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West-Central Florida Coastal Transect # 9: Casey 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 #9 extends seaward from Casey Key (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. 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.

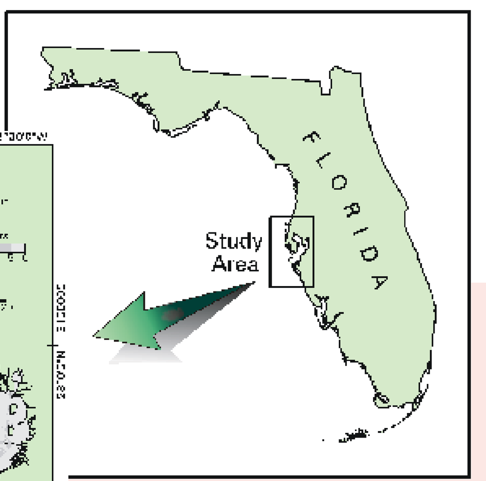
Geologic History and Morphodynamics of Barrier Islands

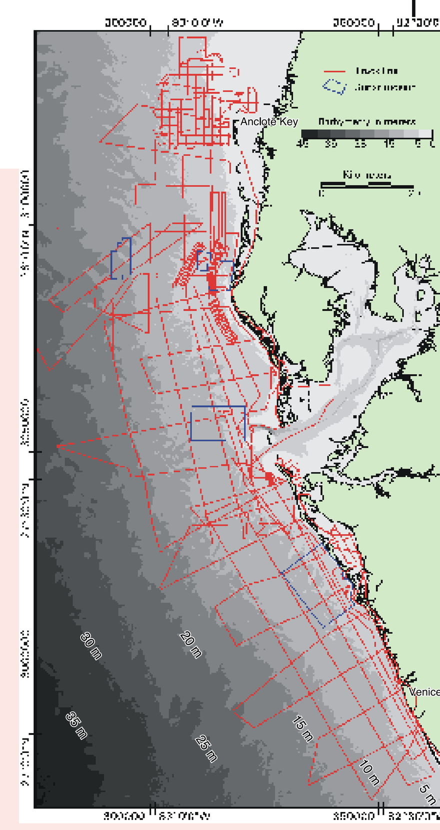
Barrier islands on the west-central Gulf coast of Florida display a wide range in morphology along the most diverse barrier/inlet coast in the world (Davis, 1994). In addition, the barriers have formed over a wide range of time scales from decades to millennia. The oldest of the barriers have been dated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

Casey Key

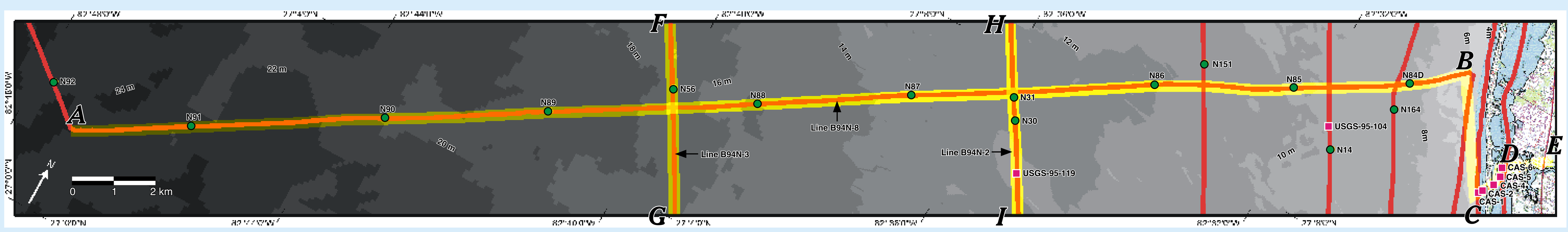
Casey Key is a distinctly wave-dominated barrier that is very narrow throughout most of its extent. This long barrier has a straight shoreline, and has been experiencing erosion problems along most of its length. The barrier is separated from the mainland by only a few hundred meters of shallow estuary.

