

## **LREE-redistribution among fluorapatite, monazite, and allanite at high pressures and temperatures**

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### **ABSTRACT**

The REE enrichment process in fluorapatite and the REE redistribution among fluorapatite, monazite, and allanite were studied in a series of three sets of experimental runs at *P-T* conditions of 0.5 to 4 GPa and 650 to 900 °C. The first two sets of experimental runs utilized fluorapatite as a P-source, synthetic monazite or allanite as the REE sources, albite, quartz, and NaF-H<sub>2</sub>O or NaCl-H<sub>2</sub>O. The third set of runs was carried out with powdered Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>, allanite, quartz, (±Al<sub>2</sub>O<sub>3</sub>), and a NaF-H<sub>2</sub>O solution.

In all runs REE-bearing fluorapatite with up to 28 wt%  $\Sigma$ REE<sub>2</sub>O<sub>3</sub> formed at the expense of monazite or allanite; either as narrow zones at the margin of synthetic fluorapatite in runs 1 and 2 or as discrete grains in run 3. The REE-enrichment of fluorapatite in melt-bearing runs is explained in terms of the high solubility of monazite in the presence of alkali-rich melts together with the high partitioning values for REEs among fluorapatite and alkali-rich melts. The formation of REE-enriched fluorapatite in melt-absent runs implies that the solubility of monazite and the REE-uptake of fluorapatite are similarly high in both alkali-rich melts and fluids and depends foremost on the activity of alkalis in fluids or melts.

The results from this study show the importance of fluorapatite as a REE-carrier in rocks whose petrogenesis involved alkali-bearing fluids/melts. In metamorphic rocks, alkali-enriched fluids or melts will likely form under higher-grade conditions, explaining the preferential occurrence of REE-enriched fluorapatite in granulite and eclogite-facies rocks.

**Keywords:** Fluorapatite, monazite, allanite, experimental petrology, alkali-rich fluids