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West-Central Florida Coastal Transect # 5: Treasure Island - Long 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 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 these data sets, and for comparison of different coastal settings within the study area.

Transect #5 extends seaward form Treasure Island (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.

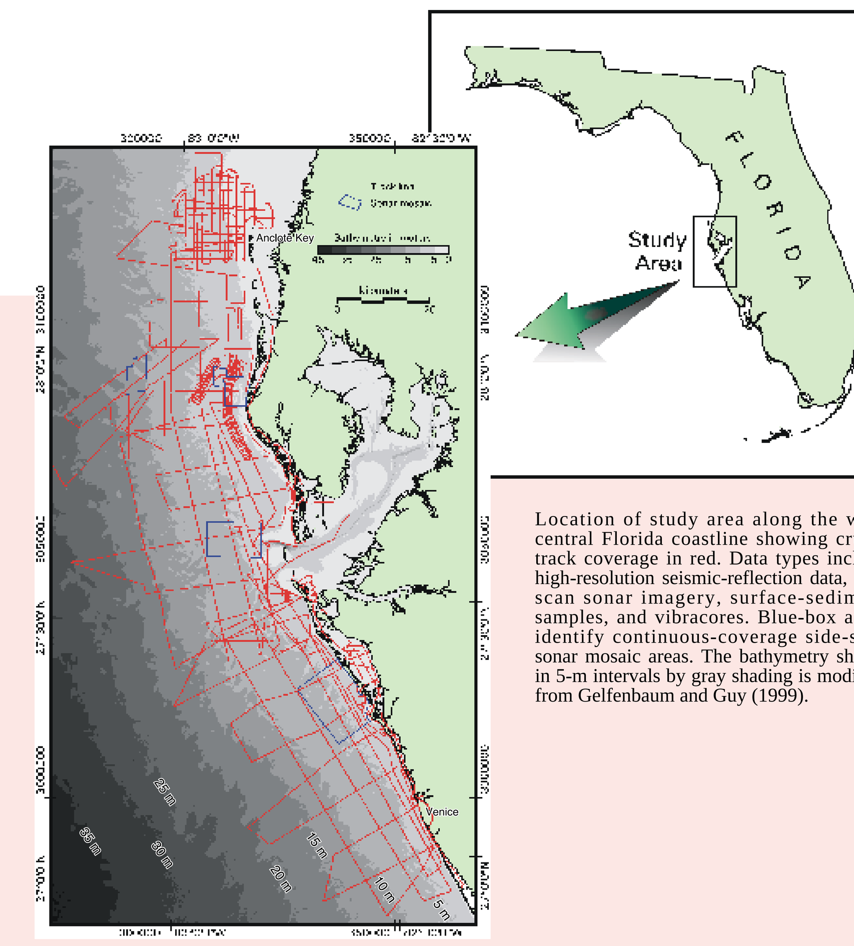
Geologic History and Morphodynamics of Barrier Islands

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.

