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A new record of shallow marine redox from Archean-Proterozoic carbonates of Western Australia

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The oxygenation of Earth's marine environments and the resulting chemical (redox) change of seawater is arguably the most significant process to affect Earth's surface evolution. In particular, the Great Oxygenation Event (GOE) represented the first major rise in oxygen in Earths' surface environments and paved the way for the later evolution of complex life. While much redox proxy work from this time concentrates on global oxygen signatures, shallow marine environments likely hosted the most dynamic redox conditions of the early Precambrian. Here, we focus on the geochemistry of Archean-Proterozoic shallow marine carbonates from Western Australia. When constrained by sedimentology, well-preserved marine precipitates (e.g. ooids, marine cements, microbialites) from these ancient carbonates capture the geochemical signature of the shallow seawater from which they precipitated. Trace metals from these carbonates, particularly the rare earth elements, can be used to interpret the paleoenvironmental conditions of the Precambrian ocean, including redox state. In this study, samples were collected from eleven Western Australian Precambrian carbonate units, from the Archean to the Paleoproterozoic (2.7 to 1.6 Ga). Samples were petrographically characterised then analysed by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to produce a new record of seawater chemistry in shallow marine environments through the GOE. New data was then compared to a new literature compilation of REE data from global settings.

These new data are variable, but demonstrate some agreement with global trends observed in Archean to Paleoproterozoic samples, including decreasing Y/Ho ratios, minor positive Ce anomalies and a diminishing europium anomalies. These data demonstrate shallow marine settings with minor but non-permanent oxygen. This new database constitutes the largest published trace metal database of carbonates from the Precambrian of Western Australia and describes significant environmental change through the terminal Archean.