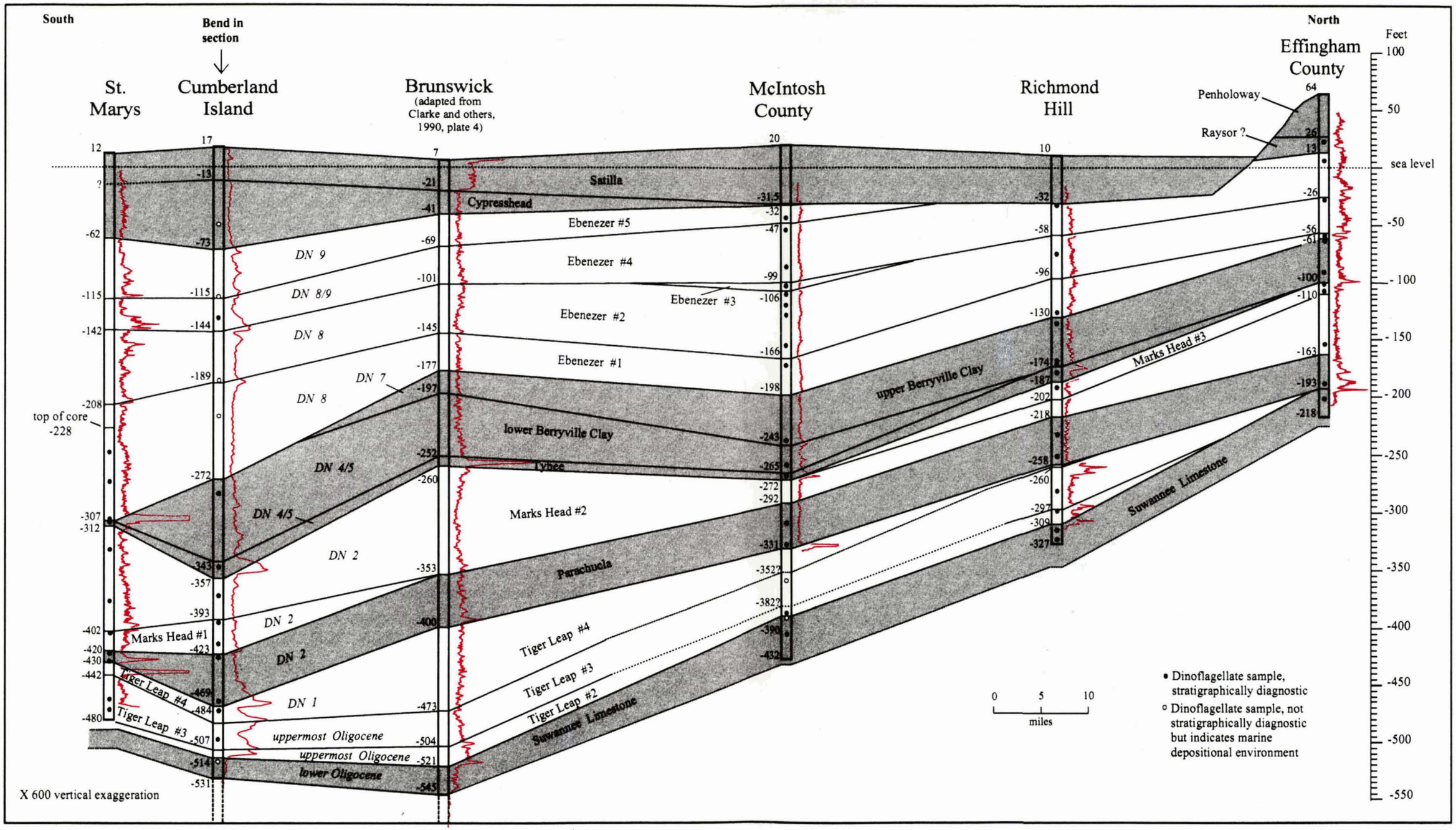

Figure 3. North-south geologic section showing Pleistocene through Oligocene allostratigraphic units, coastal Georgia. Line of section shown on figure 1. Suwannee Limestone, Parachucla Formation, Coosawhatchie Formation, and Pliocene-Pleistocene units shown in gray for contrast. Gamma logs are shown to right of each hole.

Acknowledgements

We would like to thank the Georgia Geologic Survey, U.S. Army Corps of Engineers, and the U.S. Geological Survey Water Resources Division for their help and cooperation in making this study possible. Special thanks go to Fred Falls and Chris Leeth for their thorough and helpful reviews of our manuscript, to John Clarke, Allan Giles, Michael Peck, and Will Steele for their help in making cores and logs available and facilitating their description, and to Laurel Bybell for providing nannofossil stratigraphic information.

GEOLOGIC UNITS

In the coastal area of Georgia, 19 unconformably bound Oligocene and Miocene stratigraphic units can be recognized. Oligocene units include the Suwannee Limestone, the Lazaretto Creek Formation, and the three oldest (unnamed) members of the Tiger Leap Formation. Miocene units include a fourth unnamed member of the Tiger Leap Formation, the Parachucla Formation, three unnamed members of the Marks Head Formation, four named members of the Coosawhatchie Formation (the Tybee Phosphorite, the Meigs, the Berryville Clay (lower part), and the Berryville Clay (upper part)), and five unnamed members of the Ebenezer Formation.

Lower Oligocene Stratigraphic Units

In the coastal Georgia region, upper Oligocene, Miocene, and younger deposits overlie either the yellowish-gray to dusky-yellowish-brown Suwannee Limestone or Lazaretto Creek Formation of early Oligocene age (figs. 2-4). The Suwannee Limestone and the Lazaretto Creek Formation form the upper confining unit at the top of the Floridan aquifer.

Suwannee Limestone – The Suwannee Limestone directly underlies upper Oligocene strata at all core sites in the coastal Georgia region except for the vicinity of Savannah. This formation contains a distinctive dinocyst assemblage characterized by *Membranophoridium aspinatum, Cordosphaeridium cantharellus, Charlesdowniea coleothrypta, Hystrichosphaeropsis obscura, Samlandia chlamydophora sensu* Stover and Hardenbol (1994), intermediates between *Cordosphaeridium funiculatum* and *Operculodinium divergens*, *Phthanoperidinium* spp., *Heteraulacacysta pustulosa*, and *Deflandrea* spp.

Lazaretto Creek Formation – In the vicinity of Savannah, Huddlestun (1993) recognized an early Oligocene unit different from the Suwannee Limestone that he named the Lazaretto Creek Formation. The upper part of the unit that Huddlestun defined, however, contains a distinctive assemblage of dinoflagellates that is notably younger than the age for this unit reported by Huddlestun (1993). In the Tybee Island core (Appendix H), taken in the type area of the Lazaretto Creek Formation, the upper part of the putative Lazaretto Creek contains the dinoflagellates *Apteodinium spiridoides*, *Batiacasphaera sphaerica*, *Membranophoridium aspinatum*, *Deflandrea phosphoratica* var. *spinulosa*, and *Wetzeliella symmetrica*. It lacks *Charlesdowniea coleothrypta* and *Samlandia chlamydophora sensu* Stover and Hardenbol (1994). This assemblage indicates a late Oligocene age for the upper part of this unit. In contrast, the lower part of the Lazaretto Creek yielded an early Oligocene foraminiferal assemblage; the upper part yielded no age-diagnostic Foraminifera at all (Huddlestun, 1993). A gamma log from one of the nearby wells at Fort Pulaski indicates that there is a phosphate-rich lag bed within this unit, and the nearby type section of the Lazaretto Creek Formation includes two fining-upward sequences (fig. 5). Collectively, these observations indicate that the Lazaretto Creek, as defined, includes two lithologically similar but unconformity-separated units of early Oligocene and late Oligocene age, respectively.

We here restrict the name Lazaretto Creek to the lower (early Oligocene) portion of the holostratotype core section that lies between 139 and 196 feet depth. The core section between 127 and 139 feet is referred to the Tiger Leap Formation (discussed below). Like Huddlestun (1993), we consider the Lazaretto Creek to be a lithologically distinct unit, but we conclude that it is slightly younger than the Suwannee Limestone farther south. We refer the upper (late Oligocene) part of the type section of the Lazaretto Creek Formation (as originally defined) to the Tiger Leap Formation of Huddlestun (1988), with which it is age equivalent and lithologically very similar.

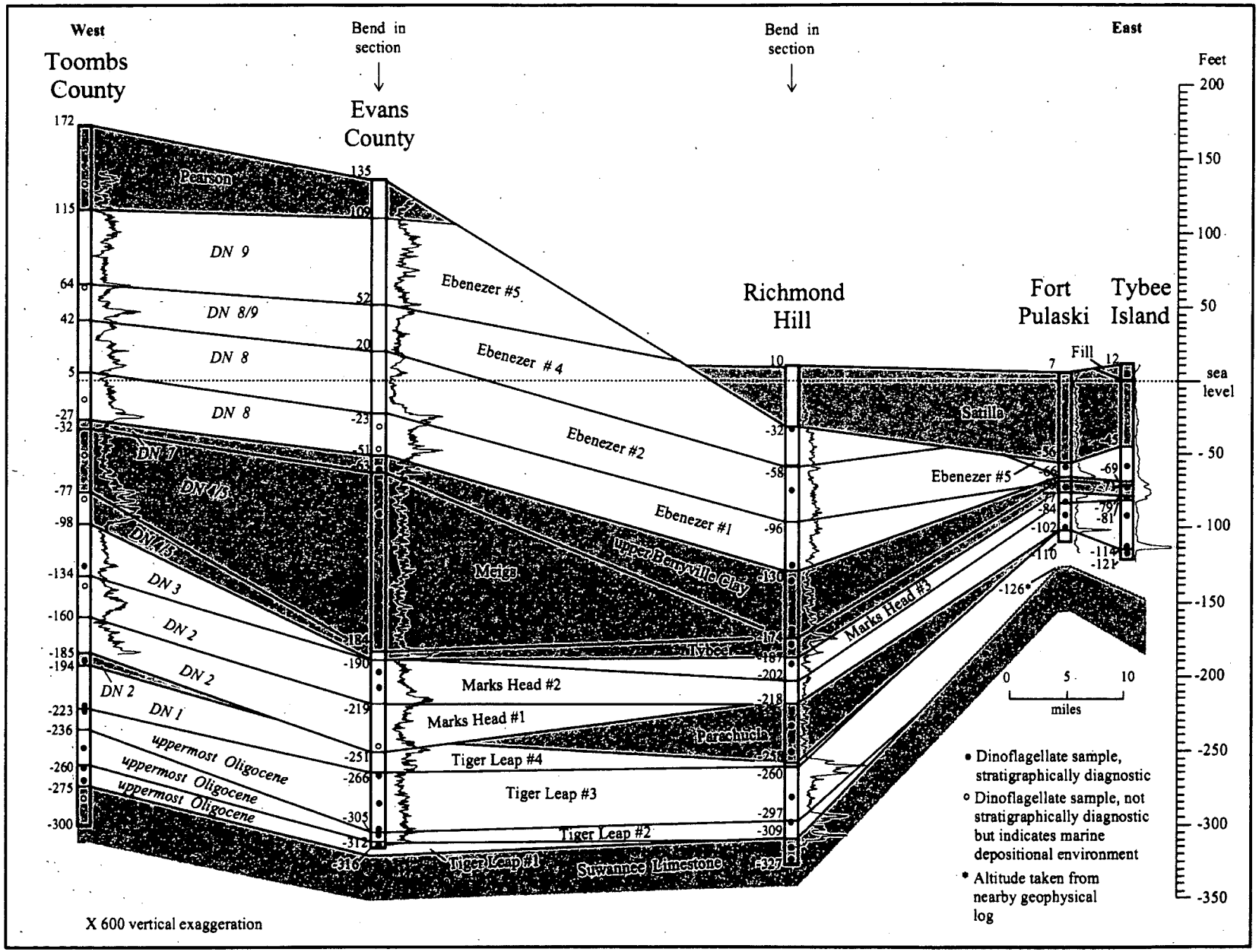

Figure 4. East-west geologic section showing Pleistocene through Oligocene allostratigraphic units, coastal Georgia. Line of section shown on figure 1. Suwannee Limestone, Parachucla Formation, Coosawhatchie Formation, and Pliocene-Pleistocene units shown in gray for contrast. Gamma logs are shown to right of each hole.

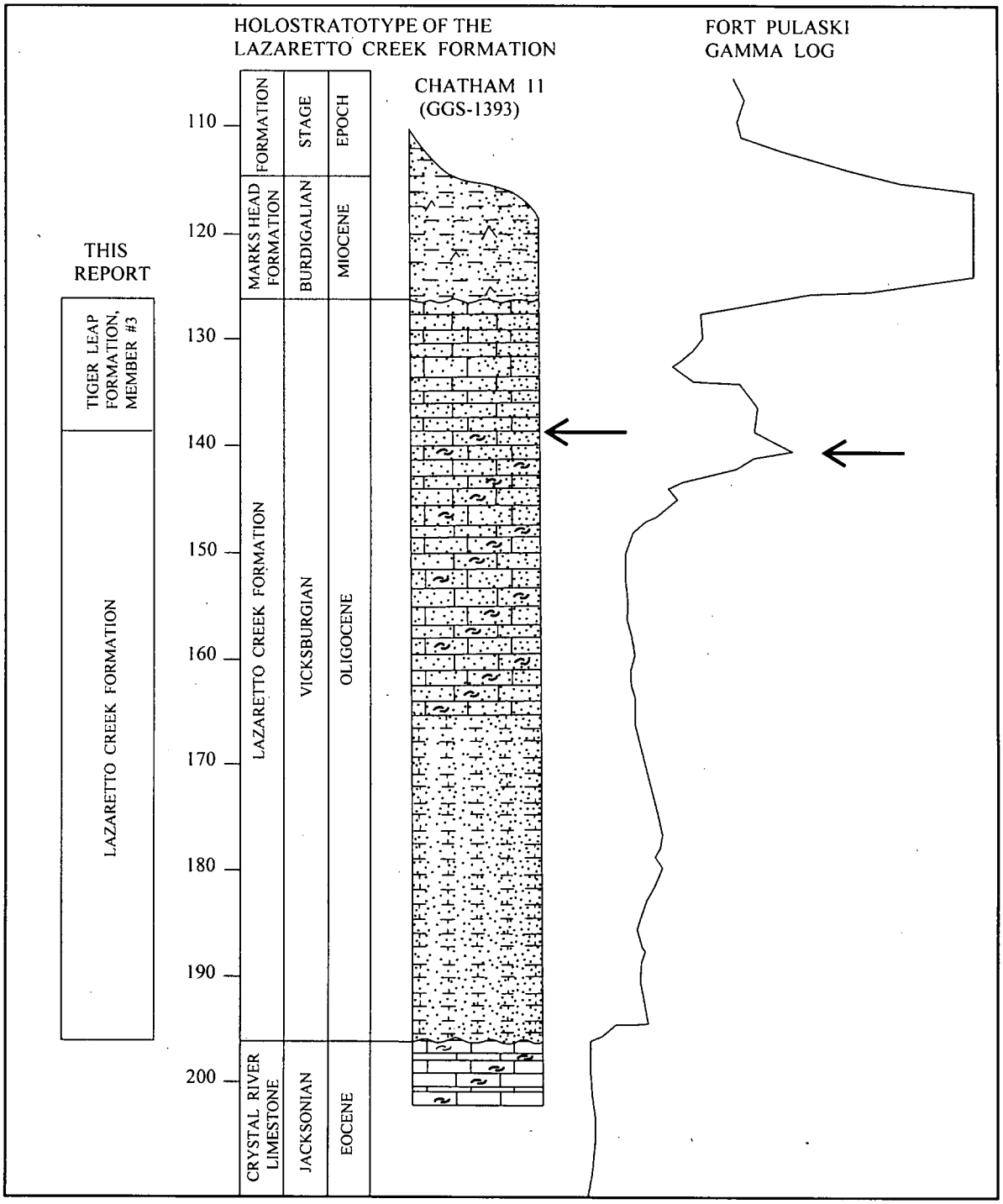

Figure 5. Holostratotype of the Lazaretto Creek Formation (adapted from Huddlestun, 1988), a gamma log from a nearby well at Fort Pulaski, and stratigraphic changes proposed here. Left arrow marks the top of the fossiliferous Lazaretto Creek (also the top of a fining-upward sedimentary cycle). Right arrow marks a gamma log peak (phosphate-rich lag deposit?) at the same horizon.

Upper Oligocene and Miocene Stratigraphic Units

In contrast to the very calcareous lower Oligocene strata, the upper Oligocene and Miocene deposits in Georgia range from very quartzose calcarenites through calcareous sand and clay to quartz sand and mudstone. Collectively, all of these strata plus the basal-most Pliocene strata were gathered together in the "Hawthorne Group" by Huddlestun (1988) (fig. 2). The spelling of this group name has varied between "Hawthorn" (for example, Cooke and Mossom, 1929; Scott, 1988) and "Hawthorne" (for example, Dall, 1892; Huddlestun, 1988). Current U.S. Geological Survey policy is to defer the choice of proper spelling to the geological survey of the state in which the stratotype is located. For this reason, we use the spelling "Hawthorn" in this report.

The stratigraphy of the Hawthorn group in Georgia has been most extensively described by Huddlestun (1988), and his stratigraphic nomenclature and concepts are followed here with two exceptions:

1) Huddlestun (1988) expanded the concept of the noncalcareous Parachucla Formation of Sloan (1908) to include carbonate-rich beds (then unnamed) that lie stratigraphically below the type section of the Parachucla. Huddlestun named this calcareous section the "Tiger Leap Member" of his expanded Parachucla Formation. At the same time, Huddlestun also designated the type section of his expanded Parachucla Formation, which did not expose the Tiger Leap beds, as the "Porters Landing Member" of his "Parachucla Formation." By doing this, Huddlestun greatly altered the original lithic concept of the "Parachucla Formation" from a discrete unit consisting of shales and mudstones to a very heterogenous unit consisting of shale, mudstone, quarztose calcarenite, and calcareous quartz sand. While he reduced this problem by naming two lithologically distinctive members, his younger member remains identical in concept and stratotype to the "Parachucla Formation" as originally erected by Sloan. Therefore "Porters Landing Member" *sensu* Huddlestun (1988) is a junior synonym of the Parachucla Formation *sensu* Sloan (1908). Huddlestun's "Tiger Leap Member" has no intimate lithologic or temporal link to the Parachucla Formation *sensu* Sloan (1908), which is lithologically quite different from both the Tiger Leap Formation below it and the Marks Head Formation above it. Furthermore, the Tiger Leap Member of Huddlestun represents the same interval as the Penney Farms unit of Scott (1988), who designated his unit as a formation in rank. In addition to the problem of disparate levels of ranking, there is another reason not to group these two lithologies into a single formation. The "Parachucla Formation," as originally defined, constitutes the confining unit separating the lower from the upper Brunswick aquifers, while the Tiger Leap is the lower Brunswick aquifer. For these reasons, the "Tiger Leap Member" here is raised in rank to the "Tiger Leap Formation," and the "Porters Landing Member" is abandoned because it is a junior name for the "Parachucla Formation" of Sloan (1908). The "Parachucla Formation" is retained but restricted in concept to the "Parachucla Formation" *sensu* Sloan (1908) (fig. 2) and not *sensu* Huddlestun (1988).

2) The dinoflagellate study presented here demonstrates that much of the upper Hawthorn Group in Georgia is late Miocene in age. Except for the lower Pliocene Wabasso beds, Huddlestun (1988) placed all of the upper Hawthorn Group strata in the Coosawhatchie Formation in the belief that this sequence was entirely middle Miocene. Instead, the strata that overlie the Meigs and Berryville Clay Members of the Coosawhatchie are all late Miocene in age (Fig. 2). These upper Miocene strata cannot be lumped uncritically with the middle Miocene Coosawhatchie Formation, because they are lithologically distinct and because there is a significant hiatus between this sequence of upper Miocene strata and underlying middle Miocene strata that is marked by an unconformity with a well defined detrital lag bed. The youngest middle Miocene strata also lie unconformably above older strata, but they have a very similar lithology and color to the Meigs and Berryville Clay Members of the Coosawhatchie. Therefore, those strata are retained in the Coosawhatchie Formation as the upper part of the Berryville Clay Member. However, we exclude all higher, upper Miocene strata from the Coosawhatchie Formation because they consist of sand that contrasts with the typical Coosawhatchie clay to sandy clay lithologies. This sandy upper Miocene sequence includes at least five unconformity-bounded members of similar lithology. The oldest of these units corresponds to the "Ebenezer Member" of Huddlestun (1988), who placed this member in the Coosawhatchie Formation.

The Ebenezer here is removed from the predominantly clay-silt Coosawhatchie Formation and raised to formational rank. As used here, it encompasses all known strata in Georgia that fall within dinoflagellate zones DN 8 through DN 10. The constituent members of this formation presently are unnamed. In the past, some of this sequence was included in the Charlton Formation by Veatch and Stephenson (1911). Huddlestun (1988) reduced this unit to a member within his Coosawhatchie Formation, on the mistaken belief that it was middle Miocene in age and merely a facies variant of the Coosawhatchie. This clearly is not the case, so we tentatively move this member to the Ebenezer Formation until such time as its age and stratigraphic relations become better known.

With these modifications, the Hawthorn Group in coastal Georgia now consists of the following units from oldest to youngest (fig. 2):

Tiger Leap Formation – Huddlestun (1988) originally named this unit as the Tiger Leap Member of the Parachucla Formation. It consists of quartzose calcarenite to calcareous quartz sand that ranges in color from olive-gray to brownish-gray, light-gray, or dark-gray. The Tiger Leap overlies the lower Oligocene Suwannee Limestone over most of the study area, except in the far northeastern part where it overlies the lower Oligocene Lazaretto Creek Formation. The type section of the Tiger Leap Formation is at Tiger Leap Bluff on the Savannah River in Screven County, Georgia. In most of the coastal Georgia area, the Tiger Leap Formation is overlain by the Parachucla Formation. Exceptions occur in the Evans County core (Appendix B) and the St. Marys core (Appendix F), where the Marks Head Formation occupies channels cut through the Parachucla and lies directly on the Tiger Leap Formation. In the Toombs County core (Appendix G) and Evans County core (Appendix B), four members of the Tiger Leap can be recognized that are separated by distinct disconformities. In the other cores, no more than two members were observed. These members are unnamed, with the probable exception of the uppermost member. That unit probably is equivalent to the lower Miocene Edisto Limestone of Sloan (1908), which was named in southern South Carolina. In Florida, the Penney Farms Formation of Scott (1988) is the lateral equivalent of the entirety of the Tiger Leap Formation.

The Tiger Leap Formation lies astride the Oligocene-Miocene boundary. The sample at a depth of 308 ft in the Richmond Hill core (Appendix E), from Tiger Leap member #3, contains a well preserved late Oligocene assemblage including *Tuberculodinium vancampoae, Batiacasphaera sphaerica, Chiropteridium* spp. and *Riculacysta perforata*. As this sample contains *Distatodinium biffii* (rare in the Georgia samples), it is below the base of DN 1. In contrast, the sample at a depth of 490 feet in the Cumberland Island core (Appendix I), from Tiger Leap member #4, lies above the highest occurrence of the genus *Chiropteridium*. Specimens of the genus *Homotryblium* (highest occurrence at or near the top of DN 1) are still present. The assemblage from this unit consists mostly of *Spiniferites* spp., *Homotryblium plectilum*, *Hystrichokolpoma rigaudiae*, and *Pentadinium* sp. (with high septa). These two samples indicate that upper member of the Tiger Leap Formation is early Miocene in age and the lower three members are latest Oligocene. Other samples contain similar, but less diverse and therefore less diagnostic, assemblages. As long as they contain *Chiropteridium* spp. and *Tuberculodinium vancampoae*, they at least can be designated as latest Oligocene and (or) early Miocene.

Parachucla Formation – The Parachucla Formation was named by Sloan (1908) for weakly lithified shales and mudstones, olive-gray to dark-greenish-gray in color, that crop out on the Savannah River. Huddlestun (1988) placed the stratotype for the formation at the bluff at Porters Landing in Effingham County. When present, the Parachucla disconformably overlies the Tiger Leap Formation and underlies the Marks Head Formation. Updip, the Parachucla thins markedly. Along the coast, it maintains a fairly constant thickness as far south as Cumberland Island. Between there and the St. Marys core, however, the Parachucla thins due to truncation and is only ten feet thick in the St. Marys core. It is unknown at present whether this occurs only locally due to a paleochannel or whether the Parachucla generally is either thin or missing south of this point. Similarly, the Parachucla is thin or missing in the vicinity of Savannah on the crest of the Beaufort arch. Either the unit was never thick or else it was truncated by erosion prior to deposition of the overlying Marks Head Formation. The Parachucla is early Miocene (late Aquitanian) in age and contains dinoflagellates

characteristic of dinoflagellate zone DN 2. The assemblages in this unit typically include *Sumatradinium soucouyantiae* and either *Cordosphaeridium cantharellus* (highest occurrences within DN 2) or *Exochosphaeridium insigne* (highest occurrence defines the top of DN 2, but lowest occurrence is within DN 2). A distinctive species, *Pentadinium* sp. I of Edwards (1986, 1991), is found in some samples, and *Cribroperidinium* spp. are common.

Marks Head Formation – The Marks Head Marl was named by Sloan (1908) for dominantly medium to very coarse phosphatic and calcareous sands, olive-gray to yellowish-gray in color, that crop out on the Savannah River. Huddlestun (1988) changed the name to Marks Head Formation and placed its stratotype at Marks Head Run in Effingham County, Georgia. The Marks Head Formation in most of coastal Georgia lies disconformably above the Parachucla Formation except in the vicinity of the Evans County and St. Marys coreholes, where it occupies paleochannels cutting through the Parachucla and lies on the underlying Tiger Leap Formation, and around Savannah, where the Parachucla thins across the Beaufort arch and is locally absent. The Marks Head is thickest in the southern Georgia coastal region and thinnest in the vicinity of Savannah. Two distinct unconformities marked by detrital lag beds are present within the unit. These split the formation into three lithologically similar members that are unnamed at present. All three members consist mostly of moderately well sorted, medium to very coarse quartz sand with minor amounts of calcite, dolomite, and phosphate. Across the Beaufort Arch, the thin remnants of these members are composed mostly of calcite, dolomite, and phosphate sand with little or no quartz. This suggests that the Beaufort arch, at that time, was an isolated high on the sea bottom, which did not receive much terrigenous sediment. The assemblages in this unit typically include *Sumatradinium soucouyantiae* and either *Cordosphaeridium cantharellus* (highest occurrences within DN 2) or *Exochosphaeridium insigne* (highest occurrence defines the top of DN 2, but lowest occurrence is within DN 2). *Cribroperidinium* spp. are common. The lower two members of the Marks Head Formation definitely can be assigned to dinoflagellate zone DN 2. The highest member probably can be assigned to dinoflagellate zone DN 3.

Coosawhatchie Formation – The Coosawhatchie clay was named by Heron and others (1965). Huddlestun (1988) raised its rank to formation and placed its type section at Dawsons Landing in Jasper County, South Carolina. In its type area, the Coosawhatchie contains abundant microfauna and microflora that show its age is middle Miocene (Ernissee and others, 1977; Abbott, 1978). Most of the Coosawhatchie is silty clay, clay, and diatomite, though its basal stratum is a distinctive and widespread phosphatic sand. The Coosawhatchie Formation can be divided into the following four units:

Tybee Phosphorite Member – The Tybee Phosphorite was named by Huddlestun (1988), who designated its type section as the 75 to 94 foot depth interval in the Chatham 10 core (GGS-1394) taken on Tybee Island in Chatham County, Georgia near Savannah. This unit consists of quartz-phosphate sand, olive to yellowish-green in color, that fines upward. The top of the unit is separated from the overlying Berryville Clay Member or Meigs Member by an unconformity. The Tybee Phosphorite Member has a middle Miocene dinocyst assemblage that typically includes *Apteodinium tectatum*, *Habibacysta tectata*, *Invertocysta lacrymosa*, *Labyrinthodinium truncatum*, and *Systematophora placacantha*. This assemblage places the Tybee Phosphorite within de Verteuil and Norris' (1996) Zone DN 5. Some samples contain a less diagnostic assemblage that is compatible with DN 5, but could be from either Zone DN 4 or DN 5.

Meigs Member – The Meigs Member was named by Huddlestun (1988) for outcrops in the Singletary pit of the Waverly Mineral Products Company, four miles southeast of the village of Meigs in Thomas County, Georgia. The Meigs unconformably overlies the Tybee Phosphorite and is the updip lateral equivalent of the Berryville Clay (lower part). It is predominantly a clayey silt to very fine sandy silt that is olive-gray to pale-olive in color. The Meigs Member has a middle Miocene dinocyst assemblage that includes *Labyrinthodinium truncatum* subsp. *modicum* and *Systematophora placacantha*. This assemblage could be either Zone DN 4 or DN 5.

Berryville Clay Member (lower part) – The Berryville Clay Member was named by Huddlestun (1988) for an outcrop in a low bluff in the vicinity of Berry Landing in Effingham County, Georgia. The Berryville Clay

Member unconformably overlies the Tybee Phosphorite Member and is the down-dip lateral equivalent of the Meigs Member. It is predominantly a silty to very fine sandy clay that is olive-gray to olive-black in color. The lower part of the Berryville Clay Member has a middle Miocene dinocyst assemblage that includes *Apteodinium tectatum*, *Labyrinthodinium truncatum*, and *Systematophora placacantha*, placing it within de Verteuil and Norris' (1996) Zone DN 5. One sample contains a less diagnostic assemblage that could be either Zone DN 4 or DN 5.

Berryville Clay Member (upper part) – Above the lower Berryville Clay member is a series of interbedded fine to very fine sands and silty to sandy clays that are bluish-gray to yellowish-green in color. In the past these beds have been included in the Berryville Clay Member of the Coosawhatchie Formation (for example in the Cumberland Island Corehole, Huddlestun, 1988, p. 72). However, this unit is separated from the lower part of the Berryville Clay by a distinct unconformity marked by a detrital lag bed. For now, this unit is simply designated the upper part of the Berryville Clay Member. Where well dated, this unit is placed in DN 7, based on the occurrence of *Erymnodinium delectabile* (lowest occurrence within DN 7). The stratigraphy occasionally is complicated by the presence of *Systematophora placacantha*, (highest occurrence defines the top of DN 5), but specimens of this species usually are fragmental and therefore presumed to be reworked.

Ebenezer Formation – Huddlestun (1988) named the Ebenezer as a member of the Coosawhatchie Formation. The type section for the Ebenezer Formation consists of clayey very fine to fine sand exposed at Ebenezer Landing on the Savannah River in Effingham County, Georgia. Huddlestun included the Ebenezer in the Coosawhatchie Formation in the mistaken belief that the Ebenezer was middle Miocene in age. Our work indicates the Ebenezer is upper Miocene. Additionally, the generally sand-rich sediments of the Ebenezer contrast markedly with the much more clayey sediments of the Meigs and Berryville Clay members of the Coosawhatchie. For these reasons, we here remove the Ebenezer from the Coosawhatchie Formation and raise it to formational rank.

In the southern Georgia coastal region, the Ebenezer is predominantly a very fine to fine sand that is pale-olive, yellowish-gray, or grayish-yellow-green in color. Four distinct unconformities allow separation of the Ebenezer into five mappable members. All consist of fine to very fine sand that grades laterally northward into sandy and clayey silt. The lower four members can be placed in DN 8 in the McIntosh core (Appendix D), because the lowest member contains *A. andalousiensis* (which defines the base of dinoflagellate zone DN 8) and the fourth member contains *Palaeocystodinium golzowense* (which approximates the top of dinoflagellate zone DN 8). In this and other cores, *A. andalousiensis* is found only sporadically. Huddlestun equated the Ebenezer with the entire DN 8 interval in the Cumberland Island core, and we follow his precedent in this regard. However, our mapping indicates that only two of the five members of the Ebenezer Formation occur as far north as the Savannah River (Fig. 3). Therefore, only part of the Ebenezer probably occurs at the type section of this unit.

The fifth member of the Ebenezer Formation includes the unit in the Savannah region that Huddlestun (1988) correlated with the Wabasso beds of Florida. These beds were sampled for calcareous nannofossils and dinocysts in the Fort Pulaski and Tybee Island cores. In addition, bulk sediment was scanned for visible microfossils, shells, and vertebrate remains. Huddlestun referred Ebenezer member #5 to the Wabasso beds on the basis of lithologic similarity, but the age of the type section of the Wabasso beds in Florida is earliest Pliocene (Huddlestun, 1988). Our results indicate that the youngest Ebenezer beds in the vicinity of Savannah instead formed during dinocyst Zone DN 9 of de Verteuil and Norris (1996), which still is late Miocene. The sample from SHE 7 at a depth of 69.3-69.8 feet contains *Hystrichosphaeropsis obscura* (highest occurrence defines the top of DN 9), *Invertocysta lacrymosa*, *Operculodinium? eirikianum*, *Selenopemphix armageddonensis*, and *Selenopemphix brevispinosum* subsp. *brevispinosum*. The sample from SHE 8 at 66.0-66.3 ft depth is less diagnostic; it contains *H. obscura*, *I. lacrymosa*, *S. brevispinosum* subsp. *brevispinosum*. Calcareous nannofossils from the youngest Ebenezer beds at depths of 78.4, 69.5, and 69 ft in SHE-7 restrict its age to the late Miocene and (or) early Pliocene time interval. *Helicosphaera sellii* (which first appears in the late Miocene) and

Sphenolithus abies (which last appears in the early Pliocene) are present in all three samples. The youngest Ebenezer member also contains abundant mollusk shells, including the pectenid *Amusium mortoni* (which occurs in the late Miocene and Pliocene). Vertebrate remains locally are abundant. A sample from corehole SHE-8, taken at 82 ft depth yielded two kinds of shark teeth (*Negaprion eurybathrodon* and *Rhizoprionodon* sp.), worn tooth fragments from a myliobatid ray, a small jaw of the ocean sunfish *Ranzania* (cf. *Ranzania laevis*), a ladyfish tooth (*Albula* sp.), a caniniform fish tooth (possibly family Sparidae), and a dermal plate from a boxfish (family Ostraciidae), as well as dozens of small vertebrae, ribs, skull elements, and fin spines of diverse bony fishes. These particular species of fish fossils indicate an open marine depositional environment.

Outside of the Savannah region, beds no older than dinoflagellate zone DN 9 occur in the Toombs County, Evans County, and McIntosh County cores, and are inferred in the St. Marys, Cumberland, and Brunswick wells. These beds are assumed to be correlative with the youngest Ebenezer beds in the Savannah region. Based on gamma-ray log correlations, the youngest member of the Ebenezer Formation forms the upper part of Clarke and others (1990) Miocene Unit A.

Pliocene Stratigraphic Units

The following Pliocene stratigraphic units were penetrated in coreholes studied in this report. According to Huddlestun (1988), more Pliocene units occur elsewhere in the region.

Wabasso beds – Beds correlative with the type Wabasso beds were not encountered in the study. However, because Huddlestun (1988) referred beds in the vicinity of Savannah to this unit, the Wabasso beds are briefly discussed here. The Wabasso beds constitute an informal unit named by Huddlestun (1988) and included by him at the top of the Hawthorn Group. The name is taken from the community of Wabasso in Indian River County, Florida and is defined as beds in the core Phred #1 (W-13958) in the depth interval 128.5 to 211 feet depth. Based on its contained foraminiferal assemblage, the type section of the Wabasso beds is early Pliocene. Beds in the vicinity of Savannah, referred to the Wabasso beds by Huddlestun (1988), instead contain late Miocene dinoflagellates. For this reason, the beds in the vicinity of Savannah cannot be correlative with the Wabasso beds. They here are included as the youngest member of the upper Miocene Ebenezer Formation and are discussed in that section (above).

Raysor Formation? – In the Effingham County core (Appendix A), bluish-gray silt and silty sand occur between elevations of 13 and 26 feet. Dinoflagellates indicate this interval is older than Pleistocene, and lithologically it matches no other unit penetrated in our coreholes. However, the lithology is similar to that of the Raysor Formation of Sloan (1908), and is tentatively placed in that formation pending better understanding of its age and stratigraphic relations.

Cypresshead Formation – This formation was named by Huddlestun (1988) for prominently thin- to thick-bedded and massive, planar- to cross-bedded, variably burrowed and bioturbated, fine to fine pebbly, coarse sand in the terrace region of eastern Georgia that is moderate-reddish-brown to orange in color. Its type locality is a sand pit in the southern valley wall of Goose Creek, 0.25 mile southeast of the confluence of Cypresshead Branch and Goose Creek in Wayne County, Georgia. Based on limited paleontologic data, the age of this unit is late Pliocene. The Cypresshead, questionably, was found in the McIntosh County and Cumberland Island #1 cores, and appears to be present in the Brunswick test well and the upper (uncored) portion of the St. Marys core. Elsewhere, the unit has been removed by erosion.

