On the use of triple oxygen isotopes in evaporated lake systems to reconstruct $\delta^{18}O$ of unevaporated precipitation

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Evaporation can increase the $^{18}O/^{16}O$ ratios of lake waters and carbonates by several per mil [1], which if unaccounted for can lead to substantial overestimates of reconstructed paleotemperature and underestimates of reconstructed paleoelevation. Evaporation also leads to a deficit in residual waters of $\Delta'^{17}O$, a measure of the departure of $^{17}O/^{16}O$ from a characteristic relationship with $^{18}O/^{16}O$ [2,3]. We explore isotope mass balance models of flowthrough and closed-basin lakes to investigate the potential of this property to help resolve local evaporative signatures from regional climate or elevation signatures. We present new triple oxygen isotope data from waters and carbonates from lakes and their source rivers in the semiarid western United States. The data illustrate marked lowering of $\Delta'^{17}O$ in closed basin lakes and freshwater lakes relative to their source rivers. The evaporation trajectory in triple oxygen isotope space (λ_{lake}) is similar for these lakes, averaging 0.5229 and ranging between 0.5221 and 0.5240.

Following on these observations, we show how triple oxygen isotopes in waters and carbonates and 'clumped isotopes' (Δ_{47}) in carbonates can be combined to improve estimates of the $\delta^{18}O$ values of primary (unevaporated) precipitation, which is more directly correlated with regional climate and elevation. The accuracy of this approach will depend largely the degree of variation of λ_{lake} in natural settings, variation in the slope and intercept of the triple oxygen isotope meteoric water line, and the extent to which these kinds of variation can be accurately predicted or reconstructed. However, even with uncertainty in these parameters, triple oxygen isotope-based estimates of unevaporated water compositions are likely to be far more accurate than those derived from solely from $\delta^{18}O$ values of lake waters and carbonates

[1] Horton *et al*. (2016). Quat. Sci. Rev. **131**, 365-379.
[2] Gázquez *et al*. (2018). Earth Planet. Sci. Lett. **481**, 177-188. [3] Surma *et al*. (2018) Sci. Reports **8**, 1-10.