

Tracing magmatic fractionation with apatite trace element chemistry in the Sokli carbonatite complex, northern Finland

SEPPO KARVINEN¹ AND AKU HEINONEN²

¹University of Helsinki

²Geological Survey of Finland

The Devonian Sokli carbonatite complex has been studied since its discovery in the 1960s and there is an on-going mine development project to survey the mineral resources and to study the economic feasibility of the project. Previous studies indicate that the complex has potential for P, Nb [1], and rare earth elements (REE) [2].

The complex, located in northern Finland (67.8°N, 29.31°E) is a concentric carbonatite intrusion comprising a multi-generational magmatic core surrounded by metasomatic replacements of older magmatic rocks, and an alteration halo (fente) that is crosscut by late-stage Sr-Ba-REE rich dikes [1,3]. Here we have studied apatite from a variety of Sokli rock types (calcite and dolomite carbonatites, phoscorites, and late-stage carbonatites) with optical, cathodoluminescence, and electron microscopy and analyzed *in situ* major and trace element compositions with electron micro probe and laser ablation ICP-MS, respectively.

Apatite is present in varying amounts and textures from individual rounded, subhedral crystals and crystal aggregates to massive interstitial apatite. Apatite end-member compositions range from fluorapatite to hydroxyl-fluorapatite as Cl is near or below detection limit in all samples. All samples display strong fractionation and varying enrichment of REE with chondrite-normalized La/Yb ratios of 70–240 and Σ REE content ranging from 2 000 to 12 000 ppm (median 4 600 ppm). Light REE (La–Gd) amount for 98 % of Σ REE. Abundances of Sr, Na, and Σ REE+Y correlate positively and typically increase from core to rim within grain and from calcite to dolomite carbonatites and to late-stage dikes. One sample, representing late-stage dikes, has coarse, round apatite (up to 20 mm) that are enriched in F, Na, Sr, Ba, Σ REE+Y and depleted in Mg and Si. These results indicate that apatite does trace the fractionation of carbonatitic magmas, and functions as a reservoir for REE throughout the evolution of the Sokli complex.

[1] Vartiainen, H. & Paarma, H., 1979. Economic Geology 74, 1296–1306.

[2] Sarapää, O. et al., 2013. Journal of Geochemical Exploration 133, 25–41.

[3] Vartiainen, H., 1980. Geological Survey of Finland, Bulletin 313, p. 126.