Pearson terrace unit (informal) – The Pearson terrace was recognized and named by Huddlestun (1988), but no name was assigned to the sediments that immediately underlie it. The sediments beneath this terrace consist mostly of poorly sorted silt to clayey sand that ranges in color from pale-olive through yellowish-gray and pale-orange to grayish-red. These sediments here are called the Pearson terrace unit. This unit was penetrated only in the westernmost Toombs and Evans County cores at elevations above 115 and 109 feet respectively.

Elsewhere, it has been removed by erosion. Based on its position above the youngest (latest Miocene) member of the Ebenezer Formation, the age of this material is assumed to be Pliocene.

Pleistocene Stratigraphic Units

The following Pleistocene stratigraphic units were penetrated in coreholes studied in this report. According to Huddlestun (1988), there are other Pleistocene units that also occur in this area.

Penholoway Formation – The Penholoway terrace was named by Cooke (1925), who subsequently also referred to the sediments associated with this terrace as the Penholoway Formation (Cooke, 1936). The type area of this formation is in Wayne and Brantley Counties, Georgia (Huddlestun, 1988). In this study, the Penholoway was found only in the Effingham County corehole. There it consists predominantly of well sorted to poorly sorted sand and silty clay that ranges in color from light-olive-gray to yellowish-gray, medium-bluish-gray, and dark-greenish-gray. The age of this unit is early Pleistocene (Weems and Lemon, 1993).

Satilla Formation – The Satilla Formation was named by Veatch and Stephenson (1911), abandoned by Cooke (1943), and reintroduced by Huddlestun (1988) for sediments in coastal Georgia. The formation includes a heterogenous mix of sand, clay, and silt ranging in color from pale-yellowish-brown to yellowish-gray and dark-greenish-gray. These sediments were deposited in coastal lagoons, as barrier islands, and in shallow marine environments. The Satilla underlies the Pamlico, Princess Anne, Silver Bluff, and Holocene (modern) terraces, ranging in age from about 130,000 years to present (Huddlestun, 1988; Weems and Lemon, 1993). The Satilla immediately underlies the land surface at all the corehole sites close to the modern coastline. This includes the coreholes south of Effingham in the north-south transect (Fig. 3) and the Tybee Island and Fort Pulaski coreholes in the east-west transect (Fig. 4).

DEPOSITIONAL ENVIRONMENTS AND LITHOFACIES

The stratigraphic units described here are unconformity-bounded, and to some degree vary in their lithologic description from corehole to corehole. For example, the Ebenezer Formation ranges from a very fine to fine sand in the southern coastal area to a silty and clayey very fine to fine sand in the more northerly cores. Even so, the units mapped here retain distinctive lithic identities and can be described and contrasted fruitfully. The coarsest, sand-rich units are the Tiger Leap Formation, the Marks Head Formation, and the Tybee Phosphorite Member of the Coosawhatchie Formation. The Ebenezer Formation is finer grained, but still quite sandy. The Parachucla Formation and the Coosawhatchie Formation (excluding the Tybee Phosphorite) are very clayey and silty. The subsurface regional distribution of these lithologic units can be envisioned most readily by consulting figs. 3 and 4.

All of these units appear to have formed in marine shelf depositional environments. Although they show gradual changes in lithology, both vertically and laterally, individual beds generally have uniform grain-size distributions over distances on the scale of miles. Fluvial deposits would be much more variable in their grain-size distribution, as well as in the rapidity of their facies changes. Coarser-grained units formed under relatively strong current conditions, which winnowed away silt and clay. Finer-grained units accumulated on quiet sea floors.

In contrast to the underlying lower Oligocene and Eocene formations, which mostly are composed of carbonates, the Tiger Leap and younger formations are composed mostly of quartz sand and clay. This change reflects a major shift in the regional depositional environment, marked by a major influx of terrigenous material into the Georgia coastal plain in latest Oligocene and Miocene time. Initially, this influx of detrital material into the Coastal Plain region probably was initiated by a general shallowing of the sea in latest Oligocene and early Miocene time. By the late Miocene, however, a significant uplift in the Appalachian source area also caused much more sediment than before to be transported onto the Georgia continental shelf.

INFLUENCE OF LITHOFACIES ON WATER AVAILABILITY

The McIntosh County and Cumberland Island #1 coreholes lie north and south, respectively, of the Brunswick Pulp and Paper Company well that is the type locality of the Upper and Lower Brunswick aquifers. Comparison of the stratigraphic columns among these three wells (Fig. 3) allows confident identification of higher stratigraphic units present in the Brunswick Pulp and Paper Company well log (shown on Plate 2 of Clarke and others, 1990). This comparison indicates that the lower Brunswick aquifer includes all of the Tiger Leap Formation. The confining unit between the lower and upper Brunswick aquifers is the Parachucla Formation. The upper Brunswick aquifer consists of the Marks Head Formation and the Tybee Phosphorite Member of the Coosawhatchie Formation. The confining unit between the upper Brunswick aquifer and the surficial aquifer consists of the rest of the Coosawhatchie Formation (except for the Tybee Phosphorite Member). The surficial aquifer is within the Ebenezer Formation, and the various Pliocene and Pleistocene terrace units form the water-table zone.

Although the Ebenezer Formation is dominantly sand, two of its members (member #2 and member #5) apparently contain enough clay to allow them to act as confining units. This has been documented at the Naval Submarine Base Kings Bay in Camden County (about midway between the St. Marys and Cumberland Island coreholes), where the clayey intervals in these two members of the Ebenezer split the surficial aquifer into two sand-rich water-bearing zones (Leeth, 1999, fig. 4). Although we did not see samples from this well for detailed correlation, a comparison of the gamma log from this well and from the St. Marys corehole demonstrates that, above the Upper Brunswick confining unit formed by the Berryville Clay Member of the Coosawhatchie Formation, Leeth's "lower water-bearing zone" is member #1 of the Ebenezer Formation, his "lower confining unit" is member #2, his "upper water-bearing zone" is member #4, and his "upper confining unit" mostly is member #5. Though not present at this locality, the very sandy member #3 would act as part of his "upper water-bearing zone." This recent information is included in fig. 2.

Structure contour maps on the base of several stratigraphic horizons (figs. 6-10), show a consistent synformal pattern in the coastal area of Georgia that is oriented NNW-SSE and plunges toward the SSE. This trough may represent the axis of the Southeast Georgia embayment. At successively higher stratigraphic horizons, the curvature of this trough becomes more gentle, indicating that it has been strongly affected by syndepositional subsidence. Because water-bearing units generally thicken toward the axis of the trough, we would anticipate that water yields will be relatively more abundant near the axis of this feature.

At the Evans County corehole, the Parachucla confining unit is breached by a cut channel so that the Marks Head lies immediately above the Tiger Leap. In this area, and possibly in the vicinity of the St. Marys core, where the Parachucla is very thin, the lower and upper Brunswick aquifers seemingly are interconnected. Similarly, the upper confining unit (Coosawhatchie Formation above the Tybee Phosphorite) is breached in the St. Marys corehole due to channeling at the base of the Ebenezer Formation. Other such breaches in the Parachucla and Coosawhatchie confining units probably exist, and these may significantly affect modeling of water movement within and between the lower and upper Brunswick aquifers.

SUMMARY

A detailed analysis of cores and geophysical well logs taken from ten sites in coastal Georgia allows us to correlate Oligocene, Miocene, Pliocene, and Pleistocene stratigraphic units across much of this area. Units that are recognized here are (from oldest to youngest) the Suwannee Limestone (lower Oligocene), the Lazaretto Creek Formation (lower Oligocene), the Tiger Leap Formation (upper Oligocene to lowest Miocene), the Parachucla Formation (lower Miocene), the Marks Head Formation (lower Miocene), the Coosawhatchie Formation (middle Miocene), the Ebenezer Formation (upper Miocene), the Raysor Formation? (upper Pliocene), the Cypresshead Formation (upper Pliocene), the Pearson terrace unit (informal, upper Pliocene), the Penholoway Formation (lower Pleistocene), and the Satilla Formation (upper Pleistocene). The lower Oligocene Suwannee Limestone

forms the upper confining unit of the Floridan aquifer. The Tiger Leap Formation composes the lower Brunswick aquifer. This aquifer is overlain, and confined by, the Parachucla Formation. The Marks Head Formation and the Tybee Phosphorite, which overlie the Parachucla, constitute the upper Brunswick aquifer. Locally, the Marks Head is channeled through or nearly through the Parachucla Formation, indicating that the lower and upper Brunswick aquifers are interconnected in at least a few areas. The upper Brunswick aquifer is overlain by the Coosawhatchie Formation (above the Tybee Phosphorite), which forms the confining unit above the upper Brunswick aquifer. Above the Coosawhatchie, the Ebenezer Formation constitutes the surficial aquifer unit. This can be divided into a lower water-bearing unit (member #1), a lower confining unit (member #2), an upper water-bearing unit (members #3 and #4) and an upper confining unit (member #5). The Pliocene and Pleistocene beds above the Ebenezer constitutes the water-table zone.

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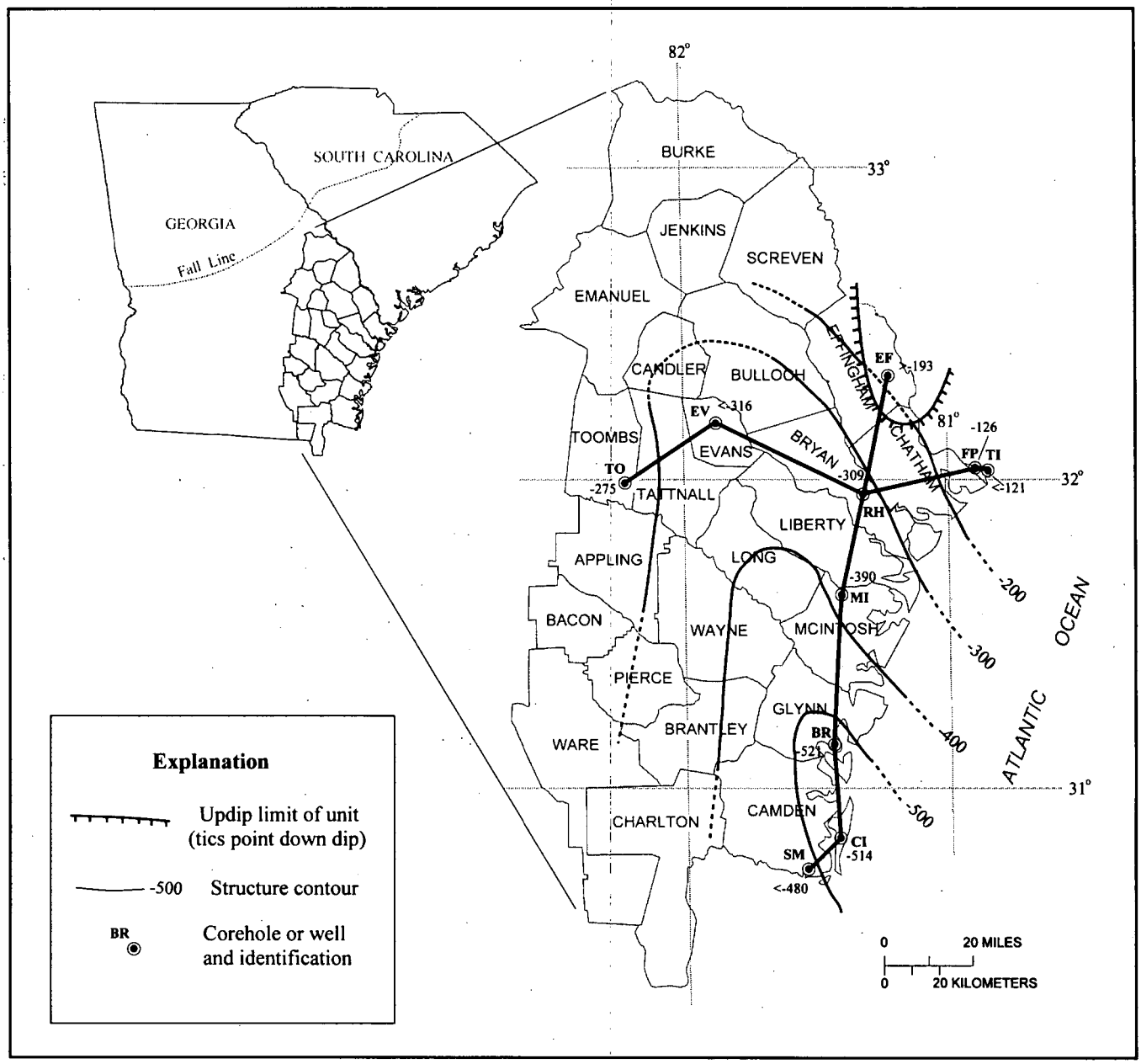

Figure 6. Altitude of the base of the Tiger Leap Formation (approximate top of Upper Floridan aquifer)

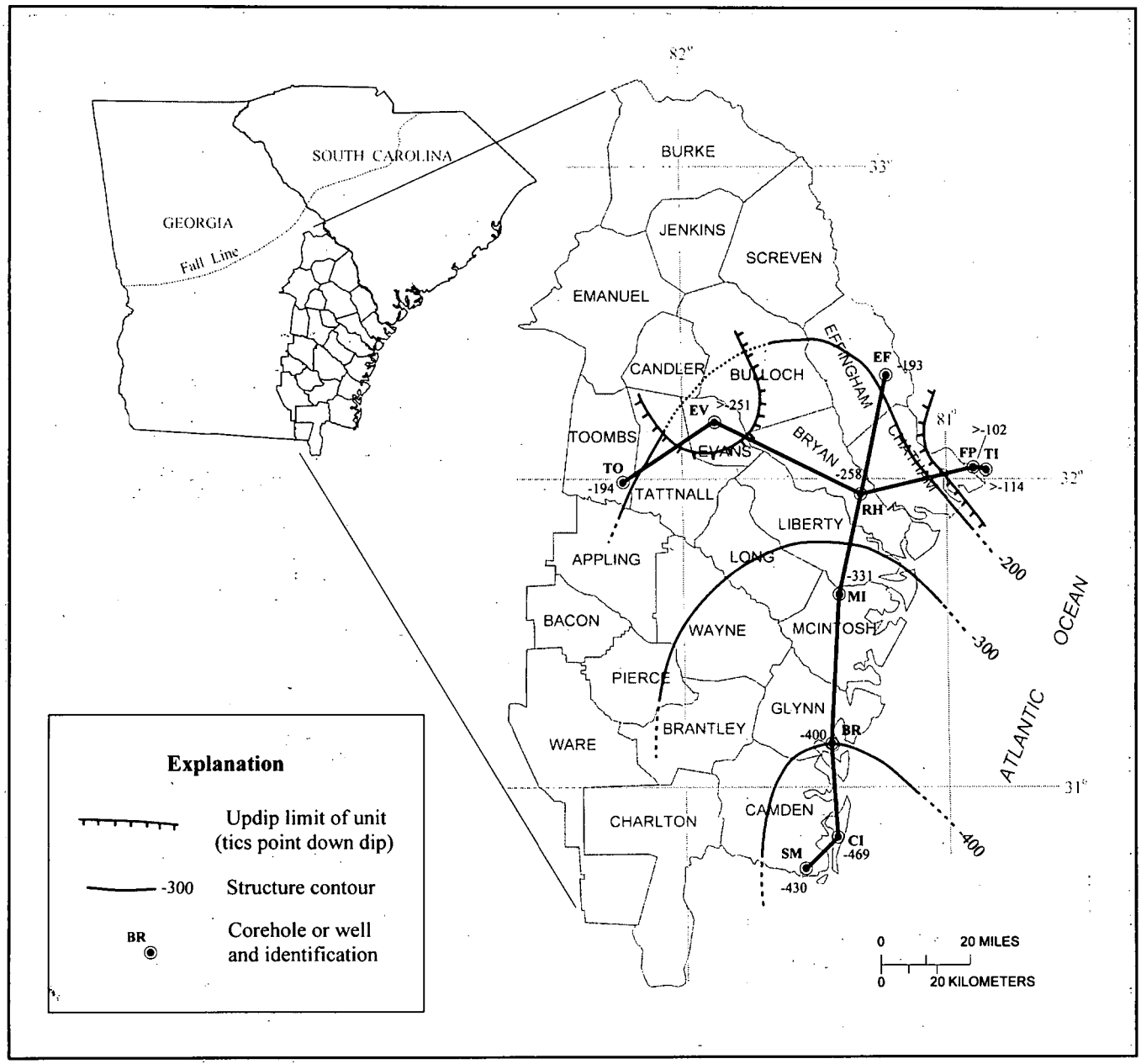

Figure 7. Altitude of the base of the Parachucla Formation (approximate top of the lower Brunswick aquifer)

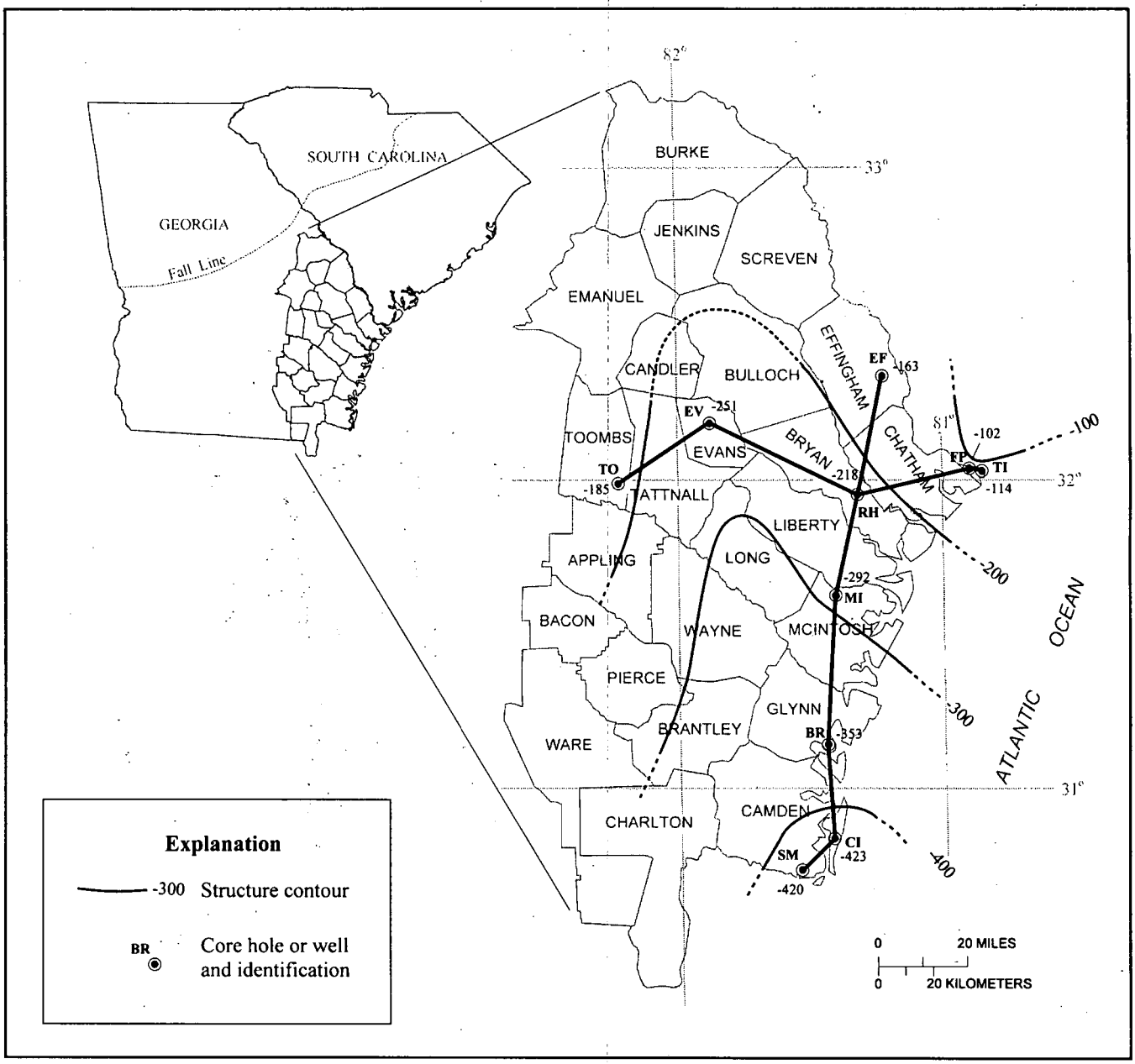

Figure 8. Altitude of the base of the Marks Head Formation (approximate base of the upper Brunswick aquifer)

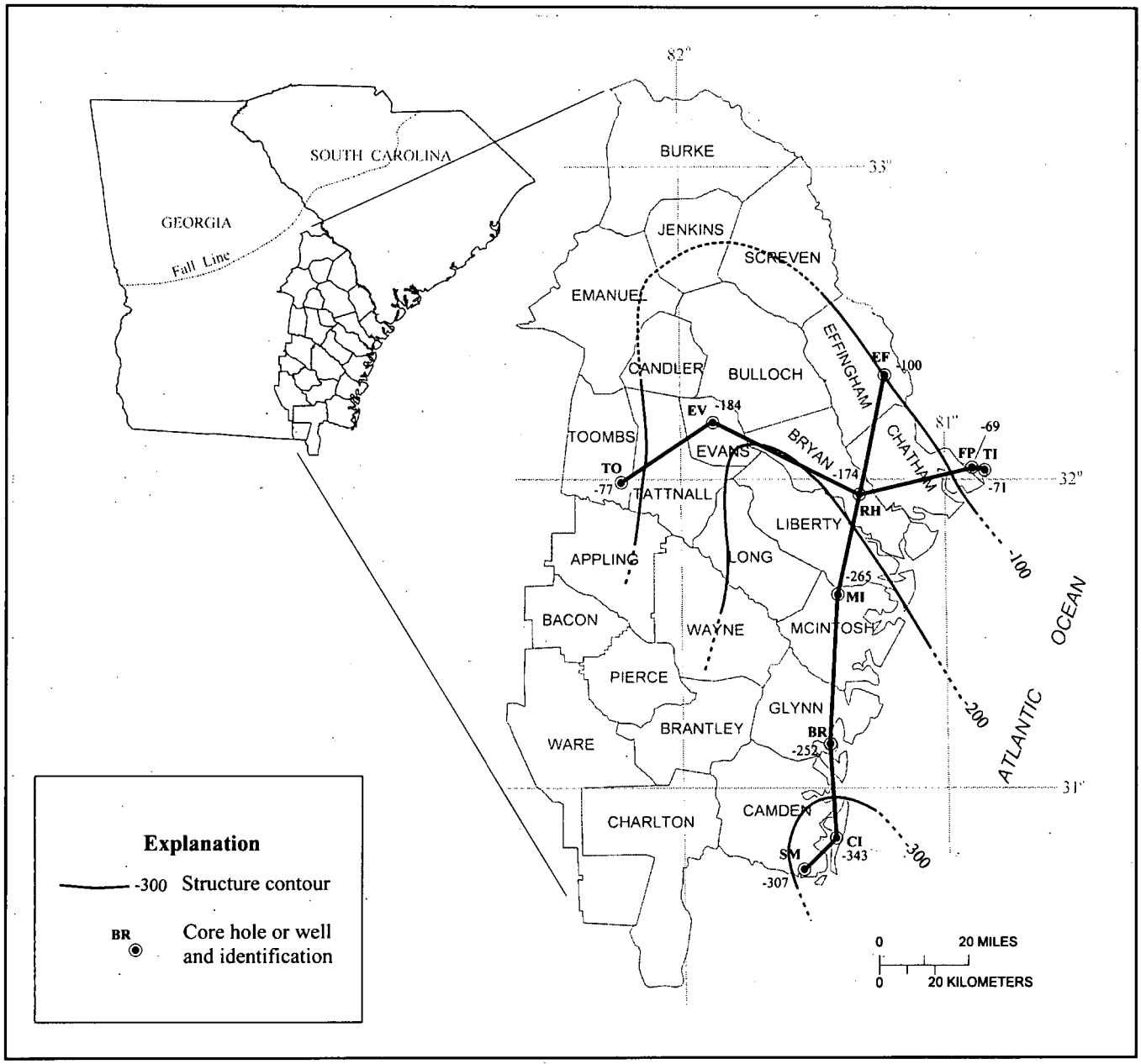

Figure 9. Altitude of the base of the Coosawhatchie Formation, excluding the Tybee Phosphorite Member (approximate top of upper Brunswick aquifer)

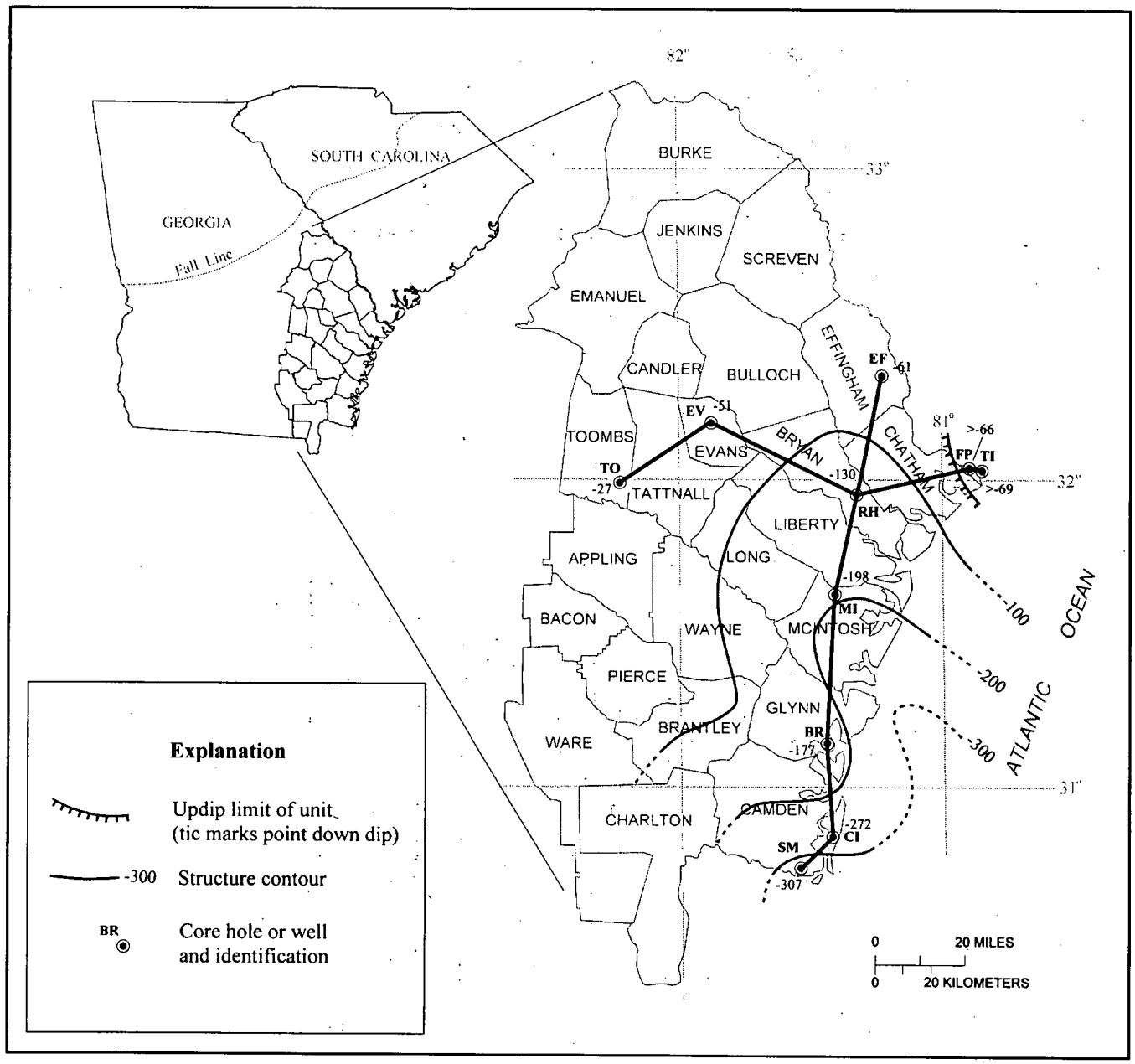

Figure 10. Altitude of the base of the Ebenezer Formation (approximate base of the surficial aquifer)

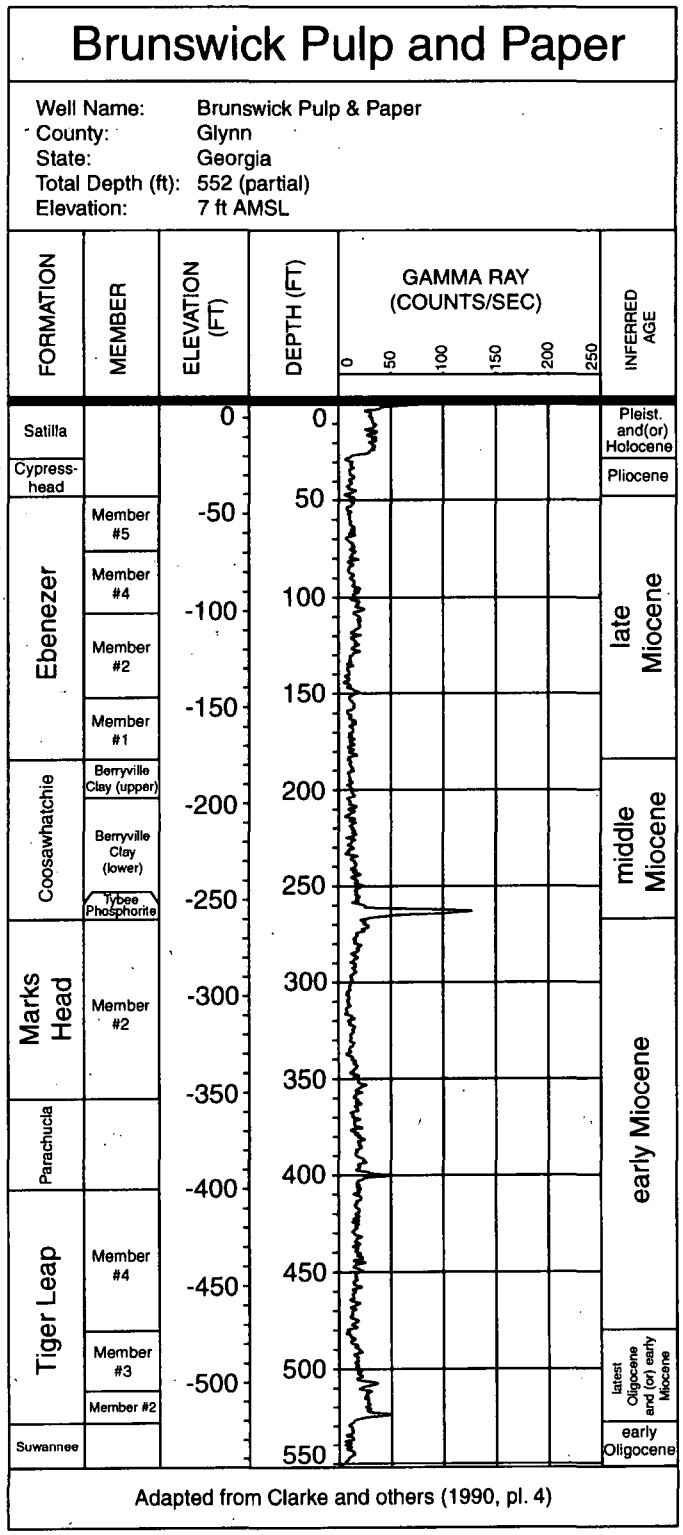

Figure 11. Geophysical log for the Brunswick Pulp and Paper well.

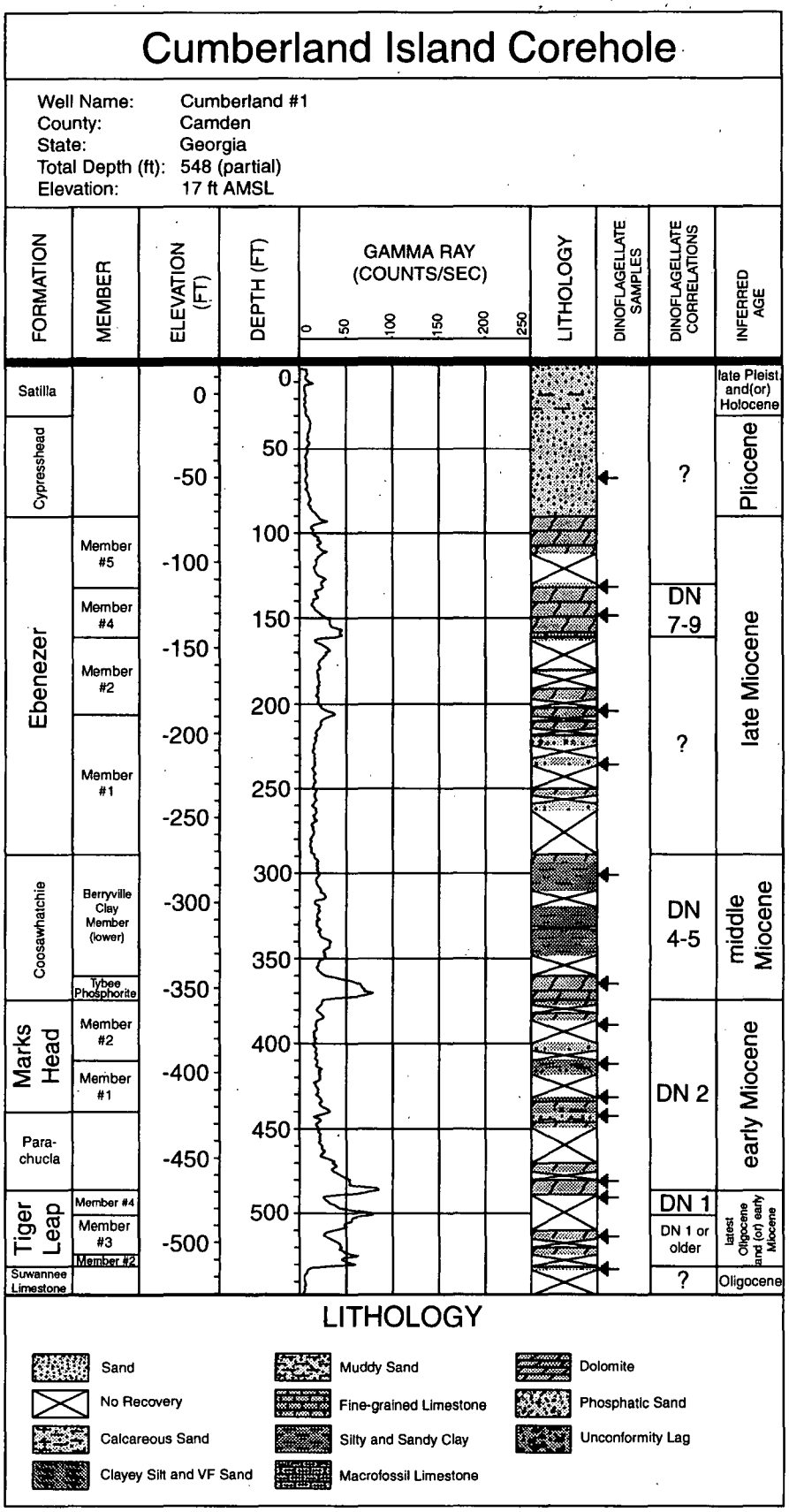

Figure 12. Lithologic and geophysical log for the Cumberland Island corehole. Adapted from Clarke and others (1990, Appendix A).

