

**Title:**

Effect of Redox and pH on the Reaction Kinetics of Anhydrite in a Coupled Chemical System:  
An Experimental Study with Implications for Modeling Vent Fluid Evolution at EPR 9-10 N

**Investigators:**

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**Summary****Intellectual Merit:**

The objective of the proposed experimental study entails acquisition of kinetic and thermodynamic data to enhance the development and application of geochemical models needed to constrain the temporal and spatial evolution of the expanding database for hydrothermal vent fluids at EPR 9-10°N and at other R2K IS Sites. Existing vent fluid data suggest that anhydrite coexisting with plagioclase, magnetite and calcic-bearing aluminosilicates may provide redox buffering in response to the addition of seawater derived sulfate into portions of subseafloor reaction zones at mid-ocean ridges. The redox buffer capacity unique to this chemical system, however, is a function of reaction rates between anhydrite and dissolved H<sub>2</sub> and ferrous iron, the principle reducing agents derived from hydrolysis of primary and secondary minerals in basalt. Thus, the experimental data we wish to obtain include the following:

1. Determination of the effects of temperature, pressure, pH on rates of anhydrite reduction and dissolution as a function of redox intensity (H<sub>2(aq)</sub>, Fe<sup>+2</sup>). In addition to anhydrite, the heterogeneous chemical system will include a logical assemblage of coexisting minerals and fluids, providing components that may enhance or inhibit reaction progress, broadening the implications of the research.
2. Mass-transfer reactions accompanying redox-induced anhydrite dissolution are likely to provide additional data on solid-solution formation involving coexisting aluminosilicate minerals, while also placing constraints on the solubility of Fe and Al. These effects have relevance to geochemical controls on vent fluid data in time and space.
3. The design implicit to the proposed experiments permits determination of partitioning of Sr between Ca-bearing minerals and coexisting fluids, adding another dimension to the study, since these data will help to link compositional changes in fluids with minerals involving a component of well-recognized importance as a tracer of seawater-rock reactions in modern and fossil subseafloor hydrothermal systems at mid-ocean ridges.

The experimental approach emphasizes use of a recently developed hydrothermal flow reactor with *in-situ* sensors for monitoring redox and pH. That the hydrothermal flow system permits independent control of source fluid chemistry and fluid residence time in the reactor enhances attainment of steady state conditions needed to constrain reaction rate data.

**Broader Impacts:**

The acquisition of kinetic and thermodynamic data under hydrothermal conditions will help to develop reaction-transport models designed to couple physical and chemical processes in subsurface reaction zones at mid-ocean ridges. This takes on added significance considering the potential role of anhydrite on crustal permeability at mid-ocean ridges. The proposed research will benefit from the participation of undergraduate summer interns in connection with the NSF/REU program in the Department of Geology and Geophysics at the UM entitled "Fluids in the Earth", while also enhancing graduate student training and mentoring. Moreover, the further development of the Ti-flow reactor in the course of the proposed study enhances the research infrastructure available to scientists involved in research and training in geology, biology and chemistry, as well as in a broad range of engineering disciplines.