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Development of Peralkaline Rhythmic Layering, Ilimaussaq Complex, S. Greenland

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The Ilímaussaq alkaline complex, S. Greenland is a peralkaline layered intrusion within the Gardar (1280-1180 Ma) igneous province. It is considered as a potential deposit of rare-earth elements, Ta, Nb and Zr. One of the places where these elements are concentrated is in the kakortokite layered series (KLS), which forms the floor sequence of the complex and is a spectacular example of macrorhythmic (i.e. typically $>$5 m in thickness) igneous layering. The KLS is composed of 29 exposed units numbered -11 to +17 [1], each composed of three layers distinguished by modal mineralogy: a basal arfvedsonite-rich black kakortokite, overlain by eudialyte-rich red kakortokite, in turn overlain by alkali feldspar- and nepheline-rich white kakortokite. Despite much work on the layered series, there is no consensus on the physico-chemical processes that led to the formation of the macrorhythmic layering, although most hypotheses suggest that the separation of minerals to form the tripartite units included the processes of gravitational settling and density sorting.

Here we use detailed petrographic studies, quantitative textural analysis (crystal size distributions [CSDs]) and mineral chemistry to interpret processes of nucleation and crystal growth within the marker horizon unit 0 and the lowest exposed units (-8 to -11) of the KLS. Sharp boundaries occur between each of the studied units (-11/10, -10/-9, -9/-8 and -1/0) while the intra-unit boundaries between the black to red and red to white kakortokites grade over 2-5 cm. The CSD data suggest that multiple modes of crystallisation (*in situ*, in suspension and through accumulation) contributed to the crystallisation of the main modal minerals in each layer, with *in situ* crystallisation being of greatest importance in the black and red kakortokites, while suspension and accumulation processes were of more importance in the white kakortokites. The key control on unit development was the rate of undercooling, potentially associated with changes in volatile pressure. This acted to control the order of nucleation, first forming the arfvedsonite-rich black kakortokite, secondly the eudialyte-rich red kakortokite and finally the alkali feldspar- and nepheline-rich white kakortokite. Geochemical discontinuities across some unit boundaries indicate that the Fe_{TOT}/Mn ratios of eudialyte become more primitive (increased ratios) above these unit boundaries, suggesting that magmatic replenishment events occurred to create the macrorhythmic layering.

[1] Bohse *et al.* (1971). *Rapport Grønlands Geologiske Undergesølgelse*, 36, 43 pp.