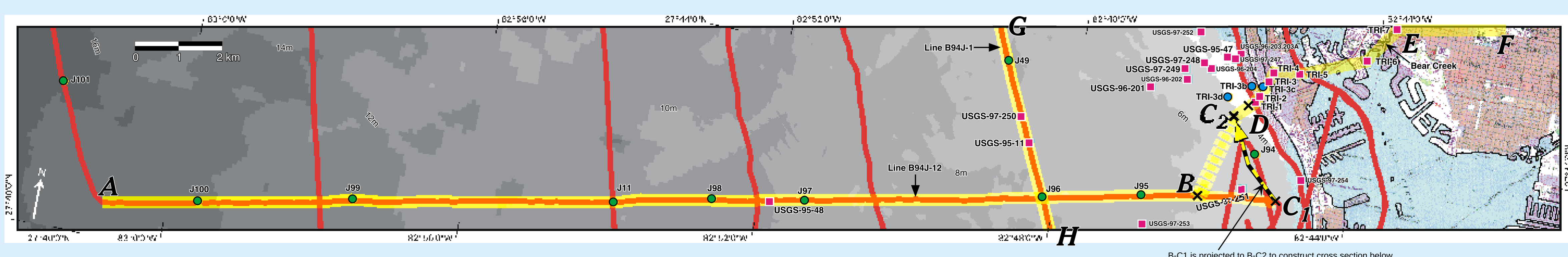
Treasure Island

Treasure Island is a drumstick barrier that has been completely developed by human activity during the past half century. The island has been reasonably stable except at the south end where Blind Pass has migrated about 2 km to the south over the past 100 years or so. Changes at Blind Pass are linked to the formation of Johns Pass (to the north) by a hurricane in 1848. Much of the tidal prism from Boca Ciega Pass (now Blind Pass) was captured by this newly formed inlet, causing it to diminish in size, become unstable, and migrate to the south (Barnard, 1998). After stabilization of Blind Pass in 1936, there has been a continual problem due to infilling from southerly littoral drift along the barrier.

The island transect (lower right) includes the southern part of Treasure Island, the northern part of Long Key (Yale, 1997) and across the back-barrier area up Bear Creek on the mainland. The basal unit recovered in the cores taken on or adjacent to the barrier islands contains muddy, shelly sand that is interpreted as representing a low-energy marine environment that may or may not have been protected by a barrier island. Channel deposits characterized by shelly sand are present under both islands and represent environments associated with the migration of Blind Pass (FitzGerald, 1995). Nearshore, beach, and dune deposits characterize the barriers themselves, with some indications of reworked washover deposits. Cores taken from Bear Creek on the mainland show a sequence of late Pleistocene to Holocene radiocarbon dates (see cross section below) that suggest a conformable transition across the Pleistocene/Holocene boundary at the landwardmost portion of the transect.



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).



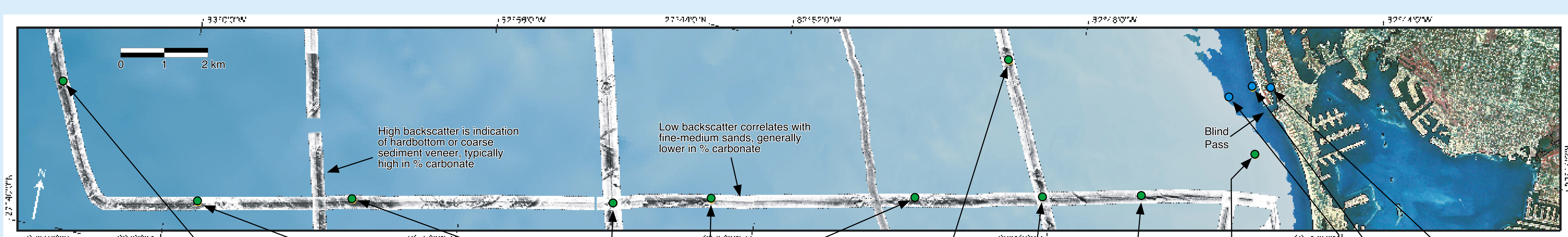
B-C1 is projected to B-C2 to construct cross section below

Location map

Location map shows bathymetry, cruise-track coverage, vibracore and surface-sample locations, and location of figures. The full transect cross section A-F is presented below. An expanded view of the island portion of the transect D-E is shown at lower right. Section G-H identifies seismic-profile data presented at lower left. Bathymetry is shaded in 2-m intervals starting at 4 m (modified from Gelfenbaum and Guy, 1999). Areas above the 4-m isobath are represented by the USGS 7.5-minute topographic map.

- 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).

