Redox structure and composition of Paleoproterozoic seawater during Great Oxidation Event: Geochemical evidence in the Yuanjiacun banded iron formation, China

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The recognized worldwide gap in BIF deposition between 2.4-2.0 billion years ago has long been considered as an obstacle to fully determining the geochemical composition of seawater at that time. However, the recently dated ~2.38-2.21 Ga Yuanjiacun banded iron formation (BIF) in China offers a possibility to redress these uncertainties. This BIF is within a metasedimentary rock succession of the Yuanjiacun Formation, which has undergone lower greenschist-facies metamorphism.

The BIF samples display distinctively seawater-like REE+Y profiles that are characterized by positive La and Y anomalies and HREE enrichment relative to LREE in PAAS-normalized diagrams. Very low Al_2O_3 (<0.5 wt%) and high field strength elements (HFSE) concentrations (<3 ppm) indicate an essentially detritus-free precipitation. Consistently positive Eu anomalies are also observed, which are typical of reduced, high-temperature hydrothermal fluids. In addition, slightly negative to positive Ce anomalies, and a large range in ratios of light to heavy REEs, are present in the oxide-facies BIF. These characteristics suggest that deposition of the BIF took place along the chemocline where upwelling of deep, anoxic, iron- and silica-rich hydrothermal fluids mixed with shallower and slightly oxygenated seawater.

These results, coupled with consistently positive $\varepsilon_{Nd}(t)$ values for the BIF, indicate that the ancient ocean during Great Oxidation Event (~2.4-2.2 Ga) was redox-stratified from oxic shallow waters to deeper anoxic waters, and that the total REE budget of paleo-seawater was probably dominated by hydrothermal circulation of seawater through depleted mantle-derived source rocks.