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 Δ_{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 Δ_{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 Δ_{47} offset. We also found no evidence for a relationship between the degree of dolomite cation ordering and Δ_{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.

Defliese et al. (2015) Compositional and temperature effects of phosphoric acid fractionation on Δ_{47} analysis and implications for discrepant calibrations. *Chemical Geology*, 396, 51-60.

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

Fernandez et al. (2014) Siderite ‘clumped isotope’ thermometry: A new paleoclimate proxy for humid continental environments. 126, 411-421.

Guo, W., et al. (2009) Isotopic fractionations associated with phosphoric acid digestion of carbonate minerals: Insights from first-principles theoretical modeling and clumped isotope measurements. *Geochimica et Cosmochimica Acta*, 73, 7203–7225.