

Trace element partitioning between apatite and carbonatite melt

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REE are frequently associated with carbonatites. The reason for this enrichment is unclear given that the REE preferentially partition into silicate rather than carbonatite melts during melt immiscibility. Fractional crystallisation may therefore be important in controlling the REE budget of carbonate melts.

Apatite [$\text{Ca}_5(\text{PO}_4)_3(\text{OH}, \text{F}, \text{Cl})$] is a common accessory phase within carbonatites. The capacity of apatite to sequester geochemically important major and minor trace elements, through the substitution of Ca sized ions into the crystal lattice, makes it a potentially significant reservoir of REE. Despite its petrogenetic importance, limited experimental data exists on trace element partitioning between apatite and carbonatite melts [1, 2].

Trace-element doped synthetic (F- and Cl-) apatites were crystallised in equilibrium with carbonatite melt as function of temperature (1150-1350 °C), pressure (10-30 kbar) and melt composition. Partition coefficients ($D^{\text{apatite/melt}}$) for Li, Be, Al, Sc, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As, Rb, Sr, Y, Zr, Nb, Sb, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, Pb, Th and U were determined by LA-ICP-MS. All trace elements investigated are incompatible in apatite. The partitioning of trivalent cations (REE and Y^{3+}) were fit by a lattice strain model enabling the prediction of partitioning and derivation of a general equation relating partitioning to P and T.

The partitioning behaviour of REEs into apatite must vary with the activity of the charge compensating species within the melt. For example, the silica concentration of apatite has been proven to correlate with REE incorporation [2]. The substitution mechanism has been explored by varying the activities of Si, monovalent cations, and oxy-anions.

[1] Klemme & Dalphé (2003) *Am. Mineral.* **88**, 639-646. [2] Hammouda *et al.* (2010) *Geochim. Cosmochim. Acta* **74**, 7220-7235.