B. Physical Stratigraphy, Calcareous Nannofossil Biostratigraphy, and Depositional History of the Quaternary Sediments in the USGS-Belle Fontaine No. 1 Core, Jackson County, Mississippi

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Stratigraphic and Paleontologic Studies of the Neogene and Quaternary Sediments in Southern Jackson County, Mississippi

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ABSTRACT

A stratigraphic corehole, USGS-Belle Fontaine No. 1, drilled near the modern shoreline on Belle Fontaine Point in southwestern Jackson County, Mississippi encountered Quaternary coastal and marine sediments above fluvial-to-estuarine Neogene deposits. A Pleistocene section between depths of 47.5 ft and 25 ft consists of fossiliferous sands and clays assigned to the previously defined late Pleistocene Biloxi Formation. The lower part of the Biloxi consists primarily of interbedded sands and clays (sand-clay lithofacies) that are interpreted to represent the transition from offshore to shoreface sedimentation in a low-energy, wave-dominated coastal setting. An overlying, strongly bioturbated, massive-sand lithofacies is interpreted to represent low-wave-energy, lower-shoreface sedimentation. A rooted organic horizon at the top of the Biloxi has a radiocarbon age greater than 35,000 yrs.

A Holocene section between the top of the Biloxi Formation and the top of the core consists of poorly sorted muddy sands and sandy muds that represent barrier-spit sedimentation. A sample of disseminated plant material from the upper part of the Holocene section has a radiocarbon age of 2,540 yrs 120 yrs.

INTRODUCTION

Three stratigraphic test holes drilled during 1990 in southwestern Jackson County, Mississippi, are part of a U.S. Geological Survey (USGS) study of the Neogene and Quaternary geology of the Mississippi coastal area. Most of the sedimentary units encountered in these holes consist of sparingly fossiliferous fluvial-estuarine deposits (Gohn and Reinhardt, this volume). However, one of the holes, USGS-Belle Fontaine No. 1, (fig. 1) encountered a highly fossiliferous Pleistocene marine section overlain by Holocene coastal deposits adjacent to the modern shoreline at Belle Fontaine Point.

This report briefly discusses the physical stratigraphy, radiocarbon ages, calcareous nannofossil biostratigraphy, and depositional history of the Quaternary section in the Belle Fontaine No. 1 corehole. Reports on various fossil groups found in the Pleistocene section also are included as chapters in this volume, and the distribution of Quaternary sediments in other Jackson County drill holes is discussed by Otvos (this volume) and Gohn and Reinhardt (this volume). Preliminary lithologic logs for the three USGS Jackson County coreholes were published by Gohn and others (1992).

Belle Fontaine Point constitutes much of the coastline of Mississippi Sound, a shallow polyhaline estuarine system (Eleuterius, 1976, 1978), between Ocean Springs and the mouth of the Pascagoula River (fig. 1). The Belle Fontaine corehole is located in section 13, township 8S, range 8W, on the landward side of a narrow Holocene coastal barrier. The surface elevation of the top of the Belle Fontaine corehole is 6 ft.

Acknowledgments. We thank Ervin G. Otvos and the staff of the Gulf Coast Research Laboratory, Ocean Springs, MS, for their assistance during USGS field studies. We also thank the Mississippi Bureau of Geology for geophysically logging the Jackson County coreholes.

PREVIOUS WORK

The Quaternary geology of coastal Jackson County and surrounding areas is described in a series of articles by E.G. Otvos (including Otvos, 1973, 1975, 1976, 1982, 1991, this volume, and Otvos and Howat, 1992). Otvos recognizes a single onshore cycle of late Pleistocene coastal and marine sedimentation along much of the northeastern Gulf of Mexico Coastal Plain. This cycle is represented by a tripartite group of sedimentary units deposited during a period of high sea level during the last interglacial stage; Otvos has formally designated these largely coeval units as the Biloxi, Gulfport, and Prairie Formations. The extent of older Pleistocene deposits is very limited in southeastern Mississippi and adjacent areas (Otvos 1991, this volume; Otvos and Howat, 1992), unlike the widespread and semi-continuous Pleistocene units that typify the seaward areas of the Atlantic Coastal Plain.

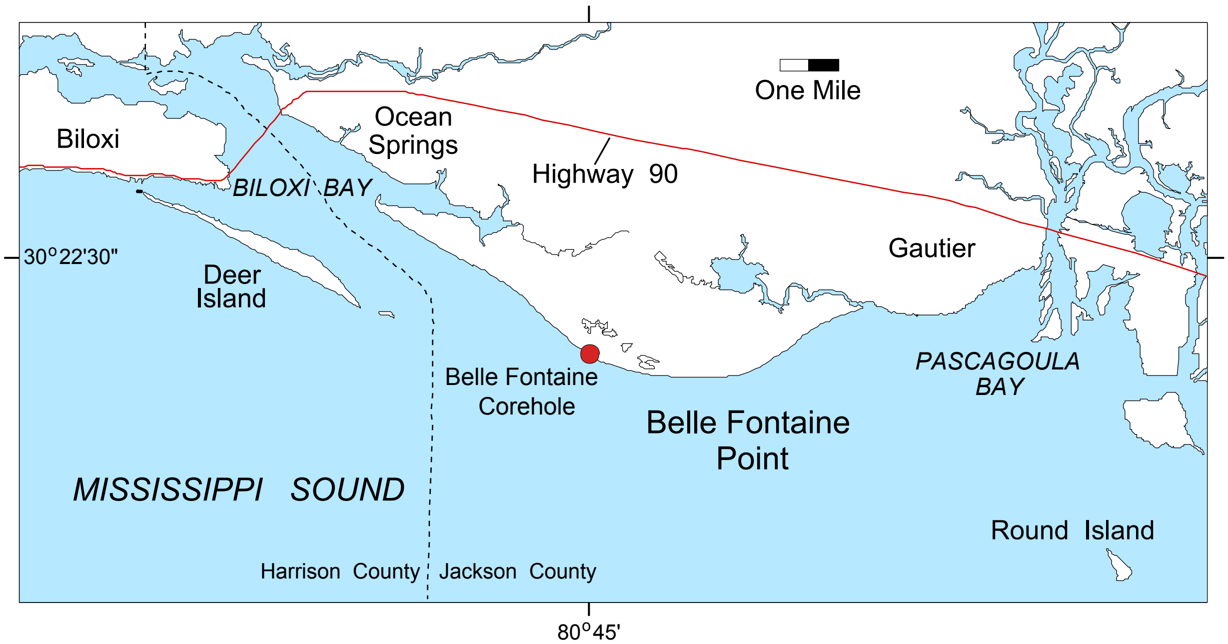


Figure 1. Location of the USGS-Belle Fontaine No. 1 stratigraphic corehole in Jackson County, Mississippi.

