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West-Central Florida Coastal Transect # 8: Siesta Key

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Introduction

A major goal of the West-Central Florida Coastal Studies Project was to investigate linkages between the barrier-island system along the west coast of Florida and offshore sedimentary sequences. High population density along this coastline and the resultant coastal-management concerns were primary factors driving the approach of this regional study. Key objectives were to better understand sedimentary processes and sediment accumulation patterns of the modern coastal system, the history of coastal evolution during sea-level rise, and resource assessment for future planning. A series of nine "swath" transects, extending from the mainland out to a depth of 26 m, was defined to serve as a focus to merge the data sets and for comparison of different coastal settings within the study area.

Transect #8 crosses Siesta Key south of Big Sarasota Pass (see location map to right). Information from seismic and vibracore studies is combined to derive a 2-D stratigraphic cross section extending from the offshore zone, through the barrier island, and onto the mainland. This stratigraphic record represents the late Holocene evolution of the coastal-barrier system and inner shelf following the last sea-level transgression and present highstand conditions. A comparison to surface-sediment distribution patterns indicated by side-scan sonar imagery and bottom grab samples illustrates the importance of spatial variability in sediment-distribution patterns offshore when considering stratigraphic interpretations of seismic and core data.

Methods

The primary data sets used in this study were collected from 1993 to 1998. Geophysical surveys included high-resolution single-channel "boomer" seismic data and 100-kHz side-scan sonar imagery (Locker and others, 2001). Most of the reconnaissance seismic and side-scan sonar data were acquired during two offshore cruises in 1994. Bottom sediments (N series) were collected during cruises using an underway grab sampler at 4-km intervals along track. Additionally, a continuous-coverage side-scan sonar mosaic in the inner-shelf area, 3.5 kHz subbottom profiles and numerous underway bottom samples (M series) were collected in 1995 (Twichell and Paskevich, 1999; Twichell and others, 2000). Offshore core locations were selected based upon seismic data and were focused in areas likely to contain sufficient sediment thickness for core retrieval (Brooks and others, 1999). Vibracores from the barrier island and probe data provided stratigraphic control in the barrier-island and bay areas.

The four panels showing location and side-scan sonar imagery, seismic data, and a stratigraphic cross section are at the same horizontal scale. The seismic profile and cross-section panels were constructed by fitting the data along the labeled cross-section turns (location map panel) that have been projected downward to the straight cross-section line. Subtle differences in the horizontal scale of segments in the cross section due to this projection are minimal. The horizontal scale, as well as vertical exaggeration of the seismic profile and cross section, are the same for all nine transects in the map series in order to facilitate comparison among transects.

