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West-Central Florida Coastal Transect # 6: Anna Maria Island

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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 #6 crosses the northern end of Anna Maria Island located on the south side of the mouth of Tampa Bay. Deposition associated with the large Tampa Bay ebb-tidal delta is an important process in this location. 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. Additionally, bottom samples were collected during the cruises using an underway grab sampler at 4-km intervals along track. Offshore core locations were selected based upon seismic data and were focused in areas likely to contain sufficient sediment thickness for core retrieval. Vibracores 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 are constructed by fitting the data between 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

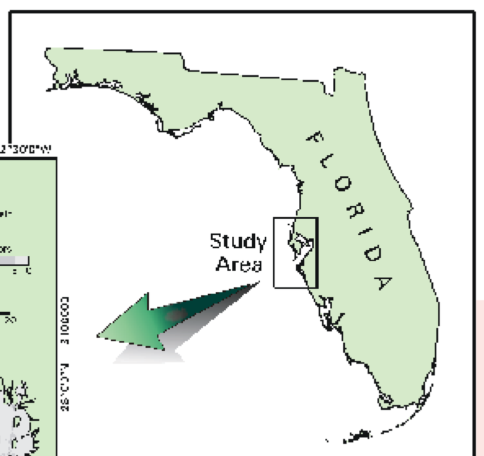
Barrier islands on the west-central Gulf coast of Florida display a wide range in morphology along the most diverse barrier/inlet coast in the world (Davis, 1994). In addition, the barriers have formed over a wide range of time scales from decades to millennia. The oldest of the barriers have been dated 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.

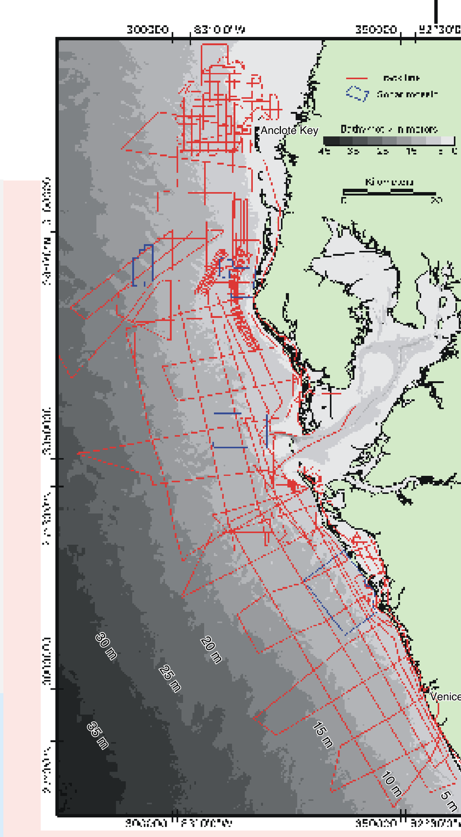
Anna Maria Island

Anna Maria Island is a drumstick barrier island that is the first barrier south of the expansive mouth of Tampa Bay. This island has been thoroughly developed, primarily with residential and small tourist facilities. The island has been fairly stable in its morphology over historical time, with the exception of significant beach erosion along the southern half or so of the island. This was remedied with a nourishment project in 1994.

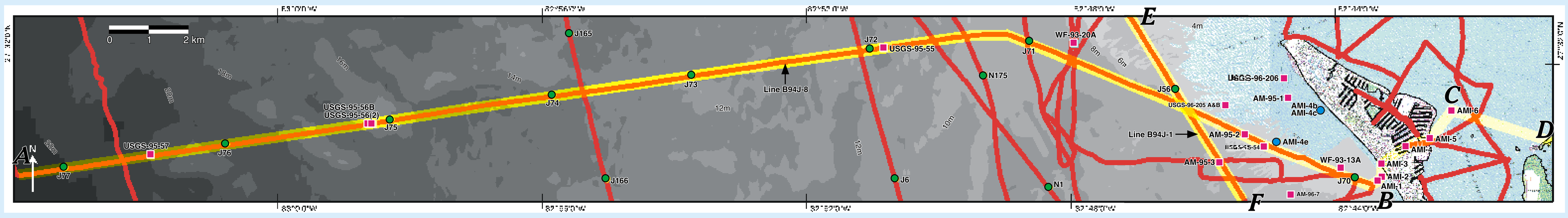
The stratigraphy of Anna Maria was investigated in detail by Pekala (1996) who took 35 vibracores throughout the island and adjacent areas. He determined that the island was a maximum of 3,000 years old and has extended itself to the south only in the past few hundred years. The transect across the north end of the island is taken from his work and modified by Yale (1997). Miocene bedrock was not penetrated by any of the cores; it has been shown to be at a depth of about 11 to 12 m below the northern part of the island (Ferguson, 1997) where this stratigraphic cross section is located.

