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Species-specific impacts of temperature and seawater Mg/Ca on foraminiferal Mg/Ca

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Variations in the Mg/Ca of foraminiferal calcite (Mg/Cacalcite) reflect changes in environmental parameters, primarily temperature, which control Mg incorporation into calcite. Therefore, Mg/Cacalcite is frequently used to reconstruct past seawater temperatures. However, several studies showed that application of Mg/Ca is limited by, amongst others, species-specific differences in Mg incorporation and the influence of Mg/Ca of the seawater (Mg/Casw). The impact of Mg/Casw is probably negligible for reconstructing paleo temperatures over short timescales (< 1 Ma), due to the long oceanic residence times of Mg2+ and Ca2+. When reconstructing seawater temperatures on longer timescales the effect of Mg/Casw cannot be neglected. Past changes in Mg/Casw are currently, however, poorly constrained. This can be resolved by using species with contrasting biologically controlled Mg incorporation, as the relative difference will reflect both temperature and Mg/Casw. This approach takes advantage of the different fractionation between Mg by different species. To extend the range of species that can used, culture experiments include deep sea species (Nonionella turgida and Buliminia marginate) and shallow water species (Elphidium crispum and Quinqueloculina sp.) in artificial seawater with ratios of 2, 3.5 and 5 mol Mg2+ /mol Ca2+, which corresponds to the expected range over the last 60 Ma. All experiments are conducted at three different temperatures: 3, 7 and 10 (for the deep-sea species) and 17, 22 and 27 °C (for the shallow-water species). Mg/Ca of foraminiferal test was determined with laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Using the obtained relationships, seawater temperature can be reconstructed correcting for Mg/Casw. Incorporation of Mg into foraminiferal calcite (Mg/Cacalcite) is expressed as the partition coefficient (DMg= (Mg/Cacalcite)/(Mg/Casw), which in turn varies as a function of temperature. Preliminary data shows that DMg itself varies also in response to Mg/Casw. Explaining this effect requires a mechanistic understanding of the cellular processes involved in ion-selection. Currently it is unknown whether Mg-ions are stored before chamber formation or are taken up during calcification. Two experiments were designed in order to investigate this mechanism in Ammonia tepida. Foraminifera were transplanted from high (10 mol Mg2+ / 1 mol Ca2+) to low (1 mol Mg2+ / 1 mol Ca2+) Mg/Casw and vice versa before calcification of the new chamber commences. Together these experiments will quantify possible a priori storage of Mg in the protoplasm (i.e. build up of Mg reservoir) before calcification. A mechanistic understanding of the differences in Mg/Cacalcite will facilitate the application of this proxy in deep geological time.