THE INFLUENCE OF SEA LEVEL RISE ON THE HISTORY OF ESTUARINE ENVIRONMENTS IN SOUTHWEST FLORIDA

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INTRODUCTION

Sea level has been rising since the last glacial maximum, 18,000 years ago, in response to global warming and thermal expansion, inundating ancient shorelines and creating those seen today. In South Florida, this rise has not been constant (Scholl, 1969; Wanless et al., 1994). The fastest rise rate (greater than 23 cm per 100 years) continued until 5500 years ago, slowing to 23 cm per 100 years until 3200 years when sea level rise slowed again to 4 cm per 100 years (figure 2 in Savarese et al., herein). The more recent, slower rate has allowed shorelines to stabilize. This stabilization led to the present-day coast, characterized by mangroves that have outpaced the rate of sea level rise (Parkinson, 1987, 1989).

This unique geomorphology depends upon a sea level rise of modest rate, however, some studies suggest sea level rise could be returning to the faster rate of as much as 20 to 40 cm per 100 years (Maul and Martin, 1993; Wanless et al., 1994). Understanding the response of coastal systems to previous changes in rise rate will help predict the potential consequences if rise rate again increases.

Estero Bay and River, located in Lee County, Florida, are part of an estuarine system of mangrove and barrier islands, and oyster reefs (Figure 1). The goals of this study were to examine changes in Estero Bay's geomorphology over time in response to sea level rise and to compare these changes with those seen in the Ten Thousand Islands area, a region in the westernmost Everglades (Parkinson, 1989; other papers in this volume). Radiocarbon dates show that as much as 4345 years are represented in the cores.

METHODS

A total of 10 3-inch diameter gravity cores, with depths ranging from 1 to nearly 4 meters, were taken along an offshore to onshore transect within Estero Bay and Estero River using both manual and vibracore techniques. An offshore to onshore transect was chosen in order to capture the changes in sea level rise throughout the river and estuary system. Five cores were taken inside the bay, and five were taken either near, at the base of, or beyond the mangrove fringe along the river.

Cores were cut lengthwise and sedimentary facies were defined based on sediment type, abundance and type of shell material, color and grain size of sediment, and sedimentary structures.

The following sedimentary analyses were conducted when appropriate: radiocarbon dating via AMS and standard counting through Beta Analytic of Miami using shell material from 4 identified facies; coarse grain

Fig. 1. Map showing location of Estero Bay and River on the Southwest Coast of Florida, located south of Fort Myers. Core transect is indicated with a white line.

sieve analysis (Figure 2); fine grain sedimentary analysis by pipette method (Figure 2); percent carbonate by selective acid dissolution of carbonates; percent organics by oxidation at 550°C ignition loss; and fossil identification.

RESULTS

All cores include a sequence of interlaminated, white fine sand with little or no shells or marine indicators. In all but one core, this sequence appears in the lower portion of the core.

In the cores closest to the Gulf (1, 5, 6 and 9), the interlaminated fine sand sequence is capped by either very fine sand or fine sand with marine or brackish mollusks (Figure 3). In Cores 2, 4 and 7 (located along the river or near the mouth), the sequence is overlain by mangrove peat. In Cores 3 and 10 (both at the river's mangrove fringe) the sequence is located near the top of the core, directly above estuarine sediments with oysters, and topped by mangrove peat in Core 3 and detrital mud in Core 10.

The upper portions of the cores vary throughout. Cores 1 and 9 (most seaward cores) include coarse silt with vermetids, giving way to coarse silt with oysters. Cores 1, 5 and 6 (middle bay) include shoal sediments in the uppermost facies, while Cores 2 and 7 (river mouth) have very fine sand with abundant mollusks. The sites of cores 3, 4 and 8 (river sites) are currently colonized by mangroves and include peat at the top.

