Tracing hydrothermal iron input to the deep ocean using iron isotopes

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Iron (Fe) is an essential micronutrient that limits primary productivity in high nutrient low chlorophyll (HNLC) regions, however the mechanism of Fe supply to the ocean is poorly understood. Hydrothermal vents are a recently discovered source of Fe and potentially other trace metals to the deep ocean. Fe isotope ratios ($^{56}Fe/^{54}Fe$) can potentially be used to trace sources and sinks of the global Fe biogeochemical cycle. Previous studies on Fe isotopes in hydrothermal plumes have focussed on particulate samples. However Fe isotope ratios could be used to trace the input of hydrothermal dissolved iron to the oceans. We test this hypothesis using samples of Total Fe (TFe) dissolved Fe (dFe) and soluble (sFe) from a hydrothermal plume in the Southern Ocean.

We show that approximately 40 to 90 % of dFe in the hydrothermal plume is present as colloidal Fe (dFe-sFe). $\delta^{56}Fe$ values (relative to IRMM-14) of dFe from the hydrothermal plume change dramatically during plume rise, ranging from -2.39 ± 0.08 ‰ to -0.13 ± 0.06 ‰. $\delta^{56}Fe$ values of TFe were generally heavier than dFe values, ranging from -0.31 ± 0.03 ‰ to 0.78 ± 0.09 ‰. Iron isotope variations between TFe and dFe are explained by the dominance of Fe-oxyhydroxide or pyrite precipitation processes; the master variables influencing the $\delta^{56}Fe$ of dFe supplied to the deep ocean.

Our study indicates dFe in hydrothermal plumes will include colloidal species, and contribute a flux of isotopically light dFe to the deep ocean.