

Evolution of the isotopic composition of dissolved iron in hydrothermal plumes in the Southern Ocean

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The Southern Ocean is of significant importance to the global carbon cycle and is a major sink for atmospheric carbon dioxide (CO₂). The micronutrient iron (Fe) is a key regulator of primary productivity and therefore CO₂ uptake in the Southern Ocean. Recent modelling efforts suggest that hydrothermal vents are an important source of Fe to the Southern Ocean but, as yet, it remains unclear how Fe is stabilised during transport away from vent sites. Here, we use the isotopic composition of Fe ($\delta^{56}\text{Fe}$) to study the processes involved in the supply, removal and recycling of Fe from hydrothermal vent sites located on the East Scotia Ridge in the Southern Ocean [1].

Our data reveal that the $\delta^{56}\text{Fe}$ value of dissolved Fe (dFe) evolves from -0.3 ‰ in the endmember (Mg = 0) high temperature hydrothermal fluid, to much lower values (as low as -1.2 ‰) in the buoyant part of the hydrothermal plume. This can be attributed to rapid precipitation of Fe sulfides followed by partial oxidation of Fe(II) to Fe(III), and precipitation of a fraction of the Fe-oxyhydroxides that subsequently form. In the neutrally buoyant part of the plume, $\delta^{56}\text{Fe}$ values increase to between -0.3 and -0.5 ‰. This cannot be explained by continued dilution of the buoyant plume with background seawater; rather, we suggest that isotope fractionation of dFe occurs during plume dilution due to complexation of Fe to organic ligands and exchange with labile particulate Fe (neoformed Fe-oxyhydroxides, adsorbed Fe, Fe-sulfides). Our results suggests that the $\delta^{56}\text{Fe}$ signal of stabilised hydrothermal dFe may be detected away from vent sites. However, this signal most likely varies between different hydrothermal systems and is especially dependant on the Fe/S ratio of the hydrothermal fluid.

[1] Klar *et al.*, 2017, *Geology*, v. 45, no. 4, p. 351-354, doi:10.1130/G38432.1