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How do Kakortokites form? Additional evidence from the Ilimaussaq Complex, S. Greenland

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The Ilímaussaq Complex, South Greenland, contains some of the most evolved igneous rocks in the world and is widely considered to represent one of the largest deposits of rare-earth elements, Ta, Nb and Zr. Our work is focused on the kakortokite layered series at the base of the complex. The layered series is composed of 29 repetitive 3-layer units (named -11 to +17, Bohse *et al.* 1971), successively enriched in arfvedsonite, eudialyte and nepheline. Despite a large body of work on the development of the kakortokite series, no consensus on the process/processes that produced the layering has been forthcoming.

We present the preliminary findings of a combined petrographical, quantitative textural and geochemical analysis on the kakortokite series, initially focused on layer 0. Although many of the hypotheses for the formation of these rocks invoke a pressure change, the enrichment of the series in volatile constituents (CH_4 and H; Konnerup-Madsen, 2001) has led many authors to suggest crystallisation occurred in a closed system, with processes of gravitational settling formed the layering. Crystal size distribution (CSD) analysis, performed on hand-digitised photomicrographs, provides insight into processes of crystal nucleation and growth. The results indicate that simple cumulate settling is untenable for layer 0. Instead the plot gradients indicate that the arfvedsonite in the black kakortokite crystallised *in situ* above a sharp boundary to the white kakortokite. The CSD plots for the alkali feldspars indicate secondary nucleation occurred, with the small crystal size fraction forming *in situ*. The feldspar phenocrysts also exhibit embayment textures indicating partial resorption. These graphs are consistent with a model whereby an influx of hotter magma results in the partial thermal erosion of the underlying white kakortokite, followed by *in situ* crystallisation of arfvedsonite above the melt infiltration boundary, followed by *in situ* crystallisation of eudialyte. Then nepheline and alkali feldspar crystallised through multiple modes of nucleation, developing the characteristic layering. Geochemical trends described by Pfaff *et al.* (2008) support an open system replenishment model during the formation of layer 0, and potentially also layers +4 and +8. To further this work we intend to apply this combined approach to investigate the formation of individual layers, scaling these processes into a model for the development of the Ilímaussaq complex.

Bohse *et al.* (1971). *Rapport Grønlands Geologiske Undergesølgelse*, 36, 43 pp. Konnerup-Madsen (2001). *Geology Greenland Surv. Bull.*, 190, 159-166. Pfaff *et al.* (2008). *Lithos*, 106, 280-296.