Clumped isotope paleothermometry in soil carbonate

K.W. HUNTINGTON[1]*, A.R. LECHLER[1], G.D. HOKE[2], L.K. BURGENER[1], D.O. BREECKER[3] AND M. SWEENEY[4]

[1]Dept. Earth and Space Sci., Univ. of Washington, Seattle, WA 981195, USA (*kate1@uw.edu)
[2]Dept. Earth Sci., Syracuse Univ., Syracuse, NY 13244, USA
[3]Dept. Geol. Sci.,Univ. of Texas, Austin, TX 78712, USA
[4]Earth Sci. Dept., Univ. of South Dakota, Vermillion, SD 57069, USA

Clumped isotope thermometry provides reliable estimates of pedogenic (soil) carbonate formation temperature without making assumptions about the composition of ancient surface waters. The challenge lies in relating soil carbonate formation temperatures—which record soil conditions when and where the carbonate forms—to convenient climate variables such as mean annual soil or air temperature. We examine this issue from two perspectives: first, by studying the relationship between environmental conditions and temperatures of Holocene soil carbonate formation, recorded by clumped isotopes, in the Andes (~30-33 °S); and second, by developing a multi-proxy climate record in the Palouse loess of Eastern Washington. Carbonate formation occurs when the soil solution becomes sufficiently supersaturated with respect to calcite. This is most likely when the soil is warm and dry, and indeed studies of Holocene soils indicate that carbonate formation is generally biased towards the summer months. However, our results from densely sampled elevation transects in the Andes show that carbonate formation may occur during cooler times of year in climates with persistently wet summers, highlighting the potential importance of the seasonality of precipitation and the phenology of vegetation for the timing and temperature of soil carbonate formation. These variables must be considered alongside temperature change when interpreting soil carbonate clumped-isotope temperatures across climate transistions. Whereas the Andean carbonates formed in stable soil profiles that did not experience significant aggradation or erosion during pedogenesis, the Palouse loess carbonates formed beneath an aggrading soil surface. Consequently, the loess stratigraphy, phytoliths and isotopic composition of soil carbonate may record Pleistocene to Holocene environmental change at a high-resolution. Our preliminary work suggests that carbonate morphology (e.g., matrix carbonate vs. rhizoliths or filaments) may be important for clumped isotope temperatures, and underscores the potential influence of the difference in timing among sediment deposition, soil development and carbonate formation on the rich archive of paleoclimate preserved in loess.