Reconstructing the MIS 2 Pascagoula-Biloxi Paleovalley and Associated Valley-Fill in the Northern Gulf of Mexico

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Abstract

Systemic modification of coastal systems in the northern Gulf of Mexico is generated by rapid geomorphic change due to storms, relative sea level rise, significant reduction in sediment supply, and anthropogenic alteration. Policy makers, engineers, and scientists must understand the overall geologic evolution as well as small scale processes associated with past sea level cycles to make informed decisions when addressing current and future sea level rise. After the Last Glacial Maximum, sea level rose rapidly during marine isotope stage (MIS) 2 (approximately 29-14 ka) leading to a transgressive reworking of lithosomes. As sea level continued to rise, Holocene sediments underwent significant reworking and backstepping resulting in drowned paleovalley architecture. Coastal geomorphic evolution is partially preserved within the geologic record specifically within incised valleys and shelf deposits. This study synthesizes ˜700 km of boomer geophysical data collected in 2021, 19 sediment cores, microfossil analyses, and radiocarbon dates to create a geomorphic evolutionary framework of the Pascagoula-Biloxi paleovalley and associated fill along the innershelf of the northern Gulf of Mexico. Sediment cores described within the footprint of the Pascagoula-Biloxi paleovalley consist of muddy bedding overlying muddy sand and sandy mud with Pleistocene clay around 450-500 cm downcore. One such core contained large wood chunks dated to ˜11 ka cal yr BP resting on a Pleistocene clay basal facies. Preserved wood indicates either rapid burial or an anoxic system, in this case - likely a swamp. Along the edge of the Pascagoula-Biloxi paleovalley, a sediment core exhibits well preserved interbedded clay and peat layers also dated to ˜11 ka cal yr BP. These similar ages indicate terrestrial/shoreline deposition, and these data provide constraints to reconstruct the immature paleo shoreline and associated features of the early Holocene.

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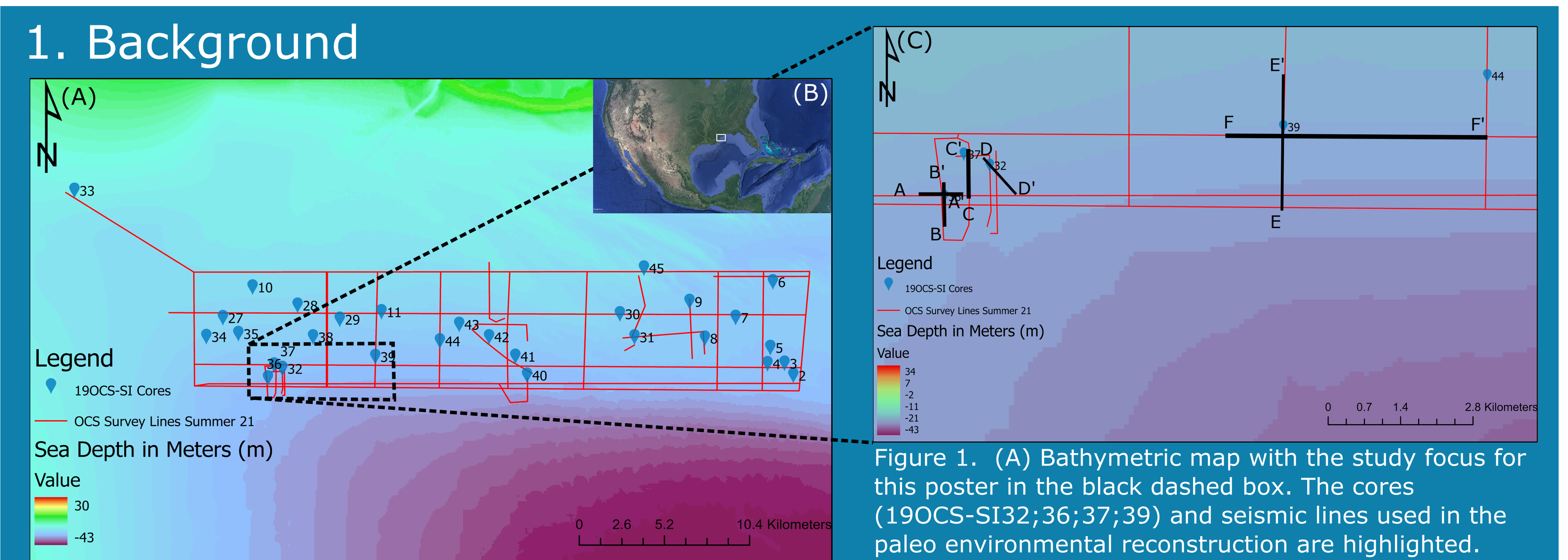
USM Coastal Evolution & Hazards Research Lab