Geologic History and Morphodynamics of Barrier Islands

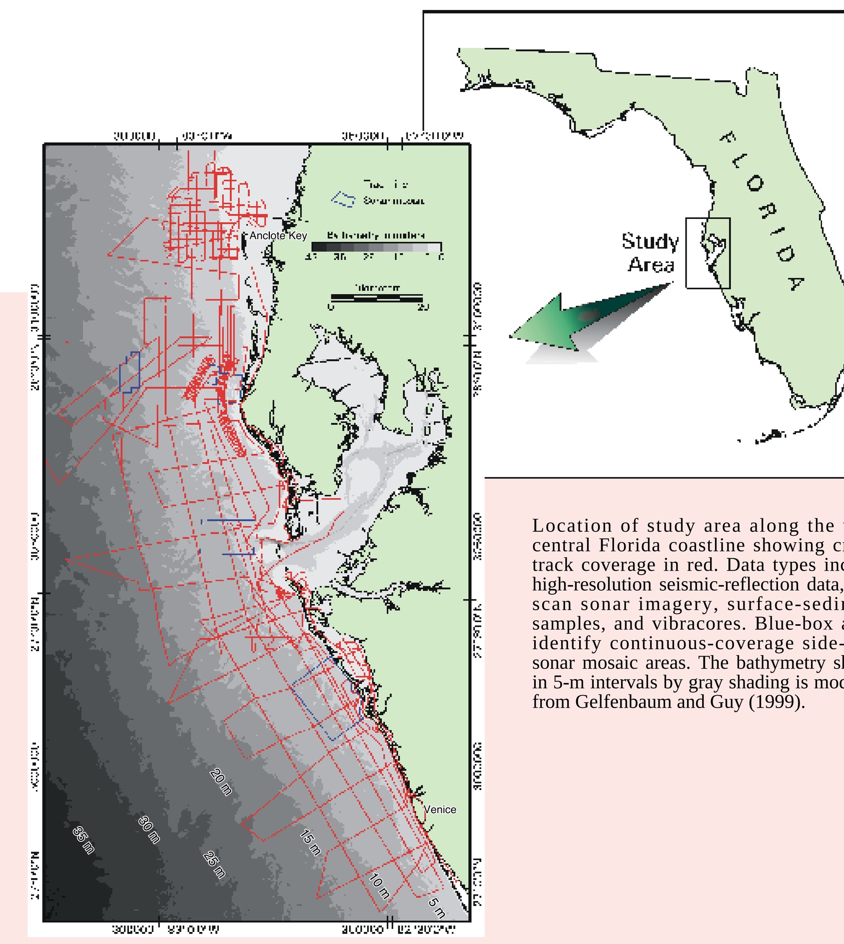
Barrier islands on the west-central Gulf coast of Florida display a wide range in morphology along the most diverse barrier/inlet coast in the world (Davis, 1994). In addition, the barriers have formed over a wide range of time scales from decades to millennia. The oldest of the barriers have been dated at 3,000 years (Stapor and others, 1988) and others have formed during the past two decades. The barrier system includes long, wave-dominated examples as well as drumstick barriers that are characteristic of mixed wave and tidal energy. Historical data on the very young barriers and stratigraphic data from coring older ones indicate that the barriers formed as the result of a gentle wave climate transporting sediment to shallow water and shoaling upward to intertidal and eventually supratidal conditions. The barriers probably formed close to their present position and several have been aided in their location and development by antecedent topography produced by the shallow Miocene limestone bedrock (Evans and others, 1985). The two most important variables that control barrier-island development along the coast are the availability of sediment and the interaction of wave and tidal energy.