Three of the cores penetrated Miocene limestone that is shallow (-1.5 m) at the mainland shoreline and dips Gulfward to -6 m a few hundred meters offshore from the island (Yale, 1997). The organic-rich, muddy sand representing a vegetated paralic environment immediately overlies the limestone; no Pleistocene sediments were penetrated. This is typical of most of the coastal system in the Sarasota Bay and Little Sarasota Bay areas (Davis and others, 1989). Muddy, shelly sand is above this facies at most places, and probably represents old washover deposits that have been thoroughly bioturbated. The facies representing the nearshore, beach, and dune environments comprise the barrier itself. The most Gulfward core penetrated the clean, shelly sand of the nearshore, which is in sharp contact with an oyster-rich muddy, sandy gravel. These oysters were radiocarbon dated at 4,670 YBP, and are much older than any of the present barrier islands. This indicates that either there was an older barrier Gulfward of these oyster-rich deposits, or that the oysters were living in a low-energy, open environment where salinities were probably below normal marine levels. The latter situation is quite similar to the extant environment in the Big Bend area of the Florida Gulf Coast located immediately to the north of the study area.





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).

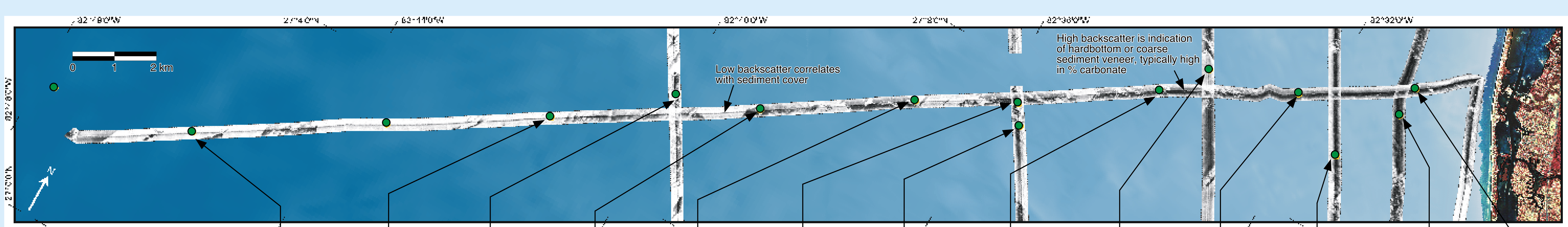


Location map

Location map showing bathymetry, cruise-track coverage, core and sample locations, and location of figures. The full transect cross section A-E is presented below. An expanded view of the island portion of the transect C-D is shown at the lower right. The two offshore seismic profiles (F-G and H-I) are shown in the lower left.

- Vibracore
- Underway surface-sediment sample
- Surface-sediment grab sample
- Cruise track in red with yellow highlight indicating line of cross section or seismic profiles (below).

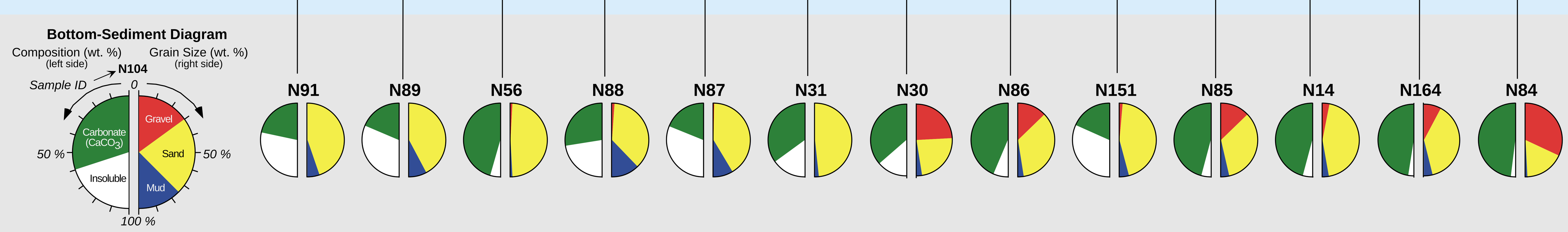
Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic.
Bathymetry in 2-m intervals starting at 4 m.
Land areas represented by USGS 7.5-Minute Topographic Map.



