Tracing subsurface iron cycling in the sediment-influenced Loki's Castle hydrothermal vent field with stable Fe isotopes

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Sedimented seafloor hydrothermal systems are characterized by lower concentrations of metals in venting fluids than bare-rock systems [1]. However, high-temperature fluids emanating from the sediment-influenced, basalt-hosted Loki's Castle vent field (Norwegian-Greenland sea) show Fe concentrations that are low even compared to other sediment-hosted (Middle Valley) or sediment-influenced (Endeavour) systems [2]. In addition, Fe/Mn ratios at Loki's Castle are much lower (down to 0.1) than expected for fluid-rock interactions with basalt at ~300°C (0.6-0.7) [3]. The origin of this Fe depletion remains unclear, but could be related to the composition of sediments in the subsurface and/or limited solubility of iron in the relatively high pH and alkalinity fluids. Alternatively, iron could have been lost from the fluids due to subsurface cooling and precipitation of seafloor massive sulfides. Here we examine this issue using stable Fe isotopes (δ^{56}Fe) measured in active hydrothermal chimneys, vent fluids and hydrothermal sediments at Loki's Castle. Chimney fragments are analyzed as bulk samples and hand-picked mineral separates from structures João (306°C), Sleepy (299°C), Menorah (316°C) and Camel (316°C), and consist of chalcopyrite, pyrrhotite, anhydrite and barite in variable proportions. Solids are paired with high-temperature fluids collected simultaneously using isobaric gastight samplers and corrected for particulate 'dregs' formation, as well as sediments from outside the hydrothermal mound. We discuss Fe isotope data and assess whether signatures are consistent with a generally low-iron system or subsurface precipitation of iron-bearing minerals.

[1] Cruse and Seewald (2001) *Geochim. Cosmochim. Acta* **65**: 3233-3247; [2] Baumberger et al. (2016) *Geochim. Cosmochim. Acta* **187**: 156-178; [3] Pester et al. (2011) *Geochim. Cosmochim. Acta* **75**: 7881–7892.