The University of Southern Mississippi

BOEM Bureau of Ocean Energy Management

1. Background



Systemic modification of coastal systems in the northern Gulf of Mexico is generated by rapid geomorphic change due to storms, significant relative sea level rise, significant reduction in sediment supply, and anthropogenic alteration.

Figure 1. (A) Bathymetric map with the study focus for this poster in the black dashed box. The cores (19OCS-SI32;36;37;39) and seismic lines used in the paleo environmental reconstruction are highlighted. (B) Satellite view from space of study area in the northern Gulf of Mexico from Google Earth at 1300 km- in a North-Western orientation. (C) Focus cores and seismic lines that correlate with figures 6-11.

2. Methods

~400 km of geophysical boomer data collected in 2021

~19 sediment cores collected in 2019

12 radiocarbon dates using in situ samples of wood and peat

Microfossil analysis

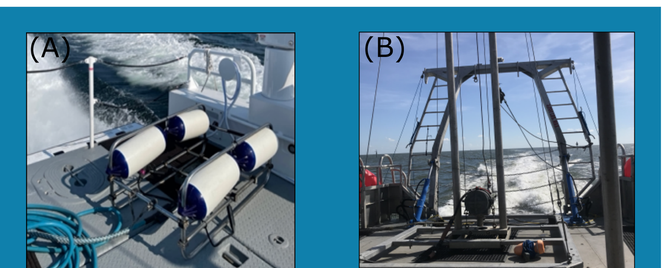


Figure 2. (A) Applied Acoustics boomer plate and catamaran; the boomer is towed with the blue HV cable attached and the hydrophone parallel from the vessel's stern. (B) The Rossfielder vibracore used during sediment core aquisition in 2019.

3. Results

After the Last Glacial Maximum, sea level rose rapidly during marine isotope stage (MIS 2) (approximately 29-14 ka) leading to a transgressive reworking of lithosomes.

