West-Central Florida Coastal Transect # 2: Caladesi Island - Clearwater Beach Island

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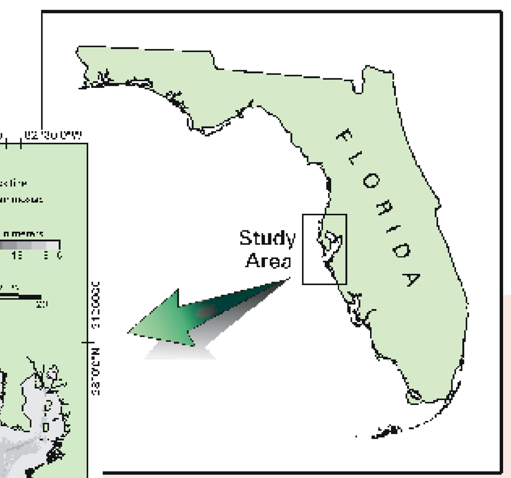
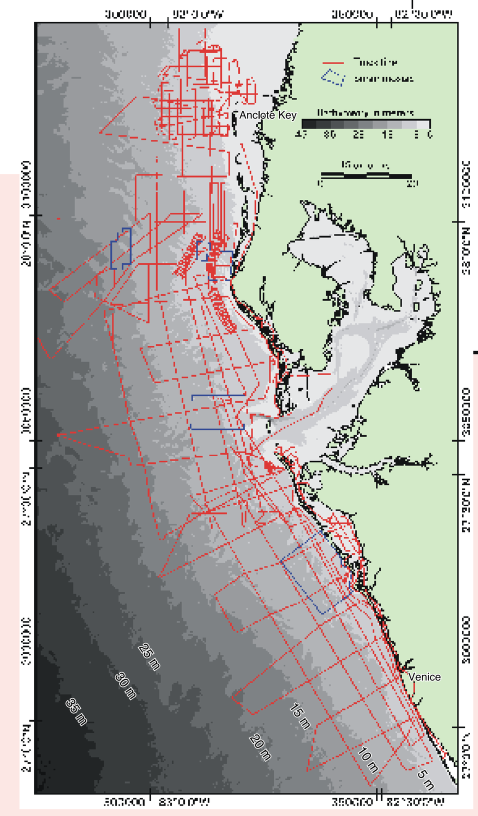




Location of study area along the west-central Florida coastline showing cruise-track coverage in red. Data types include high-resolution seismic-reflection data, side-scan sonar imagery, surface-sediment samples, and vibracores. Blue-box areas identify continuous-coverage side-scan sonar mosaic areas.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

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 #2 extends seaward from Caladesi Island and North Clearwater Beach (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 (Brooks and others, 1999). 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.

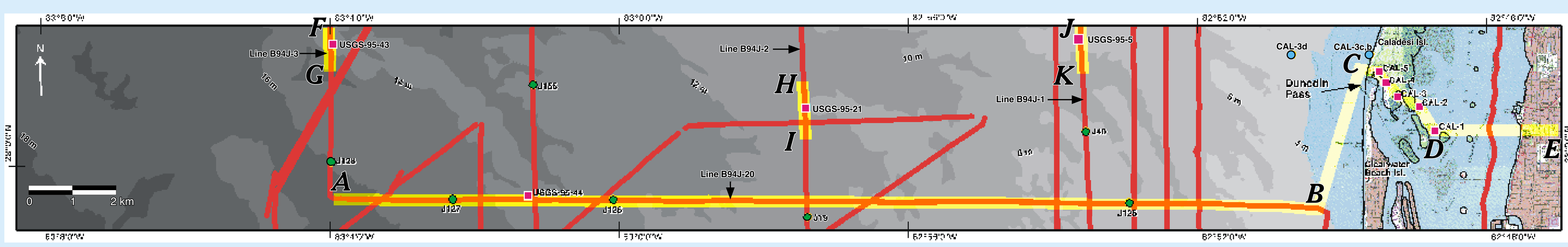
Geologic History and Morphodynamics of Barrier Islands

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.

