Neogene and Quaternary Geology of a Stratigraphic Test Hole on Horn Island, Mississippi Sound

U.S. Geological Survey Open-file Report 96-20A

Prepared in cooperation with the National Park Service
Gulf Islands National Seashore

U.S. Department of the Interior

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards nor with the North American Stratigraphic Code.

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NEOGENE AND QUATERNARY GEOLOGY OF A STRATIGRAPHIC TEST HOLE ON HORN ISLAND, MISSISSIPPI SOUND

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INTRODUCTION

During April and May, 1991, the U.S. Geological Survey (USGS) drilled a 510-ft-deep, continuously cored, stratigraphic test hole on Horn Island, Mississippi Sound, as part of a field study of the Neogene and Quaternary geology of the Mississippi coastal area. Horn Island is part of an east-west chain of offshore barrier islands that is present along the boundary between Mississippi Sound and the Gulf of Mexico in the Mississippi-Alabama coastal area (fig. 1). The USGS Horn Island drill site is located near the center of Horn Island at the National Park Service ranger station (Gohn and others, 1994). This site is in section 22 (SE/4, SE/4), Township 9S, Range 7W, in the Horn Island West 7.5-minute quadrangle. The surface elevation at the drill site is estimated from the topographic map to be +5 feet.

Relatively few pre-existing drill holes are known from Horn Island. Brown and others (1944) described two U.S. Army wells on the island (Army #1 and Army #2) that reached depths of 836 and 819 ft respectively (fig. 1). These authors provided lithologic descriptions of drill cuttings (Brown and others, 1944, pl. 14, p. 154-156), as well as paleontologic data (their table 2 and p. 51) that was supplied by J.A. Cushman (USGS) and Julia Gardner (USGS). An additional well of unknown origin ("old well" on fig. 1) is identified on the 1982 USGS Horn Island West 7.5-minute topographic quadrangle.

The USGS drilled two new holes at the Horn Island site. The first hole was continuously cored to a depth of 510 ft; coring stopped at this depth due to mechanical problems. To facilitate geophysical logging, an unsampled second hole was drilled to a depth of 519 ft at the same location.

Three informal lithostratigraphic units are recognized in the new Horn Island core; they are designated as unit 1 of Pliocene age, unit 2 of Pliocene(?) age, and unit 3 of Holocene age. Their physical stratigraphy, paleontology, correlations, and depositional history are described briefly in the following sections. Correlations with previously described formations are suggested for unit 1 and unit 2. However, only informal stratigraphic nomenclature is used in this report because of the limited scope of our study.

Descriptions of the recovered cores (Gohn and others, 1994) and the foraminiferal assemblages in units 1 and 3 (Gibson, 1994) have been published previously. Lists of taxa for five fossil groups found in the Horn Island core are given in Appendix A (tables 1 through 5). Project responsibilites for data collection and analysis are as follows: physical stratigraphy and depositional history (G. Gohn), Mollusca (L. Brewster-Wingard), Ostracoda (T. Cronin), dinoflagellates (L. Edwards), Foraminifera (T. Gibson), pollen (D. Willard), and radiocarbon analysis (M. Rubin).

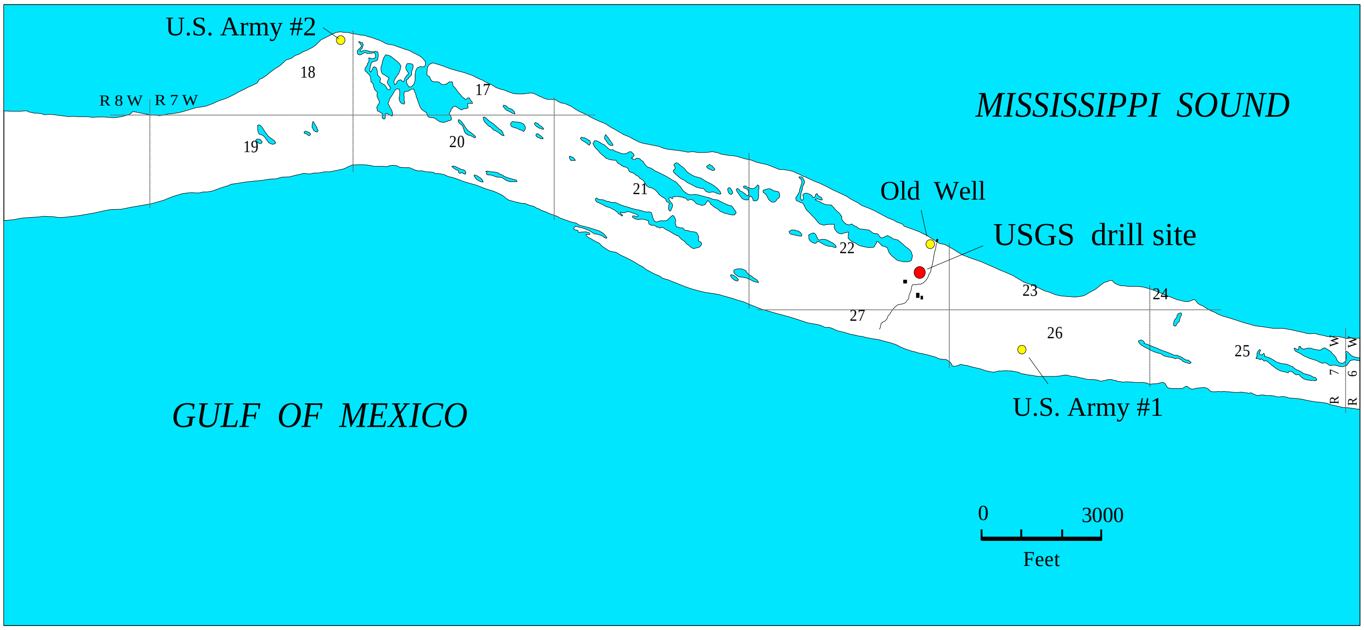
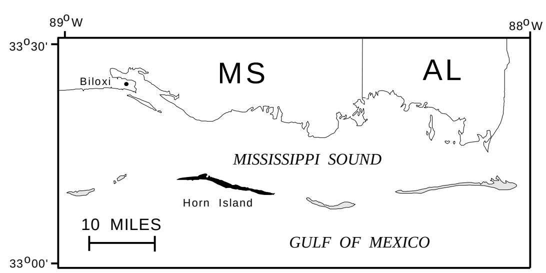


Figure 1. Map of the central part of Horn Island showing the location of the USGS drill site.
Sections within Township 9 South, Range 7 West, are indicated.