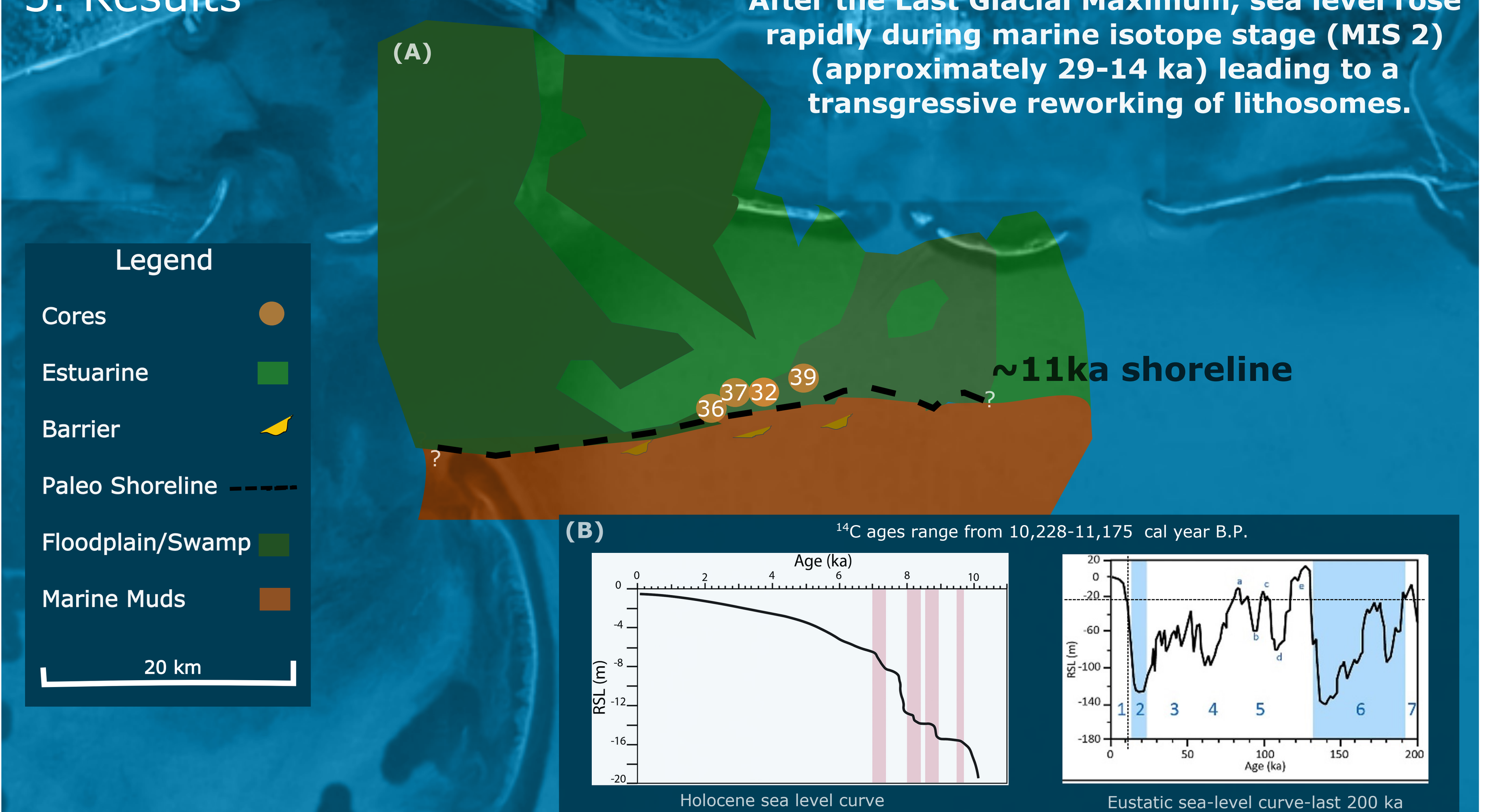
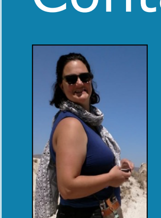


Figure 3. (A) Immature paleo shoreline reconstruction and associated features of the Early Holocene. Sediment cores described within the footprint of the Pascagoula-Biloxi paleovalley consist of muddy bedding overlying muddy sand and sandy mud with Pleistocene clay around 450-500 cm downcore. 19OCS-SI36 contained large wood chunks dated to 10,763-11,175 cal yr B.P. resting on a Pleistocene clay basal facies. Preserved wood indicated either rapid burial or an anoxic system, in this case likely a swamp/floodplain. Along the edge of the Pascagoula-Biloxi paleovalley, 19OCS-SI39 exhibits well preserved interbedded clay and peat layers dated to 10,228-11,066 cal yr B.P. indicative of a stark environmental change. (B) Sea-Level curve in the northern Gulf of Mexico (modified from Hollis et al., 2019; Milliken et al., 2008; Shackleton, 2000). Blue numbers indicate Marine Isotope Stage (MIS) number; dashed black lines indicate the intersection between relative sea level (RSL) and approximate age derived from wood and peat. Using a multi-proxy approach, we continued the reconstruction of early Quaternary deposits south of Horn and Petit Bois Islands' (Gal et al. 2021).

Contact Information, References, and Acknowledgements



Thank you to the crew of the R/V Appalachee, R/V Ken Barbor, and R/V Jim Franks
Thank you to Jim Flocks (USGS) for the Rossfelder P-5 vibracorer and associated training
Thank you to Easy Core for providing the software that generated core logs
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^{14}C ages suggest terrestrial/shoreline deposition, providing constraints to reconstruct the immature paleo shoreline and associated features of the Early Holocene.