Side-scan sonar data

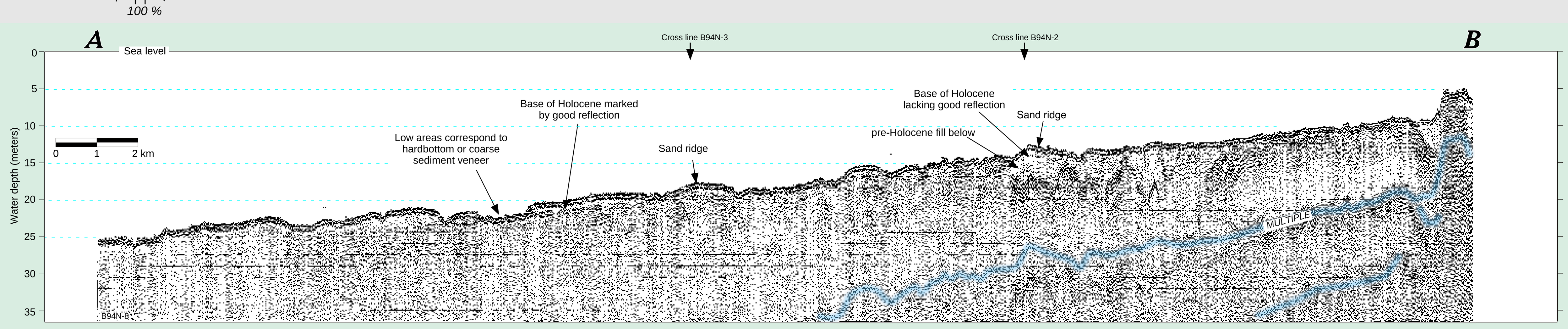
Side-scan sonar imagery overlain on bathymetry reveals a northeast-trending sand-ridge morphology offshore. This trend is opposite that found in areas north of Tampa Bay, particularly transects 1-4. Nearshore surface-sediment cover is thin and exhibits a patchy and discontinuous distribution. Low backscatter (light gray) areas correspond to sand ridges and flats dominated by siliciclastic quartz sand. The dark (high backscatter) areas are largely coarse sediment veneer with increased carbonate material (primarily shell material) or some 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).



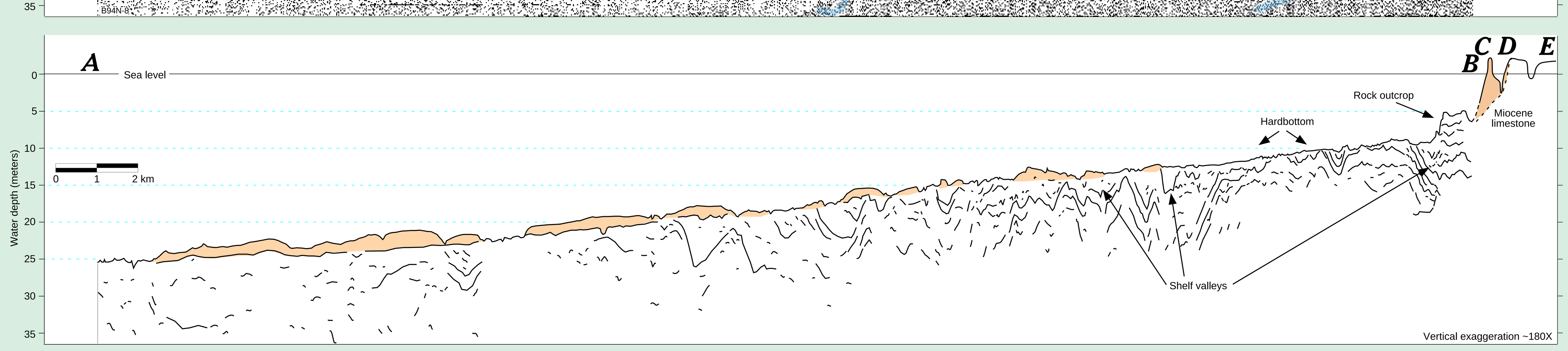
Surface sediments

Grain-size and composition data for bottom grab samples are presented below the sonar imagery. Samples generally consist of quartz-rich sand and carbonate sand and gravel. Carbonate sand and gravel dominate throughout most of the transect. Low backscatter correlates with medium to fine siliciclastic sand with minor carbonate grains and is associated with the thicker sand-ridge deposits. The higher backscatter areas correlate with coarse grain size and increased carbonate.



