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Oxic Fe(III) reduction could have generated Fe(II) in the photic zone of Precambrian seawater

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Abstract:

Many marine Precambrian iron formations (IF) record deep anoxic seawater enriched in Fe(II) (i.e. ferruginous) overlain by mildly oxygenated surface water. This is reflected by iron-rich sediments forming in deep basins, and relatively iron-poor sediments forming in shallow, sunlit waters. Such an iron gradient is often interpreted as a redox interface where dissolved Fe(II) was oxidized and precipitated as Fe(III)-bearing minerals. As such, sedimentary iron enrichments are proxy to the progressive oxidation of the oceans through geological time. However, this interpretation is founded on the assumption that Fe(II) could not persist within an oxygenated water column. Here, we cultivated cyanobacteria in an illuminated column supplied with FE(II)-rich seawater medium in a laboratory-scale analog of a continental margin supporting IF deposition. We first observed FE(II) oxidation with oxygen then biologically/mediated reduction of Fe(III) (oxyhydr)oxides, which maintained a pool of Fe(II) in the presence of oxygen. Such steady-state iron redox cycling may have maintained dissolved, and hence mobile Fe(II) in oxygenated seawater above ferruginous deep basins such as those inferred for many Precambrian IF.

Keywords: deep anoxic seawater, oxygenated surface water, iron redox cycling, Precambrian iron formations, Fe(III) oxyhydroxides, photochemical and oxic Fe(III) reduction