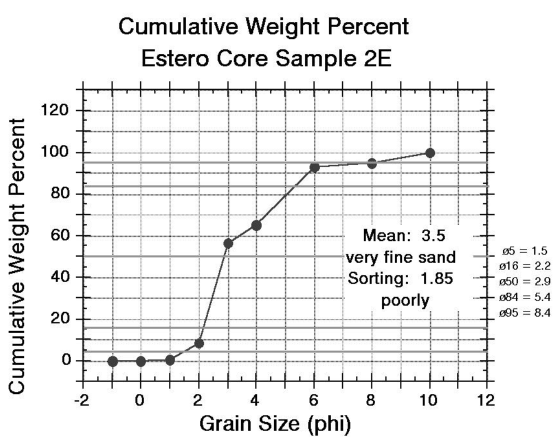

Fig. 2. Chart showing cumulative weight percent and grain size distribution from near the top of Core 2, Facies E, as determined from coarse-grain sieve and fine-grain pipette sedimentary analyses.

Radiocarbon dates

Shells from 4 locations within 3 cores were used to obtain calibrated intercept radiocarbon dates. The results are reported below, with depths below the sediment surface for each sample:

Core 1, 80-90 cm, 2880 ybp (+/- 80)

Core 1,165-175 cm, 4345 ybp (+/- 40)

Core 2, at 65 cm, 1260 ybp (+/- 40)

Core 3, at 177 cm, 2400 ybp (+/- 80)

Using these dates and the depth of the initial flooding surface from present-day sea level in Cores 1 and 2, a rise rate of 5.2 cm/100 years was calculated.

CONCLUSIONS

An inundation/transgression of Estero Bay can be seen in all 10 cores as supratidal and subaerial sediments give way to either mangroves or bay environments, and grain size becomes finer moving up through the bottom portions of the cores (Figure 3). In the case of Cores 3 and 10, the sequence begins at bedrock, shifting to subaerial sediments and then immediately to oysters. The encroaching sea has pushed back the environments in the Estero Bay and River system.

This transgression occurs through approximately 2,400 to 2880 ybp, when the location of the most seaward Cores 1 and 9 (now located in the middle of the bay) was an open coastal environment, characterized by coarse silts with vermetid gastropods present. Vermetids require salinities of at least 25 ppt, strong currents for bringing food and hard substrate to colonize (Shier, 1969). This, coupled with the grain size of the facies where vermetids appear, indicates a deeper water, marginal environment. These facies are found in no other cores, suggesting this area was in a deeper subtidal setting that never extended to the location of the other cores. The transgression can also been seen clearly in Cores 3 and 10 (now located at the edge of the river's mangrove fringe), once the site of low intertidal oysters.

Evidence also exists for a regression due to progradation of mangroves as the rise rate of sea level slowed. The vermetid facies give way to oysters, and in Core 1 the coarse silt and oysters give way to a very fine sand shoal environment. In Cores 3 and 10, a supratidal environment overlies the oyster environment and mangroves are ultimately able to colonize this region. The timing of this slow down is between 2400 and 2880 ybp based on radiocarbon dates in Cores 1 and 3, which is consistent with the timing of the slow down in other studies (Wanless et al., 1994).

This progradation of Estero Bay's coastline is consistent with the model developed by Parkinson (1987, 1989) in the Ten Thousand Islands region, and further documented by other papers herein. The calculated sea level rise rate of 5.2 cm/100 years found in this study is comparable to that found for the same time period in other studies (Wanless et al., 1994).

There is some evidence to suggest this area may no longer be prograding due to an acceleration of sea level rise. The most landward core was taken in an area that was a freshwater marsh, but is now being colonized by white mangroves. In Cores 2 and 7, mangrove peat lies in the middle of the core, and is overlain by bay sediments founded on a shell-rich tempestite. This suggests the mangrove forest in this area may have been destroyed by a storm and did not re-establish. If indeed sea level rise rate is returning to 20 to 40 cm/100 years, as some studies suggest, the characteristic mangrove island geomorphology of Southwest Florida may be unable to keep pace and could begin to degrade.