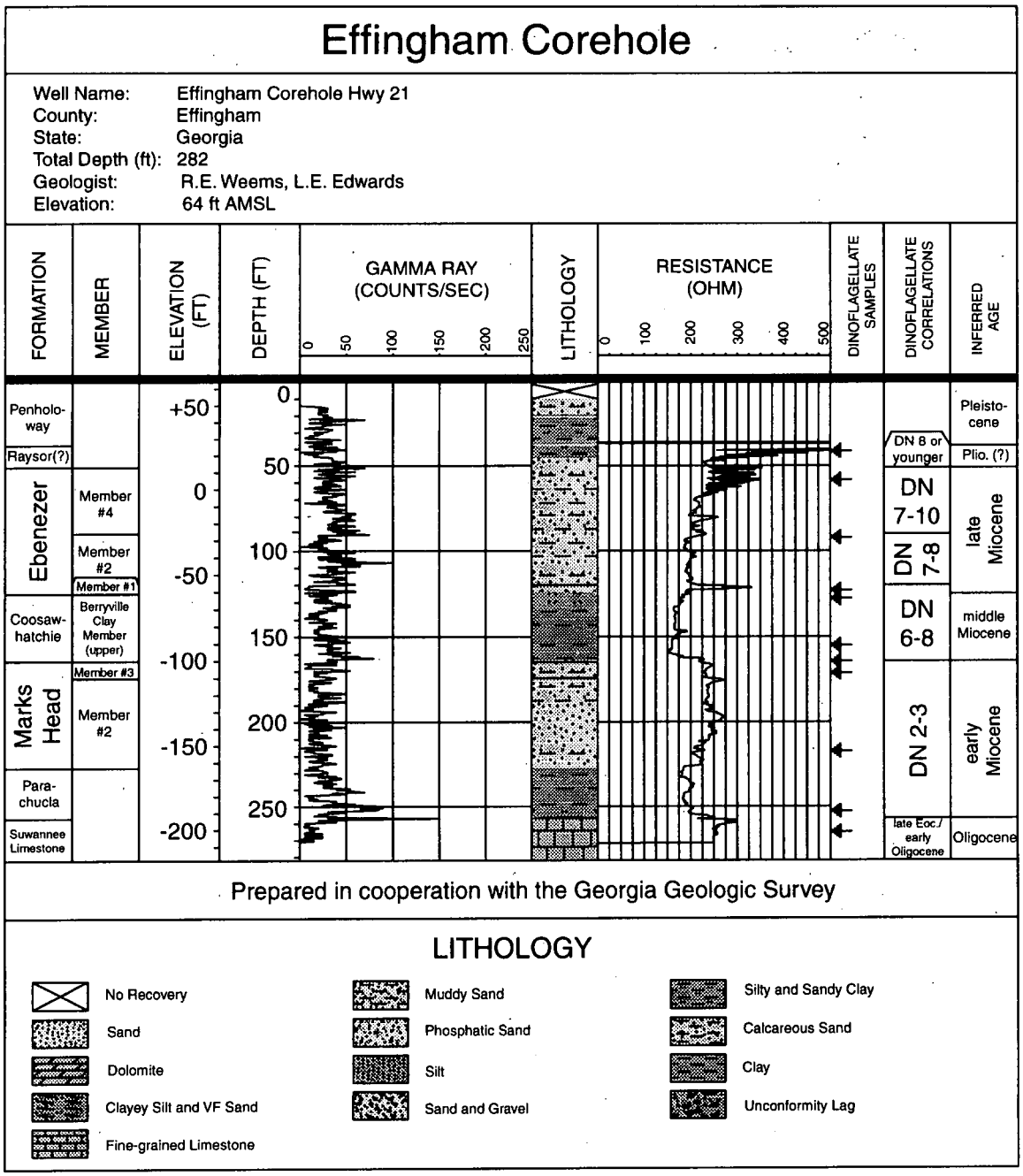

Figure 13. Lithologic and geophysical logs for the Effingham corehole.

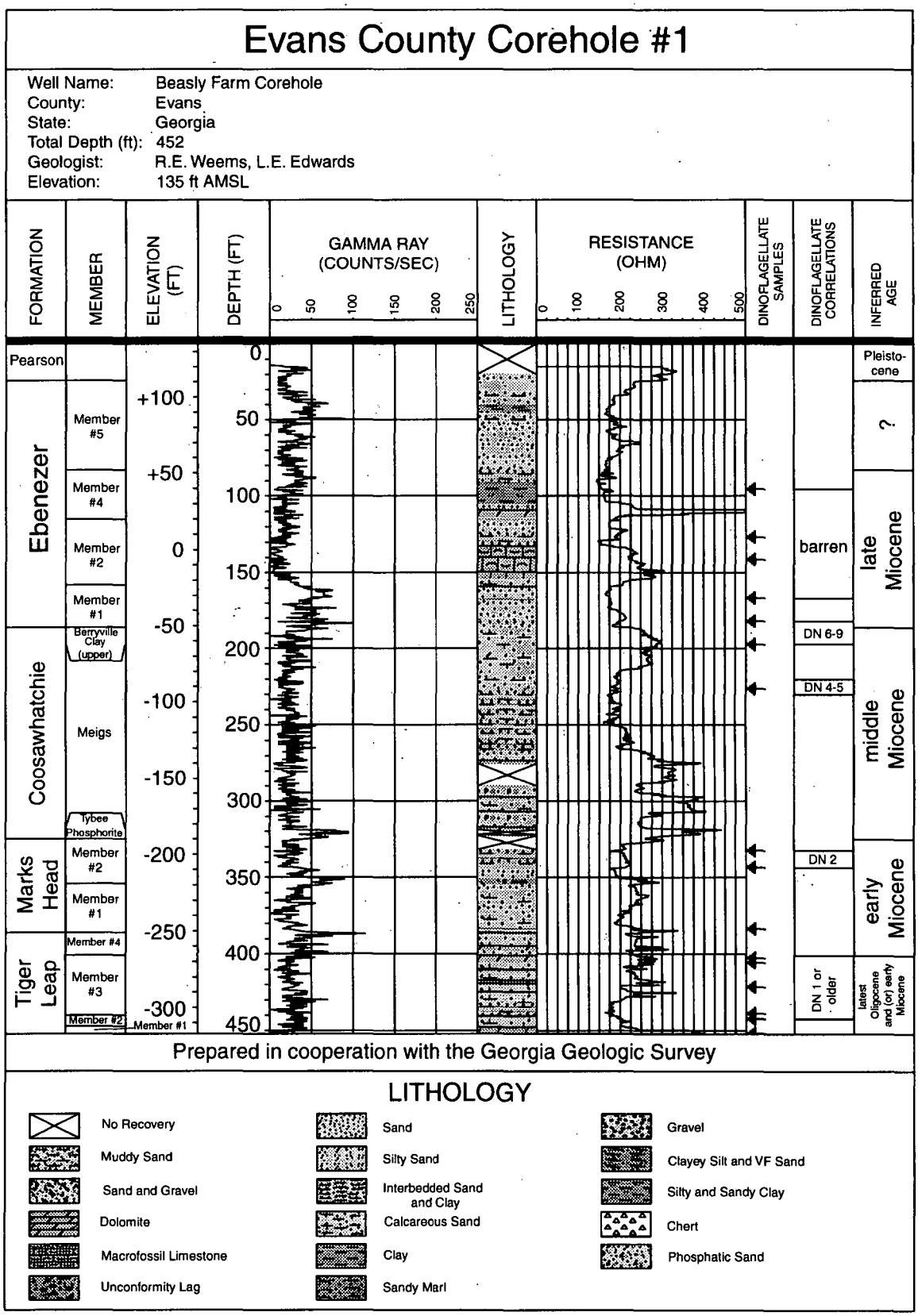

Figure 14. Lithologic and geophysical logs for the Evans County corehole #1.

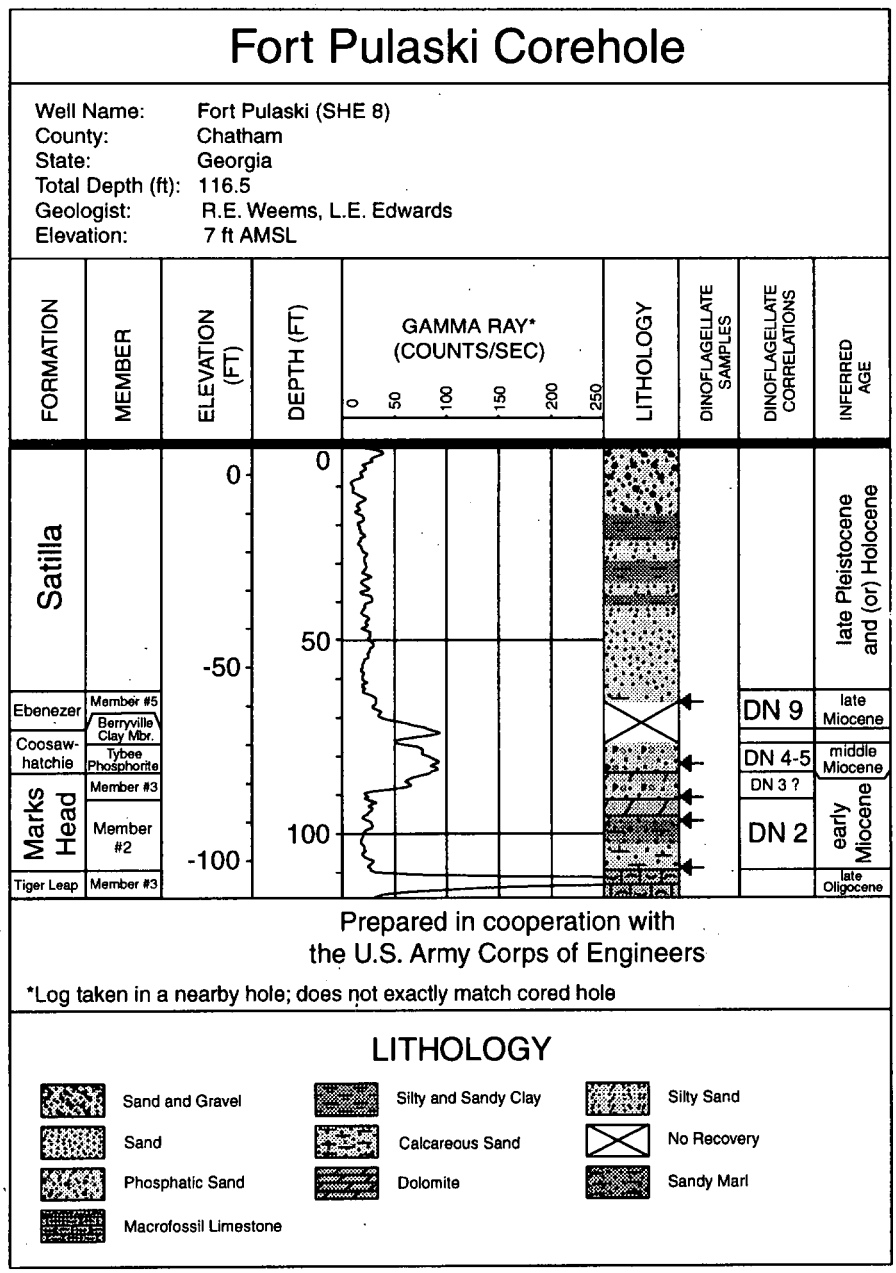

Figure 15. Lithologic and geophysical log for the Fort Pulaski corehole.

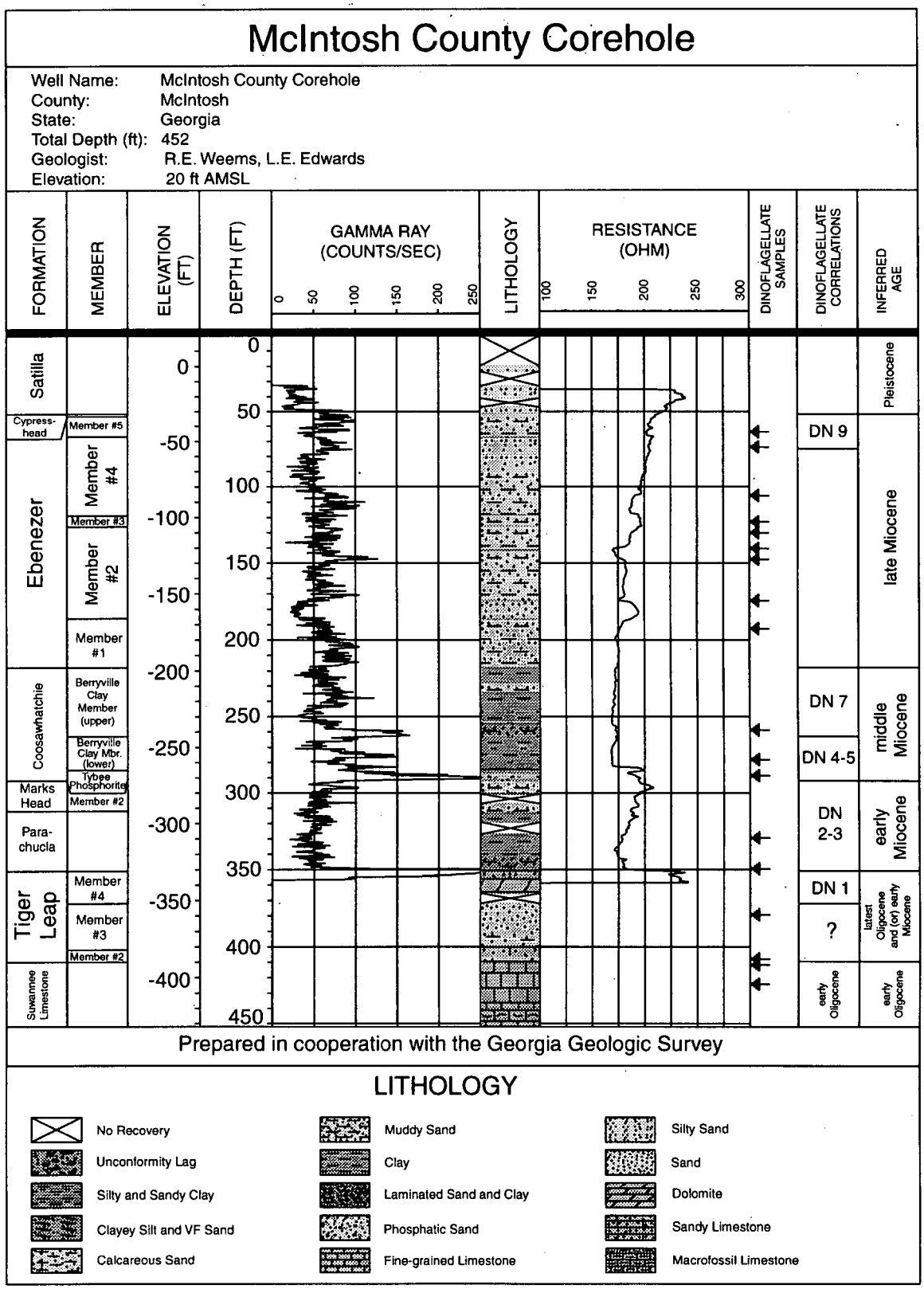

Figure 16. Lithologic and geophysical logs for the McIntosh County corehole.

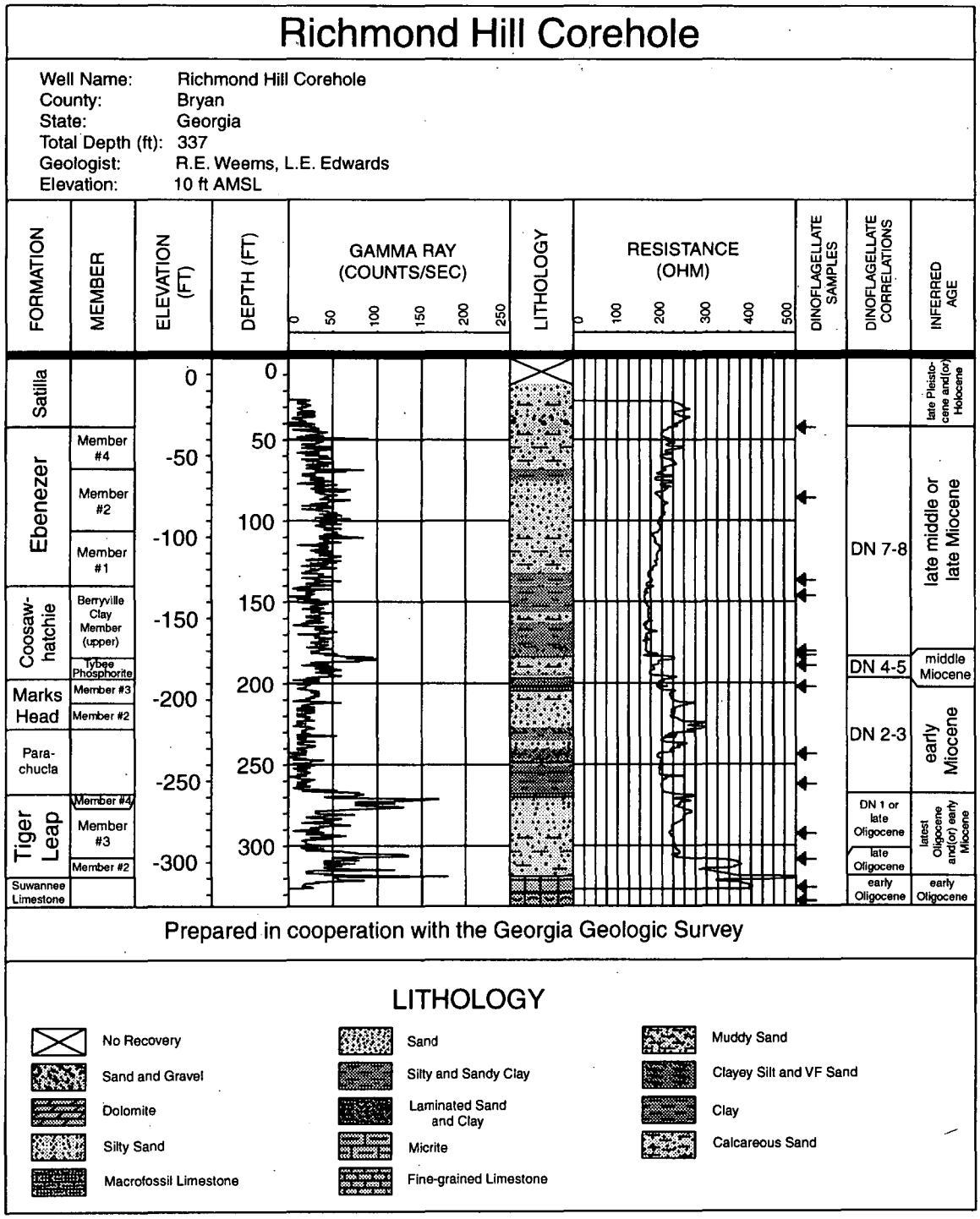

Figure 17. Lithologic and geophysical logs for the Richmond Hill corehole.

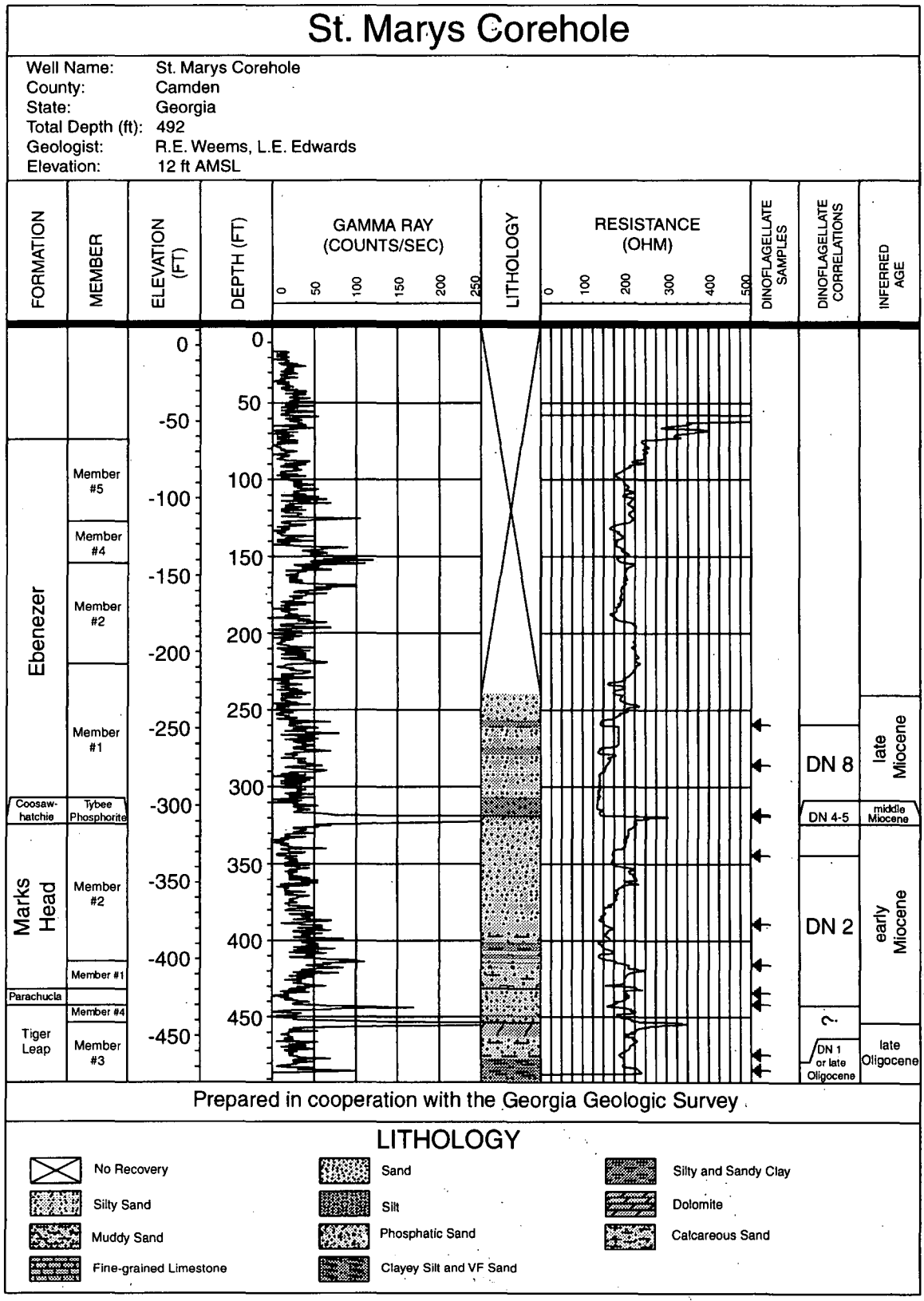

Figure 18. Lithologic and geophysical logs for the St. Marys corehole.

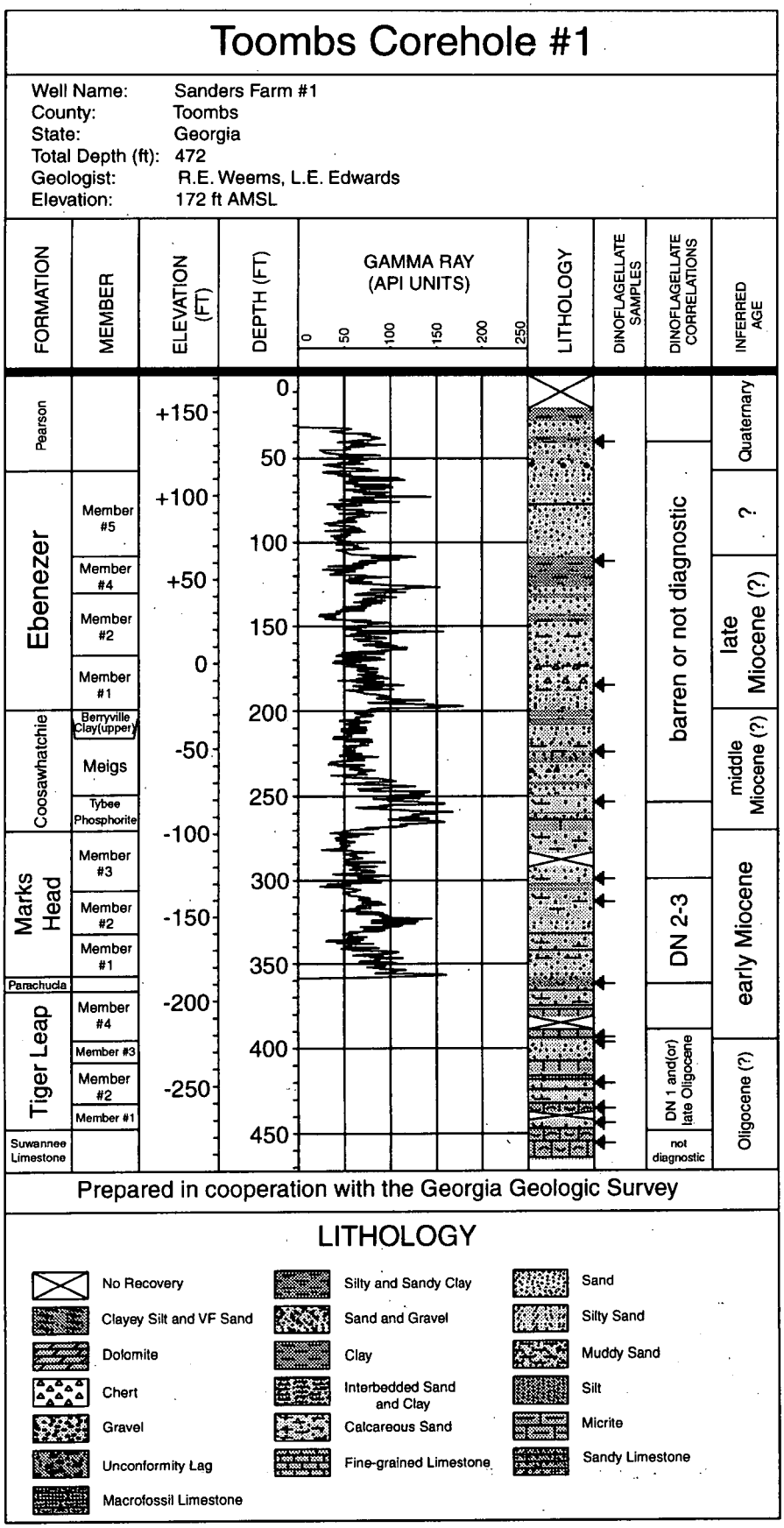

Figure 19. Lithologic and geophysical log for the Toombs County corehole #1.

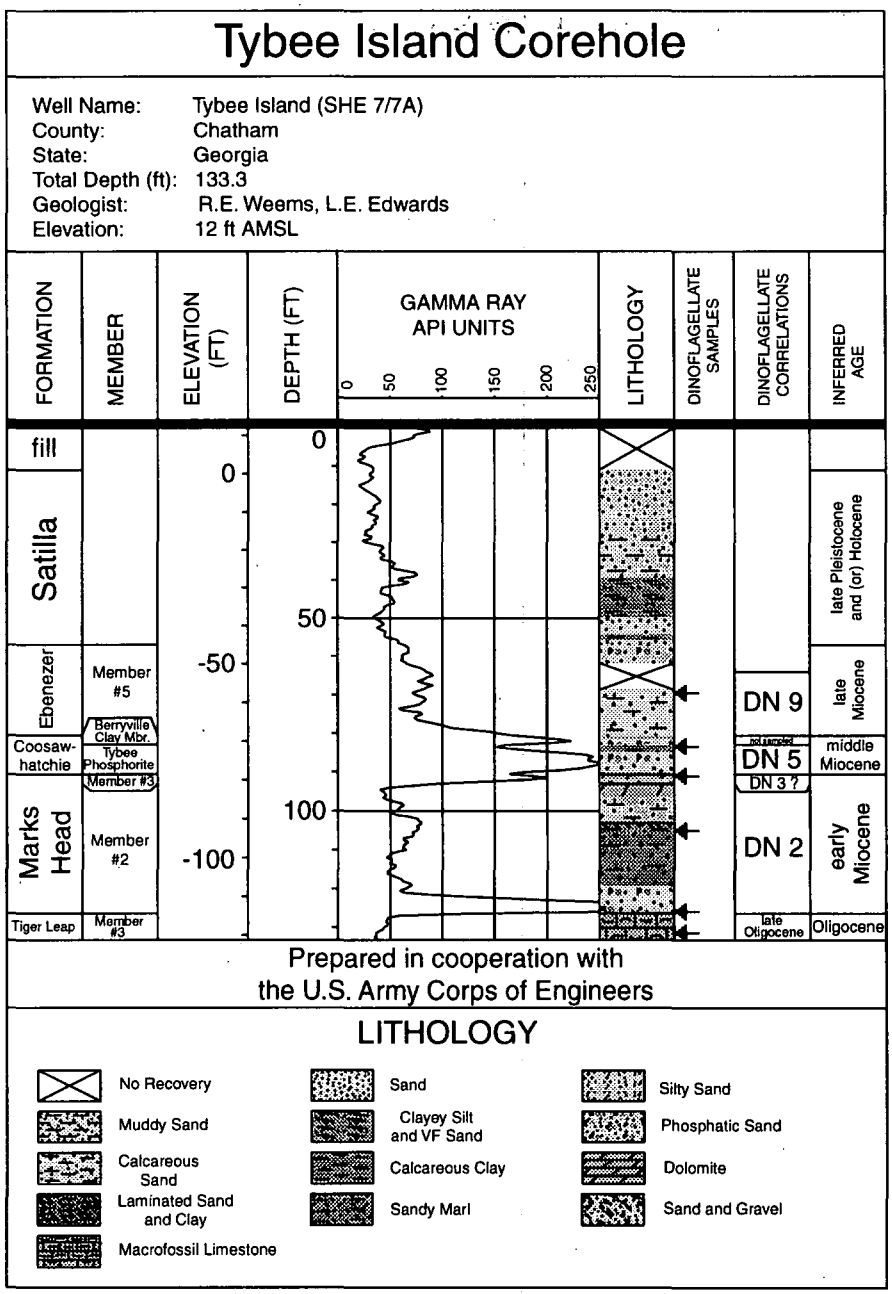

Figure 20. Lithologic and geophysical log for the Tybee Island corehole.

APPENDICES

Appendix A– Lithologic description of the Effingham County Corehole

Location: Springfield South 7.5'-quadrangle (NE 1/9)
Latitude: 32° 19' 42" N
Longitude: 81° 15' 15" W
Surface altitude: 64 feet above sea level
Total Depth: 282.0 feet (-218.0 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
Penholoway Formation		
(No recovery)	0.0 to 10.0	64.0 to 54.0
Sand, quartz, fine to medium, well sorted, angular, micaceous, silty and clayey, light-olive-gray (5Y5/2); contains about 20% silt and clay and 1% fine, round to angular, black botryoidal opaque sand	10.0 to 12.4	54.0 to 51.6
(No recovery)	12.4 to 15.0	51.6 to 49.0
Sand, quartz, fine to medium, well sorted, angular, silty and clayey, yellowish-gray (5Y7/2); contains about 20% silt and clay and 1% fine, round to angular, black botryoidal opaque sand	15.0 to 19.0	49.0 to 45.0
Clay, silty, sparsely micaceous, sticky, light-olive-gray (5Y6/1); contains scattered grains of very fine to fine quartz	19.0 to 19.7	45.0 to 44.3
Sand, quartz, fine to coarse but mostly medium, angular, clayey, yellowish-gray (5Y7/2); contains about 2% very fine to medium phosphate and another dark opaque mineral	19.7 to 21.0	44.3 to 43.0
Clay, sticky, light-olive-gray (5Y6/1), with sand partings; partings consist of mostly medium, very fine to coarse angular quartz and about 2% angular to round dark opaque-mineral granules	21.0 to 23.0	43.0 to 41.0
(No recovery)	23.0 to 30.0	41.0 to 34.0
Clay, silty, massive, sticky, medium-bluish-gray (5B5/1); contains about 1% very fine quartz and dark opaque minerals	30.0 to 30.8	34.0 to 33.2
(No recovery)	30.8 to 32.8	33.2 to 31.2
Clay, silty, massive, sticky, medium-bluish-gray (5B5/1); contains about 1% very fine quartz and dark opaque minerals	32.8 to 36.0	31.2 to 28.0
(No recovery)	36.0 to 37.0	28.0 to 27.0
Sand, quartz, mostly medium, fine to coarse, angular to subangular, clayey and silty, micaceous, dark-greenish-gray (5GY4/1); contains about 1-2% dark opaque sand including tourmaline? (green and conchoidal fracture); mica includes brown mica; sand grains coated with clay	37.0 to 38.0	27.0 to 26.0

Raysor Formation(?)		
Clay, silty, massive, sticky, medium-bluish-gray (5B5/1); contains about 4% very fine quartz and a dark opaque mineral	38.0 to 43.0	26.0 to 21.0
(No recovery)	43.0 to 47.0	21.0 to 17.0
Sand, quartz, very fine to very coarse, very poorly sorted, angular, coarsens downward to very coarse and granular, angular to subround, clayey and silty, dark-greenish-gray (5GY4/1); quartz grains coated by clay	47.0 to 49.0	17.0 to 15.0
(No recovery, gamma log indicates unconformity)	49.0 to 51.0	15.0 to 13.0
---------- unconformity ----------		
Ebenezer Formation **member #4**		
(No recovery)	51.0 to 52.0	13.0 to 12.0
Sand, quartz, mostly fine to medium, fine to very coarse, angular to subangular, clayey, burrow mottled, dark-greenish-gray (5GY4/1) grading through olive-gray (5Y3/2) to olive-gray (5Y4/1; contains about 2% medium to coarse mica, 1-2% fine to medium green and dark opaque minerals, and scattered 0.05-0.20-inch diameter chunks of carbonized wood	52.0 to 73.0	12.0 to -9.0
Sand, quartz, mostly upper fine to lower medium, well sorted, angular to subangular, clayey, calcareous, olive-gray (5Y4/1); contains about 1% mica flakes up to coarse, less than 1% opaque minerals, and less than 1% green mineral (epidote?); carbonate fraction in interstitial spacesconstitutes about 1/3 of volume	73.0 to 74.5	-9.0 to -10.5
Sand, quartz, mostly upper fine to lower medium, well sorted, angular to subangular, clayey, olive-gray (5Y3/2) grading down to olive-gray (5Y4/2); contains about 1% mica flakes up to coarse, less than 1% opaque minerals, and less than 1% green mineral (epidote?)	74.5 to 81.8	-10.5 to -17.8
(No recovery)	81.8 to 82.0	-17.8 to -18.0
Sand, quartz, fine to coarse, mostly medium, well sorted, angular, clayey and silty, dark-yellowish-brown (10YR4/2) grading through olive-gray (5Y4/2) back to dark-yellowish-brown (10YR4/2); contains less than 1% mica flakes, 1-2% opaque minerals, and less than 1% green mineral (epidote?)	82.0 to 89.7	-18.0 to -25.7
(No recovery)	89.7 to 90.0	-25.7 to -26.0
Sand, quartz, fine to coarse, mostly medium, well sorted, angular, clayey and silty, dark-yellowish-brown (10YR4/2) grading through olive-gray (5Y4/2) back to dark-yellowish-brown (10YR4/2); contains less than 1% mica flakes, 1-2% opaque minerals, and less than 1% green mineral (epidote?)	90.0 to 90.4	-26.0 to -26.4

Ebenezer Formation, member #2		
(No recovery)	90.4 to 92.0	-26.4 to -28.0
Sand, quartz, very fine to medium, mostly fine, well sorted, angular, clayey and silty, olive-gray (5Y3/2) grading down to olive-gray (5Y4/1); contains less than 1% opaque minerals, 1% mica flakes, and 1% green mineral (epidote?); silt fraction contains dolomite	92.0 to 96.8	-28.0 to -32.8
(No recovery)	96.8 to 97.0	-32.8 to -33.0
Sand, quartz, very fine to medium, mostly fine, well sorted, subangular to angular, clayey and silty, olive-gray (5Y4/1); contains about 1% fine opaque minerals; thin laminae of sandy clay scattered throughout interval	97.0 to 106.7	-33.0 to -42.7
(No recovery)	106.7 to 107.0	-42.7 to -43.0
Sand, quartz, mostly fine but ranges from silt to medium, well sorted, subangular to angular, clayey and silty, olive-gray (5Y4/1); contains about 1% fine opaque minerals; 0.05-0.10 inch thick laminae of sandy clay interbedded with sand layers about 0.5 inch thick; sparse burrow mottles present	107.0 to 116.5	-43.0 to -52.5
(No recovery)	116.5 to 117.0	-52.5 to -53.0
Sand, quartz, mostly fine, very fine to medium, well sorted, subangular to angular, clayey and silty, olive-gray (5Y4/1); contains about 1% fine opaque minerals; 0.05-0.10 inch thick laminae of sandy clay interbedded with sand layers about 0.5 inch thick; sparse burrow mottles present	117.0 to 119.7	-53.0 to -55.7
Sand, quartz, very fine to medium, mostly fine, angular to subangular, shelly, clayey and silty, light-olive-gray (5Y5/2); contains about 1% platy opaque minerals and 1% round amber and black phosphate; clayballs to 0.1 inch diameter concentrated at base	119.7 to 120.0	-55.7 to -56.0
---------- unconformity ----------		
Ebenezer Formation, member #1		
Sandstone, quartz, fine, well sorted, calcite-cemented, shelly, pyritic, light-greenish-gray (5GY8/1) grading down to light-olive-gray (5Y6/1); contains about 5% moldic porosity; shells chalky	120.0 to 121.2	-56.0 to -57.2
Sand, quartz-phosphate, very fine to medium, clayey and silty, and silt, very fine sandy, clayey, sparsely shelly, olive-gray (5Y3/2); quartz constitutes about two-thirds of sand fraction, angular to subangular; phosphate constitutes about one-third of sand fraction, subangular to round; sparse coarse grains of rutilated quartz present; 0.05 inch clay laminae scattered throughout interval	121.2 to 123.7	-57.2 to -59.7

