

Calibration between temperature and Mg/Ca and oxygen isotope ratios in high-magnesium calcite precipitated by asexually reproduced juveniles of large benthic foraminifera

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The potential usefulness of test composition of reef-dwelling large benthic foraminifera as paleotemperature proxies was demonstrated by our previous study which reports that Mg/Ca and oxygen isotope ratios ($\delta^{18}\text{O}$) in the high-magnesium calcite tests represent a good correlation with seawater temperature. However, the distinction of temperature correlation with chemical composition in tests between perforate and imperforate species still remains unclear. We cultured asexual reproduced juveniles of four species among large benthic foraminifera at controlled temperatures (21°C–31°C). *Neorotalia calcar*, *Baculogypsina sphaerulata*, and *Calcarina gaudichaudii* were selected as the perforate species, whereas *Amphisorus kudakajimensis* was chosen as the imperforate species. The results of analyses and measurements suggest linear relations between Mg/Ca and temperature except at 31 °C, regarding *A. kudakajimensis* also except at 29°C, which is likely attributed to metabolic anomaly of foraminifera under chronic thermal stress. Additionally, *A. kudakajimensis* (imperforate species) exhibited different Mg/Ca–temperature equation from those of perforate species. The Mg/Ca–temperature and $\delta^{18}\text{O}$ –temperature equations are yielded using the least square method as follows: $\text{Mg/Ca} = 2.73 T + 74.71$ for three perforate species, which is applicable to temperature range of 21°C–30°C. The temperature relations of $\delta^{18}\text{O}$ differ across perforate species. We observed that the $\delta^{18}\text{O}$ values were between the equilibrium of pure calcite and those of high-magnesium calcite. A species-specific calibration is necessary for the temperature relation of $\delta^{18}\text{O}$. Between perforate and imperforate species, respective calibrations are needed for Mg/Ca–temperature relationship, although the similar Mg/Ca range is observed in 21°C–30°C.

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