4. Analysis and Interpretation

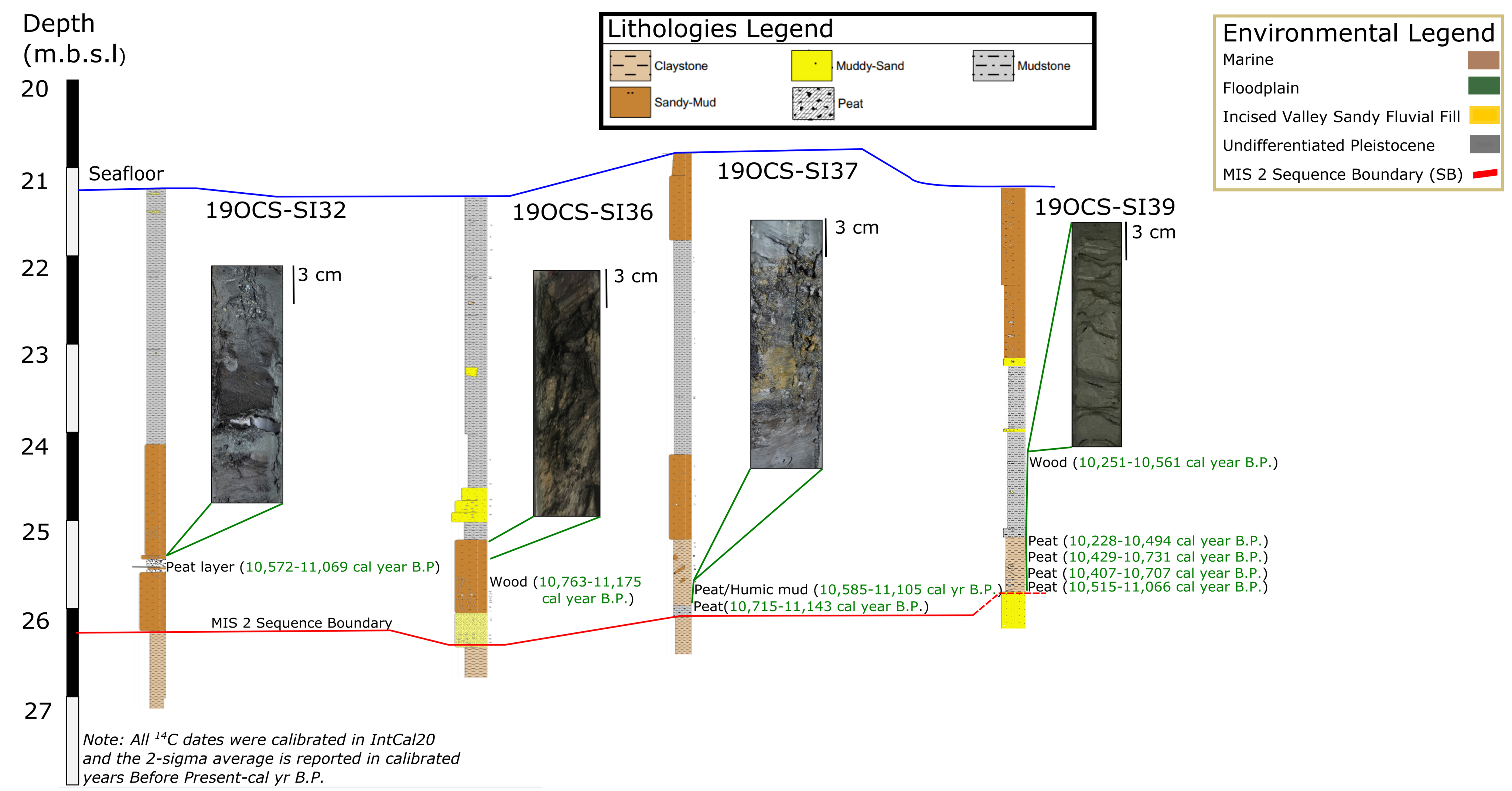

Figure 4. Lithologues of cores 19OCS-SI32; 19OCS-SI36; 19OCS-SI37; 19OCS-SI39 with ^{14}C calibrated ages labeled in green. Photos of the associated organic material (i.e. wood or peat) are emphasized at the appropriate interval. The interpreted (MIS2) Pleistocene surface/sequence boundary is shown in blue. Peat from 19OCS-SI32 dated to 10,572-11,069 cal year BP. Interbedded peat and mud from 19OCS-SI39 dates range from 10,228-11,066 cal year BP. In situ wood from 19OCS-SI36 dated to 10,763-11,175 cal year BP. 19OCS-SI37 contained humic muds and peat dated between 10,585-11,143 cal year B.P.