Caladesi Island

One of the oldest islands in this system is Caladesi Island, a classic example of a drumstick barrier. The north end of the island was separated from what is now Honeymoon Island as the result of the hurricane of 1921, which broke through Hog Island to form Hurricane Pass (Brame, 1976). Caladesi Island experienced considerable progradation at its southern end due to the entrapment of sediment downdrift north of Dunedin Pass throughout most of the history of the island. Numerous beach/dune ridges separate swales and ponds. Dunedin Pass closed in 1988, three years after Hurricane Elena removed the ebb-tidal delta and facilitated longshore transport across the mouth of the small and unstable inlet (Davis and Hine, 1989; Barnard, 1998). Since that time, the southern end of the island has experienced erosion, and considerable accretion has taken place on the north end.

Sediments that comprise the barrier/inlet system along this coast display little variety (Yale, 1997). Fine quartz sand dominates with carbonate skeletal debris and mud as subordinant constituents. Most sediments are distinctly bimodal, with a shell-gravel fraction and the sand fraction dominated by quartz with lesser amounts of fine carbonate skeletal material. Stratigraphically, Caladesi Island shows a sand-dominated series of lithofacies with a range of shell gravel and mud. Back-barrier facies that originated as washover deposits are bioturbated and contain a significant amount of mineral and organic mud. Shallow to intertidal shoals, beach, and dune environments are represented by clean sand and shelly sand. As progradation of beach/dune ridges took place with mangrove environments intercalated between them, the surface and near-surface sediments reflected the presence of mangrove environments.

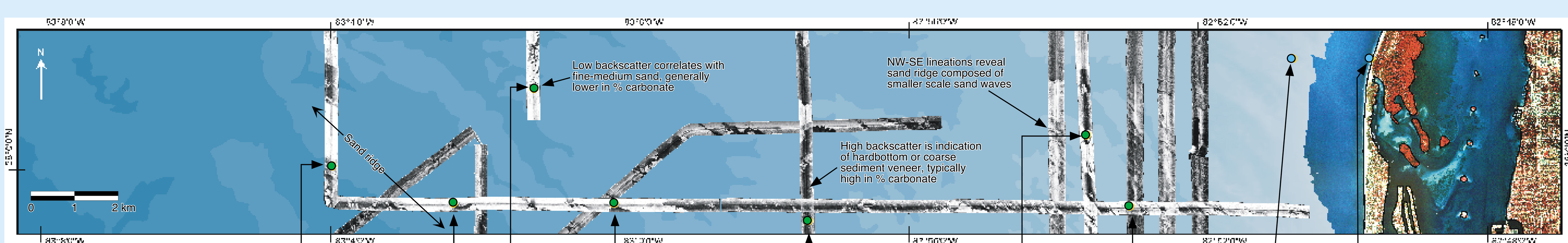


Location map

Location map showing bathymetry, cruise-track coverage, core and sample locations, and location of figures. Evidence for shoreline change is shown by comparing the 1997 shoreline, drawn in black, with a 1974 USGS quadrangle map. Dunedin Pass is shown open on the quadrangle map, and the north end of Clearwater Beach Island was narrower. The closing of Dunedin Pass occurred in 1988. The line of section A-E is linked to the seismic profile and cross sections presented below. F-G, H-I and J-K identify seismic profile locations presented with offshore core data at the bottom of this sheet.

- 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).

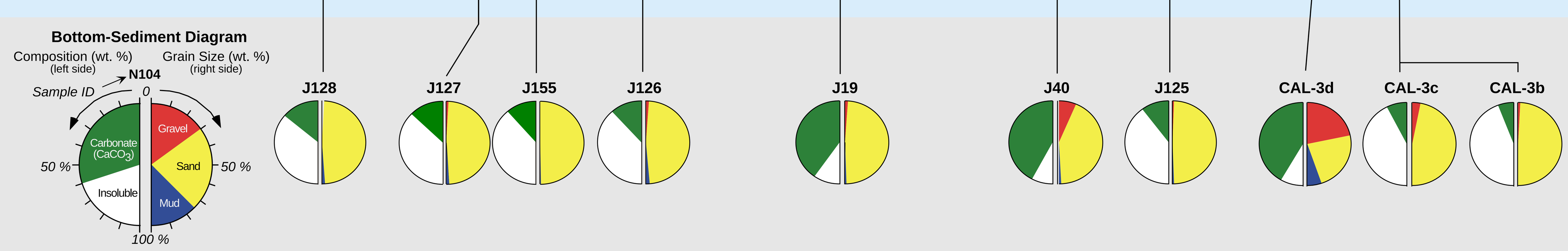
Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic.
Bathymetry in 2-m intervals starting at 4 m (modified from Gelfenbaum and Guy, 1999).
Land areas represented by USGS 7.5-Minute Topographic Map.



