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The Fayetteville Green Lake Ocean: Redox stratification and DIC storage of ^{12}C as a driver of the Paleoproterozoic Lomagundi-Jatuli Positive Isotope Excursion

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The Lomagundi-Jatuli positive carbon isotope excursion during the Paleoproterozoic (~2.30 to 2.06 Ga) remains one of the outstanding mysteries of the Precambrian. Given the occurrence of multiple carbonate units across the globe with $\delta^{13}C$ values exceeding 10 ‰, including the Nash Fm. with values reported here of up to 31.2 ‰, previous attempts to explain the mechanisms for a sustained imbalance in the global carbon cycle that can also explain these localized extremely positive values have fallen short in addressing this mystery.

Previous work has suggested increased sulfate delivery to the oceans following the Great Oxidation Event may have increased ocean sulfate concentrations to up to 15 mM thus driving sulfate reducing organisms (SROs) to create a redox-stratified ocean with oxic surface water above the redoxcline and euxinic water below[1, and refs therein]. This environment would have been ideal for the proliferation of purple sulfur bacteria (PSB), using H_2S and sunlight for anoxygenic phototrophy.

Fayetteville Green Lake (FGL), NY, USA provides a unique natural laboratory to test the effects of a sulfate replete water column (~12 mM) with cyanobacteria driving oxygenic phototrophy in the surface water, a robust PSB plate at the redoxcline, and euxinic water maintained by SROs below. With evidence that carbon cycling naturally produces $CaCO_3$ with enrichments of +6.7 ‰ from source water[2], we can use observations of FGL to explain how the ocean produced globally distributed ^{13}C-enriched carbonates for over 200 million years, and how tectonics created environments that generated localized enrichments of up to 31.2 ‰. Based on these observations, we test the validity and limits of this interpretation using the GENIE Earth system model to reconstruct biogeochemical cycling during the L-J for the open ocean and restricted basins.

[1]Havig, Hamilton, Bachan, & Kump (2017), *Earth-Science Reviews*, *174*, 1-21.

[2]Havig, Hamilton, McCormick, McClure, Sowers, Wegter, & Kump (2018), *Limnology and Oceanography*, 63(2), 570-587.