# BORON, SULFUR, AND CLUMPED ISOTOPES AS DIAGENETIC INDICATORS

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## KEY POINTS AND PROJECT DESCRIPTION

- Conduct boron, sulfur, and clumped isotopic analyses of carbonates from the Bahamas, Enewetak, and various ODP, IODP, and DSDP sites that have experienced meteoric and marine diagenesis.
- Combine these with traditional geochemical indicators of diagenesis such as $\delta^{13}C$ and $\delta^{18}O$ values to better define the sedimentological systems with respect to temperature, pH fluctuation, and bacterial sulfate reduction.
- Compare data from Clino to similar geochemical data of Enewetak Atoll to constrain the global influence of diagenetic resetting on sedimentological records.

## OBJECTIVE

This project will construct a high resolution, multiproxy geochemical record of cores from the Great Bahama Bank in the Atlantic Ocean basin and compare this data with sediment core records from Enewetak Atoll in the Pacific Ocean. The aim of this

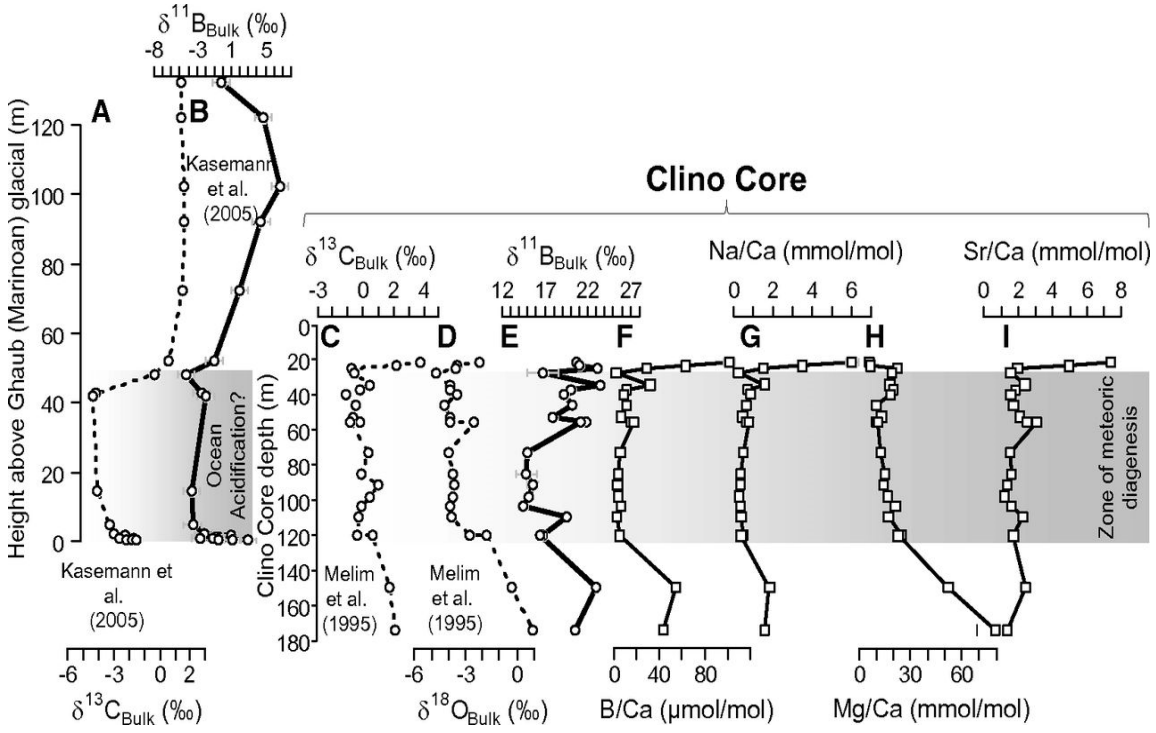


*Figure 1. Comparison of $\delta^{11}B$ and $\delta^{13}C$ values from rocks deposited after the Marinoan glaciation (A & B) in which changes have been interpreted as being original and indicating that there was a change in ocean pH during the recovery of the Snowball Earth. Data from the Clino core (C-I) show similar changes in the $\delta^{11}B$ and $\delta^{13}C$ values during a period where the oceans have not changed in pH. Obviously these $\delta^{11}B$ values from Clino have been diagenetically altered. From Stewart et al. (2015).*

research is to constrain diagenetic signatures preserved within shallow water carbonate sediment records globally, demonstrating that many of these large magnitude shifts are diagenetic and are not associated with complex changes in long-term ocean chemistry.

## PRELIMINARY RESULTS

The $\delta^{11}B$, $\delta^{34}S$, and clumped isotope values from Clino indicate regions of diagenesis resulting in isotopic excursions from accepted values of seawater, complementing XRD data showing recrystallization of aragonite to calcite in several regions throughout the core. In contrast, based on $\delta^{34}S$ values, Enewetak is dominated by an open system fluid flow.

Initial data indicates large magnitude shifts in $\delta^{11}B$ values are prevalent throughout the Clino core (Stewart et al., 2015) (Fig. 1), changes which may be related to pH variations associated with the degradation of organic material near or at the water table. The magnitude of these variations are similar to those measured in ancient sediments (Clarkson et al., 2015; Kasemann et al., 2010; Ohnemueller et al., 2014) which have been interpreted as being original and suggesting that there had been large changes in the pH of the oceans after major events such as the Permian-Triassic boundary and the end of the Marinoan glaciation. Future work will examine changes in the behavior of the $\delta^{11}B$ values associated with marine diagenesis.

## REFERENCES


Clarkson, M.O., Kasemann, S.A., Wood, R.A., Lenton, T.M., Daines, S.J., Richoz, S., Ohnemueller, F., Meixner, A., Poulton, S.W. and Tipper, E.T. (2015) Ocean acidification and the Permo-Triassic mass extinction. Science 348, 229-232.

Kasemann, S. A., Hawkesworth, C. J., Prave, A. R., Fallick, A. E., and Pearson, P. N. (2010). Boron and calcium isotope composition in Neoproterozoic carbonate rocks from Namibia: evidence for extreme environmental change. Earth and Planetary Science Letters, 231(1-2), 73-86.

Melim, L. A., Swart, P. K., and Maliva, R. G. (1995). Meteoric-like fabrics forming in marine waters: Implications for the use of petrography to identify diagenetic environments. Geology, 23(8), 755-758.

Ohnemueller, F., Prave, A.R., Fallick, A.E. and Kasemann, S.A. (2014) Ocean acidification in the aftermath of the Marinoan glaciation. Geology 42, 1103-1106.

Stewart, J. A., Gutjahr, M., Pearce, F., Swart, P. K., and Foster, G. L. (2015). Boron during meteoric diagenesis and its potential implications for Marinoan snowball Earth $\delta^{11}B$-pH excursions. Geology, 43(7), 627-630.