Side-scan sonar imagery

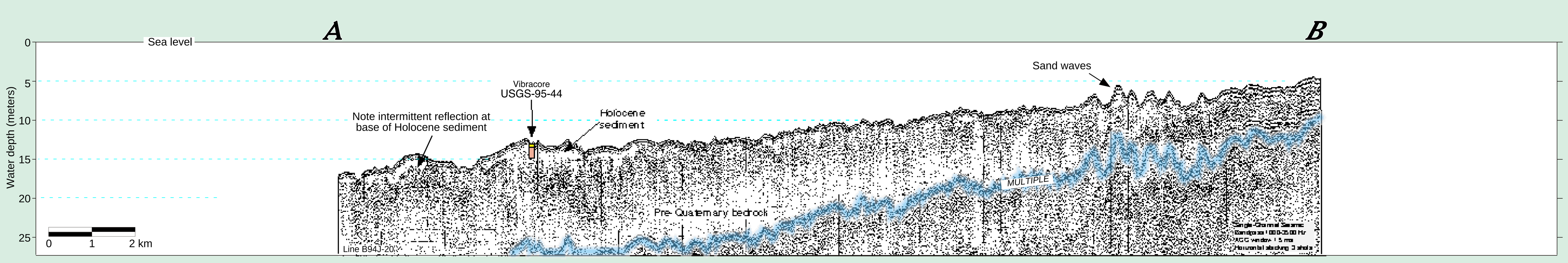
Side-scan sonar imagery overlain on bathymetry reveals a northwest-trending sand-ridge morphology common throughout the inner shelf in this region. Surface-sediment cover is thin and exhibits a patchy and discontinuous distribution. Low backscatter (light gray) areas correspond to sand ridges and flats dominated by quartz sand. The dark (high backscatter) areas are largely coarse sediment veneer with increased carbonate material (primarily shell material), or some hardbottoms. Landward of the 4-m isobath, a 1995 color infrared digital orthophotograph shows the extension and seaward accretion of the north end of Clearwater Beach Island – compare with the USGS quadrangle map in panel above.

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).