Acknowledgments

We thank the staff of the National Park Service, Gulf Islands National Seashore, for access to the Horn Island drill site and for their logistical support of the drilling project. We also thank the Mississippi Bureau of Geology for running electric and gamma-ray surveys in the Horn Island drill hole. Many helpful discussions with Ervin G. Otvos (Gulf Coast Research Laboratory) have greatly enhanced our understanding of the geology of the Mississippi coastal area. The late Juergen Reinhardt (USGS) was instrumental in the conception and planning of the Horn Island study. The Horn Island core was drilled by the USGS Branch of Eastern Regional Geology drilling team using a wireline, mud-rotary coring rig. Reviews by Suzanne D. Weedman (USGS) and Laurel M. Bybell (USGS) substantially improved this report.

UNIT 1

Lithology

The section between the bottom of the logged drill hole at 519 ft and a depth of 173 ft is assigned to informal stratigraphic unit 1. This unit consists predominantly of silts and very fine to fine sands, laminated silty clays, bioturbated silty clays, and moderately oxidized silts. In contrast to these relatively finer grained deposits, the deepest samples from unit 1 (at 504.5 ft to about 503.4 ft) consist of loose, well-sorted, medium to coarse sand.

The fine-grained deposits above 503.4 ft in unit 1 are arranged in 10- to 20-ft-thick cycles (fig. 2). Each cycle has a basal, slightly muddy, very fine or very fine to fine sand that overlies a lithologically sharp, but irregularly burrowed, basal contact. Clay intraclasts and fragmented molluscs are present in some of these basal sands. From 503.4 ft to approximately 390 ft, the basal sands of each cycle are overlain by sections of burrowed, sparingly fossiliferous, thinly interlaminated clays and silts. These laminated sections are rare above 390 ft. In all cycles, sections of bioturbated silty clay that locally contain microfossils and molluscs overlie the basal sand, or the laminated section if present. The tops of many cycles consist of rooted and moderately oxidized, texture-mottled, clayey silts.

Paleontology

Foraminifera. Three samples from unit 1 contain low-diversity (2 to 5 species) foraminiferal assemblages that are indicative of low- to moderate-salinity, estuarine paleoenvironments. *Ammonia beccarii* strongly dominates these assemblages.

Ostracoda. Low-diversity ostracode assemblages in four samples from unit 1 consist of fresh-water to mesohaline taxa. These assemblages suggest middle to upper estuarine paleoenvironments.

Mollusca. The molluscan assemblages in nine samples from unit 1 are dominated by the pelecypods *Rangia cuneata* and *Mulinia lateralis*. Fragmented ostreids are less common, and few additional taxa are represented. The low diversity and composition of the mollusc assemblages in this unit indicate low-salinity estuarine to marginal-marine paleoenvironments. Julia Gardner (in Brown and others, 1944, p. 51) reported *R. cuneata* in "a number of samples" from both Army wells.

Dinoflagellates. Nine dinocyst samples were studied from unit 1. The deepest sample at 501.5 ft contains a very sparse assemblage dominated by *Pediastrum* (fresh-water algae) and reworked Cretaceous (*Palaeohystrichophora infusorioides*) and Paleogene (*Wetzeliella* sp.) forms. A few specimens of *Operculodinium* spp. and *Spiniferites* spp. likely are in place. Samples from 481.3 ft and 457.3 ft contain moderately well-preserved dinocyst assemblages. The 481.3-ft sample is dominated by *Polysphaeridium zoharyi* but contains significant numbers of *Spiniferites* spp. The sample at 457.3 ft contains subequal numbers of *P. zoharyi* and *Spiniferites* spp., and significant numbers of the

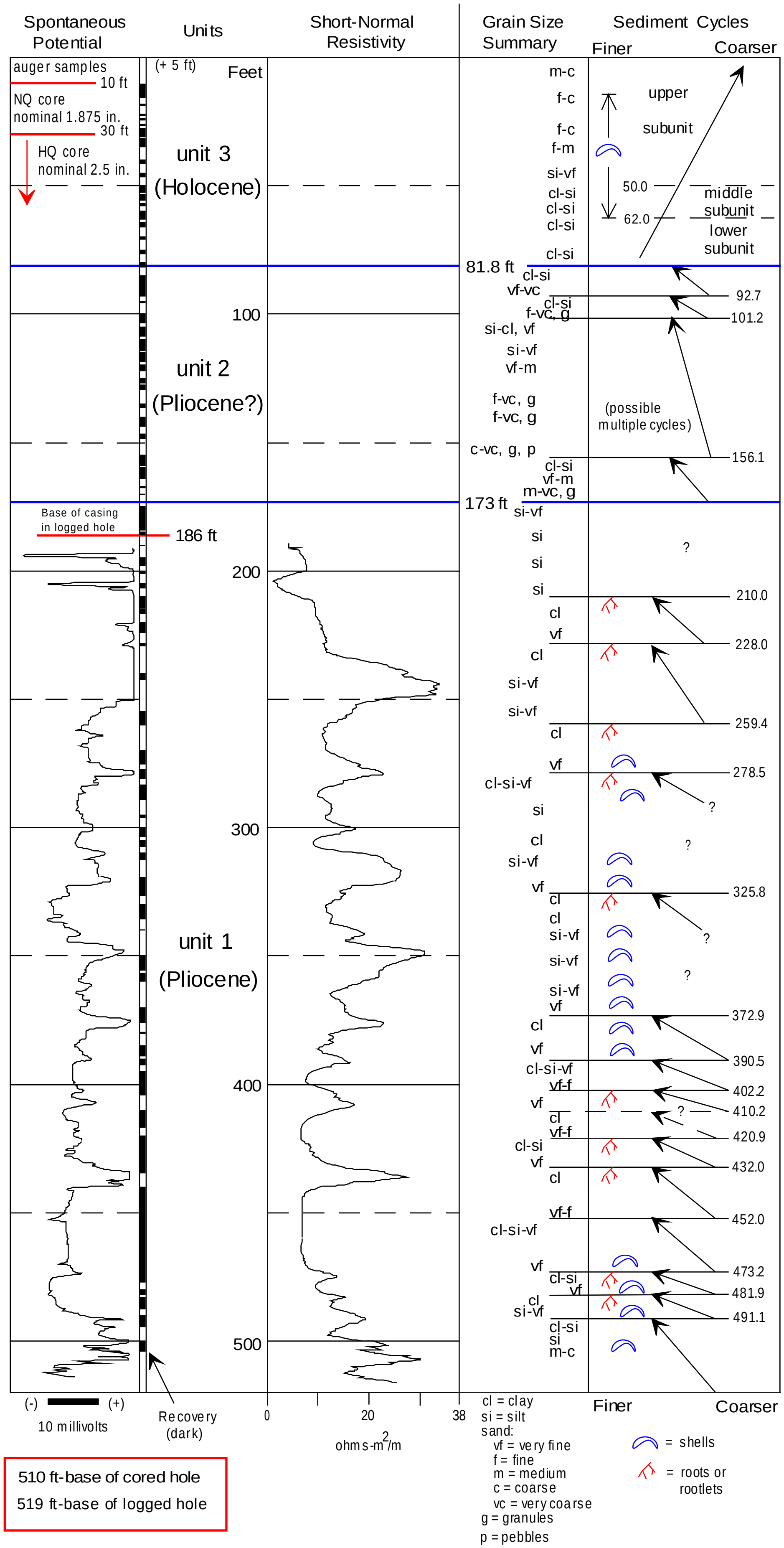


Figure 2. Electric log and lithologic data for the USGS Horn Island core.

