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Modeling $\delta^{18}O_w$ to calculate paleotemperatures from deep time lacustrine carbonates

Benavente C.A. [1] Irmis R.B.[2] Bowen G.J.[2] Mancuso A.C.[1]
[1] IANIGLA, CONICET, Mendoza, Argentina
cebenavente@gmail.com
[2] University of Utah, UT, USA

Paleotemperature proxy data from lacustrine sediments are fundamental to understanding terrestrial paleoclimate. Because the relationship between the oxygen isotope composition of water ($\delta^{18}O_w$), the oxygen isotope composition of carbonate ($\delta^{18}O_c$), and temperature are well understood in the modern, $\delta^{18}O_c$ has been used to estimate Quaternary lacustrine paleotemperatures. This could be applied for deep time calculations, but is challenging because $\delta^{18}O_w$ is affected by geographic and climatic factors as well as evaporation of lake water, all of which control precipitation isotope ratios. We have faced these challenges in interpreting records from Middle Triassic carbonate-rich paleolakes from the Cuyana Rift Basin, central-west Argentina. A multiproxy paleoenvironmental reconstruction was obtained for these systems using stable C and O isotope compositions. To infer paleotemperature, we estimated $\delta^{18}O_w$ using the geographic relationship of Bowen and Revenaugh (2003) to predict precipitation of $\delta^{18}O$, with two end members of paleolatitude calculated from paleopole data and two end members of paleoelevation from the range of East African Rift modern lake systems. Following Leng and Marshall (2004), this yielded four different paleotemperature estimates for each $\delta^{18}O_c$ value. This approach is limited in that it: a) is imprecise; b) assumes a modern geographic distribution of precipitation isotope ratios, and c) does not account for possible lake water evaporation. To address these issues, we explore a multiproxy analysis using the joint proxy inversion method of Bowen et al. (2020), combining $\delta^{18}O$ and $\delta^{13}C$ data from our lake carbonates with contemporaneous marine isotopic data. The resulting analysis leverages multiple lines of information to help constrain our regional paleotemperature estimates, providing a promising path forward for developing more accurate and precise continental paleotemperature reconstructions from these and other deep time lake sequences.