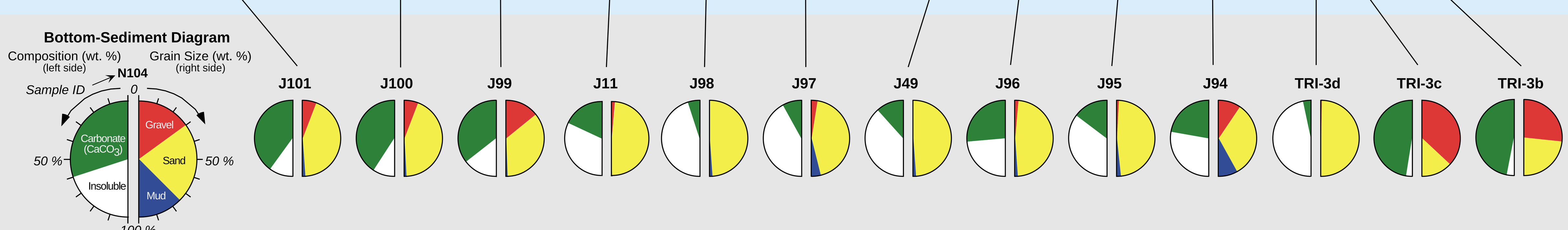
Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic.



Side-scan sonar data

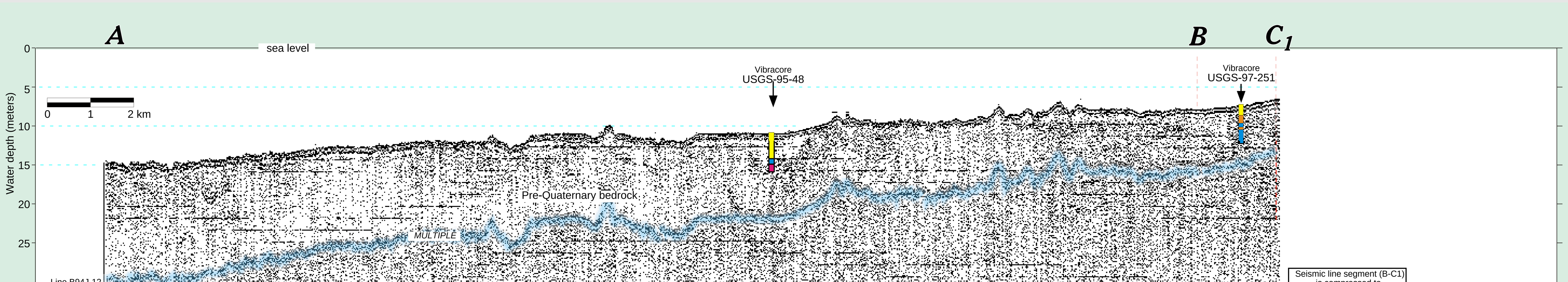
Side-scan sonar imagery reveals more extensive sediment cover in the nearshore area of the transect and little sediment cover over bedrock offshore. Low backscatter (light gray) areas correspond to sand cover. The sand-ridge morphology typical off Indian Rocks Beach to the north is not evident here. The dark areas (high backscatter) are more extensive in the offshore portion of this transect and correspond to a coarse sediment veneer with increased carbonate material (primarily shell material or shore 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).



