Iron cycling and isotope fractionation in shelf sediments of King George Island, Antarctica

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Iron fluxes from reducing sediments and subglacial environments are potential sources of bioavailable iron into the Southern Ocean. Stable iron isotopes are considered a proxy for Fe sources, but respective data are scarce and Fe cycling in complex natural environments is not understood sufficiently to constrain respective δ^{56}Fe "endmembers" for different types of sediments, environmental conditions and biogeochemical processes.

We show δ^{56}Fe data from pore waters and sequentially leached solid Fe (for method see [1]) of two contrasting sites in a bay of King George Island that is affected by fast glacier retreat. Sediments close to the glacier front contain more reactive Fe oxides and pyrite compared to those close to the ice-free beach and show a broader ferruginous zone. Since sulfate reduction (SR) is almost negligible at this site, the pyrite likely derives from eroded bedrock. Interestingly, ^{56}Fe depletion in pore water and most reactive Fe oxides is more pronounced close to the ice-free beach where SR was observed at shallow sediment depth. Downcore δ^{56}Fe variability close to the glacier front is limited to surface-reduced Fe, whereas it also occurs in the ferrihydrite-lepidocrocite fraction station close to the ice-free beach. The ferrihydrite-lepidocrocite fraction is at least 0.5‰ lighter than goethite-hematite and magnetite at both sites indicating that it incorporates Fe that previously underwent redox cycling. High amounts of easily reducible Fe oxides, esp. at the glacier site, stimulate dissimilatory iron reduction (DIR) and prevent the use of less reactive Fe oxides. We infer that pyrite oxidation (subglacially or within the deposited sediment in the bay) and/or Fe^{2+} supply from subglacial environments promote Fe cycling and that DIR-dominated sediments do not necessarily result in isotopically lighter Fe fluxes compared to SR-dominated sediments.

[1] Henkel et al. (2016), Chem. Geol. 421, 93-102.