Revisiting Mg isotopic fractionation in foraminifera

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Magnesium elemental and isotopic compositions of foraminiferal calcite are species-specific and vary significantly, even within each taxonomic group. For example, high-Mg foraminifera *Heterostegina* show Mg/Ca and δ^{26}Mg values similar to inorganic calcite precipitates from modern seawater. Conversely, shell compositions of low-Mg foraminifera, such a planktonic foraminifera, are up to two orders of magnitude lower in Mg/Ca values and also have light δ^{26}Mg compositions. This variability has been attributed to the ability of foraminifera to regulate the Mg content of their calcifying fluid by actively removing or complexing bioavailable Mg. However, the mechanism(s) responsible for Mg fractionation is largely unknown, limiting the applicability and accuracy of Mg-based palaeoclimate proxies. Here we summarise results of studies from Harry Elderfield's laboratory over the last five years on Mg fractionation, and present new data on Mg isotopic and elemental fractionation in four different groups of foraminifera. We show that, despite two orders of magnitude difference in Mg content, the general patterns of Mg response to changing Mg/Ca and carbonate ion are similar. Moreover, we show a link between Mg fractionation patterns of bulk shell composition with microscale variability of Mg/Ca and δ^{26}Mg values within shell calcite. These results are discussed in the context of a simple biomineralisation model, which accommodates both the inorganic and organic components of foraminiferal calcite on micro and macro levels.