Hydrothermal vent fluids induce scavenging of PO_4 from an oxygenated water column

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Along the mid-ocean ridges, hydrothermal vents expel geothermally heated, chemically altered seawater back into the overlying water column. These vents are considered to play an important, but poorly constrained role in global marine biogeochemical cycles. Accurate understanding of source/sink behavior of these extreme deep-sea environments with respect to nutrients and trace metals remains elusive.

The so-called 'black smokers' of the ultramafic-hosted Rainbow hydrothermal vent field, located at 36°N on the mid-Atlantic ridge, introduce high-temperature reducing fluids, enriched in trace metals and hydrogen sulfide (H_2S), into the cold and well-oxygenated overlying seawater, leading to the rapid formation of highly reactive metal (oxyhydr)oxides.

Here, we analyze particulate and dissolved phases in the water column directly above and several kilometers away from the active vent field, aiming to better understand the formation of these iron (Fe) and manganese (Mn) (oxyhydr)oxides and investigate their role in phosphorus (P) scavenging.

The results show the impact of the oxidation of reduced, vent-derived metals and subsequent sorption processes on the availability of essential elements such as Fe, Mn and P. We find high concentrations of particulate Fe and Mn and a large variability in the redox state and mineralogy of these particles in waters overlying the vent field. Furthermore, increasing dissolved N:P ratios in the water column above and in the vicinity of the vent field suggest significant P removal through scavenging by Fe/Mn particles.

Hydrothermal vent systems may therefore represent an important, yet unconstrained net sink for P in the deep ocean, potentially influencing oceanic P-residence times and hence nutrient availability on geological time scales.