Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.15208

Does grain size matter? Pedogenic carbonate clumped isotope temperatures in fine grained, clay-rich soils

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Pedogenic carbonate nodules are an important paleoenvironmental archive because they are relatively robust in the geologic record and multiple stable isotope records can be made from them. Over the last 10 years, there has been renewed interest in understanding how pedogenic carbonate records information about climate because of the development of clumped isotope thermometry. Most of the efforts to understand how clumped isotope temperatures of pedogenic carbonate relate to climate parameters like mean annual air temperature have been focused on medium - coarse grained soils because of the abundance of associated carbonate and location in climatic and elevation gradients. But, recent work has shown that grain size may exert a critical control on the temperature recorded by pedogenic carbonate nodules [1].

In this study, we present a modern calibration of pedogenic carbonate clumped isotope thermometry in three fine - medium grained soils from Colorado and Nebraska, USA. These soils have grain size characteristics similar to many paleosols in the geologic record and complement existing modern calibrations of pedogenic carbonate clumped isotope thermometry. We compare clumped isotope temperatures and the accompanying oxygen isotope values of soil water with records of air temperature, precipitation amount, precipitation isotope values, soil temperatures and soil water isotope values. Holocene (6 - 10 Kyr) nodules from two of the fine-medium grained soils yielded temperatures similar to mean annual air temperature. At these sites, the oxygen isotope values of soil water at carbonate bearing levels fall on the global meteoric water line and are relatively invariant from summer to fall, indicating little evaporative effect. These data indicate that calculated soil water isotopes from clumped isotope measurements may give researchers nuanced information about hydroclimate evolution in the geologic past. In contrast to the other two sites, the third and most clay-rich soil records a warm-season biased temperature. Our work points to a continued need to study pedogenic carbonate formation in fine grained and clay rich soils.

Citations:

[1] Kelson, Huntington, Breecker, Burgener, Gallagher, Hoke, & Petersen, (2020), *Quaternary Science Reviews,* 234, 106259.