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Effects of Diagenesis on Boron Isotopic Ratios in a Well-Preserved Pliocene Coral

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Reconstructions of pre-Quaternary surface ocean pH have generally focused on boron isotopes in planktonic foraminifera. While often preserved with high fidelity, foraminifera lack the temporal resolution that other proxies, such as coral, are able to provide. Corals represent an ideal alternative, but because they are highly susceptible to dissolution, recrystallization of aragonite to calcite, precipitation of secondary aragonite or calcite cements, and chemically open system behavior, such analyses are often impossible. Although they are rare, suites of extremely well-preserved corals composed of at least partially unaltered primary material can be found at a limited number of pre-Quaternary sites. These corals provide an opportunity to apply the boron isotopic method to examine paleo pH, but only after thoroughly characterizing the nature of micro-scale diagenesis and its impact on coral boron isotopic signatures within the samples of interest. Detailed diagenetic analyses are, therefore, an important step in understanding the utility of these proxies.

In this study, we investigated the δ11B values in a well-preserved aragonite coral (Sideastrea radians) from the Pliocene Limón formation in eastern Costa Rica. Degree of diagenetic alteration was assessed using X-ray diffraction (XRD), X-radiography (X ray), scanning electron microscopy (SEM), cathodoluminescence (CL), mineral-specific stains, and thin section petrography. Regions of secondary cements and recrystallization are apparent within a skeleton that also contains unaltered material. We measured boron isotopic ratios in both well preserved and clearly altered sections of this coral using secondary ion mass spectrometry (SIMS). Preliminary results show significant differences in both δ 11B values and B concentrations between altered (secondary) and unaltered material. δ 11B values of secondary material are on average $\sim$10‰ lower than those of unaltered material within a measured aliquot from the coral, such that every 10% increase in secondary material results in a $\sim$1.3‰ decrease in δ 11B value. This relationship demonstrates the importance of accurately accounting for all types of diagenetic alteration in samples before analysis, as even minimal inclusions of secondary material can drastically alter paleoclimate reconstructions.

This initial study highlights the need to carefully constrain diagenetic alteration in fossil corals before conducting boron isotopic analysis. As calibrations for the δ 11B-pH proxy are further developed, fossilized corals could prove to be a valuable resource in understanding ancient surface ocean pH variations with high temporal resolution.