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# The solubility of $CePO_4$ monazite and $YPO_4$ xenotime in KCl-$H_2O$ fluids at 800 °C and 1.0 GPa: Implications for REE transport in high-grade crustal fluids

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## Abstract

Monazite ($CePO_4$) and xenotime ($YPO_4$) are important hosts for REE and thus can be used to monitor REE mass transfer in various settings. In this investigation, the solubilities of synthetic monazite and xenotime were measured in KCl-$H_2O$ fluids at 800 °C and 1.0 GPa, using the piston-cylinder apparatus. The experimental results indicate an increase in monazite and xenotime solubility in aqueous fluids with moderate KCl mole fractions ($X_{KCl}$) in agreement with previous investigations of the solubility of these phases in NaCl-$H_2O$. Under all conditions, monazite and xenotime dissolve congruently. The solubility of synthetic monazite increases from 8 ppm in pure $H_2O$ to 335 ppm at $X_{KCl} = 0.506$. The solubility of synthetic xenotime rises from 46 ppm in pure $H_2O$ to 126 ppm at $X_{KCl} = 0.348$, above which it is constant or declines slightly. Monazite and xenotime solubilities are considerably lower in KCl-$H_2O$ than in NaCl-$H_2O$ at the same salt concentration. Best-fit equations for the solubilities of the two phases are:

$$c_{mz} = -464\, X^2_{KCl} + 891\, X_{KCl} + 8$$

and

$$c_{xt} = -563\, X^2_{KCl} + 432\, X_{KCl} + 46$$

where mz and xt stand for monazite and xenotime, and $X_{KCl} = n_{KCl}/(n_{KCl} + n_{H_2O})$ where $n$ is moles. The change in solubilities with KCl implies that Ce dissolves as an anhydrous chloride complex ($CeCl_3$), whereas Y forms a mixed Cl-OH solute [$YCl(OH)_2$]. The data also imply that $H_2O$-NaCl fluids and $H_2O$-KCl fluids close to neutral pH can transport substantial amounts of REE and Y, thus obviating the need to invoke low-pH solutions in high-grade environments where they are highly unlikely to occur.

**Keywords:** Monazite, xenotime, solubility, experimental petrology, REE mobility, metamorphic fluids, brines