

Boron Isotope Behavior During Seawater Evaporation

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Estimating $\delta^{11}\text{B}$ in past seawater remains a crucial step in advancing the boron isotope paleo-pH proxy beyond the last few million years. Fluid inclusions in marine evaporites are widely used to constrain past seawater chemistry, making them a promising archive for constraining past seawater $\delta^{11}\text{B}$. Previous analyses of $\delta^{11}\text{B}$ in halite fluid inclusions were successful in reconstructing modern seawater $\delta^{11}\text{B}$ values but found 4–6 ‰ discrepancies between ancient evaporite estimates and foraminifera-based expected values [1]. To explain these discrepancies, we examine boron isotopes in brines and co-precipitated salts during experimental seawater evaporation to determine the phases that contain boron and their end member $\delta^{11}\text{B}$ values. Our results confirm that brine $\delta^{11}\text{B}$ values remain stable through a degree of evaporation of 30, while bulk halite $\delta^{11}\text{B}$ values are consistently lower. This suggests a contribution of lighter boron from trace mineral inclusions of carbonates and gypsum, in addition to the brine within fluid inclusions. Furthermore, we present the first known estimate of the partition coefficient (K_d) and fractionation factor of boron in gypsum from marine settings. We show how endmember mineral $\delta^{11}\text{B}$ values can be used in combination with trace element analyses to elucidate the contributions of different trace mineral phases (mainly carbonate and gypsum) to the bulk $\delta^{11}\text{B}$ measured in halites. These results show that minor contributions of B from carbonate and gypsum could explain the lower $\delta^{11}\text{B}$ values observed in ancient halites and provide a potential opportunity for arriving at more accurate estimates of ancient seawater $\delta^{11}\text{B}$.

[1] Paris, G., Gaillardet, J., & Louvat, P. (2010). *Geology*, 38 (11), 1035-1038.