The isotopic expression of Fe shuttling in modern and ancient euxinic sediments: implications for the rise of oxygen

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Modern sediments that are deposited beneath a sulfidic water column, such as in the Black Sea, are typically enriched in reactive iron relative to average oxially or suboxically deposited sediments. Similar iron enrichments are observed in sedimentary rocks from ancient euxinic (anoxic and sulfidic) basins. The mechanism commonly proposed for this iron enrichment is shuttling of benthic iron from suboxic shelf sediments to the deep basin, where it is sequestered quantitatively during Fe-sulfide precipitation. In this study we investigate how iron isotopes, in combination with traditional paleoredox proxies, can be used to identify this benthic iron source and to recognize ancient euxinia. Low δ^{56}Fe values in porewaters from suboxic sediments indicate that sedimentary iron flux has a characteristically light (<-2.0 ‰) iron isotope composition [1]. These low δ^{56}Fe values are a consequence of the continuous iron redox-recycling in suboxic continental shelf sediments. Consistent with shelf-to-basin iron transport, modern and ancient euxinic sediments show light bulk iron isotope compositions that are significantly decreased relative to average oxic weathering products. Low δ^{56}Fe values of sedimentary pyrites and bulk sediments throughout the Archean [2,3] may indicate that a similar iron-shuttle could have operated during that time. Our interpretations implies that shallow sediments in the Archean ocean underwent redox-cycling in order to generate an isotopically light benthic iron flux. The isotopic expression of the iron enrichment mechanism could therefore provide important insights into the evolution of the iron cycle and the redox balance of the atmosphere-ocean system in the early Earth.

References

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