Experimental perspectives on hydrothermal vent fluid chemistry at mid-ocean ridges

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Recent advances in the design of reactors for hydrothermal experiments have facilitated investigation of processes relevant to geochemical controls on mass transfer processes in deep sea hydrothermal vent fluids. Thus, experimental data have now been obtained for partitioning of transition metals[1] between coexisting vapor and liquid (isothermal decompression) at unusually challenging chemical and physical conditions. These data reveal surprising increases in Fe/Cl and Mn/Cl in vapor, consistent with similar observations of vent fluid chemistry at EPR 9ºN in the aftermath of eruptive events. Further, new experimental data for quartz solubility[2] at elevated temperature (420-500ºC) and low to moderate pressure (31- 51 MPa) in single and two-phase fluids (vapor-liquid) extend the pressure range of density-based algorithms, permitting more accurate estimates of temperature of vent fluids using quartz geothermometry. Applying the quartz solubility data with constraints imposed by phase equilibria in the two-phase NaCl-H_2O system to vapor-rich vent fluid issuing from the Piccard site at Mid-Cayman Rise, suggest temperature and pressures of 540 ± 15ºC and 62.5 ± 3.0 MPa. More recently, pH and redox buffered experiments elucidate the partitioning of dissolved H_2 between coexisting NaCl-bearing vapor and liquid, with quantitative implications for establishing subsurface redox controls from dissolved H_2 in hydrothermal vent fluids. Combination of experimental data with time series observations of vent fluid chemistry and data from reaction path and reactive transport models provide a particularly effective framework to assess geochemical controls on the temporal evolution of both basalt and ultramafic hosted hydrothermal systems at mid-ocean ridges in time and space.

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[1] Pester and Seyfried (2014) *Geology.* **42**, 255-258.
[2] Scheuermann, Tan & Seyfried (2018) *Geochemistry, Geophysics, Geosystems* **19**, 3570-3582.