Polybaric crystallization of the Ahvenisto anorthosite

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The recent confirmation of high-aluminum orthopyroxene megacrysts (HAOM) in the ∼1.64 Ga Ahvenisto rapakivi granite – massif-type anorthosite complex provides further evidence to support the suggested mantle-derived origin for the anorthositic rocks of the complex.

Fieldwork in the northwestern flank of the Ahvenisto complex revealed two morphologically different types of HAOM embedded in leucogabbroic rocks. The "type 1" HAOMs commonly display a complex rim structure comprised of plagioclase, low-Al orthopyroxene, olivine (mostly altered) and sulphides. "Type 2" HAOMs have less well-developed rim structures and are associated with megacrystic plagioclase.

An "Al-in-opx"-geobarometer was used to evaluate crystallization pressures of orthopyroxene in different textural positions of the studied rocks. A three-stage polybaric evolution was observed. The highest recorded Al-abundances from the cores of the HAOM (∼7.6 wt. %) correspond to crystallization pressures up to ∼1.1 GPa and depths of ∼34 km. The rims have crystallized in much lower pressures (maximum of ∼0.5 GPa/20 km) and the highest estimates within barometer calibration for the host rock orthopyroxene were ∼0.2 GPa (<10 km).

This suggests that the inner parts of the HAOMs have crystallized in high-pressure conditions at lower crustal levels. The reaction rims have most likely formed during initial igneous cooling and in the presence of some melt, followed by a subsequent hydration of the system. The occurrence of magmatic olivine within the rim may reflect the effects of pressure decrease in the ternary Fo-An-Si system, which stabilized olivine over orthopyroxene in the late stages of crystallization. Groundmass orthopyroxene composition is concurrent with late low pressure crystallization at intrusion depth.

Additionally, these results offer constraints for intrusion depth estimates for the whole Fennoscandian rapakivi suite; specifically the early emplacement stages (∼1.64 Ga) of the Wiborg batholith.