DECODING THE EVOLUTION OF THE LOOP CURRENT-GULF STREAM FROM SEDIMENT DRIFTS

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WORKING HYPOTHESES

- Sediment drifts along the Campeche Bank and the Florida Straits reflect changes in the Loop Current-Gulf Stream circulation patterns through the Neogene.
- Geometry, unconformities, and thickness variation of the sediment drifts archive the current strength, width, and direction along the Campeche Bank and Florida Straits.
- Changes in past climate affected sediment distribution in Campeche Bank and Florida Straits, which is crucial for understanding global teleconnections, feedback thresholds, and forcing mechanisms.

PROJECT RATIONALE

Scientists use geochemical proxies, such as the $\delta^{18}O$ values of benthic foraminifer tests, to decode the timing of paleoclimatic and palaeoceanographic changes. Recent research has shown that the geometry of sediment drifts and unconformities recorded in them can act as physical indicators of palaeoceanographic changes. The formation of sediment drifts results from the actions of bottom currents and can be heavily impacted by current speed, direction, and sediment properties. Although sediment drifts on the Campeche Bank (Hübscher et al., 2023; Lowery et al., 2023) and the Florida Straits (Anselmetti et al., 2000; Bergman, 2005) offer insights into past oceanographic conditions, no stratigraphic correlation exists between the two areas.

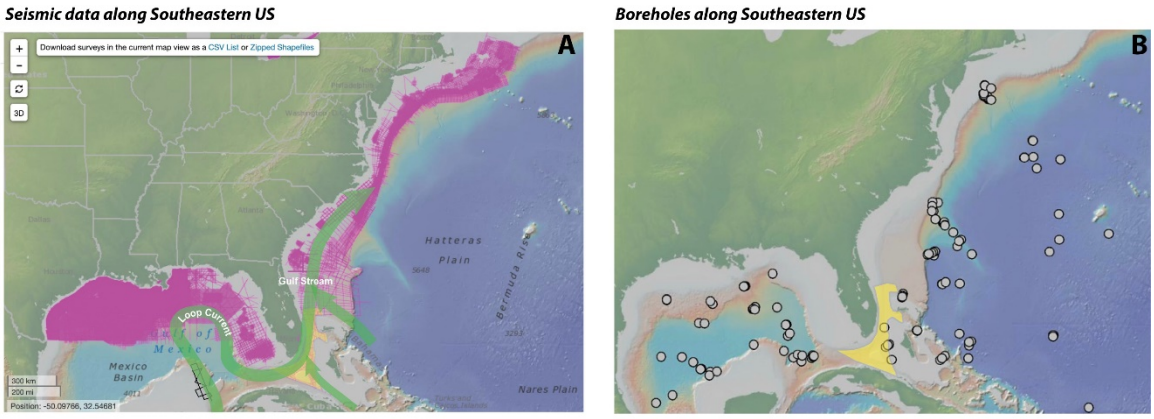

Fig. 1. The map shows A) the location of available seismic data with Loop Current and the Gulf Stream indicated in green and B) boreholes along the Campeche Bank and the Florida Platform, black lines, and yellow polygons indicating past mapped areas.

To address this gap, our study seeks to map and identify the distribution of sediment drifts in these regions and explore the timing and variability of the current processes responsible for their formation. By analyzing sediment drifts geometry, we can track

long-term ocean circulation changes, while unconformities indicate abrupt Gulf Stream and Loop Current changes.

DATASETS

The study relies on a robust dataset encompassing multichannel 2D seismic data, well-logs, cores, bathymetric data, oceanographic data, and submersible dives. The seismic data is part of a large data set accessible on the National Archive of Marine Seismic Surveys and the Academic Seismic Portal in areas along the Florida Straits and Campeche Bank, while the core data are from ODP (Fig. 1).