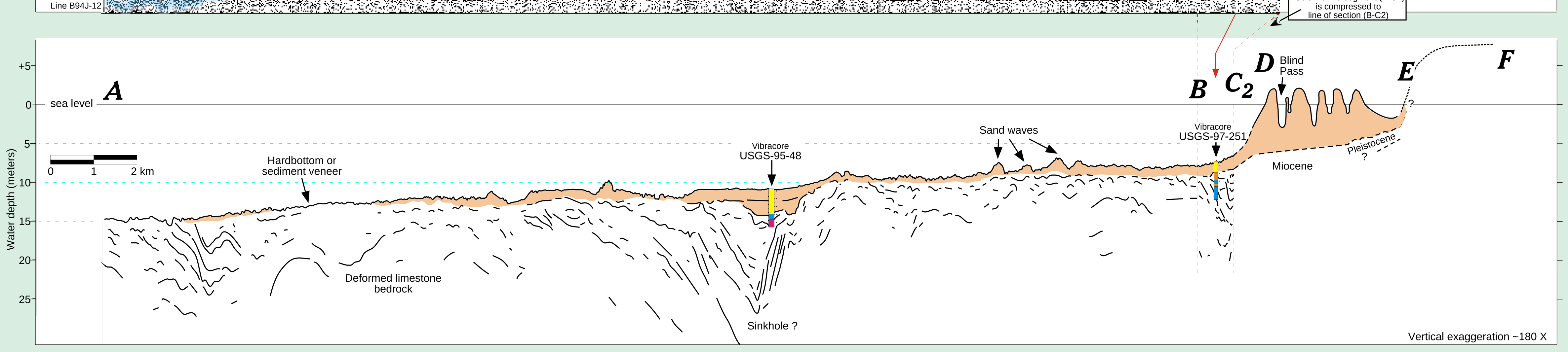
Surface sediments

Grain-size and composition data for bottom grab samples are presented below the sonar imagery. Samples consist principally of quartz-rich sand and carbonate sand and gravel. Carbonate sand and gravel dominate offshore and immediately adjacent to the barrier island. Quartz sand dominates on the inner shelf. The coarse-grained facies is thin and typically exhibits ripple crests that trend N-S with a 40- to 70-cm spacing.



Seismic-profile data

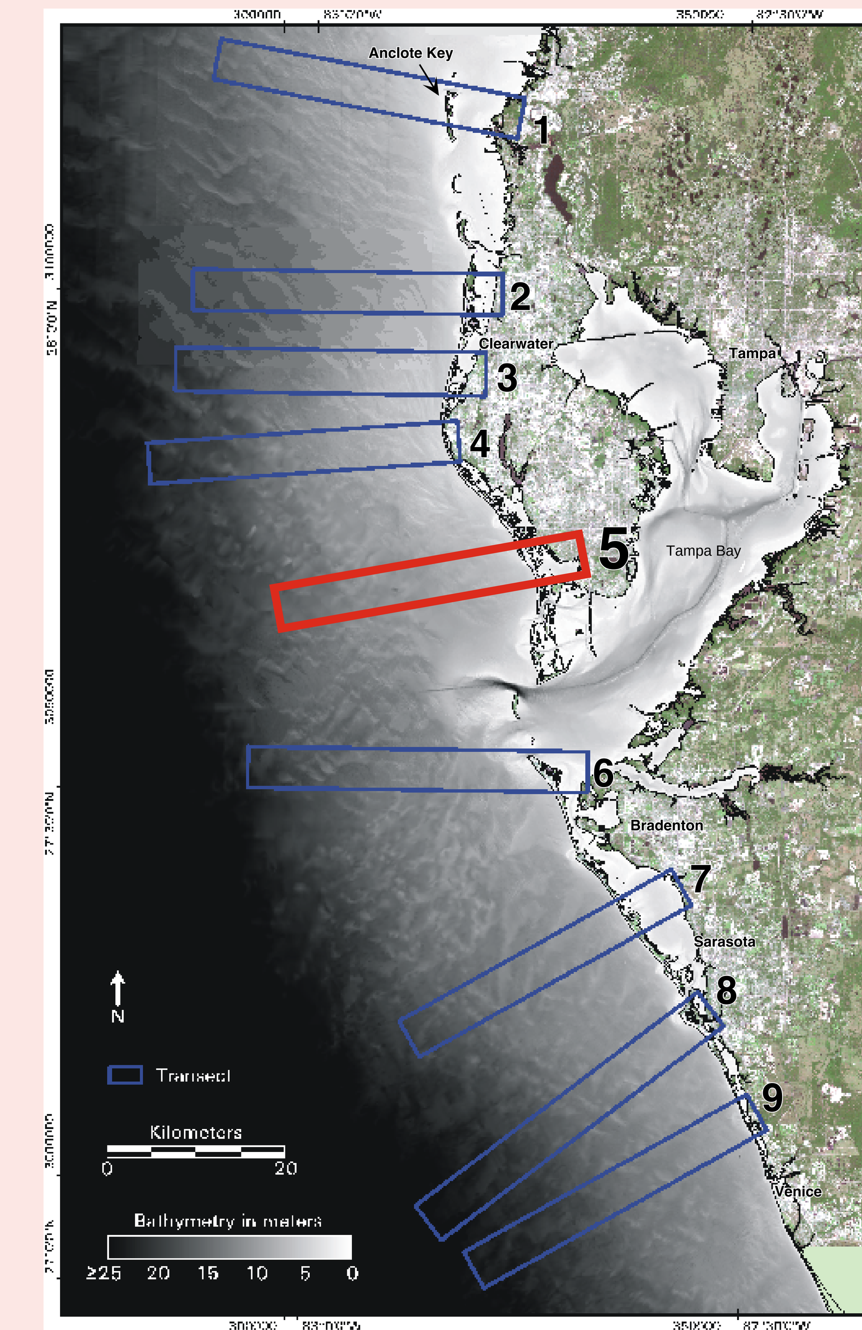
Uninterpreted high-resolution "boomer" seismic data show limited penetration and a change from more continuous sediment cover nearshore to a more discontinuous distribution of sand waves offshore. Poor acoustic contrast between the Holocene sediment cover and the underlying pre-Quaternary bedrock is attributed, in part, to the weathered nature of the Neogene limestone. Some deformation of the pre-Quaternary bedrock is attributed to karst processes at depth. The modern sediment cover is typically less than 2 m thick, corresponding with the higher relief portions of the sand waves and ridges seen here.