Siesta Key

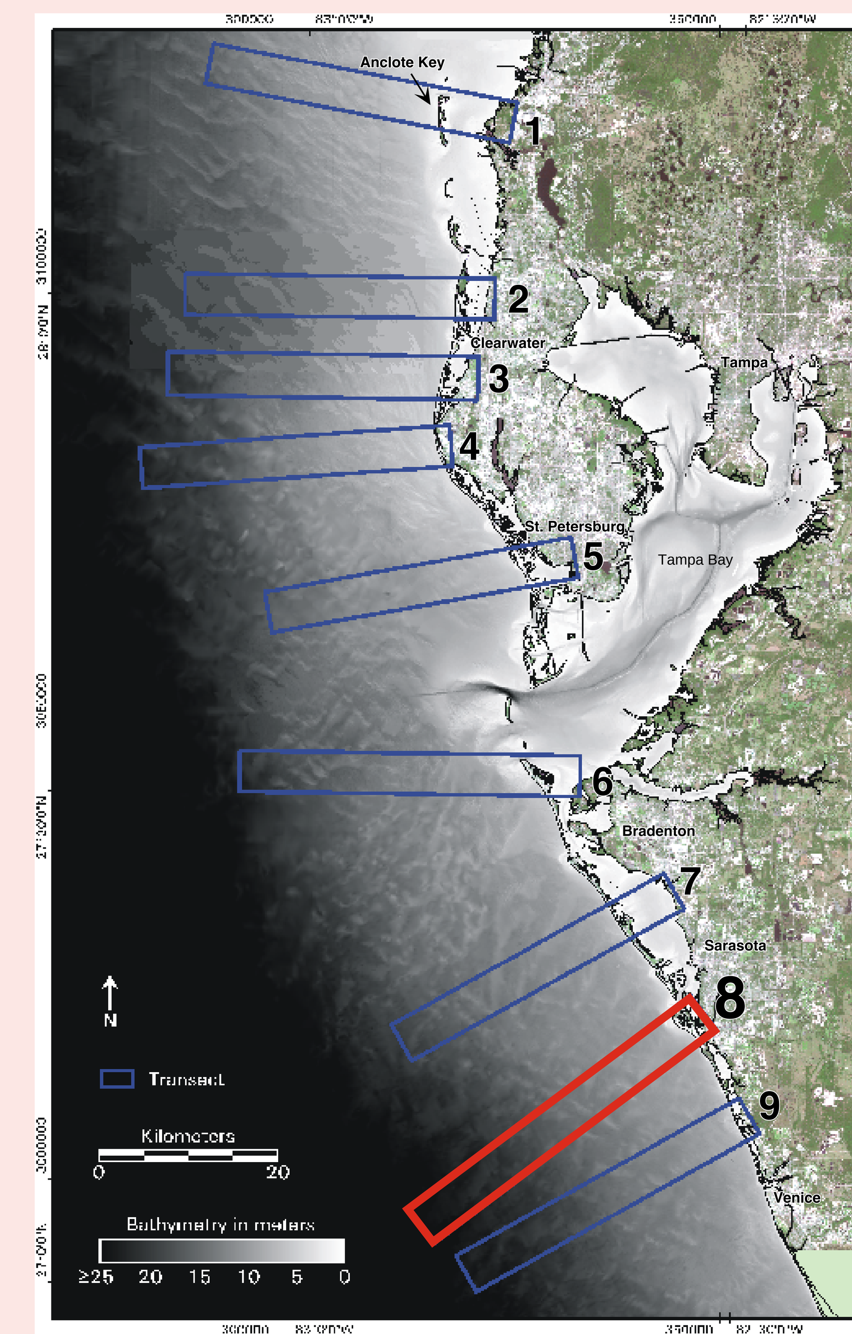
Siesta Key is a pronounced drumstick barrier island with multiple generations and orientations of beach-ridge sets. Development is essentially complete on the northern part of the island and has included dredging of numerous channels to provide water access for residents. These activities have obscured the geomorphology of the island. Nevertheless, Stapor and others (1988) were able to define several sets of beach ridges and obtained numerous radiocarbon dates of shells from these ridges. They found that the oldest beach-ridge set is 3,000 YBP and is located near the center of the island, landward of Point O'Rocks (see aerial photo below), where dates of 4,300 to 1,900 YBP have been obtained from "beachrock" that extends from present mean sea level to -2.5 m (Spurgeon, 1997).

The stratigraphic cross section (lower right) extends across the northern, widest portion of Siesta Key where Stapor and others (1998) determined that two ridge sets had ages of 1,000-500 YPB on the landward portion, and less than 500 YBP on the Gulfward set. Clean sand and shell make penetration difficult, and only one of the cores on the cross section penetrated into a distinctly pre-island unit. This organic-rich, muddy sand is at about 4 to 5 m below present sea level and is interpreted to represent a vegetated paralic environment. Overlying the muddy sand is a series of interfingering facies that represent backbarrier, washover, beach and nearshore environments progressing from the landward, older side of the island to the Gulfward, younger side. Dune ridges cap the island.

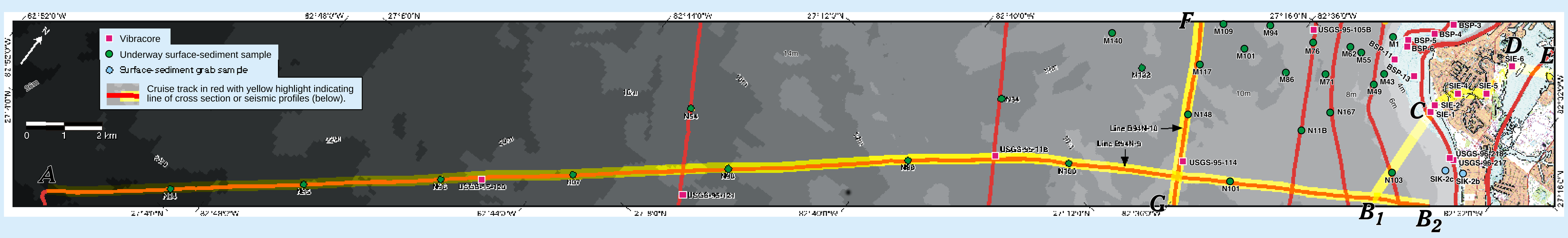
The ebb-tidal delta at Big Sarasota Pass has been cored in detail (Kowalski, 1995) and shows two distinct facies; shelly sand and sandy shell gravel. Gravels represent channel-margin and floor environments and sand dominates on the shoals and platform of the tidal delta.