Seismic profile

Uninterpreted seismic profile illustrates the limited acoustic penetration in the deformed limestone bedrock. The acoustic contrast between the Holocene sediment cover and the Pleistocene exposure surface is variable and can be difficult to resolve. This is typical throughout the region and is attributed to the karst and weathered nature of the underlying bedrock. The modern sediment cover is usually less than 2 to 3 m thick, corresponding with the higher-relief portions of the sand waves or ridges seen here. Just off the beach on this profile is a several-meter-high limestone outcrop - a very rare occurrence in the overall study area. The outcrop may indicate a nearshore limestone terrace that was bypassed by the developing barrier island in this area - perhaps due to a lack of sediment supply sufficient to maintain the barrier. The barrier now fringes the pre-Holocene mainland structure high.

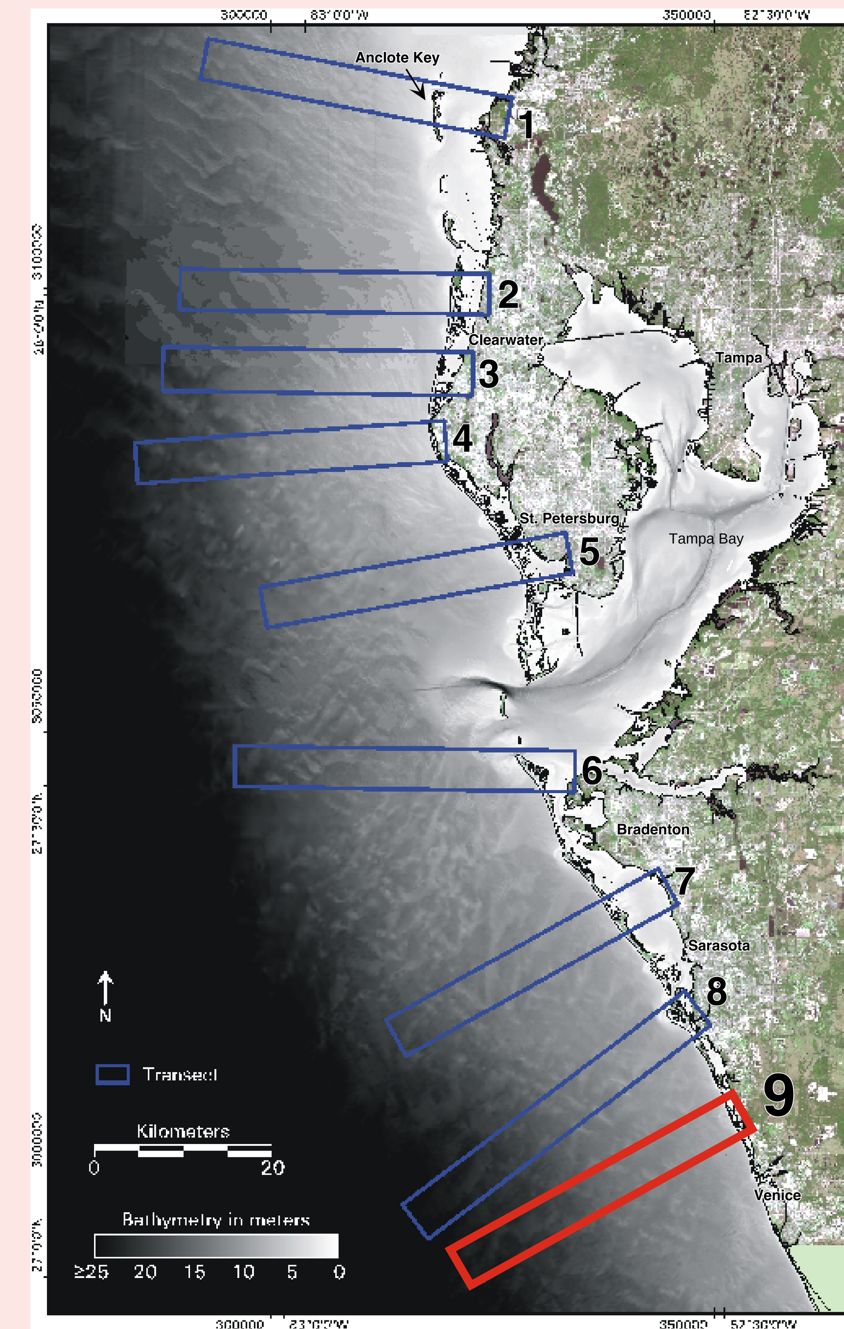


Transect cross section *A-E*

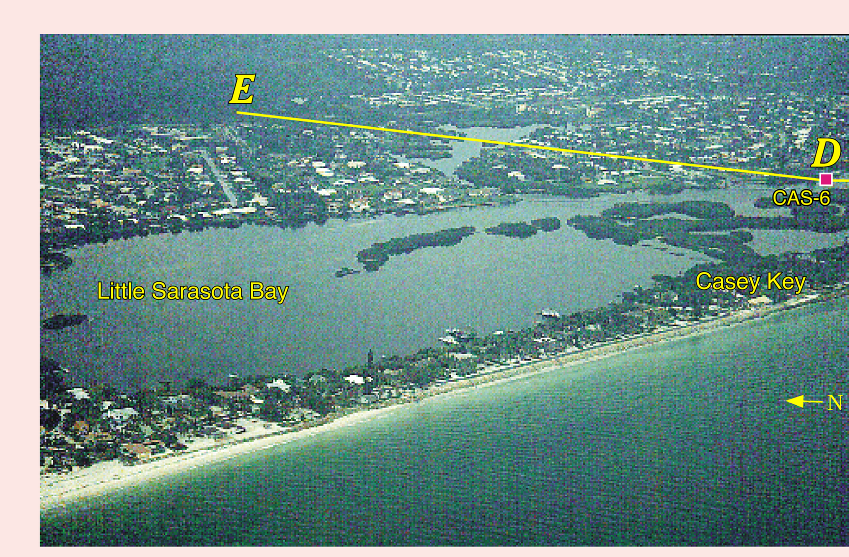
Integrated stratigraphic cross section combining interpretation of seismic data, ground-truthed by coring, with a coastal cross section based on vibracores. Cores in the offshore transect have no cross-shelf correlation potential because they commonly sample different ridge deposits, shown in side-scan sonar imagery and bathymetry data. This transect is just north of the rocky coastal headland in the Venice, FL, area and is similar to the Sand Key transect #3 just north of Indian Rocks Beach. In both areas a narrow barrier island and back-barrier lagoon are positioned against the rising bedrock surface. However, the nearshore settings at 5 km from the beach are quite different. Off Sand Key, sand ridges are present in water depths of 5 to 6 m. In contrast, the cross section here reveals undetectable sediment cover nearshore in twice the water depth, 10-11 m, and a steeper offshore gradient. The volume of sand contained in the barrier-island section is similar to that in a single offshore sand ridge.

In the subsurface, deformed limestone bedrock is attributed to mid-Cenozoic karstic processes. This stratigraphic interval is truncated by a relatively flat erosional surface that regionally forms the base of the Holocene section. Overall, the base of the Holocene is extrapolated from vibracore data that supports the seismic interpretations.

