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Northern Gulf of Mexico (NGOM) Ecosystem Change and Hazard Susceptibility Project

Seafloor Erosional Processes Offshore of the Chandeleur Islands, Louisiana

The Chandeleur Islands are a chain of barrier islands that lies along the eastern side of the modern Mississippi River Delta plain (fig. 1A). The island chain is located near the seaward edge of the relict St. Bernard Delta, the part of the Mississippi Delta that formed between approximately 4,000 and 2,000 years before present and was later abandoned as sedimentation shifted southward. After abandonment of the St. Bernard Delta, deposits were reworked, and the sandy component was shaped into the Chandeleur Islands. With continued subsidence, the islands became separated from their original delta headland sources and presently are isolated from the mainland by the shallow Chandeleur Sound.

Newly acquired geophysical data and vibracores provide an opportunity to better understand the processes that are shaping seafloor morphology (i.e., shape, geometry, and structure of the seafloor) on the inner shelf adjacent to the Chandeleur Islands. The inner shelf offshore of the Chandeleur Islands was mapped in 2006 and 2007 using swath bathymetry, sidescan sonar, and high-resolution seismic-reflection techniques (fig. 1B). The detailed results of this study were published in December 2009 (Twichell and others, 2009) as part of a special issue of Geo-Marine Letters that documents early results from the Northern Gulf of Mexico (NGOM) Ecosystem Change and Hazard Susceptibility Project. This study addresses questions and concerns related to limited sand resources along the Louisiana shelf and their implications to long-term relative sea-level rise and storm impacts.

Stratigraphy

Building upon previous surveys of the modern inner shelf offshore of the Chandeleur Islands, the detailed seismic-reflection data collected as part of the NGOM project confirm that the seafloor within the study area beyond the part covered by the barrier island sand sheet is an erosional surface. The stratigraphic units or facies associated with the relict St. Bernard Delta and the overlying Chandeleur Islands were mapped based on high-resolution seismic-reflection and vibracore interpretations. The detailed maps of surficial geology and morphology indicate that the shallow stratigraphy has a strong control on seafloor morphology. Three acoustic facies were distinguished in the seismic profiles (see table 1), and the vibracores show that the three acoustic facies coincide with distinct lithologic facies (fig. 2).

With the detailed geophysical and core data that are now available, we can (1) evaluate some of the processes that have contributed to the formation of this erosional surface and (2) demonstrate the control that the underlying geology