The basal unit recovered in cores is a brown, organic-stained Pleistocene sand. It is unconformably overlain by an organic-rich, muddy sand containing scattered shell debris which is interpreted to represent a vegetated paralic environment. Above this is a muddy and shelly sand that was probably originally deposited by swashover and/or washover processes and has subsequently been reworked extensively by bioturbation. Beach, nearshore, and dune deposits represent the island facies and are characterized by well-sorted sand and shelly sand. The prograding beach ridges on this end of the island are typical of drumstick barriers with beach and eolian components.





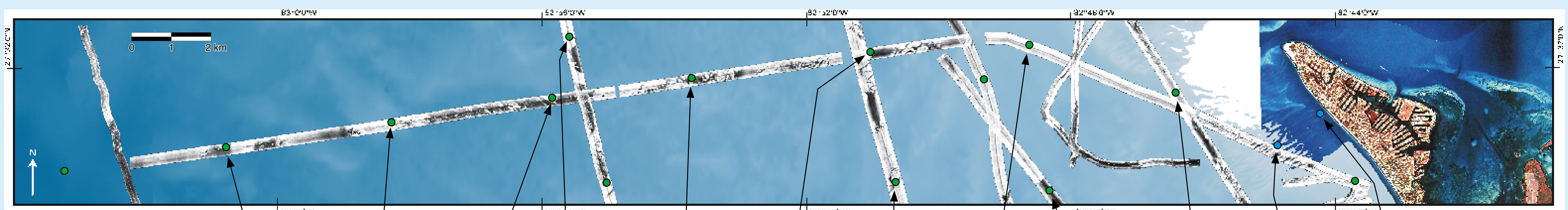
Location of study area along the west-central Florida coastline showing cruise-track coverage in red. Data types include high-resolution seismic-reflection data, side-scan sonar imagery, surface-sediment samples, and vibracores. Blue-box areas identify continuous-coverage side-scan sonar mosaic areas.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



Location map

Location map showing bathymetry, cruise-track coverage, vibracore and surface-sediment sample locations, and location of figures. The full transect cross section A-D is presented below. An expanded view of the island portion of the transect B-C is shown at lower right. Line E-F locates the seismic profile shown below the offshore core data at lower left.

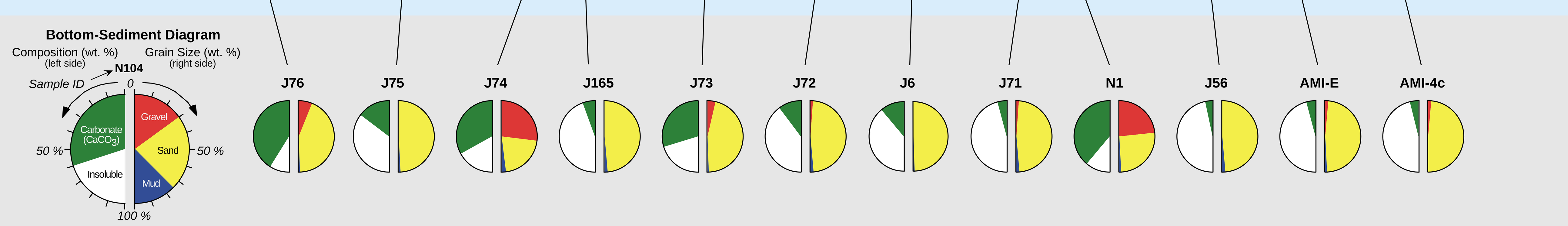
Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic. Bathymetry in 2-m intervals starting at 4 m. Land areas represented by USGS 7.5-Minute Topographic Map.