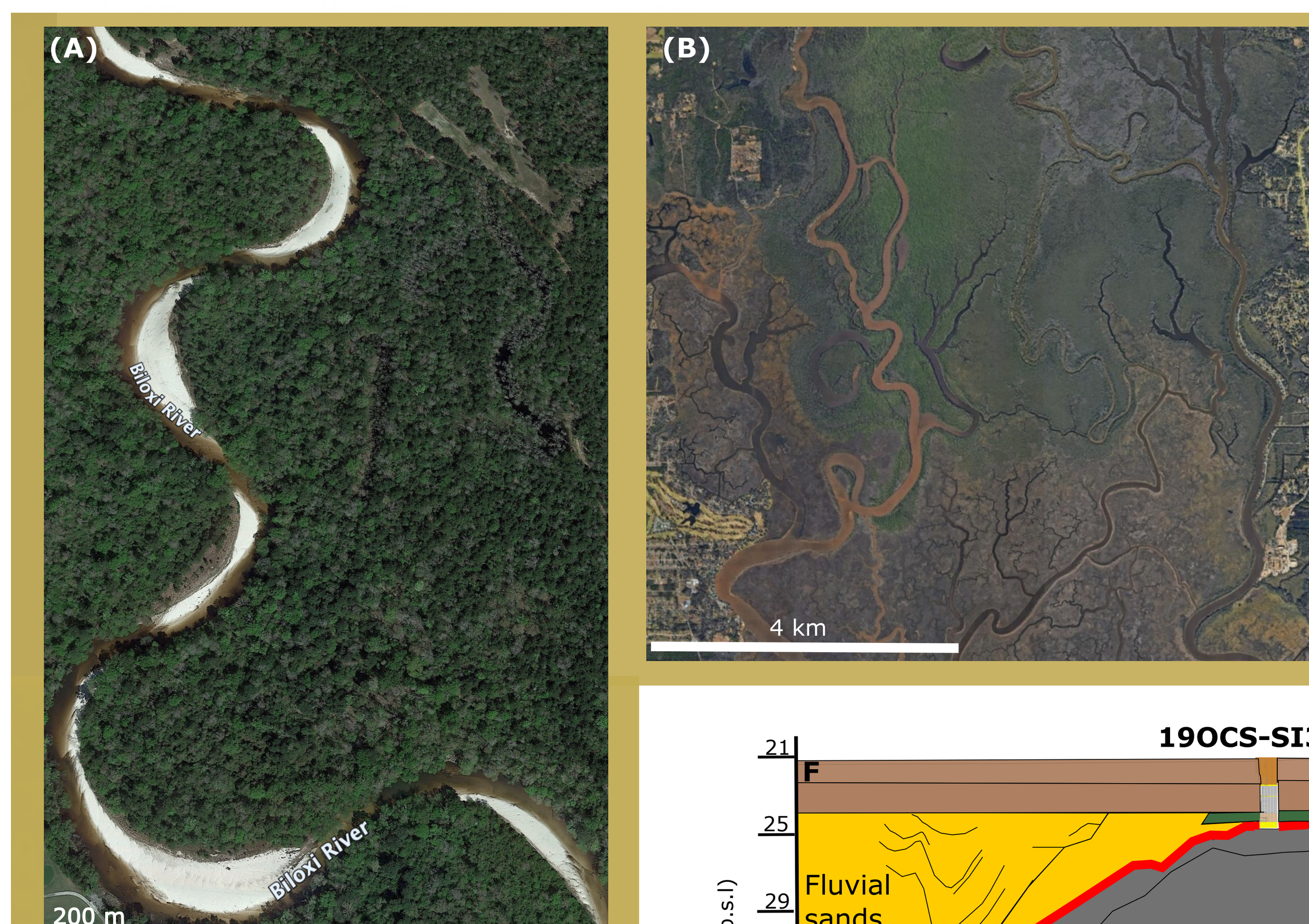

Figure 5. (A) The modern Biloxi River is a meandering system with high sand content; providing an excellent analogue for the Biloxi ~ 11 ka.;as seen in figures 10 and 11, preserved in the sedimentary record and captured in the 2021 seismic survey. Note the modern point bar deposition and cut bank in plan view above and in figure 10 the crosssection. (B) Plan view of Pascagoula River and associated floodplain exhibiting a similar environment that would have existed near core 19OCS-SI39 ~11 ka. Satellite images from of Google Earth.

