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# The impact of mineralogy and diagenesis on bulk carbonate $\delta^{11}B$: a multi-proxy approach

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The isotopic composition of boron ($\delta^{11}B$) in marine calcifiers, such as foraminifera and deep-sea corals, has emerged as a potent tool for reconstructing past oceanic pH dynamics [1]. Given the abundance of shallow-marine carbonates preserved in the geological record, there has been considerable interest in utilizing bulk carbonates for analogous purposes, which could potentially yield paleo-pH records for older intervals of Earth history. Notably, $\delta^{11}B$ excursions in shallow-marine carbonates during the Neoproterozoic and Early Triassic have been interpreted as indicative of oceanic acidification events [2]. However, interpreting geochemical data from bulk carbonates is challenging due to the potential for alteration of their primary values through diagenetic processes. Few studies suggest $\delta^{11}B$ and B/Ca in platform carbonates decline due to meteoric and marine burial diagenesis [3, 4]. However, the influence of early-marine diagenesis, including dolomitization, remains underexplored. In this study, we propose an analytical framework for identifying diagenetic alterations of boron in bulk carbonates. Our investigation focuses on Eocene-age shallow-marine carbonates from the Avon Park Formation in Florida (USA), which have undergone lithification and dolomitization. This site offers an exceptional opportunity for studying early, near-surface diagenetic processes, without complication from burial diagenesis. We combine $\delta^{11}B$ and B/Ca measurements with traditional ($\delta^{13}C$, $\delta^{18}O$, and $\delta^{34}S$ of carbonate-associated sulfate (CAS)) and non-traditional ($\delta^{44}Ca$ and $\delta^{26}Mg$) isotopic analyses, alongside major-, minor-, and trace-element measurements (e.g., Mg, Sr, Mn, Li, Na). Our findings reveal significant variability in $\delta^{11}B$ (~10‰) and B/Ca (~90%) throughout the core, comparable in magnitude to previous observations attributed to diagenetic processes such as meteoric [4] and marine burial influences [3]. Additionally, we observe correlations with Mg/Ca ratios and CAS abundance, suggesting potential mineralogical and crystallographic controls on boron incorporation. Our comprehensive multi-proxy approach allows us to discern the processes and diagenetic styles influencing boron variability, emphasizing the importance of carefully considering potential resetting of boron signatures in bulk carbonates.

[1] Foster (2008), *Earth and Planetary Science Letters* 271, 254–266.

[2] Kasemann et al. (2005), *Earth and Planetary Science Letters* 231, 73–86.

[3] Zhao et al. (2023), *American Journal of Science* 323.

[4] Stewart et al. (2015), *Geology* 43, 627–630.