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Temperature dependence of Mg isotope fractionation in deep-sea coral: paleoceanographic implications as a new proxy

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This study presents magnesium isotopic composition and its temperature dependence of high Mg biogenic calcium carbonates to evaluate their potential proxy of paleo seawater temperature. Degrees of Mg isotope fractionation compared to present seawater were measured in deep-sea coral. The mean d26Mg value of deep-sea corals was -2.5 permil. Moreover, Mg isotope fractionation in deep-sea coral showed a clear temperature dependence from 2.5 to 19.5 degree. The observed temperature dependence of Mg isotope fractionation in deep-sea coral skeletons implies that a combination of proxy developments and further high-precision isotope analysis allows potential application of Mg isotopes of high-Mg calcite to an environmental proxy for water temperature. The mean Mg isotope value of large benthic foraminifera which are also composed of high-Mg calcite was -2.34 permil. Even though the precipitation rates of deep-sea coral, benthic foraminifera were several order of magnitude different, they both plot on the same regression line within uncertainty. This result suggests that kinetic isotope fractionation may not be a major controlling factor, and indicate a possible further application of Mg isotope values as temperature proxy. Deep-sea corals and benthic foraminifera also showed similar Mg isotope fractionation factor to inorganically precipitated calcite, and the slope of temperature dependence in Mg isotope fractionation is similar to that for an inorganically precipitated calcite speleothem. Moreover, Mg concentrations and the relationship between Mg/Ca and temperature were also similar between deep-sea corals and inorganically precipitated calcite. Taking into account elemental partitioning and the calcification rate of biogenic $CaCO_3$, the similarity among inorganic minerals, deep-sea corals and benthic foraminiferas may indicate a strong mineralogical control on Mg isotope fractionation for high-Mg calcite.

Keywords: magnesium isotope, precious coral, MC-ICP-MS, temperature dependence, proxy