Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11285

Carbonate triple oxygen isotope values during the Shuram carbon isotope excursion

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The Shuram carbon isotope excursion (~550-560 Ma) is the largest negative carbon isotope excursion in the geologic record where $\delta^{13}C$ values reach < -10‰ during the nadir and is seen in formations globally. When interpreted as a surface water signal, the Shuram carbon isotope excursion represents a dramatic change in marine surface environments. However, the excursion, based on $\delta^{13}C$ and $\delta^{18}O$ covariance throughout the excursion (e.g., Derry, 2010), amongst other evidence, has also been linked to diagenesis or authigenic carbonate formation.

Here, we report triple oxygen isotope values (reported as $\delta'^{17}O$, where $\delta'^{17}O=\delta'^{17}O-0.528\delta'^{18}O$) to investigate whether the oxygen isotope composition of the carbonate in the Wonoka formation of southern Australia can be interpreted as primary. The triple oxygen isotope values of marine carbonates distinguish between primary and diagenetic processes due to there being only one unique solution for a given temperature for equilibrium calcite-water fractionation in seawater with a $\delta^{18}O$ value similar to modern. In the samples analyzed from the Wonoka formation, the $\delta'^{17}O$ value range between -0.04 to -0.13‰ and do not vary with $\delta^{18}O$ or $\delta^{13}C$ values. The $\delta'^{17}O$ values are lower than expected for equilibrium precipitation, but follow the expected trend of CO_2 ingassing (Guo and Zhou, 2019). The simplest interpretation of this data is diagenetic overprinting of primary isotopic signals when two fluids with very different pCO_2 mixed, causing rapid dissolution of the primary calcite and re-precipitation of carbonate that is not in equilibrium with water. Therefore, the $\delta^{13}C$ values observed in the Wonoka formation are not representative of surface ocean conditions.

Derry, L.A. (2010) A burial diagenesis origin for the Ediacaran Shuram–Wonoka carbon isotope anomaly. *Earth and Planetary Science Letters* 294, 1, 152-162.

Guo, W. and Zhou, C. (2019) Triple oxygen isotope fractionation in the DIC-H_2O-CO_2 system: A numerical framework and its implications. *Geochim. Cosmochim. Acta* 246, 541-564.