The Gulfport Formation typically consists of 10 to 30 ft of well-sorted fine-to-medium quartz sand that constitute a discontinuous series of dune-covered, progradational barriers or strandplains located immediately landward of the modern shoreline in Mississippi, Alabama, and the Florida panhandle (Otvos, 1982; Otvos and Howat, 1992). The geomorphic expression of the Gulfport Formation in the Belle Fontaine area is the Pleistocene barrier shown on figure 2.

A marine facies of the Biloxi Formation gradationally underlies the barrier/strandplain sands of the Gulfport Formation and extends seaward under Mississippi Sound. This marine facies typically consists of 10 to 25 ft of macro- and microfossiliferous, slightly muddy, fine to medium sand with subordinate amounts of fossiliferous fine-grained sediment (Otvos, 1975, 1982, this volume; Otvos and Howat, 1992). Landward of the Gulfport Formation barriers, a relatively thin, sparingly fossiliferous section underlies the low-relief Prairie terrace (fig. 2). Fluvial sediments in the upper part of this section are assigned to the Prairie Formation, while underlying, locally *Crassostrea*-bearing sediments are assigned to an estuarine facies of the Biloxi Formation (Otvos, 1973, 1982, this volume; Otvos and Howat, 1992).

The Holocene geology of the Belle Fontaine coastline also has been described by Otvos (1973, p. 55-56; 1982, p. 52-54, fig. 30) and Oivanki and Otvos (1994). The principal coastal features are an eroding Pleistocene headland and a westward-prograding spit and associated tidal marsh (fig. 2).

The lithologies and the positions of the contacts in the upper 50 ft of the USGS-Belle Fontaine No.1 corehole (fig. 3) closely match the section illustrated by Otvos and Howat (1992, fig. 4) and Otvos (this volume, figs. 11, 12) in a nearby corehole on Belle Fontaine Point. The shelly marine section in the USGS core between depths of 47.5 ft and 25.0 ft is readily assigned to the Pleistocene Biloxi Formation (Otvos, 1975), which is equivalent to the lower part of informal unit GB of Gohn and Reinhardt (this volume). Poorly sorted muddy sands and sandy muds between the top of the Biloxi and the top of the hole constitute the Holocene spit-marsh section.

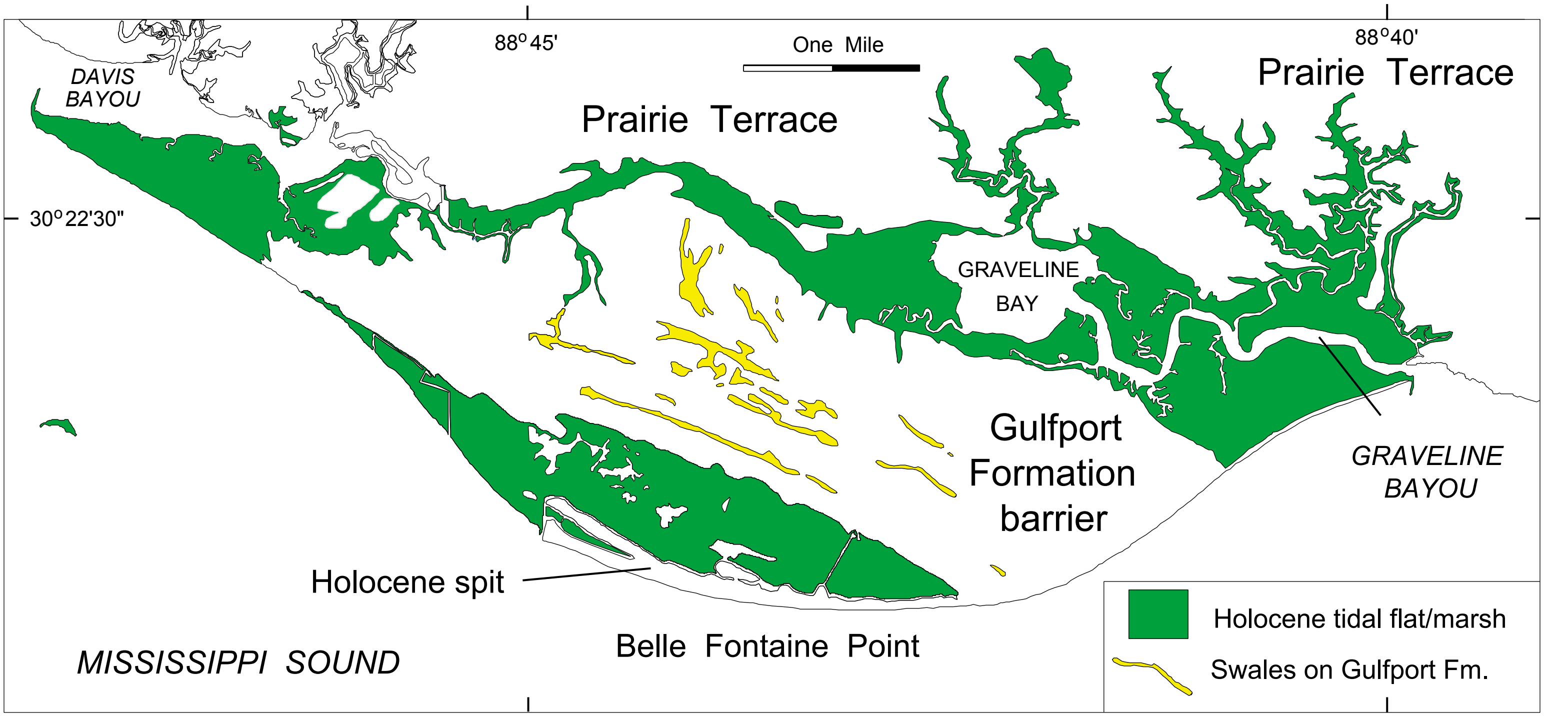


Figure 2. Generalized geomorphic map showing the principal land features in the Belle Fontaine area.