Side-scan sonar data

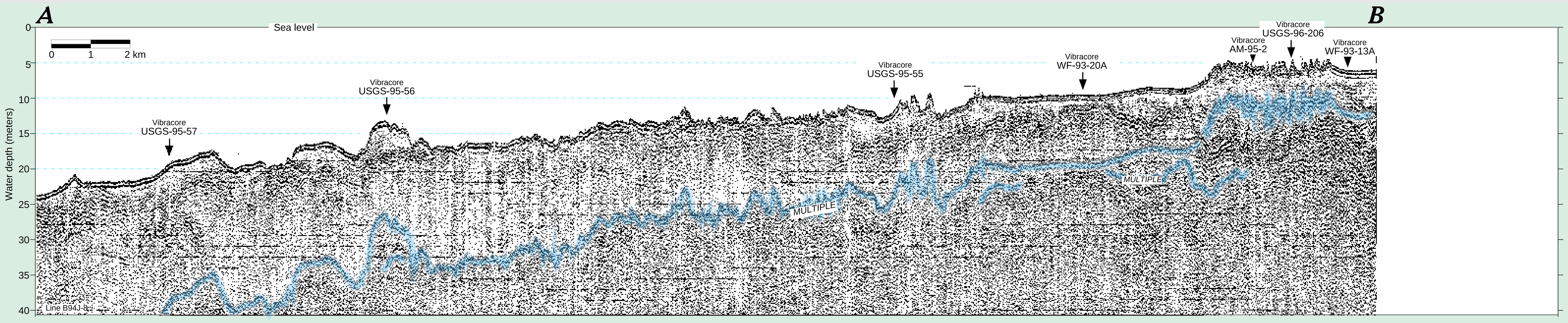
Side-scan sonar imagery overlain on bathymetry reveals a mixed pattern of bedform orientation. Offshore ridges appear to trend NW-SE. In contrast, the nearshore area associated with ebb-tidal deposits exhibits more NE-SW-oriented bedforms, including an area of shore-normal sand bars adjacent to the shoreface immediately south of Southwest Channel. Although thicker and more abundant sediment accumulation characterizes the shelf in this area, hardbottom areas are still present offshore. Low backscatter (light gray) areas correspond to sand ridges and flats dominated by quartz sand. The dark (high backscatter) areas are mainly a coarse sediment veneer containing carbonate material (primarily shell material) or hardbottoms.

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).



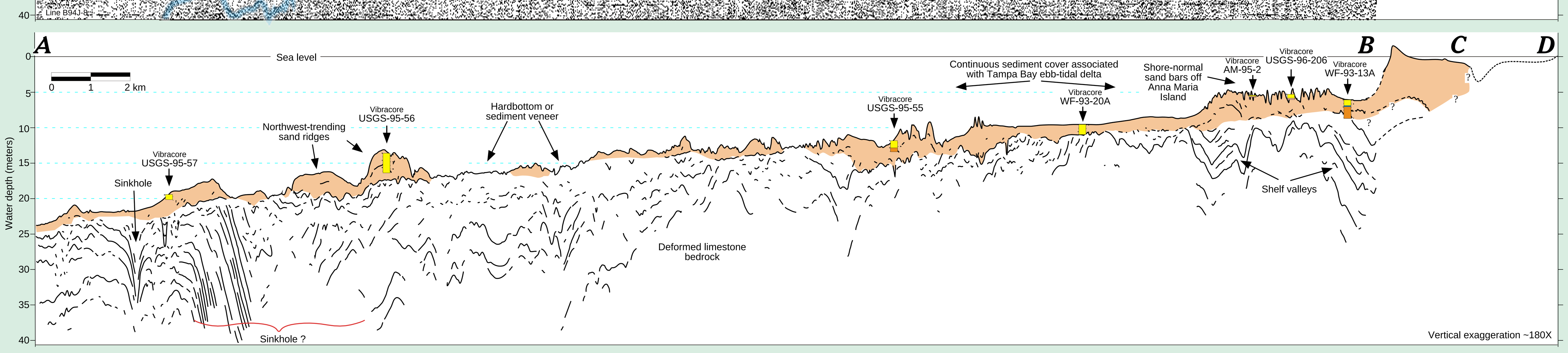
Surface sediments

Grain-size and composition data for bottom grab samples are presented below the sonar imagery. Samples generally consist of quartz-rich sand with subordinate amounts of gravel and mud. Locally, samples are rich in carbonate gravel or sand. The carbonate gravel primarily occurs offshore, but also is found in areas such as the troughs between the nearshore sand bars.