(No recovery, probable unconformity in this interval)	123.7 to 125.0	-59.7 to -61.0
---------- unconformity ----------		
Coosawhatchie Formation, Berryville Clay Member (upper part)		
Siltstone, calcareous, light-olive-gray (5Y5/2); contains less than 1% fine, round phosphate and very fine angular quartz; less than 1% moldic porosity	125.0 to 125.3	-61.0 to -61.3
Clay, slightly calcareous, blocky, sparsely shelly, olive-gray (5Y3/2); contains 10-20% very fine to medium angular quartz, about 1% mica and platy opaque minerals, and less than 1% phosphate	125.3 to 129.0	-61.3 to -65.0
Siltstone, calcareous, olive-gray (5Y3/2); contains 2-5% very fine to medium angular quartz; contains 2-5% moldic porosity	129.0 to 130.4	-65.0 to -66.4
Clay, calcareous, blocky, olive-gray (5Y3/2); contains 2-5% very fine to medium angular quartz, about 1% mica and platy opaque minerals, and less than 1% phosphate; shell impressions present	130.4 to 133.8	-66.4 to -69.8
(No recovery)	133.8 to 136.0	-69.8 to -72.0
Clay, calcareous, blocky, olive-gray (5Y3/2); contains 2-5% very fine to medium angular quartz, about 1% mica and platy opaque minerals, and less than 1% phosphate; shell impressions present	136.0 to 137.6	-72.0 to -73.6
(No recovery)	137.6 to 140.0	-73.6 to -76.0
Clay, calcareous, blocky, olive-gray (5Y3/2); contains 2-5% very fine to medium angular quartz, about 1% mica and platy opaque minerals, and less than 1% phosphate; shell impressions present	140.0 to 143.5	-76.0 to -79.5
(No recovery)	143.5 to 145.0	-79.5 to -81.0
Clay, calcareous, blocky, olive-gray (5Y3/2); contains about 2% very fine to fine angular quartz, about 1% fine or smaller mica, and less than 1% platy opaque minerals; shell impressions present	145.0 to 147.8	-81.0 to -83.8
(No recovery)	147.8 to 148.0	-83.8 to -84.0
Siltstone, calcareous, clayey, well laminated, olive-gray (5Y3/2); contains molds of diatoms; no visible porosity	148.0 to 149.8	-84.0 to -85.8
Clay, slightly calcareous, massive, olive-gray (5Y3/2); contains about 1% very fine to fine angular quartz and traces of mica and phosphate	149.8 to 152.8	-85.8 to -88.8
(No recovery)	152.8 to 153.0	-88.8 to -89.0
Clay, slightly calcareous, massive, olive-gray (5Y3/2); contains about 1% very fine to fine angular quartz and traces of mica and phosphate	153.0 to 157.9	-89.0 to -93.9

(No recovery)	157.9 to 158.0	-93.9 to -94.0
Clay, slightly calcareous, massive, olive-gray (5Y3/2); contains about 10-15% very fine to fine angular quartz and traces of mica and phosphate	158.0 to 161.8	-94.0 to -97.8
(No recovery)	161.8 to 162.0	-97.8 to -98.0
Clay, slightly calcareous, massive, olive-gray (5Y3/2); contains about 1% very fine to fine angular quartz and traces of mica and phosphate	162.0 to 162.6	-98.0 to -98.6
Clay and sandy clay, interlaminated, olive-gray (5Y3/2); contains scattered bone fragments	162.6 to 163.5	-98.6 to -99.5
Sand, quartz, medium to coarse, subangular to subround, olive-gray (5Y4/1); contains fine subround to round quartz and phosphate pebbles to 0.5 inch diameter	163.5 to 163.8	-99.5 to -99.8
---------- unconformity ----------		
Marks Head Formation, member #3		
Clay, massive and featureless, dark-greenish-gray (5G4/1)	163.8 to 164.5	-99.8 to-100.5
Sandstone, quartz, mostly medium, very fine to coarse, subangular to subround, clayey and silty, calcareous, light-olive-gray (5Y5/2); contains about 2% fine to medium, subround to round phosphate; some rutilated quartz grains present; calcareous fraction both dolomite and calcite, coats about 30% of sand grains	164.5 to 165.1	-100.5 to -100.1
(No recovery)	165.1 to 168.0	-100.1 to -104.0
Sand, quartz, as above	168.0 to 169.8	-104.0 to -105.8
(No recovery)	169.8 to 171.0	-105.8 to -107.0
Sand, medium to coarse, angular to sub-round, clayey and silty, light-olive-gray (5Y5/2); contains about 1% medium, round to subround phosphate; grains coated with clay or small dolomite crystals; 0.5 inch diameter blocky clayballs present at 171.5	171.0 to 173.8	-107.0 to -109.8
(No recovery)	173.8 to 174.0	-109.8 to -110.0
---------- unconformity ----------		
Marks Head Formation, member #2		
Sandstone, quartz, medium to very coarse, poorly sorted, subangular to subround, calcite-cemented, light-olive-gray (5Y5/2); contains about 2% medium, round phosphate; quartz grains abundantly coated with calcite and some with manganese (?)	174.0 to 174.5	-110.0 to -110.5

Sand, quartz, medium to very coarse, angular to round, clayey, calcareous, light-olive-gray (5Y5/2) grading down to olive-gray (5Y4/1); contains about 2% medium to coarse, round phosphate; quartz and phosphate grains abundantly coated with small calcite crystals and some coated with manganese (?)	174.5 to 177.1	-110.5 to -113.1
(No recovery)	177.1 to 184.0	-113.1 to -120.0
Sand, quartz, fine to coarse, subangular to subround, clayey and silty, very slightly calcareous, dark-greenish-gray (5GY4/1); contains about 1% medium, subround to round phosphate and sparse coarse rutilated quartz grains; many grains coated with manganese (?) thin clay laminae define faint bedding; sparse burrow mottling present; grades to:	184.0 to 188.0	-120.0 to -124.0
Sand, quartz, fine to coarse, angular to round, olive-gray (5Y4/1); contains 2-5% medium to very coarse, round to well round phosphate; loose, porous, and permeable	188.0 to 201.3	-124.0 to -137.3
(No recovery)	201.3 to 202.0	-137.3 to -138.0
Sand, quartz, fine to coarse, angular to round, olive-gray (5Y4/1); contains 2-5% medium to very coarse, round to well round phosphate; loose, porous, and permeable	202.0 to 205.5	-138.0 to -141.5
(No recovery)	205.5 to 206.5	-141.5 to -142.5
Sand, quartz, fine to coarse, angular to subround, olive-gray (5Y4/1); contains about 5% coarse, subround to round, black and amber phosphate; loose, porous, and permeable	206.5 to 211.6	-142.5 to -147.6
(No recovery)	211.6 to 212.0	-147.6 to -148.0
Sand, quartz, medium to coarse, angular to subround, olive-gray (5Y4/1); contains about 5% coarse, subround to round, black and amber phosphate; loose, porous, and permeable	212.0 to 214.0	-148.0 to -150.0
Sand, quartz, medium to coarse, angular to subround, clayey, interbedded with clay, very fine to fine quartz sandy, olive-gray (5Y3/2) grading down to light-olive-gray (5Y5/2)	214.0 to 216.5	-150.0 to -152.5
(No recovery)	216.5 to 217.0	-152.5 to -153.0
Sand, quartz, medium to coarse, angular to subround, clayey, interbedded with clay, very fine to fine quartz sandy and silty, olive-gray (5Y4/1); clay contains diatom molds; silt fraction mostly dolomite	217.0 to 220.7	-153.0 to -156.7
(No recovery)	220.7 to 222.0	-156.7 to -158.0
Sand, quartz, medium to very coarse, subround to round, clayey, olive-gray (5Y4/1); contains 2-5% medium to coarse, round phosphate; grains coated mostly with dolomite and a few with manganese(?)	222.0 to 226.2	-158.0 to -162.2
(No recovery)	226.2 to 227.0	-162.2 to -163.0

---------- unconformity ----------

Parachucla Formation

Clay, waxy, olive-gray (5Y3/2) grading down to greenish-black (5GY2/1); contains less than 1% very fine to fine, angular to subangular quartz; scattered sandy laminae in basal foot	227.0 to 231.6	-163.0 to -167.6
(No recovery)	231.6 to 232.0	-167.6 to -168.0
Clay, waxy, and sand, very fine to coarse, angular to round, clayey, thinly interbedded, burrow mottled, olive-gray (5Y3/2) grading down to olive-gray (5Y4/1); sand layers contain about 2% fine, angular to round phosphate	232.0 to 235.8	-168.0 to -171.8
(No recovery)	235.8 to 237.0	-171.8 to -173.0
Clay, waxy, and sand, very fine to medium, angular to round, clayey, thinly interbedded, burrow mottled, olive-gray (5Y4/1); sand layers contain about 2% fine, angular to round phosphate	237.0 to 240.5	-173.0 to -176.5
(No recovery)	240.5 to 244.0	-176.5 to -180.0
Clay, waxy, and sand, fine, angular to subangular, clayey, slightly calcareous, thinly interbedded, olive-gray (5Y3/2); sand layers contain about 2% very fine to fine, subangular to subround phosphate and about 1% other opaque mineral grains	244.0 to 246.8	-180.0 to -182.8
(No recovery)	246.8 to 252.0	-182.8 to -188.0
Clay, dolomitic, poorly bedded, burrow mottled, olive-gray (5Y3/2) grading rapidly to light-olive-gray (5Y4/2); contains 3-5% very fine to fine, round to well rounded phosphate and less than 1% fine to medium, subangular quartz; 1.6 inch diameter chert clast at base, fine phosphate pebbles, and scattered medium to coarse, subround quartz grains	252.0 to 256.7	-188.0 to -192.7
(No recovery)	256.7 to 257.0	-192.7 to -193.0

---------- unconformity ----------

Suwannee Limestone

Calcarenite, very fine to medium, sub-round, coated and partially cemented by calcite coatings, yellowish-gray (5Y7/2 to 5Y8/1); contains about 5% moldic porosity	257.0 to 265.0	-193.0 to -201.0
Calcarenite, very fine to medium, subround, coated and partially cemented by calcite coatings, light-olive-gray (5Y6/1) and yellowish-gray (5Y8/1) interlayered; contains about 5% moldic porosity	265.0 to 265.5	-201.0 to -201.5
Calcarenite, very fine to medium, sub-round, coated and partially cemented by calcite coatings, light-olive-gray (5Y6/1); contains about 5% moldic porosity	265.5 to 266.9	-201.5 to -202.9
(No recovery)	266.9 to 267.0	-202.9 to -203.0

Calcarenite, very fine to medium, subround, coated and partially cemented by calcite coatings, light-olive-gray (5Y6/1); contains about 5-10% fine, subangular quartz and about 1% fine, subround phosphate; porosity about 40-50%	267.0 to 276.8	-203.0 to -212.8
Calcarenite, medium, all grains coated with calcite, yellowish-gray (5Y8/1); contains less than 1% quartz and phosphate	276.8 to 281.5	-212.8 to -217.5
(No recovery)	281.5 to 282.0	-217.5 to -218.0
Base of corehole	**282.0 feet**	**-218.0 feet elev.**

Appendix B: Lithologic description of the Evans County Corehole #1 (Beasly Farm Corehole)

Location: Claxton 7.5-minute quadrangle
Latitude: 32° 12' 52"
Longitude: 81° 52' 37"
Surface altitude: about 135 feet above sea level
Total Depth: 452 feet (-317 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
Pearson terrace unit		
(No recovery)	0.0 to 20.0	+135.0 to +115.0
Sand, quartz, mostly medium to coarse with subordinate fine fraction, poorly sorted, angular to subangular, slightly silty and clayey, pale-yellowish-brown (10YR6/2) and moderate-reddish-brown (10R4/6) with streaks of moderate-yellowish-brown (10YR5/4); contains less than 1% very fine to fine opaque minerals; quartz oxide coated; massive and unbedded	20.0 to 25.0	+115.0 to +110.0
Gravel, pebble, subangular to subround fine to medium quartz pebbles up to 0.75-inch in diameter in matrix of silty and clayey quartz sand, fine to coarse, pale-olive (10Y6/2); white matrix looks kaolinitic	25.0 to 25.6	+110.0 to +109.4
---------- unconformity ----------		
Ebenezer Formation, member #5		
Sand, quartz, medium, well sorted, subround, silty and clayey, light-brown (5YR5/6) to pale-olive (10Y6/2); contains less than 1% very fine opaque minerals; quartz iron-stained; very kaolinitic (about 50%), kaolin pseudomorphs of feldspar sand discernable; massive and unbedded	25.6 to 28.0	+109.4 to +107.0
Sand, quartz, mostly coarse but fine to very coarse, scattered subangular quartz granules present, poorly sorted, angular to subangular and rarely subround, silty, yellowish-gray (5Y7/2); contains 1-2% mica and scattered kaolin pseudomorphs of medium feldspar, massive and unbedded	28.0 to 29.5	+107.0 to +105.5
---------- base of fining upward cycle ----------		
Sand, quartz, mostly fine but ranges from very fine to medium, poorly sorted, angular very fine fraction grading up to subround medium fraction, silty and clayey, contains scattered rounded quartz granules, pale-olive (10Y6/2) to olive-yellowish-gray (5Y7/2); less than 1% opaque minerals and a trace of mica; fines downward to mostly very fine to fine, range very fine to medium; massive and unbedded	29.5 to 39.4	+105.5 to +95.6

---------- base of fining upward cycle ----------		
Siltstone, very fine quartz sandy, clayey, yellowish-gray (5Y7/2); silt fraction composed of a mix of kaolin grains and quartz; contains a trace of opaque minerals and mica; laminated on a 0.5 to 1.0-inch scale	39.4 to 45.0	+95.6 to +90.0
Sand, quartz, fine, well sorted, subangular to subround, silty and clayey, yellowish-gray (5Y7/2); contains a trace of opaque minerals and mica silt; silt fraction probably mostly kaolinite grains; quartz coated with clay; massive and unbedded	45.0 to 49.8	+90.0 to +85.2
Sand, quartz, mostly medium but very fine to granular, very poorly sorted, subangular to subround, slightly silty, yellowish-gray (5Y7/2); contains less than 1% very fine to fine opaque minerals and mica; contains scattered granules to very small pebbles; massive and unbedded	49.8 to 50.2	+85.2 to +84.8
---------- base of fining upward cycle ----------		
Sand, quartz, very fine to medium, very poorly sorted, subangular, very silty, pale-olive (10Y6/2) to yellowish-gray (5Y7/2); contains less than 1% opaque minerals and mica; silt fraction probably mostly grains of kaolinite; top 3 inches indurated; massive and unbedded	50.2 to 52.4	+84.8 to +82.6
Sand, quartz, mostly fine but with subordinate medium to coarse fraction, fine fraction angular to subangular, medium to coarse fraction subround, scattered quartz granules, slightly silty and clayey, yellowish-gray (5Y8/1); contains less than 1% opaque minerals; silt fraction probably mostly grains of kaolinite; grades down to sand, quartz, very fine to very coarse, subround, with granules and fine pebbles	52.4 to 53.5	+82.6 to +81.5
---------- base of fining upward cycle ----------		
Sand, quartz, fine to medium with a subordinate fraction of very fine, poorly sorted, subangular to subround, yellowish-gray (5Y7/2) grading down by 59 feet to yellowish-gray (5Y8/1); contains less than 1% opaque minerals; unbedded and massive; grades to:	53.5 to 64.0	+81.5 to +71.0
Sand, quartz, fine to medium, well sorted, angular to subangular, very silty, moderate-yellowish-brown (10YR5/4) and pinkish-gray (5YR8/1); contains less than 1% opaque minerals; silt fraction probably mostly kaolinite; quartz iron-stained; goethite filling in fracture planes; unbedded and massive; grades to:	64.0 to 72.0	+71.0 to +63.0
Sand, quartz, fine to medium, poorly sorted, angular to subangular, slightly silty, grayish-orange (10YR7/4) grading down by 80.5 feet to very pale-orange (10YR8/2); less than 1% opaque minerals and mica; quartz coated with clay; unbedded and massive	72.0 to 83.2	+63.0 to +51.8
---------- unconformity ----------		

Ebenezer Formation, member #4		
Sand and clay interbedded; sand fraction quartz, very fine to fine, well sorted, very angular to angular, silty and slightly clayey, yellowish-gray (5Y7/2); contains less than 1% very fine to silt opaque minerals; layers massive to planar cross-bedded; clay fraction silty, moderate-yellowish-green (5GY7/4); breaks with a conchoidal fracture; poorly laminated on a 0.05 inch scale; clay and sand beds 1 to 4 inches thick, clay beds become more abundant downward	83.2 to 90.4	+ 51.8 to +44.6
Clay, slightly silty, pale-olive (10Y6/2); breaks with conchoidal fracture; contains around 250 micron diameter dish-shaped impressions, probably of diatoms, concentrated on bedding planes; laminated on a 0.05 inch scale	90.4 to 104.7	+44.6 to +30.3
Sand, quartz, fine to medium, poorly sorted, mostly subangular to subround but ranges from angular to well rounded, silty and slightly clayey, pale-olive (10Y6/2); contains less than 1% very fine to silt opaque minerals; black and carbonized wood chips locally abundant; unbedded and massive	104.7 to 109.0	+30.3 to +26.0
Sandstone, quartz sand, mostly medium, well sorted, in amorphous silica matrix, light-olive-gray (5Y5/2) streaked very-pale-orange (10YR8/2); matrix about 50% of rock volume; contains about 1% fine to silt opaque minerals and kaolin pseudomorphs of feldspar; contains blebs that look like silicified rounded mudballs; broken surfaces cut across some sand grains; no porosity; pyrolusite forms dendrites and fills rock fractures; massive and unbedded; grades in basal foot to:	109.0 to 113.4	+26.0 to +21.6
Sand, quartz-calcite, mostly medium, well sorted, silty and clayey, friable, grayish-orange (10YR7/4); contains less than 1% fine to silt opaque minerals; contains 0.8 inch long chalky pectenid shell; massive and unbedded	113.4 to 114.8	+21.6 to +20.2
---------- unconformity ----------		
Ebenezer Formation, member #2		
Silt, clayey and very fine sandy, dusky-yellow (5Y6/4); mottled with burrows filled with matrix from unit above; massive and unbedded	114.8 to 115.5	+20.2 to +19.5
Chert, dusky-yellow (5Y6/4), massive and unbedded; contains molds of snails and clams, about 5% void porosity	115.5 to 116.0	+19.5 to +19.0
Sand, quartz, fine, well sorted, angular to subangular, silty, pale-olive (10Y6/2), massive and unbedded; contains about 1% very fine to silt opaque minerals; grades to:	116.0 to 122.0	+19.0 to +13.0
Sand, quartz, fine, well sorted, angular, slightly silty, yellowish-gray (5Y7/2); contains less than 1% opaque minerals	122.0 to 123.7	+13.0 to +11.3
Sand and clay interbedded; sand quartz, mostly fine with a subordinate fraction of very fine, well sorted, angular, quartz clay-coated, silty, dusky-yellow (5Y6/4); clay silty and about 1% very fine sandy, massive, yellowish-gray		

(5Y7/2); scattered angular to subangular 0.5 to 1.5-inch wide blocks of clay scattered about in sand fraction as well as scattered fragments of thin-shelled mollusks; clay layers predominate only in the interval 130.0 to 131.2 feet	123.7 to 132.2	+11.3 to +2.8
Sand, calcite-quartz, very fine to medium, poorly sorted, subangular to subround, dusky-yellow (5Y6/4), unbedded and massive; contains abundant blade-shaped shell fragments up to 0.25-inch long; contains less than 1% opaque minerals	132.2 to 132.4	+2.8 to +2.6
Limestone, bioclastic, dusky-yellow (5Y6/4) grading by 134 feet to yellowish-gray (5Y7/2), unbedded and massive; contains less than 1% very fine to silt quartz and opaque minerals; contains abundant molds and casts of mollusks; porosity varies from 5-30%, higher porosity areas appear to be interconnected; sparry calcite growth in molds; grades to:	132.4 to 139.0	+2.6 to -3.0
Limestone, bioclastic, yellowish-gray (5Y7/2), unbedded and massive; contains less than 1% very fine to silt quartz and an opaque mineral; contains abundant mollusk shells and large barnacle plates;	139.0 to 148.5	-3.0 to -13.5
Limestone, fine micrite, yellowish-gray (5Y7/2); firmly cemented; unfossiliferous; no porosity	148.5 to 148.8	-13.5 to -13.8
Limestone, bioclastic, yellowish-gray (5Y7/2), unbedded and massive; quartz and phosphate sand increasingly abundant downward, phosphate round; abundant mollusk shells	148.8 to 153.5	-13.8 to -18.5
Sand, quartz, fine to medium, well sorted, subangular to subround, slightly silty, calcareous, yellowish-gray (5Y7/2); contains about 1% very fine to silt phosphate with rough and angular surfaces	153.5 to 158.0	-18.5 to -23.0
---------- unconformity ----------		
Ebenezer Formation, member #1		
(No recovery)	158.0 to 159.0	-23.0 to -24.0
Sandstone, very fine to medium but mostly fine quartz in noncalcareous matrix, light-olive-gray (5Y5/2), massive and unbedded; contains about 1% very fine to silt opaque minerals; rock fractures around sand grains; rock has a rectangular pattern of stains reminiscent in appearance to pedogenic shrink-swell fractures;	159.0 to 159.2	-24.0 to -24.2
Sand, quartz, mostly fine but very fine to medium, poorly sorted, angular to subround, slightly silty, light-olive-gray (5Y5/2); contains about 1% very fine to silt phosphate, angular to subangular, and a trace of mica; sparingly mottled by burrows filled with brownish-black (5YR2/1) clayey sand	159.2 to 166.6	-24.2 to -31.6
Clay, carbonaceous, dense, laminated, brownish-black (5YR2/1)	166.6 to 166.7	-31.6 to -31.7

Sand, quartz, mostly fine but very fine to medium, poorly sorted, angular to subround, slightly silty, light-olive-gray (5Y5/2); contains about 1% very fine to silt phosphate, angular to subangular, and a trace of mica; unbedded and massive	166.7 to 169.0	-31.7 to -34.0
Sand, quartz, mostly fine but very fine to medium, poorly sorted, angular to subangular, light-olive-gray (5Y5/2); contains about 2% very fine to silt opaque minerals (probably graphite) and scattered fine to medium round phosphate sand; quartz may be coated; burrow mottled, grades to:	169.0 to 178.0	-34.0 to -43.0
Sand, quartz, mostly fine, well sorted, subangular to subround, slightly silty, olive-gray (5Y4/1); contains about 3% silt to coarse phosphate, medium to coarse fraction well rounded, and a trace of mica; burrow mottled	178.0 to 181.7	-43.0 to -46.7
Sand, interbedded with thin clay beds; sand quartz, mostly fine, well sorted, subangular to subround, slightly silty, olive-gray (5Y4/1); interbedded with clay, silty, very fine to fine sandy, fractures conchoidally, dark-gray (N3); clay layers less than 1 inch thick	181.7 to 183.5	-46.7 to -48.5
Sand, quartz, mostly fine, well sorted, subangular to subround, slightly silty and clayey, olive-gray (5Y4/1); contains 3-5% fine phosphate and a scattering of larger round and polished grains up to coarse; shelly and calcareous; unbedded and massive	183.5 to 184.0	-48.5 to -49.0
(No recovery, but gamma log has a big spike that tops at 183.0 feet and bottoms at 186.0 feet)	184.0 to 186.0	-49.0 to -51.0
---------- unconformity ----------		
Coosawhatchie Formation, Berryville Clay Member (upper part)		
No recovery)	186.0 to 189.0	-51.0 to -54.0
Sand, quartz, fine to medium, well sorted, subround, very calcareous, slightly clayey and silty, medium-gray (N5); contains about 3% opaque minerals, mostly very fine to medium subround to well rounded phosphate; contains about 1% mollusk shells; unbedded and massive; phosphate granules abundant at 197.0 to 198.0	189.0 to 198.0	-54.0 to -63.0
---------- unconformity ----------		
Coosawhatchie Formation, Meigs Member		
Sand, quartz, mostly fine, subangular, silty and clayey, medium-gray (N5); contains less than 1% very fine to medium subround phosphate; burrow mottled	198.0 to 216.0	-63.0 to -81.0
Sand, quartz, mostly fine, subangular, silty and clayey, greenish-gray (5G6/1); contains less than 1% very fine to medium subround phosphate; burrow mottled	216.0 to 225.2	-81.0 to -90.2

Sand, quartz, fine, very well sorted, angular, silty and clayey, calcareous, dark-greenish-gray (5G4/1); contains about 1% very fine to fine round phosphate and about 5% shell fragments; denser than sand above; burrow mottled	225.2 to 227.7	-90.2 to -92.7
Sand and clay interbedded; sand quartz, mostly fine but very fine to medium, poorly sorted, subround, slightly silty and clayey, greenish-gray (5GY6/1); contains 1-2% opaque minerals including graphite and very fine to medium subangular to round phosphate; quartz coated; layers of 0.5 to 1.0 inch-thick silty, medium-dark-gray (N5) clay scattered throughout interval	227.7 to 231.0	-92.7 to -96.0
Sand and clay interbedded; sand quartz, mostly fine grading to very fine to fine, well sorted, angular to subangular, moderately silty, slightly clayey, slightly calcareous, light-olive-gray (5Y5/2) grading by 235.0 feet to olive-gray (5Y4/1); contains about 1% medium to silt phosphate, coarser grains round and finer grains subangular; grades to:	231.0 to 251.0	-96.0 to -116.0
Sand and clay interbedded; sand quartz, medium to coarse grading down to fine to medium, poorly sorted, subangular, slightly to moderately silty, slightly clayey, moderately calcareous, light-olive-gray (5Y5/1) grading down by 264.0 feet to olive-gray (5Y4/1); contains 3-5% coarse to silt opaque minerals, some of which are graphite and others fine round phosphate; below 262.0 feet contains 1-2% shell fragments up to 0.25 inch in width; layers of 0.25 to 6 inch-thick calcareous silty and sandy clay scattered throughout interval, phosphate very fine to fine and subround	251.0 to 266.0	-116.0 to -131.0
Sand, quartz, mostly medium but with a subordinate fine fraction, well sorted, mostly subangular but angular to subround, slightly silty, moderately calcareous, medium-dark-gray (N4); contains 5-10% medium, round and polished phosphate; a 0.25 inch wide clayball containing phosphate grains present in this interval; 0.5 inch wide polished phosphate discoid-shaped pebble present at 271.0 feet; unbedded and massive	266.0 to 273.0	-131.0 to -137.0
Sandstone, as above but calcite-cemented, light-olive-gray (5Y6/1)	273.0 to 275.0	-137.0 to -139.0
(Not recovered except for about 2 feet of phosphatic sand from unknown horizon within this interval)	275.0 to 290.0	-139.0 to -155.0
Sand, quartz, fine to medium, well sorted, angular to subangular, pebbly, slightly silty, slightly calcareous, light-olive-gray (5Y5/1); contains 5-10% medium to silt, mostly round but to subangular phosphate; pebbles are quartz, very coarse to fine, up to 1.0 inch in diameter and clayballs up to 1.6 inches in diameter; unbedded and massive	290.0 to 294.2	-155.0 to -159.2
(No recovery)	294.2 to 297.0	-159.2 to -162.0
Sandstone, quartz sand mostly medium to coarse, poorly sorted, subround, pebbly, calcite-cemented, light-olive-gray (5Y6/1); very fine to fine pebbles composed of quartz, phosphate, and clayballs, subround to round, up to 0.5 inch in diameter; massive and unbedded; grades to:	297.0 to 298.5	-162.0 to -163.5

Sand, quartz, mostly medium but ranges into coarse, poorly sorted, subangular to subround, slightly silty and clayey, very calcareous, yellowish-gray (5Y7/2); contains 5-10% medium to silt round phosphate and scattered shell fragments; some quartz coated by silica or calcite; unbedded and massive, grades to:	298.5 to 306.5	-163.5 to - 171.5
Sandstone, quartz sand, medium to coarse, pebbly, poorly sorted, subangular to subround, slightly silty and clayey, yellowish-gray (5Y7/2); contains 5-10% medium to silt round phosphate and scattered shell fragments; calcite-cemented	306.5 to 307.5	-171.5 to -172.5
Sand, quartz-phosphate, quartz fraction fine to medium, subround, phosphate fraction very fine to medium, subround to round, in micrite matrix, slightly silty, medium-gray (N5); interval includes scattered lenses of nearly pure micrite 0.5 to 1.5 inches thick, containing 1-2% phosphate	307.5 to 308.3	-172.5 to -173.3
(No recovery)	308.3 to 309.0	-173.3 to -174.0
Sand, quartz-phosphate, as above	309.0 to 312.8	-174.0 to -177.8
(No recovery)	312.8 to 317.0	-177.8 to -182.0
Sandstone, quartz sand fine to medium, well sorted, mostly subangular, slightly silty, yellowish-gray (5Y7/2); contains 5-10% fine to silt phosphate, larger grains round and polished, smallest grains irregular and rough; calcite cement represents about 30% of rock volume; about 10% void porosity present; unbedded and massive	317.0 to 318.7	-182.0 to -183.7
----------slight unconformity ? ----------		
Coosawhatchie Formation, Tybee Phosphorite Member		
(No recovery, gamma log suggests phosphatic interval)	318.7 to 322.0	-183.7 to -187.0
Sandstone, quartz sand, medium, pebbly, yellowish-gray (5Y7/2); pebbles to 1.0 inch in diameter, about 80% quartz and 20% phosphate; rock cemented by micrite, about 15% of rock volume; unbedded and massive	322.0 to 322.6	-187.0 to -187.6
(No recovery, but gamma and resistivity logs indicate a phosphate-rich indurated zone ends at 325.0 feet; probably base of formational unit)	322.6 to 325.0	-187.6 to -190.0
---------- unconformity ----------		

Marks Head Formation, member #2		
(No recovery, but gamma and resistivity logs indicate this interval is probably similar to the lithology below)	325.0 to 332.0	-190.0 to -197.0
Sand, fine, well sorted, subangular, olive-gray (5Y4/1); contains 2-5% very fine to fine round to angular phosphate; unbedded, massive, and friable	332.0 to 332.2	-197.0 to -197.2
Clay and fine sand, interlaminated on a 0.05 inch scale; clay fractures conchoidally, slightly calcareous; sand quartz, very fine to fine, containing scattered grains of phosphate; brownish-black (5YR2/1)	332.2 to 332.3	-197.2 to -197.3
Sand, fine, well sorted, subangular, olive-gray (5Y4/1); contains 2-5% very fine to fine round to angular phosphate; unbedded, massive, and friable.	332.3 to 332.4	-197.3 to -197.4
Clay and fine sand, interlaminated on 0.05 inch scale; clay has conchoidal fracture, slightly calcareous; sand quartz, very fine to fine with scattered grains of phosphate; brownish-black (5YR2/1)	332.4 to 332.6	-197.4 to -197.6
Sand, fine, well sorted, subangular, slightly calcareous, olive-gray (5Y4/1); contains 2-5% very fine to fine round to angular phosphate; unbedded, loose, and permeable	332.6 to 338.8	-197.6 to -203.8
Sand, quartz, medium, well sorted, subround to well rounded, minor fraction of very fine to fine subangular quartz, silty and clayey, very calcareous, olive-gray (5Y4/1); contains about 5% fine to medium, round to angular phosphate; scattered shell fragments present; denser than sand above; unbedded and massive	338.8 to 343.5	-203.8 to -208.5
Clay, slightly silty, slightly calcareous, olive-black (5Y2/1); paper laminated on a 0.05-0.10 inch scale	343.5 to 343.8	-208.5 to -208.8
Sand, quartz, fine to medium, well sorted, subangular to round, silty, calcareous, medium-dark-gray (N4) to dark-gray (N3); contains about 2% very fine to medium, angular to round and polished phosphate; grains coated by sparry to micritic calcite; loose, friable, and unbedded	343.8 to 350.5	-208.8 to -215.5
Coquina, pebbly, shell hash in quartz-calcite-phosphate sand matrix, olive-gray (5Y4/1); quartz sand fraction mostly medium but ranges up to very coarse, poorly sorted, subround, comprises about 40% of matrix; calcite medium to very coarse, poorly sorted, subround to round, comprises about 40% of matrix; phosphate sand fraction medium to granular, poorly sorted, very polished and round; contains wood chips and large clasts; clasts are very coarse pebbles to cobbles ranging up to at least 0.5 foot in diameter, locally sheared and crushed, and formed of indurated pebbly quartz sandstone, quartz matrix medium and subround, pebbles and granules of phosphate, quartz, and micrite balls range to 0.5 inch in diameter; shell fragments mostly clams, oysters, and occasional sand dollars; chaotic and jumbled	350.5 to 354.0	-215.5 to -219.0
---------- unconformity ----------		

Marks Head Formation, member #1		
Sand, quartz, mostly medium but fine to coarse, poorly sorted, subangular, slightly clayey and silty, carbonaceous, calcareous, olive-gray (5Y4/1); contains 2-5% very fine to very coarse and subangular to well rounded phosphate; grains coated by micrite crystals; very shelly (some preserving iridescence); unbedded and massive	354.0 to 356.0	-219.0 to -221.0
(No recovery)	356.0 to 362.0	-221.0 to -227.0
Sand, quartz, medium, well sorted, subround to round, very calcareous micrite matrix, olive-gray (5Y4/1); contains about 5-10% shell fragments and 1-2% phosphate sand; grains all coated with micrite	362.0 to 362.2	-227.0 to -227.2
(No recovery)	362.2 to 363.5	-227.2 to -228.5
Sand, quartz, mostly medium with minor fine, well sorted, subangular to subround, slightly silty and clayey, calcareous, olive-gray (5Y4/1); contains about 5% granule to silt, round to angular phosphate and about 5% granule to sand shell fragments	363.5 to 365.5	-228.5 to -230.5
(No recovery)	365.5 to 368.0	-230.5 to -233.0
Sand, quartz, fine to medium, well sorted, subangular to subround, slightly silty, slightly calcareous, graphitic, light-olive-gray (5Y6/1) grading to medium-light-gray (N6); contains about 2-5% medium to silt, round to angular phosphate and about 2% shell fragments; unbedded and massive	368.0 to 371.0	-233.0 to -236.0
(No recovery)	371.0 to 372.0	-236.0 to -237.0
Sand, as above	372.0 to 373.0	-237.0 to -238.0
Sand, quartz, mostly medium with minor fine, well sorted, subround, slightly silty and clayey, moderately calcareous, olive-gray (5Y4/1); contains about 1-2% fine to medium, angular to round phosphate and about 5% shell fragments; grains coated with micrite; burrow mottled; grades to:	373.0 to 375.0	-238.0 to -240.0
Sand, quartz-calcite, fine to medium, well sorted, subangular, slightly silty and clayey, medium-dark-gray (N4) except light-olive-gray (5Y6/1) from 382.5 to 383.0; contains 1-2% medium to silt, round to angular phosphate; calcite sand formed from shell fragments; basal 0.8 feet contains large shells, some articulated	375.0 to 383.3	-240.0 to -248.3
Clay, contains sandy partings with shell fragments and Foraminifera, very calcareous, olive-black (5Y2/1); poorly laminated	383.3 to 383.6	-248.5 to -248.6