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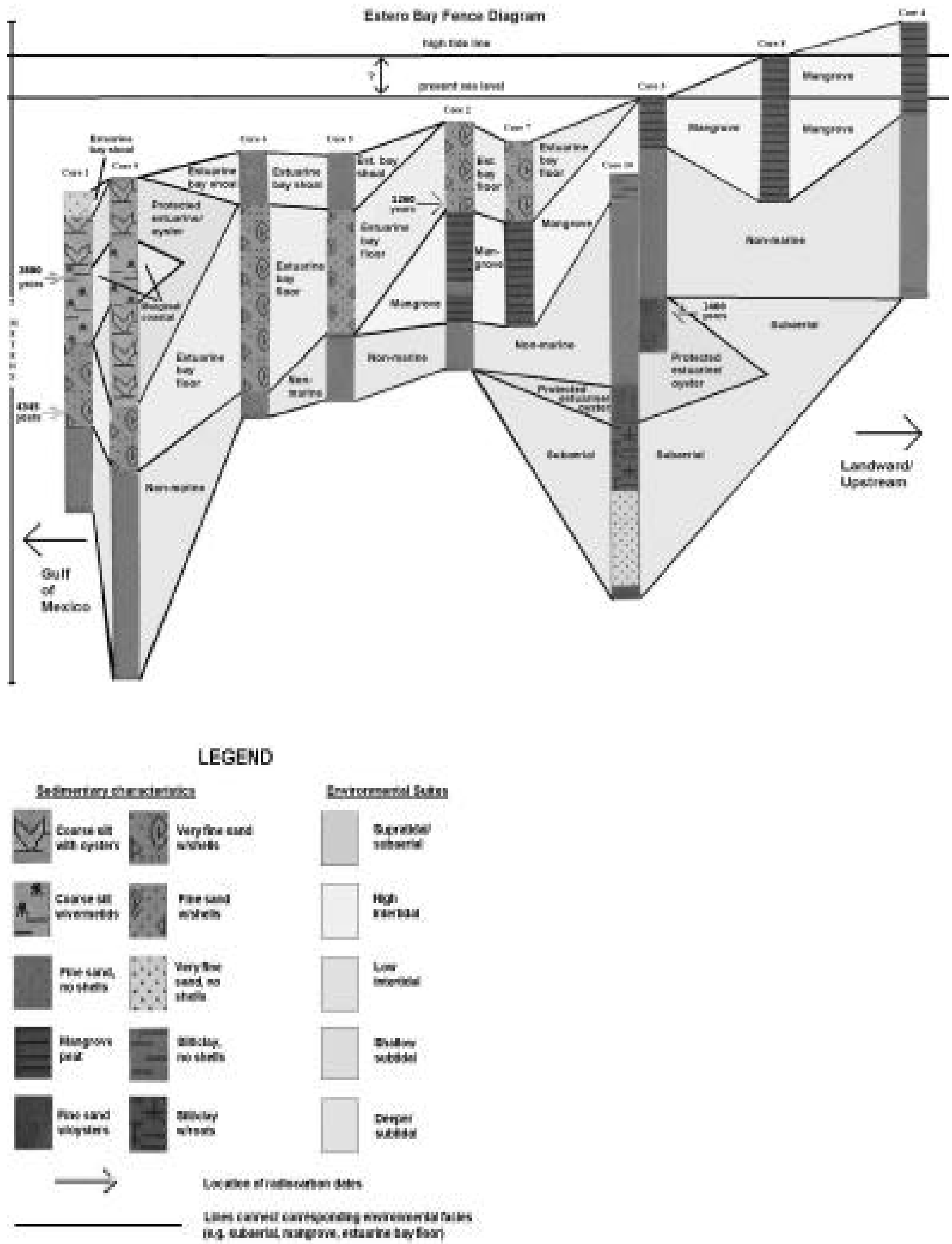

Fig. 3. Fence diagram showing sediment characteristics of each core, correlation of facies between cores, and correlation of general environmental suites of all cores.