Calibration of Dolomite Clumped Isotope Thermometry

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Differences between dolomite and calcite clumped isotope calibrations have yet to be resolved empirically across a range of temperatures. Acid fractionation differences calculated by Guo et al. (2009) suggest that dolomite $\Delta_{47}$ values should be ~0.02 ‰ lower than calcites formed at the same temperature. Empirical calibrations for siderite (Fernandez et al. 2014) and apatite (Eagle et al. 2010), however, suggest that a universal $\Delta_{47}$ – temperature relationship may exist across all carbonate-bearing mineral phases.

We analyzed five synthetic and four natural dolomites formed at known temperatures. Synthetic dolomites were grown in Mg-Ca-Cl solutions at temperatures of 200 – 235 °C. Natural samples are constrained by fluid inclusion analyses (~90 °C), tropical climate (~25 and ~27 °C), and ocean water column depth (~3 °C).

These data result in a calibration line that is statistically indistinguishable from the high acid reaction temperature calibration of Defliese et al. (2015). At least with current measurement capabilities, we find no evidence for a consistent dolomite $\Delta_{47}$ offset. We also found no evidence for a relationship between the degree of dolomite cation ordering and $\Delta_{47}$. These results further support the idea of a universal calibration for carbonate clumped isotope thermometry and enable new investigations into conditions of dolomite formation.

Eagle et al. (2010) Body temperatures of modern and extinct vertebrates from $^{13}$C-$^{18}$O bond abundances in bioapatite. PNAS, 107, 10377-10382.