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Species-specific Fe-isotopes on Palaeoproterozoic BIF and their implications

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Banded iron formations (BIF), deposited prior to and concurrent with the Great Oxidation Event (GOE) at ~2.4 Ga, record changes in the oceanic and atmospheric chemistry during this critical time interval. Three previously unstudied drill-cores from the western Transvaal Basin, South Africa, capturing the rhythmically mesobanded Kuruman BIF and the overlying granular Griquatown BIF, were sampled every ~20 m. along core depth. These samples were analysed for mineralogy, geochemistry and bulk Fe and C-isotopes.

Bulk Fe-isotopic values of 50 samples show an apparent relationship with mineralogy. The lower $\delta^{56}\text{Fe}$ values (< -1.3) correlate with carbonate-rich samples, whereas higher $\delta^{56}\text{Fe}$ values (>0.0) correspond to samples rich in bulk modal magnetite. To further investigate this relationship, a 3-step sequential extraction protocol was developed to separate the three main Fe-hosting fractions (Fe-carbonates, Fe-oxides and Fe-silicates). Rare Earth Element (REE) patterns were resolved for the individual fractions and using the leachate destruction protocol of Henkel et al. [1] we were able to measure for the first time species specific Fe-isotopes of bulk-BIF samples.

Species specific Fe-isotopes are probably a better proxy for the Palaeoproterozoic ocean than bulk-rock values, since the latter are strongly influenced by the modal mineralogy of each sample. We used bulk-rock C-isotope data combined with the species specific REE and $\delta^{56}\text{Fe}$ to argue that the Fe-carbonates (and possibly Fe-silicates) in the Transvaal BIFs record primary chemical signatures. It follows that chemical signatures can be preserved, through changes of the textural appearance of minerals in BIF during diagenesis and low-grade metamorphism [2].

Preliminary data indicate that the Fe-oxides (dominated by magnetite) are probably formed by recycling and mixing of precursor Fe-(oxy)hydroxides and ferrous sea- or pore-waters, since their positive $\delta^{56}\text{Fe}$ values deviate strongly and consistently from the negative ones of the other fractions. The post-GOE Fe-oxides of the stratigraphically higher Hotazel Formation have negative $\delta^{56}\text{Fe}$ values, which supports a basin-wide Rayleigh fractionation of isotopically heavy-Fe [3].

References:

[1] Henkel et al., (2016) *Chemical Geology*, 421, 93-102

[2] Frost et al., (2007) *Contributions to Mineralogy and Petrology* 153, 211-235

[3] Tsikos et al., (2010) *Earth and Planetary Science Letters*, 298, 125-134

