Ferruginous ecosystems and the environmental dynamics of a Paleoproterozoic sea

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Our detailed analyses of redox conditions in the McArthur Basin of northern Australia during deposition of the 1.64 Ga Barney Creek Formation (BCF) reveal that deep waters were ferruginous most of the time. Based on biomarkers, purple sulphur bacteria (Chromatiaceae) were dominant during these periods, suggesting that these anoxygenic phototrophs utilised ferrous iron as an electron source for photosynthesis – the first evidence for this unusual metabolism in the Proterozoic. However, our data indicate a dynamic redox environment where the dominantly ferruginous deep waters saw intermittent, possibly seasonal, incursions of oxygenated surface waters, as indicated by the oxygenation of redox sensitive biomarkers. These oxygenation events appear to have been short lived, however, since unique correlations between biomarker and iron speciation proxies indicate that mixing events were followed by periods of euxinia. Our data also indicate variations in chemocline depth that influenced the community composition of green and purple sulphur bacteria. The dynamic nature of the marine system can be explained by variations in climatic conditions, such as storm events. Wind driven mixing may have extended the mixed layer depth, suppressing growth of purple sulphur bacteria that have high light requirements and therefore usually populate shallow chemoclines (< 20 m depth) [1]. Instead, growth of green sulphur bacteria (Chlorobiaceae) was favoured during more turbulent periods when run-off also increased, as indicated by higher abundances of siliciclastics relative to carbonates. As a result, an increased influx of sulphate and/or nutrients fueled bacterial sulphate reduction, leading to the development of euxinic conditions. In addition to strong short term fluctuations, long term trends in diverse environmental proxies are evocative of an orbital control on the inferred climatic processes that underlie the basin dynamics.

[1] Brocks and Schaeffer (2008), *GCA* **72**, 1396-1414.