Location of study area along the west-central Florida coastline showing cruise-track coverage in red. Data types include high-resolution seismic-reflection data, side-scan sonar imagery, surface-sediment samples, and vibracores. Blue-box areas identify continuous-coverage side-scan sonar mosaic areas. The bathymetry shown in 5-m intervals by gray shading is modified from Gelfenbaum and Guy (1999).



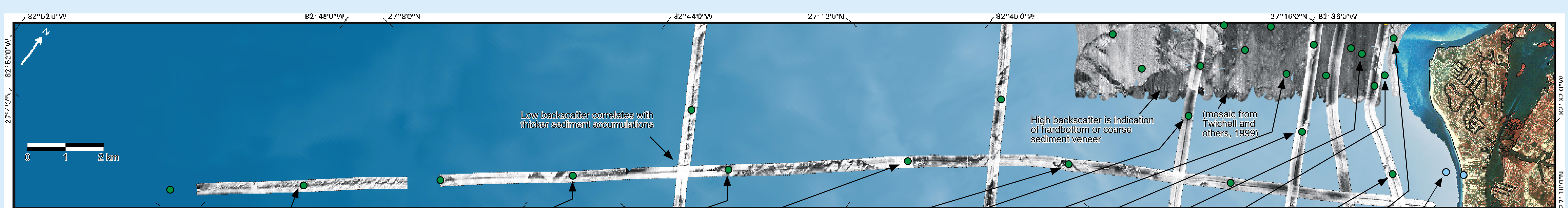
Location of west-central Florida coastal-transect maps with Transect #8 shown in red. 1997 LANDSAT TM imagery of Florida's west coast is merged with a bathymetric-surface model (Gelfenbaum and Guy, 1999). Bathymetric trends offshore in part reflect sediment-distribution patterns. The study area extends from Anclote Key to Venice, FL.



Location map

Location map shows bathymetry, cruise-track coverage, core and sample locations, and location of figures. The beach has accreted seaward at the location of the transect cross section. The transect cross section A-E is presented below. An expanded view of the island portion of the transect C-D is shown at lower right. A seismic section F-G is at lower right.

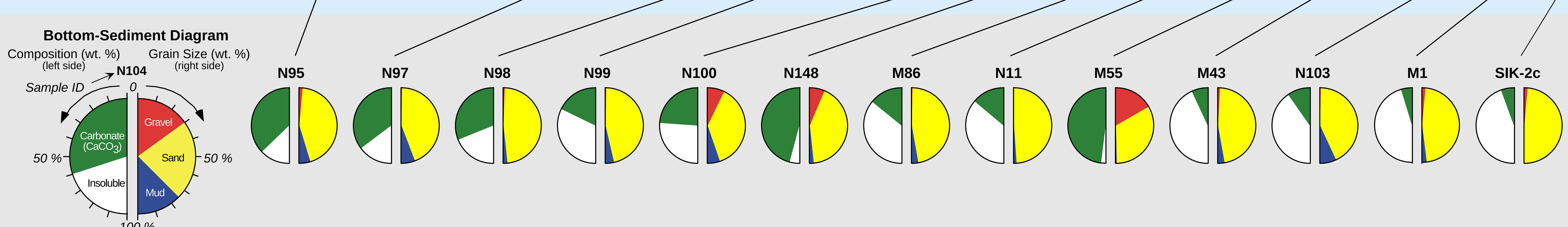
Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic. Bathymetry in 2-m intervals starting at 4 m. Land areas represented by USGS 7.5-Minute Topographic Map.