Transect cross section *A-F*

Integrated stratigraphic cross section combines line-drawing interpretation of seismic data, ground-truthed by coring, with a coastal cross section based on vibracores. Overall, the base of the Holocene is extrapolated from vibracore data that support the seismic interpretations. Additional evidence includes hardbottoms (pre-Holocene bedrock) and probe-rod measurements of sediment thickness. The location of the barrier islands is correlated with a rise in the underlying pre-Quaternary bedrock consisting of Miocene limestone intermittently overlain by Pleistocene deposits. Offshore, vibracore USGS-95-48 penetrated a valley structure containing an unusually thick Holocene infill. Such depressions containing Holocene fill are rare and are attributed to both karst processes and erosion of channels. The depressions can also be preferred sites of Pleistocene lime mud accumulation. The shelf further south from the Indian Rocks Beach headland exhibits an increase in channel and valley-fill structures.

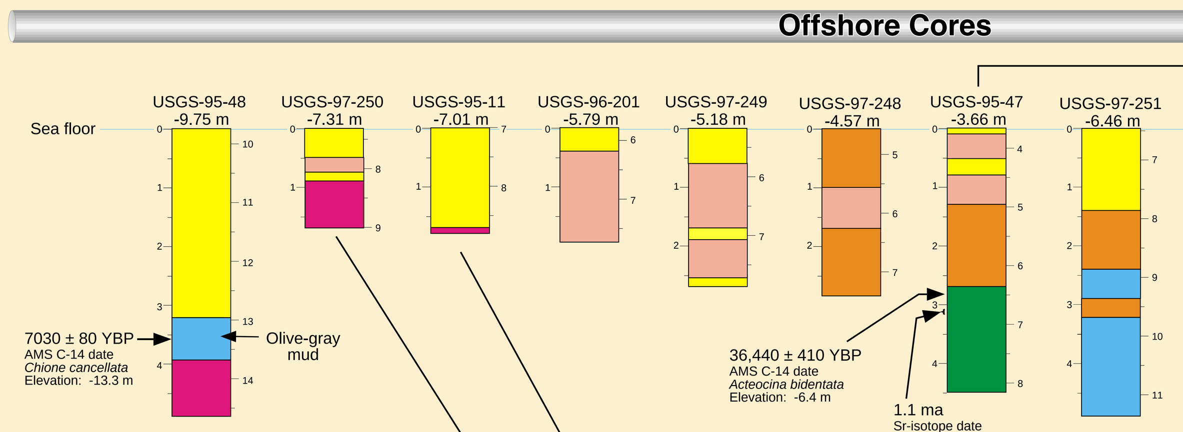
Holocene sediment

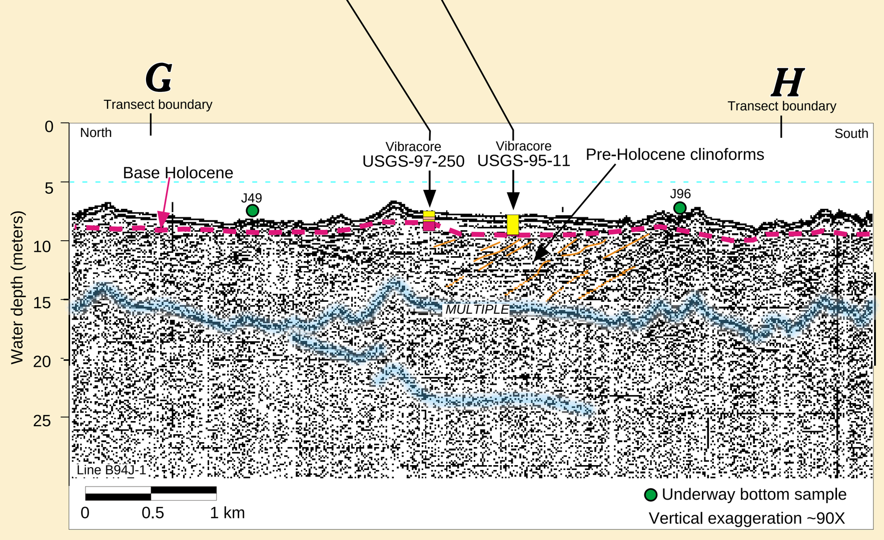


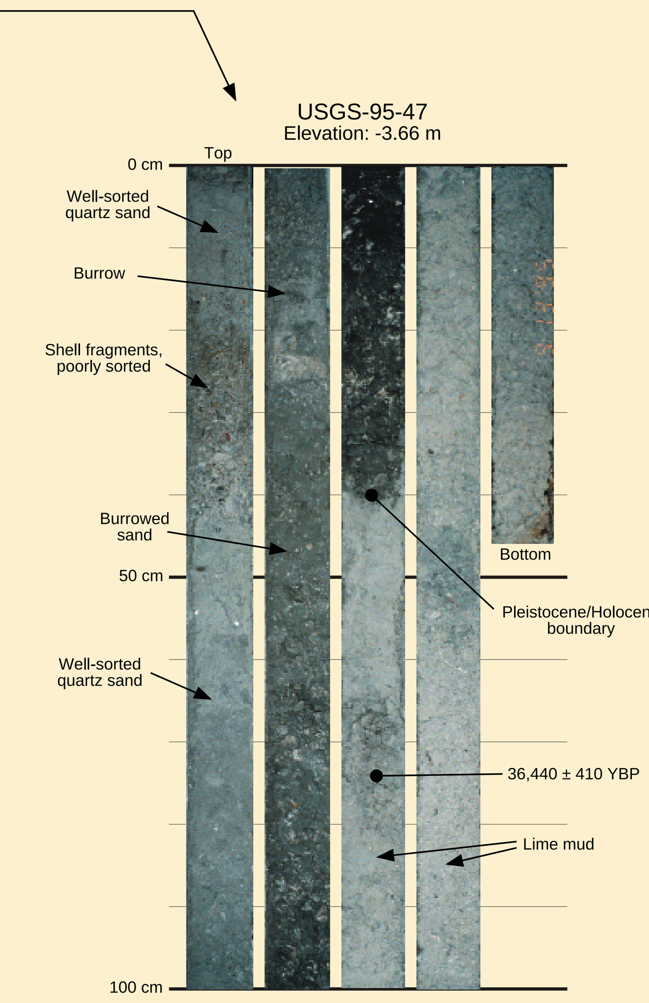
Location of west-central Florida coastal-transect maps with Transect #5 shown in red. 1997 LANDSAT TM imagery of Florida's west coast is merged with a bathymetric-surface model (Gelfenbaum and Guy, 1999). Bathymetric trends offshore in part reflect sediment-distribution patterns. The study area extends from Anclote Key to Venice, FL.

