Evaluation of clumped isotope thermometry of fossil shells from the Himalayan-Tibetan Plateau

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The recently developed carbonate clumped-isotope thermometry provides a promising tool for paleoclimate research. The new method has been applied to fossil gastropod shells from southwestern Tibet to reconstruct the paleo-environment and paleo-elevation of the region. However, the inferred paleo-elevation and climatic conditions are inconsistent with the paleontological evidence. Here we report the results of X-ray diffraction (XRD) and clumped isotope analyses of fossil shells from two late Cenozoic sedimentary basins on the Himalayan-Tibetan Plateau. All the fossil shells analyzed in this study appeared to be pristine based on visual inspection. Clumped-isotope (Δ_{47}) temperatures derived from the fossil shells display a large range of variation (>20°C). The XRD data reveal that more than half of the "pristine" fossil shells contain trace amounts (~0.4-1.2%) of calcite. The Δ_{47}-temperatures derived from shells with traces of calcite are significantly lower than those derived from shells with no detectable calcite. This suggests that the clumped isotope ordering in aragonite shells can be "reset' in low-temperature environments at or near the Earth's surface even in shells that do not show any visual signs of alteration or recrystallization. The fossil shell samples with no detectable amount of calcite have all yielded Δ_{47}-temperatures that are on average ~15°C higher than those shells with traces of calcite from the same strata. This finding has important implications for paleoclimate and paleoelevation reconstructions using clumped isotope data from fossil shells.