

Semiquantitative modelling of parameters controlling agpaitic crystallization in nepheline syenite in the Pilanesberg alkaline complex, South Africa.

TOM ANDERSEN^{1,2}, MARLINA A. ELBURG² AND
HENRIK FRIIS³

¹University of Oslo

²University of Johannesburg

³Natural History Museum, University of Oslo

Presenting Author: tom.andersen@nhm.uio.no

Agpaitic nepheline syenite with alkali- and volatile- bearing HFSE minerals typically form in anorogenic or extensional magmatic systems. The factors that stabilize agpaitic mineral assemblages have been discussed for more than a century. Whereas increasing peralkalinity is an important driving force, elevated halogen contents are also required to stabilize F-bearing Zr and Ti disilicate minerals and Cl-bearing eudialyte. The role of water is less clear – agpaitic nepheline syenite magmas are generally not water saturated, and increasing water activity may both stabilize and destabilize agpaitic HFSE mineral assemblages. The lack of thermodynamic data for most of the important mineral species prevents conventional thermodynamic modelling in agpaitic systems, but the use of semiquantitative chemical potential diagrams and chemographic analysis of critical low-variance mineral-melt reactions may still allow important parameters to be constrained.

The Pilanesberg alkaline intrusive complex in South Africa was emplaced in an intraplate setting at ca. 1395 Ma. Two distinct suites of peralkaline nepheline syenite (the White and Green Foyaite suites) have developed independently from a common parent magma. The Green Foyaite Suite (GFS) is distinctly agpaitic in its composition and mineralogy.

A heterogeneous, eudialyte-bearing member of the GFS from the SW perimeter of the complex carries Ti-bearing minerals: aenigmatite (*Aen*), titanite (*Ttn*), a Ca-Na-Ti -F disilicate mineral related to l avenite (*TiDS*), and titaniferous aegirine (*Ti-Aeg*). A succession of mineral assemblages can be recognized: *Aen+Ttn+TiDS+Ti-Aeg*, *Ttn + Ti-Aeg*, *TiDS+Ti-Aeg*. The changes in mineralogy correspond to simultaneous increases in oxygen fugacity and water activity, with a mild increase in peralkalinity during crystallization. The trend terminates with simultaneous crystallization of aegirine and potassic arfvedsonite, defining an upper limit for water activity, short of water saturation. In this process, the HFSE are decoupled, with Zr being hosted in eudialyte throughout the evolution of titanium mineral assemblages.

Although Na-Ca-Ti-F disilicates are uncommon minerals that form mainly in highly peralkaline, silica-undersaturated magmatic systems, they are potentially important indicators of parameters influencing the crystallization of such magmas, e.g. the (Na+K)/Al ratio of the coexisting melt, and activities of