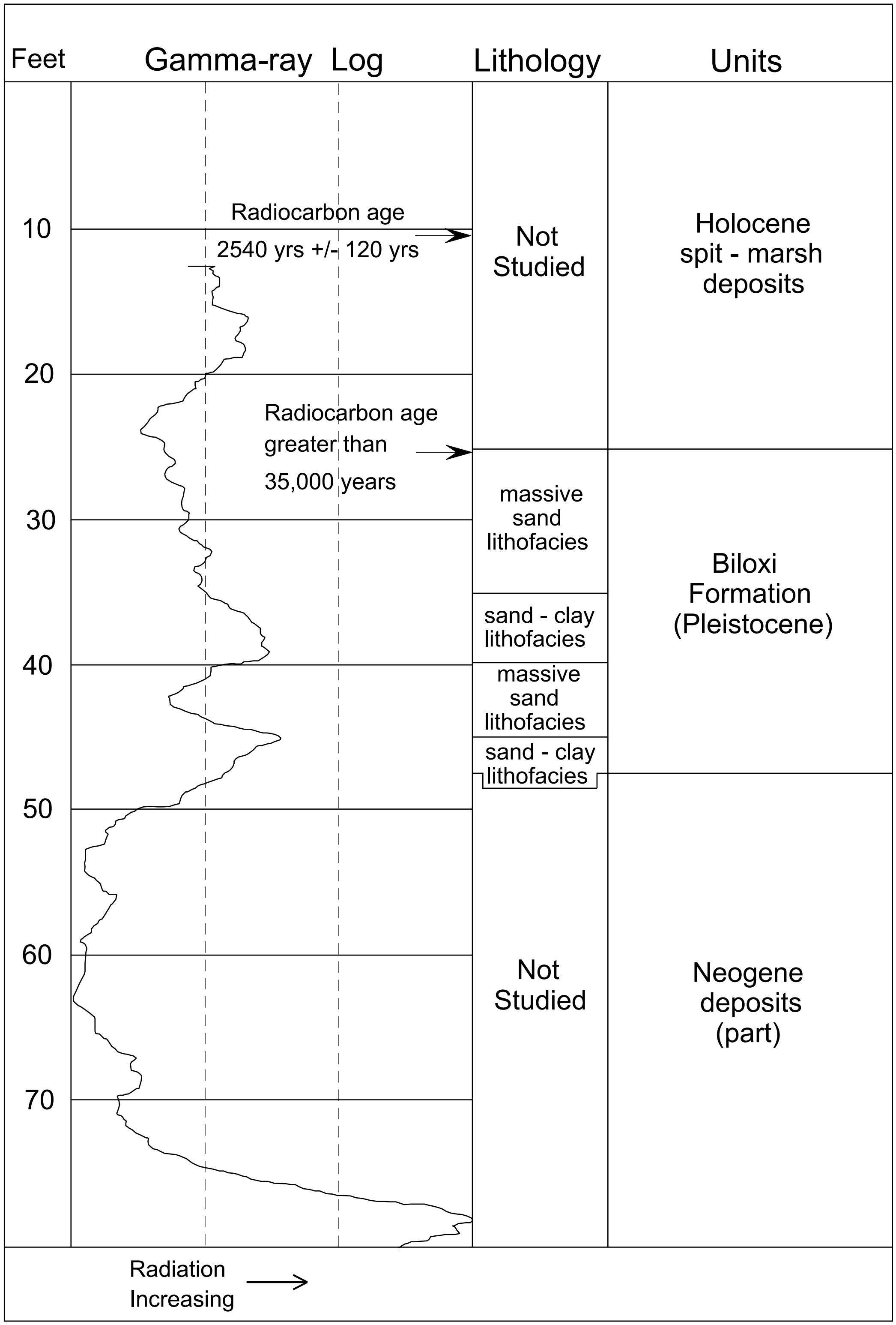


Figure 3. Stratigraphy, lithologies, radiocarbon ages, and gamma-ray log for the upper 80 feet of the USGS Belle Fontaine No. 1 corehole.

BILOXI FORMATION (PLEISTOCENE)