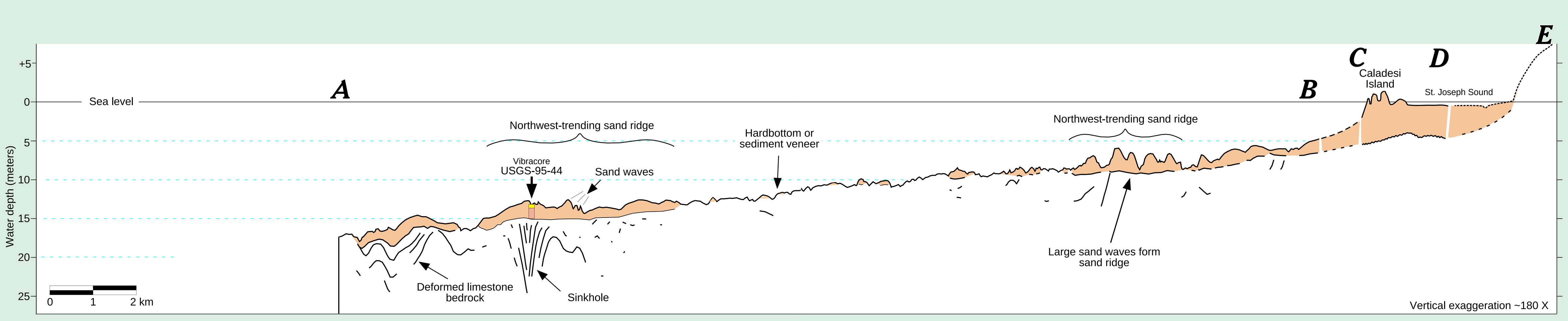
Surface sediments

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. Side-scan sonar 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 carbonates. The coarse-grained sediments are usually <10 to 20 cm thick, occupy low areas adjacent to thicker sand bodies, and form ripples oriented N-S with a 40- to 70-cm spacing.



Seismic-profile data

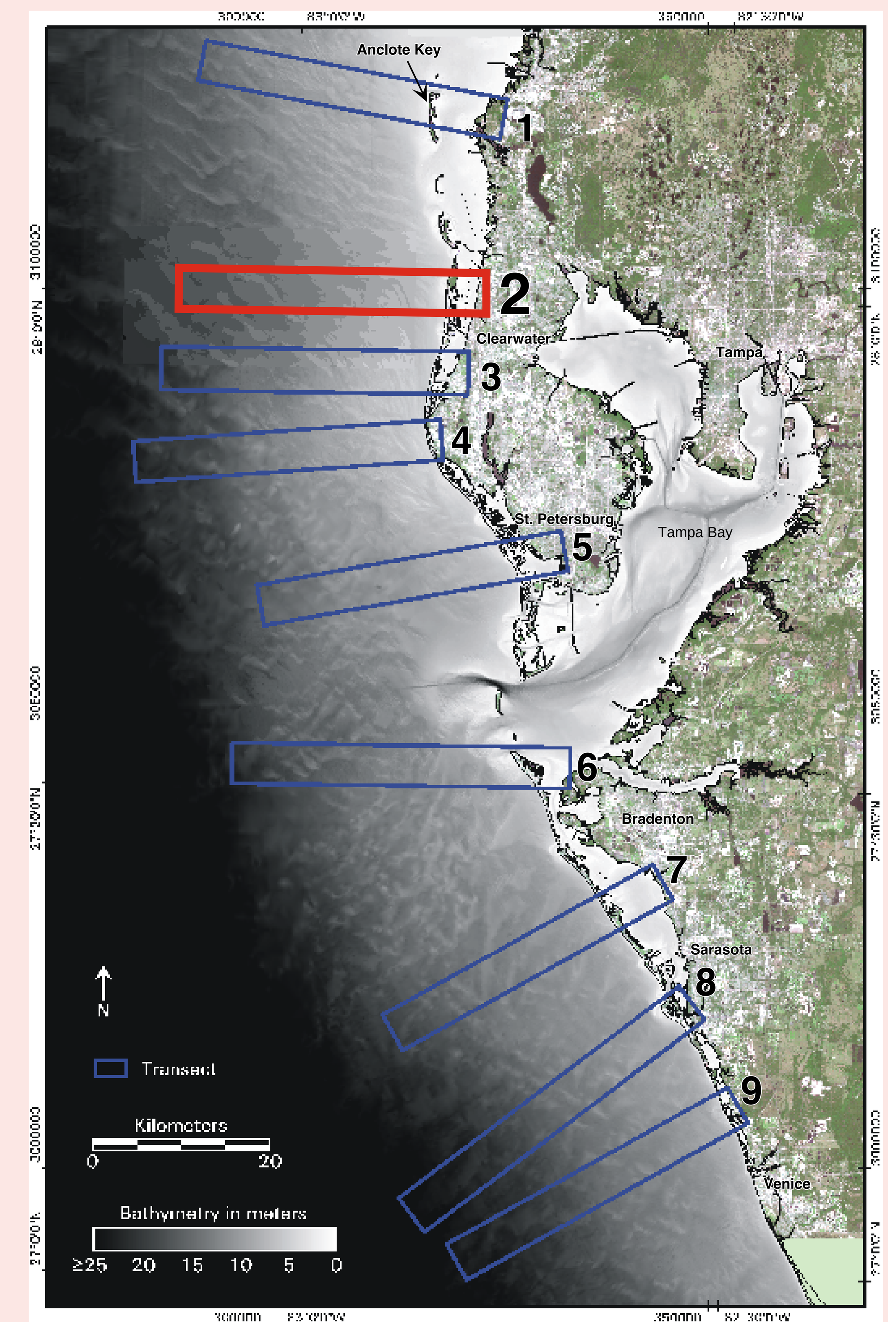
Uninterpreted high-resolution "boomer" seismic profile illustrates the poor acoustic contrast between the Holocene sediment cover and the Pleistocene exposure surface. The poor contrast is typical throughout the region and is attributed to the karst and weathered nature of the underlying pre-Quaternary bedrock. The offshore Holocene sediment thickness is usually less than 2 to 3 m, corresponding with the higher relief portions of the sand waves or ridges seen here.



