DECODING SUBTLE DIAGENETIC ALTERATION: COMBINING GEOCHEMICAL AND PETROPHYSICAL APPROACHES

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PROJECT OBJECTIVES

- Contribute enhanced records of $\delta^{13}C$ and $\delta^{18}O$ values, as well as major, trace, and ultra-trace elemental concentrations at Unda, Clino, ODP Site 1003, and ODP Site 1006.
- Assess diagenetic variability (cementation/dissolution, isotopic signatures) in shallow marine carbonates using geochemical, petrophysical, and seismic sequence stratigraphic approaches.

PROJECT RATIONALE

Diagenetic alteration in shallow marine carbonates is often complicated by varying degrees of cementation, dissolution, and recrystallization in a range of diagenetic regimes through space and time. Recently, the utility of integrating sedimentology, geochemistry, and petrophysical logs has provided a high-resolution perspective into both cryptic and obvious diagenetic alteration in the Clino core from Great Bahama Bank. This multi-disciplinary approach incorporated a statistical analysis of carbonate $\delta^{13}C$ and $\delta^{18}O$ values using rolling window regression (RWR, Oehlert and Swart, 2019) with the velocity-deviation log ("DL", Anselmetti and Eberli, 1999) to produce a high-resolution perspective of the changes in cementation and diagenetic signatures within the core. In some instances, this analysis identified significant deviations in the DL without a corollary signature in the carbonate $\delta^{13}C$ and $\delta^{18}O$ values or RWR, suggesting either a zone of dissolution, or a zone of rock-buffered diagenesis depending on the sign of the deviation in the DL. Such ambiguities require further analysis to identify unique combinations of geochemical and petrophysical signatures for major diagenetic processes in shallow marine carbonates.

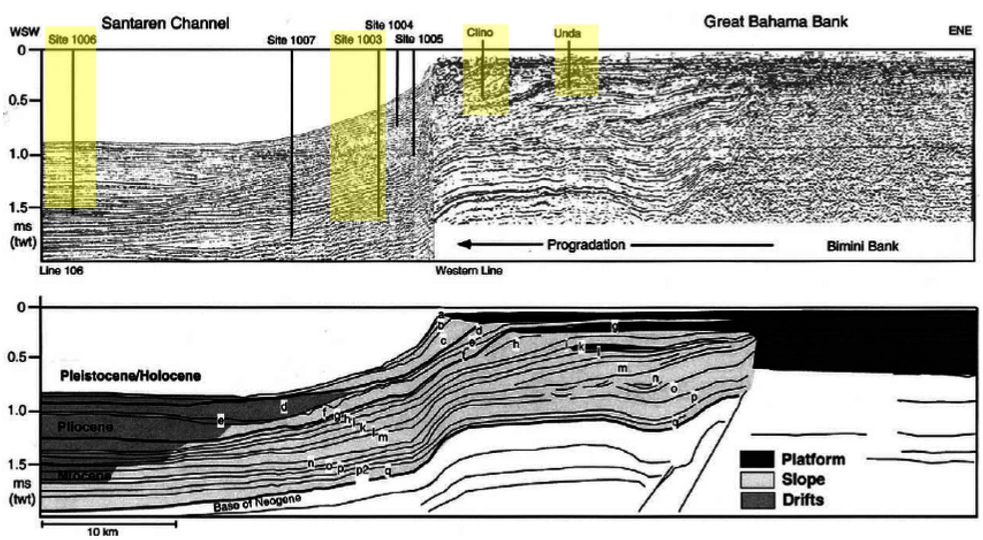

Figure 1. Seismic cross section across the western margin of Great Bahama bank. Yellow boxes indicate locations of Clino, Unda, ODP Sites 1003 and 1006, which will be analyzed in this study (after Eberli, 2000).

APPROACH

To improve permeability estimates from the DL, we will integrate the resistivity log into our multi-disciplinary analysis. DL inherently focuses on differences in the rock framework (e.g., fast rocks with simple geometry vs. slow rocks with complex geometry). Incorporating resistivity logs will allow us to focus also on variations in pore connectivity. Resistivity decreases with the number of pore connections and will allow us to distinguish between connected and separate vug porosity (Verver et al., 2011). Combining velocity and resistivity logs will thus help discriminate stratigraphic horizons with cemented pore space, resulting in fast velocity and high resistivity intervals from horizons with interparticle velocity that display high velocity but low resistivity.

To develop a more nuanced perspective into the diagenetic impacts of repeated Neogene sea-level oscillations, we will expand our dataset to include a proximal-distal transect (Fig. 1) of shallow marine depositional environments. Incorporation of cores Unda and Clino on top of Great Bahama Bank (Ginsburg, 2001) with cores at ODP Sites 1003 and 1006 on the lower slope and basin, respectively, will refine our understanding of the spatial heterogeneity of the diagenetic overprint from the shallow to the deep marine environment regarding both cementation/dissolution and geochemical signatures. We will contribute additional measurements of $\delta^{13}C$ and $\delta^{18}O$ values, and new measurements of major, trace, and ultra-trace elemental concentrations using ICP-QQQ in these cores coupled with detailed RWR and DL analyses. Finally, these observations will be integrated into a transect-wide assessment of diagenetic alteration through the incorporation of sequence stratigraphic framework at the seismic scale.

SIGNIFICANCE

Incorporation of petrophysical and geochemical approaches in the characterization of diagenetic impacts on shallow-deep marine carbonates has revealed zones of subtle alteration that were previously "below detection". Integration of RWR, DL, with the resistivity log and elemental concentrations, and seismic sequence stratigraphy is expected to provide new insights into the influence of repeated diagenetic alteration over the past 10 Mys.

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