Sand, quartz-calcite, fine to medium, well sorted, subangular, slightly silty and clayey, dark-greenish-gray (5GY4/1); contains 1-2% medium to silt, round to angular phosphate; calcite sand formed from shell fragments; basal 0.8 feet contains large shells, some articulated	383.6 to 384.0	-248.6 to -249.0
Sandstone, quartz sand, very fine to very coarse, very poorly sorted, pebbly, calcareous, light-olive-gray (5Y6/1); contains about 2% phosphate sand; very fine to fine pebbles range up to 0.3 inches in diameter and consist of quartz, gray feldspar, and phosphate; grains coated with calcite; soft shells present	384.0 to 384.3	-249.0 to -249.3
Sand, quartz, medium to coarse, well sorted, subangular to subround, pebbly, silty, shelly, calcareous, yellowish-gray (5Y8/1); contains about 2% phosphate sand, 20% shell fragments, and 10% micrite matrix; pebbles quartz, very fine, round, up to 0.4 inch in diameter; silt graphitic; some grains coated with calcite	384.3 to 386.0	-249.3 to -251.0
---------- unconformity ----------		
Tiger Leap Formation, member #4		
Sandstone, quartz sand mostly fine but very fine to medium, poorly sorted, subangular to round in coarsest fraction, shelly, olive-gray (5Y4/1); contains about 1-2% very fine to fine phosphate; burrows present, filled with matrix from above	386.0 to 386.4	-251.0 to -251.4
(No recovery)	386.4 to 387.0	-251.4 to -252.0
Sand, quartz, fine to medium, well sorted, subangular to subround, silty and clayey, light-olive-gray (5Y6/1) grading through olive-gray (5Y4/1) to medium-gray (N5); contains 1-2% opaque minerals and 5-10% shell fragments; grains coated with calcite	387.0 to 388.7	-252.0 to -253.7
(No recovery)	388.7 to 392.0	-253.7 to -257.0
Sand, quartz-calcite, medium, well sorted, subangular, slightly silty and micaceous, very calcareous, olive-gray (5Y4/1); contains about 3% medium to granular round phosphate and about 1% other very fine to silt opaque minerals; unbedded and massive	392.0 to 394.5	-257.0 to -259.5
Sandstone, composed of 40% sand and 60% micrite matrix; quartz sand, fine, subangular to well rounded, light-olive-gray (5Y6/1); contains about 1% phosphate sand and scattered mudballs up to 0.05 inch in diameter, unbedded and massive	394.5 to 397.2	-259.5 to -262.2
Sand, quartz, very fine to very coarse and granular, very poorly sorted, angular to subround, slightly silty and micaceous, olive-gray (5Y4/1); contains about 5% very fine to granule, subangular to round phosphate and shell fragments; unbedded and massive	397.2 to 399.0	-262.2 to -264.0

(No recovery)	399.0 to 400.0	-264.0 to -265.0
Sand, quartz, mostly fine but very fine to medium, well sorted, subangular, very calcareous, silty, olive-gray (5Y4/1); contains about 5% fine subround phosphate sand and abundant shell fragments; grains coated with calcite	400.0 to 400.8	-265.0 to -265.8
---------- unconformity ----------		
Tiger Leap Formation, member #3		
Sandstone, quartz sand cemented by calcite, slightly silty and clayey, light-olive-gray (5Y6/1); quartz fine, subangular to subround, very calcareous; contains about 2-3% round and polished phosphate grains, fish teeth, and other opaque minerals, as well as abundant shell fragments; areas around calcite-filled shell molds generally better cemented than other areas; unit burrowed down to 402.0 feet, burrows lined with phosphate and filled with very fine phosphate pebbles up to 0.8 inch in diameter and matrix from above; little apparent porosity down to 403.7 feet and about 15% moldic porosity from there to base of bed	400.8 to 405.0	-265.8 to -270.0
Sand, quartz, mostly very fine to fine but up to medium, poorly sorted, angular to subangular, very clayey and silty, calcareous, pale-yellowish-brown (10YR6/2); contains less than 1% phosphate sand and scattered shell fragments; very porous and massive	405.0 to 407.7	-270.0 to -272.7
Sand, quartz, fine to medium, well sorted, angular to subangular, slightly silty, very clayey, very calcareous, light-olive-gray (5Y6/1); contains about 1% fine to medium subangular to round phosphate grains, about 5% shell fragments, and less than 1% green crystals of unknown composition; grains coated with micrite	407.7 to 409.4	-272.7 to -274.4
(No recovery)	409.4 to 411.0	-274.4 to -276.0
Sandstone, calcite-cemented; quartz sand, medium, well sorted, subangular, light-olive-gray (5Y6/1), shelly; contains 1-2% phosphate sand	411.0 to 411.2	-276.0 to -276.2
(No recovery)	411.2 to 415.5	-276.2 to -280.5
Sand, quartz, mostly medium, well sorted, subangular, very slightly silty and clayey, very calcareous, light-olive-gray (5Y5/2); contains about 3% very fine to medium angular to round phosphate and abraded shell fragments; massive and soft, possibly a karst fill or drilling artifact	415.5 to 417.0	-280.5 to -282.0

Sandstone, calcite-cemented; sand, quartz, mostly fine, well sorted, angular to subangular, silty and clayey, light-olive-gray (5Y6/1), calcareous; contains about 2% very fine to medium, angular to round phosphate and abundant shell fragments; about 5% moldic porosity	417.0 to 417.9	-282.0 to -282.9
Sand, quartz-calcite, fine, well sorted, subangular to subround, slightly silty and clayey, yellowish-gray (5Y7/2) grading down to olive-gray (5Y4/1); contains less than 1% phosphate sand, lignitic graphite, and abundant shell fragments; some clam shells iridescent, some oysters present; calcite sand fraction composed of sparry calcite	417.9 to 419.0	-282.9 to -284.0
Sandstone, shelly, calcite-cemented; about 34% quartz sand, medium, well sorted, subround to well rounded, about 1% phosphate sand, and about 30% shell material; about 30% of rock is void space filled by sparry calcite subsequently coated with micrite; about 5% moldic porosity remaining; light-olive-gray (5Y6/1); unbedded and massive	419.0 to 420.2	-284.0 to -285.2
Sand, quartz, fine to medium, well sorted, angular to subangular, slightly silty and clayey, very calcareous, olive-gray (5Y4/1) grading down to medium-gray (N5) and then back to olive-gray (5Y4/1); contains about 2% very fine to medium round phosphate, about 1% graphite, and about 1% shell fragments; occasional stringers of lignite and clay present; faintly bedded	420.2 to 424.7	-285.2 to -289.7
Sandstone, calcite-cemented, light-olive-gray (5Y6/1); quartz sand fine to medium, well sorted, subround to round; contains about 2% very fine to medium round phosphate and about 1% graphite	424.7 to 425.3	-289.7 to -290.3
Sand, quartz, fine to medium, well sorted, angular, silty and clayey, very calcareous, variably light-olive-gray (5Y6/1), olive-gray (5Y4/1), and medium-gray (N5); contains about 3% very fine to medium subangular to round and polished phosphate and about 10% shell fragments; unbedded and massive	425.3 to 432.1	-290.3 to -297.1
Clay, micro-mottled, very finely micaceous, brownish-black (5YR2/1); laminated on a 0.05 inch scale	432.1 to 432.2	-297.1 to -297.2
Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5); contains about 2% very fine to medium, subround to round phosphate, unbedded and massive	432.2 to 432.6	-297.2 to -297.6
Clay, micro-mottled, very finely micaceous, brownish-black (5YR2/1); thinly laminated	432.6 to 432.7	-297.6 to -297.7
Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5) to brownish-gray (5YR4/1); contains about 2% very fine to medium, subround to round phosphate, unbedded and massive	432.7 to 435.0	-297.7 to -300.0
Clay, micro-mottled, very finely micaceous, brownish-black (5YR2/1); thinly laminated	435.0 to 435.2	-300.0 to -300.2

Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5) to brownish-gray (5YR4/1); contains about 2% very fine to medium, subround to round phosphate, unbedded and massive	435.2 to 436.0	-300.2 to -301.0
(No recovery)	436.0 to 437.0	-301.0 to -302.0
Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5) to brownish-gray (5YR4/1); contains about 2% very fine to medium, subround to well rounded phosphate, unbedded and massive	437.0 to 437.8	-302.0 to -302.8
Clay, micro-mottled, very finely micaceous, brownish-black (5YR2/1); thinly laminated	437.8 to 438.0	-302.8 to -303.0
Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5) to brownish-gray (5YR4/1); contains about 2% very fine to medium, subround to round phosphate, unbedded and massive	438.0 to 439.4	-303.0 to -304.4
Clay, micro-mottled, very finely micaceous, brownish-black (5YR2/1); thinly laminated	439.4 to 439.5	-304.4 to -304.5
Sand, quartz, fine, well sorted, angular, silty and clayey, carbonaceous, medium-gray (N5) to brownish-gray (5YR4/1); contains about 2% very fine to medium, subround to round phosphate, unbedded and massive	439.5 to 439.9	-304.5 to -304.9
Sand, quartz, fine to medium, well sorted, angular to subangular, silty and clayey, medium-dark-gray (N4); contains 1-2% phosphate sand, phosphate granules abundant near base; unbedded	439.9 to 440.5	-304.9 to -305.5
---------- unconformity ----------		
Tiger Leap Formation, member #2		
Sandstone, 60% sand and 40% calcite-cementing matrix, medium-gray (N5); quartz fine to medium, well sorted, subround to round; 1-2% round phosphate sand and about 1% graphite; very burrowed, with burrows filled with phosphate granules and sediment from above	440.5 to 440.7	-305.5 to -305.7
(No recovery)	440.7 to 442.0	-305.7 to -307.0
Sand, quartz, fine to medium, well sorted, mostly angular but some subangular to subround, silty and clayey, very calcareous, variably medium-gray (N5), light-olive-gray (5Y6/1), and olive-gray (5Y4/1); contains about 3% very fine to medium subangular to well rounded and polished phosphate, about 1% graphitic flakes, and about 1% shell fragments; basal foot has about 5% medium to very coarse round and polished phosphate and about 5% shell fragments	442.0 to 447.4	-307.0 to -312.4
---------- unconformity ----------		

Tiger Leap Formation, member #1		
Sandstone, about 40% sand, 30% shell, and 30% micrite cementing-matrix, light-olive-gray (5Y6/1); quartz-calcite sand fine, well sorted, subangular to subround; contains about 2% fine to medium, angular to round and polished phosphate; solid to 5% moldic porosity; shells variably still present or represented by molds; upper 0.5 foot burrowed and filled with matrix from above; 448.1 to 449.0 slightly softer than area above and below; unbedded and massive	447.4 to 451.0	-312.4 to -316.0
(No recovery)	451.0 to 452.0	-316.0 to -317.0
Base of corehole	**452.0 feet**	**-317.0 feet elev.**

Appendix C – Lithologic description of the Fort Pulaski Corehole (SHE-8)

Location: Fort Pulaski North 7.5-minute quadrangle
Latitude: 32° 02' 01"
Longitude: 80° 54' 11"
Surface altitude: 7 feet above sea level
Total Depth: 116.5 feet (-102.5 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
(Top 64.5 feet not cored; description for this interval taken from C. Robbins Drilling Log)		
Satilla Formation		
Sand, quartz, fine to medium, slightly silty and clayey, brown, contains scattered fine pebbles	0.0 to 4.5	7.0 to 2.5
(No recovery)	4.5 to 6.0	2.5 to 1.0
Gravel, fine to coarse, silty and sandy, slightly clayey, gray, calcareous	6.0 to 7.5	1.0 to -0.5
(No recovery)	7.5 to 9.0	-0.5 to -2.0
Gravel, mostly fine but poorly sorted, silty and sandy, gray, calcareous	9.0 to 12.0	-2.0 to -5.0
Sand, quartz, fine, contains scattered clasts of fine to coarse gravel and shell fragments, grayish-brown, calcareous	12.0 to 13.5	-5.0 to -6.5
(Wash)	13.5 to 15.0	-6.5 to -8.0
Gravel, fine to coarse, silty, slightly clayey and sandy, dark-bluish-gray, calcareous	15.0 to 16.5	-8.0 to -9.5
(Wash)	16.5 to 18.0	-9.5 to -11.0
Clay, sparsely fine to medium sandy, gray; "fat clay"	18.0 to 19.5	-11.0 to -12.5
(Wash)	19.5 to 21.0	-12.5 to -14.0
Clay, slightly fine to medium sandy, gray, calcareous; "fat clay", contains small shell fragments	21.0 to 22.5	-14.0 to -15.5
(Wash)	22.5 to 24.0	-15.5 to -17.0
Sand, quartz, fine, silty and slightly clayey, gray, contains small shell fragments, slightly calcareous	24.0 to 25.5	-17.0 to -18.5
(Wash)	25.5 to 27.0	-18.5 to -20.0
Sand, quartz, fine, silty and slightly gravelly, gray, contains small shell fragments, calcareous	27.0 to 28.5	-20.0 to -21.5

(Wash)	28.5 to 30.0	-21.5 to -23.0
Clay, fine to medium sandy, gray, contains small shell fragments, calcareous	30.0 to 31.5	-23.0 to -24.5
(Wash)	31.5 to 33.0	-24.5 to -26.0
Clay, silty and fine sandy, gray, sparse shell fragments, calcareous	33.0 to 34.5	-26.0 to -27.5
(Wash)	34.5 to 36.0	-27.5 to -29.0
Sand, quartz, fine, clayey and silty, gray, shelly, calcareous	36.0 to 37.5	-29.0 to -30.5
(Wash)	37.5 to 39.0	-30.5 to -32.0
Clay, silty and fine sandy, gray, "fat", sparsely shelly, slightly calcareous	39.0 to 40.5	-32.0 to -33.5
(Wash)	40.5 to 42.0	-33.5 to -35.0
Sand, quartz, fine to medium, clayey, gray, sparse shells and a few clay layers, slightly calcareous	42.0 to 43.5	-35.0 to -36.5
(Wash)	43.5 to 45.0	-36.5 to -38.0
Sand, quartz, fine to medium, silty, light-brownish-gray	45.0 to 46.5	-38.0 to -39.5
(Wash)	46.5 to 48.0	-39.5 to -41.0
Sand, quartz, mostly medium, poorly sorted, light-gray	48.0 to 49.5	-41.0 to -42.5
(Wash)	49.5 to 51.0	-42.5 to -44.0
Sand, quartz, mostly medium to coarse, poorly sorted, light-gray, slightly silty and calcareous	51.0 to 52.5	-44.0 to -45.5
(Wash)	52.5 to 54.0	-45.5 to -47.0
Sand, quartz, mostly coarse, poorly sorted, light-gray, slightly silty and calcareous	54.0 to 55.5	-47.0 to -48.5
(Wash)	55.5 to 57.0	-48.5 to -50.0
Sand, quartz, mostly coarse, poorly sorted, light-gray, slightly silty and calcareous	57.0 to 58.5	-50.0 to -51.5
(Wash)	58.5 to 60.0	-51.5 to -53.0
(No recovery)	60.0 to 61.5	-53.0 to -54.5
(Wash)	61.5 to 63.0	-54.5 to -56.0

---------- unconformity ----------

Ebenezer Formation **member #5**		
Sand, quartz, mostly fine but up to medium, subround to subangular, slightly silty, calcareous, olive-gray (5Y3/2), grains coated; about 2% mostly fine, angular to well rounded phosphate sand and sparse grains of phosphate ranging up to granules; less than 1% carbonaceous material; siliceous perforated tubules present	63.0 to 65.9	-56.0 to -58.9
(No recovery)	65.9 to 73.0	-58.9 to -66.0
---- unconformity (depth estimated from gamma log)----		
Coosawhatchie Formation, **Berryville Clay Member (upper part)**		
(No recovery, comparison of gamma log with Tybee Island gamma log indicates Berryville Clay Member (upper part) of the Coosawhatchie Formation is present in this interval)	73.0 to 76.0	-66.0 to -69.0
---- unconformity (depth estimated from gamma log)-----		
Coosawhatchie Formation, **Tybee Phosphorite Member**		
(No recovery)	76.0 to 76.8	-69.0 to -69.8
Sand, phosphate-quartz-calcite, fine to medium, olive- black (5Y2/1), clayey and silty, porous and friable; phosphate fraction mostly fine but ranges to granules, mostly round; quartz fraction mostly fine to medium, subangular to subround; clay and silt fraction mostly calcite; contains less than 1% very fine to silt carbonaceous material; clay and silt content decreases downward; pebbles at base containing phosphate clasts to 0.16 inch and quartz clasts to 0.12 inch, burrows filled with this matrix penetrate unit below	76.8 to 84.3	-69.8 to -77.3
---------- unconformity ----------		
Marks Head Formation, **member #3**		
Sandstone, phosphate-quartz, calcite-cemented, olive-gray; (5Y3/2); phosphate fraction fine to medium, quartz fraction mostly medium; contains less than 1% very fine to silt carbonaceous matter, grades rapidly to:	84.3 to 86.5	-77.3 to -79.5

Sand, quartz-phosphate, slightly silty, friable, olive-black (5Y2/1), calcareous; quartz fraction medium and mostly subangular; phosphate fraction mostly fine, well rounded, and well sorted, but includes scattered grains up to coarse and a teleost fish vertebra; contains less than 1% carbonaceous silt; subround rip-up clasts to 0.4 inch in diameter of lithology below present on basal contact and burrows filled with matrix penetrate unit below	86.5 to 91.2	-79.5 to -84.2
---------- unconformity ----------		
Marks Head Formation, member #2		
Mudstone, dolomitic, light-olive-gray (5Y5/2); contains about 1% very fine to fine, well rounded phosphate and about 5-15% very fine to fine, subangular quartz, and less than 1% carbonaceous silt, grades to:	91.2 to 96.0	- 84.2 to -89.0
Calcisiltite, very fine quartz sandy, grayish-olive (10Y4/2), partially indurated	96.0 to 101.2	-89.0 to -94.2
(No recovery)	101.2 to 103.4	-94.2 to -96.4
Sand, calcite, mostly fine, subangular, grains coated, light-olive-gray (5Y5/2); contains slightly micaceous calcite mud matrix and about 5% very fine to fine, angular to well rounded phosphate; grades rapidly to:	103.4 to 108.8	-96.4 to -101.8
Sand, phosphate-quartz-calcite, medium to coarse, olive-gray (5Y3/2); phosphate fraction medium to coarse, mostly round; quartz and calcite fractions medium to coarse, subangular to subround	108.8 to 109.4	-101.8 to -102.4
---------- unconformity ----------		
Tiger Leap Formation, member #3		
Limestone, moldic, yellowish-gray (5Y8/1), friable; contains less than 1% subround very fine phosphate and about 5% medium subangular quartz; molds mostly of bivalves	109.4 to 110.3	-102.4 to -103.3
(No recovery)	110.3 to 113.4	-103.3 to -106.4
Limestone, moldic, yellowish-gray (5Y8/1), friable; contains less than 1% subround very fine phosphate and medium subangular quartz; molds mostly of bivalves	113.4 to 113.9	-106.4 to -106.9
(No recovery)	113.9 to 116.5	-106.9 to -109.5
Base of corehole	**116.5 feet**	**-109.5 feet elev.**

Appendix D – Lithologic description of the McIntosh County Corehole

Location: Eulonia 7.5-minute quadrangle
Latitude: 31° 36' 58.15"
Longitude: 81° 24' 09.89"
Surface altitude: about 20 feet above sea level
Total Depth: 452.0 feet (- 432.0 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
Satilla Formation		
(No recovery)	0.0 to 20.0	20.0 to 0.0
Sand, quartz, mostly fine, well sorted, subangular, silty and clayey, light-gray (N7); contains about 1% opaque minerals	20.0 to 23.5	0.0 to -3.5
(No recovery)	23.5 to 33.0	-3.5 to -13.0
Sand, quartz, mostly fine, angular to round, silty medium-light-gray (N6); contains 1-2% dark opaque minerals, including some round and polished phosphate sand; 0.16 inch-thick clay lamina present at 34 feet depth	33.0 to 35.5	-13.0 to -15.5
(No recovery)	35.5 to 39.0	-15.5 to -19.0
Sand, quartz, bimodally very fine to fine and coarse to granular, subangular, silty, light-olive-gray (5Y5/2); contains 1-2% polished and subangular phosphate sand	39.0 to 41.0	-19.0 to -21.0
(No recovery)	41.0 to 47.0	-21.0 to -27.0
Sand, quartz, mostly fine, very fine to medium, silty, subangular to subround, light-olive-gray (5Y6/1); contains about 1% opaque minerals and sparse rutilated quartz grains	47.0 to 49.0	-27.0 to -29.0
(No recovery)	49.0 to 51.0	-29.0 to -31.0
Sand, quartz, very fine to very coarse, poorly sorted, angular to round, pebbly, light-olive- gray (5Y5/2); contains less than 1% phosphate sand; contains 1-2 % other opaque minerals; some blue quartz present; contains polished quartz discoids up to 0.8 inch in diameter	51.0 to 51.5	-31.0 to -31.5
---------- unconformity ----------		

Cypresshead Formation?

Sand, quartz, mostly very fine to fine but up to medium, subangular to subround, silty, slightly micaceous, olive-gray (5Y5/1); contains about 2% dark opaque minerals, of which about one-fourth are phosphate; basal few inches grades to very coarse and round	51.5 to 52.0	-31.5 to -32.0

---------- unconformity ----------

Ebenezer Formation, member #5

Sand, quartz, fine, well sorted but sparse grains up to medium, fine fraction angular to subangular, medium fraction subangular to subround, silty and clayey, sparsely micaceous olive-gray (5Y4/1); contains 1-2 % opaque minerals (mostly not phosphate); phosphate fraction round and polished	52.0 to 66.0	-32.0 to -46.0
Sand, quartz, mostly fine, poorly sorted, subangular, pebbly, clayey and silty, olive-gray (5Y4/1); contains about 1-2% opaque minerals (not phosphate); micaceous; some quartz pebbles polished	66.0 to 67.4	-46.0 to -47.4

---------- unconformity ----------

Ebenezer Formation, member #4

Sand, quartz, mostly fine but some to medium, subangular to subround, silty, faintly laminated, dark-greenish-gray (5GY4/1); contains about 5% fine, round phosphate; sparsely micaceous, grades to:	67.4 to 74.0	-47.4 to -54.0
Sand, quartz, mostly fine but some to medium, subangular to subround, silty, faintly laminated, olive-gray, (5Y4/2); contains about 5% fine, round phosphate; sparsely micaceous, grades to:	74.0 to 81.0	-54.0 to -61.0
Sand, quartz, mostly fine but some medium, subangular to subround, silty, faintly laminated, light-olive-gray, (5Y5/2); contains about 5% fine, round phosphate; sparsely micaceous, grades to:	81.0 to 89.0	-61.0 to -69.0
Sand, quartz, mostly fine but some medium, subangular to round, clayey and silty, faintly laminated, olive-gray (5Y4/2 to 5Y4/1); contains about 2% fine, round and polished phosphate; sparsely micaceous; one fish tooth observed, grades to:	89.0 to 103.0	-69.0 to -83.0
Sand, quartz, fine, well sorted, subangular to subround, clayey and silty, faintly laminated, light-olive-gray (5Y5/2 to 5Y5/1); contains about 2% fine, subround to round, polished phosphate; sparsely micaceous; one fish tooth observed	103.0 to 106.0	-83.0 to -86.0

Sand, quartz, very fine to fine, well sorted, subangular, clayey and silty, burrow mottled, olive-gray (5Y3/2) mottled light-olive-gray (5Y5/2); contains about 1% fine round phosphate; sparsely micaceous	106.0 to 112.0	-86.0 to -92.0
Sand, quartz, fine, well sorted, subangular, clayey and silty, massive, olive-gray (5Y3/2); contains about 1% fine round phosphate; sparsely micaceous	112.0 to 116.0	-92.0 to -96.0
Sand, quartz, fine, well sorted, subangular, clayey and silty, olive-gray (5Y3/2) mottled light-olive-gray (5Y5/2) burrow mottled; contains about 1% fine round phosphate; sparsely micaceous; layer of polished discoidal quartz pebbles, up to 0.5 inch in diameter, at 117.5 feet depth	116.0 to 118.0	-96.0 to -98.0
Sand, very fine to very coarse, very poorly sorted, mostly fine, pebbly, olive-gray (5Y4/1); quartz fine fraction angular to subangular, medium to very coarse fraction round; contains less than 1% fine phosphate, round and polished; sparse fish teeth present; pebbles round to subdiscoidal, polished, up to 0.6 inch in diameter	118.0 to 118.5	-98.0 to -98.5
---------- unconformity ----------		
Ebenezer Formation member #3		
Sand, quartz, fine, well sorted, sub-angular to subround, clayey and silty, light-olive-gray (5Y5/2); contains about 1% fine phosphate, some round and polished, some amber but mostly black; sparsely micaceous	118.5 to 125.3	-98.5 to -105.3
Sand, quartz, bimodally fine and coarse, silty, light-olive-gray (5Y6/1); fine quartz fraction subangular, coarse fraction subround to round; contains less than 1% very fine to fine phosphate, polished and round; burrows penetrate bed below	125.3 to 125.7	-105.3 to -105.7
---------- unconformity ----------		
Ebenezer Formation, member #2		
Sand, quartz, very fine to fine, well sorted, subangular, silty grading downward to clayey and silty, olive-gray (5Y4/1); contains about 1% fine phosphate, round and polished	125.7 to 140.0	-105.7 to -120.0
Clay, thinly laminated, sparsely micaceous, dark-greenish-gray (5G4/1); contains less than 1% very fine subround quartz	140.0 to 142.0	-120.0 to -122.0
Sand, quartz, very fine to fine, well sorted, subangular to subround, clayey and silty, micaceous, olive-gray (5Y4/1); contains about 1% fine, round and polished phosphate and 1-2% dark mica	142.0 to 147.0	-122.0 to -127.0

Sand, quartz, fine, well sorted, subangular to subround, clayey and silty, olive-gray (5Y4/2); contains chalky thin aragonitic shells and about 1% fine, round and polished phosphate	147.0 to 148.0	-127.0 to -128.0
Sand, quartz, mostly very fine to fine but some up to medium, well sorted, subangular to subround, clayey and silty, burrow mottled, olive-gray (5Y4/1) with light-olive-gray (5Y6/1) burrows; contains 1-2% fine, round and polished phosphate; sparsely micaceous; one bony fish tooth observed	148.0 to 174.0	-128.0 to -154.0
Clay and very fine sand, planar interbedded on a 0.05 to 0.4 inch scale, olive-black (5Y2/1); clay waxy, dense, tough, micaceous; muscovite flakes form bedding planes	174.0 to 174.8	-154.0 to -154.8
Sand, quartz, medium, well sorted, clean, mostly subround, massive to faintly bedded, light-olive-gray (5Y5/2); contains less than 1% opaque minerals (not phosphate) and about 1% smoky quartz grains; one green amphibole grain observed	174.8 to 179.7	-154.8 to - 159.7
(No recovery)	179.7 to 182.0	-159.7 to - 162.0
Sand, quartz, medium, well sorted, mostly subround, light-olive-gray (5Y5/2); contains less than 1% opaque minerals (possibly amphiboles); a few clay stringers present; quartz pebbles present at base up to 0.35 inch in diameter	182.0 to 186.4	-162.0 to -166.4
---------- unconformity ----------		
Ebenezer Formation, member #1		
Sand, quartz, mostly very fine to fine, well sorted, angular to subangular, clayey and silty, burrow mottled, dark-greenish-gray (5G4/1); contains less than 1% very fine to fine, round and polished phosphate and less than 1% other opaque minerals; sparsely micaceous	186.4 to 190.0	-166.4 to -170.0
(No recovery)	190.0 to 192.0	-170.0 to -172.0
Sand, quartz, mostly very fine to fine, well sorted, angular to subangular, clayey and silty, burrow mottled, dark-greenish-gray (5G4/1); contains less than 1% very fine to fine, round and polished phosphate and less than 1% other opaque minerals; sparsely micaceous	192.0 to 201.7	-172.0 to -181.7
(No recovery)	201.7 to 202.0	-181.7 to -182.0
Sand, quartz, very fine, very well sorted, angular to subangular, clayey and silty, burrow mottled, dark-greenish-gray (5G4/1); contains 1-2% dark opaque minerals (not phosphate); sparsely micaceous; occasional fish spine fragments present	202.0 to 210.0	-182.0 to -190.0
(No recovery)	210.0 to 211.0	-190.0 to -191.0

Sand, quartz, very fine, very well sorted, angular to subround, clayey and silty, burrow mottled, dark-greenish-gray (5G4/1); contains about 1% dark opaque minerals (not phosphate); sparsely micaceous	211.0 to 215.0	-191.0 to -195.0
(No recovery, contact picked from gamma log)	215.0 to 218.0	-195.0 to -198.0
Coosawhatchie Formation, Berryville Clay Member (upper part)		
(No recovery)	218.0 to 219.0	-198.0 to -199.0
Clay, dense, waxy, sparsely micaceous, massive to poorly laminated, dark-greenish-gray (5G4/1); contains about 2% very fine, angular to subangular quartz	219.0 to 223.0	-199.0 to -203.0
(No recovery)	223.0 to 224.0	-203.0 to -204.0
Clay, dense, waxy, sparsely micaceous, massive to poorly laminated, dark-greenish-gray (5G4/1); contains about 2% very fine, angular to subangular quartz	224.0 to 228.0	-204.0 to -208.0
Sand, quartz, very fine, angular to subangular, clayey and silty, massive to faintly burrowed, dark-greenish-gray (5G4/1); contains about 1% dark opaque minerals (not phosphate), calcite sand, and mica flakes	228.0 to 229.0	-208.0 to -209.0
(No recovery)	229.0 to 232.0	-209.0 to -212.0
Silt, very fine quartz sandy, angular to subangular, clayey, massive to faintly burrowed, dark-greenish-gray (5G4/1); contains about 1% dark opaque minerals (not phosphate), calcite sand, and mica flakes	232.0 to 233.5	-212.0 to -213.5
Clay, dense, waxy, poorly laminated to massive, calcareous, dark-greenish-gray (5G4/1); contains about 1% very fine angular quartz	233.5 to 243.0	-213.5 to -223.0
Clay, slightly calcareous (Foraminifera?), sparsely micaceous, poorly laminated, olive-gray (5Y3/2); contains about 1% very fine, angular to subangular quartz	243.0 to 243.5	-223.0 to -223.5
Clay, dense, waxy, poorly laminated to massive, calcareous, dark-greenish-gray (5GY3/2); contains about 1% very fine angular quartz, grades rapidly to:	243.5 to 246.0	-223.5 to -226.0
Clay, silty, slightly calcareous, sparsely micaceous, massive and softer than above, dark-greenish-gray (5GY4/1); contains less than 1% very fine, angular to subangular quartz	246.0 to 252.5	-226.0 to -232.5
Silt, very fine to fine quartz sandy, angular to subround, clayey, slightly calcareous, sparsely micaceous, massive, dark-greenish-gray (5GY45/1); contains less than 1% very fine, round and polished phosphate and sparse rutilated quartz grains	252.5 to 253.5	-232.5 to -233.5

Clay, silty, slightly calcareous, sparsely micaceous, poorly laminated, olive-gray (5Y4/1) grading down to dark-greenish-gray (5GY4/1); contains 2-5% very fine, angular to subangular quartz; at 255.5 is a drop-stone clast of silica-cemented, fine, subround to round quartz sandstone, grades to:	253.5 to 257.0	-233.5 to -237.0
Clay and very fine quartz sand, interlaminated on a 0.05 inch scale, olive-gray (5Y3/2); clay laminae, dense, waxy, massive, slightly calcareous; sand laminae very well sorted, subangular, contain 2-5% very fine to silt phosphate, sparsely micaceous; sparse fish spines present in sand laminae	257.0 to 261.3	-237.0 to -241.3
(No recovery, gamma log indicates a phosphatic lag deposit in this interval)	261.3 to 262.5	-241.3 to -242.5
---------- unconformity ----------		
Coosawhatchie Formation, Berryville Clay Member (lower part)		
Clay, silty, sparsely micaceous, laminated, olive-gray (5Y3/2); contains about 1% black opaque mineral (carbon?) and mica silt	262.5 to 269.6	–242.5 to -249.6
(No recovery)	269.6 to 272.0	-249.6 to -252.0
Clay, silty and sandy, sparsely micaceous, laminated, olive-gray (5Y3/2); contains about 30% very fine to fine quartz and silt, angular to subangular; contains 2-5% very fine to silt phosphate and about 1% finely disseminated opaque minerals (carbon?)	272.0 to 276.9	-252.0 to -256.9
(No recovery)	276.9 to 282.0	-256.9 to -262.0
Clay, silty and sandy, sparsely micaceous, laminated, olive-gray (5Y3/2) grading down to olive-black (5Y2/1); contains about 1-2% very fine to fine, angular quartz and very fine to silt dark opaque minerals	282.0 to 284.5	-262.0 to -264.5
Sandstone, quartz-phosphate, very fine to medium, poorly sorted, dolomite-cemented, light-olive-gray (5Y5/2); quartz fraction about 30% of bulk, subround; phosphate fraction about 20% of bulk, round; dolomite cement about 50% of bulk; well cemented and tight	284.5 to 285.3	-264.5 to -265.3
---------- unconformity ----------		
Coosawhatchie Formation, Tybee Phosphorite Member		
Silt, clayey, dolomitic, weakly cemented, light-olive-gray (5Y5/2); contains about 5% very fine well rounded phosphate and about 2% fine to medium subround quartz, grades to:	285.3 to 287.0	-265.3 to -267.0

Sand, quartz-phosphate, in dolomite matrix, soft, olive-gray (5Y4/1); quartz fraction about 25% of bulk, fine to medium and angular; phosphate fraction about 25% of bulk, mostly fine and subround; dolomite matrix about 50% of bulk, grades to:	287.0 to 288.0	-267.0 to -268.0
Sand, quartz-phosphate, mostly fine, poorly sorted, granular, clayey and silty, olive-black (5Y2/1); quartz fraction about 70% of bulk, angular to round; phosphate fraction about 20% of bulk, subround to round	288.0 to 290.0	-268.0 to -270.0
(No recovery, but gamma log peak indicates there should be a phosphate-rich lag bed in this interval)	290.0 to 292.0	-270.0 to -272.0

---------- unconformity ----------

Marks Head Formation, member #2

Sand, quartz, mostly medium but ranges up to very coarse, poorly sorted, angular to subangular, clayey and silty, olive-gray (5Y3/2) grading through greenish-gray (5GY6/1) to olive-gray (5Y4/1); contains about 2-5% mostly fine, poorly sorted, subround to rounded phosphate	292.0 to 300.0	-272.0 to -280.0
Clay, olive-gray (5Y4/1)	300.0 to 300.1	-280.0 to -280.1
Sand, quartz, very fine to fine, interbedded with clay laminae 0.25 to 0.50 inch thick, olive-gray (5Y4/1)	300.1 to 300.6	-280.1 to -280.6
(No recovery)	300.6 to 307.0	-280.6 to -287.0
Sand, quartz, fine to medium, angular to subangular, clayey, massive, olive-gray (5Y4/1) grading down to dark-greenish-gray (5GY4/1); contains 2-5% fine, round phosphate	307.0 to 311.0	-287.0 to -291.0
Sand, quartz, fine to medium, angular to subangular, clayey, laminated, olive-gray (5Y4/1) grading down to dark-greenish-gray (5GY4/1); contains 2-5% fine, round phosphate	311.0 to 311.6	-291.0 to -291.6
(No recovery)	311.6 to 312.0	-291.6 to -292.0

---------- unconformity ----------

Parachucla Formation

Clay, silty and sandy, slightly calcareous, sparsely micaceous, laminated, olive-gray (5Y4/1); contains abundant very fine to fine, angular quartz and minor very fine to fine, subangular to subround phosphate	312.0 to 316.5	-292.0 to -296.5
(No recovery)	316.5 to 317.0	-296.5 to -297.0

Clay, silty and sandy, slightly calcareous, sparsely micaceous, laminated, olive-gray (5Y4/1); contains abundant very fine to fine, angular quartz and minor very fine to fine, subangular to subround phosphate	317.0 to 319.2	-297.0 to -299.2
(No recovery)	319.2 to 327.0	-299.2 to -307.0
Clay, faintly calcareous, breaks with conchoidal fracture, massive, olive-gray (5Y3/2); contains 1-2% very fine, subangular quartz	327.0 to 330.8	-307.0 to -310.8
(No recovery)	330.8 to 332.0	-310.8 to -312.0
Clay, faintly calcareous, breaks with conchoidal fracture, massive, olive-gray (5Y3/2); contains 1-2% very fine, subangular quartz	332.0 to 334.2	-312.0 to -314.2
(No recovery)	334.2 to 337.0	-314.2 to -317.0
Clay, faintly calcareous, breaks with conchoidal fracture, massive, olive-gray (5Y3/2); contains 1-2% very fine, subangular quartz	337.0 to 340.8	-317.0 to -320.8
(No recovery)	340.8 to 342.0	-320.8 to -322.0
Clay, faintly calcareous, breaks with conchoidal fracture, massive, olive-gray (5Y3/2); contains 1-2% very fine, subangular quartz	342.0 to 342.5	-322.0 to -322.5
Clay, calcareous, olive-gray (5Y3/2) with thin, light-olive-gray (5Y5/2) interlaminae of sand, calcite-quartz; calcite and quartz about 1% each, very fine to fine, angular; also contains about 1% very fine to silt opaque minerals	342.5 to 344.5	-322.5 to -324.5
(No recovery)	344.5 to 347.0	-324.5 to -327.0
Clay, calcareous, olive-gray (5Y3/2) with thin, light-olive-gray (5Y5/2) interlaminae of sand, calcite-quartz; calcite and quartz about 1% each, very fine to fine, angular; also contains about 1% silt to very fine opaque minerals, grades to:	347.0 to 349.0	-327.0 to -329.0
Silt, very fine quartz-phosphate sandy, micaceous, calcareous, grading down to sand, quartz-phosphate, fine to coarse, in dolomitic matrix, light-olive-gray (5Y5/2); contains sub-angular lithic fragments of unit below at base, basal contact has phosphate coating	349.0 to 350.6	-329.0 to -330.6

---------- unconformity ----------

Tiger Leap Formation, member #4?

