Triple oxygen isotope systematics of lacustrine chert

DANIEL E. IBARRA[1,2]*, MAX K. LLOYD[1], TYLER KUKLA[2], ZACHARY D. SHARP[3], C. PAGE CHAMBERLAIN[2]

[1] Earth and Planetary Sciences, UC Berkeley, Berkeley, California 94709, USA (*danieli@stanford.edu)
[2] Geological Sciences, Stanford University, Stanford, California 94305, USA
[3] Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, 87131, USA

Triple oxygen isotope measurements are emerging as a new tool in paleothermometry, terrestrial paleoclimate, and paleoaltimetry reconstructions. In this contribution we develop the application of triple oxygen isotope measurements to lacustrine sediments, focusing here on an example dataset from the Eocene Green River Formation in the Flagstaff Basin (UT) using chert samples previously measured for $\delta^{18}O$ and δD [1]. This basin is suggested to be indicative of a terminal balanced-filled lake system.

We present new $\Delta^{17}O$ measurements made by laser fluorination of chert. Across an evaporation trend spanning 12.2‰ in $\delta^{18}O$ we observe a strong negative correlation with $\Delta^{17}O$ ranging from –0.081‰ to –0.203‰ ($\lambda_{RL} = 0.528$), with an empirical slope (λ_{chert}, $\delta'^{17}O$ vs. $\delta'^{18}O$) of 0.523.

Given temperature-dependent fractionation factors for the SiO_2-H_2O system [2] and compilations of trends in meteoric water [3], we derive mixing relationships analogous to modern lake trends in $\delta^{18}O$-δD. In doing so, we demonstrate calculation of the $\delta^{18}O$ and $\Delta^{17}O$ composition of the unevaporated lake source water. For the Flagstaff Basin chert samples we derive a source water of $\delta'^{18}O$ = –17.9±1.4‰ and $\Delta^{17}O$ = 0.030±0.021‰, a comparison point for climate model simulations. Our λ_{chert} is between equilibrium processes related to meteoric water and SiO_2 precipitation (~0.528) [2,3], and kinetic fractionation of evaporating water (~0.519) [4], indicating that lacustrine cherts, and possibly diatoms, may be suitable for quantitative relative humidity reconstructions similar to those made on gypsum hydration waters [5]. Proxy system modeling development is needed to establish the use of triple oxygen isotope measurements of chert to quantify patterns of regional moisture balance in the past.

[1] Abruzese et al. (2005) *Geochim. Cosmochim. Acta*, **69**, 1377-1390. [2] Sharp et al. (2016) *Geochim. Cosmochim. Acta*, **189**, 105-119. [3] Sharp et al. (2018) *Geochemical Perspectives Letters*, **7**, 27-31. [4] Barkan & Luz (2007) *Rapid Commun. Mass. Sp.,* **21**, 2999-3005. [5] Gázquez et al. (2018) *Earth Planet. Sci. Lett.*, **481**, 177-188.