Sinking feelings: Iron isotope and global circulation model evidence for the fate of Fe from the East Pacific Rise hydrothermal system

S. G. JOHN[1], J. N. FITZSIMMONS[2,3], C. M. MARSAY[4], C. R. GERMAN[5], AND R. M. SHERRELL[3]

[1]University of Southern California, Dept. Earth Sciences, Los Angeles, CA 900893, USA. sethjohn@usc.edu
[2]Texas A&M University, Dept. of Oceanography, College Station, TX 77843, USA. jessfitz@tamu.edu
[3]Rutgers University, Depts Marine & Coastal Sciences, New Brunswick, NJ 08901, USA.
[4]Skidaway Institute of Oceanography, University of Georgia, Savannah, GA 31411, USA.
[5]Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA. cgerman@whoi.edu

A plume of hydrothermal dissolved Fe from the East Pacific Rise was observed on the US GEOTRACES Eastern Pacific Zonal Transect (GP16), travelling thousands of km through the deep Pacific ocean (Resing et al., 2015). A parallel plume of particulate Fe follows a similar path. Both Fe plumes follow hydrothermal ^{3}He; however close examination reveals that both dissolved and particulate Fe plumes descend slowly in the water column as they advect westward. Using Fe stable isotope data (δ^{56}Fe) and modeling, we seek to understand the chemical and physical processes that govern Fe behavior within the plume.

Hydrothermal particulate δ^{56}Fe remains close to -0.3 ‰ throughout the plume, even as particulate [Fe] decreases by two orders of magnitude away from the EPR. Loss of Fe by a fractionating chemical process would cause very large δ^{56}Fe changes over this concentration range; we therefore conclude that the loss of particulate Fe is most likely by a physical process such as aggregation into sinking particles, not loss by chemical reaction. Within the dissolved phase, δ^{56}Fe is well fit by two-component mixing between background seawater δ^{56}Fe near +0.7 ‰, and hydrothermal dissolved δ^{56}Fe near -0.3 ‰. The similarity in dissolved and particulate δ^{56}Fe values suggests that the two phases represent the same chemical form of Fe. For example, dissolved hydrothermal Fe may be composed of smaller (colloidal) sizes of the same Fe oxyhydroxides that comprise the particulate phase.

Using a 3D ocean circulation model, we find that sinking of Fe plumes dramatic decreases the supply of Fe to the surface oceans where it could support biological productivity. Thus, sinking may have a substantial effect on the global distribution of hydrothermal Fe and it‘s role supporting phytoplankton growth in HNLC regions.