Sandstone, calcite-quartz, very moldic but with some remaining shell material, light-olive-gray (5Y6/1) grading through yellowish-gray (5Y7/2) to very-light-gray (N8); calcite fraction about 50% of bulk, fine, angular, probably recrystallized from aragonitic shells;

quartz fraction fine to coarse, mostly medium, angular to round, about 40% of bulk; contains about 1-2% fine to coarse, round phosphate; rock contains about 5-10% moldic porosity, not interconnected	350.6 to 354.7	-330.6 to -334.7
(No recovery)	354.7 to 357.0	-334.7 to -337.0
Sandstone, quartz, mostly medium, subangular, calcite-cemented, sparsely micaceous, yellowish-gray (5Y8/1); contains less than 5% fine to coarse, round phosphate; matrix about 60% of bulk; contains molds of aragonitic shells and original calcitic oyster shells	357.0 to 359.3	-337.0 to -339.3
(No recovery)	359.3 to 362.0	-339.3 to -342.0
Sandstone, quartz, mostly medium, subangular, calcite-cemented, sparsely micaceous, yellowish-gray (5Y8/1); contains less than 5% fine to coarse, round phosphate; matrix about 60% of bulk; contains molds of aragonitic shells and original calcitic oyster shells	362.0 to 363.5	-342.0 to -343.5
(No recovery)	363.5 to 364.0	-343.5 to -344.0
Sandstone, quartz, mostly medium, subangular, calcite-cemented, sparsely micaceous, yellowish-gray (5Y8/1); contains less than 5% fine to coarse, round phosphate; matrix about 60% of bulk; contains molds of aragonitic shells and original calcitic oyster shells	364.0 to 365.4	-344.0 to -345.4
(No recovery)	365.4 to 372.0	-345.4 to -352.0
---------- unconformity ? ----------		
Tiger Leap Formation, member #3?		
Sand, quartz, mostly medium, angular, light-olive-gray (5Y5/2); contains 1-2% fine to medium, angular to round phosphate; most grains coated with calcite, but grains not intercemented; contains rare, coarse grain-size clayballs	372.0 to 382.0	-352.0 to -362.0
Sand, quartz, mostly medium to coarse but ranges from very fine to very coarse, angular, light-olive-gray (5Y6/1 to 5Y5/2) grading down to yellowish-gray (5Y7/2); contains about 2% fine to very coarse, round phosphate; sparsely micaceous; most grains coated with calcite, but grains not intercemented; contains shell fragments to 0.3 inch in length	382.0 to 387.7	-362.0 to -367.7
(No recovery)	387.7 to 389.0	-367.0 to -369.0
Sand, quartz, calcite-cemented, medium to coarse, angular to subangular, yellowish-gray (5Y8/1); contains 2-5% fine, angular to subround phosphate; calcite matrix forms about 50% of bulk; about 2% moldic porosity, not interconnected	389.0 to 389.1	-369.0 to -369.1

(No recovery)	389.1 to 392.0	-369.1 to -372.0
Sand, quartz, medium to very coarse, mostly coarse, angular, yellowish-gray (5Y7/2); contains less than 1% medium, subangular to round phosphate; void spaces filled with micritic to fine calcite rhombs that forms about 55% of bulk	392.0 to 394.0	-372.0 to -374.0
(No recovery)	394.0 to 397.0	-374.0 to -377.0
Sand, quartz, medium to very coarse, mostly coarse, angular, light-olive-gray (5Y6/1); contains less than 1% medium, subangular to round phosphate; void spaces filled with micritic to fine calcite rhombs that form about 55% of bulk	397.0 to 397.8	-377.0 to -377.8
(No recovery)	397.8 to 402.0	-377.8 to -382.0
---------- unconformity ? ----------		
Tiger Leap Formation, member #2?		
Micritic limestone, calcite-quartz, yellowish- gray (5Y7/2 to 5Y8/1); calcite sand fraction about 20% of bulk, medium to coarse, subangular to round; quartz sand fraction about 25% of bulk, mostly medium but up to coarse, subangular to subround; contains less than 1% medium to coarse, subangular to round phosphate; cemented by micrite, about 60% of bulk; grades rapidly to:	402.0 to 406.0	-382.0 to -386.0
Sand, quartz, mostly coarse but medium to very coarse, angular to subangular; quartz grains coated with fine calcite rhombs; contains 1-2% medium to very coarse, angular to round phosphate; sparsely micaceous; calcitic matrix forms about 50% of bulk; phosphate granules present at basal contact, burrows extend into unit below	406.0 to 409.5	-386.0 to -389.5
---------- unconformity ----------		
Suwannee Limestone		
Limestone, fine, well cemented, very-light-gray (N8) grading down to yellowish-gray (5Y7/2); contains micro-shell molds and shell fragments up to 0.02 inch in diameter; contains 1-2% fine to coarse, angular to subangular quartz; contains less than 1% very-fine to medium, subround phosphate; a burrow or crevasse filled with quartz-phosphate sand and phosphate granules present at 410.4 to 410.8 feet	409.5 to 415.4	-389.5 to -395.4
(No recovery)	415.4 to 417.0	-395.4 to -397.0

Limestone, fine, well cemented, yellowish-gray (5Y7/2); contains micro-shell molds and shell fragments up to 0.02 inch in diameter; contains 1-2% fine to coarse, angular to subangular quartz; contains less than 1% very-fine to medium, subround phosphate	417.0 to 420.1	-397.5 to -400.1
(No recovery)	420.1 to 422.0	-400.1 to -402.0
Limestone, fine to mostly medium, grains angular to well rounded, soft, wavy laminated, yellowish-gray (5Y8/1); contains about 10% fine to medium, angular to subangular quartz; contains less than 1% fine, round phosphate and other sparse opaque minerals (tourmaline?); micrite matrix about 10% of bulk	422.0 to 425.0	-402.0 to -405.0
(No recovery)	425.0 to 427.0	-405.0 to -407.0
Limestone, mostly fine to medium, angular to well rounded, soft, wavy laminated, yellowish-gray (5Y8/1 grading down to 5Y7/2); contains about 10-15% fine to medium, angular to subangular quartz; contains less than 1% fine, round phosphate and other opaque minerals (tourmaline?); micrite matrix about 10% of bulk	427.0 to 430.4	-407.0 to -410.4
(No recovery)	430.4 to 431.0	-410.4 to -411.0
Limestone, fine to mostly medium, grains angular to well rounded, soft, wavy laminated, yellowish-gray (5Y7/2 grading down to 5Y8/1); contains about 10% fine to medium, angular to subangular quartz; contains less than 1% fine, round phosphate and other opaque minerals (tourmaline?); micrite matrix about 10% of bulk	431.0 to 436.2	-411.0 to -416.2
(No recovery)	436.2 to 439.0	-416.2 to -419.0
Limestone, fine to mostly medium, grains angular to well rounded, soft, wavy laminated, yellowish-gray (5Y8/1); contains about 10% fine to medium, angular to subangular quartz; contains less than 1% fine, round phosphate and other opaque minerals (tourmaline?); micrite matrix about 10% of bulk	439.0 to 441.0	-419.0 to -421.0
Limestone, medium to very coarse, Foraminifera-bryozoan-shell hash, well indurated, yellowish-gray (5Y8/1); contains 1-2% medium, angular quartz; most calcite grains coated with micrite	441.0 to 441.6	-421.0 to -421.6
(No recovery)	441.6 to 447.0	-421.6 to -427.0
Limestone, very fine to very coarse, Foraminifera-bryozoan-shell hash, well indurated, yellowish-gray (5Y8/1 grading down to 5Y7/2); contains 1-2% medium, angular quartz; most calcite grains coated with micrite	447.0 to 450.1	-427.0 to -430.1
(No recovery)	450.1 to 452.0	-430.1 to -432.0
Base of corehole	**452.0 feet**	**-432.0 feet elev.**

Appendix E: Lithologic description of the Richmond Hill Corehole

Location: Richmond Hill 7.5-minute quadrangle
Latitude: 31° 57' 28"
Longitude: 81° 18' 59"
Surface altitude: 10 feet above sea level
Total Depth: 337.0 feet (-327.0 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
Satilla Formation		
(No recovery)	0.0 to 16.5	10.0 to -6.5
Sand, quartz, poorly compacted, slightly silty, pale-yellowish-brown (10YR6/2) to yellowish-gray (5Y8/1) grading by 17.5 feet to dark-greenish-gray (5G4/1); quartz moderately well sorted, mostly fine to some medium, angular to subangular; less than 1% dark minerals including black and amber phosphate and some charcoal; occasional clay interbeds present, 0.5 to 2 inches thick	16.5 to 23.0	-6.5 to -13.0
(No recovery)	23.0 to 25.0	-13.0 to -15.0
Sand, quartz, clayey, micaceous, pebbly, dark-greenish-gray (5G4/1); quartz poorly sorted, very fine to very coarse, angular to subangular; quartz pebbles subround and up to 0.25 inch in diameter; less than 1% dark minerals including round to subround polished fine to medium phosphate	25.0 to 26.5	-15.0 to -16.5
(No recovery)	26.5 to 29.0	-16.5 to -19.0
Sand, quartz, as above	29.0 to 30.5	-19.0 to -20.5
(No recovery)	30.5 to 32.0	-20.5 to -22.0
Sand, quartz, as above	32.0 to 33.0	-22.0 to -23.0
Sand, quartz, clean, dark-greenish-gray (5G4/1); quartz well sorted, subangular to subround; contains about 1% dark minerals, mostly subangular, very fine to fine amber and black phosphate	33.0 to 35.0	-23.0 to -25.0
(No recovery)	35.0 to 37.0	-25.0 to -27.0
Sand, quartz, clayey, micaceous, pebbly, dark-greenish-gray (5G4/1); quartz poorly sorted, very fine to very coarse, angular to subangular; quartz pebbles round and polished and up to 0.6 inch in diameter, one pebble is a single large gray feldspar crystal; less than 1% dark minerals ranging from silt to 0.25 inch granules, mostly amber and black phosphate	37.0 to 38.8	-27.0 to -28.8
(No recovery)	38.8 to 42.0	-28.8 to -32.0

---------- unconformity ----------

Ebenezer Formation,
member #4

Sand, quartz, clayey, micaceous, dark-greenish-gray (5GY4/1); quartz moderately well sorted, very fine to fine, subround to subangular; less than 1% dark minerals, mostly phosphate, round to subround, mostly very fine; mica concentrated along bedding planes	42.0 to 45.9	-32.0 to -35.9
(No recovery)	45.9 to 47.0	-35.9 to -37.0
Sand, quartz, as above except color grades to greenish-gray (5GY6/1) from 48-52 feet and then goes back to dark-greenish-gray (5GY4/1)	47.0 to 55.7	-37.0 to -45.7
(No recovery)	55.7 to 57.0	-45.7 to -47.0
Sand, quartz, as above	57.0 to 59.5	-47.0 to -49.5
Sand, quartz, clayey, micaceous, olive-gray (5Y4/1); quartz mostly fine to medium, subangular (fine) to subround (medium); 2-3% dark minerals, mostly phosphate, very fine to fine, some round and polished	59.5 to 60.0	-49.5 to -50.0
(No recovery)	60.0 to 62.0	-50.0 to -52.0
Sand, quartz, as above	62.0 to 64.7	-52.0 to -54.7
(No recovery)	64.7 to 67.0	-54.7 to -57.0
Sand, quartz, as above	67.0 to 67.5	-57.0 to -57.5

---------- unconformity ----------

Ebenezer Formation,
member #2

Clay, micaceous, silty, quartz sandy, slightly calcareous, olive-gray (5Y4/1); quartz fraction very fine to fine, subangular	67.5 to 68.5	-57.5 to -58.5
(No recovery)	68.5 to 71.0	-58.5 to -61.0
Clay, as above	71.0 to 73.0	-61.0 to -63.0
(No recovery)	73.0 to 75.0	-63.0 to -65.0
Clay, as above	75.0 to 75.3	-65.0 to -65.3
Sand, quartz, well sorted, laminated (0.05 to 0.4 inch layers), clayey, olive-gray (5Y4/1); quartz very fine, subround to round; 1-2% round, very fine to fine phosphate	75.3 to 77.0	-65.3 to -67.0

(No recovery)	77.0 to 80.0	-67.0 to -70.0
Sand, quartz, internally as above, gypsum precipitated on outer core surface	80.0 to 84.0	-70.0 to -74.0
Sand, quartz, well sorted, burrow mottled, clayey, olive-gray (5Y4/1); quartz very fine, subround to round; 1-2% very fine to fine, round phosphate; wood fragment present at 86.7 feet	84.0 to 91.3	-74.0 to -81.3
(No recovery)	91.3 to 102.0	-81.3 to -92.0
Sand, quartz, as above	102.0 to 105.0	-92.0 to -95.0
(No recovery, gamma log indicates slight phosphate enrichment here)	105.0 to 106.0	-95.0 to -96.0
---------- unconformity ----------		
Ebenezer Formation member #1		
(No recovery)	106.0 to 107.0	-96.0 to -97.0
Sand, quartz, very fine, angular to subangular; clayey, faintly calcareous, sparsely micaceous, laminated, dark-greenish-gray (5G4/1); about 1% phosphate, very fine to fine, well rounded; layers 0.1 inch or less, separated by thin clay laminae	107.0 to 114.0	-97.0 to -104.0
(No recovery)	114.0 to 118.0	-104.0 to -108.0
Sand, quartz, as above	118.0 to 131.6	-108.0 to -121.6
Silt, very quartz sandy, clayey, greenish-black (5GY2/1); clay dense, lumpy, waxy, slightly micaceous and calcareous; silt and sand quartz-phosphate; sand very fine to fine, subround; about 5% charcoal silt also present	131.6 to 132.3	-121.6 to -122.3
Silt, very quartz sandy, clayey, slightly micaceous, greenish-black (5GY2/1) grading to olive-black (5Y2/1); silt and sand mostly quartz, sand very fine to fine, subangular to subround, with minor (1-2%) phosphate; sharp basal contact	132.3 to 138.5	-122.3 to -128.5
Sand, quartz, clean, slightly silty and micaceous, olive-gray (5Y4/1); quartz very fine, very well sorted, mostly subround; 1-2% dark minerals, round to angular, mostly phosphate but also includes charcoal; sharp basal contact	138.5 to 139.5	-128.5 to -129.5
---------- unconformity ----------		

Coosawhatchie Formation,
Berryville Clay Member (upper part)

Clay, silty and sandy, slightly micaceous, greenish-black (5GY2/1); silt and sand quartz-phosphate, sand very fine to fine, subround	139.5 to 141.0	-129.5 to -131.0
(No recovery)	141.0 to 142.0	-131.0 to -132.0
Clay, as above but olive-black (5Y2/1), burrows from bed above extend down to 149 feet, grades to	142.0 to 151.0	-132.0 to -141.0
Clay, as above but olive-gray (5Y4/1), grades to	151.0 to 154.0	-141.0 to -144.0
Silt, quartz sandy, clayey, dark-greenish-gray (5GY4/1); sand and silt mostly quartz, sand very fine, subround to subangular; 1-2% very fine charcoal or biotite, grades to	154.0 to 156.0	-144.0 to -146.0
Sand, quartz, clayey and silty, slightly micaceous, olive-gray (5Y4/1) grading down to dark-greenish-gray (5G3/1); quartz very fine, angular to subangular; less than 1% very fine charcoal and phosphate, grades rapidly to	156.0 to 162.0	-146.0 to -152.0
Clay, slightly silty and sandy, sparsely micaceous, poorly laminated, dark-greenish-gray (5G3/1), grades rapidly to:	162.0 to 167.0	-152.0 to -157.0
Clay, slightly silty and sandy, sparsely micaceous, well laminated, greenish-black (5G2/1), grades rapidly to:	167.0 to 168.0	-157.0 to -158.0
Clay, slightly silty and sandy, sparsely micaceous, poorly laminated, olive-black (5Y2/1) grading rapidly to olive-gray (5Y4/1)	168.0 to 173.4	-158.0 to -163.4
Clay, slightly silty and sandy, indurated, olive-gray (5Y4/1)	173.4 to 173.6	-163.4 to -163.6
Silt, sandy and slightly clayey, micaceous, laminated, olive-gray (5Y4/1); quartz very fine, subangular; 1-2% silt to very fine charcoal	173.6 to 174.5	-163.6 to -164.5
(No recovery)	174.5 to 177.0	-164.5 to -167.0
Silt, as above	177.0 to 181.5	-167.0 to -171.5
Sand, quartz, clayey and silty, brownish-black (5YR2/1); sand very poorly sorted, very fine to coarse, coarse fraction subround; contains a few clay balls, sparse mica, and pods of silty, very fine, subangular to subround quartz that includes 1-2% charcoal and a trace of biotite and muscovite; sharp basal contact	181.5 to 183.5	-171.5 to -173.5

---------- unconformity ----------

Coosawhatchie Formation, **Tybee Phosphorite Member**		
Sandstone, dolomite-quartz, greenish-gray (5GY6/1); quartz coarse, subangular to subround; contains about 10% medium phosphate, subround to round; cemented by dolomite into an impervious hard bed	183.5 to 183.7	-173.5 to -173.7
(No recovery)	183.7 to 187.0	-173.7 to -177.0
Sand, quartz, silty and slightly clayey, olive-gray (5Y4/1); quartz very fine to fine, subangular to angular; contains 2-5% very fine to fine round phosphate; slightly micaceous, grades to	187.0 to 193.0	-177.0 to -183.0
Sand, quartz, silty and clayey, olive-black (5Y2/1); quartz fine to medium, fine fraction angular to subangular, medium fraction subround, scattered coarse grains present; contains 2-5% fine, round phosphate	193.0 to 194.2	-183.0 to -184.2
Sand, quartz, and clay interlaminated, olive-black (5Y2/1); quartz very fine to fine, subround to subangular; contains 2-5% very fine, subangular to subround phosphate and a trace of mica	194.2 to 194.5	-184.2 to -184.5
Sand, quartz, silty and clayey, olive-black (5Y2/1); quartz very fine to fine, angular to subangular; contains 2-5% fine, subround phosphate and mica	194.5 to 195.5	-184.5 to -185.5
Clay, finely micaceous, massive to poorly bedded, olive-black (5Y2/1)	195.5 to 196.9	-185.5 to -186.9
(No recovery)	196.9 to 197.0	-186.9 to -187.0
---------- unconformity ----------		
Marks Head Formation, **member #3**		
Dolomicrite, sandy, light-olive-gray (5Y6/1); quartz fine to medium, subround; contains 2-5% fine to medium, subround phosphate; indurated hard bed containing burrows filled with dark-greenish-gray (5GY4/1) sandy and clayey silt	197.0 to 198.1	-187.0 to -188.1
Clay, silty, massive, sticky, dark-greenish-gray (5GY4/1)	198.1 to 198.6	-188.1 to -188.6
(No recovery)	198.6 to 201.5	-188.6 to -191.5
Silt, clayey, very fine sandy, massive, dark-greenish-gray (5GY4/1)	201.5 to 201.7	-191.5 to -191.7
Dolomicrite, sandy, yellowish-gray (5Y8/1)	201.7 to 201.9	-191.7 to -191.9
Clay, silty and micaceous, partially indurated, dark-greenish-gray (5GY4/1)	201.9 to 204.5	-191.9 to -194.5
Dolomicrite, sandy, semi-indurated, greenish-gray (5GY6/1); quartz sand very fine, subangular to subround; contains about 1% charcoal and 1% phosphate silt	204.5 to 205.0	-194.5 to -195.0

Sand, quartz, clayey and silty, olive-gray (5Y4/1); quartz very fine to medium, subangular to subround; contains about 1% very fine phosphate and a trace of charcoal; slightly dolomitic	205.0 to 207.0	-195.0 to -197.0
(No recovery, gamma log suggests stratigraphic break at 212 feet)	207.0 to 212.0	-197.0 to -202.0
---------- unconformity ----------		
Marks Head Formation member #2		
Sand, clayey and silty, upper foot indurated, light-olive-gray (5Y6/1); quartz medium, subangular to subround; contains 2-5% medium to coarse, subround to round and polished phosphate	212.0 to 214.0	-202.0 to -204.0
Sand, slightly silty, slightly dolomitic, olive-gray (5Y4/1); quartz mostly fine to medium, subround to subangular; contains 1-2% fine, round phosphate and scattered bone fragments	214.0 to 214.5	-204.0 to -204.5
(No recovery)	214.5 to 222.0	-204.5 to -212.0
Sand, quartz, clean, loose, olive-gray (5Y4/1) grading through medium-dark-gray (N4) to medium-gray (N5); quartz fine to coarse, subround to subangular, contains 1-2% fine to coarse, subround to round and polished phosphate	222.0 to 228.0	-212.0 to -218.0
---------- unconformity ----------		
Parachucla Formation		
Sand, quartz, silty, and claystone interbedded, light-olive-gray; quartz mostly fine, subangular to round and polished; clay dolomite-cemented; layers 0.2 inch thick or less; contains about 2% rough to round and polished, very fine to fine phosphate; some quartz grains rutilated	228.0 to 230.0	-218.0 to -220.0
(No recovery)	230.0 to 232.0	-220.0 to -222.0
Clay, silty and sandy, indurated, friable, olive-gray (5Y4/1); silt and sand mostly quartz, very fine to fine; contains scattered round phosphate grains and charcoal silt	232.0 to 233.0	-222.0 to -223.0
(No recovery)	233.0 to 237.0	-223.0 to -227.0
Sand, quartz, silty, medium-gray (N5); quartz mostly fine but poorly sorted (silt to medium), subangular to subround; contains about 5% very-fine to medium, subround to round and polished, amber to black phosphate; some quartz grains rutilated	237.0 to 239.5	-227.0 to -229.5
(No recovery)	239.5 to 242.5	-229.5 to -232.5

Sand, quartz, and clay, interlaminated on a 0.05 inch scale, calcareous, micaceous, olive-gray (5Y4/1) grading down to dark-greenish-gray (5GY4/1); quartz very fine to fine, subround to subangular; sandy layers contain 1-2% silt to fine phosphate; sparsely micaceous	242.5 to 248.5	-232.5 to -238.5
Micrite, thinly laminated, olive-gray (5Y4/1); contains about 1% fine, subround quartz and less than 1% mica	248.5 to 249.0	-238.5 to -239.0
(No recovery)	249.0 to 251.0	-239.0 to -241.0
Clay, slightly calcareous and sandy, dark-greenish-gray (5GY4/1); contains less than 1% very fine to fine sand and charcoal	251.0 to 255.0	-241.0 to -245.0
Micrite, indurated, light-greenish-gray (5GY8/1); contains less than 1% round to subround very fine quartz and charcoal	255.0 to 255.5	-245.0 to -245.5
Clay, silty and slightly sandy, olive-gray (5Y4/1); contains about 2% very fine to fine quartz and less than 1% charcoal and phosphate silt	255.5 to 256.0	-245.5 to -246.0
(No recovery)	256.0 to 261.0	-246.0 to -251.0
Clay, as above	261.0 to 262.5	-251.0 to -252.5
(No recovery)	262.5 to 267.0	-252.5 to -257.0
Clay, silty and sandy, olive-gray (5Y4/1); sand fraction about 40%, consisting of about equal amounts of quartz and phosphate; quartz very fine to medium, angular to subangular, poorly sorted; phosphate very fine to fine, subround to round; phosphate granules to 0.15 inch in diameter abundant on basal contact and in burrows into unit below	267.0 to 268.0	-257.0 to -258.0
---------- unconformity ----------		
Tiger Leap Formation member #4		
Sandstone, quartz, dolomite-cemented, light-olive-gray (5Y6/1); quartz fine and angular to subround; contains less than 1% round and polished fine phosphate; dolomite cement micritic; burrowed and burrows filled with matrix from above	268.0 to 268.7	-258.0 to -258.7
Sand, quartz, silty, light-olive-gray (5Y5/1); quartz fine to medium and subround; contains about 5% very fine to fine, round and polished phosphate; micritic dolomite forms non-binding matrix (about 1/3 total volume)	268.7 to 269.3	-258.7 to -259.3
Sand, quartz, clayey and silty, olive-gray (5Y4/1); quartz mostly very fine to medium and angular to subangular; contains 2-5% mostly round and polished, very fine to fine phosphate; silt-clay matrix dolomitic	269.3 to 269.7	-259.3 to -259.7
----------unconformity----------		

Tiger Leap Formation **member #3**		
Sandstone, quartz, dolomite-cemented, light-olive-gray (5Y6/1); quartz very fine to fine and angular; contains 2-5% mostly round and polished phosphate; slightly micaceous; rock strongly cemented but with 5-10% porosity	269.7 to 272.0	-259.7 to -262.0
Sand, quartz, silty, dolomitic, light-olive-gray (5Y5/2); quartz mostly fine to medium but ranges up to coarse, poorly sorted, angular; contains 1-2% phosphate, some round and polished	272.0 to 274.0	-262.0 to -264.0
(No recovery)	274.0 to 282.0	-264.0 to -272.0
Sand, as above	282.0 to 284.0	-272.0 to -274.0
(No recovery)	284.0 to 287.0	-274.0 to -277.0
Sand, as above except color changes to olive-gray (5Y4/1)	287.0 to 289.0	-277.0 to -279.0
(No recovery)	289.0 to 292.0	-279.0 to -282.0
Sand, quartz, silty and clayey, olive-gray (5Y4/1); quartz mostly medium but ranges up to very coarse, poorly sorted; contains 2-5% medium to very coarse round phosphate; abundant very fine dolomite matrix present; porosity about 10%	292.0 to 307.5	-282.0 to -297.5
---------- unconformity ----------		
Tiger Leap Formation **member #2**		
Sand, calcite-quartz, yellowish-gray (5Y7/2); quartz fine to coarse and subround; calcite fine to medium, angular to subangular; contains about 5% round and polished phosphate granules; pelecypod shell impressions abundant, porosity about 25%; grades to	307.5 to 315.0	-297.5 to -305.0
Sand, calcite-quartz, yellowish-gray (5Y8/1); quartz fine to coarse, subangular; calcite fine to medium, angular to subangular; contains about 2% round and polished phosphate granules; pelecypod and gastropod impressions and molds abundant; quartz and phosphate pebbles to 0.2 inch in diameter abundant along basal contact	315.0 to 318.7	-305.0 to -308.7
---------- unconformity ----------		
Suwannee Limestone		
Limestone, moldic, yellowish-gray (5Y7/2); calcite fine, angular to subangular; pelecypod impressions abundant; burrowed from above and burrows filled with matrix and fossils from unit above, including coral impressions; porosity about 5% but not interconnected	318.7 to 321.0	-308.7 to -311.0

Sand, quartz, clayey, calcareous, yellowish-gray (5Y8/1); quartz very fine to coarse and subround; contains abundant micritic calcite matrix, about 2% round and polished, amber and black phosphate grains, and about 1% black and white mica	321.0 to 323.5	-311.0 to -313.5
(No recovery)	323.5 to 324.0	-313.5 to -314.0
Sand, quartz, as above; contains a thin, noncalcareous clay lamina at 325.6 feet depth	324.0 to 328.0	-314.0 to -318.0
(No recovery)	328.0 to 329.0	-318.0 to -319.0
Limestone, moldic, quartz sandy, yellowish-gray (5Y8/1); contains about 10-15% quartz sand, very fine to medium, angular to round, and about 1-2% phosphate sand, very fine to medium, mostly round and polished; molds and casts of pelecypods abundant; noncalcareous clay lamina present at 334 feet depth	329.0 to 335.5	-319.0 to -325.5
(No recovery)	335.5 to 337.0	-325.5 to -327.0
Base of corehole	**337.0 feet**	**-327.0 feet elev.**

Appendix F: Lithologic description of the St. Marys Corehole

Location: St. Marys 7.5-minute quadrangle
Latitude: 30° 44' 06"
Longitude: 81°33' 07"
Surface altitude: about 12 feet above sea level
Total Depth: 492 feet (-480 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
(No recovery, but gamma and resistivity logs suggest major lithic breaks at 74 feet, 127 feet, 154 feet, and 220 feet)	0.0 to 240.0	+12.0 to -228.0
Ebenezer Formation, member #1		
Sand, quartz, fine to coarse, well sorted to poorly sorted, mostly sub-angular but some subround, crumbly and unlithified, light-olive-gray (5Y6/1); includes about 3% dark opaque minerals (mostly not phosphate), coarse phosphate round and polished and a trace of rounded fragmental mollusk-shell sand; sharp basal contact but no basal coarsening	240.0 to 256.0	-228.0 to -244.0
Mudstone, quartz and calcite silt mixed with clay, with laminae of fine quartz sand at about 0.5-inch intervals, planar bedded, dark-greenish-gray (5GY4/1); contains about 3% phosphate silt	256.0 to 261.0	-244.0 to -249.0
Sand, quartz, very fine to medium, subround to subangular, silty, sparsely micaceous, dark-greenish-gray (5GY4/1); contains about 10-15% phosphate sand, more rounded than equivalent quartz fractions, silt fraction calcareous; massive, unbedded, gradational lower contact from 274.0-274.2	261.0 to 274.2	-249.0 to -262.2
Mudstone, quartz and calcite silt interbedded with clay on less than 0.5-inch scale, dark-greenish-gray; clay has conchoidal fracture; fine sand-size vacuities, possibly Foraminifera or diatom molds; clay is "swelling clay"	274.2 to 278.5	-262.2 to -266.5
Sand, quartz, fine to coarse, angular to subangular, very poorly sorted, silty, olive-black (5Y2/1); contains about 1% non-phosphatic opaque minerals; silt fraction slightly calcareous; grades rapidly into bed below	278.5 to 280.8	-266.5 to -268.8
Sand, quartz, very fine to medium, subround to mostly subangular, silty, slightly micaceous, greenish-black (5GY2/1); contains 1-2% very fine to fine phosphate; silt fraction moderately calcareous; mostly massive to poorly laminated and planar bedded, a few intervals have faint wavy laminae 0.25-inch or less in thickness; grades rapidly to:	280.8 to 306.0	-268.8 to -294.0
Silt, gypsiferous, sparsely micaceous and phosphatic, wavy laminated, dark-greenish-gray (5GY4/1); contains molds of Foraminifera, noncalcareous	306.0 to 316.0	-294.0 to -304.0

Silt, calcareous, sandy (fine to coarse subround quartz), olive-black (5Y2/1); contains about 3-5% phosphate silt to sand; wavy laminations on 0.05 inch scale; sharp basal contact	316.0 to 318.5	-304.0 to -306.5
---------- unconformity ----------		
Coosawhatchie Formation, Tybee Phosphorite Member		
Sandstone, grain supported, composed of quartz-phosphate sand, fine to coarse, subangular to subround, calcite cemented, olive-gray (5Y4/1); consists of about 35% quartz sand, 15% phosphate sand, and 50% calcite matrix; snails, clams, and molds thereof are abundant; one large irregular nodule of chert observed; about 10% moldic porosity, very unevenly distributed; resistivity log indicates this layer is 2.5-feet thick, but only one foot recovered	318.5 to 319.5	-306.5 to -307.5
(No recovery, but gamma log suggests an unconformity in this interval)	319.5 to 324.0	-307.5 to -312.0
---------- unconformity ----------		
Marks Head Formation, member #2		
Sand, quartz, very fine to coarse, subround to subangular, poorly sorted, slightly micaceous, slightly silty, dark-greenish-gray (5GY4/1); contains 1-2% round phosphate sand; silt moderately calcareous; clay lamina present at 327.3 feet; massive and unbedded to 332.5 feet and burrow mottled below that, grades rapidly to:	324.0 to 340.5	-312.0 to -328.5
Sand, quartz, very fine to coarse, poorly sorted, angular to subangular slightly silty, olive-black (5Y2/1) grading by 350.0 feet to greenish-black (5GY2/1); contains 1-3% subangular to round phosphate sand; silt fraction slightly calcareous; burrow mottled; grades rapidly to:	340.5 to 356.0	-328.5 to -344.0
Sand, quartz, very fine to coarse, poorly sorted, subangular to subround, moderately silty, olive-gray (5Y4/1); contains 2-3% very fine to granular, round phosphate and silt; silt moderately calcareous; massive and unbedded	356.0 to 361.5	-344.0 to -349.5
Sand, quartz, mostly very fine to coarse, scattered polished granules present, subround to subangular, poorly sorted, slightly silty, olive-black (5Y2/1); contains 2% very fine to granular phosphate, coarse to granular fraction round and polished; contains about 10% chalky clam shells; massive and unbedded	361.5 to 362.0	-349.5 to -350.0
Sand, quartz, very fine and coarse, angular to subround, bimodally sorted, slightly silty, olive-gray (5Y4/1); contains about 2% phosphate sand and silt; silt fraction moderately calcareous; massive and unbedded	362.0 to 364.0	-350.0 to -352.0

Sand, quartz, very fine to coarse, angular to subround, poorly sorted, slightly silty, olive-gray (5Y2/1); contains about 2% phosphate sand and silt and about 2-5% shell material; silt fraction moderately calcareous; burrow mottled	364.0 to 368.0	-352.0 to -356.0
Sand, quartz, mostly fine but very fine to coarse, subround to angular, moderately well sorted, silty, slightly calcareous, olive-black (5Y2/1) to greenish-black (5GY2/1); contains about 2% phosphate and a trace of mica silt; quartz grains silt-coated; white silt clasts 0.05-0.20 inch in diameter present from 384.0 to 386.5; massive and unbedded at top but burrow mottled below 370.0 feet	368.0 to 392.7	-356.0 to -380.7
Sand, quartz, mostly very fine to medium but with subordinate coarse to very coarse fraction, poorly sorted, subangular to angular, very silty and clayey, dark-greenish-gray (5GY4/1); mixed burrow mottled and laminated bedding interval	392.7 to 394.6	-380.7 to -382.6
Silt, mostly very fine to medium quartz sandy but with some coarse to very coarse; quartz fraction poorly sorted, subangular to angular, very clayey, sparsely micaceous, dark-greenish-gray (5GY4/1); contains about 2% very fine to medium round to subangular phosphate; laminated on a 0.05-0.15 inch scale, with more silt-rich laminae alternating rhythmically with clay-rich laminae	394.6 to 400.5	-382.6 to -388.5
Clay, micaceous, silty, about 10% very fine to medium grains consisting of quartz, phosphate, and Foraminifera tests, slightly calcareous, greenish-black (5G2/1); phosphate fraction round, clay cuts in ribbons and has a smooth and shiny surface; well laminated on a 0.05 inch scale	400.5 to 406.5	-388.5 to -394.5
Sand, quartz, mostly very fine to medium but with subordinate coarse to very coarse fraction, poorly sorted, angular to subangular, very silty and clayey, sparsely micaceous, dark-greenish-gray (5GY4/1); contains about 2% very fine to very coarse round to subangular phosphate; laminated on a 0.05-0.15 inch scale, with more silty laminae alternating rhythmically with more clayey laminae	406.5 to 408.5	-394.5 to -396.5
Clay, micaceous, silty, about 20% very fine to fine sand consisting of quartz, phosphate, and Foraminifera tests, slightly calcareous, greenish-black (5G2/1); phosphate fraction round, clay cuts in ribbons and has a smooth shiny surface; well laminated on a 0.05 inch scale	408.5 to 411.5	-396.5 to -399.5
Sand, quartz-phosphate, mostly coarse to very coarse, granules present, angular to subround but mostly subangular, slightly silty, moderately calcareous, olive-black (5Y2/1); contains about 30% mostly fine to medium round to subround phosphate and sparse mollusk shells; sharp basal contact	411.5 to 413.7	-399.5 to -401.7
---------- unconformity ----------		

