



Deglacial temperature estimates from dual clumped-isotope measurements and fluid inclusion noble gas concentrations in a stalagmite from McLean's Cave, western Sierra Nevada

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Clumped-isotope (Δ_{47}) measurements from speleothem calcite have the potential to record formation temperatures with an uncertainty of $\pm 2^\circ\text{C}$ but are strongly impacted by kinetic effects during mineral precipitation that lead to isotopic disequilibrium and erroneously high-temperature estimates. The application of dual clumped-isotope (Δ_{47} - Δ_{48}) measurements can identify the influence of kinetic effects and has the potential to provide temperature estimates that are corrected for the degree of isotopic disequilibrium, though this involves a decrease in precision ($\pm 4.5^\circ\text{C}$). The concentration of noble gases in water that is trapped in fluid inclusions in speleothems is another independent estimate of paleo-temperatures that is based on the temperature dependence of noble gas solubility in freshwater systems.

We combine these two newly emerging techniques by applying dual-clumped isotope ($n = 15$) and fluid inclusion noble gas measurements ($n = 3$) to a speleothem from McLeans Cave, located in the western foothills of the Sierra Nevada, that grew during the last deglaciation (~ 11 to 19 ka). We obtain temperature estimates using the noble gas measurements as well as using the Δ_{47} measurements for samples that do not exhibit isotopic disequilibrium in dual clumped-isotope space and compare these estimates with other western US temperature records from proxy records and climate model simulations. Many of the dual clumped-isotope samples, however do exhibit isotopic disequilibrium. We assess the degree to which disequilibrium can be corrected for using dual clumped-isotopes and test the sensitivity of these isotopic relationships to different published corrections to assess the implications for estimates of paleo-temperatures. Additionally, we compare the new dual-clumped isotope data with coeval $d^{18}\text{O}$ and $d^{13}\text{C}$ measurements, as well we previously collected measurements of $d^{18}\text{O}$ and $d^2\text{H}$ from fluid inclusions in the sample to investigate what processes may be driving the isotopic variability in both speleothem calcite and fluid inclusion water in this sample.