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Hydrothermal Iron Nanoparticles – A missing link in the deep sea biogeochemical cycle?

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Motivated by the goal to better understand the impact of hydrothermal iron (Fe) nanoparticles on ocean chemistry and to explore their unique catalytic capabilities, Expedition 64PE509 sampled solid and dissolved matter from the water column above the Rainbow (36°-33°N) and the Menez Gwen (37°N) hydrothermal vent fields at the Mid-Atlantic Ridge. Innovative sampling techniques that preserve pristine nanoparticles were used to gain novel insights into the (trans)formation of hydrothermal iron.

Using an array of (micro- and nano-scale) micro(spectro)scopic techniques allows us to characterize hydrothermal Fe nanoparticles in these environments and to unravel their fate in the ocean biogeochemical cycle and interaction with other trace metals and organic compounds. These associated organic compounds are poorly studied but are thought to play a key role in stabilizing and transporting hydrothermal Fe into the deep sea. Initial results show that we successfully collected pristine Fe nanoparticles from different distances to the venting site. The water column samples collected closest to the actual venting site show Fe nanoparticles enriched in Cr, Ni, S, and O and often associated with silica clusters at both venting fields. Organic compounds associated with plume particles at Rainbow include methanol, ethanol, and formate, and at Menez Gwen, glycerol, and unknown unsaturated fatty acids.

The omnipresent silica clusters, especially in the hydrothermal plume above the Rainbow hydrothermal vent field, suggest a role for silica in controlling Fe nanoparticle nucleation, growth, and properties, including catalytic capabilities of nanoparticles for both prebiotic and abiotic carbon fixation in oceanic hydrothermal alteration systems.