Side-scan sonar

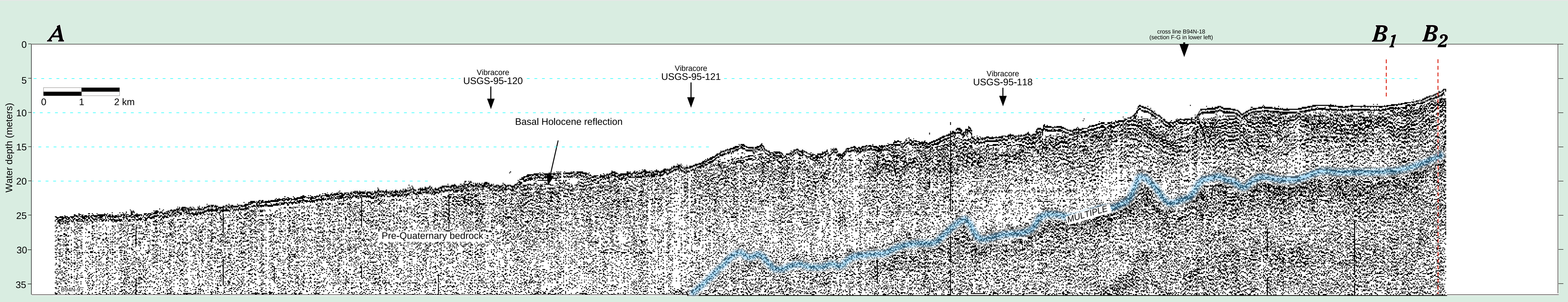
Side-scan sonar imagery overlain on continuous-tone bathymetry indicates northeast-trending sand-ridge morphology is most common throughout the inner shelf in this region. Surface-sediment cover is thin and exhibits a patchy and discontinuous distribution. Low backscatter (light gray) areas are most common and are largely dominated by siliciclastic quartz sand. The dark (high backscatter) areas are largely coarse sediment veneer with increased carbonate material (primarily shell material), or some hardbottom. Phosphatic sands also appear to correlate with higher backscatter.

Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic. Bathymetry (areas > 4 m) after Gelfenbaum and Guy (1999). Coastal areas (< 4 m) represented by Digital Orthophoto Quarter Quadrangle (1995).



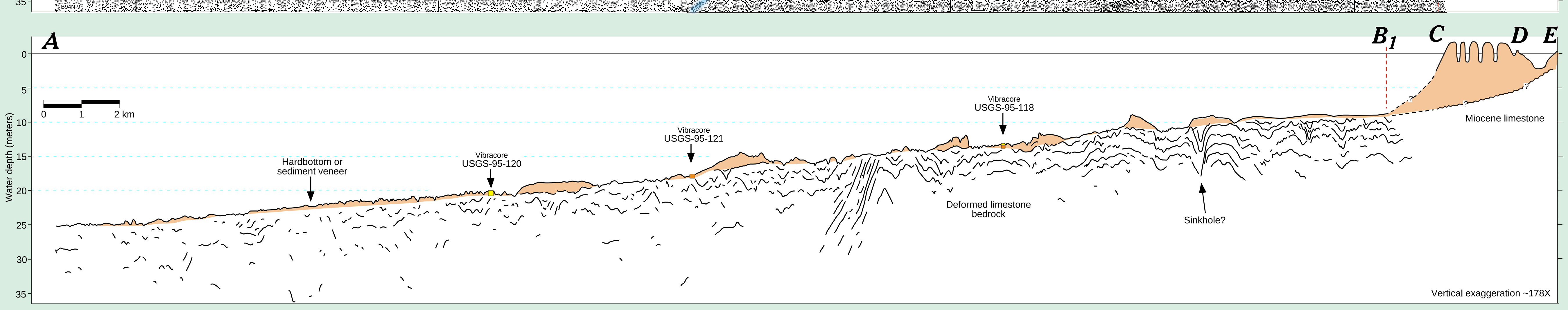
Surface sediments

Grain-size and composition data for bottom grab samples are presented below the sonar imagery. Samples generally consist of carbonate sand and gravel with subordinate amounts of quartz. Quartz-rich sands are noticeable in the inner portion of the transect. In general, the low acoustic backscatter correlates with medium to fine siliciclastic sand with minor carbonate grains - the higher backscatter areas correlate with coarse grain size and increased carbonate.



