Testing 'Bio-inorganic Bridges' using the iron formation record: Updates on nickel and zinc

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A 'bio-inorganic bridge' links changes in the inorganic chemistry of the ocean with biological evolution [1]. When first proposed, there were relatively few examples of bio-essential trace elements that had been extensively studied in the sedimentary rock record of deep geological time. However, with recent investigations into trace element concentrations in Precambrian banded iron formations (BIF) and shales, this is no longer the case [2–4]. Here we examine updated compilations of nickel and zinc in BIF, which show vastly different temporal trends and have unique implications for the emerging biosphere. A dramatic decline in nickel is thought to have contributed to a collapse of methanogens ca. 2.7-2.5 Ga, with implications for timing of the Great Oxidation Event [2]. Zinc, on the other hand, was previously thought to have been present at very low concentrations in the early oceans, becoming bioavailable and rapidly incorporated into eukaryotic enzymes during the Neoproterozoic; this trace element trajectory was proposed to be a contributing factor to the delay in eukaryotic evolution [5]. However, in the BIF record, zinc appears to be relatively constant over geological time [3]. This calls into question which bio-essential trace elements can be viewed in terms of 'bio-inorganic bridge' hypotheses vs. other intrinsic and/or environmental factors that may act as the driving force behind biological evolution.

[1] Anbar & Knoll (2002) *Science* **297**: 1137-1142. [2] Konhauser *et al* (2009) *Nature* **458**: 750-753. [3] Robbins *et al* (2013) *Geobiology* **11**: 295-306. [4] Scott *et al* (2012) *Nature Geoscience* **6**, 125-128. [5] Dupont *et al* (2010) *PNAS* **107**: 10567-10572.