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Development of triple oxygen isotopes in hackberry plant carbonates as a proxy for past relative humidity

CELIA KONG-JOHNSON[1], ANDREW C TURNER[2], MASON A SCHER[3], REBEKAH S SPRENGEL[4], NICHOLAS M ELLIS[1], RONALD AMUNDSON[5] AND DANIEL A STOLPER[1]

[1]University of California, Berkeley
[2]U.S. Geological Survey
[3]Princeton University
[4]Travertine Technologies
[5]University of California

Relative humidity (RH) is an important climatic parameter that has likely varied significantly in past climate states. Many paleohygrometers utilize the $^{18}O/^{16}O$ ratios of terrestrial sedimentary minerals to reconstruct source water $^{18}O/^{16}O$, which can be sensitive to RH. However, these ratios are also controlled by other parameters including the $^{18}O/^{16}O$ of rainfall. Consequently, it can be challenging to uniquely reconstruct past humidity based on mineral $^{18}O/^{16}O$ alone. Triple oxygen isotope measurements ($\Delta'^{17}O$) – the measurement of all three stable oxygen isotopes – overcomes this as continental rainfall is largely invariant in $\Delta'^{17}O$. Based on this, $\Delta'^{17}O$ measurements have been employed to reconstruct past RH using ancient lacustrine, soil, and phytolith minerals.

Here we explore the potential of $\Delta'^{17}O$ determinations of carbonate formed in the fruit of *Celtis* trees (common name "hackberry") as a proxy for RH. Hackberry carbonates are found across multiple continents, can be radiocarbon dated, and are commonly found in packrat middens and human deposits in the Quaternary, making them good archives for climate reconstructions. Prior work has found large isotopic enrichments (>10‰) of some hackberry carbonate $\delta^{18}O$ vs. that expected for isotopic equilibrium relative to local rainwater, potentially indicating strong evaporative isotopic enrichment in some fruit waters. If correct, hackberry $\Delta'^{17}O$ determinations could be used for RH reconstructions during fruit formation (~May to August).

Here we present results to test the potential of a hackberry $\Delta'^{17}O$ paleohygrometer. Specifically, we measured 20 samples from North America spanning latitudes from 18-47°N and summer average RH from 30-78%. $\Delta'^{17}O$ was determined via carbonate digestion on a TILDAS spectroscopy system and normalized to declared values of IAEA-603 and NBS-18. Initial data yield a $\Delta'17O$ and $\delta^{18}O$ range of ~ -320 to -140 per meg and 26 to 43‰, respectively (both vs. VSMOW). $\Delta'17O$ and the difference in $\delta^{18}O$ of carbonate and mean annual precipitation are negatively correlated (R^2=0.9). We propose this relationship is due to the degree of evaporative enrichment occurring from the fruit due to variations in RH. We explore this with a quantitative model and discuss the potential for hackberries as a new archive of past humidity.