Mineral solubility in low-density mid-ocean ridge hydrothermal fluids: experimental measurement and thermodynamic calculation

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Thermodynamic predictions of fluid-mineral equilibria significantly expand our ability to test hypotheses regarding mass and heat transfer in geological systems. In many cases, successful development of thermodynamic models relies heavily on experimental measurements. A dearth of experimental data in low-density hydrothermal fluids has prevented calculation of fluid-mineral equilibria at the most extreme temperature-pressure conditions associated with mid-ocean ridge hydrothermal systems. This study compares newly attained mineral solubility measurements in low-density hydrothermal fluids (400 - 500 ºC, 25 – 50 MPa) with constraints imposed by available thermodynamic models. To address the lack of aqueous species equilibrium constants at the precise temperature-pressure conditions of the experiments, data are extrapolated from reference conditions as a linear function of the logarithm of water density. Several solubility calculations are performed that vary in the choice of aqueous speciation and activity coefficient model. There is overall good agreement between experimental observations and thermodynamic predictions, indicating the potential for accurate assessment of fluid-mineral equilibria in low-density fluids. Results also highlight uncertainties in aqueous speciation and calculation of activity coefficients that will require further examination. This study represents an important first step in increasing the temperature-pressure conditions over which thermodynamic calculations of fluid-mineral equilibria are possible, with important implications for understanding mass and heat transfer in submarine hydrothermal systems.