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 because they often contain different ridge deposits, shown in side-scan sonar imagery and bathymetry data. Most of the sediment volume in this coastal system is found in the barrier-island section.

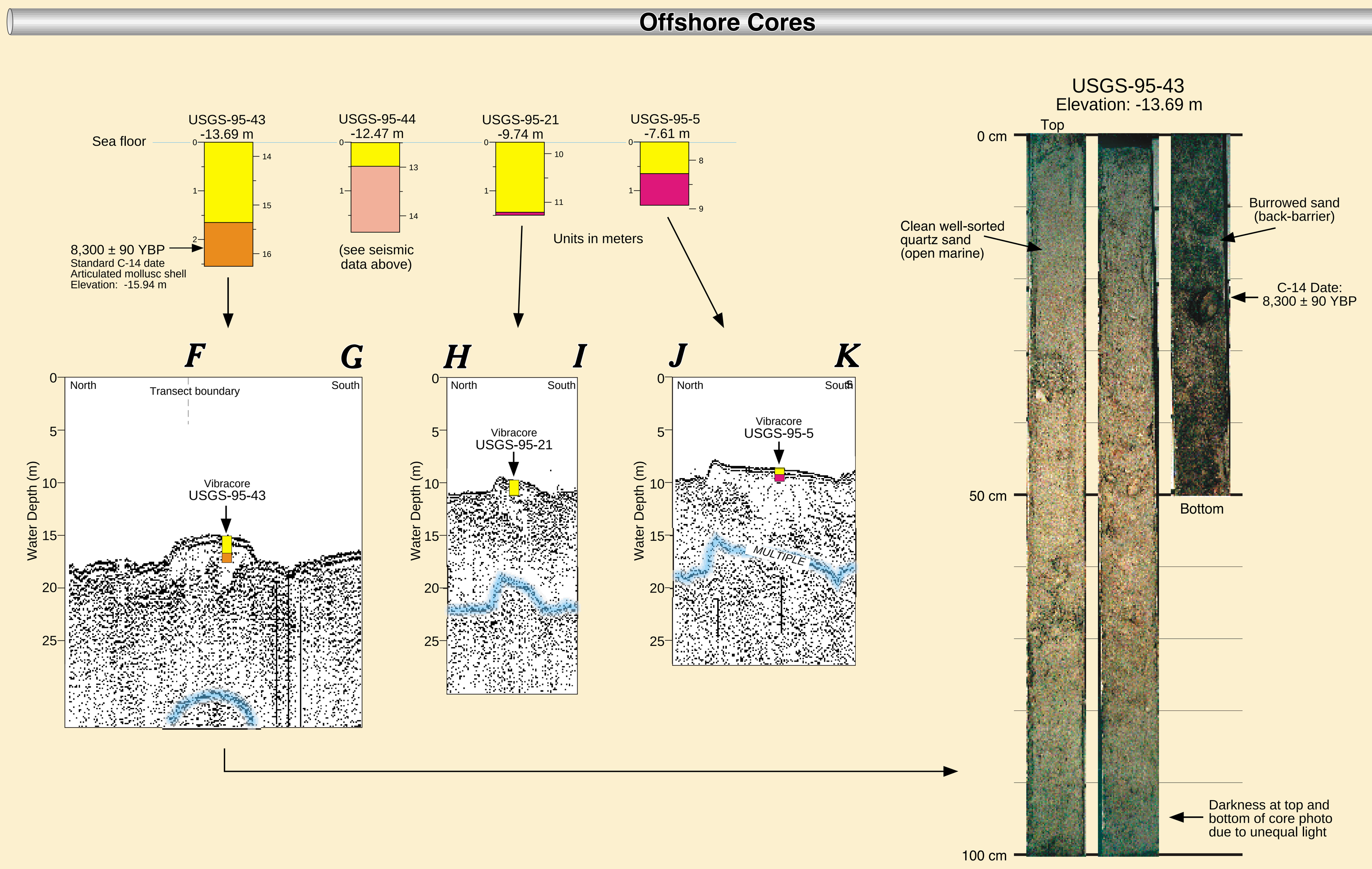
Holocene sediment



Location of west-central Florida coastal-transect maps with Transect #2 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 (taken in 1992) of Dunedin Pass which closed in 1988. Vegetated beach ridges, washover, and flood-tidal deposits occur landward of the beach. Vibracore locations are shown for the island-transect portion (C-D) presented below. Depth to bedrock is 4 to 5 m below sea level along this section.

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-95-43 (most seaward) and CAL-1 (most landward).

Offshore vibracore retrieval ranged from a little over 1 m to approximately 2.5 m in length. Although the vibracores penetrated to bedrock, there is often little indication of a bedrock reflection seen in the seismic data. A poor impedance contrast between well-sorted shelf sands and the underlying exposure surface appears to be responsible for the lack of a well-defined seismic boundary at the base of the Holocene section.

