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Burial of Fe bearing precursors to ‘chemical sediments’ in the deep past

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Chemical sediments such as Banded Iron Formations (BIFs) are potential recorders of biogeochemical cycles and nutrient availibility in ancient oceans. In particular, their metal and nutrient contents may help reconstruct concentrations of dissolved elements in seawater. However, chemical sediments consist in non-continuous and non-homogeneous archives throughout Earth history, and their formation still remains largely controversial, challenging our ability to reconstruct these geochemical cycles. For instance, the mineralogy of their precursors is highly uncertain, and how such primary mineralogy transformed through diagenesis (and potentially metamorphism) is also unclear.

Here, we explored the mineralogical transformations occuring uppon rising pressure (P) and temperature (T) on key Fe-bearing minerals, commonly reported as ubiquitous in Archean, anoxic and Fe-rich oceans. Specifically, we performed P-T experiments in diamond anvil cells, spanning 25 to 300°C and 0 to 3 GPa to simulate sediment burial and metamorphism, on a range of Fe bearing minerals including ferrihydrite, goethite, hematite, carbonated green rust and greenalite, and used in-situ XRD and Raman spectroscopy to characterize the evolution of mineralogical assemblages. We find that over this P-T window, temperature exerts higher controls over P for the observed mineral transformations. We discuss the potential role of these Fe minerals as precursors of BIFs.