family Congruentidiaceae. The presence of *P. zoharyi* suggests subtropical to tropical, relatively nearshore environments, but *P. zoharyi* seldom occurs with abundant *Spiniferites* spp. in reported modern samples (Wall and others, 1977). The 457.3-ft sample contains significant numbers of reworked Cretaceous forms (*Chatangiella*, *Dinogymnium*, *Isabelidinium*, *Odontochitina*); the 481.3-ft sample contained a lesser number of Cretaceous forms (including *Palaeohystrichophora infusorioides*). A moderately common form that is intermediate between the genus *Spiniferites* and *Impagidinium fenestroseptatum* is present at 481.3 ft (and some higher samples). Small numbers of *Impagidinium fenestroseptatum* also are present in the 481.3 ft-sample; this species is restricted to the Pliocene.

A sample at 401.7 ft contains a very sparse dinocyst assemblage that is dominated by *Pediastrum* and reworked forms of various ages (including Cretaceous Deflandreoideae, *Manumiella* sp., *Phelodinium magnificum*, and *Charlesdowniea* sp.). A few specimens of *Impagidinium fenestroseptatum* and *Spiniferites* spp. are likely to be in place.

The sample at 387.5 ft contains a moderately well-preserved dinocyst assemblage that is dominated by the intermediate *Spiniferites/ Impagidinium fenestroseptatum* form. Specimens clearly assignable to *Impagidinium fenestroseptatum* also are present. Obviously reworked Cretaceous dinocysts include *Chatangiella* sp., *Dinogymnium* sp., *Isabelidinium* sp., and *Odontochitina* sp.

The upper four samples from unit 1 (358.2, 354.3, 284.7, 197.0 ft) contain very sparse dinocyst assemblages. Reworked specimens are prominent and include *Hystrichosphaeridium tubiferum* (Cretaceous-Eocene), *Palaeohystrichophora infusorioides* (Cretaceous), and assorted Cretaceous Deflandreoideae. *Impagidinium fenestroseptatum* is present in three of these samples.

Pollen. Pollen assemblages were analyzed from eight samples in unit 1, ranging from 501.4 ft to 197.0 ft in the core. Six samples collected between 457.2 ft and 284.6 ft are dominated by reworked palynomorphs ranging in age from Carboniferous through Cenozoic. Because preservation of the reworked grains varied from poor to good, it was difficult to reliably distinguish reworked Cenozoic grains from non-reworked Cenozoic grains. Therefore taxa in these samples were tallied only as present or absent.

The bottom and top samples of unit 1 (501.4 ft and 197.0 ft) had fewer reworked palynomorphs than the middle interval from 457.2 ft to 284.6 ft, and pollen was quantified for these two samples. The presence of *Pterocarya* and the lack of more tropical elements in both samples indicates a Pliocene age for the entire unit. The bottom sample is dominated by *Quercus* (oak) pollen, with *Pinus* (pine) pollen subdominant, and the top sample contains nearly equal abundances of *Quercus*, *Pinus*, TCT (Taxodiaceae, Cupressaceae, Taxaceae; cypress), and Poaceae (grass) pollen. Pollen assemblages in both samples differ markedly from those of today in the region, which typically are dominated by *Pinus* pollen with subdominant *Quercus* pollen (D.A. Willard, unpublished data). The differing compositions of the two Pliocene assemblages may indicate differences in temperature or in precipitation and water availability; analysis of additional productive samples from the core would be necessary to interpret patterns of vegetational change at this site.

Age and Correlation

Palynomorphs in several samples from the Horn Island core indicate a Pliocene age for unit 1. The exotic pollen genus *Pterocarya* and the dinoflagellate *Impagidinium fenestroseptatum* are both indicative of this age. The bivalves *Rangia cuneata* and *Mulinia lateralis* indicate an age no older than late Pliocene.

Brown and others (1944) reported green-gray, gray, and blue-gray clay with minor sand from 526 ft to 168 ft in the Army #1 well and a similar section of green, gray, and blue-gray clay and shale with minor fine sand and a shell layer from 495 ft to 166 ft in the Army #2 well. These sections probably correlate with the fine-grained cyclic deposits of unit 1 in the USGS core. The medium to coarse sand recovered in the basal foot of the USGS core probably represents the top of a sand section reported from the Army wells by Brown and others (1944). These authors reported fine to medium sand from from 537 ft to 526 ft in the Army #1 well and fine sand with shale fragments from 523 ft to 495 ft in the Army #2 well.

Brown and others (1944) included these stratigraphic sections (537 ft to 168 ft, Army #1 well; 523 ft to 166 ft, Army #2 well) in the upper part of their newly defined Graham Ferry Formation. The lithology, stratigraphic position, and late Pliocene age of unit 1 in the USGS core are compatible with this stratigraphic assignment, although Otvos (1994, fig. 2) assigns an early Pliocene age to his redefined Graham Ferry Member of the Pensacola Formation (middle Miocene to lower Pliocene).

Depositional History

The sedimentary and paleontologic characteristics of unit 1 suggest that it represents estuarine sedimentation. The calcareous fossil groups from this unit all consist of low-salinity assemblages that indicate paleosalinities of 10 to 20 parts per thousand (ppt) or less.

The sediment cycles in unit 1 closely resemble Clifton's (1982) general model for the vertical sediment sequence produced by fine-grained estuarine systems (fig. 3). The basal shelly fine sand of each cycle represents channel deposits of an intertidal creek, whereas the overlying laminated clay-silt section represents lateral-accretion deposits produced by migration of the intertidal creek. Higher in the cycle, the bioturbated, *Rangia*-bearing clays represent intertidal mud flats, and the rooted, oxidized clayey silts represent supratidal flats. The coarser sand section at the base of unit 1 probably represents one of the main channels of the estuary.

UNIT 2

Lithology

The section between depths of 173.0 ft and 81.8 ft is assigned to informal unit 2. The lower contact of unit 2 at 173 ft was placed arbitrarily near the center of a 4.2-ft unrecovered interval that separates sediments typical of unit 2 (above) and unit 1 (below). Unit 2 consists of cyclic fining-upward sections of noncalcareous sands and clays. The observed cycles range from 10 ft to nearly 20 ft in thickness, although the exact number of cycles in the middle part of the unit could not be determined due to the lack of core recovery in several intervals. Observed cycle boundaries are present at the base of the unit and at depths of 156.1 ft, 101.2 ft, and 92.7 ft (shown in part on fig. 4).