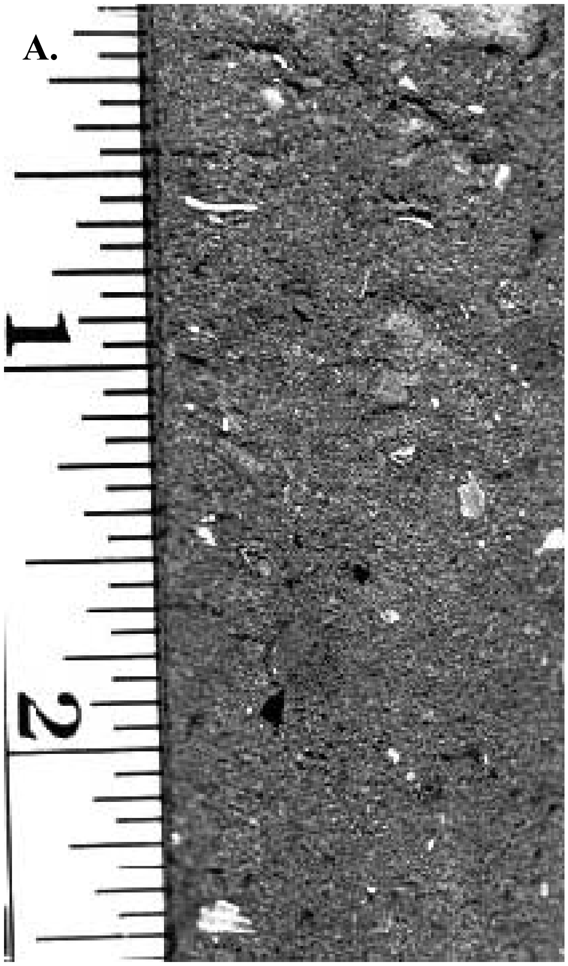
Contacts and Lithology

In the USGS Belle Fontaine core, the lower contact of the Biloxi Formation is at a depth of 47.5 ft between greenish-gray, shelly, muddy, very fine to medium sand at the base of the Biloxi and very pale orange, sparingly fossiliferous, very fine to medium sand at the top of an underlying Pleistocene(?) section (fig. 3; also see plate 1 of Gohn and Reinhardt, this volume). The upper contact of the Biloxi Formation is at a depth of 25 ft between a thin layer (approximately 2 in. thick) of very fine to medium sand containing abundant plant material (wood and roots) at the top of the Biloxi and overlying poorly sorted, muddy, very fine to coarse sand containing very sparse, sand-sized mollusk fragments. A 7-in-long root extends down from the plant-rich layer into the more typical shelly sand of the Biloxi. The abundance of mollusks in the Biloxi and their paucity in the underlying and overlying sections are readily apparent in the Belle Fontaine core. Approximately 72 percent of the Biloxi section was recovered in cores.

The Biloxi Formation consists of two contrasting lithologies: moderately well-sorted to well-sorted, fossiliferous quartz sand; and fossiliferous silty and sandy clay. These lithologies are arranged in two distinct lithofacies: 1) interbedded sands and clays, and 2) massive sands (fig. 3). The interbedded sand-clay lithofacies is present between 47.5 ft and 44.9 ft and between 39.8 ft and 35.0 ft. The massive-sand lithofacies is present between 44.9 ft and 39.8 ft and above 35.0 ft.

Sands and clays are interbedded at scales of a few inches to 1.5 feet in the sand-clay lithofacies. The fine-grained beds consist of calcareous, silty and locally sandy (very fine to fine) clay containing common mollusks and microfossils. The mollusks occur as disseminated whole valves and as sand-sized and larger fragments. No physical sedimentary structures were seen; most of the clay is massive or faintly texture mottled, suggesting thorough bioturbation. Sparse to locally common subvertical, 0.5-inch-wide, sand-filled tubes, which are probably assignable to *Planolites*, are the only discernable burrow type (fig. 4). Dry colors of the clay vary from greenish-gray to light-olive-brown. Sands in the sand-clay lithofacies are shelly and microfossiliferous, somewhat muddy (about 20 percent clay plus silt), and very fine to fine grained. They have sharp basal contacts that are disrupted by burrows. Their upper contacts are difficult to locate exactly because of sand-clay mixing caused by *Planolites*. Clay intraclasts up to 1.5 in. typically are present in the basal few inches of most sands. Few sedimentary structures are discernible in these beds; inch-thick zones of low-angle laminations defined by aligned sand- and granule-sized shell fragments are present near the bases of two beds. Dry colors of these sands vary from light olive gray and olive gray to light olive brown and light brown.

Figure 4. Photographs of cores from the Biloxi Formation. Scales in inches.

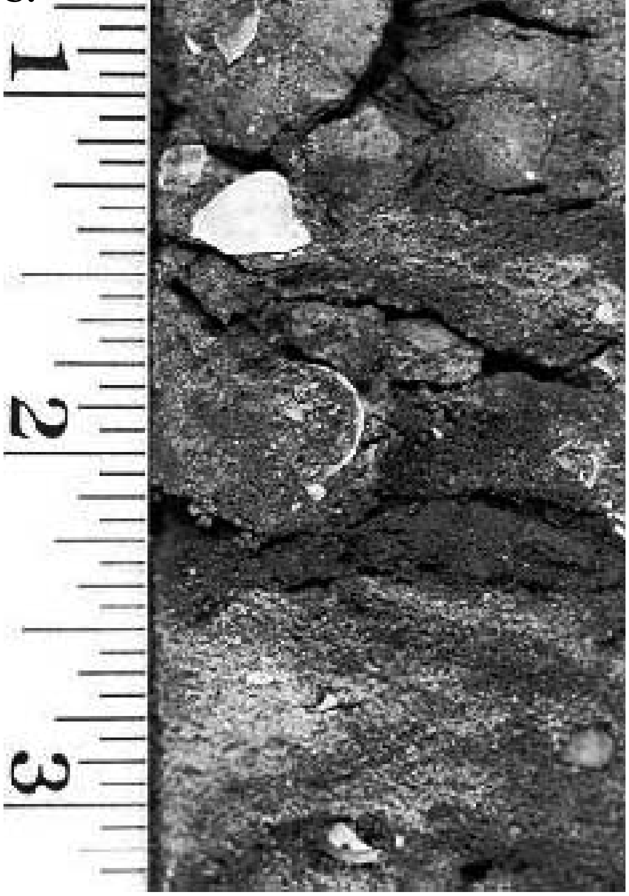


a. Shelly sand in the massive-sand lithofacies. Mollusks (generally light colored) and lignite fragments (dark) are scattered throughout the interval. Small clay blebs probably represent truncated clay-lined burrows. Sample from a depth of 33.1 ft.