Seismic-profile data

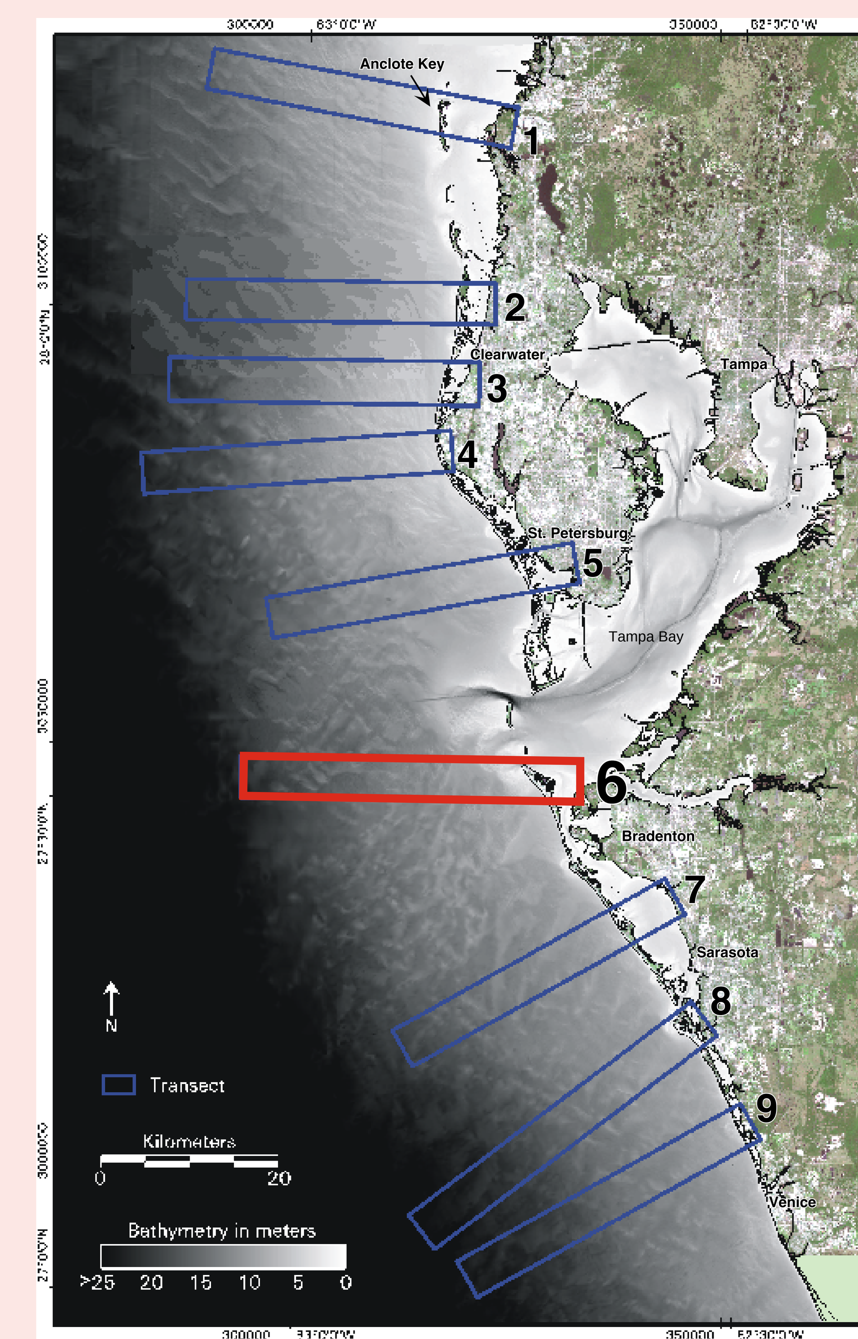
Uninterpreted seismic profile reveals a variety of morphology associated with the sediment cover in this area. Large and relatively thick sand ridges offshore contrast with sand flats and ridged sandwave fields related to the Tampa Bay ebb-tidal delta nearshore. Overall, the base of the Holocene is extrapolated from vibracore data that supports the seismic interpretations. Additional evidence includes hardbottoms (pre-Holocene bedrock) and probe-rod measurements of sediment thickness. Typically, there is poor acoustic contrast between the Holocene sediment cover and the Pleistocene exposure surface, which is attributed to the karstic and weathered nature of the underlying pre-Quaternary bedrock.



