Geophysical Research Abstracts
Vol. 15, EGU2013-2903, 2013
EGU General Assembly 2013

The evolution of hyperagpaitic magma in the Ilímaussaq alkaline complex, Greenland: Fractional crystallization or intraplutonic assimilation ?

Tom Andersen
University of Oslo, Department of Geosciences, Oslo, Norway (tom.andersen@geo.uio.no)

Hyperagpaitic rocks are highly peralkaline nepheline syenites in which minerals like ussingite (Na2AlSi3O8(OH)) and naujakasite (Na6FeAl4Si8$O_2$6) crystallize instead of or in addition to feldspars and feldspathoids, eudialyte is replaced by complex sodium-calcium silicate and phosphosilicate minerals like steenstrupine, and highly water soluble minerals such as villiaumite (NaF) form part of magmatic mineral assemblages. Most hyperagpaitic rocks are pegmatites or veins that can be attributed to late magmatic fluid-rock interaction (Khomyakov 1995). However, in the Ilímaussaq alkaline complex in South Greenland, hyperagpaitic villiaumite-, steenstrupine-, and naujakasite-bearing lujavrite (i.e. melanocratic, silica-undersaturated syenite) forms genuine magmatic intrusions (Sørensen and Larsen 2001, Rose-Hansen and Sørensen 2002).

The agpaitic part of the Ilímaussaq complex consists of an upper series of sodalite foyaite and naujaite (i.e. sodalite-rich nepheline syenite) roof cumulates, and a floor series of kakortokite (i.e. modally layered arfvedsonite, eudialyte and nepheline + alkali feldspar cumulates). Different varieties of aegirine and arfvedsonite-bearing lujavrite make up a sandwich-horizon, and form intrusions in roof cumulate and non-agpaitic border group rocks (Ferguson 1964).

The albite-nepheline-aegirine plane forms a critical boundary between agpaitic and potentially hyperagpaitic liquid compositions in the NaO0.5-AlO1.5-SiO_2-FeOt tetrahedron (Andersen and Sørensen 2005). Both eudialyte and sodalite plot to the high-alkali side of this plane. In contrast, kakortokite and related rocks in Ilímaussaq plot within the less alkaline albite-nepheline-arfvedsonite-aegirine volume. Co-precipitation of sodalite and / or eudialyte with albite, nepheline and arfvedsonite from such magma will therefore prevent formation of more highly peralkaline (i.e. hyperagpaitic) residual liquids by closed system fractional crystallization. Hyperagpaitic residual liquids can only form if aegirine, eudialyte and sodalite do not crystallize. This is not applicable to the main line of magma evolution in Ilímaussaq, where massive accumulation of eudialyte-bearing kakortokite and sodalite-bearing naujaite has taken place. An isolated batch of Zr and Cl depleted residual liquid after crystallization of a eudialyte-rich kakortokite unit can in principle develop beyond the boundary. Assimilation of sodalite-rich cumulate rocks into a chlorine-depleted, sodalite-undersaturated lujavrite magma provides an alternative route to late, hyperagpaitic liquids. When interacting with such a liquid, sodalite may break down to albite, nepheline and excess sodium silicate. Hyperagpaitic lujavrite has intruded the upper part of the sandwich horizon and the roof cumulates, which has generally been taken as evidence of increasing degree of closed-system fractional crystallization. The spatial relationship is, however, equally compatible with a selective, intraplutonic assimilation process, since late intrusions in those parts of the complex would have the highest probability of interacting with naujaite cumulates

References

Andersen, T., Sørensen, H., 2005. Mineralogical Magazine 69, 125-136.
Ferguson, J. , 1964. Meddelelser om Grønland 172, 4, 82 pp
Khomyakov, A.P., 1995. Mineralogy of hyperagpaitic alkaline rocks. Clarendon Press, Oxford.
Rose-Hansen, J., Sørensen, H. 2002. Meddelelser om Grønland, Geoscience, 40
Sørensen, H., Larsen, L.M., 2001. Geology of Greenland Survey Bulletin 190. 83-94.