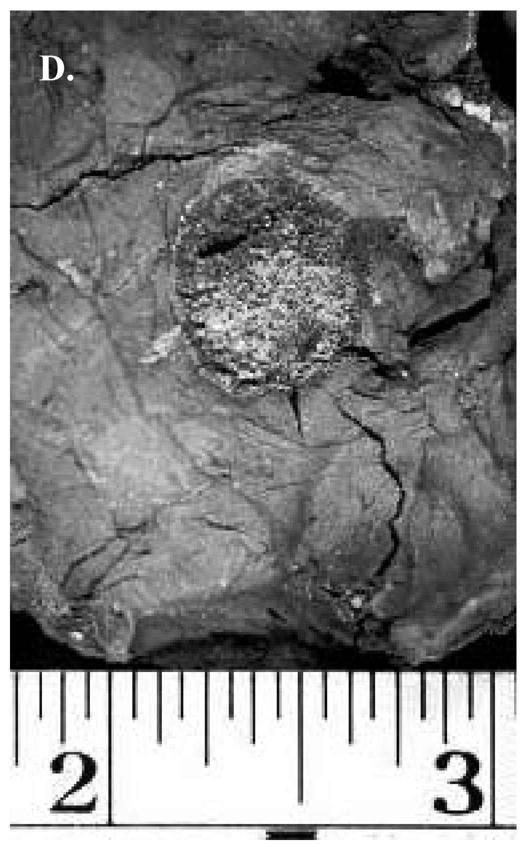
b. Cross-sectional view of core segment showing mollusk valves in the massive-sand lithofacies. Sample from a depth of 31.3 ft.

Figure 4, continued.

C.



C. Shells and clay intraclasts in sand. Sample from the base of the upper section of the massive-sand lithofacies at 34.9 ft.



D. Cross-sectional view of core segment from the sand-clay lithofacies showing a lined, sand-filled burrow in silty clay. Sample from a depth of 37.6 ft.

The section of the massive-sand lithofacies between depths of 44.9 ft and 39.8 ft was poorly recovered in cores. The available samples consist of slightly muddy to well-sorted, very fine to fine-grained (locally very fine to coarse-grained) sand that is shelly only in certain layers. Very few physical sedimentary structures were seen; however, irregular clay stringers and blebs in various orientations probably represent truncated clay-lined burrows. These burrows, as well as pervasive texture and color mottling, suggest thorough bioturbation. The basal contact at 44.9 ft is sharp with 0.5 inches of relief. Low-angle laminations defined by aligned sand- and granule-sized shell fragments are present in a thin zone a few inches above this contact. Dry colors of this sand section vary from yellowish gray to light brownish gray to to light olive gray.

Above the depth of 35.0 ft, sands of the massive-sand lithofacies are variably very fine to fine grained, very fine to medium grained, or very fine to coarse grained, and are somewhat muddy (typically about 20 percent clay plus silt). Mollusks are common to locally abundant and range in size from sand-sized fragments to whole valves (fig. 4); microfossils are similarly abundant. Detrital wood fragments up to one inch are sparse to locally abundant. Clay intraclasts up to 1.5 inches are present just above the sharp basal contact at 35.0 ft (fig. 4).

No physical sedimentary structures are discernible in the sand above 35 ft; shells in this interval are randomly oriented. Sparse, irregular clay stringers and blebs similar to those seen between 44.9 ft and 39.8 ft also probably represent truncated clay-lined burrows (fig. 4). Judging from these fabric elements, the Biloxi sands above 35 ft have been thoroughly bioturbated. Dry colors of these sands vary from medium light gray to light olive gray.

Biostratigraphy and Age

Four calcareous nannofossil samples were collected from the Biloxi Formation (48.8 ft, 44.8 ft, 44.3 ft, and 39.3 ft). All four samples contain common calcareous nannofossils (one specimen per 1 to 10 fields of view through a Zeiss photomicroscope at 500 X magnification); preservation of the calcareous nannofossil specimens is fair. Species diversity was low in all four samples with a maximum of five species present, and each sample had essentially the same species representation: *Braarudosphaera bigelowii*, *Gephyrocapsa* small species, *Gephyrocapsa* large species, *Helicosphaera carteri*, and possible medium-sized representatives of the genus *Reticulofenestra* (Table 1). The *Reticulofenestra* specimens are questioned because, without examination with a scanning electron microscope, they could be *Gephyrocapsa* specimens with the crossbar missing. While it is impossible to be highly confident about the age of the Biloxi Formation because of this limited assemblage, the greatest probability is that the unit is middle to late Pleistocene in age.

Table 1. Calcareous nannofossil species discussed in this report:

Braarudosphaera bigelowii (Gran & Braarud, 1935) Deflandre, 1947
Calcidiscus macintyrei (Bukry & Bramlette, 1969) Loeblich & Tappan, 1978
Discoaster brouweri Tan Sin Hok, 1927
Emiliania huxleyi (Lohmann, 1902) Hay & Mohler in Hay et al, 1967
Gephyrocapsa caribbeanica Boudreaux & Hay, 1969
Gephyrocapsa oceanica Kamptner, 1943
Helicosphaera carteri (Wallich, 1877) Kamptner, 1954
Helicosphaera sellii Bukry & Bramlette, 1969) Jafar & Martini, 1975
Pseudoemiliania lacunosa (Kamptner, 1963) Gartner, 1969

Based on the presence of large specimens of the genus *Gephyrocapsa*, the Biloxi Formation can be no older than the very latest Pliocene. This statement requires some additional explanation of *Gephyrocapsa*. Individual small species of the genus *Gephyrocapsa* are very difficult, if not impossible, to distinguish with the light microscope and are even difficult to distinguish with the scanning electron microscope. No attempt was made to differentiate these species in the Biloxi Formation samples. Small species of *Gephyrocapsa* first occurred in the Pliocene and are present in the modern ocean. In addition, there is a significant amount of confusion and disagreement among calcareous nannofossil experts concerning the distinguishing characteristics of many large as well as small species within *Gephyrocapsa* (Perch-Nielsen, 1985).

Gephyrocapsa oceanica and *Gephyrocapsa caribbeanica* are two large species within this genus. Calcareous nannofossil experts agree that these species first appear within Zone NN 19 or Zone NN 20 (fig. 5) and that *Gephyrocapsa oceanica* probably evolved after *Gephyrocapsa caribbeanica* (Pujos-Lamy, 1977a; Okada & Bukry, 1980; Perch-Nielsen, 1985). Berggren and others (1985b) placed the first appearance datum (FAD) of *G. caribbeanica* at 1.74 Ma and the FAD of *G. oceanica* at 1.68 Ma. Specimens in the Bell Fontaine core more closely resemble *Gephyrocapsa oceanica* than *Gephyrocapsa caribbeanica*, but not confidently so. The first occurrence of *G. oceanica* has been variously described from near the base of Zone NN 19 (Martini 1971; Gartner, 1977), near the middle of Zone NN 19 (Okada and Bukry, 1980), and within Zone NN 20 (Pujos-Lamy, 1977a, b). It appears safest to assume that the presence of large *Gephyrocapsa* species indicates an age from lower Zone NN 19 to recent (fig. 5). Both large species are present in modern oceans.