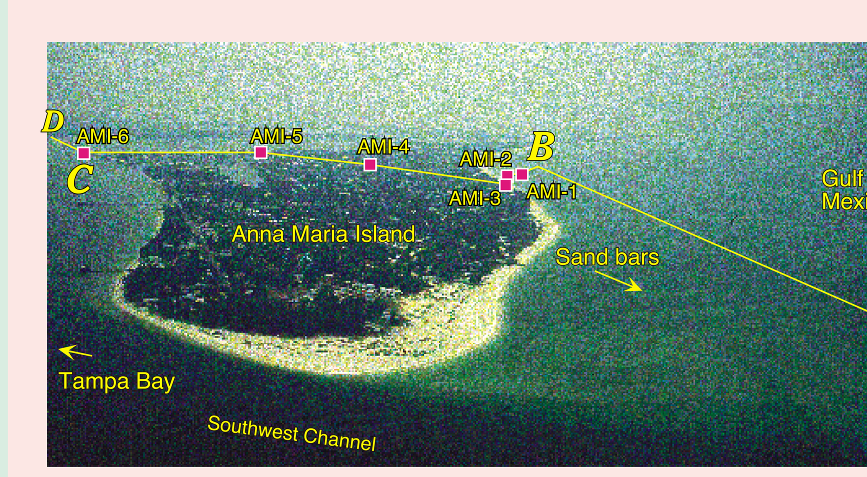
Transect cross-section A-D

Integrated stratigraphic cross section combining line-drawing interpretation of seismic data, ground-truthed by coring, with a coastal cross section based on vibracores. The modern sediment cover can be over 4 m thick offshore, corresponding with the higher-relief portions of the sand waves or ridges seen here. Over 8 m of Holocene sediment are indicated beneath Anna Maria Island. The subsurface is highly deformed due to karstic processes forming structures ranging from sinkholes to shelf valleys. The base of the Holocene is a major unconformity that truncates these structures, indicating that most, if not all of the deformation occurred after deposition of the Miocene limestone. Subsequently, the major hiatal surface, reworked during Quaternary transgressions and regressions of sea level, has not been significantly deformed.