Holocene sediment

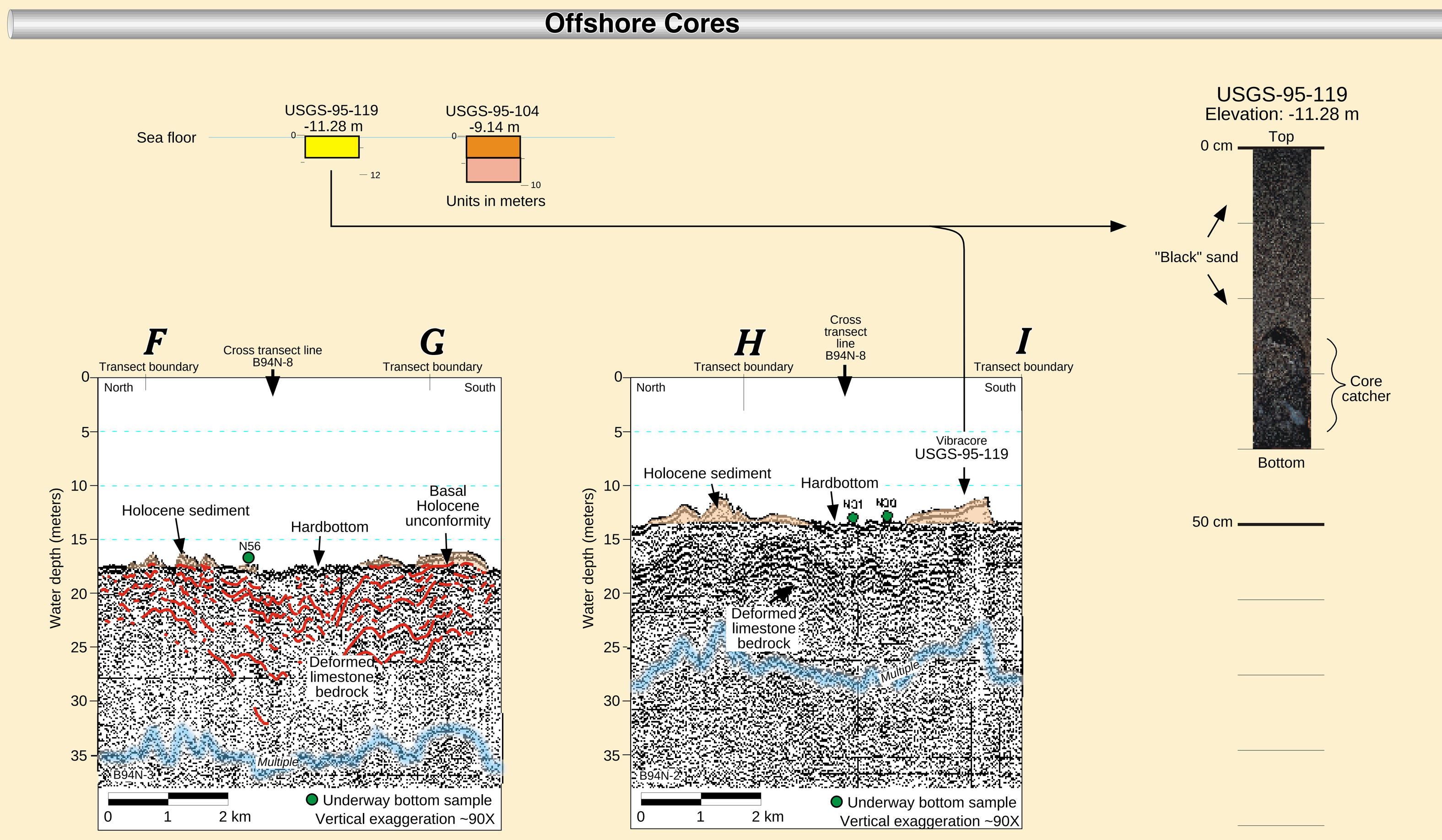


Location of west-central Florida coastal-transect maps with Transect #9 shown in red. 1997 LANDSAT TM imagery of Florida's west coast is merged with a bathymetric-surface model (Gelfenbaum and Guy, 1999). Bathymetric trends offshore in part reflect sediment-distribution patterns. The study area extends from Anclote Key to Venice, FL.



Oblique aerial photograph of Casey Key and Little Sarasota Bay taken in 1993. Vegetated washover and flood-tidal deposits occur landward of the beach (notice islands in bay north of vibracore CAS-6). Part of the island-transect section (C-D) and extension to the mainland (E) are shown here.

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).

The offshore core photo USGS-95-119 (left) is located 2 km south of the main transect on a northwest-trending sand ridge (see section H-I). Vibracore USGS-95-119 is a good representation of the thin sand facies containing black grains that is found throughout the southern portion of the west-central Florida study area.

Offshore core retrieval was consistently less than 1 m in length. The contorted bottom of the barrels indicates that cores penetrated the entire sediment thickness. Sediment cover consists dominantly of blackened sands interpreted as phosphatic-rich grains derived from older Miocene sequences. Shelly sand and gravel represent modern open-marine conditions. Quartz-rich sediments occur only within a few kilometers of shore in this part of the study area. The thin, discontinuous sediment cover is in contrast to the thicker, quartz-dominated sediment cover in the northern portion of the study area.