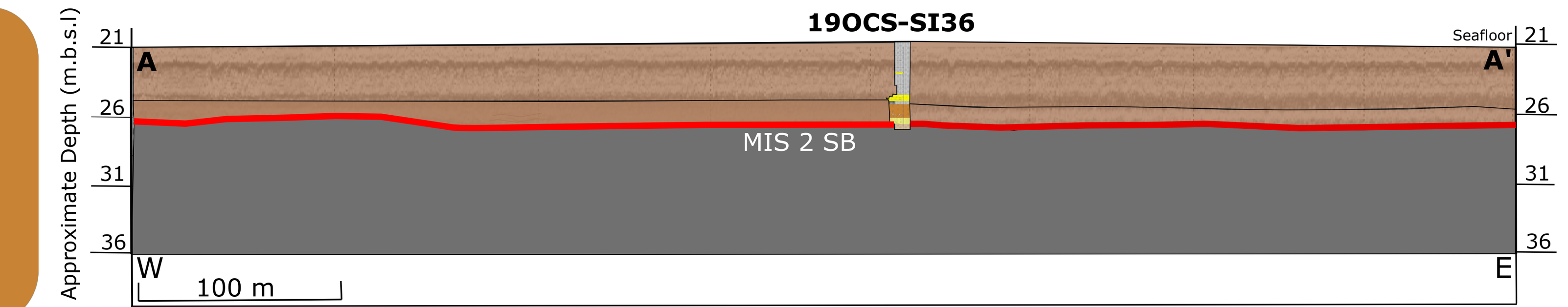

Figure 6. Seismic line (A-A') collected by USM in Summer 2021. The line is in a strike orientation and crosses over core 19OCS-SI36. It exhibits reflectors of Holocene marine mud and sandy mud facies along with a strong MIS 2 sequence boundary (SB) reflector.

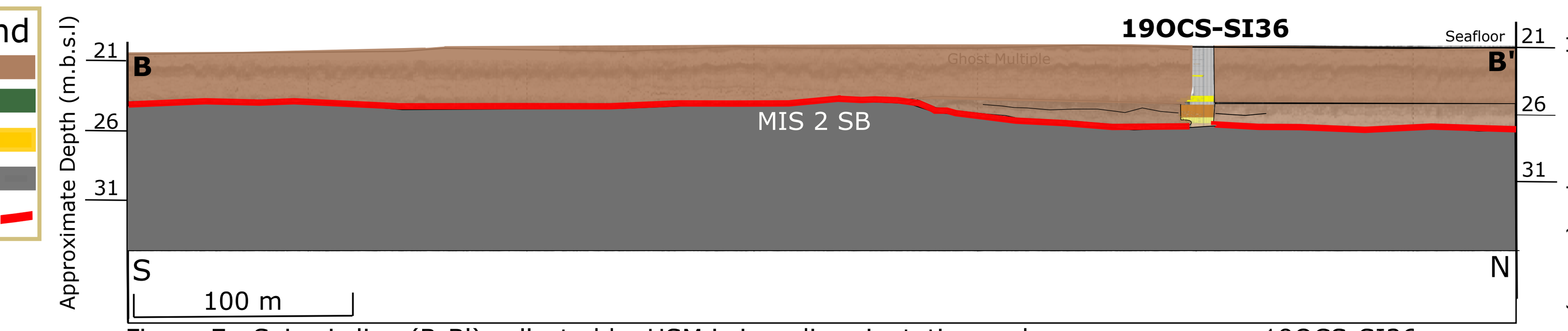

Figure 7. Seismic line (B-B') collected by USM is in a dip orientation and crosses over core 19OCS-SI36; exhibiting reflectors of marine muds and sandy muds as well as a strong MIS 2 reflector indicating the erosional sequence boundary.

