Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.3886

Untangling the Fe isotope signal in Neoarchean carbonates and iron formations from Carajás (Brazil)

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Iron (Fe) isotope systematics are extensively used to constrain redox pathways and microbial influence on the deposition of carbonates and iron formations (IFs) throughout the Precambrian. However, the identification of primary signatures (*e.g.* processes in near-equilibrium with seawater), as opposed to secondary process (*e.g.* mineral formation during diagenesis and metamorphism) remains a topic of ongoing debate. Here we combine iron ($\delta^{56}Fe$) and carbon ($\delta^{13}C_{carb}$) isotope data with magnetic mineral separation and X-Ray diffraction (XRD) techniques to characterize diagenetic effects in Neoarchean carbonates and IFs from Carajás (Brazil). The range of $\delta^{56}Fe$ values measured in carbonate leachates and magnetite separates varies from - 0.54 to + 0.54 ‰ and + 0.49 to + 1.59 ‰, respectively. A remarkably homogeneous fractionation factor between carbonate leachates and magnetite separates was observed ($\Delta^{56}Fe_{mag\text{-}carb}$ = 0.98 ± 0.11 ‰, n = 32) in two drill-cores separated by 50 km in the paleo-basin, suggesting a re-equilibration of the Fe isotopic system during burial heating. In carbonates with lower Fe contents, the range in $\delta^{13}C_{carb}$ values (-0.56 ‰ to + 0.86 ‰) appears unaffected and possibly reflects precipitation in near-equilibrium with local seawater. In combination with XRD data, this dataset opens new perspectives on how Fe isotopic compositions of carbonate and magnetite relate to distinct fractionation processes and/or evolving isotopic composition of Fe reservoirs in the paleobasin.