



**HAL**  
open science

## Experimental simulation and predictive modelling of rare earth element enrichment in carbonatites and alkaline magmas.

Johann Tuduri, Zineb Naby, Fabrice Gaillard, Malcolm Massuyeau, Giada Iacono-Marziano, Jérémie Melleton, Laurent Bailly

### ► To cite this version:

Johann Tuduri, Zineb Naby, Fabrice Gaillard, Malcolm Massuyeau, Giada Iacono-Marziano, et al.. Experimental simulation and predictive modelling of rare earth element enrichment in carbonatites and alkaline magmas.. 33RD NORDIC GEOLOGICAL WINTER MEETING, Jan 2018, Copenhagen, Denmark. hal-01635332

**HAL Id: hal-01635332**

**<https://brgm.hal.science/hal-01635332>**

Submitted on 15 Nov 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Experimental simulation and predictive modelling of rare earth element enrichment in carbonatites and alkaline magmas

JOHANN TUDURI, ZINEB NABYL, FABRICE GAILLARD, MALCOM MASSUYEAU, GIADA IACONO-MARZIANO, JÉRÉMIE MELLETON & LAURENT BAILLY

*Johann Tuduri (j.tuduri@brgm.fr), Zineb Naby (zineb.naby@univ-orleans.fr), Fabrice Gaillard (fabrice.gaillard@cnrs-orleans.fr), Giada Iacono-Marziano (giada.iacono@cnrs-orleans.fr), Jérémie Melleton (j.melleton@brgm.fr), Laurent Bailly (L.bailly@brgm.fr), BRGM, UMR7327, 3 avenue Claude Guillemin, 45100 Orléans, France and also University of Orléans, ISTO/CNRS, UMR7327, 1A rue de la Férollerie, 45100 Orléans, France, Malcom Massuyeau (mmassuyeau@uj.ac.za), University of Johannesburg, PO Box 524, Auckland Park 2006, South Africa.*

Carbonatites and alkaline magmas are key pieces of the deep carbon cycle and constitute one of the principal resources of rare metals including REE. Several experimental studies have tackled the rare metal partitioning between immiscible carbonate and silicate liquids (Martin *et al.* 2013; Veskler *et al.* 1998, 2012). They show negative to massive enrichments in the carbonate liquid. However, no prevailing cause has been clearly isolated as such enrichments can be ruled by experimental conditions (P, T,  $fO_2$ ), melt compositions (water and alkali contents), or technical issues such as unequilibrated experiments.

The aim of this study is to simulate, by HP-HT experiments in the nephelinite-carbonatite system, crystal fractionation and immiscibility between carbonate and silicate liquids, in order to assess the factors ruling REE enrichment during the differentiation of alkaline magmas.

Thirty experimental charges were synthesized using piston-cylinder and internally heated pressure vessel. The partitioning of REE between carbonate liquids, silicate liquids and crystals (pyroxene, calcite, nephelinite, perovskite, titanite) has been characterized. REE partition coefficients between carbonate and silicate liquid increase while Ca partition coefficient increases, suggesting that both have the same behavior. Also, the more the silicate liquid is polymerized, the more REE are concentrated into carbonate liquids. The Ca partition coefficient has been thus calibrated by an empirical model based on the silicate melt composition.

This study reveals the optimum conditions for which carbonatite melts get enriched by >10 times with respect to the residual silicate melts. This predictive approach may serve as guide for prospection of REE-enriched carbonatites.

- Martin, L.H.J., Schmidt, M.W., Mattsson, H.B., & Guenther, D. 2013: Element partitioning between immiscible carbonatite and silicate melts for dry and H<sub>2</sub>O-bearing systems at 1-3 GPa. *Journal of Petrology* 54, 2301-2338.
- Veskler, I.V., Petibon, C., Jenner, G.A., Dorfman, A.M., & Dingwell, D.B. 1998: Trace element partitioning in immiscible silicate-carbonate liquid systems: an initial experimental study using centrifuge autoclave. *Journal of Petrology* 39, 11-12.
- Veskler, I.V., Dorfman, A.M., Dulski, P., Kamenetsky, V.S., Danyushevsky, L.V., Jeffries, T. & Dingwell, D.B. 2012: Partitioning of elements between silicate melt and immiscible fluoride, chloride, carbonate, phosphate, and sulfate melts, with implications to the origin of natrocarbonatite. *Geochimica et Cosmochimica Acta* 79, 20-40.