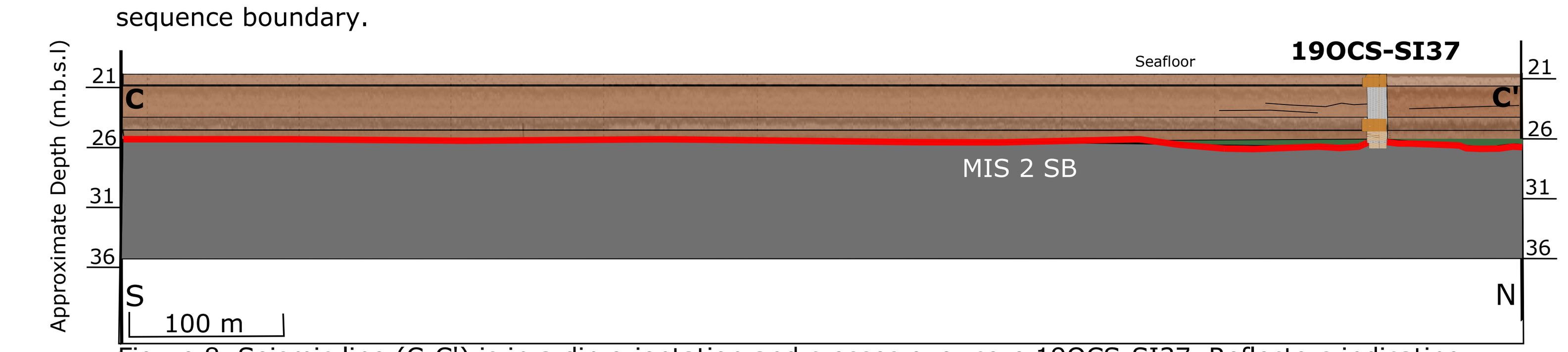

Figure 8. Seismic line (C-C') is in a dip orientation and crosses over core 19OCS-SI37. Reflectors indicating estuarine deposition are present and sandy mud, marine mud, and humic mud facies are intrepreted. The MIS 2 sequence boundary is shown in red and undifferentiated Pleisotocene in gray.

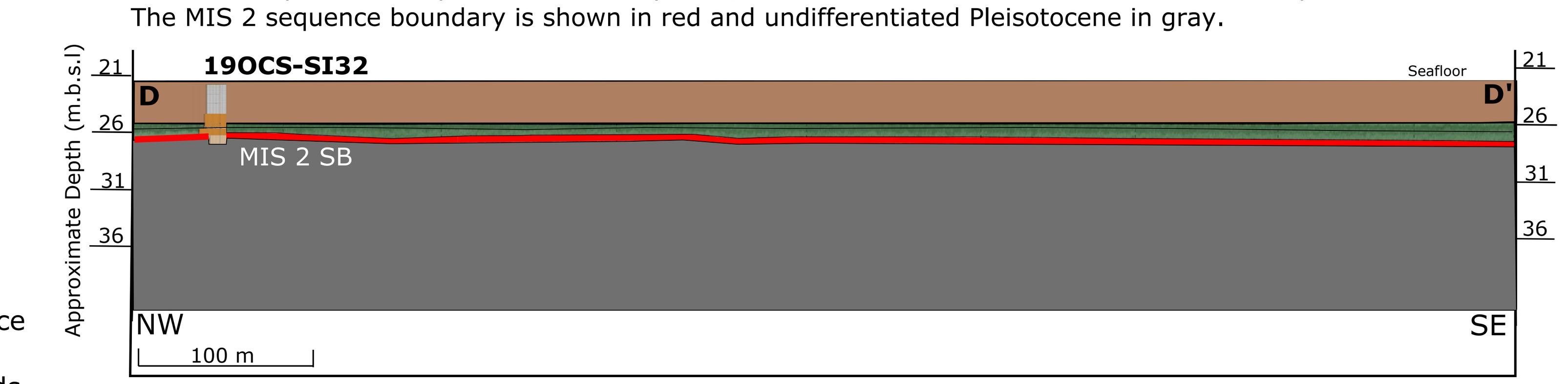

Figure 9. Seismic line (D-D') collected by USM in Summer 2021. The line is in a NW-SE orientation and crosses over 19OCS-SI32. Reflectors indicating marine mud and sandy mud deposition is present. The MIS 2 SB is in red.