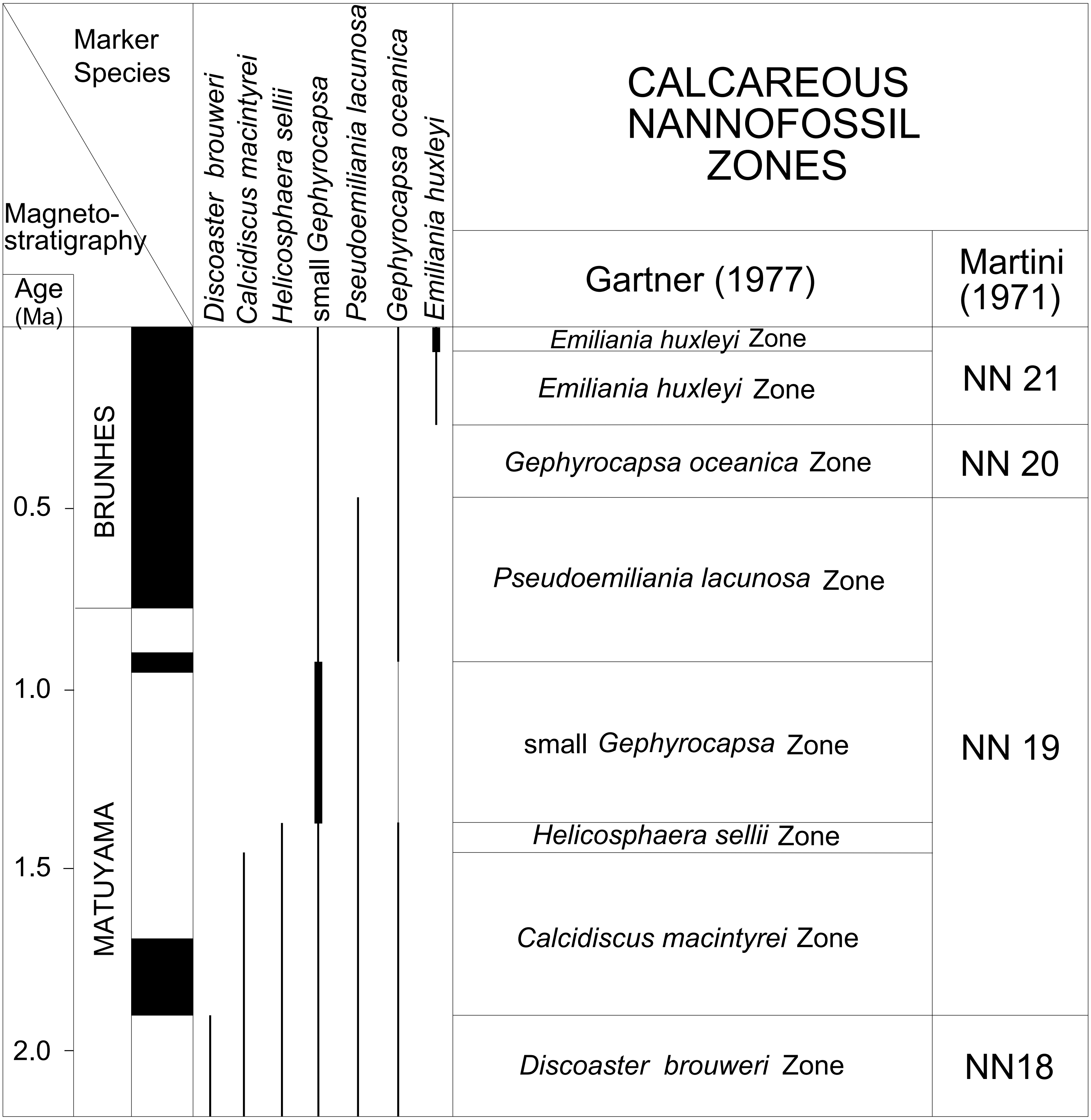


Figure 5. Calcareous nannofossil zonation for the Pleistocene and latest Pliocene.

The genus *Discoaster* does not extend above Zone NN 18, and extinction of the species *Discoaster brouweri* defines the top of Zone NN 18. This extinction occurred at 1.9 Ma, according to Berggren and others (1985b). There were no specimens of the genus *Discoaster* present in the Biloxi samples, which indicates an age equivalent to that of Zone NN 19 or younger zones.

The base of Zone NN 19 was traditionally used as the base of the Pleistocene until Berggren and others (1985a) placed the base of the Pleistocene within the lower part of Zone NN 19. Therefore, according to those authors, the lowest part of Zone NN 19 still could be within the Pliocene.

However, neither *Calcidiscus macintyrei* nor *Helicosphaera sellii* are present in the examined samples. These two robust species, which are fairly resistent to dissolution, have their last occurrences within the lower part of Zone NN 19 (fig. 5; Gartner, 1977). Berggren and others (1985b) place the last appearance datum (LAD) of *C. macintyrei* at 1.45 Ma and the LAD of *H. sellii* at 1.37 Ma. If their absence is indeed accurate, then the Biloxi Formation is younger than the lower part of Zone NN 19.

Gartner (1977) recognized that, within the middle of Zone NN 19, there is an interval in which the large gephyrocapsas decrease significantly in abundance, and the assemblage is dominated by small gephyrocapsas (fig. 5). This does not occur in the examined Bell Fontaine core samples, there are essentially equal numbers of large and small gephyrocapsas. Thus, it appears that the Biloxi Formation is younger than the middle of Zone NN 19.

To continue, the last occurrence of *Pseudoemiliania lacunosa* defines the top of Zone NN 19. Berggren and others (1985b) placed this event at 474 ka. The absence of this commonly occurring species from the Biloxi Formation indicates placement within either Zone NN 20 or Zone NN 21.