Seismic profile

Uninterpreted seismic profile reveals several Holocene sand ridges with good basal Holocene reflections marking the top of Pre-Quaternary bedrock. These ridges are separated by 1-km-or-greater expanses of sea floor where sediment thickness decreases below the level of detection (approximately 0.5 m). Sand ridges are less than 2 to 3 m thick, corresponding with the higher-relief portions of the sand waves or ridges seen here. Somewhat better subbottom penetration shallower than the 20-m isobath reveals deformed bedrock strata typical of isolated shelf-valley structures found in the nearshore zone south of Tampa Bay (see transect #6 for example of shelf valley).

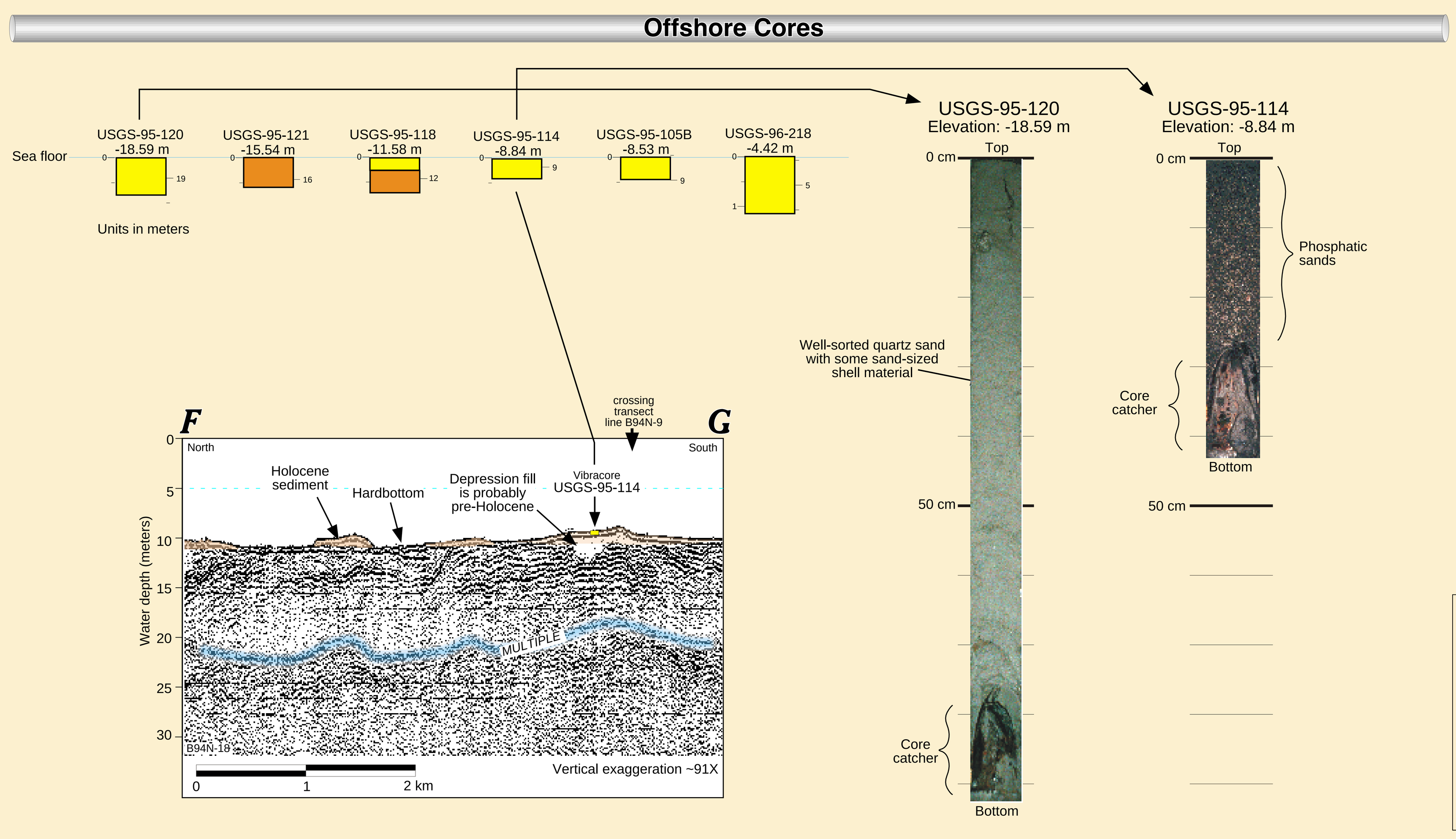


Transect cross section A-E

Integrated stratigraphic cross section combining line-drawn interpretation of seismic data, ground-truthed by coring, with a coastal cross section based on vibracores. Cores in the offshore transect have no cross-shelf correlation potential due to orientation and separation of ridge deposits, shown in side-scan sonar imagery and bathymetry data. This transect line indicates very little sediment offshore because most of the sediment volume in this coastal system resides in the barrier-island section. The natural geometry of the drumstick barrier has been significantly altered by development.

Oblique aerial photograph of Big Sarasota Pass taken in 1997. The island transect section (C-D) is shown here with vibracore interpretations presented below. The extensive development on this wide prograding end of the barrier has obliterated the numerous prograding beach ridges that characterize a drumstick barrier. Natural migration of Big Sarasota Pass to the south has led to seawall fortifications on the north end of Siesta Key. However, beach accretion occurs 1 km south of the inlet, in part due to inlet bypassing around the ebb-tidal delta.

