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Diffusively limited element exchange during diagenesis results in decoupled $\delta^{18}O$ and Mg/Ca paleotemperatures of recrystallized foraminifera

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Comparison between well-preserved and texturally recrystallized foraminifera suggests that $\delta^{18}O$ values can change significantly, while trace-element (e.g. Mg/Ca) ratios may remain largely unchanged. EPMA analyses show moderate preservation of fine-scale features in trace element abundance such as Mg-banding, even in frosty planktonic foraminifera whose $\delta^{18}O$ values are more similar to benthic temperatures; this process occurred in the absence of partial dissolution. This behavior has been modeled with a reaction-diffusion model, which simulates recrystallization with diffusively limited exchange with external water. This model assumes that recrystallization of the test is largely internal, and facilitated by fluid films, which also facilitate the transport of ions into the fossil. Due to the abundance of oxygen, and relative scarcity of Mg^{2+}, Ca^{2+} and Sr^{2+} in seawater, $\delta^{18}O$ values will change more rapidly in the carbonate phase. This “internal buffering” model can be applied to make testable predictions for other element and isotope ratios (such as Ca, Mg or Sr isotopes) which could be used to provide additional constraint on the effects of these diagenetic processes. These results show that micro-spatial analyses of foraminifera can be used to screen for numerous diagenetic processes, which can in turn be used to improve confidence in the use of different geochemical paleothermometers.