The first appearance of *Emiliania huxleyi* defines the base of Zone NN 21; Berggren and others (1985b) place this event at 275 ka (fig. 5). There is an acme zone for this species that is used to subdivide Zone NN 21; according to Berggren and others (1985b), this event began at 85 ka in low-latitude waters and at 73 ka in mid-latitude waters and continues to the present. *E. huxleyi* was not observed in the Biloxi samples. However, *E. huxleyi* also is not present in any Zone NN 21 samples below the acme zone in my (LMB) extensive set of middle Atlantic Coastal Plain Pleistocene samples. If conditions at this time in Mississippi were at all similar to those along the Atlantic coast, then the absence of *E. huxleyi* might indicate only the absence of the Zone NN 21 acme zone and possible placement within the lower part of Zone NN 21, that is from 275 to 73 ka (Berggren and others, 1985b). In summary, it appears most likely that the Biloxi Formation samples are either within middle Pleistocene Zone NN 20, which according to Berggren and others (1985b), extends from 474 ka to 275 ka, or in the lower part of the late middle to late Pleistocene Zone NN 21 between 275 ka and 73 ka..

Mollusk and microfossil assemblages from the Biloxi Formation are compatible with a late Pleistocene age. Many of the Biloxi ostracode species in the Belle Fontaine core also occur in sediments of late Pleistocene and Holocene age in Corpus Christi Bay, Texas, (Cronin, 1986, this volume), whereas characteristic Neogene and early Pleistocene ostracode species of the Atlantic Coastal Plain are not present in the studied Biloxi assemblages. Although many of the identified molluskan species in the Biloxi Formation range throughout the Neogene and Quaternary, the Biloxi assemblages at Belle Fontaine most closely resemble late middle to late Pleistocene assemblages of the Atlantic and Gulf Coastal Plains (Wingard, this volume).

A segment of a root associated with the layer of plant material at the top of the Biloxi Formation yielded a radiocarbon age of greater than 35,000 yrs (USGS radiocarbon sample W-6265). Given this minimum age, and the position of the rooted zone at the top of a late Pleistocene highstand-marine section, it is likely that this organic zone represents the subaerial accumulation of plant material following the peak of highstand-marine sedimentation (Biloxi Formation) during the late Sangamonian to early Wisconsinan.

Sedimentary History

The distribution of sands and clays in the Biloxi Formation at Belle Fontaine Point suggests a shoaling-upward pattern of nearshore-marine sedimentation associated with a prograding shoreline. Deposition of this section of the Biloxi is interpreted in the context of the well-known Galveston Island, Texas, model for progradational beach-to-offshore sedimentation (summarized by McCubbin, 1982).

Models for wave-dominated nearshore sedimentation typically recognize four energy regimes and associated lithofacies: the offshore area (shelf), the shoreface, the foreshore, and the backshore (fig. 5). Unfortunately, unanimity on the definitions of these regimes has not been reached; for example, compare the differences in terminology among Howard (1972), McCubbin (1982), Reinson (1984), and Walker (1984). In this report (fig. 6), the area below (seaward of) the storm wave base is called the offshore area; the area between storm wave base and fairweather wave base is called the offshore-shoreface transition zone; and the area from fairweather wave base to mean low water is called the shoreface. The foreshore area is the ocean-facing intertidal zone.

In the lower part of the Biloxi (fig. 3), the alternating sand beds and clay beds of the sand-clay lithofacies represent the offshore-shoreface transition zone. The bioturbated, shelly clays represent slow, low-energy shelfal sedimentation below fairweather wave base. The erosive bases and erosional intraclasts of the interbedded sands suggest comparatively rapid storm-wave redeposition of sand eroded from shoreface and foreshore environments. The paucity of remnant physical sedimentary structures in these sands indicates thorough fairweather bioturbation between infrequent storms.

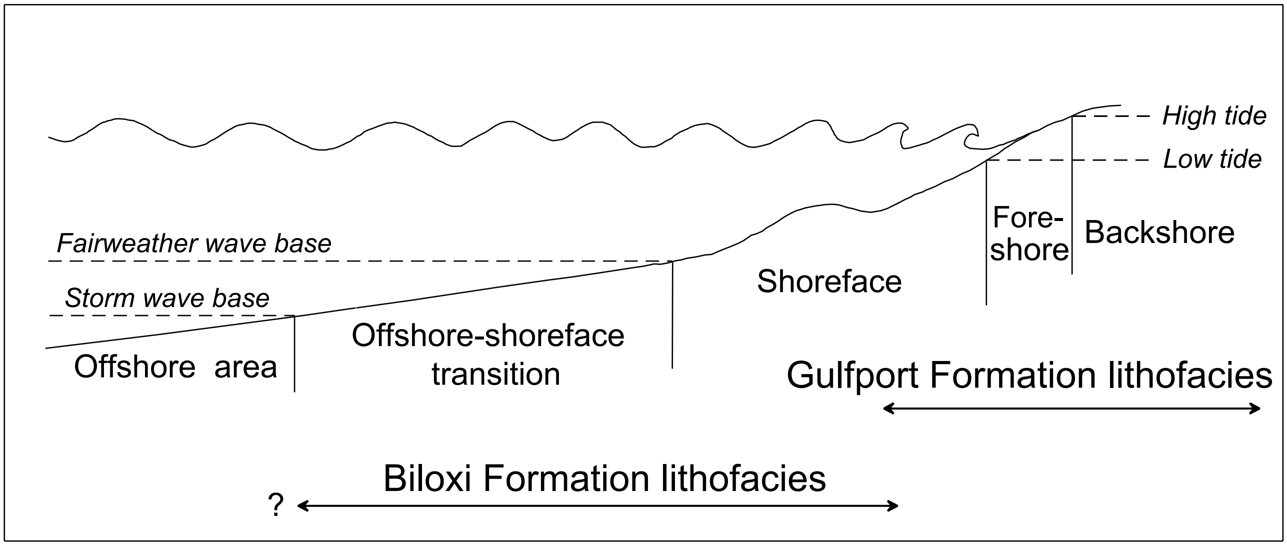


Figure 6. Depositional model for the Biloxi and Gulfport Formations at Belle Fontaine Point. Adapted from figures and discussions in Reinson (1984), Walker (1984), and McCubbin (1982).