The cycles have sharp erosional bases that are overlain by fine to very coarse sands. These sands typically have clay intraclasts as well as granules and small pebbles of quartz, quartzite, and chert in their basal foot. These coarser sands grade upward into fine to medium sands and subsequently, in some cycles, into silty, very fine to fine sands. Thin intervals of silty clay (typically less than 5 ft) are present at the tops of some cycles, particularly those in the upper half of the unit. The uniformly coarse-grained interval between 156.1 ft and approximately 127.0 ft may represent two or more amalgamated cycles in which coarse sand at the base of one cycle overlies coarse sand at the base of the underlying, severely eroded cycle.

Although no calcareous fossils were noted in unit 2, comminuted plant material is locally common. Small burrows are present in some of the finer grained intervals. The clays are typically dense and light olive gray when dry. The sands are typically loose or loose to friable and light colored, either yellowish gray or pinkish gray when dry.

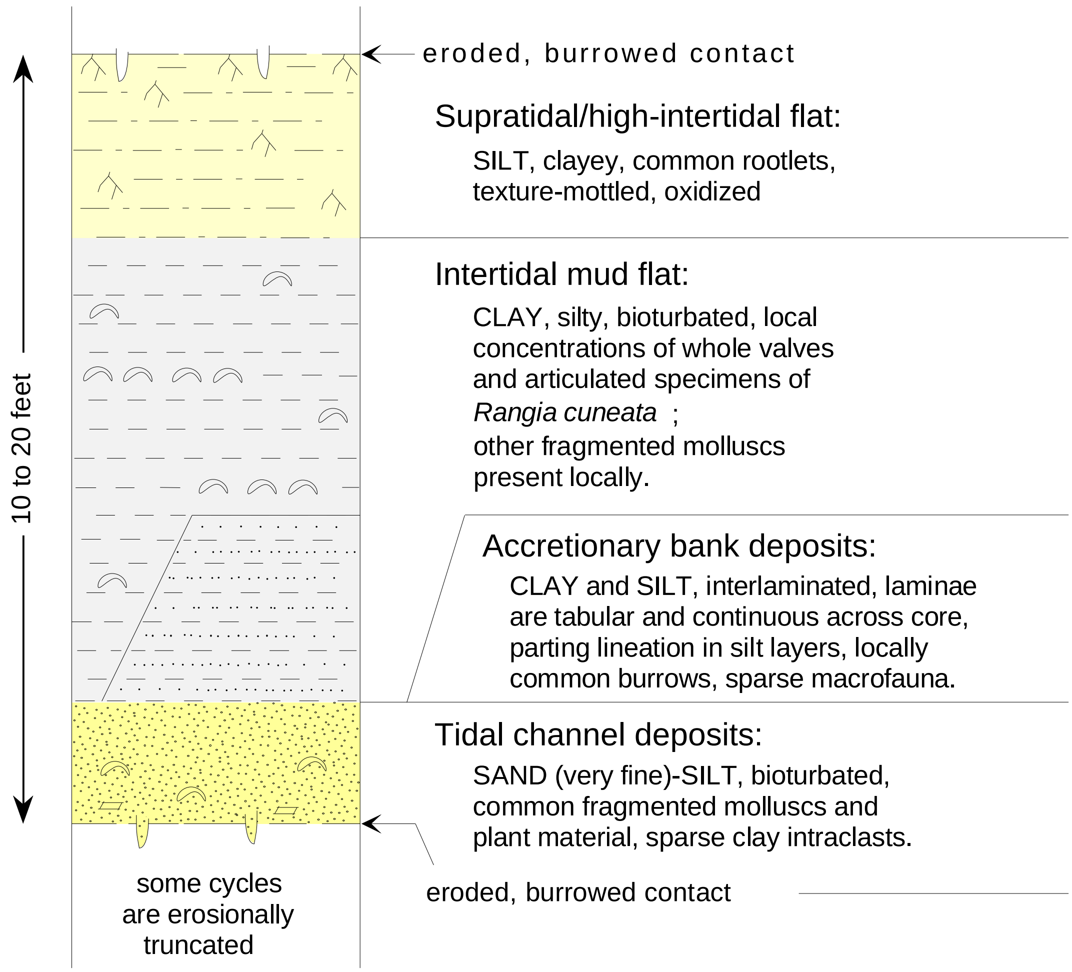


Figure 3. Generalized sediment cycle found in the estuarine deposits of unit 1 (modeled on figure 20 of Clifton, 1982). Accretionary bank deposits are rare in the upper two-thirds of unit 1.

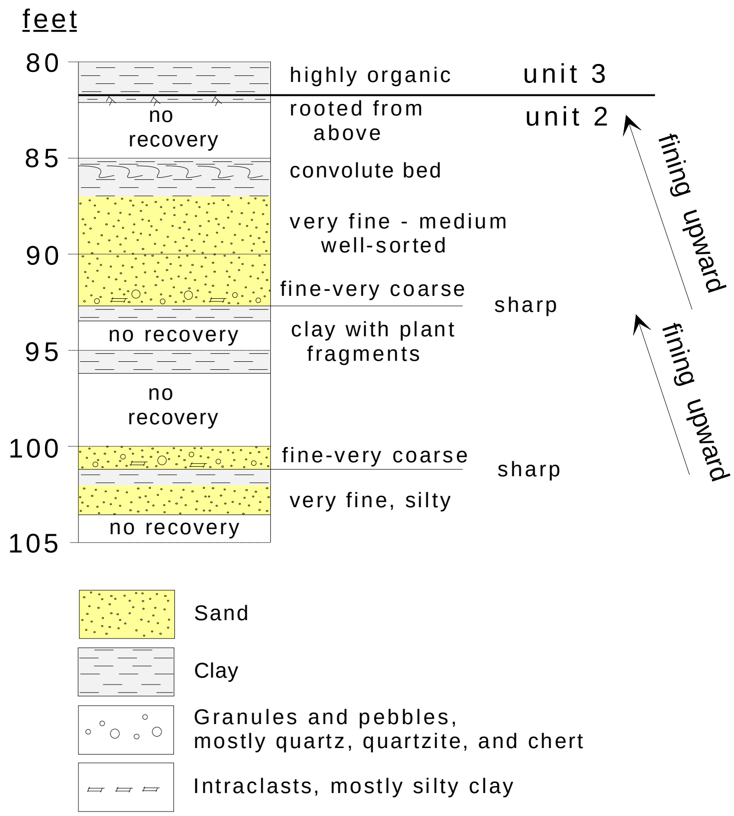


Figure 4. Representative fining-upward cycles in the upper part of unit 2.