Offshore cores contain a surface layer dominated by quartz sand. The facies is interpreted to have been deposited under modern open-marine conditions. In the seaward most core, the quartz sand unit is underlain by a muddy sand unit with numerous visible burrows. The muddy sand is interpreted to have been deposited in a back-barrier environment. Radiocarbon dates indicate that it was deposited 8,300 ±90 years before present (YBP).

In the two landwardmost 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.

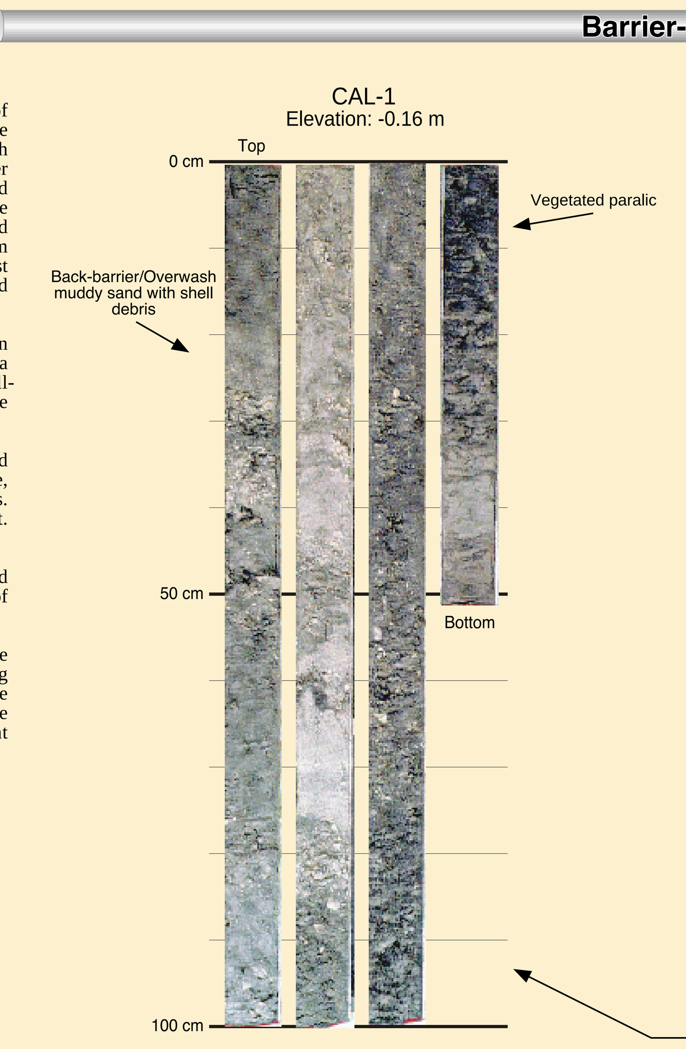
The barrier-island transect cores (right), taken across the prograding southern end of the barrier, record a transition from back-barrier and overwash sedimentary facies containing a more abundant shell and mud fraction, to cleaner sands in the beach and dune sedimentary facies. On cross sections where cores do not penetrate to bedrock, the control is based on probe-rod data. The expanded coastal cross section to the right includes general environmental interpretations.

