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Triple oxygen isotope values of microbially mediated carbonate from Green Lake, Fayetteville, NY, USA

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Biogenic carbonate oxygen isotope ratios are a key proxy for paleotemperature reconstructions. However, they are limited in their temporal scope because the most commonly used fossils – foraminifera and brachiopods – only emerged in the Phanerozoic. Microbial carbonates like stromatolites and thrombolites exist from the Archaean to modern and are also frequently leveraged as paleotemperature proxies, especially in Precambrian rocks. However, there is some debate over whether microbial carbonates precipitate in oxygen isotope equilibrium with the water or whether kinetic effects impact their oxygen isotope ratios. In this work, we present $\delta^{13}C$, $\delta^{17}O$, $\delta^{18}O$, and $\Delta'^{17}O$ values of carbonate sediment, thrombolitic bioherms, and water from Green Lake in Fayetteville, New York, USA. In a 57-cm lake sediment core, we found a steady decrease in carbonate $\delta^{18}O$ values going down core. We find an increase in $\delta^{13}C$ until 35 cm depth, followed by a decrease, reflecting oxidation of organic matter occurring below the sediment-water interface. Triple oxygen isotope values indicate that none of the carbonate is precipitating in oxygen isotope equilibrium with the sampled lake water. All carbonate samples have lower $\delta^{18}O$ and $\Delta'^{17}O$ values than expected for equilibrium. After modeling multiple precipitation scenarios, we conclude that carbonate precipitation within Green Lake is most likely driven by rapid changes in DIC driving authigenic carbonate precipitation. Future work will explore whether similar processes impact the oxygen isotope values in marine microbial carbonates and the implications for their use as a proxy for paleotemperatures.