Holocene sediment

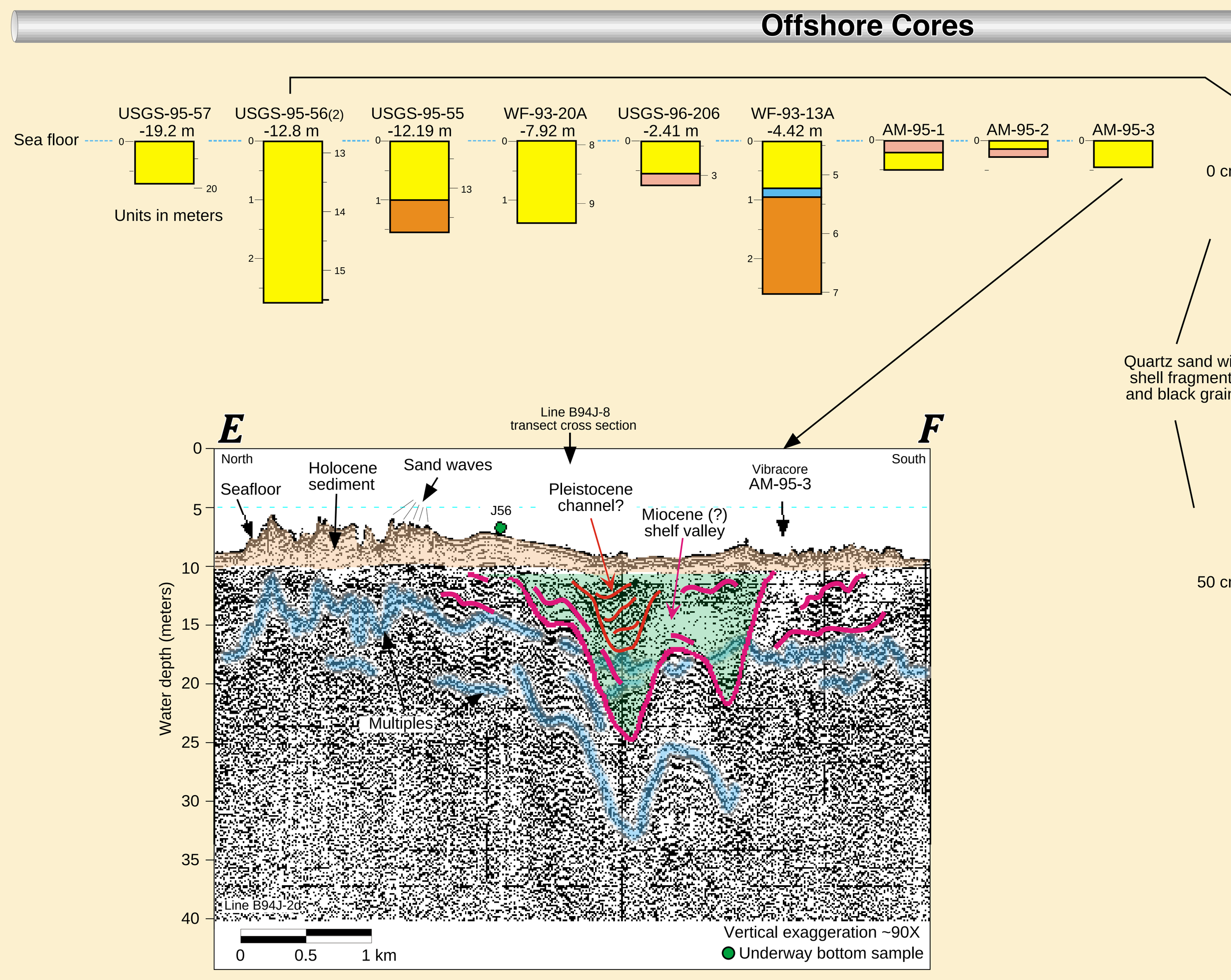


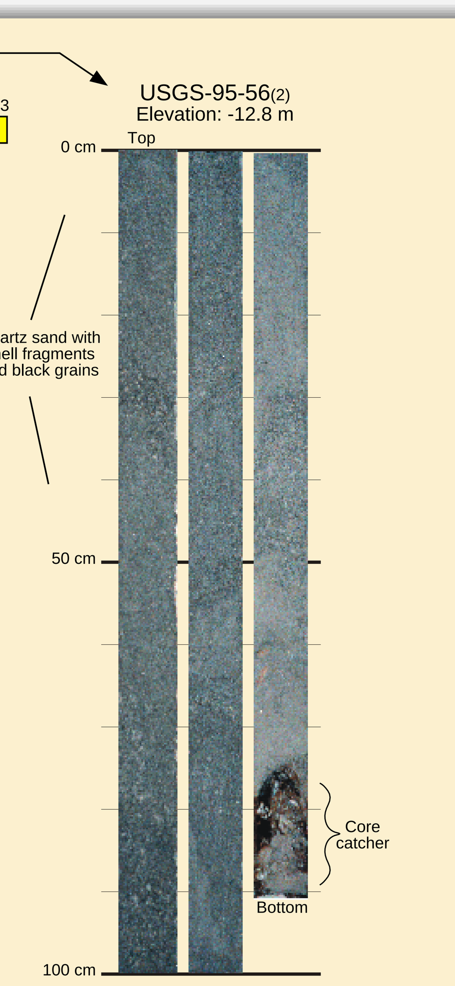
Location of west-central Florida coastal-transect maps with Transect #6 shown in red. 1997 LANDSAT TM imagery of Florida's west coast is merged with a bathymetric-surface model (Gelfenbaum and Guy, 1999). Bathymetric trends offshore in part reflect sediment-distribution patterns. The study area extends from Anclote Key to Venice, FL.



Oblique aerial photograph of Anna Maria Island looking south (taken in 1993). The island transect portion (B-C) is shown here with vibracore interpretations presented below.

