

The effects of F, Cl, P and H₂O on the immiscibility and rare metals partitioning between carbonate and phonolite melts

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Carbonatite and alkaline magma constitute one of the principal resources of rare metals (REE, Nb, Ti, Zr). Carbonatite rare metals enrichment is mainly considered as the result of hydrothermal or supergen processes. However, the magmatic processes linked to carbonatites genesis and differentiation are still debated and whether these processes can significantly impact on the rare metal concentrations remains unclear.

Experimental studies have shown that immiscibility processes between carbonate and silicate melts can lead to both REE enrichments and depletions in carbonatites. Anionic species (F, Cl, P or S) and water may impact both melt compositions and expand the immiscibility gap. Moreover, anionic species are assumed to play an important role in REE behaviour in carbonate melts [1]. Indeed, halogens may occur in carbonatites as immiscible salt melts in melt inclusions [2] and primary REE- fluoride minerals have been identified as magmatic phases in carbonatites. Such occurrences thus question on the role of salt (carbonate, phosphate, fluoride and chloride) melts in REE and other rare metals partitioning. F, Cl, P and also H₂O may all significantly increase the window of primary REE enrichment in carbonatites.

Here we present high pressure and high temperature experiments made in piston-cylinder (850 to 1050°C, 8kb) simulating the immiscibility between carbonate and differentiated alkaline melts. We added F, Cl, P and H₂O in order to assess the effect of salts and water on the immiscibility gap and on the rare metals partitioning between carbonatite and evolved silicate melts. The partitioning data are analysed using LA-ICP-MS, nano-SIMS, FTIR and RAMAN. The characterization of rare metal partition coefficients allow to determine the relative importance of F, Cl, P and H₂O on carbonatites rare metal enrichments at evolved magmatic stage.

[1] Veskler *et al.* (2012) *Geoch. et Cosmoch. Acta* **79**, 20-40.

[2] Panina and Motorina (2008) *Geochem.Int.* **46**, 448-464.