Geochemical controls on the composition of hydrothermal vent fluids at mid-ocean ridges

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Recent investigations of hydrothermal systems at mid-ocean ridges have confirmed that magmatic and tectonic processes play a key role in vent fluid composition, as well as duration and style of venting. At fast-spreading ridges (e.g., EPR 9°N) the existence of shallow axial magma chambers limit depth of fluid circulation, while high thermal gradients enhance phase separation effects, with profound implications for the chemical composition of hydrothermal vent fluids. This is especially apparent in the immediate aftermath of eruptive events, where temperature and pressure extrema can cause large depletions in vent fluid chlorinity and increases in Fe/Cl, Fe/Mn ratios, and dissolved gas (H_2, H_2S, and CO_2) concentrations [1]. In contrast, hydrothermal vent fluids on the tectonically active Mid-Atlantic Ridge (slow-spreading) suggest very different compositional controls, in part due to reaction of seawater with gabbroic and ultramafic rocks facilitated by low-angle detachment faults. The Rainbow hydrothermal system (36°N, MAR) is an especially good example. Here, vent fluids reveal high dissolved concentrations of Fe, H_2, Cl, moderate dissolved Si, and complex hydrocarbons. Calculations indicate that chlorite-tremolite-talc-magnetite alteration likely contributes to the buffering of pH and redox chemistry, although geochemical controls on the mechanism of carbon reduction reactions, and brine formation, are less clear. Heat and chemical fluxes measured for Rainbow vents, confirm an unusually long-lived and stable system [3,4]. Hydrothermal processes associated with both basalt and ultramafic-hosted systems would benefit from long-term monitoring with newly developed chemical and physical sensors. There is also need for thermodynamic data at near-critical conditions (NaCl-H_2O), since these conditions play such an important role in governing mass transport processes.

[1] Pester *et al* (2014) *Geology* (in-press). [2] Seyfried *et al* (2011) *GCA*, **75**, 1574-1593. [3] Cave, *et al* (2002) *GCA* **66**, *1905-1923*. [4] German *et al* (2010) *Deep Sea Res (I)*, **57**, 518-527.