Offshore Cores



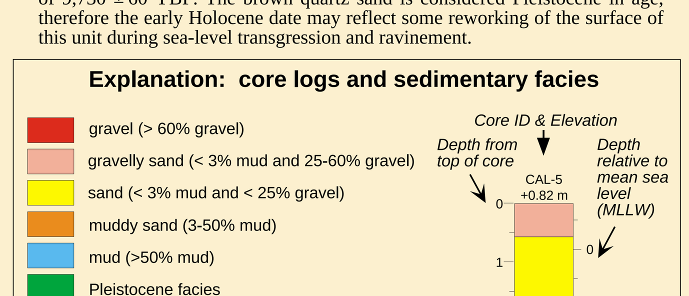


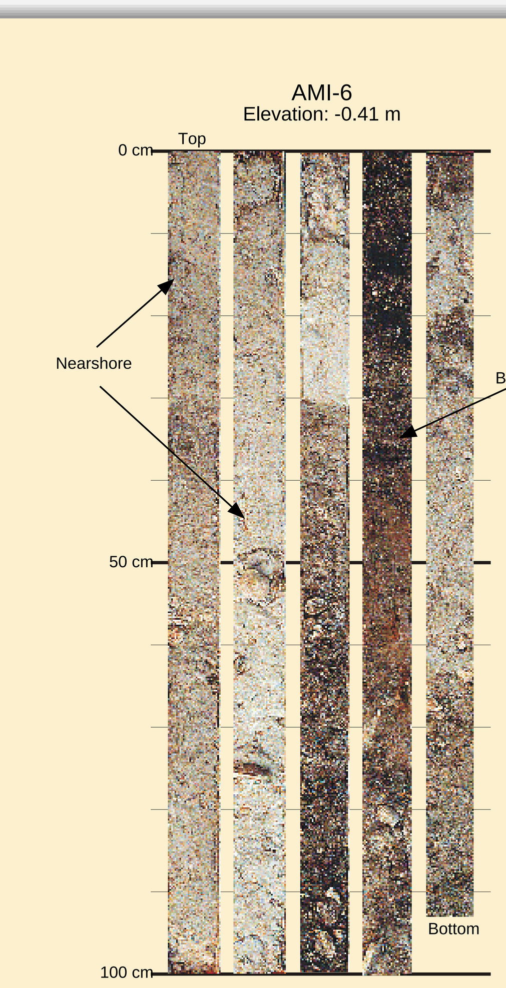
Core Data

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 avoid pre-Holocene strata. Elevations and depths were determined from water depth and tide tables. The datum for the barrier-transect cores is the mean lowest low water (MLLW). Representative cores are shown for USGS-95-56 (offshore sand ridge) and AMI-6 (back-barrier).