Higher in the Biloxi, the massive sand lithofacies represents lower-shoreface sedimentation above the fairweather wavebase. The dominance of bioturbation over physical sedimentary structures in this Biloxi lithofacies is similar to that seen in the lower-shoreface section of the Galveston Island model (McCubbin, 1982, figs. 4, 22, 24). The Galveston Island sequence is characterized by a thin stratified upper-shoreface section underlain by a thick, sandy, bioturbated lower-shoreface section, which is in turn underlain by interbedded offshore sands and clays (transition-zone of this report). The dominance of bioturbation in the lower-shoreface sections at Galveston Island and in the Biloxi Formation is a consequence of a routinely low-energy wave regime (except for infrequent hurricanes and other strong storms).

The presence of a sand-dominated shoreface interval at 44.9 ft to 39.8 ft within the transition zone sand-clay section (fig. 3) may reflect changes in the position of the associated shoreline. Alternatively, this sandy interval may represent bioturbated longshore-bar deposits.

Upper-shoreface, foreshore, and backshore deposits are not recognizably present in the Biloxi Formation at Belle Fontaine, probably owing to erosion along the base of the overlying Holocene section. Lithofacies representing these paleoenvironments likely constitute the overlying Gulfport Formation (figs. 2, 5) where it is preserved inland of the Holocene coastal deposits (for example, see the Gulfport Formation described by Otvos and Howat, 1992, Table 3).

The mollusk and ostracode assemblages of the Biloxi indicate sedimentation in polyhaline to euhaline coastal paleoenvironments as well as euhaline shelf paleoenvironments (Wingard, this volume; Cronin, this volume). The apparent mixing of these faunas is compatible with storm-wave erosion of shoreface, foreshore, and perhaps tidal-inlet and open-bay deposits and their redeposition further offshore.

HOLOCENE SECTION

Lithology

The Holocene section in the Belle Fontaine core consists of 25 ft of silty and clayey sand, silty and sandy clay, and minor well-sorted sand (fig. 3). These lithologies are arranged into upper and lower sand-dominated sections separated by a finer grained section. Although microfaunas were not studied from the USGS core, Oivanki and Otvos (1994) report Foraminifera assemblages dominated by agglutinated forms from the Holocene sections in their nearby drill holes 10 and 16. Approximately 50 percent of the Holocene section was recovered in cores.

At the bottom of the Holocene section, cores recovered between depths of 25 ft and 19 ft consist of friable, color-mottled, muddy, very fine to coarse sand. This poorly sorted deposit contains a trace amount of detrital, very fine to fine mica and sparse to locally common rootlets. These sediments are mottled pale yellowish brown and very pale orange. Very sparse, chalky, sand-sized mollusk fragments in the lower two feet of this section may have been reworked from the underlying shelly Pleistocene section. Above this poorly sorted sand, a finer grained interval between depths of 19 ft and 10.5 ft is documented by the available cores and the gamma-ray log (fig. 3). Cores collected from the upper part of this interval consist of compact, sandy clay containing locally common, disseminated, sand-sized plant debris and common branching, unlined, sand-filled burrows. The clay varies from dark greenish gray to medium gray, and the sand-filled burrows vary from light brownish gray to light brown.

The upper sand-dominated interval consists of friable, silty and clayey, color- and texture-mottled, very fine to coarse sand that contains common disseminated plant debris in its lower part. Burrows (or possibly root casts) filled with better sorted fine to coarse sand are common throughout this section, which is mottled brownish gray and yellowish gray.

Age

The section above the depth of 25 ft is barren of calcareous fossils except for mollusk fragments in the basal two feet, which are not biostratigraphically useful and are probably reworked from the Biloxi Formation. Palynomorphs were not studied from this unit. However, a sample of disseminated plant material concentrated from muddy sand at a depth of 10 ft to 10.5 ft has a radiocarbon age of 2,540 yrs 120 yrs (USGS radiocarbon sample W-6266), thereby establishing the late Holocene age of this unit.

Sedimentary History

The Holocene section in the Belle Fontaine corehole is interpreted as part of a laterally prograding, spit complex, in agreement with the interpretation of Otvos (1973, 1982) and Oivanki and Otvos (1994), and with the distribution of modern sedimentary environments at Belle Fontaine Point. As shown in figure 2, the modern shoreline of Belle Fontaine Point between Graveline Bayou and Davis Bayou consists of several contrasting segments. An eroding Pleistocene headland, consisting of the barrier complex of the Gulfport Formation, constitutes the 1.5-mile-long segment immediately southwest of the tidal marshes in Graveline Bayou (Otvos and Howat, 1992; Oivanki and Otvos, 1994). Long-term average historic erosion rates in the range of 1 to 3 ft/yr, or greater, appear typical for this headland (Otvos, 1973, p. 56; 1982, p.52-53; Meyer-Arendt, 1991; Oivanki and Otvos, 1994).

The central part of Belle Fontaine Point, where the USGS-Belle Fontaine No. 1 corehole is located, is a low, narrow Holocene barrier spit that is attached at its eastern end to the Pleistocene headland; elsewhere, this spit is separated from the Pleistocene barrier by a Holocene tidal marsh (fig. 2). This broadly curved, dune-covered, terminally bifurcating spit was produced by the westward littoral drift of sediment contributed by the eroding headland and probably by the Pascagoula River (fig. 1). Considering the fine-grained and poorly sorted character of the Holocene section in the Belle Fontaine core, and the position of the corehole on the landward side of the spit, it is likely that this section primarily represents tidal-marsh and tidal-flat sedimentation. The western part of the Belle Fontaine shoreline consists of a continuation of the tidal marsh associated with the westward-advancing spit, the western terminus of the Pleistocene (Gulfport Formation) barrier, and the tidal marshes of Davis Bayou (fig. 2).

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