

## Behaviour of Rare Earth Elements during the Earth's core formation

Pierre Faure, Mohamed Ali Bouhifd, Maud Boyet, Tahar Hammouda, and Geeth Manthilake

Université Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France

Rare Earth Elements (REE) are classified in the refractory group, which means that they have a high temperature condensation and their volatility-controlled fractionation is limited to high-temperature processes. Anomalies have been measured for Eu, Yb and Sm, which are the REE with the lowest condensation temperatures in CAIs and chondrules (e.g. [1]). REE are particularly abundant in the sulfides of enstatite chondrites, 100 to 1000 times the CI value [e.g. 2,3], proving that these elements are not strictly lithophile under extremely reducing conditions. However by investigating experimentally the impact of Earth's core formation on the behavior of Sm and Nd, we have shown the absence of fractionation between Sm and Nd during the segregation of the metallic phase [4]. Recently, Wohlers and Wood [5] proposed that Nd and Sm could be fractionated in presence of a S-rich alloy phase. However, their results were obtained at pressure and temperature conditions below the plausible conditions of the Earth's core formation. Clearly, large pressure range needs to be covered before well-constrained model can be expected. Furthermore, our preliminary metal-silicate partitioning results show that Ce and Eu have higher metal/silicate partition coefficients than their neighboring elements, and that the presence of sulphur enhances the relative difference between partition coefficients.

In this presentation, we will present and discuss new metal-silicate partition coefficients of all REE at a deep magma ocean at pressures ranging from those of the uppermost upper mantle (~5 GPa) to a maximum pressure expected in the range of 20 GPa, temperatures ranging from 2500 to about 3000 K, and oxygen fugacities within IW-1 to IW-5 (1 to 5 orders of magnitude lower than the iron-wüstite buffer). We will discuss the effect of S, as well as the effect of H<sub>2</sub>O on the behaviour of REE during the Earth's core formation: recent models suggest that contrary to currently accepted beliefs, the presence of water during the formation of metallic core of terrestrial planets is very plausible [e.g. 6-8].

### References

[1] Pack et al. (2004) *Science* 303, 997-1000. [2] Crozaz and Lundberg (1995) *Geochim. Cosmochim. Acta* 59, 3817-3831. [3] Gannoun et al. (2011) *Geochim. Cosmochim. Acta* 75, 3269-3289. [4] Bouhifd et al. (2015) *Earth Planet. Sci. Lett.* 413, 158-166. [5] Wohlers and Wood (2015) *Nature* 520, 337-340. [6] Marty (2012) *Earth Planet. Sci. Lett.* 313-314, 56-66. [7] Morbidelli et al. (2000) *Meteor. Planet. Sci.* 1320, 1309-1320. [8] Sarafian et al. (2014) *Science* 346, 623-626.