Marks Head Formation, member #1		
Clay, silty, calcareous, light-olive-gray; clay breaks with conchoidal fracture; prominently burrowed from above down to 414.3 feet, burrows filled with matrix from above	413.7 to 414.7	-401.7 to -402.7
Sand, quartz-phosphate, medium to coarse, granular, subangular to subround, slightly silty, moderately calcareous, olive-black; contains about 20% fine to very coarse round to subround phosphate and less than 1% shell fragments; Foraminifera visible	414.7 to 418.2	-402.7 to -406.2
Sand, quartz, very fine to medium, subangular to subround, silty, very calcareous, greenish-gray (5GY6/1); contains about 3% very fine to medium subangular to round phosphate; silt matrix mostly composed of calcite; poor recovery in this interval	418.2 to 418.8	-406.2 to -406.8
Sandstone, quartz, very fine to medium, carbonate cemented, olive-gray (5Y5/1); contains about 3% phosphate sand; massive and unbedded	418.8 to 420.0	-406.8 to -408.0
Sand, quartz, very fine to medium, angular to subround, very silty, slightly calcareous, dark-greenish-gray (5GY4/1) grading by 429.8 feet to light-olive-gray (5Y5/1); contains about 3% very fine to medium subround to round phosphate and silt; less than 1% shell fragments; massive and unbedded	420.0 to 431.2	-408.0 to -419.2
Limestone, very fine to medium, light-olive-gray (5Y5/1); contains about 1-3% very fine to very coarse round and polished phosphate and 5-30% fine to medium, subangular to subround quartz; about 5% moldic porosity, mostly consisting of clam shell molds; massive and firmly cemented	431.2 to 431.7	-419.2 to -419.7
---------- unconformity ----------		
Parachucla Formation		
Sand, quartz, very fine to mostly fine and medium, subangular to subround, silty, very calcareous, light-olive-gray; contains about 1% very fine to medium subround to round phosphate and about 5% shell fragments; fish tooth (cf. *Scomberomorus*) observed; massive and unbedded	431.7 to 437.0	-419.7 to -425.0
Sand, quartz, very fine to medium, subangular to angular, slightly silty, very calcareous, dark-greenish-gray (5G4/1); quartz grains coated with micrite; contains 2-3% very fine to fine subround phosphate, about 20% shell fragments, and 1% Foraminifera; burrow mottled	437.0 to 441.8	-425.0 to -429.8
Sand, quartz, mostly very fine with subordinate coarse to granular fraction, very poorly sorted, very fine to medium fraction angular to subangular and coarse to granular fraction subround, silty and		

clayey, moderately calcareous, greenish-black (5GY2/1); contains sparse fine subangular to subround phosphate; bedding laminated with laminae about 0.5-inch thick	441.8 to 442.4	-429.8 to -430.4
---------- unconformity ----------		
Tiger Leap Formation, member #4		
Clay, silty, calcareous, greenish-black (5GY2/1) with streaks of yellowish-gray (5Y8/1); burrowed and burrows filled with matrix from above	442.4 to 443.0	-430.4 to -431.0
Sand, quartz, coarse, well sorted, subangular to subround, dark-greenish-gray (5GY4/1); contains about 1% very fine to fine phosphate and about 5% sparry calcite in matrix; resistivity log suggests base of this unit is probably at 448.0 feet	443.0 to 445.0	-431.0 to -433.0
(No recovery, resistivity log suggests lost clay/silt bed from 448.0 to 450.0)	445.0 to 450.0	-433.0 to -438.0
Sand, quartz, coarse, well sorted, subangular to subround, slightly silty, very calcareous, dark-greenish-gray (5GY4/1); contains about 1% very fine to fine phosphate and about 5% Foraminifera and Foraminifera fragments; quartz grains coated with very fine to silt grains of sparry calcite	450.0 to 453.0	-438.0 to -441.0
Sand, quartz, coarse to granular with a subordinate very fine to fine fraction, bimodally sorted, very angular to angular, slightly calcareous, soft, light-olive-gray (5Y5/1); contains 1-2% very fine to fine subround and polished phosphate and 1% shell fragments; massive and unbedded	453.0 to 453.6	-441.0 to -441.6
---------- unconformity ----------		
Tiger Leap Formation, member #3		
Sandstone, quartz, very calcareous, to calcarenite, quartzose, very fine to coarse, poorly sorted, subangular to subround, light-olive-gray (5Y6/1); contains 1-5% very fine to medium round and polished to angular phosphate and a trace of shell fragments; matrix comprises about 40-50% of rock and consists mostly of very fine to fine calcite; smoky quartz more abundant than above; about 1% moldic porosity	453.6 to 462.0	-441.6 to -450.0
Sand, quartz, very fine to medium, moderately well sorted, angular to subround, very silty and clayey, very calcareous, soft, dark-greenish-gray (5GY4/1); contains 1-2% very fine to fine subround phosphate and about 3% calcite sand; burrow mottled; grades rapidly to:	462.0 to 476.0	-450.0 to -464.0
Silt, clayey, very calcareous, olive-gray (5Y4/1); contains about 3% very fine to fine phosphate, burrow mottled	476.0 to 481.0	-464.0 to -469.0

Mudstone, denser than above, moderately calcareous, dark-greenish-gray (5GY4/1); less than 1% phosphate; laminated on a 0.25-inch scale; grades to:	481.0 to 483.0	-469.0 to -471.0
Silt, slightly clayey, very fine to fine quartz-calcite-phosphate sandy, moderately calcareous, dark-greenish-gray (5Y4/1) grading down to olive-gray (5Y3/2); less than 1% phosphate; contains shell fragments; burrow mottled	483.0 to 487.0	-471.0 to -475.0
(No recovery)	487.0 to 492.0	-475.0 to -480.0
Base of corehole	**492.0 feet**	**-480.0 feet elev.**

Appendix G – Lithologic description of the Toombs County Corehole #1

Location: Baxley Northeast 7.5'-quadrangle, NE1/9
Latitude: 31° 59' 52"
Longitude: 82° 16' 27"
Surface altitude: 172 feet above sea level
Total Depth: 472.0 feet (-300.0 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
Pearson terrace unit		
(No recovery)	0.0 to 20.0	172.0 to 152.0
Clay, massive, silty, yellowish-gray (5Y7/2); contains scattered grains of very fine to fine quartz and about 1% dark opaque mineral silt; grades to:	20.0 to 27.0	152.0 to 145.0
Sand, quartz, mostly fine to medium but includes a few lenses of medium to coarse, angular to subangular, yellowish-gray (5Y8/1); contains less than 1% dark opaque minerals, slightly calcareous; grades to:	27.0 to 36.0	145.0 to 136.0
Silt, clayey and sandy, light-greenish-gray (5GY8/1) grading through dusky-yellow (5Y6/4) and yellowish-gray (5Y7/2) back to light-greenish-gray (5GY8/1); contains scattered grains of very fine to fine, subangular quartz and less than 1% dark, opaque mineral silt; calcareous	36.0 to 40.1	136.0 to 131.9
Sand, quartz, very fine to granular but mostly medium, subangular, calcareous, yellowish-gray (5Y7/2); contains less than 1% dark opaque minerals	40.1 to 41.2	131.9 to 130.8
(No recovery)	41.2 to 42.0	130.8 to 130.0
Sand, quartz, very fine to granular but mostly medium, subangular, calcareous, yellowish-gray (5Y7/2) grading rapidly to very-pale-orange (10YR8/2); contains less than 1% dark opaque minerals	42.0 to 45.6	130.0 to 126.4
(No recovery)	45.6 to 47.0	126.4 to 125.0
Sand, quartz, very fine to granular but mostly medium, subangular, calcareous, yellowish-gray (5Y7/2) grading rapidly at 49.0 to grayish-red (10R4/2); contains less than 1% dark opaque minerals	47.0 to 49.3	125.0 to 122.7
Silt, fine to medium subangular quartz sandy, calcareous, dusky-yellow (5Y6/4); sparsely micaceous	49.3 to 50.4	122.7 to 121.6
Sand, very fine to coarse, poorly sorted, angular to subangular, clayey and silty, light-olive-brown (5Y5/6) grading gradually to sand, very fine to very coarse, very poorly sorted, angular to subround, pebbly, silty and clayey, pale-olive (10Y6/2); contains less than 1% fine to medium dark opaque minerals and 1-2% feldspar; pebbles round and up to 0.25 inch in diameter; sharp basal contact	50.4 to 57.5	121.6 to 114.5

---------- unconformity ----------

Ebenezer Formation
member #5

Sand, quartz, very fine to coarse but mostly medium, angular to subround, silty, slightly calcareous, dusky-yellow (5Y6/4) grading downward to yellowish-gray (5Y7/2); contains about 1% dark opaque mineral silt and sparse fine to medium phosphate; calcite occurs as grain coatings	57.5 to 64.5	114.5 to 107.5
Sand, quartz, very fine to fine, angular to subangular, scattered subangular medium grains present, silty, calcareous, laminated, pale-olive (10Y6/2); contains less than 1% silt to fine dark opaque minerals; calcite occurs as grain coatings	64.5 to 65.5	107.5 to 106.5
Sand, quartz, very fine to medium, angular to subangular, scattered subangular medium grains present, silty, calcareous, yellowish-gray (5Y7/2); contains less than 1% dark opaque mineral silt; calcite occurs as abundant grain coatings; grades to:	65.5 to 73.0	106.5 to 99.0
Sand, quartz, fine to medium, subangular to subround, calcareous, pale-olive (10Y6/2); contains less than 1% very fine dark opaque minerals; calcite occurs as abundant grain coatings	73.0 to 77.0	99.0 to 95.0
Sandstone, fine to medium, subangular to subround, clay-cemented, slightly calcareous, iron-stained, fractures conchoidally, moderate-yellowish-brown (10YR5/4) grading downward to light-olive-gray (5Y6/1); contains less than 1% dark opaque minerals	77.0 to 78.0	95.0 to 94.0
Sand, quartz, fine to coarse, angular, feldspathic, calcareous, light-olive-gray (5Y6/1) grading downward to grayish-yellow-green (5GY7/2); contains less than 1% fine dark opaque minerals; calcite occurs as grain coatings	78.0 to 82.4	94.0 to 89.6
Sand, quartz, fine to coarse, better sorted than above, subangular to subround, grains iron-stained, calcareous, moderate-brown (5YR4/4) grading at 82.9 to yellowish-gray (5Y7/2) mottled dark-yellowish-brown (10YR4/2); contains less than 1% fine dark opaque minerals including some phosphate; calcite occurs as grain coatings; grades to:	82.4 to 93.0	89.6 to 79.0
Sand, quartz, mostly fine but up to medium, subangular to subround, grains iron-stained, calcareous, light-olive-gray (5Y6/1) mottled moderate-reddish-brown (10R4/6); contains less than 1% fine dark opaque minerals including some phosphate; calcite occurs as grain coatings	93.0 to 102.2	79.0 to 69.8
(No recovery)	102.2 to 102.8	69.8 to 69.2
Sand, quartz, mostly fine but up to medium, subangular to subround, grains iron-stained, calcareous, grayish-yellowish-green (5GY7/2) grading down to light-olive-gray (5Y6/1); contains less than 1% fine dark opaque minerals including some phosphate; calcite occurs as grain coatings	102.8 to 107.2	69.2 to 64.8

Sand, quartz, very fine to medium, subangular to subround, pebbly, clayey, calcareous, light-olive-gray (5Y6/1); pebbles subround to round, up to 0.3 inch in diameter; contains less than 1% silt to very fine dark opaque minerals	107.2 to 107.7	64.8 to 64.3
---------- unconformity ----------		
Ebenezer Formation, member #4		
Clay interbedded with silt, laminated, calcareous, pale-olive (10Y6/2) mottled moderate-yellowish-brown (10YR5/4) in upper foot; clay brecciated and blocky; contains less than 1% dark opaque mineral silt; contains scattered fine to medium clayballs	107.7 to 114.5	64.3 to 57.5
(No recovery)	114.5 to 121.0	57.5 to 51.0
Clay, silty, laminated, calcareous, pale-olive (10Y6/2); fractures conchoidally	121.0 to 126.0	51.0 to 46.0
Sand, quartz, fine to medium, subangular to subround, calcareous, sparsely micaceous, dusky-yellow (5Y7/2) grading down to yellowish-gray (5Y7/2); contains less than 1% silt to medium dark opaque minerals including phosphate; calcite occurs as grain coatings; grades rapidly to:	126.0 to 129.5	46.0 to 42.5
Sand, quartz, fine to mostly medium, subangular to well rounded, calcareous, grayish-yellowish-green (5GY7/2); contains about 1% very fine to fine phosphate and abundant round clayballs up to 0.8 inch in diameter; calcite occurs as grain coatings; burrows filled with this lithology penetrate into unit below	129.5 to 130.0	42.5 to 42.0
---------- unconformity ----------		
Ebenezer Formation, member #2		
Clay, sparsely micaceous, monotonous, calcareous, yellowish-gray (5Y7/2) grading downward to grayish-yellowish-green (5GY7/2); contains less than 1% silt to very fine dark opaque minerals and scattered very fine to fine quartz grains	130.0 to 132.8	42.0 to 39.2
Sand, quartz, mostly fine, very well sorted, mostly subround, calcareous, yellowish-gray (5Y7/2); contains 1-2% very fine to fine, subangular to subround dark opaque minerals including glauconite; quartz grains not calcite coated; becomes more subangular, more clayey, and less calcareous downward	132.8 to 142.0	39.2 to 30.0
Clay, sparsely micaceous, breaks conchoidally, calcareous, grayish-yellowish-green (5GY7/2); contains less than 1% silt to very fine dark opaque minerals	142.0 to 147.1	30.0 to 24.9

Sand, quartz, fine to medium, subangular to subround, calcareous, yellowish-gray (5Y7/2); contains about 1% very fine to fine, subangular to subround phosphate; some grains calcite coated	147.1 to 149.0	24.9 to 23.0
(No recovery)	149.0 to 150.0	23.0 to 22.0
Sand, quartz, fine to medium, subangular to subround, calcareous, yellowish-gray (5Y7/2); contains about 1% very fine to fine, subangular to subround phosphate; some grains calcite coated	150.0 to 151.1	22.0 to 20.9
(No recovery)	151.1 to 152.0	20.9 to 20.0
Sand, quartz, fine to medium, subangular to subround, clayey and silty, calcareous, pale-olive (10Y6/2) grading through greenish-gray (5GY6/1) from 154.0 to 154.5 to light-olive-gray (5Y6/1); contains 1-3% dark opaque minerals including silt to very fine phosphate and charcoal silt	152.0 to 161.5	20.0 to 10.5
(No recovery)	161.5 to 162.0	10.5 to 10.0
Sand, quartz, fine to medium, subangular to subround, calcareous, light-olive-gray (5Y6/1) grading downward to light-olive-gray (5Y5/2); contains 2-3% fine to medium, round amber phosphate and about 3% charcoal	162.0 to 167.0	10.0 to 5.0
---------- unconformity ----------		
Ebenezer Formation, member #1		
(No recovery)	167.0 to 172.0	5.0 to 0.0
Sand, quartz, fine to mostly medium, subangular to subround, clayey and silty, faintly calcareous, light-brown (5YR5/6) mottled grayish-reddish-purple (5RP5/6); grains iron-coated; contains less than 1% dark opaque minerals, probably charcoal	172.0 to 172.4	0.0 to -0.4
Sand, quartz, fine, subangular to subround, clayey, faintly calcareous, olive-gray (5Y4/1); contains about 1% charcoal and less than 1% amber phosphate	172.4 to 173.3	-0.4 to -1.3
(No recovery)	173.3 to 175.0	-1.3 to -3.0
Clay, silty, slightly calcareous, olive-gray (5Y4/1); fractures conchoidally; contains less than 1% charcoal and fine phosphate and quartz	175.0 to 175.3	-3:0 to -3.3
Chert, olive-black (5Y2/1)	175.3 to 175.4	-3.3 to -3.4
Clay, silty, slightly calcareous, olive-gray (5Y4/1); fractures conchoidally; contains less than 1% charcoal and fine phosphate and quartz	175.4 to 175.8	-3.4 to -3.8

Chert, olive-black (5Y2/1)	175.8 to 176.6	-3.8 to -4.6
Sand, quartz, very fine to coarse but mostly fine, poorly sorted, subangular to subround, clayey and silty, calcareous, light-olive-gray (5Y6/1); contains 1-2% fine to medium phosphate and about 1% silt to fine charcoal	176.6 to 177.5	-4.6 to -5.5
(No recovery)	177.5 to 182.0	-5.5 to -10.0
Chert, clay, and quartz sand interbedded; chert olive-black (5Y2/1); clay light-olive-gray (5Y6/1), contains molds of diatoms; sand fine, angular to subangular, calcareous, light-olive-gray (5Y6/1); sand contains about 1% fine, black and tan round phosphate and charcoal; sand grains coated with calcite rhombs	182.0 to 183.0	-10.0 to -11.0
Sand, quartz, fine to mostly medium, angular to subangular, clayey and silty, calcareous, light-olive-gray (5Y6/1); contains about 5% fine to medium, round to discoidal black and tan phosphate and about 1% very fine charcoal; sand grains coated with calcite rhombs	184.0 to 190.2	-12.0 to -18.2
(No recovery)	190.2 to 192.0	-18.2 to -20.0
Sand, quartz, fine to coarse but mostly fine to medium, subangular to subround, slightly silty, calcareous, light-olive-gray (5Y6/1); contains 1-2% medium, round tan phosphate, 1-2% silt to very fine charcoal, and 3-5% sand-size shell fragments	192.0 to 194.3	-20.0 to -22.3
Chert, olive-black (5Y3/1)	194.3 to 194.5	-22.3 to -22.5
Sand, quartz, fine to coarse but mostly fine to medium, subangular to subround, slightly silty, calcareous, olive-gray (5Y5/1); contains 1-2% medium, round tan phosphate, 1-2% silt to very fine charcoal, and 3-5% sand-size shell fragments	194.5 to 196.2	-22.5 to -24.2
Chert, olive-black (5Y3/1)	196.2 to 196.3	-24.2 to -24.3
Sand, quartz, fine to medium, subangular to subround, silty, slightly calcareous, olive-gray (5Y5/1); contains 3-5% medium, round black and tan phosphate and about 1% silt to very fine charcoal; sand grains coated with calcite rhombs	196.3 to 198.5	-24.3 to -26.5
Sand, quartz, fine to medium, subangular to subround, pebbly, partially indurated, light-olive-gray (5Y6/1); pebbles composed of clay clasts up to 1.0 inch in diameter and phosphate clasts up to 0.2 inch in diameter; contains about 5% very fine to coarse, subangular to round black and tan phosphate, about 1% very fine to fine charcoal chips, and sparse zircon grains; sand grains coated with calcite rhombs; burrows filled with this matrix penetrate unit below	198.5 to 199.0	-26.5 to -27.0

---------- unconformity ----------

Coosawhatchie Formation, **Berryville Clay Member (upper part)**		
Clay, fractures conchoidally, slightly silty, medium-bluish-gray (5B5/1) drying to greenish-gray (5GY6/1) grading downward to grayish-yellowish-green (5GY7/2); contains less than 1% charcoal silt and scattered very fine quartz grains; grades to:	199.0 to 203.7	-27.0 to -31.7
Sand, quartz, very fine, subangular, silty and slightly clayey, grayish-yellowish-green (5GY7/2); contains scattered fine to medium quartz grains and shell fragments; burrows filled with this material extend into unit below	203.7 to 203.9	-31.7 to -31.9
---------- unconformity ----------		
Coosawhatchie Formation, **Meigs Member**		
Clay, silty, indurated, breaks into blocky fragments, brecciated texture, light-olive-gray (5Y6/1) grading down to pale-olive (10Y6/2); contains about 1% silt to very fine charcoal and scattered very fine quartz grains; possibly a paleosol	203.9 to 208.0	-31.9 to -36.0
Sand, quartz, mostly fine, angular to subangular, sparsely micaceous, slightly calcareous, slightly clayey, silty, light-olive-gray (5Y5/2); contains about 1% very fine to fine, round charcoal and phosphate; sand grains coated with clay	208.0 to 210.2	-36.0 to -38.2
(No recovery)	210.2 to 212.0	-38.2 to -40.0
Sand, quartz, mostly fine, angular to subangular, sparsely micaceous, slightly calcareous, slightly clayey, silty, light-olive-gray (5Y5/2); contains about 1% very fine to fine, round charcoal and phosphate; sand grains coated with calcite rhombs; voids present to 217.0 depth filled with grayish-olive-green (5G3/2) clay	212.0 to 218.2	-40.0 to -46.2
Sand, quartz, interbedded with clay laminae; quartz mostly fine, angular to subangular, sparsely micaceous, slightly calcareous, slightly clayey, silty, light-olive-gray (5Y5/2); contains about 1% very fine to fine, round charcoal and phosphate; sand grains coated with calcite rhombs	218.2 to 220.2	-46.2 to -48.2
(No recovery)	220.2 to 223.0	-48.2 to -51.0
Sand, quartz interbedded with clay laminae; quartz mostly very fine to fine, subangular to subround, light-olive-gray (5Y5/2); clay laminae thin, olive-gray (5Y4/1); sand fraction includes about 10% calcite sand; sand and clay both contain less than 1% silt to very fine charcoal	223.0 to 224.2	-51.0 to -52.2

(No recovery)	224.2 to 227.0	-52.2 to -55.0
Chert, olive-gray (5Y4/1)	227.0 to 227.1	-55.0 to -55.1
Siltstone, quartz, laminated, silicified, slightly calcareous, light-olive-gray (5Y5/2); contains less than 1% charcoal silt and abundant impressions of diatoms	227.1 to 228.2	-55.1 to -56.2
(No recovery)	228.2 to 232.0	-56.2 to -60.0
Sand, quartz, mostly fine to medium, well sorted, subangular to subround, silty, calcareous, light-olive-gray (5Y6/1); contains about 1% silt to very fine charcoal and about 1% fine, round to platy phosphate	232.0 to 232.4	-60.0 to -60.4
Sand, quartz, interbedded with clay laminae, olive-gray (5Y4/1); quartz fraction mostly fine to medium, well sorted, subangular to subround, silty, calcareous, light-olive-gray (5Y6/1); contains about 1% silt to very fine charcoal and about 1% fine, round to platy phosphate	232.4 to 232.6	-60.4 to -60.6
Sand, quartz, mostly fine to medium, well sorted, subangular to subround, silty, calcareous, light-olive-gray (5Y6/1); contains about 1% silt to very fine charcoal and about 1% fine, round to platy phosphate	232.6 to 233.5	-60.6 to -61.5
Conglomerate, pebble, mudball, light-olive-gray (5Y5/2); clasts are discoidal to round, colors include very light-gray (N8), olive-gray (5Y4/1), and light-olive-gray (5Y6/1); matrix is quartz, mostly fine to medium; matrix includes less than 1% silt to very fine charcoal; weakly calcite-cemented	233.5 to 236.0	-61.5 to -64.0
Sand, quartz, fine, subangular, calcareous, slightly silty and clayey, light-olive-gray (5Y6/1); contains 1-2% fine, subround phosphate and less than 1% silt to very fine charcoal; sand grains coated with calcite rhombs	236.0 to 239.2	-64.0 to -67.2
(No recovery)	239.2 to 242.0	-67.2 to -70.0
Sand, quartz, fine, subangular, calcareous, slightly silty and clayey, light-olive-gray (5Y6/1); contains 1-2% fine, subround phosphate and less than 1% silt to very fine charcoal; sand grains coated with calcite rhombs	242.0 to 243.0	-70.0 to -71.0
Clay, conchoidal fracture, olive-gray (5Y4/1); contains less than 1% very fine phosphate	243.0 to 243.3	-71.0 to -71.3
Sand, quartz, fine, mostly subangular, calcareous, silty, light-olive-gray (5Y6/1); contains 1-2% very fine to fine, round to well rounded black and tan phosphate and about 1% very fine to fine charcoal; sand grains thinly coated with calcite rhombs; thin stringers of clay interspersed within the sand	243.3 to 247.6	-71.3 to -75.6

Conglomerate, pebble, mudball, light-olive-gray (5Y6/1); mudballs discoidal to spherical, up to 0.8 inch in diameter, varicolored; quartz sand matrix, fine to mostly medium, mostly subangular, silty, calcareous, and 1-2% very fine to medium, subangular to subround phosphate	247.6 to 248.8	-75.6 to -76.8
---------- unconformity ----------		
Coosawhatchie Formation, Tybee Phosphorite Member		
Clay, indurated, calcareous, silty and sandy, porous, laminated, dusky-yellowish-green (5GY5/2); contains scattered fine grains of quartz and phosphate; laminations tilted at about 10^0; grades down to:	248.8 to 250.0	-76.8 to -78.0
Sand, calcite-quartz, very fine to fine, angular, slightly silty and clayey, dusky-yellowish-green (5GY5/2); calcite fraction about 74% of bulk; quartz fraction about 25% of bulk, grains coated by calcite rhombs; contains about 1% silt to very fine charcoal	250.0 to 251.4	-78.0 to -79.4
(No recovery)	251.4 to 252.0	-79.4 to -80.0
Calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, dusky-yellowish-green (5GY5/2); calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains less than 1% round fine phosphate, silt to fine charcoal, and scattered small mudballs	252.0 to 254.0	-80.0 to -82.0
Calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, dusky-yellowish-green (5GY5/2), interlayered with wispy clay laminae; calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains less than 1% round fine phosphate and silt to fine charcoal	254.0 to 254.3	-82.0 to -82.3
Calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, dusky-yellowish-green (5GY5/2); calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains less than 1% round fine phosphate and silt to fine charcoal, and scattered small mudballs	254.3 to 256.2	-82.3 to -84.2
Mudballs, sand-size, in matrix of calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, dusky-yellowish-green (5GY5/2); calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains less than 1% round fine phosphate and silt to fine charcoal	256.2 to 256.3	-84.2 to -84.3
Calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, dusky-yellowish-green (5GY6/1); calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains less than 1% round fine phosphate and silt to fine charcoal, and scattered small mudballs	256.3 to 258.5	-84.3 to -86.5

Calcite-quartz sand, very fine to medium, mostly fine, subangular to subround, slightly silty and clayey, partially indurated, greenish-gray (5GY6/1); calcite fraction about 75% of bulk, quartz fraction about 25% of bulk; contains large, round mudballs; contains less than 1% round fine phosphate and silt to fine charcoal	258.5 to 259.0	-86.5 to -87.0
Clay, silty, calcareous, greenish-gray (5GY6/1); breaks with conchoidal fracture; contains about 1% very fine to fine quartz grains and charcoal	259.0 to 260.0	-87.0 to -88.0
Sand, composed of small round mudballs, greenish-gray (5GY6/1) grading down to pale-olive (10Y6/2)	260.0 to 262.5	-88.0 to -90.5
Conglomerate, pebble, composed of mudballs, in clay matrix, pale-olive (10Y6/2); round micritic mudballs up to 0.4 inch in diameter; silty micrite matrix contains sparse very fine to fine quartz grains and about 1% charcoal	262.5 to 263.6	-90.5 to -91.6
Clay, micrite, massive, dusky-yellow-green (5GY5/2) grading through greenish-gray (5GY6/1) to pale-olive (10Y6/2)	263.6 to 270.0	-91.6 to -98.0
---------- unconformity ----------		
Marks Head Formation, member #3		
Sand, calcite, fine, slightly silty, with interbedded clay laminae, micritic, light-olive-gray (5Y6/1) grading down to light-olive-gray (5Y5/2); contains about 1% very fine to silt charcoal	270.0 to 276.0	-98.0 to -104.0
(No recovery)	276.0 to 279.0	-104.0 to -107.0
Sand, quartz-calcite, fine to mostly medium, mostly subangular but some subround, well sorted, semi-indurated, slightly silty, interbedded with thin micrite clay laminae, light-olive-gray (5Y5/2) grading down to light-olive-gray (5Y6/1); contains about 20% calcite sand and about 1% fine charcoal	279.0 to 281.4	-107.0 to -109.4
(No recovery)	281.4 to 282.0	-109.4 to -110.0
Sand, quartz-calcite, fine to mostly medium, mostly subangular but some subround, well sorted, semi-indurated, slightly silty, interbedded with thin micrite clay laminae, light-olive-gray (5Y5/2) grading down to light-olive-gray (5Y6/1); contains about 20% calcite sand and about 1% fine charcoal	282.0 to 283.1	-110.0 to -111.1
(No recovery)	283.1 to 292.0	-111.1 to -120.0
Sand, mostly fine to medium, angular to subangular, porous, slightly silty, light-olive-gray (5Y5/2); contains about 5% round, fine to medium, tan to black phosphate and 2-3% round sand-size shell fragments	292.0 to 293.7	-120.0 to -121.7

(No recovery)	293.7 to 294.0	-121.7 to -122.0
Sand, mostly fine to medium, angular to subangular, porous, slightly silty, light-olive-gray (5Y5/2); contains about 5% round, fine to medium, tan to black phosphate and 2-3% round sand-size shell fragments	294.0 to 294.8	-122.0 to -122.8
(No recovery)	294.8 to 296.0	-122.8 to -124.0
Sand, calcite, fine, angular to subangular, interbedded with clay laminae and sparse clay beds, olive-gray (5Y4/1); most calcite grains are coated with calcite, most clay laminae and beds noncalcareous	296.0 to 299.2	-124.0 to -127.2
Sand, quartz-calcite, fine to medium, silty, subround, light-olive-gray (5Y5/2); quartz fraction mostly fine and with calcite overgrowths, calcite fraction mostly medium; contains about 1-2% fine phosphate	299.2 to 299.8	-127.2 to -127.8
(No recovery)	299.8 to 303.0	-127.8 to -131.0
Clay, laminated, olive-gray (5Y3/2)	303.0 to 303.3	-131.0 to -131.3
Sand, quartz-calcite, fine to medium, silty, subround, light-olive-gray (5Y3/2) interbedded with olive-gray (5Y4/1); quartz fraction mostly fine and with calcite overgrowths, calcite fraction mostly medium; contains about 1-2% fine phosphate	303.3 to 304.8	-131.3 to -132.8
Clay, laminated, olive-gray (5Y3/2)	304.8 to 305.0	-132.8 to -133.0
Sand, quartz-calcite, fine to medium, silty, subround, olive-gray (5Y4/1) interbedded with light-olive-gray (5Y3/2); quartz fraction mostly fine and with calcite overgrowths, calcite fraction mostly medium; contains about 1-2% fine phosphate	305.0 to 305.8	-133.0 to -133.8
Sand, calcite, fine to medium, subangular, friable, olive-gray (5Y3/2); contains 5-10% quartz sand, about 2% round fine to medium black phosphate, and 1-2% very fine to silt charcoal; lag bed at base includes round lumps of charcoal up to 0.10 inch in diameter, clay balls up to 0.3 inch, and round phosphate granules up to 0.1 inch; burrows into bed below filled with this matrix	305.8 to 306.2	-133.8 to -134.2
---------- unconformity ----------		
Marks Head Formation member #2		
Sand, calcite, fine to mostly medium, micrite coated, light-gray (N7) grading through very-light-gray (N8) to yellowish-gray (5Y8/1); contains about 10% fine to medium subround quartz and 2-3% fine to medium round to well rounded phosphate	306.2 to 311.7	-134.2 to -139.7
(No recovery)	311.7 to 312.0	-139.7 to -140.0

Sand, calcite, mostly fine, grains coated, clayey and silty, porous, yellowish-gray (5Y8/1) grading down to light-olive-gray (5Y6/1); contains 2-3% fine, round quartz, about 1% very fine phosphate, and about 1% charcoal silt	312.0 to 314.0	-140.0 to -142.0
Sand, quartz-calcite, mostly fine to medium, subangular to round, light-olive-gray (5Y5/2) grading down to olive-gray (5Y4/1); contains about 50% quartz sand, 45% calcite sand, 3-5% very fine to very coarse and variably rounded phosphate, 1% very fine to silt charcoal	314.0 to 316.6	-142.0 to -144.6
(No recovery)	316.6 to 318.0	-144.6 to -146.0
Sand, quartz-calcite, mostly fine to medium, subangular to round, olive-gray (5Y4/1) grading down to light-olive-gray (5Y5/2); contains about 50% quartz sand, 45% calcite sand, 3-5% very fine to very coarse variably rounded phosphate, and 1% very fine to silt charcoal	318.0 to 323.0	-146.0 to -151.0
(No recovery)	323.0 to 324.0	-151.0 to -152.0
Sand, quartz, fine to medium, subangular to angular, grains coated with calcite, silty and slightly clayey, light-olive-gray (5Y6/1); contains about 2% very fine to medium, subround to well rounded phosphate, about 2% calcite sand, and less than 1% charcoal silt; scattered grains of phosphate up to 0.1 inch in diameter; indurated beds at 324.0-324.2, 325.0-325.2, and 326.0 to 326.1 feet	324.0 to 331.0	-152.0 to -159.0
(No recovery)	331.0 to 332.0	-159.0 to -160.0
---------- unconformity ----------		
Marks Head Formation, member #1		
Sand, calcite, very fine to fine, indurated, light-olive-gray (5Y6/1); burrowed to a depth of 333.2, burrows filled with sand as above containing phosphate and quartz granules	332.0 to 333.3	-160.0 to -161.3
Sand, calcite, mostly very fine to silt but some to medium, clayey, pale-olive (10Y6/2); contains less than 1% very fine, subround to subangular phosphate, less than 1% charcoal silt, and about 2% very fine to fine, subangular to subround quartz	333.3 to 342.0	-161.3 to -170.0
Sandstone, calcite, light-gray (N7)	342.0 to 342.2	-170.0 to -170.2
Sand, quartz, fine to mostly medium, subangular to subround, well sorted, clayey and silty, porous, olive-gray (5Y4/1); contains about 1% very fine to medium, well rounded to round, tan to black phosphate	342.2 to 344.1	-170.2 to -172.1

(No recovery)	344.1 to 352.0	-172.1 to -180.0
Sand, quartz, fine to mostly medium, subangular to subround, well sorted, clayey and silty, porous, olive-gray (5Y4/1); contains about 1% very fine to medium, well rounded to round, tan to black phosphate	352.0 to 354.4	-180.0 to -182.4
Sand, quartz, fine to mostly medium, subround to subangular, clean, olive-gray (5Y4/1), interbedded with clay, laminated, olive-gray (5Y3/2); sand fraction includes about 5% fine to medium, well rounded to round phosphate, 1-2% shell fragments, and less than 1% fine to silt charcoal, calcareous matrix; clay contains about 1% charcoal silt	354.4 to 356.5	-182.4 to -184.5
Sand, quartz, very fine to coarse but mostly medium, angular to subround, some coated with calcite, slightly micaceous, calcareous, silty, olive-gray (5Y4/1); contains 3-5% very fine to very coarse, subround to angular, brown to mostly black phosphate and less than 1% fine to silt charcoal	356.5 to 357.5	-184.5 to -185.5
---------- unconformity ----------		
Parachucla Formation		
Silt, calcareous, laminated, indurated, light-olive-gray (5Y5/2); contains about 5% very fine to medium, subangular to subround quartz, less than 1% sand and silt phosphate, and less than 1% fine charcoal; burrowed to 358.5 feet; grades to:	357.5 to 361.6	-185.5 to -189.6
Clay, calcareous, slightly silty, waxy, laminated, olive-gray (5Y3/2); contains about 1% very fine quartz and less than 1% charcoal silt	361.6 to 363.6	-189.6 to -191.6
Sand, quartz, very fine to coarse, very poorly sorted, angular to sparsely subangular and subround, olive-gray (5Y4/1); contains about 5% calcite sand, 3% very fine to coarse, angular to subround phosphate, and about 1% very fine to silt charcoal; basal part contains granules and small pebbles of quartz and phosphate	363.6 to 365.7	-191.6 to -193.7
---------- unconformity ----------		
Tiger Leap Formation, member #4		
Calcarenite, medium-light-gray (N6), contains burrows filled with lithology from above	365.7 to 366.3	-193.7 to -194.3
Sand, calcite, very fine to mostly medium, subangular to angular, calcite coated, silty, porous, light-olive-gray (5Y5/2); contains about 10% very fine to medium, subround to subangular quartz, about 2% very fine to medium, round to subround phosphate, and less than 1% charcoal; echinoid spine observed at 367.5 feet	366.3 to 370.0	-194.3 to -198.0
(No recovery)	370.0 to 372.0	-198.0 to -200.0