Age and Correlation

No paleontology samples were processed from unit 2. A provisional Pliocene(?) age is assigned to unit 2 on the basis of the generally high degree of clay induration in the unit and its lithologic resemblance to units of Pliocene and probable Pliocene age in nearby Jackson County, Mississippi (Otvos, 1994).

Medium to coarse sands at 168 ft to 65 ft in the Army #1 well (with a thin layer of dark-gray clay) and at 166 ft to 69 ft in the Army #2 well are probably correlative with unit 2 of the USGS core. Brown and others (1944) assigned these sections to the lower part of their Citronelle(?) Formation. Otvos (1994) assigns a late Pliocene age to the Citronelle Formation in coastal areas of Mississippi. Common Foraminifera in these intervals in the Army wells probably represent cavings from the Holocene section, as implied by Brown and others (1944, p. 155) for the Army #1 well.

Depositional History

The cyclic fining-upward sedimentation units, the paucity of burrows, and the lack of calcareous fossils suggest that unit 2 was deposited in a fluvial to perhaps upper estuarine paleoenvironment. The fining-upward sand-clay cycles represent deposition by laterally migrating, mixed-load streams. Channel-lag, lateral-accretion, and perhaps channel-macroform sands are present, as well as overbank fine-grained sediments.

UNIT 3

Lithology

Unit 3 consists of coastal and nearshore-marine sediments found in the upper 81.8 ft of the Horn Island core. Three lithologically contrasting subunits are present. The lower subunit, from 81.8 ft to 62.0 ft, consists of noncalcareous, dark-brown, highly organic, silty clays containing abundant plant material. Cylindrical and hemispherical, sand-filled burrows with clayey spreiten are common in the upper four feet of this interval. Also present are low-density, clayey and sandy peat layers consisting of a variety of plant materials, including a 17-inch-thick log at depths of 76.9 ft to 75.5 ft.

Calcareous fine-grained deposits overlie the clay-peat section along a sharp contact at 62.0 ft and extend upward to about 50 ft in the core. This middle subunit consists primarily of medium-olive-gray, macro- and microfossiliferous, burrowed silty clays and clayey silts. Unlined, silt-filled, cylindrical burrows are common throughout this interval.

The fine-grained middle subunit is broadly gradational with the coarser grained upper subunit. The four feet of core recovered between depths of 50 ft and 40 ft contain two thin beds of calcareous silty clay similar to the clay below 50 ft, whereas the remainder of this interval consists of micaceous, macro- and microfossiliferous, silty, very fine sand. Above 40 ft, this very fine sand grades upward into fine to medium sand with some intervals of fine to coarse or medium to very coarse sand. These light-colored, loose, fossiliferous sands (above the 50-ft depth) constitute the upper subunit of unit 3. Microfossils, echinoid spines, and fragmented molluscs are disseminated throughout this section up to a depth of about 14.5 ft. Physical sedimentary structures were not seen in the upper subunit; texture mottling in some intervals probably represents burrowing.

Paleontology

Foraminifera. Two samples from the fine-grained middle subunit (62 ft to 50 ft) contain moderately diverse (20 to 28 species), barrier-inlet to nearshore-marine foraminiferal assemblages. *Ammonia beccarii*, *Buliminella elegantissima*, *Elphidium excavatum*, and *Haynesina germanica* are abundant species in this subunit. Two samples from the sandy upper subunit (above 50 ft) contain moderately to highly diverse (28 to 32 species) nearshore-marine assemblages. *Ammonia beccarii*, *Elphidium gunteri*, *Hanzawaia concentrica*, and *Quinqueloculina seminula* are the abundant species in this subunit.

Ostracoda. Low- to moderate-diversity ostracode assemblages in two samples from the fine-grained middle subunit dominantly consist of mesohaline and polyhaline taxa suggestive of middle-bay to lower-bay and inlet paleoenvironments. More diverse assemblages in one sample from near the top of the middle subunit, and two samples from the sandy upper subunit, consist of euhaline taxa indicative of a nearshore-marine paleoenvironment.

Mollusca. Four samples representing the fine-grained middle subunit and the sandy upper subunit of unit 3 contain relatively diverse mollusc assemblages. These assemblages indicate a euhaline, inner-neritic paleoenvironment.

Dinoflagellates. Three samples from the middle subunit contain abundant, well-preserved dinocysts. The assemblages are strongly dominated by *Polysphaeridium zoharyi* and are indistinguishable from the modern assemblages found in sediments from Mississippi Sound. Reworked Cretaceous forms (*Andalusiella* sp. at 54.7 ft) and lower Tertiary forms (*Homotryblium plectilum* at 51.5 ft) are present, but rare.

Pollen. Pollen assemblages were examined from three samples of the middle subunit. All assemblages are dominated by *Pinus* (pine) pollen, with subdominant *Quercus* (oak) pollen and common TCT (Taxodiaceae, Cupressaceae, Taxaceae; cypress) and *Carya* (hickory) pollen. These assemblages are analogous to those found in modern sediments in the region.

Age and Correlation

A radiocarbon age of 9,470 radiocarbon years +/- 90 radiocarbon years was obtained for the central part of a log at that was recovered at 76.9 ft to 75.5 ft in the core (USGS radiocarbon sample W-6544). This early Holocene radiocarbon age is the principal basis for assigning a Holocene age to unit 3. In addition, all of the molluscan taxa in unit 3 have middle Pleistocene to Recent ranges; all of the described molluscan species are extant forms.

Brown and others (1944, p. 154-155) describe fossiliferous quartz sand from the land surface down to depths of 55 ft in the Army #1 well and 46 ft in the Army #2 well. These sections likely correlate with the sandy upper subunit of the Holocene section in the USGS core. Similarly, a section of slightly carbonaceous, pyritic and micaceous, dark-gray clay at 65 ft to 55 ft in the Army No. 1 well probably represents the fine-grained middle subunit and (or) the peaty lower subunit of the Holocene section in the new core. A section of light-colored and dark-colored clays at 69 ft to 46 ft in the Army No. 2 section may also represent these subunits and perhaps the upper part of unit 2 of the new core. Brown and others (1944) questionably assigned these clay sections in the Army wells to the Pliocene or late Pleistocene Citronelle(?) Formation, in contrast to the Holocene age assigned herein.

Depositional History

Unit 3 provides a sedimentary record of Holocene sea-level rise and barrier island migration along the southern margin of Mississippi Sound. The radiocarbon age for the log at 76.7 ft in the core (approximate elevation of log is -71.7 ft), as well as the lithologic and biologic character of the basal peaty sediments of unit 3, suggest that an early Holocene shoreline was established in the vicinity of modern Horn Island at approximately 9.5 ka. These organic marsh and tidal flat deposits at the base of the Holocene section represent a low-energy part of that shoreline complex.