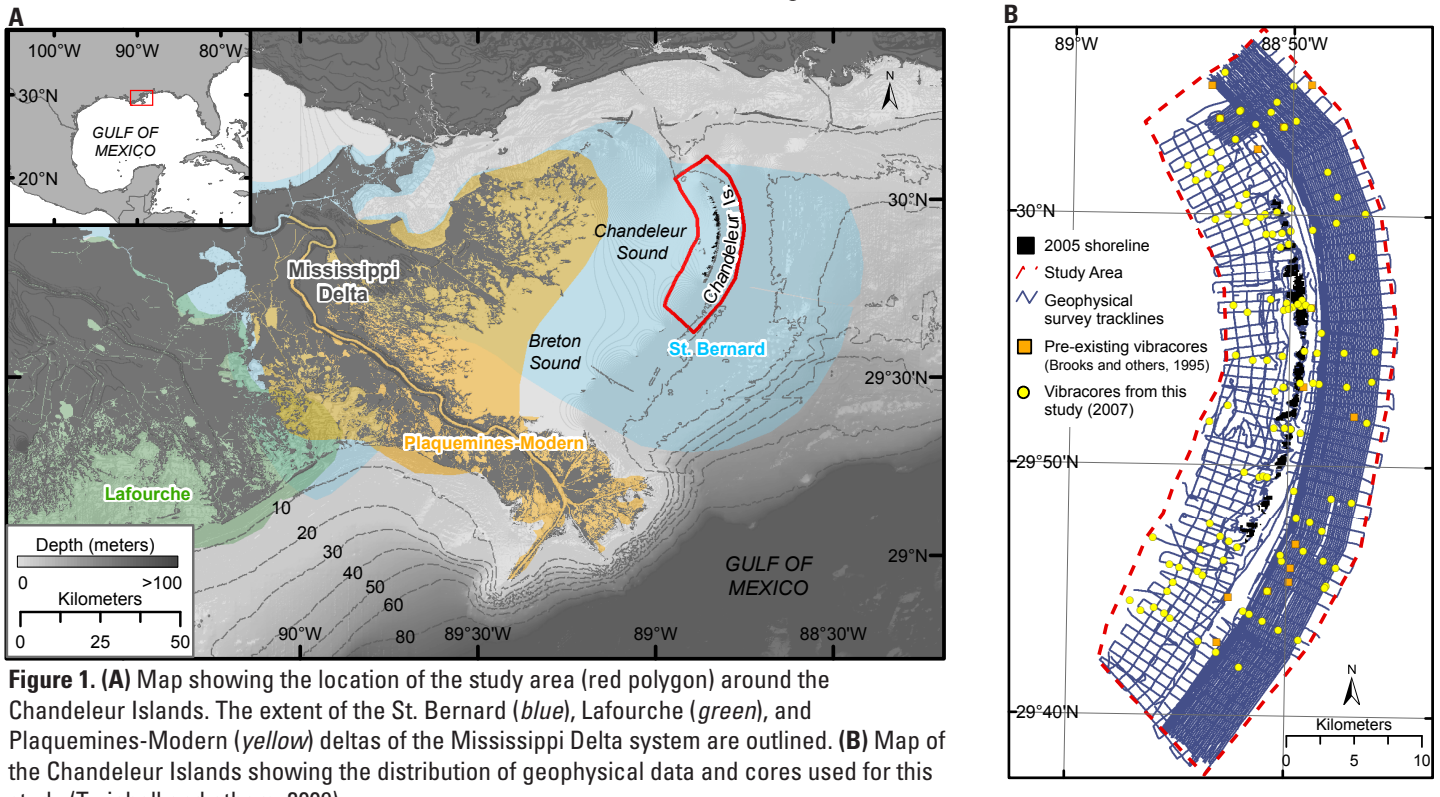

Figure 1. (A) Map showing the location of the study area (red polygon) around the Chandeleur Islands. The extent of the St. Bernard (*blue*), Lafourche (*green*), and Plaquemines-Modern (*yellow*) deltas of the Mississippi Delta system are outlined. **(B)** Map of the Chandeleur Islands showing the distribution of geophysical data and cores used for this study (Twichell and others, 2009).

has on the continuing evolution of its morphology.

Seafloor Geology

The sidescan-sonar imagery provides a high-resolution view (1-meter pixel size) of the seafloor. Two important features observed in the sidescan-sonar imagery are linear depressions and subcircular depressions, with the latter being referred to as pits (fig 2B). The linear depressions identified off the Chandeleur Islands, to our knowledge, have not been observed elsewhere. Nearly all (91%) of the linear depressions incise distributary-channel deposits, and their trends parallel the orientation of the channels into which they are incised, which suggests that substrate differences control their distribution.

The origin of the subcircular pits is unclear. Pits with similar morphologies have been identified in other settings and have a variety of origins. However, the morphology of these pits is most consistent with pit formation resulting from sediment collapse, perhaps triggered by cyclic loading of the seafloor by storm waves. Large storm waves may also induce the release of biogenic gas from the shallow sediment, as evidenced by occasional vents in the floors of the depressions and gas chimneys observed in other seismic profiles.

The timing and environmental conditions associated with linear depression and pit formation are uncertain; likewise, the duration of their geomorphic expression on the seafloor is unknown. The survey off the Chandeleur Islands was done approximately 1 year after the passage of Hurricanes Katrina and Rita. Some features of the pits appear to be recently formed, and it is possible to attribute their formation to the passage of Hurricanes Katrina and Rita. Mississippi Delta deposits did fail in response to the passage of Hurricanes Katrina and Rita. Collapse depressions may be how these delta-front deposits respond to the passage of large storms.