Offshore Cores

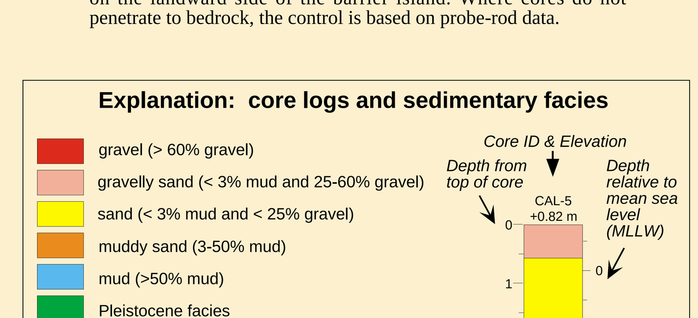


Core Data

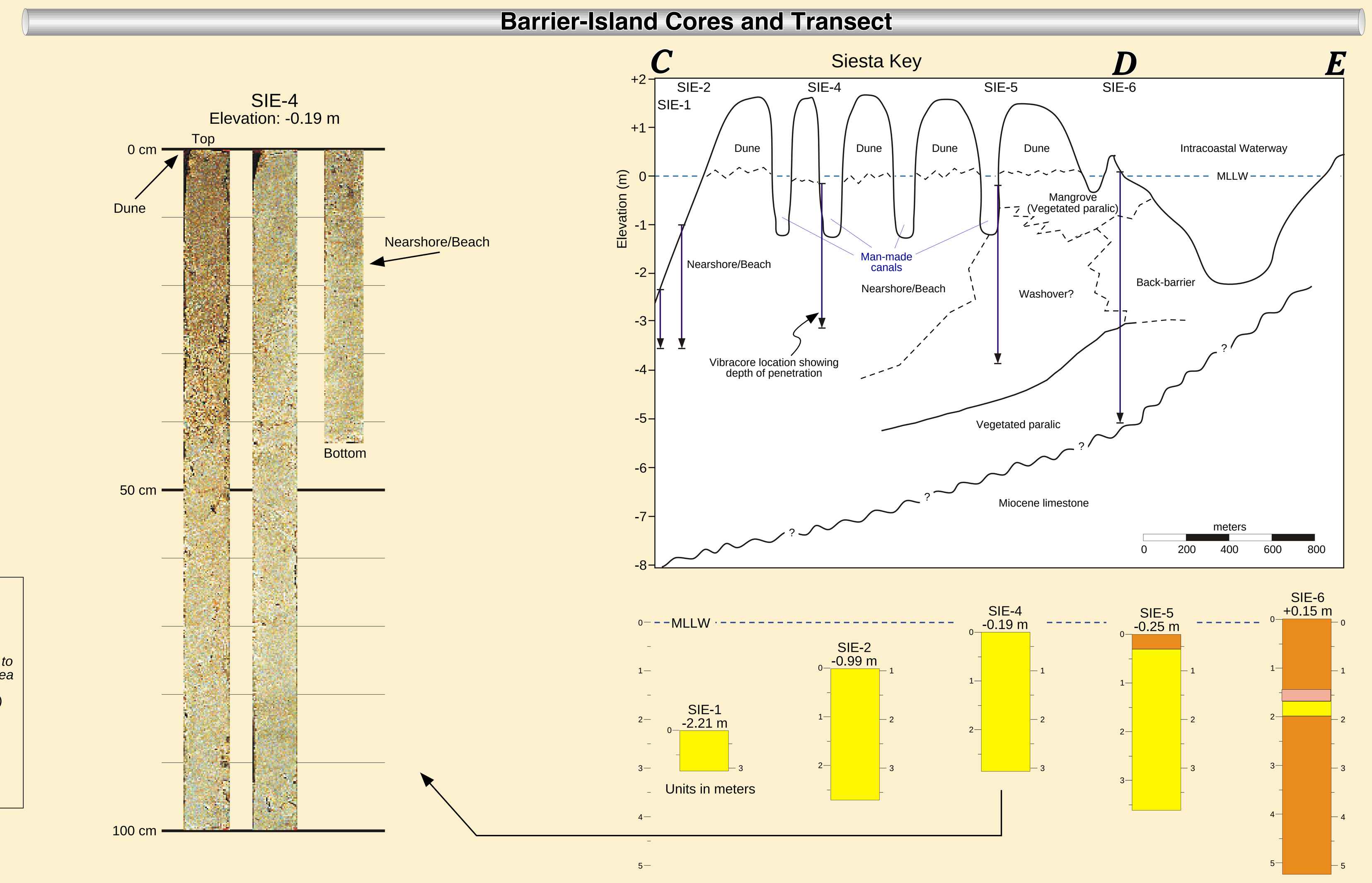
Seven generalized sedimentary-facies types were defined for a unified comparison of core data from the entire study area. All seven color-coded facies for the entire study are shown in the Explanation below. However, not all facies necessarily are present on each transect. Core photographs present individual cores cut into 1-m sections from top (upper left) to bottom (lower right). Discrepancies in core length between the photographs and the diagrams are due to compaction during the coring process. Offshore cores (left) are aligned at core tops. Core locations were chosen to sample thicker Holocene sections and to aid in identifying pre-Holocene stratigraphy. Core elevations were determined from water depth and tide tables. The datum for the barrier-transect cores is the mean lowest low water (MLLW).

Offshore vibracore retrieval ranged from less than 0.5 m to a little over 1 m in length. Sediments consist dominantly of sand-size material rich in blackened grains believed to have been derived from the underlying Miocene sequences. The thin sediment cover and erosional origin of surface sediments illustrate the lack of significant sediment influx to this part of the study area.

