Fractionation of agpaitic magmas from compositional zoning in kakortokite-hosted eudialyte, Ilímaussaq Complex, Greenland

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The kakortokites in the ~1.16 Ga Ilímaussaq Complex, S Greenland, form a suite of rhythmically layered agpaitic nepheline syenites characterised by complex Na-Zr-Ti-silicates, such as eudialyte-group minerals (EGM) and rinkite, instead of common HFSE-phases like zircon and titanite. To further investigate detailed crystallisation mechanisms of agpaitic magmas, we performed major and trace-element analyses on cumulus EGM from kakortokite layers across the sequence. The data reveal complex compositional zoning patterns, e.g. hour-glass sector-zoning, sub-μm scale oscillatory zoning and core-rim relationships. The latter were explored to identify subtle trends in the chemical evolution and in-situ fractionation of the agpaitic melts. Most crystals exhibit a rimward increase in REE+Y contents (1.0-1.3 wt% Ce_20_3 and 0.5-0.7 wt% La_2O_3), consistent with REE+Y enrichment in the evolving bulk magma. Barium contents increase significantly towards the rim (300-900 ppm), while Cl (1.0-1.6 wt%), Rb (7-20 ppm) and Pb (60-160 ppm) decrease. In few cases, EGM exhibit partial rims with relatively low REE contents (~0.5 wt% RE_2O_3), which contrasts the general core-rim trend in the euhedral cores. These partial rims are interpreted as crystallites from isolated inter-cumulate melt that underwent a distinctly different chemical evolution from that of the bulk magma. The decrease in REE contents may reflect the onset of crystallisation of new intercumulus REE-phases, such as rinkite-group minerals. Hour-glass sector zoning in the euhedral eudialyte cores is associated with minor variations (< 0.2 wt%) in Nb, Ce, La and Y contents between coevally grown crystal sectors. These indicate the preferential incorporation of Nb and REE on a specific set of growth surfaces and may provide important clues to the diffusion mechanisms in agpaitic magmas.