Subsequently, continued sea-level rise and the resultant flooding of the early Holocene shoreline produced the upward change to fine-grained subtidal deposits seen at 62.0 ft in the core. Moderately diverse calcareous faunas and dinocyst assemblages from these clays and silts indicate variable paleosalinities ranging from about 20 ppt, or lower, to 35 ppt. These values suggest sedimentation in a spectrum of shallow, inner-neritic paleoenvironments, perhaps in the seaward part of a partially barred, shelf estuary similar to the modern Mississippi Sound.

Higher in the Holocene section, euhaline macrofossil and calcareous microfossil assemblages in the sandy upper subunit suggest a change to less restricted, inner-neritic paleoenvironments produced during continued sea-level rise. The coincident increase in grain size from the fine-grained middle subunit to the sandy upper subunit records the late Holocene westward migration of Horn Island to its present position. Hence, the sandy upper subunit primarily represents the pre-modern subtidal part of Horn Island, which likely includes inter-barrier, inlet sediments and shoreface sediments. The sands above modern sea level at the top of unit 3 may be largely eolian in origin.

SUMMARY

The USGS Horn Island core presents a highly selective record of Pliocene and Quaternary sedimentation at the margin between Mississippi Sound and the northern Gulf of Mexico. Units 1 and 2 in the core are sequences of Pliocene or probable Pliocene fluvial to estuarine sediments that likely represent valley-fill sedimentation during periods of low to rising sea level. The late Pleistocene highstand marine and coastal deposits (Gulfport and Biloxi Formations and related deposits) that are widespread along the mainland coast of Mississippi (Otvos and Howett, 1992) are absent on Horn Island, at least at the USGS drill site. Unit 3 consists of a fairly complete sedimentary record of Holocene sea-level rise and the migration of Horn Island to its present position at the seaward margin of Mississippi Sound.

REFERENCES CITED

Brown, G.F., Foster, V.M., Adams, R.W., Reed, E.W., and Padgett, H.D., Jr., 1944, Geology and ground-water resources of the coastal area in Mississippi: Mississippi State Geological Survey Bulletin 60, 232 p.

Clifton, H.E., 1982, Estuarine deposits, *in* Scholle, P.A., and Spearing, Darwin, eds., Sandstone Depositional Environments: American Association of Petroleum Geologists Memoir 31, p. 179-189.

Gibson, T.G., 1994, Neogene and Quaternary Foraminifera and paleoenvironments of a corehole from Horn Island, Mississippi: U.S. Geological Survey Open-file report 94-702, 24 p.

Gohn, G.S., Reinhardt, Juergen, Powars, D.S., Schindler, J.S., Stone, B.D., Queen, D.G., and Cobbs, E.F., 1994, Preliminary lithologic log for a stratigraphic corehole on Horn Island, Mississippi Sound: U.S. Geological Survey Open-file report 94-558, 40 p.

Otvos, E.G., 1994, Mississippi's revised Neogene stratigraphy in northern Gulf context: Gulf Coast Association of Geological Societies Transactions, v. 44, p. 541-554.

Otvos, E. G. and Howett, W.E., 1992, Late Quaternary coastal units and marine cycles: Correlations between northern Gulf sectors: Gulf Coast Association of Geological Societies Transactions, v. 42, p. 571-586.

Wall, David, Dale, Barrie, Lohmann, G.P., and Smith, W.K., 1977, The environmental and climatic distribution of dinoflagellate cysts in modern marine sediments from regions in the North and South Atlantic Oceans and adjacent seas: Marine Micropaleontology, v. 2, p. 121-200.

APPENDIX A: Paleontologic Data

Table 1. Foraminifera from the Horn Island core. Maximum frequencies of foraminiferal species in each indicated interval in the core based upon an aliquot of greater than 300 specimens.

Unit 3, Holocene

26.3 ft and 40.8 ft: moderate to high diversity (28 to 32 species) inner neritic assemblage.

Abundant species (> 10%)

Ammonia beccarii	*Hanzawaia concentrica*
Elphidium gunteri	*Quinqueloculina seminula*

Common species (2-10%)

Buliminella elegantissima	*Pseudononion atlantica*
Cibicides sp.	*Quinqueloculina auberiana*
Elphidium discoidale	*Quinqueloculina compta*
Elphidium mexicanum	*Quinqueloculina* sp.
Guttulina australis	*Rosalina aubaraucana*
Haynesina germanica	*Rosalina* n. sp.

Rare species (< 2%)

Archais angulatus	*Globulina gibba*
Asterigerina carinata	*Guttulina* sp.
Bigenerina irregularis	*Nonionella basiloba*
Bolivina paula	*Nonionina* sp.
Buccella hannai	*Quinqueloculina agglutinans*
Elphidium fimbriatulum	*Quinqueloculina poeyana*
Elphidium poeyanum	*Reusella atlantica*
Elphidium n. sp.	*Sagrina pulchella*
Elphidium sp. A	*Stetsonia minuta*
Elphidium sp. B	*Textularia agglutinans*
Eponidella gardenislandensis	*Triloculina lineiana*
Fursenkoina pontoni	*Triloculina* sp. A
Glabratella sp.	

51.8 to 61.9 ft: moderate diversity (20 to 28 species) inlet/nearshore-marine assemblage.

Abundant species (> 10%)

Ammonia beccarii	*Elphidium excavatum*
Buliminella elegantissima	*Haynesina germanica*

Common species (2-10%)

Buccella hannai	*Elphidium* n. sp.
Cibicides sp.	*Quinqueloculina seminula*
Elphidium mexicanum	*Rosalina* n. sp.

Rare species (< 2%)

Asterigerina carinata	*Fursenkoina mexicana*
Bolivina lowmani	*Gavelinopsis umbonata*
Bolivina striatula	*Globulina gibba*
Bolivina sp.	*Hanzawaia concentrica*
Buccella hannai	*Nonionella basiloba*
Cassidulina reniforme	*Pseudononion atlantica*
Elphidium discoidale	*Quinqueloculina laevigata*
Elphidium gunteri	*Quinqueloculina* sp.
Elphidium sp. A	*Reusella atlantica*
Elphidium sp. B	*Rosalina subaraucana*
Eoeponidella delicatulum	*Sagrina pulchella*
Eponidella gardenislandensis	*Spiroloculina antillarum*
Fissurina sp. A	*Stetsonia minuta*
Fissurina sp. B	*Triloculina schreiberiana*

Unit 1, Pliocene

357.5 ft: low diversity (5 species) estuarine assemblage.

Abundant species (> 86%)
- *Ammonia beccarii*

Common species (2-10%)
- *Elphidium gunteri*

Rare species (< 2%)
- *Elphidium discoidale*
- *Elphidium* sp.
- *Lenticulina* sp.

