

The behaviour of rare earth elements (REEs) in carbonate melts and phosphate ore minerals

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Rare earth elements (REEs) are critical components for modern electronic devices. It is known that REE mineralisation is most commonly associated with carbonatites [1]. However, it is not known how the carbonate melts became enriched with REE. Economic REE mineralisation is most commonly hosted in phosphate minerals like monazite or xenotime. This study aims to determine experimentally the favourable conditions for crystallization of monazite from carbonate magmas by determining the solubility of monazite in carbonate melts as a function of pressure, temperature and melt composition.

We conducted piston-cylinder experiments at upper mantle pressures of 1 and 2 GPa, and temperatures from 1000 to 1450°C. We used a synthetic sintered oxide mix with the composition of a natural monazite and a sodic dolomitic composition that approximates a mantle-derived carbonatite melt. The monazite and melt mixes were combined in a 1:1 ratio by weight in most experiments. We systematically varied the composition of the carbonate melt component by the addition of SiO₂, CaF₂ and H₂O to determine their effects on monazite solubility.

Preliminary results indicate that (1) with increasing temperature the solubility of monazite increases in carbonate melt, (2) in fluoride-bearing samples monazite solubility increases relative to the F-free system, and (3) the solubility of monazite decreases with adding SiO₂ in carbonate melt.

In future, we will investigate the effect of H₂O on the solubility of monazite and generate a multiple nonlinear regression model in order to understand monazite solubility as a function of temperature, pressure and melt compositions, which will allow the conditions where monazite forms in natural carbonatites to be predicted.

[1] Chen, Wei, et al. "Geochemistry of monazite within carbonatite related REE deposits." *Resources* 6.4 (2017): 51.