

## **Aegirine-melt element partitioning and implications for the formation of nepheline syenite REE deposits**

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Sodic clinopyroxene is a key fractionating phase in alkaline magmatic systems but its impact on metal enrichment processes, and the formation of REE + HFSE mineralizations in particular, is not fully understood. Sodic pyroxenes appear to more readily incorporate REE than their calcic equivalents<sup>1</sup>. Despite this, melts in evolved alkaline systems can attain high REE contents, even up to economic levels (e.g. the Nechalacho layered suite in Canada<sup>2</sup>).

To constrain the control of pyroxene on REE + HFSE behaviour in alkaline magmas, a series of internally heated pressure vessel experiments was performed to determine pyroxene-melt element partitioning systematics. Synthetic trachy-andesite to phonolite compositions were run water saturated at 650–825°C with  $fO_2$  buffered by *ca.* 1 bar of H<sub>2</sub> (QFM + 1) or by Hm-Mt (QFM +5). Fluorine was added to selected experiments (0.3 to 2.5 wt %) to ascertain its effect on element partitioning. Run products were analysed by EMP for major elements and LA-ICP-MS for trace elements. Mineral and glass compositions bracket the compositions of natural alkaline systems, allowing for direct application of our experimental results to nature.

Our results indicate that REE partitioning systematics vary strongly with pyroxene composition: Diopside-rich pyroxenes (Aeg<sub>5–25</sub>) prefer the MREE, medium aegirine pyroxenes (Aeg<sub>25–50</sub>) preferentially incorporate the LREE, whereas high aegirine pyroxenes (Aeg<sub>55–95</sub>) strongly prefer HREE. REE partitioning coefficients are 0.3–40, typically 2–6, with minima for high aegirine pyroxenes. Melt composition (e.g. (Na+K)/Al) also impacts partitioning although to a lesser extent, except for the F-content, which shows no impact at all. The composition of fractionating pyroxene has a major impact on the REE pattern of the residual melt, and thus on the ability of a system to develop economic concentrations of the REE. Element partitioning systematics suggest that late-crystallising aegirine-rich cumulates would be HREE-rich, in accord with the composition of mineralised intrusions, such as Nechalacho<sup>2</sup>.

1 – Marks, M., Halama, R., Wenzel, T. & Markl, G., 2004. *Chem. Geol.* **211**, 185–215.

2 – Möller, V. & Williams-Jones, A. E., 2016. *J. Petrology* **57**, 229-276.