Sand, calcite, fine to very coarse, very poorly sorted, angular, silty, semi-indurated, light-olive-gray (5Y5/2); contains about 3% fine to medium subround quartz, less than 1% medium, round phosphate, and less than 1% charcoal silt; calcite sand largely composed of shell debris	372.0 to 374.7	-200.0 to -202.7
Calcarenite, impermeable, light-gray (N7)	374.7 to 375.0	-202.7 to -203.0
Sand, calcite, fine to coarse, mostly medium, angular, silty, semi-indurated, light-olive-gray (5Y5/2); contains about 3% fine to medium subround quartz, less than 1% medium, round phosphate, and less than 1% charcoal silt; calcite sand largely composed of shell debris	375.0 to 377.0	-203.0 to -205.0
Calcarenite, impermeable, light-olive-gray (5Y6/1); contains sparse calcitic shells	377.0 to 377.4	-205.0 to -205.4
Calcarenite, about 5% moldic porosity, light-olive-gray (5Y6/1); contains sparse calcitic shells	377.4 to 381.0	-205.4 to -209.0
(No recovery)	381.0 to 389.0	-209.0 to -217.0
Calcarenite, about 5% moldic porosity, light-olive-gray (5Y6/1) grading down to yellowish-gray (5Y7/2); contains sparse calcitic shells	389.0 to 391.0	-217.0 to -219.0
(No recovery)	391.0 to 392.0	-219.0 to -220.0
Calcarenite, about 5% moldic porosity, light-gray (N7)	392.0 to 393.0	-220.0 to -221.0
Calcarenite, impermeable, enclosed shells preserved, dark-gray (N3)	393.0 to 393.4	-221.0 to -221.4
Sand, quartz-calcite, fine to medium, subround to subangular, shelly, olive-gray (5Y4/1); contains 1-2% medium, subround phosphate and about 1% charcoal silt	393.4 to 393.8	-221.4 to -221.8
Calcarenite, 2-5% moldic porosity, light-olive-gray (5Y6/1); base of layer includes granules and small pebbles of quartz and phosphate	393.8 to 395.0	-221.8 to -223.0
---------- unconformity ----------		
Tiger Leap Formation, member #3		
Sand, quartz-calcite, fine to medium, subangular, sparely shelly, olive-gray (5Y4/1); contains about 2% fine to medium, subround to round phosphate and 1- 2% fine charcoal; burrows in top of unit filled with matrix from above	395.0 to 398.0	-223.0 to -226.0
(No recovery)	398.0 to 400.0	-226.0 to -228.0

Sand, quartz, fine to mostly medium, subangular to subround, silty, porous, light-olive-gray (5Y6/1) grading to medium-gray (N5) and medium-light-gray (N6); contains about 2% fine to medium, variably rounded phosphate, 1-2% shell fragments, and less than 1% fine to silt charcoal; silt fraction mostly carbonate; 0.8 inch pebble with weathering or reaction rind sitting on basal contact	400.0 to 407.5	-228.0 to -235.5
---------- unconformity ----------		
Tiger Leap Formation, member #2		
Calcarenite, contains about 5% moldic porosity, light-olive-gray (5Y6/1); contains about 2% fine quartz and phosphate; shells and molds both present; contains burrows full of sand and pebbles	407.5 to 410.0	-235.5 to -238.0
(No recovery)	410.0 to 411.5	-238.0 to -239.5
Calcarenite, contains about 5% moldic porosity, medium-light-gray (5Y6/1); contains about 2% fine quartz and phosphate; shells and molds both present	411.5 to 413.5	-239.5 to -241.5
Sand, quartz, medium, subround, silty, shelly, porous, light-olive-gray (5Y6/1); contains 1-2% medium, round phosphate and less than 1% charcoal silt; about 25% shell fragments; silt fraction mostly calcite	413.5 to 415.0	-241.5 to -243.0
(No recovery)	415.0 to 417.0	-243.0 to -245.0
Calcarenite, impermeable, shelly, olive-gray (5Y4/1)	417.0 to 417.5	-245.0 to -245.5
Sand, calcite, medium, subangular, shelly, porous, brownish-gray (5YR5/1); contains about 10% medium quartz and 5% medium phosphate	417.5 to 418.0	-245.5 to -246.0
Calcarenite, impermeable, sparsely shelly, olive-gray (5Y4/1)	418.0 to 419.5	-246.0 to -247.5
Sand, quartz-calcite, medium, subangular, silty, shelly, porous, brownish-gray (5YR5/1) grading down to olive-gray (5Y4/1); contains about 25% shell fragments, 1% medium phosphate, and less than 1% charcoal silt	419.5 to 422.4	-247.5 to -250.4
(No recovery)	422.4 to 425.0	-250.4 to -253.0
Calcarenite, impermeable, dark-grayish-black (N2)	425.0 to 425.5	-253.0 to -253.5
Sand, quartz-calcite, fine to medium, subangular, silty, brownish-gray (5YR5/1) grading down to olive-gray (5Y4/1); contains about 25% fragmental shell sand, 1-2% fine to medium, sub-round phosphate, and less than 1% charcoal silt; most grains coated by calcite or more rarely iron hydroxide	425.5 to 430.0	-253.5 to -258.0
(No recovery)	430.0 to 431.0	-258.0 to -259.0

Sand, quartz-calcite, fine to medium, subangular, silty, brownish-gray (5YR5/1) grading down to olive-gray (5Y4/1); contains about 25% fragmental shell sand, 1-2% fine to medium, subround phosphate, and less than 1% charcoal silt; most grains coated by calcite or more rarely iron hydroxide	431.0 to 431.5	-259.0 to -259.5
(No recovery)	431.5 to 432.0	-259.5 to -260.0
---------- unconformity ----------		
Tiger Leap Formation, member #1		
Calcarenite, impermeable, shelly, medium-dark-gray (N4); upper part of bed burrowed and burrows filled with lithology above	432.0 to 437.0	-260.0 to -265.0
(No recovery)	437.0 to 442.0	-265.0 to -270.0
Calcarenite, impermeable, shelly, dusky-yellowish-brown (10YR2/2)	442.0 to 442.5	-270.0 to -270.5
Sand, quartz, medium, subround to subangular, silty, brownish-gray (5YR5/1); contains about 5% fragmental shell sand, 2-3% fine to coarse, subround phosphate, and 1% very fine to silt charcoal; remaining silt composed of calcite	442.5 to 445.0	-270.5 to -273.0
(No recovery)	445.0 to 447.0	-273.0 to -275.0
---------- unconformity ----------		
Suwannee Limestone		
Calcarenite, impermeable, shelly, dusky-yellowish-brown (10YR2/2); burrowed and burrows filled with matrix from above	447.0 to 448.0	-275.0 to -276.0
(No recovery)	448.0 to 449.0	-276.0 to -277.0
Calcarenite, impermeable, shelly, dusky-yellowish-brown (10YR2/2)	449.0 to 449.2	-277.0 to -277.2
Sand, quartz-calcite, medium, angular to subangular, silty, dusky-yellowish-brown (10YR2/2); contains about 20% fragmental shell sand and 5% medium, angular to subangular phosphate; silt fraction composed of calcite	449.2 to 449.4	-277.2 to -277.4
Calcarenite, impermeable, shelly, dusky-yellowish-brown (10YR2/2)	449.4 to 451.4	-277.4 to -279.4
(No recovery)	451.4 to 452.0	-279.4 to -280.0
Calcarenite, impermeable, shelly, dusky-yellowish-brown (10YR2/2)	452.0 to 453.0	-280.0 to -281.0
Calcarenite, contains about 5% moldic porosity, shelly, light-olive-gray (5Y5/2) to yellowish-gray (5Y7/2)	453.0 to 458.0	-281.0 to -286.0
(No recovery)	458.0 to 464.0	-286.0 to -292.0

Calcarenite, impermeable, shelly, light-olive-gray (5Y5/2) to yellowish-gray (5Y7/2)	464.0 to 465.0	-292.0 to -293.0
(No recovery)	465.0 to 472.0	-293.0 to -300.0
Base of corehole	**472.0 feet**	**-300.0 feet elev.**

Appendix H – Lithologic description of the Tybee Island Corehole (SHE-7 and 7a)

Location: Tybee Island North 7.5-minute quadrangle
Latitude: 32° 01' 28"
Longitude: 80° 51' 10"
Surface altitude: 12 feet above sea level
Total Depth: 133.3 feet (-121.3 feet elev.)

Lithologic description	Depth below Land surface, in feet	Altitude Interval, in feet
(Top 61.5 feet described but not cored; description for this interval taken from C. Robbins Drilling Log)		
Fill material	0.0 to 11.0	+12.0 to 1.0
Satilla Formation		
Sand, quartz, poorly sorted, slightly silty, light-brown	11.0 to 15.5	1.0 to -3.5
Sand, quartz, poorly sorted, slightly silty, sparse snail shell fragments present, slightly calcareous, gray	15.5 to 19.5	3.5 to -7.5
Sand, quartz, fine, silty, sparse snail shell fragments present, slightly calcareous, gray	19.5 to 22.5	-7.5 to -10.5
Sand, quartz, poorly sorted, slightly silty, shell fragments present, slightly calcareous, gray	22.5 to 24.0	-10.5 to -12.0
Sand, quartz, fine, silty, sparse shell and wood fragments, slightly calcareous, gray	24.0 to 27.0	-12.0 to -15.0
Sand, quartz, fine, clayey, contains sparse shell fragments, slightly calcareous, gray	27.0 to 31.5	-15.0 to -19.5
Sand, quartz, fine, silty, contains sparse shell fragments, slightly calcareous, gray	31.5 to 33.0	-19.5 to -21.0
Sand, quartz, fine to medium, clayey, contains sparse shell fragments and wood, slightly calcareous, gray	33.0 to 34.5	-21.0 to -22.5
Sand, quartz, fine to medium, silty, contains sparse shell fragments, slightly calcareous, gray	34.5 to 37.5	-22.5 to -25.5
Sand, quartz, fine to medium, clayey, contains sparse shell fragments, slightly calcareous, gray	37.5 to 39.0	-25.5 to -27.0
Clay, silty, fine to medium quartz sandy, contains sparse shell fragments, slightly calcareous, gray	39.0 to 49.5	-27.0 to -37.5

Sand, quartz, fine to medium-gray, contains sparse shell fragments, slightly calcareous, gray	49.5 to 54.0	-37.5 to -42.0
Clay, silty, fine to medium quartz sandy, contains shell fragments, slightly calcareous, gray	54.0 to 55.5	-42.0 to -43.5
Sand, quartz, fine to medium, silty, contains abundant shell fragments, slightly calcareous matrix, gray	55.5 to 57.0	-43.5 to -45.0
---------- unconformity ----------		
Ebenezer Formation, member #5		
Sand, quartz, fine, clayey, contains abundant shell fragments, calcareous, gray and olive-gray	57.0 to 61.5	-45.0 to -49.5
(Begin interval of core recovery)		
Sand, phosphate-calcite-quartz, mostly fine but very fine to medium, angular to subangular quartz and calcite fractions, subangular to round phosphate fraction, very silty, grains coated with calcite; contains shell fragments, Foraminifera, siliceous perforated tubules, scattered round phosphate pebbles to 0.2 inch in diameter and a trace of very fine to silt carbonaceous material, very calcareous, dark-olive-gray (5Y3/1); friable, porous, texture massive and probably bioturbated	61.5 to 61.8	-49.5 to -49.8
(No recovery)	61.8 to 68.7	-49.8 to -56.7
Sand, quartz-calcite-phosphate, fine and well sorted but ranges from very fine to coarse; quartz fraction (about 50-70%) mostly subangular with calcite-coated grains; black and tan phosphate fraction (about 4-12 %) angular to round, as well as worn shark teeth and fish bones; calcite fraction (about 12-30 %) composed mostly of fine shell fragments, very calcareous, trace of carbonaceous silt, shelly below 78 foot depth (including *Amusium mortoni*), dark-olive-gray (5Y3/1), grades rapidly to:	68.7 to 79.8	-56.7 to -67.8
Sand, quartz, mostly fine but ranges up to coarse, smaller grains subangular, larger grains subround, very silty, olive-black (5Y2/1); phosphate fraction (5 %) fine (angular) to medium (round), black to tan; contains sparse (<1 %) shell fragments and a teleost fish vertebra; coarse quartz and phosphate at base and round phosphate pebbles to 0.2 inch in diameter	79.8 to 80.5	-67.8 to -68.5
---------- unconformity ----------		

Coosawhatchie Formation,
Berryville Clay (upper part)

Calcisiltite, porous, contains fine to medium round black and tan phosphate and scattered shell fragments, olive-gray (5Y4/1); unit prominently burrowed with burrows filled with matrix from unit above, grades to:	80.5 to 81.1	-68.5 to -69.1
Sand, quartz-phosphate, very fine to fine, sparse medium, angular, silty, olive-gray (5Y4/1); phosphate fraction (about 20%) ranges from very fine to granular, mostly round, mostly black to some tan; contains very sparse shell fragments and abundant calcite rhombs in fine fraction; base of bed contains quartz and phosphate granules to 0.25 inch in diameter, subround to round	81.1 to 82.8	-69.1 to -70.8

---------- unconformity ----------

Coosawhatchie Formation,
Tybee Phosphorite Member

Calcisiltite, quartz-phosphate sandy, porous, laminated, olive-gray (5Y4/1); quartz and phosphate very fine to medium; contains minor shell fragments and carbonaceous silt, grades to:	82.8 to 84.6	-70.8 to -72.6
Sand, phosphate-quartz, phosphate fraction fine and round to well rounded, quartz fraction fine to medium and angular to subangular, grains coated with calcite, silty, olive-gray (5Y4/1) grading downward to olive-black (5Y2/1); bulk composition about 80% phosphate sand, 10% quartz sand, and 10% calcite grain-coatings; scattered subround quartz and rock fragments to 0.8 inch in diameter present on basal contact	84.6 to 90.6	-72.6 to -78.6

---------- unconformity ----------

Marks Head Formation,
member #3

Dolosiltite, quartz-phosphate sandy, light-olive-gray (5Y5/2), indurated, contains molds of mollusk shells; quartz sand very fine to medium, well rounded to subround; phosphate very fine to medium, well rounded; burrows from above are filled with fine to very coarse granular quartz, round and well polished, granules of phosphate containing quartz grains, and worn shark teeth, grades to:	90.6 to 91.6	-78.6 to -79.6
Sand, quartz-phosphate, mostly medium but up to very coarse, quartz angular to subround, phosphate subangular to round, sparsely granular, slightly silty, grayish-black (N2); contains 1-2% shell fragments and clumps of grains cemented together by calcite; basal two inches contains round granules of quartz and phosphate and rounded rip-up clasts of bed below	91.6 to 93.0	-79.6 to -81.0

---------- unconformity ----------

Marks Head Formation,
member #2

Sandstone, quartz, fine, well rounded, well sorted, in abundant dolomite matrix, light-olive-gray (5Y6/1); contains 5-10% phosphate sand and sparse mollusk shell molds; grades to:	93.0 to 96.1	-81.0 to -84.1
Sand, quartz-calcite, very fine to fine, angular to subround, well sorted, with abundant calcite silt and clay matrix, and silt, very fine to fine sandy, interbedded; micaceous, grayish-olive (10Y4/2); moderately indurated but porous, contains sparse shell molds, about 2% fine to medium subangular to very round phosphate, and less than 1% very fine to silt carbonaceous matter; grades rapidly to:	96.1 to 103.0	-84.1 to -91.0
Sandstone, dolomite-quartz, fine to medium, subangular to subround, clayey and silty, light-olive-gray (5Y5/2); contains 1-2% fine subangular to round phosphate and less than 1% very fine to silt carbonaceous matter and mica	103.0 to 103.5	-91.0 to -91.5
Clayey silt and silty sand, interlaminated, olive-gray (5Y3/2), clay shrinks on drying	103.5 to 105.2	-91.5 to -93.2
Silt, calcite-quartz, very fine quartz sandy, clayey, angular to subangular, olive-gray (5Y3/2); contains about 1% very fine to fine subround to round phosphate, about 1% very fine to silt carbonaceous matter, and mica that is sparse at top and more abundant downward, grades to:	105.2 to 110.5	-93.5 to -98.5
Silt, quartz-calcite, very fine to fine, quartz sandy, angular to subround, clayey and silty (mostly calcite), olive-gray (5Y4/2) to light-olive-gray (5Y5/2); well indurated, porous and lightweight; contains less than 1% phosphate sand, mica, and a small teleost fish tooth; grades to:	110.5 to 119.0	-98.5 to -107.0
Sand, phosphate-calcite-quartz, fine to coarse, clayey and silty, partially indurated, olive-gray (5Y3/2); phosphate fine to coarse and subround to round, quartz and calcite fine to medium and subangular; contains less than 1% very fine to silt carbonaceous matter and sparse mica; grades to:	119.0 to 125.5	-107.0 to -113.5
Sand, phosphate-quartz-calcite, fine to medium, subangular to subround, silty and very clayey, partially indurated, olive-gray (5Y4/1); silt and clay mostly calcite; contains fine subround to well rounded phosphate and bivalve shell fragments; basal six inches contains phosphate pebbles to 0.33 inch in diameter	125.5 to 126.4	-113.5 to -114.4

---------- unconformity ----------

Tiger Leap Formation,
member #3

Limestone, moldic, yellowish-gray (5Y8/1); contains about 20-40% medium subangular to subround quartz, 1-2% medium round phosphate, and less than 1% very fine to silt carbonaceous matter; rock has about 20% moldic porosity at top which decreases to about 5% moldic porosity by base of core, porosity results from dissolved mollusk shells; top of unit is a phosphate-coated, bored hard-ground	126.4 to 133.3	-114.4 to -121.3
Base of corehole	**133.3 feet**	**-121.3 feet elev.**

Appendix I -- Supplemental Observations on the Cumberland Island Corehole

A detailed log of the Cumberland Island corehole #1 is presented in Clarke and others (1990), p. 65-68. To this description the following observations may be added:

Depth	Observations
0-12	Clean dune sand
12-30	Sand, clayey and silty
30-90	Sand, shelly, coarse at base with fish tooth fragments present
90-96	Clayey dolomite, like from 96-100
130-132	Clayey sand
at 132	Unconformable contact, coarse sand lying on fine dolomite that contains burrows filled with coarse sand
135-137	Listed as missing, but is present
159-163	Listed as missing, but is present.
at 161	Unconformable contact, abrupt change to unit below
161-163	Calcareous hardground
at 206	Unconformable contact
at 289	Unconformable contact
at 360	Unconformable contact, picked from gamma log
at 374	Unconformable contact
at 410	Unconformable contact (top of recovered interval burrowed)
435-440	Not present in coreboxes, listed as present in log
at 440	Unconformable contact
at 486	Unconformable contact, phosphate pebbles present and burrows penetrate underlying unit
489-510	Interval listed as "no recovery" but partly present in core boxes
at 501	Unconformable contact, medium to coarse pebbly sand on bored dolomite, borings filled with sand

Appendix J – Grain-size distributions of selected samples

Effingham County Corehole

Sample Number	All mineral components vf	f	m	c	vc	gr	Silt & Clay
Raysor Formation?							
Eff-42.5'	4	t	t	t	0	0	96
Ebenezer Formation, member #4							
Eff-72.5'	15	49	t	t	t	0	36
Ebenezer Formation, member #2							
Eff-112.5'	34	3	1	2	1	t	59
Ebenezer Formation, member #1							
Eff-122.5'	29	3	1	5	1	1	60
Coosawhatchie Formation, Berryville Clay Member (upper part)							
Eff-128.0'	8	1	t	t	t	t	90
Eff-129.8'	2	1	t	t	t	0	96
Eff-140.0'	1	1	t	t	0	0	98
Eff-159.0'	14	t	t	t	t	0	86
Marks Head Formation, member #2							
Eff-185.0'	1	34	41	8	1	0	15
Eff-195.0'	4	21	57	13	t	0	5
Eff-208.0'	6	13	39	34	t	0	8
Parachucla Formation							
Eff-233.5'	26	9	3	2	t	0	60
Eff-255.0'	3	t	t	t	t	t	97
Suwannee Limestone							
Eff-268.0'	13	36	6	1	t	t	44

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. The resulting weight distributions were used to create this table. No acid treatment was attempted for the samples from this corehole.

Fort Pulaski Corehole (SHE-8)

Sample Number	Carbonate vf	f	m	c	vc	gr	Phosphate vf	f	m	c	vc	gr	Other (mostly quartz) vf	f	m	c	vc	gr	Silt & Clay	Silt, Clay, & Carbonate*
Tybee Phosphorite																				
SHE-8-82'	0	2	5	1	t	t	13	24	10	4	2	2	7	8	8	3	1	t	10	
Marks Head Formation member #2																				
SHE-8-92'	1	t	t	t	0	0	0	t	0	0	0	0	6	6	1	t	t	0	84	
SHE-8-96'	3	0	0	0	0	0	2	t	0	0	0	0	21	7	t	t	t	0	67	
Tiger Leap Formation member #3																				
SHE-8-109'	(Calcite cemented)*						0	t	t	0	0	0	t	1	4	1	t	0		94

* Carbonate-cemented samples could not be disaggregated to separately determine the grain-size distribution of the carbonate sand fraction or to distinguish the carbonate sand fraction from the clay/silt fraction. "t" means less than 0.5% of total, other values rounded to nearest whole percent.

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. For carbonate-indurated samples, this step was skipped. All samples were recombined and treated in dilute (20%) hydrochloric acid until all reaction ceased (usually two days or less). When reaction ceased, samples were then sieved, dried, and weighed again. When reaction ceased, the samples again were sieved, dried, and weighed to determine the acid-insoluble fraction of the sample. The resulting weight distributions were used to create this table.

McIntosh County Corehole

Sample Number	Carbonate / Phosphate vf	f	m	c	vc	gr	Other (mostly quartz) vf	f	m	c	vc	gr	Silt &* Clay
Cypresshead Formation?													
McI - 52'	0	2	1	t	t	0	15	52	4	13	4	1	8
Ebenezer Formation member #5													
McI - 57'	0	0	0	0	0	0	27	62	1	1	t	t	9
Ebenezer Formation, member #4													
McI - 78'	t	2	t	t	0	0	5	83	1	t	t	t	9
McI -108'	3	2	t	t	t	0	55	19	1	1	t	t	19
Ebenezer Formation, member #3													
McI -121'	0	3	1	0	0	0	18	70	2	t	t	t	5
Ebenezer Formation, member #2													
McI -135'	0	1	1	t	0	0	33	27	13	2	1	t	22
McI -153'	1	0	t	0	0	0	39	45	1	t	t	t	14
McI -183'	0	2	8	0	0	0	1	5	75	5	t	t	4
Ebenezer Formation, member #1													
McI -205'	3	t	0	0	0	0	50	2	t	t	t	0	45
Coosawhatchie Formation, Berryville Clay Member (upper part)													
McI -233'	4	0	0	0	0	0	26	1	t	0	0	0	69
McI -253'	t	2	0	t	0	0	3	17	17	t	0	0	60
McI -258'	1	t	0	0	0	t	3	1	1	t	t	2	91
Coosawhatchie Formation, Berryville Clay Member (lower part)													
McI -282'	1	t	t	t	t	0	4	1	1	t	t	0	92
Coosawhatchie Formation, Tybee Phosphorite Member													
McI -286'	4	3	3	1	t	t	2	9	8	3	1	t	66
Marks Head Formation, member #2													
McI -296'	t	t	4	1	t	t	2	5	39	31	6	1	12
Parachucla Formation													
McI -333'	t	t	t	0	0	0	1	t	t	0	0	0	98
McI -348'	t	t	t	0	0	0	1	t	t	t	0	0	99

McIntosh County Corehole--Continued

Sample Number	Carbonate / Phosphate vf	f	m	c	vc	gr	Other (mostly quartz) vf	f	m	c	v c	gr	Silt &* Clay
Tiger Leap Formation, members undifferentiated													
McI -354'	3	2	5	6	8	0	3	3	31	8	1	0	30
McI -383'	3	t	3	2	1	1	2	12	25	20	5	0	26
McI -405'	1	1	4	6	3	5	t	1	16	7	t	0	56
Suwannee Limestone													
McI - 427'	8	28	9	2	1	0	4	9	t	t	0	0	39
McI -448'	16	16	7	8	4	1	t	t	t	0	0	0	48

* "t" means less than 0.5% of total, other values rounded to nearest whole percent.

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. For carbonate-indurated samples, this step was skipped. All samples were recombined and treated in dilute (20%) hydrochloric acid until all reaction ceased (usually two days or less). When reaction ceased, samples were then sieved, dried, and weighed again. When reaction ceased, the samples again were sieved, dried, and weighed to determine the acid-insoluble fraction of the sample. The resulting weight distributions were used to create these tables.

Richmond Hill Corehole

Sample Number	All mineral components vf	f	m	c	vc	gr	Silt & Clay
Ebenezer Formation, member #4							
RiH - 48'	36	45	2	t	t	t	17
Ebenezer Formation, member #2							
RiH - 72'	12	2	t	t	t	t	85
RiH - 88'	65	11	t	t	t	0	24
Ebenezer Formation, member #1							
RiH - 125'	64	5	1	t	t	t	30
RiH - 136'	40	4	1	1	t	t	54
Coosawhatchie Formation, Berryville Clay Member (upper part)							
RiH - 154'	36	1	t	t	t	t	63
RiH - 171'	7	1	1	t	t	0	90
RiH - 182'	17	10	14	19	2	t	37
Marks Head Formation, member #3							
RiH - 206'	18	26	16	4	1	t	35
Marks Head Formation, member #2							
RiH - 226'	7	35	26	13	1	2	16
Parachucla Formation							
RiH - 267.5'	3	24	10	5	2	1	55
Tiger Leap Formation, member #3							
RiH - 301'	5	13	54	8	1	t	19
Tiger Leap Formation, member #2							
RiH - 310'	8	13	34	16	1	1	27
Suwannee Limestone							
RiH - 324'	6	18	13	11	3	1	37
RiH - 332'	6	18	24	10	2	t	40

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. The resulting weight distributions were used to create these tables.

St. Marys Corehole

Sample Number	Carbonate / Phosphate vf	f	m	c	vc	gr	Other (mostly quartz) vf	f	m	c	vc	gr	Silt & Clay	Silt, Clay, & Carbonate*
Ebenezer Formation member #1														
StM - 241.0'	t	t	1	1	1	t	3	6	33	44	4	t	7	
StM - 266.0'	2	11	t	t	0	0	30	43	t	t	0	0	14	
StM - 279.0'	1	t	2	2	t	t	3	24	22	33	2	t	11	
StM - 287.0'	2	8	t	t	t	0	27	19	t	t	t	0	44	
StM - 307.0'	1	1	1	0	0	0	16	1	t	t	0	0	80	
Marks Head Formation member #2														
StM - 325.0'	1	t	4	3	2	3	1	8	41	16	4	1	16	
StM - 339.0'	1	1	1	1	t	t	3	21	31	6	1	0	34	
StM - 354.0'	2	2	1	4	1	t	2	8	30	27	6	t	17	
StM - 361.0'	t	3	2	3	4	2	1	13	25	16	11	2	18	
StM - 369.0'	t	1	1	0	0	0	2	17	54	4	t	0	21	
StM - 385.5'	2	t	t	0	t	t	14	4	t	t	1	0	78	
StM - 397.0'	7	1	t	t	0	0	7	1	t	t	t	0	84	
StM - 403.0'	1	4	t	0	0	0	1	1	t	t	t	0	93	
Marks Head Formation member #1														
StM - 415.0'	1	7	6	2	t	t	2	4	25	22	2	t	29	
StM - 431.5'	(carbonate-cemented)*						1	2	6	2	t	t		89
Parachucla Formation														
StM - 434.8'	4	7	7	5	2	t	5	14	40	11	t	0	5	
Tiger Leap Formation, member #3														
StM - 454.5'	(carbonate-cemented)						t	1	11	10	4	t		74
StM - 479.0'	14	9	2	1	t	t	13	1	1	t	t	0	59	
StM - 483.0'	7	6	2	2	t	t	11	2	t	t	0	0	70	

* Carbonate-cemented samples could not be disaggregated to separately determine the grain-size distribution of the carbonate sand fraction or to distinguish the carbonate sand fraction from the clay/silt fraction. "t" means less than 0.5% of total, other values rounded to nearest whole percent.

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. For carbonate-indurated samples, this step was skipped. All samples were recombined and treated in dilute (20%) hydrochloric acid until all reaction ceased (usually two days or less). When reaction ceased, the samples again were sieved, dried, and weighed to determine the acid-insoluble fraction of the sample. The resulting weight distributions were used to create this table.

Toombs County Corehole

Sample Number	All mineral components vf	f	m	c	vc	gr	Silt & Clay
Ebenezer Formation, member #5							
Too - 69.0'	12	22	16	5	2	1	42
Too - 90.0'	4	18	42	23	1	t	12
Too - 107.5	18	34	15	2	1	1	29
Ebenezer Formation, member #2							
Too - 140.0'	13	55	5	1	t	t	26
Too - 165.0'	2	38	40	9	t	t	11
Ebenezer Formation, member #1							
Too - 194.0'	2	53	25	2	t	t	18
Too - 198.5'	3	46	23	9	3	1	15
Coosawhatchie Formation, Meigs Member							
Too - 219.0'	10	75	3	t	t	0	12
Coosawhatchie Formation, Tybee Phosphorite Member							
Too - 257.0'	8	53	18	t	t	0	21
Marks Head Formation member #3							
Too - 280.0'	6	1	1	t	0	0	80
Marks Head Formation member #2							
Too - 328.0'	4	51	24	6	1	t	14
Marks Head Formation member #1							
Too - 356.0'	7	28	38	12	3	t	12
Tiger Leap Formation, member #4							
Too - 374.0'	7	15	16	15	19	1	27

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. The resulting weight distributions were used to create this table.

Tybee Island Coreholes (SHE-7/7A)

Sample Number	Carbonate vf	f	m	c	vc	gr	Phosphate vf	f	m	c	vc	gr	Other (mostly quartz) vf	f	m	c	vc	gr	Silt & Clay	Silt, Clay, & Carbonate*
Ebenezer Formation member #5																				
SHE-7-69'	9	18	2	t	0	0	2	2	t	t	t	t	11	35	2	1	t	t	18	
SHE-7-78'	0	11	1	t	t	0	1	5	1	1	2	2	9	54	3	1	1	t	8	
Tybee Phosphorite																				
SHE-7-84'	1	t	t	t	0	0	1	2	1	t	t	0	2	3	1	t	t	t	89	
Marks Head Formation, member #3																				
SHE-7A-91'	(Dolomite cemented)*						1	1	2	1	3	4	1	3	10	8	4	2		61
SHE-7-93'	(Dolomite cemented)*						t	3	0	0	0	0	6	34	3	t	0	0		54
Marks Head Formation, member #2																				
SHE-7A-99'	0	0	0	0	0	0	0	0	0	0	0	0	18	30	1	t	0	0	51	
SHE-7A-103'	(Dolomite cemented)*						1	1	t	0	0	0	4	33	4	t	0	0		57
SHE-7A-107'	2	0	0	0	0	t	1	0	0	0	0	0	12	6	t	t	t	0	80	
SHE-7A-118'	4	t	0	0	0	0	0	0	0	0	0	0	28	8	t	t	t	0	60	
SHE-7A-126'	1	1	1	1	1	1	21	8	2	1	1	5	6	1	2	4	1	t	42	
Tiger Leap Formation member #3																				
SHE-7A-129'	(Calcite cemented)*						0	0	1	1	t	0	1	7	22	9	1	0		58

* Carbonate-cemented samples could not be disaggregated to separately determine the grain-size distribution of the carbonate sand fraction or to distinguish the carbonate sand fraction from the clay/silt fraction. "t" means less than 0.5% of total, other values rounded to nearest whole percent.

Samples of 70-110 grams were taken from each corehole at the depths indicated for sediment analysis. Samples were wet-sieved through 10, 35, 60, 120, and 240 mesh sieves to collect granule, very coarse sand, coarse sand, medium sand, fine sand, and very fine sand fractions. Each fraction was dried and weighed, and the missing weight was ascribed to the silt-clay fraction. For carbonate-indurated samples, this step was skipped. All samples were recombined and treated in dilute (20%) hydrochloric acid until all reaction ceased (usually two days or less). When reaction ceased, the samples again were sieved, dried, and weighed to determine the acid-insoluble fraction of the sample. The resulting weight distributions were used to create these tables.

Appendix K – Dinoflagellate datums in the Miocene

(HO = highest occurrence; LO = lowest occurrence), extracted from de Verteuil and Norris (1996).

HO+ *Distatodinium biffii* - defines the base of DN 1, uppermost Oligocene (Chattian)
LO *Hystrichosphaeropsis obscura* - at or near the base of DN 1, lower lower Miocene (Aquitanian) [are older reports in the literature]
HO genus *Homotryblium* - within DN 1, lower lower Miocene (Aquitanian)

HO+ *Chiropteridium galea* - defines the top of DN 1/base of DN 2, lower lower Miocene (Aquitanian)
LO *Sumatradinium hamulatum* and *S. soucouyantiae* - at or near the base of DN 2, lower lower Miocene (Aquitanian)
LO *Cousteaudinium aubryae* - low in DN 2, lower lower Miocene (Aquitanian)

LO *Pentadinium* sp. I of Edwards (1986, 1991), within DN 2, lower lower Miocene (Aquitanian)
LO *Operculodinium piaseckii* - within DN 2, lower lower Miocene (Aquitanian)
HO *Cordosphaeridium cantharellus* - within DN 2, middle lower Miocene (Burdigalian)

HO *Dinopterygium cladoides* sensu Morgenroth 1966 - within DN 2, middle lower Miocene (Burdigalian)
HO *Cerebrocysta satchelliae* - within DN 2, middle lower Miocene (Burdigalian)
HO *Cribroperidinium tenuitabulatum* - within DN 2, middle lower Miocene (Burdigalian)

HO+ *Exochosphaeridium insigne* - defines the top of DN 2/base of DN 3, middle lower Miocene (Burdigalian)
LO *Sumatradinium druggii* - low in DN 3, upper lower Miocene (Burdigalian)
HO *Pentadinium* sp. I of Edwards (1986, 1991), within DN 3, upper lower Miocene (Burdigalian)

LO *Cerebrocysta poulsenii* - high in DN 3, upper lower Miocene (Burdigalian)
HO *Sumatradinium hamulatum* - high in DN 3, upper lower Miocene (Burdigalian)
LO+ *Labyrinthodinium truncatum* - defines the top of DN 3/base of DN 4, uppermost lower Miocene or lowermost middle Miocene (Burdigalian/Langhian)

HO *Cousteaudinium aubryae* and *Apteodinium spiridoides* - at or near the top of DN 4, lower middle Miocene (Langhian)
HO+ *Distatodinium paradoxum* - defines the top of DN 4/base of DN 5, lower middle Miocene (Langhian)
HO+ *Apteodinium tectatum* - within DN 5, middle middle Miocene (Serravallian)

LO *Habibacysta tectata* - within DN 5, middle middle Miocene (Serravallian)
LO *Trinovatedinium papulum* - within DN 5, middle middle Miocene (Serravallian)
HO+ *Systematophora placacantha* - defines the top of DN 5/base of DN 6, middle middle Miocene (Serravallian)

LO *Selenopemphix dionaeacysta* - at or near the base of DN 6, middle middle Miocene (Serravallian)
LO+ *Cannosphaeropsis passio* - defines the top of DN 6/base of DN 7, upper middle Miocene (Serravallian)
LO *Erymnodinium delectabile* - within DN 7, upper middle Miocene (Serravallian)

Appendix K -- Dinoflagellate datums in the Miocene--Continued

HO *Cyclopsiella elliptica/granosa* complex and *Pentadinium laticinctum* complex - within DN 7, upper middle Miocene (Serravallian)

LO *Trinovantedinium glorianum* - at or near the top of DN 7, upper middle Miocene (Serravallian)

HO+ *Cannosphaeropsis passio* -- defines the top of DN 7/base of DN 8, uppermost middle Miocene (Serravallian)

LO *Achomosphaera andalousiensis* - at or near the base of DN 8, lowermost upper Miocene (Tortonian)

LO *Operculodinium janduchenei* - within DN 8, lower upper Miocene (Tortonian)

HO *Cordosphaeridium minimum sensu* Benedek and Sarjeant (1981) - within lower DN 8, lower upper Miocene (Tortonian)

HO *Cerebrocysta poulsenii* - within lower DN 8, lower upper Miocene (Tortonian)

HO *Sumatradinium druggii* and *Palaeocystodinium golzowense* - at or near the top of DN 8, middle upper Miocene (Tortonian)

HO+ *Sumatradinium soucouyantiae* - defines the top of DN 8/base of DN 9, middle upper Miocene (Tortonian)

LO *Operculodinium ? eirikianum* and *Barssidinium evangelineae* - at or near the base of DN 9, middle upper Miocene (Tortonian)

HO *Operculodinium piaseckii* - within DN 9, middle upper Miocene (Tortonian)

HO *Heteraulacacysta campanula*, *Dapsilidinium pseudocolligerum*, and *Labyrinthodinium truncatum* - at or near the top of DN 9, upper upper Miocene (upper Tortonian)

HO+ *Hystrichosphaeropsis obscura* - defines the top of DN 9/base DN 10, upper upper Miocene (upper Tortonian) [this species is known to range higher in Florida (Weedman and others, 1995)]

LO *Selenopemphix armageddonensis* and *Filisphaera microornata* - at or near the base of DN 10, upper upper Miocene (upper Tortonian)

HO+ *Erymnodinium delectabile* - defines the top of DN 10, upper upper Miocene (Messinian)

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