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Revealing the mid-Proterozoic seawater redox condition based on geochemical records from the lower Belt-Purcell Supergroup

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The mid-Proterozoic (ca. 1.8 to 0.8 Ga) bridges the Great Oxidation Event and the Neoproterozoic Oxidation Event. Recently, evidence of transient oxidation events and the diversification of early eukaryotes have drawn more attention to the mid-Proterozoic interval. The “Boring Billion” has proven less boring than previously thought. However, redox and other environmental proxy data on mid-Proterozoic carbonate sediments are relatively sparse, hindering a comprehensive understanding of the co-evolution of early eukaryotes and the environment.

Here, we present trace-element and isotopic analyses of marine carbonate samples collected from the Waterton and Altyn Formations in the lower Belt-Purcell Supergroup from Alberta, Canada, dated at ~1.47 to ~1.45 Ga. A multi-proxy approach including stable Ca isotopes ($\delta^{44/40}$Ca), Mg isotopes (δ^{26}Mg), trace elements, and rare earth elements (REE) was applied to constrain the effect of diagenetic processes (recrystallization, dolomitization, etc) and to evaluate their impact on the original geochemical/isotope records. The samples that had experienced sediment buffered diagenesis, with respect to Ca and Mg, were selected as the most promising archives of primary seawater signatures and were used for ancient seawater redox reconstruction using I/Ca and Ce/Ce* proxies. Diagenesis results in net loss of iodine from carbonate sedimentary rocks, thus our I/Ca data provides the most conservative estimation of paleo-redox conditions. Together, our data provide new constraints on marine redox variation along the western margin of mid-Proterozoic Laurentia known for its record of early eukaryotes and helps evaluate the potential link between redox dynamics and eukaryotic diversification.