Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.6494

Experimental study on Fe solubility in vapor-rich hydrothermal fluids at 400-450ºC, 215-470 bar: Implication for Fe mobility in seafloor vent systems

DR. YANLU XING, PHD[1], PETER SCHEUERMANN[1,2] AND WILLIAM SEYFRIED[1]

[1]University of Minnesota Twin Cities
[2]University of British Columbia
Presenting Author: xing0048@umn.edu

In seafloor hydrothermal systems, vent fluids usually contain elevated dissolved iron (Fe) that is significantly enriched relative to deep ocean seawater. It is commonly thought that Fe is preferentially transported in dense Cl-rich fluids due to the formation of aqueous Fe-Cl complexes. However, Fe enrichment in low density vapor-rich fluids with low Cl concentrations (<550 mmol/kg) underscores the efficacy of the low-Cl vapor-rich phase to transport Fe in both subaerial and submarine hydrothermal systems. Currently, transport of Fe in low density vapor-rich fluids is poorly understood due to the lack of high T-P solubility experiments and requisite thermodynamic data. Here, we report new data of Fe solubility (m($FeCl_2$)) from experiments conducted at 400-450 ºC, 215-470 bar, targeting fluids with low density (~0.1-0.4g/cm^3). The experiments were performed in the KCl-H_2O system with hematite-magnetite and K-feldspar-muscovite-quartz as mineral buffering assemblages. Our results show that Fe solubility positively correlates to density and fluid chlorinity which are affected by temperature and pressure. The equilibrium constants (log K_{hm}) for Fe-buffering reaction Fe_3O_4(s) + 2HCl(aq) = Fe_2O_3(s) + $FeCl_2$(aq) + H_2O were determined. The new data and the data calculated using HKF equation of state were fitted into a density model that incorporates temperature and water density to describe log K_{hm} over a wide T-P range. The density models for magnetite dissolution reaction and pyrite-pyrrhotite equilibrium are also fitted based on HKF to allow redox constraints. We show that calculated values of m($FeCl_2$) using the density model are in good agreement with measured m($FeCl_2$) in vapor-rich fluids formed via phase separation in mineral buffered and basalt alteration experiments at elevated T-P from other studies. The density model was further applied to model Fe transport in fluids at the Brandon hydrothermal field at East Pacific Rise (EPR) 21ºS, with T-P constrained by Si-Cl geothermobarometer. The calculations suggests that the reported Fe concentrations of vent fluids at Brandon reflect phase separation occurring at depth in the seafloor, with T-P up to 450 ºC, 500 bar, and redox conditions buffered by pyrite-pyrrhotite-magnetite equilibrium.