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Coupled cycling of Fe and organic carbon in submarine hydrothermal systems: Impacts on Ocean Biogeochemistry?

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Submarine hydrothermal venting was first discovered in the late 1970s. For decades the potential impact that vent-fluxes could have on global ocean budgets was restricted to consideration of processes in hydrothermal plumes in which the majority of chemical species are incorporated into polymetallic sulfide and/or oxyhydroxide particles close to the ridge-crest and sink to the underlying seafloor. This restricted view of the role that hydrothermal systems might play in global-ocean budgets has been challenged, more recently, by the recognition that there might also be a significant flux of dissolved Fe from hydrothermal systems to the oceans that is facilitated through thermodynamically stable nanoparticles and organic complexation. The latest results from the recently completed US GEOTRACES program, which has traced high concentrations of dissolved Fe over long distances off-axis from the Southern East Pacific Rise near 15°S, only help to confirm the potential that such fluxes might be important at the global scale.

In this paper we review field-based and modeling results, including investigations that we have carried out under the auspices of SCOR-InterRidge Working Group 135, that reveal potential relationships between organic carbon (Corg) and Fe in hydrothermal plumes and allow us to investigate the roles that hydrothermal systems may play in the global biogeochemical cycles of both Fe and Corg. Using the particularly well-studied EPR 9N hydrothermal system as our "type locality" – even though we recognize that no one site can adequately represent the diversity of all hydrothermal systems worldwide – our modeling efforts allow us to reach some significant conclusions concerning: the predicted partitioning of heat fluxes between focused and diffuse flow at ridge axes; and the recognition that while Corg fluxes associated with hydrothermal plume removal may be small on the global scale, they are likely to result in extremely pronounced fluxes, locally, to the seafloor in areas immediately surrounding deep sea hydrothermal systems.