The island cross section shown to the right (Yale, 1997) illustrates the importance of dune and nearshore sediments in construction of this drumstick barrier. Cores from the barrier island typically recovered dune or nearshore sands, with a transition to muddy sands on the landward side of the barrier island. Where cores do not penetrate to bedrock, the control is based on probe-rod data.



Barrier-Island Cores and Transect



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Data references:

Color Infrared Digital Orthophoto Quarter Quadrangles (CIR DOQQ), (1994, 1995), USGS EROS Data Center, Sioux Falls, SD 57198. CD-ROMs.

Landsat TM Image, February 18, 1997, path 17, row 40. USGS EROS Data Center, Sioux Falls, SD 57198. CD-ROM.

7.5-Minute Series (Topographic) Quadrangles, U.S. Geological Survey, Reston, VA 22092.

List of west-Florida coastal-transect series maps (1 sheet each):

Transect #1: Anclote Key, USGS Open-File Report 99-505
Transect #2: Caladesi Island-Clearwater Beach, USGS Open File-Report 99-506
Transect #3: Sand Key, USGS Open-File Report 99-507
Transect #4: Indian Rocks Beach, USGS Open-File Report 99-508
Transect #5: Treasure Island-Long Key, USGS Open-File Report 99-509
Transect #6: Anna Maria Island, USGS Open-File Report 99-510
Transect #7: Longboat Key, USGS Open-File Report 99-511
Transect #8: Siesta Key, USGS Open File-Report 99-512
Transect #9: Casey Key, USGS Open File-Report 99-513