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A Mesoarchean oxygen oasis expanded: new trace element and stable isotope data from the 2.8 Ga Mosher Carbonate, Steep Rock Lake, Canada

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The 2.8 Ga Mosher Carbonate exposed at Steep Rock Lake in Ontario is one of Earth's oldest limestone deposits. The Mosher Carbonate's thickness (500 m), diverse biosignatures, and relative level of preservation (greenschist facies) make the location an ideal candidate for understanding Mesoarchean paleoenvironments. Rare earth element (REE) systematics have revealed the likely presence of oxidizing conditions on a restricted marine platform [1,2], while $\delta^{13}C$ from organic carbon suggests the presence of specific carbon fixation pathways within giant microbial domes [3]. Both lines of evidence have been used to propose the presence of an "oxygen oasis" prior to the Great Oxidation Event and provide a solid framework for more detailed examination of this unique deposit.

This study provides an expanded set of high-precision major, trace, and rare earth element data from the Mosher Carbonate. The REE data reveal clear seawater-like patterns and confirm the presence of important true negative Ce anomalies in the Mosher carbonate, extending the reported range of Ce/Ce* values down to 0.2, with corresponding Pr/Pr* as high as 1.3. Importantly, our study expands the stratigraphic range of negative Ce anomalies beyond the giant microbial domes of the Elbow Point Member into the stromatolites of the underlying Hogarth Member. We also provide the first chemostratigraphic profile of $\delta^{13}C$ from Steep Rock Lake organic carbon, including the first reported values from the Hogarth Member. Combined with $\delta^{13}C$, $\delta^{13}O$, and elemental data from carbonates, this novel dataset provides a more detailed picture of the evolving redox conditions and microbial community structure at different points in the evolution of the Mosher Carbonate, and reinforces its position as an Archean oxygen oasis.

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[2] Fralick & Riding (2015), Earth Science Reviews 151, 132–175.

[3] Nisbet, Grassineau, Howe, Abell, Regelous & Nisbet (2007), Geobiology 5, 311–335.