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Deciphering the evolution of rapakivi magmas from mineral inclusions in alkali feldspar megacrysts and zircon

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Rapakivi granites are ferroan (A-type) granites that are characterized by ovoid-shaped alkali feldspar megacrysts (diameter up to 15 cm) commonly mantled by plagioclase forming the namesake rapakivi texture. The ~1.63 Ga Wiborg batholith in southeastern Finland is the type area of rapakivi granites.

Recent studies into the chemistry and geochronology of the mineral inclusions within the Wiborg rapakivi granite ovoids have shown that the megacrysts may represent magmas that crystallized significantly earlier and either in different P/T conditions or from magmas with dissimilar compositions than the matrices of the respective granites. It is possible that the ovoids crystallized from magmas with more evolved geochemical characteristics than the matrices, including higher levels of REE and other incompatibe elements.

All ovoids are perthitic and have concave and rod-shaped quartz, hypidiomorphic or slightly resorbed plagioclase (often with partial quartz rim), zircon, biotite, apatite, and ilmenite (and occasionally minor magnetite) inclusions. The ovoids of the mafic rapakivi granite types have also hornblende and sometimes olivine and clinopyroxene inclusions, whereas the more felsic types have abundant fluorite. In contrast to the ovoids, the groundmass feldspar grains have hardly any inclusions. Differences are also observed in the hornblende compositions between the ovoid inclusion (dominantly ferroedenitic) and matrix (ferropargasitic/hastingsitic) populations.

As zircon is an almost ubiquitous inclusion phase, time-integrated trace element composition comparisons of not only ovoid inclusion and matrix populations but also between different morphological types have been possible. Also the zircon crystals themselves contain plenty of inclusions. Alkali feldspar (albite and potassic feldspar) and quartz constitute the bulk of the inclusions within zircon crystals but chloritized mafic minerals, and sometimes also fluorite and ilmenite are common. A detailed analysis of the distribution of inclusion types within different morphological zircon domains and between ovoid vs. matrix populations will provide a more in depth view into the crystallization history and magmatic evolution of the granite hosts.