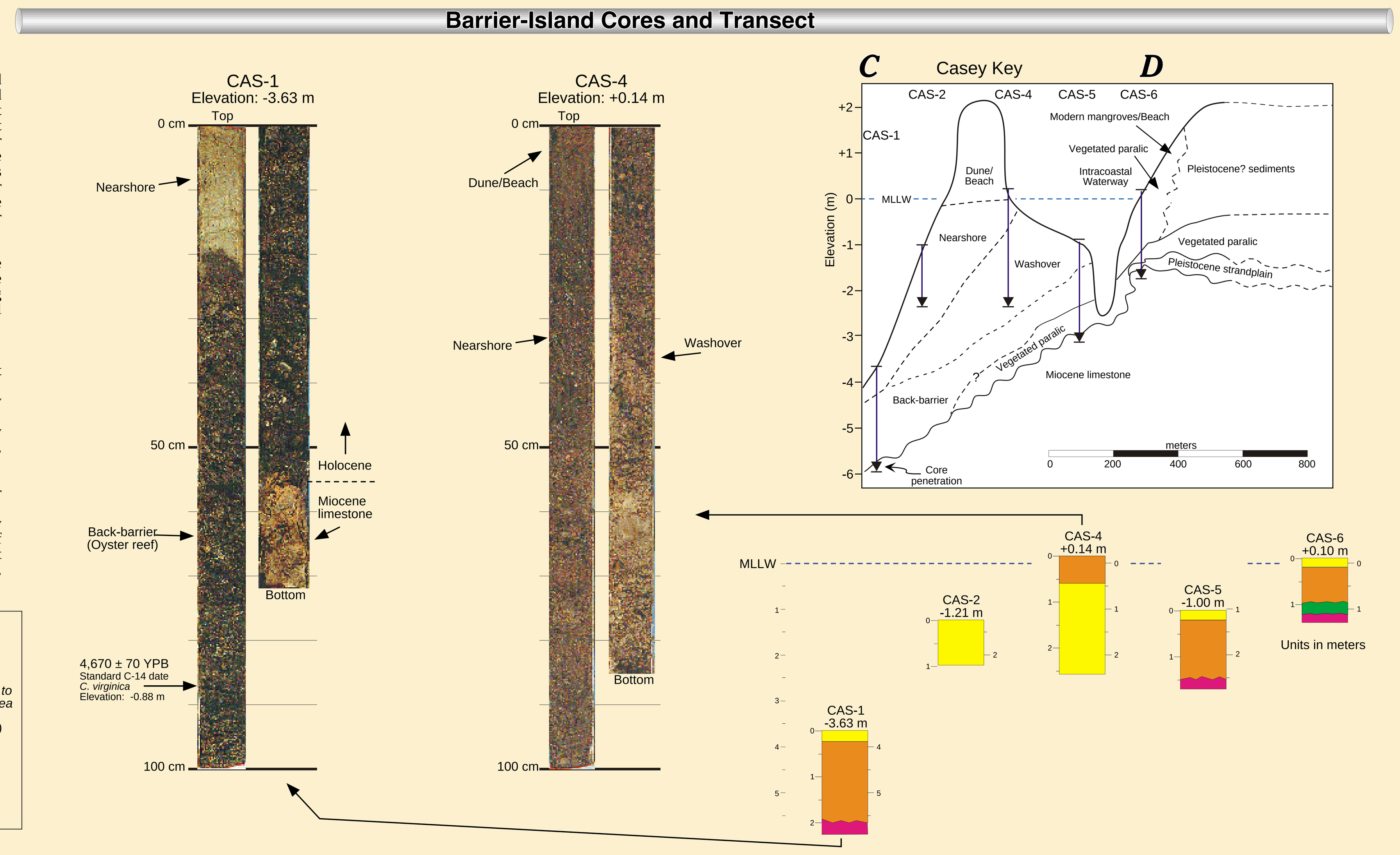
The island cross section shown to the right (Yale, 1997) indicates the barrier island is situated against a rising limestone bedrock surface. In the two landward-most cores, the Miocene limestone surface was penetrated immediately below the surficial sediment sand layer, once again indicating the paucity of sediments on this part of the shelf (see seismic data showing restricted extent of sand bodies). On cross sections where cores do not penetrate to bedrock, the control is based on probe-rod data.

Explanation: core logs and sedimentary facies

- gravel (> 60% gravel)
- gravelly sand (< 3% mud and 25-60% gravel)
- sand (< 3% mud and < 25% gravel)
- muddy sand (3-50% mud)
- mud (>50% mud)
- Pleistocene facies
- Miocene (limestone and blue-green clay)

Core ID & Elevation
Depth from top of core
Depth relative to mean sea level (MLLW)
CAL-5 +0.82 m
Units in meters

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