These detailed observations suggest that erosion of this inner shelf surface may be ongoing, is controlled by the underlying stratigraphy, and has varied morphologic expression.

Table 1. Description of three acoustic facies as distinguished in seismic profiles.

Unit (relative age)	Acoustic Properties	Lithology	Depositional Environment	Erosional
Unit 1 (oldest)	Flat-lying to gently undulating, high- to moderate-amplitude, continuous, closely spaced reflections	Scattered thin laminations of silt and fine sand; near-surface sand content less than 15%	Prodelta and delta-front deposits	Yes
Unit 2	Steeply dipping reflections that commonly fill channel-shaped features	Moderate to high sand contents averaging 53% and exceeding 80% in some intervals	Distributary channel deposits	Yes
Unit 3 (youngest)	Transparent interval, contains discontinuous reflections	Sand and silty sand	Barrier island sand facies	Unknown

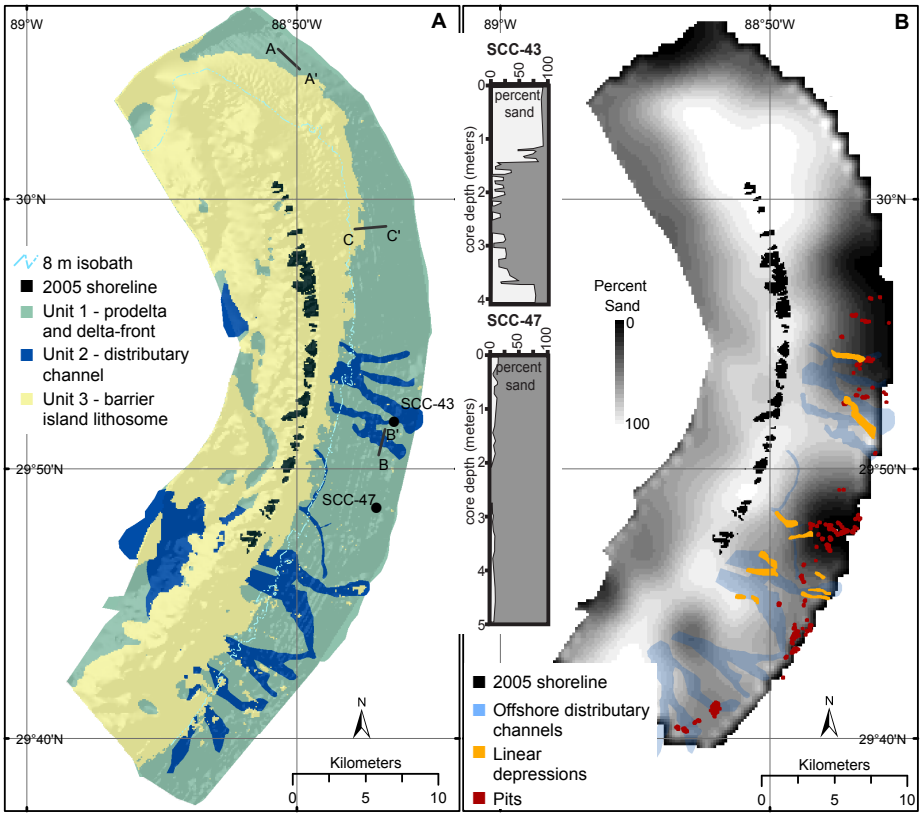

Figure 2. Maps showing (A) where the three units are exposed on the seafloor and (B) the distribution of linear troughs and subcircular pits throughout the study area overlain on a map showing near-surface sand content. The two cores show the difference in sand content of delta front and distributary channel facies (Twichell and others, 2009).

References Cited

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