The magnesium isotopic composition of planktonic foraminifera

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Global climate is strongly influenced by the atmospheric concentration of the greenhouse gas CO_2. The weathering of continental rocks consumes CO_2 as well as transports cations to the oceans, playing a critical role in both seawater chemistry and climate. Magnesium, a major component of continental silicate minerals, is homogeneous in both concentration and isotopic composition. Seawater Mg isotopic composition $\delta^{26}Mg_{SW}$ (-0.82‰) reflects a balance between continental weathering driven input, via rivers ($\delta^{26}Mg_{River}$ ~ -1.09‰) and groundwaters, and removal by high-temperature hydrothermal oceanic crust alteration ($\Delta\delta^{26}Mg_{SW-HT}$ ~ 0.0‰), dolomite formation, and authigenic alumino-silicate clay formation during low-temperature alteration of the oceanic crust. Since the oceanic residence time of Mg is significantly longer than the oceanic mixing time, variations in Mg isotopic composition of seawater ($\delta^{26}Mg_{SW}$) recorded by marine calcites reflect a global picture that is driven by an imbalance between the source and sink [1-3]. Preliminary work [2] [3] has highlighted the potential of planktonic foraminifera as an archive of $\delta^{26}Mg_{SW}$ despite a temperature effect on the Mg concentration in the $CaCO_3$ shell. The limiting factor in the published Mg isotope work has been the choice of foraminifera species and of the sample cleaning method to minimize post depositional alterations. The present study investigates the Mg isotopic composition of planktonic foraminiera as a potential proxy for $\delta^{26}Mg_{SW}$ [1-4]. We analyzed 48 core-top planktonic foraminifera (covering 10 species) with an average of $\delta^{26}Mg$ = -4.63±0.57‰ (2σ) (Fig. 1). Our study demonstrates that there is limited species-specific variability and that the fractionation of Mg during calcification of inorganic calcite is not only smaller, but is also less variable than that of foraminiferal calcite ($\Delta^{26}Mg_{Calcite-Solution}$ = 2.13±0.24‰ [5]; $\Delta^{26}Mg_{Foram-Seawater}$ = -3.81±0.57‰). In addition, we observe that the $\delta^{26}Mg$ of foraminifera cleaned with and without the reductive cleaning step is consistent (Fig. 1), suggesting that the Mg isotopic composition of high-Mg calcite bands which are preferentially dissolved during reductive cleaning (hydrazine + citric acid), is of similar composition as low-Mg bands.

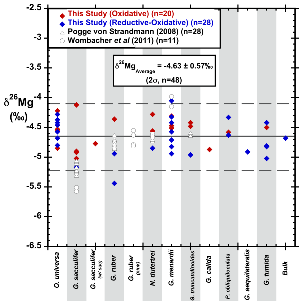

Figure 1: $\delta^{26}Mg$ (‰) of 48 core-top planktonic foraminifera cleaned with Reductive cleaning (blue diamonds, n=28) and without it (red, n=20). The data set is compared to other planktonic foram values open diamonds [2] and open circles [4].

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