Dissolved, colloidal and particulate iron in hydrothermal vent fluids and rising plumes from Broken Spur and Rainbow, Mid-Atlantic Ridge

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Mid-Atlantic Ridge (MAR), with its slow spreading character, forms geological heterogeneity throughout the ridge system by deep crustal faults and their resultant tectonic valleys, which result in existence of different types of hydrothermal vent fields. Therefore, examining MAR opens a gate to understand the concentration ranges of ecosystem-limiting metals emanating from compositionally distinct hydrothermal settings for both near-field chemosynthetic ecosystems and far-field transport into the ocean interiors. Here we present on-board measured, size fractionated dissolved iron results from 2018 R/V Atalante – ROV Victor expedition, during which samples were taken from the mixing zone of black smokers with Titanium majors and PEP samplers attached to ROV Victor, using a ROV-assisted plume sampling. Iron size fractionation (<2, 2-200 and >200 nanometer) data were obtained on board sequential filtering, followed by measurement via ferrozine assay and spectrophotometric detection at 562 nm. Our results showed the persistent presence of a nanoparticulate/colloidal phase (retained within 20-200 nm filtrates) even in high-temperature samples and a significant fraction of this phase was retrievable only under a HNO_3 treatment – a stronger acid known to attack and dissolve pyrite nanocyrstals (HCl cannot dissolve this). Upon mixing and removal of iron in the higher parts of the buoyant plume, the larger size fractions become dominant as the total iron levels decreased but we still detected significant (micromolars) levels of nanoparticulate/colloidal Fe even in Niskin bottles sampled from 5 m in the plume. The lowest-temperature sample (<10 degrees C) still contained more than 1 μM of only nitric-acid leachable nanoparticle/colloidal, about 200 times higher than a typical Fe concentration in the non-buoyant plume. Our results are in support of previous reports of dissolved Fe in MAR vents and we propose that this recalcitrant Fe pool - surviving the immediate precipitation- is the fraction that maintains high hydrothermal iron fluxes to the deep ocean.