BORON AND SULFUR ISOTOPES: ORIGINAL SIGNALS OR DIAGENETIC INDICATORS?

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PROJECT OBJECTIVES

- To understand changes in the B and S isotopic composition of carbonates subjected to well-constrained diagenetic conditions.
- Apply B and S isotopic systematics to ancient sediments for the purposes of constraining the paleoenvironment and paragenesis.

PROJECT RATIONALE

While sulfur ($\delta^{34}S$) and boron isotopes ($\delta^{11}B$) have been used to interpret changes in oceanic conditions during the Neogene, they have also been used in much older materials extending back into the Proterozoic. For example the S isotopic composition ($\delta^{34}S$) of carbonate associated sulfate has been used to interpret changes in the burial of organic material (Lyons et al., 2005) and weathering from continental sources, while B isotopes ($\delta^{11}B$) have been used as a paleo pH proxy (Kasemann et al., 2010) during snowball earth and other climate events such as those identified at the Permo-Triassic boundary (Clarkson et al., 2015). This study is investigating the diagenetic influences upon both of these proxies by examining their behavior in sediments, which have experienced well constrained diagenetic conditions.

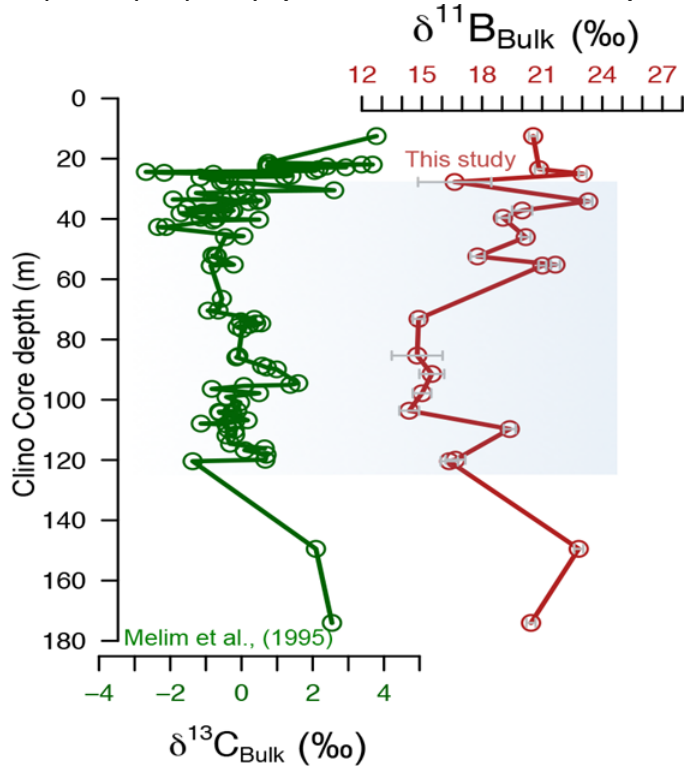

Figure 1: Changes in the $\delta^{11}B$ and co-occurring variations in the $\delta^{13}C$ in the Clino core taken on Great Bahama Bank. The large change in $\delta^{11}B$ could be interpreted as reflecting changes in oceanic pH, but in this case is associated with freshwater diagenesis. Data from Stewart et al. (2015) and Melim et al. (2001).

SCOPE OF WORK

The work outlined here proposes to make measurement on materials collected from environments with established diagenetic histories. These materials will include cores taken in the shallow sub-surface of the Bahamas (Clino and Unda) as well as cores drilled during the Ocean Drilling Program and the

International Ocean Discovery Program. From the Clino cores samples will be taken through the zones affected by vadose, freshwater, mixing zone and marine diagenesis. Preliminary results from core Clino shows changes in the $\delta^{11}B$ values associated with freshwater diagenesis (Fig. 1). We are interpreting this change as reflecting cementation associated with the water table. Sampling will be extended to the base of the Clino core and sulfur isotopic measurements will be made on the same samples. Samples from marine cores will be taken across a non-depositional surface, zones affected by bacterial sulfate reduction, zones influenced by advective fluid flow, and zones characterized by diffusive process.

SIGNIFICANCE

Knowledge of the past pH of the oceans is an important control on the conditions under which past carbonates were formed. Similarly, the S isotopic composition of the oceans places important constraints upon the burial and the oxidation of organic material. The important question addressed by this research is whether these geochemical proxies can survive diagenetic processes and, if not, can the information contained in these records be used to understand the diagenesis of carbonates and help constrain paragenesis.

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