Ediacaran Banded Iron Formations: the missing link in the biogeochemical evolution of the oceans

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Multiple lines of evidence suggest that the Earth's atmosphere underwent a significant rise of O_2 somewhat 2.45 (Ga) billion-years ago (the so-called 'Great Oxidation Event') but the persistent oxygenation of the oceans developed much later, perhaps around 580 Ma. These changes in environmental redox invariably affected the abundance of bioessential elements and ultimately, the evolution of life.

Banded iron formations (BIF) are a distinctive type of rock that can provide insights into our understanding of the early Earth system by preserving a history of Precambrian oceanic elemental abundance. Widespread in the Archean and largely absent after ca. 2.45 Ga (with significant exceptions at ca. 1.8 Ga and ca. 0.75 Ga) the presence of BIF is generally interpreted as evidence for anoxic waters, although the mechanism of oxidation remains disputed.

Previous studies have suggested that the rise in oxygen during the late-Neoproterozoic created an environment permissive for animal evolution. They indicate that the ocean became increasingly oxygenated after the end of the Marinoan glaciation, which would led to the oxidation of deep ocean and the rise of animal life after the Gaskiers glaciation. Most recently, it has been proposed that even during the beginning of the Ediacaran period, and up to the end of the Gaskiers glaciation (635-580 Ma), anoxia remained widespread beneath the mixed layer of the oceans. The deeper waters were sometimes sulfidic, but for the most part, they were Fe(II)-enriched, much like the oceans before 1.8 Ga. Although these conditions would favor the widespread deposition of iron-rich sediments, the evidence supporting this model is based on the speciation of Fe in clastic sedimentary rocks and no iron formations associated with the Ediacaran, despite the plausibility for Fe(II)-enriched ocean waters, have been described.

This study deals with the sedimentology, stratigraphy and various geochemical aspects of Ediacaran BIF -the youngest iron formation yet reported- and associated strata deposited after a period of severe glaciations and concurrent with the rise of complex life. Crucially, these deposits constitute the first direct evidence of the long-postulated link between oxygen levels and the emergence of metazoa by which the deep-sea ventilation allowed Ediacaran macrobiota to flourish and colonize the deep seafloors.