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Effect of fluid chemistry on the solubility of monazite-(Nd) and Nd speciation in high temperature and pressure supercritical aqueous fluids.

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Critical mineral deposits commonly display a significant overprint and mobilization of rare earth elements (REE) by hydrothermal aqueous fluids [1-2]. Previous thermodynamic modeling work has focused on the properties of REE aqueous complexes determined experimentally between 100–350 °C [3]. However, predicting the effect of hydrothermal fluids on mobilizing REE in critical mineral deposits requires an understanding of REE solubility and speciation in high-temperature and -pressure supercritical aqueous fluids. To understand the effect of fluid chemistry on the solubility and speciation of Nd in supercritical aqueous fluids, we equilibrated pure, synthetic $NdPO_4$ monazite crystals with acidic solutions (pH of 2) and varying initial salinities and ionic strengths (0.008–0.77 mNaCl). Experiments were conducted in Waspaloy pressure vessels at 500–600°C and 1.5 kb. The $NdPO_4$ crystals and starting solutions were weighed using a microbalance and enclosed in a gold capsule followed by equilibration at temperature and pressure for 168h. Capsules were partially opened and soaked in 2% HNO_3 solution to extract the fluid. Diluted solutions were analyzed for Nd concentrations using ICP-OES, and monazite-(Nd) crystals were inspected using SEM. Total solubilities based on crystal mass loss range from -1.75 and -1.63 log mNd. In contrast, preliminary data from fluid analyses indicate solubilities between -4.0 and -5.0 log mNd, indicating possible precipitation upon quenching. Previous $NdPO_4$ solubility experiments conducted at pH of 2 and 100-250°C [4] report a solubility range between -8.2 and -6.6 log mNd. Experiments by Pourtier et al. [5] at 300-800°C and 2 kbar indicate a prograde $NdPO_4$ solubility range between -5.4 and -2.6 log mNd. Our measured $NdPO_4$ solubilities are within the range reported in the experiments by Pourtier et al. [5] but more experimental data are needed for determining the controlling effects of pressure, temperature, and fluid chemistry on Nd solubility in these supercritical fluids.

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