Impact of hydrothermal venting on iron and chromium supply to the North Atlantic Ocean

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One of the most prominent findings of the GEOTRACES programme is that hydrothermal inputs of trace metals to the ocean can be detected many thousands of kilometers away from the mid-ocean ridge. However, the chemical processes in hydrothermal plumes that regulate the dispersal of ridge-derived metals are poorly constrained, making it difficult to assess the far field impacts of hydrothermal sources on the deep ocean metal inventory and, for some metals, on primary productivity in surface waters.

Iron and chromium isotopes are emerging tools for assessing the provenance of metal inputs to the ocean, and for exploring the effects of biogeochemical cycling and redox processes. Here we present results of the analysis of dissolved Fe and Cr concentrations, and dissolved Fe isotope ($\delta^{56}Fe$) and Cr isotope ($\delta^{53}Cr$) distributions, in seawater samples collected from above several hydrothermal sites on the Mid-Atlantic Ridge during the UK GEOTRACES GA13 cruise. Our Fe isotope data show that $\delta^{56}Fe$ values are as low as −1.91‰ in hydrothermal plumes above the basalt-hosted TAG site, and as low as −6.95‰ above the ultramafic-hosted Rainbow site. Differences in $\delta^{56}Fe$ values between the two sites likely reflect differences in the proportion of dissolved Fe that precipitates as Fe-sulfide vs Fe-oxide. At both locations, the $\delta^{56}Fe$ signal of dissolved Fe evolves to heavier values in the distal part of the hydrothermal plume, likely due to exchange of iron with the particulate fraction and mixing with background seawater. $\delta^{53}Cr$ values of dissolved Cr also change with increasing dilution of the hydrothermal plume.

Our study shows that the isotopic signatures of dissolved Fe and Cr can be used to distinguish metal inputs from dust and hydrothermal activity, improving our understanding of how hydrothermal venting impacts the oceanic trace metal cycles.