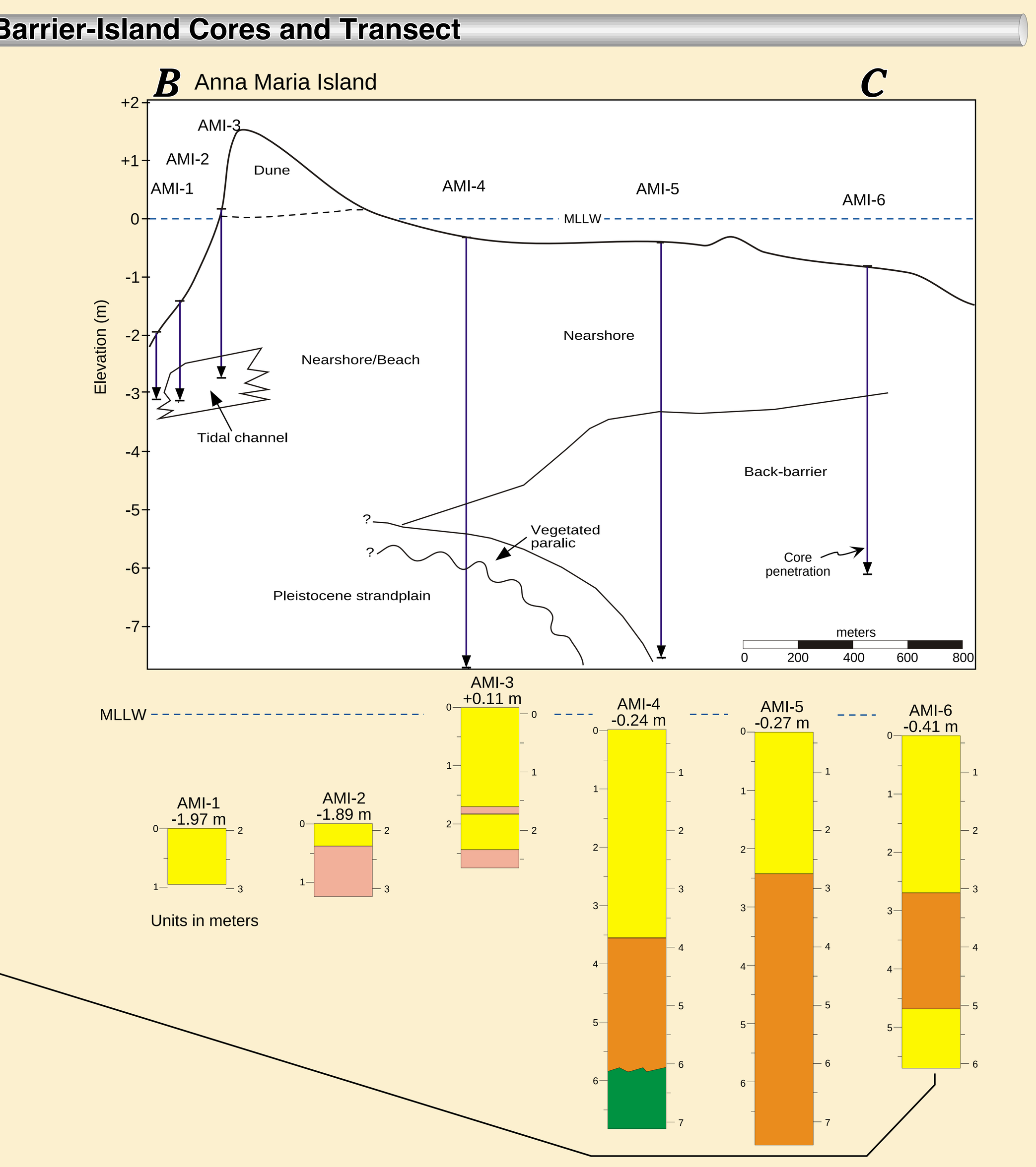
Offshore vibracore retrieval ranged up to 2.7 m in thickness. Sediments consist dominantly of quartz sand on the surface, occasionally overlying mud and muddy sand, which probably represent back-barrier deposits. The thick quartz-sand units are probably related to the Tampa Bay ebb-tidal delta and shore-normal bars lying immediately seaward of Anna Maria Island (Gelfenbaum and Brooks, 1997). Seawardmost cores contain a considerable amount of blackened sands.

The island cross section shown to the right (modified from Yale, 1997) shows sandy nearshore and dune deposits overlapping muddier back-barrier sands to landward. The boundary between "nearshore" sediments overlying "back-barrier" sediments represents a ravinement or maximum flooding surface, and suggest more open marine or lower bay conditions existed in this location prior to the late-Holocene development of northern Anna Maria Island. Beneath northern Anna Maria Island a significant hiatus may be associated with this boundary. Radiocarbon dates from a core located on the landward side of the island, about a kilometer north of the transect yielded a date of 1,040 ±60 YBP (standard C-14 date) from the base of the nearshore facies, directly and unconformably overlying a brown quartz sand that yielded an AMS C-14 date of 9,730 ±60 YBP. The brown quartz sand is considered Pleistocene in age, therefore the early Holocene date may reflect some reworking of the surface of this unit during sea-level transgression and ravinement.





Barrier-Island Cores and Transect



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Acknowledgments

The large field program and combination of data sets brought to this compilation are the result of significant efforts by many people. Kristy Guy and Beau Suthard helped compile, process, and display much of the imagery presented. Special contributions were made by Nancy DeWitt and Kristin Yale. We thank the following people for help in the field or laboratory: Patrick Barnard, Greg Berman, Jim Edwards, Brian Donahue, Larry Doyle, Dave Duncan, John Cargill, Tom Ferguson, Megan FitzGerald, Mark Hafen, Jackie Hand, Scott Harrison, Tessa Hill, Bret Jarrett, Jennifer Kling, Katie Kowalski, David Mallinson, John Nash, Steve Obrochta, Meg Palmsten, John Pekala, Boudewijn Remick, Peter Sedgwick, Brian Silverman, Darren Spurgeon, David Ulnar, Ping Wang, and Tao Yucong. We also thank the crews and support staff of the research vessels R/V *Bellows*, R/V *Suncoaster* (Florida Institute of Oceanography) and R/V *Gilbert* (U.S. Geological Survey) for their assistance. Technical reviews by Barbara Lidz and Bob Morton are greatly appreciated.

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