Oblique aerial photograph of Blind Pass taken in 1974. A net southward transport of sediment contributes to beach accretion at the south end of Treasure Island and shoaling in Blind Pass. Entrapment of this littoral drift at Blind Pass contributes to beach erosion just south of Blind Pass as seen by the landward shift in the beach south of the building protected by seawall. Vibracore locations are shown for the island transect presented below.

Offshore Cores







Core Data

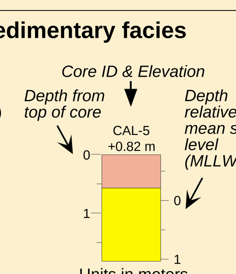
Seven generalized sedimentary-facies types were defined for a unified comparison of core data from the entire study area. All seven color-coded facies for the entire study are shown in the Explanation below. However, not all facies necessarily are present on each transect. Core photographs present individual 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 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). Core photographs are shown for USGS-95-47 (shelf) and TRI-4 (Long Key).

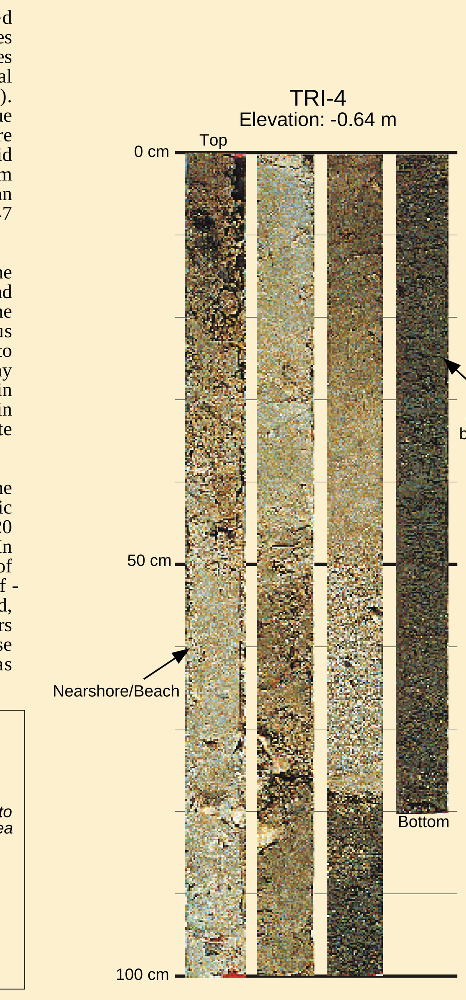
Offshore cores along transect 5 are among the longest of any recovered in the study area. Cores generally contained a surface layer of well-sorted quartz sand interpreted to represent deposition under open marine conditions. Beneath the surficial quartz-sand units are mud and muddy sand containing numerous burrows and lagoonal foraminiferal assemblages. These units are interpreted to represent back-barrier environments during the Holocene transgression. Many cores also contain a white, fluidized Pleistocene lime mud, probably deposited in a low-energy, restricted environment. This lime mud facies typically occurs in depressions associated with pre-Quaternary solution features or possible late Pleistocene channels. Several offshore cores penetrated to Miocene limestone.

Cores from the landward side of Boca Ciega Bay and in Bear Creek include the organic, muddy sand facies that is interpreted to represent a vegetated paralic environment. Radiocarbon dates from two of these cores were 3,140 and 4,220 YBP, similar to dates in this unit from other locations within the study area. In addition, samples from this unit taken from core TRI-6 located at the mouth of Bear Creek gave dates of 11,780 YBP at the base of the unit at an elevation of -4.3 m and 7,930 YBP at the top of the unit, an elevation of -3.2 m (FitzGerald, 1995). These dates straddle the Pleistocene-Holocene boundary at 10,000 years ago, and suggest continuous deposition across this sequence boundary. These strata are interpreted to represent an eolian strandplain system that was significantly above sea level at the time of accumulation.