376.1 and 380.2 ft: low diversity (2 to 3 species) estuarine assemblage.

Abundant species (> 98%)
- *Ammonia beccarii*

Rare species (< 2%)
- *Elphidium gunteri*
- *Elphidium mexicanum*

Table 2. Characteristic Ostracoda in the Horn Island core.

<u>Unit 3, Holocene</u>

26.3 ft, 40.8 ft, 52.3 ft: primarily sublittoral, euhaline taxa.

Actinocythereis subquadrata
Climacoidea (Proteoconcha) gigantica
Climacoidea (Proteoconcha) tuberculata
Cytherelloidea sp.
Hulingsina sulcata
Malzella floridana
Megacythere repexa
Paracytheridea altila
Pellucistoma magniventra
Peratocytheridea bradyi
Pontocythere sp.
Protocythere littorea
Pseudocytheretta edwardsi
Pterygocythereis cf. *P. alophia*
Pumilocytheridea sp.
Puriana cf. *P. carolinensis*
Puriana krutaki
Puriana aff. *P. mescostalis*

55.3 ft: includes midddle-bay, mesohaline taxa.

Peratocytheridea setipunctata
Perissocytheridea brachyforma

61.4 ft: primarily lower-bay, polyhaline taxa.

Cytherura fiscina
Cytherura nucis
Cytherura radialirata
Loxoconcha moralesi
Megacythere repexa
Paracytheroma stephensoni
Paradoxostoma delicata

<u>Unit 1, Pliocene</u>

340.0 ft, 357.5 ft: middle-bay, mesohaline taxa.

Perissocytheridea sp.
Cyprideis cf. *C. bensoni*
Hulingsina rugipustulosa
Cytherura cf. *C. forulata*

376.1 ft, 380.2 ft: upper-bay, fresh-water to mesohaline taxa.

Perissocytheridea sp.
Cyprideis cf. *C. bensoni*
cyprid species indeterminate

Table 3. Macroinvertebrates in the Horn Island core.

Unit 3, Holocene

Depth	Pelecypods:	Gastropods:	Miscellaneous:
26.3 ft:	*Abra aequalis* *Anadara ovalis* *Anomia simplex* *Chione* sp. *Corbula* sp. *Dinocardium* sp. *Noetia limula* *Nuculana acuta* *Parastarte* sp. *Tellina* sp. *Transenella* sp.	*Anachis* sp. *Cyclostremiscus* sp. *Kurtziella* sp. *Nassarius acutus* *Olivella* sp. *Polinices* sp. *Turbonilla?* sp.	echinoid fragments *Dentalium* sp.
40.8 ft:	*Anadara transversa* *Linga amiantus* *Mulinia lateralis* *Noetia limula* *Nuculana acuta* *Parastarte* sp. *Strigilla carnaria* *Tellina* sp. *Transenella* sp.	*Eulimastoma?* sp. *Kurtziella* sp. *Nassarius acutus* *Olivella* sp. *Polinices* sp. *Terebra* sp.	barnacle fragments echinoid fragments
52.3 ft:	*Abra aequalis* *Chione cancellata* *Mysella* sp. *Noetia limula* *Nuculana acuta* *Parvilucina multilineata* *Raeta plicatella* *Tellina* spp.	*Anachis* sp. *Cylichnella biplicata* *Melanella* sp. *Nassarius acutus* *Odostomia* sp. *Olivella sp.* *Polinices* sp.	crab claws and carapace fragments echinoid fragments
61.4 ft:	*Abra aequalis* *Anadara transversa* *Nuculana acuta* *Mulinia lateralis*	*Anachis* sp. *Nassarius acutus* *Olivella* sp.	crab claws and carapace fragments echinoid spines

<u>Unit 1, Pliocene</u>

	Pelecypods:	Gastropods:	Miscellaneous:
278.3 ft:	*Rangia cuneata*	None	wood fragments
312.5 ft:	*Rangia cuneata*	None	None
340.0 ft:	*Rangia cuneata* *Mulinia lateralis*	None	None
357.5 ft:	*Mulinia lateralis*	two minute, indeterminate species	barnacle fragments
371.2 ft:	*Rangia cuneata*	None	None
371.3 ft:	*Rangia cuneata* ostreid fragment	None	None
376.1 ft:	*Rangia cuneata*	one minute, indeterminate species	None
380.2 ft:	*Rangia cuneata*	None	None
481.7 ft:	ostreid fragments	None	None

Table 4. Dinoflagellates in the Horn Island core.

Unit 3, Holocene: Counts of 300 in-place specimens, P = present.

51.5 ft (R4541L):

Lingulodinium machaerophorum	1.3%
Nematosphaeropsis rigida	0.7
Operculodinium spp.	P
Polysphaeridium zoharyi	86.7
Spiniferites spp.	8.3
Tuberculodinium vancampoae	0.3
Congruentidiaceae*	0.3

54.7 ft (R4541K):

Lingulodinium machaerophorum	3.0%
Nematosphaeropsis rigida	0.3
Operculodinium spp.	0.3
Polysphaeridium zoharyi	87.7
Spiniferites spp.	6.0
Tuberculodinium vancampoae	2.3
Congruentidiaceae*	0.3

61.8 ft (R4541J):

Lingulodinium machaerophorum	0.7%
Operculodinium spp.	0.3
Polysphaeridium zoharyi	92.3
Spiniferites spp.	6.3
Congruentidiaceae*	0.3

Unit 1, Pliocene: Counts of 300 in-place specimens, if available. P = present.

197.0 ft (R4541I):

Operculodinium spp.	P
Polysphaeridium zoharyi	P
Spiniferites spp.	P
Congruentidiaceae*	P
Pediastrum (freshwater alga)	P
reworked dinocysts	P

284.7 ft (R4541H):

Impagidinium paradoxum	P
Polysphaeridium zoharyi	P
intermediate *Spiniferites*-*I. fenestroseptatum*	P
Spiniferites spp.	P
Impagidinium fenestroseptatum	P
Congruentidiaceae*	P
Pediastrum (freshwater alga)	P
reworked dinocysts	P

354.3 ft (R4541G):

Operculodinium spp.	P
Polysphaeridium zoharyi	P
intermediate *Spiniferites-* *I. fenestroseptatum*	P
Spiniferites spp.	P
Impagidinium fenestroseptatum	P
Congruentidiaceae*	P
Pediastrum (freshwater alga)	P

358.2 ft (R4541F):

Spiniferites spp.	P
Impagidinium fenestroseptatum	P
Congruentidiaceae*	P
Pediastrum (freshwater alga)	P
reworked dinocysts	P

387.5 ft (R4541E):

