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# Did a Mn-shuttle operate in a redox-stratified ocean at the onset of late Archean BIF deposition?

**VERA HOOGLAND**[1], DAVID T FLANNERY[1], LUKE NOTHDURFT[1] AND OSAMA Y.A. GHIDAN[2]

[1]Queensland University of Technology
[2]Australia's Nuclear Science and Technology Organisation

The ~2.63 Ga Carawine Dolomite (Hamersley Group, Pilbara Craton) preserves a substantial carbonate platform deposited prior to the Great Oxidation Event (GOE). It contains several hundred metres of microbial carbonate, evidence for a bolide impact event manifested by a spherule-bearing megabreccia (SBMB), and banded iron-formation (BIF). Low metamorphic grades present a rare opportunity to study changing sea water chemistry, impact-related perturbations and microbial ecological responses. We aim to construct a high-resolution chemostratigraphy across a continuous stratigraphic transect using field observations, major, trace and rare earth elements (REEs), stable organic and stable inorganic carbon isotope measurements, and radiometric dating techniques.

Deep-water facies are dominated by planar laminated and/or stromatolitic dolomite, representing a prolonged regression after craton drowning and shale deposition. Within these facies, the SBMB consists of multiple fining-upward mass-flows containing impact spherules. A subsequent transgression initiated local deposition of shale and BIF, before a renewed regression resulted in deposition of diverse shallow-water facies. These include; 1) a subtidal facies dominated by tented microbialites and (pseudomorphed) aragonite crystal fans; 2) a storm facies consisting of oncolytic grainstone, and; 3) a sub-to peritidal facies containing stromatolites, microbial tubestone, putative thrombolites, large oncolites, ooids, and current and wind generated ripple cross-stratification. Sequence stratigraphic analysis reveals numerous small-scale transgressive and regressive cycles.

REE patterns obtained from the subtidal and sub- to intertidal facies reflect mixing of marine and fresh water in an estuarine setting. Storm facies patterns are consistent with siliciclastic contamination limiting development of marine REE patterns. The deep-water facies generally exhibits characteristics typical of Archean anoxic marine environments. Notably, Ce-anomalies shift from absent to positive above the impact event. We posit that the impact event accelerated nutrient upwelling, increasing productivity and rates of organic matter burial, resulting in (partial) oxidation of shallow waters. Redox stratification driven by this or other means may then have initiated a Mn-shuttle facilitating transport of Ce to anoxic, deeper water environments where the dissolution of Mn-oxides under reducing conditions released Ce and produced positive Ce-anomalies. Upwelling of $Fe^{2+}$, possibly also associated with impact events, may have increased rates of microbial iron-oxidation, triggering BIF-deposition.