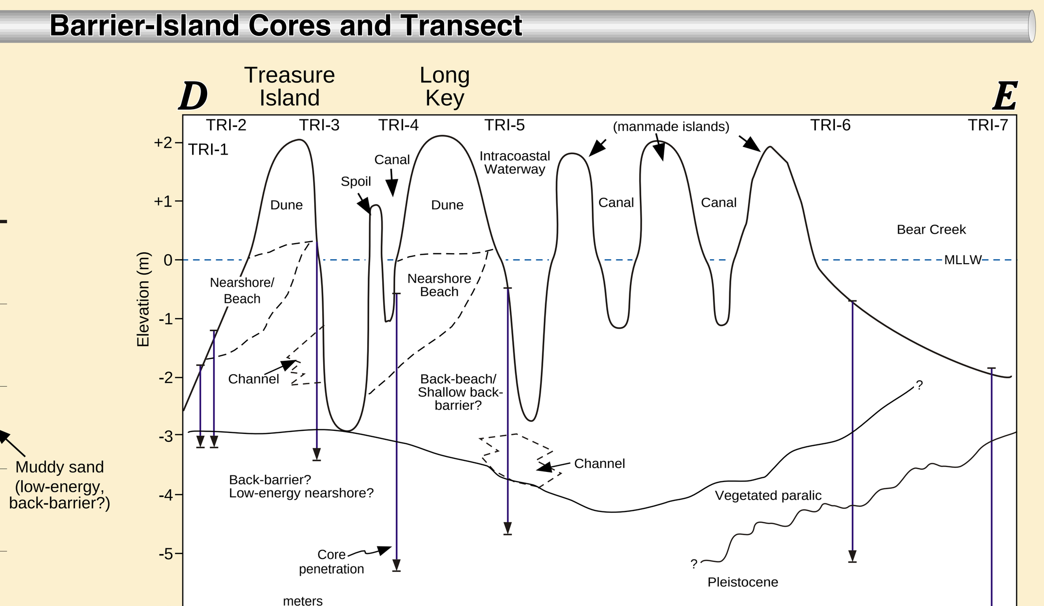
Explanation: core logs and sedimentary facies

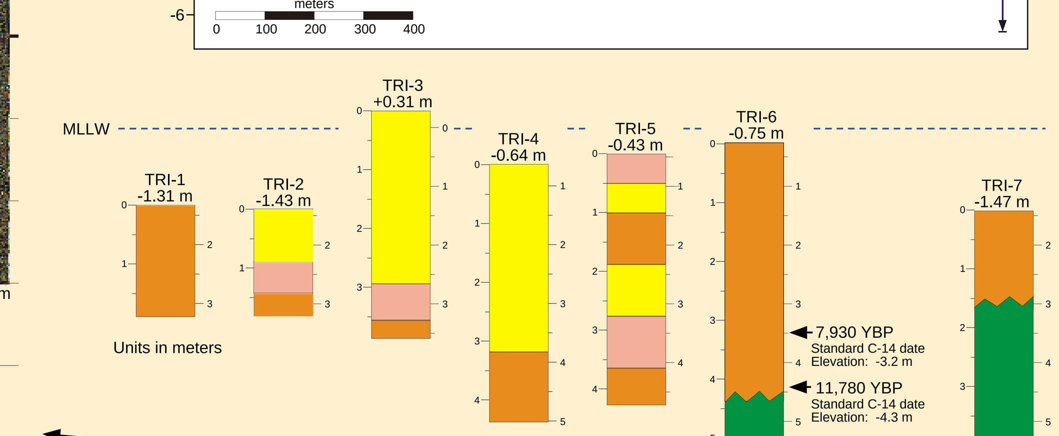
- gravel (> 60% gravel)
- gravelly sand (< 3% mud and 25-60% gravel)
- sand (< 3% mud and < 25% gravel)
- muddy sand (3-50% mud)
- mud (>50% mud)
- Pleistocene facies
- Miocene (limestone and blue-green clay)





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