Impagidinium fenestroseptatum	16.7 %
intermediate *Spiniferites-* *I. fenestroseptatum*	78.3
Tuberculodinium vancampoae	1.3
Congruentidiaceae*	2.7
indeterminate	1.0
Pediastrum (freshwater alga)	P, not counted
reworked dinocysts	P, not counted

457.3 ft (R4541C) (count of 88 specimens):

Hystrichokolpoma	3.4%
?Sumatradinium	0.3
Lingulodinium machaerophrorum	2.3
Nematosphaeropsis	1.1
Operculodinium spp.	6.8
Polysphaeridium zoharyi	31.8
Spiniferites spp.	30.7
Tuberculodinium vancampoae	2.3
Congruentidiaceae*	19.0
indeterminate	2.3
Pediastrum (freshwater alga)	P, not counted
reworked dinocysts	P, not counted

481.3 ft (R4541B):

?Batiacasphaera micropapillata	0.3
Impagidinium fenestroseptatum	3.3
intermediate *Spiniferites-* *I. fenestroseptatum*	5.7
Lingulodinium machaerophrorum	3.7
Nematosphaeropsis	0.7
Operculodinium spp.	0.3
Polysphaeridium zoharyi	61.3
Spiniferites spp.	22.0
Tuberculodinium vancampoae	P
Congruentidiaceae*	1.0
indeterminate	1.3
Pediastrum (freshwater alga)	P, not counted
reworked dinocysts	P, not counted

501.5 ft (R4541A):

Operculodinium spp.	P
Spiniferites spp.	P
reworked dinocysts	P

* Family Congruentidiaceae Schiller includes specimens referable to *Brigantedinium*, *Cristadinium*, *Lejeunecysta*, *Multispinula*, *Quadrina*, *Selenopemphix*, *Trinovantedinium*, and *?Xandarodinium*.

Table 5. Pollen in the Horn Island core.

Unit 3, Holocene samples (feet):		**51.5**	**54.7**	**61.7**
Arboreal pollen	Common Name of plant			
Pinus	Pine	67.7%	83.3%	71.3%
Quercus	Oak	14.0	9.0	17.0
TCT*	Cypress	6.3	1.7	0.7
Carya	Hickory	1.0	1.7	2.3
Alnus	Alder	0.0	0.3	P
Betula	Birch	0.3	0.3	0.7
Celtis	Sugarberry	1.3	0.0	0.0
Corylus	Hazlewood	0.3	0.3	P
Fraxinus	Ash	1.0	0.0	0.3
Ilex	Holly	0.3	0.3	0.7
Juglans	Walnut	0.3	0.0	0.0
Liquidambar	Sweet Gum	2.0	0.3	1.0
Magnolia	Magnolia	0.0	0.3	0.3
Myrica	Wax Myrtle	0.0	P	0.0
Nyssa	Tupelo/ Sour Gum	1.0	0.3	1.3
Ostrya/ Carpinus	Ironwood/eastern blue beech	0.3	0.0	0.0
Salix	Willow	0.3	P	0.0
Ulmus	Elm	0.3	P	P
Non-arboreal pollen	Common Name of plant			
Asteraceae	Aster family	0.3%	P	1.0%
Chenopodiaceae	Goosefoot/pigweed family	0.7	0.7	1.0
Cyperaceae	Sedge family	1.3	0.0	0.7
Ericaceae	Heath family	0.0	0.0	0.3
Euphorbiaceae	Spurge family	0.3	0.0	0.0
Leguminosae	Legume/bean family	0.3	P	0.0
Poaceae	Grass family	0.3	1.0	1.3
Typha	Cattails	0.0	0.3	0.0
Total pollen counted		300	300	300
Spores				
Trilete spores		2	3	6
Monolete spores		1	1	1
Sphagnum		2	1	0

(*Taxodiaceae, Cupressaceae, Taxaceae)

Unit 1, Pliocene samples (feet):		**197.0**	**284.6**	**354.2**	**358.2**	**387.5**	**401.7**	**457.2**	**501 .4**
Arboreal pollen	Common Name of Plant								
Pinus	Pine	17.7%	P	P	P	P	P	P	13.5%
Quercus	Oak	25.3	P	P	P	P	P	P	66.7
TCT*	Cypress	10.7	P	P	P	P	P	P	4.4
Carya	Hickory	9.3	P	P	P	P	P	P	2.4
Acer	Maple	0.0	P						0.0
Alnus	Alder	0.0	P		P		P		1.3
Annonaceae	Custard apple family	0.0						P	0.0
Betula	Birch	0.3	P						1.0
Castanea	Chestnut	0.0							0.7
Celtis	Sugarberry	0.3							0.7
Cercis	Redbud	0.0							0.7
Cornus	Dogwood	0.3	P						0.0
Corylus	Hazlewood	0.0	P		P		P		0.7
Fraxinus	Ash	0.3	P				P		0.3
Ilex	Holly	0.7	P	P			P		1.0
Juglans	Walnut	0.0	P	P	P	P		P	0.0
Lauraceae	Sassafras family	0.0						P	0.0
Liquidambar	Sweet gum	0.3	P	P	P	P	P	P	0.7
Magnolia	Magnolia	0.3	P				P		0.3
Nyssa	Tupelo/sour gum	0.7	P						0.0
Ostrya/ Carpinus	Ironwood/east. blue beech	P							0.0
Pterocarya	Wingnut	0.7	P				P	P	0.0
Salix	Willow	1.0	P	P		P	P		0.3
Symplocos	---	0.0			P				0.3
Tilia	Basswood	0.0				P			0.0
Ulmus	Elm	1.7	P	P	P	P	P	P	0.3
Non-arboreal pollen	Common Name of Plant								
Asteraceae	Aster family	5.0	P	P	P	P	P	P	0.0
Chenopodiaceae	Goosefoot/pigweed family	1.3	P	P	P	P	P	P	0.3
Combretaceae	Buttonwood family	0.3							0.0
Cyperaceae	Sedge family	2.7	P	P	P	P	P	P	2.0
Ephedra	Mormon tea	0.0				P			0.0
Ericaceae	Heath family	0.0	P						0.0
Itea	---	0.3							0.0
Labiatae	Mint family	0.0				P			0.0
Leguminosae	Legume/bean family	0.7	P		P	P			0.7
Poaceae	Grass family	18.3	P	P	P	P	P	P	1.7
Sagittaria	Arrowhead	1.3	P	P					0.0
Solanaceae	Tomato/potato family	0.0		P		P			0.0
Typha	Cattails	0.3	P			P			0.0
Umbelliferae	Parsley family	0.0			P	P			0.0
Total pollen counted		300							300
Spores									
Trilete spores		3	P	P			P		
Monolete spores				P	P		P	P	
Sphagnum		1							

(*Taxodiaceae, Cupressaceae, Taxaceae)