Isotopic composition of hydrothermal iron delivered to the ocean interior

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Concentrations of iron (Fe) in high temperature hydrothermal vent fluids are 6-7 orders of magnitude greater than in seawater It is generally assumed that hydrothermal Fe is quantitatively removed from solution by precipitation of Fe oxides and sulphides after eruption at the seafloor, so hydrothermal activity is not considered a major source of Fe to the ocean interior. However, recent studies have revealed that as much as 46% hydrothermal Fe may remain in the dissolved (<0.2 μm) phase, either in the form of colloids or as organic complexes [1]. Additionally, a map of the distribution of Fe isotopes in the Atlantic Ocean reveals relatively low δ^{56}Fe values close to the Mid-Atlantic Ridge, leading to speculation that the Fe isotopic composition of dissolved Fe delivered to the ocean interior may be as low as -1.3‰ [2], lower than the range reported for high temperature hydrothermal fluids (-0.64 to +0.28‰; e.g. [3]).

Here we report the first measurements of dissolved Fe in hydrothermal plumes. Samples were obtained from three vent sites in the East Scotia Sea: E2 and E9 are located on the East Scotia Ridge backarc spreading centre; Kemp Caldera is a submarine volcano that forms part of the South Sandwich Island arc. In the early stages of plume mixing, δ^{56}Fe values (-1.19‰ at E2 and -0.76‰ at E9) are lower than the value of the endmember vent fluids and, as the plume becomes more and more dilute, δ^{56}Fe values for dissolved Fe converge towards -0.56 to -0.29‰. δ^{56}Fe values of dissolved Fe in the hydrothermal plume at Kemp Caldera (-0.37 to +0.01‰) are, on average, slightly higher at equivalent dilution. Considered together, our data indicate that the Fe isotopic signature of stabilised Fe, that may be delivered to the ocean interior, is lower than average deep ocean water (+0.35±0.18‰), but not as low as previously speculated [2].

[1] Hawkes et al. (2014) *Geophys. Res. Lett.*, 2013GL058817. [2] Conway & John (2014) *Nature* **511**, 212. [3] Bennett et al. (2008) *Earth Planet. Sci. Lett.* **270**, 157.