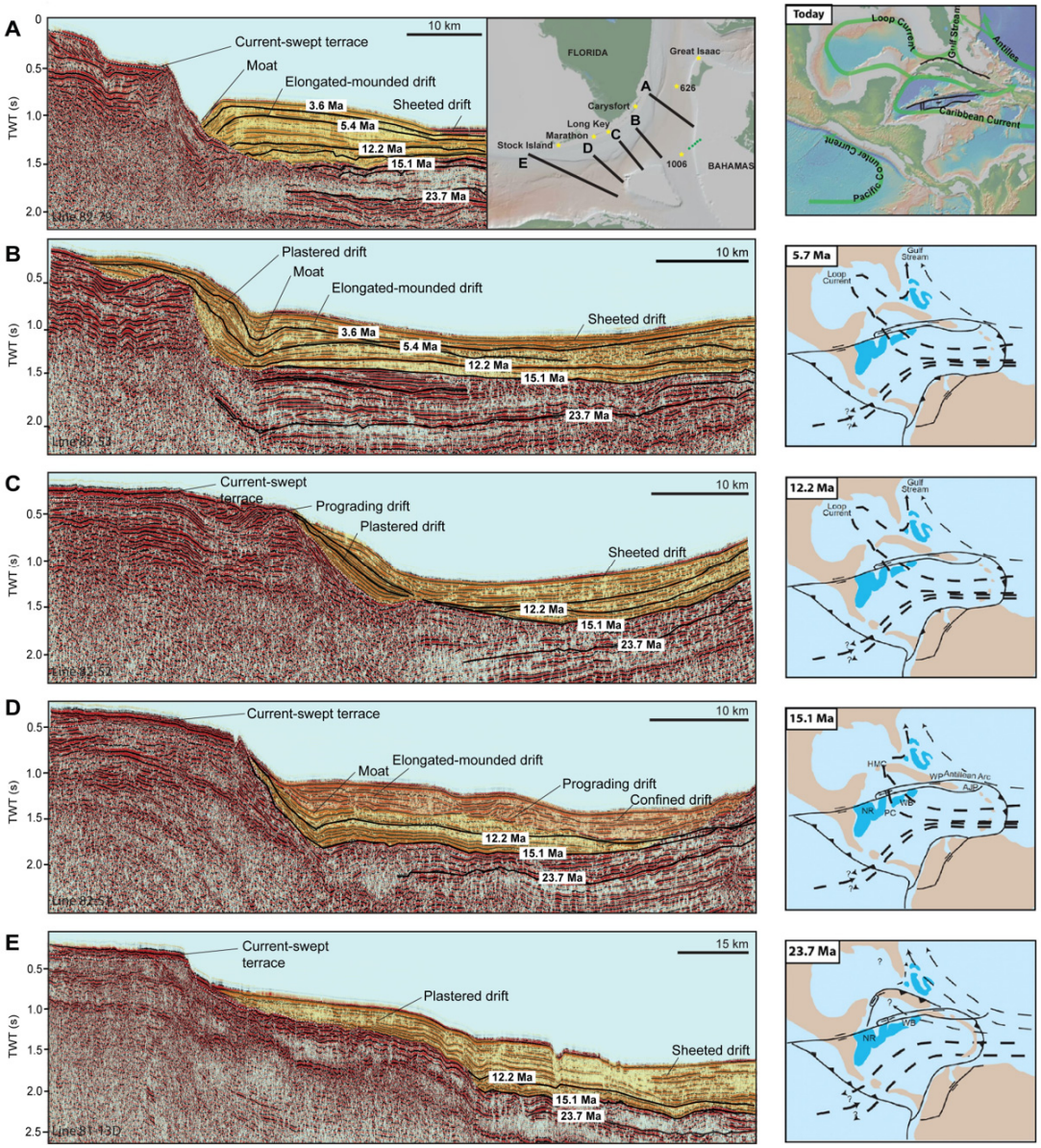

Fig. 2. Evolution of the Pourtales Drift in the Straits of Florida and the tectonic evolution and surface circulation of the Caribbean and Gulf of Mexico (modified from Bergman, 2005).

WORKFLOW

Characterization of bottom current-controlled sedimentary features

The primary objective of this study is to accurately identify and map sedimentary sequences controlled by bottom currents. To achieve this goal, a comprehensive analysis of seismic, bathymetric, sediment cores, and seafloor images will be conducted. The oceanographic data from the World Ocean Database 2018 (Boyer et al., 2018) and available current data will be utilized to establish hydrographic cross-section and temperature-salinity diagrams.

Seismic stratigraphic analysis

The age model from the ODP and IODP cores will be updated to ages from Gradstein et al. (2012). Subsequently, the seismic stratigraphic analysis will be conducted by correlating and generating thickness maps of the study areas to gain insights into phases of ocean current evolution.

Regional and global palaeoceanographic changes

The seismic sequence boundaries within the designated study areas will be assessed considering global sea level changes, paleoceanography, and tectonic events spanning the Neogene to the Present Day (e.g., Fig. 2 and Fig. 3).

SIGNIFICANCE

The Gulf Stream plays a critical role in the North Atlantic circulation system, affecting climate, hurricane activity, and sea levels. Recent data shows that the volume transport of the Gulf Stream through the Florida Straits has decreased by 1.2 ± 1.0 Sv in the past 40 years (Piecuch and Beal, 2023). This study aims to provide additional understanding of the evolution of the Loop Current-Gulf Stream system on a geological timescale, which is essential for comprehending global teleconnections, feedback thresholds, and forcing mechanisms.

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