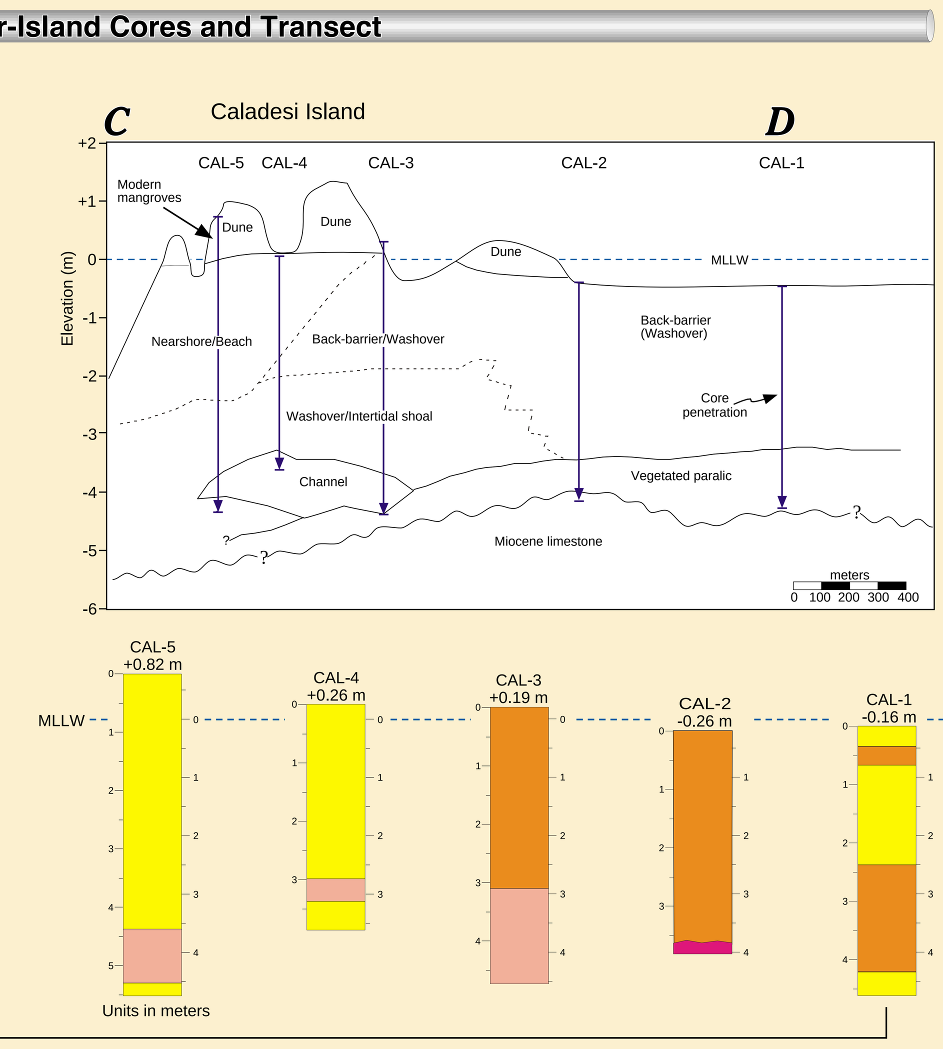
Explanation: core logs and sedimentary facies

- 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