Iron colloid formation during hydrothermal plume dispersion

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Iron (Fe) limits or co-limits primary productivity and nitrogen fixation in large regions of the worlds oceans. Hydrothermal vent supply of Fe to the deep ocean is now known to be extensive, however the mechanism of Fe plume stabilisation in the deep ocean is poorly understood. To examine this process, hydrothermal plumes above the Beebe and Von Damm vent fields were sampled for Total Fe (TFe) dissolved Fe (dFe) and soluble (sFe). Plume particles sampled *in situ* were characterised using scanning x-ray microscopy.

We show that 48 to 87 % of dFe in the Beebe hydrothermal plume is present as colloidal Fe (dFe-sFe = cFe). In the first 100 m of plume rise 30 % of the sFe fraction is added to the cFe fraction. sFe behaves conservatively from 100 m above the sea floor. PFe (TFe-dFe) increases by 25 % in the neutrally buoyant plume along with a 22 % decrease in cFe which is a result of colloid aggregation in the non-bouyant plume. Dissolved Fe in the Von Damm plume contained 14 to 81 % cFe. The highest cFe concentrations of 6 nmol kg^{-1} were measured in the most dispersed plume samples which had the lowest PFe concentrations of 1 nmol kg^{-1}.

Beebe Fe plume profiles can be explained by plume dilution and exchange of Fe between different size fractions. In contrast Von Damm Fe plume profiles may reflect the variability in vent sources adding Fe to the plume as well as exchange of Fe between size fractions.

Our study highlights the very different processes occurring during plume dispersion above two hydrothermal sites that are 21km apart on the Mid-Cayman Rise. Plume processing of iron-rich colloids and particles will control the flux of dFe to the deep ocean from hydrothermal systems.