Quantifying diagenetic alteration of marine carbonate δ^{26}Mg in an open system influenced by advection

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The Mg isotopic composition (δ^{26}Mg) of marine carbonates is a promising proxy for reconstructing secular variations in seawater δ^{26}Mg, which helps elucidate long-term changes in the global Mg cycle. However, recrystallization of marine carbonates, which has been documented to occur over tens of million-year time scales, can impact the fidelity of a range of carbonate-based geochemical proxies (e.g., ^{87}Sr/^{86}Sr, Sr/Ca, Mg/Ca, and B/Ca), especially those that utilize elements present in trace amounts (<1 ppm). In this study, we quantify the effect of diagenesis on the δ^{26}Mg of bulk carbonates in a marine sedimentary section influenced by advection, which can help place interpretations of secular changes in seawater δ^{26}Mg in context.

This study presents the δ^{26}Mg (‰, DSM-3 scale) of bulk carbonates and pore fluids from Ocean Drilling Project Site 1171 (South Tasman Rise; 2148.2 m water depth), a site that has been used to generate proxy records but also has been reported to exhibit sizeable diagenetic effects [1]. The δ^{26}Mg values of 1171 pore fluids are higher than modern seawater (-0.84‰) and increase systematically with depth (from -0.53‰ at 40.5 mbsf to -0.39‰ at 262.9 mbsf). The δ^{26}Mg of bulk carbonates range systematically with depth from -2.23‰ (at 0.73 mbsf) to -3.98‰ (at 115.53 mbsf). This variability can be ascribed mainly to diagenesis, with a fraction of the variability accounted for nannofossil and foraminiferal composition.

The inferred diagenetic effect on bulk carbonate δ^{26}Mg correlates with previously documented downcore changes in Sr/Ca and ^{87}Sr/^{86}Sr ratios [1]. A depositional reactive-transport model is employed to validate the hypothesis that recrystallization in this advection-influenced system generates sizeable shifts in carbonate δ^{26}Mg. Preliminary model results suggest constraints on the fractionation factor (0.9945) and partition coefficient (1.2) to explain the observed trends in pore fluid and bulk carbonate δ^{26}Mg, assuming calcite recrystallization rates of ~7%/Ma. Ultimately, the objectives of quantifying such diagenetic effects are two-fold: (1) to evaluate the potential of carbonate δ^{26}Mg to fingerprint diagenesis and, if the tool proves useful, (2) to estimate the extent to which carbonate-based geochemical proxies are altered diagenetically in an open marine sedimentary column.

[1] Fantle M. S. (2015), *Geochim. Cosmochim. Acta*, **148**, 378–401