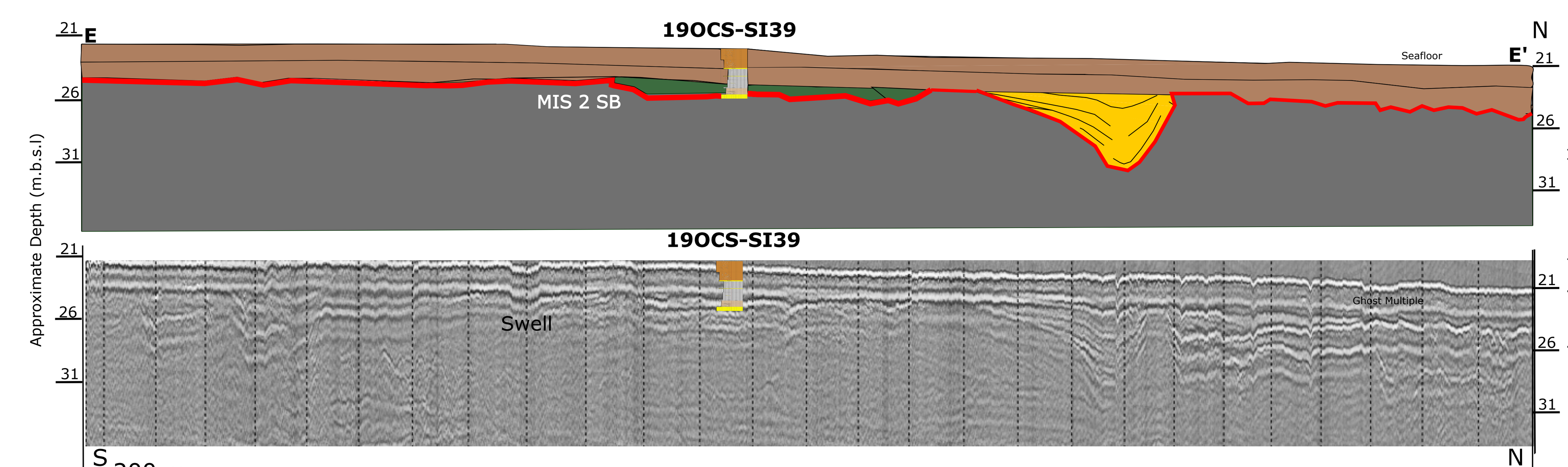

Figure 10. Seismic line (E-E') is in a dip orientation crossing over core 19OCS-SI39 and exhibits reflectors of sandy muds, marine muds, and fine-grained sands facies overlain on floodplain deposits and interbedded muds and peat indicative of an erosional surface. The MIS 2 SB is highlighted in red. A ~400 m wide paleochannel with fluvial sandy infill and textbook point bar and cutbank features is shown in yellow.

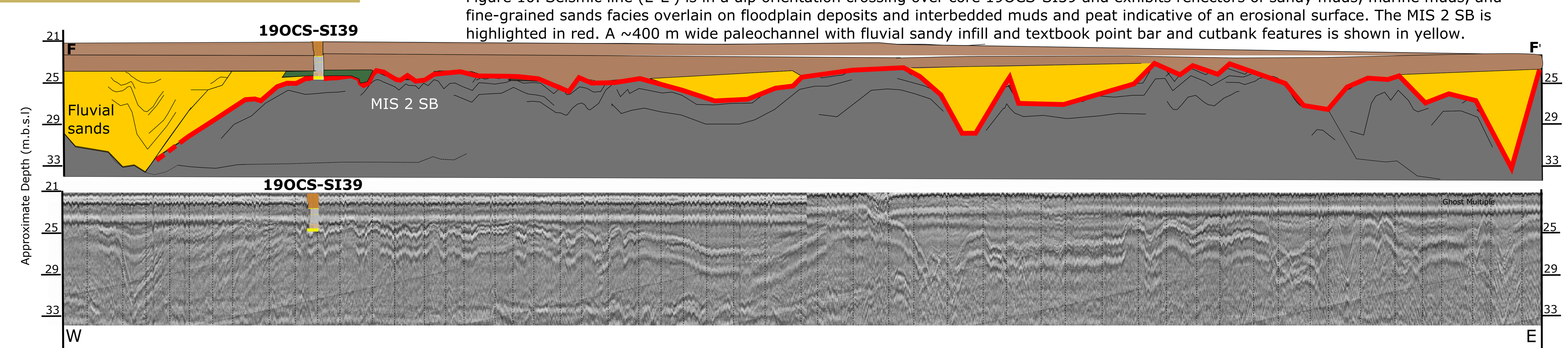

Figure 11. Seismic line (F-F') is in a strike orientation crossing over core 19OCS-SI39. The line exhibits reflectors of sandy muds, marine mud, and fine-grained sands facies overlain on floodplain deposits and innerbedded muds and peat indicative of an erosional surface. The MIS 2 sequence boundary is highlighted in red. Two incised valleys are intrepreted with fluvial sand infill as well as smaller interfluves; indicative of a meandering river and leading into the incised valley to the east.