Storage of crustal forming events in lamprophyres: Examples from the Fennoscandian Shield

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Lamprophyres are volatile-rich, peralkaline to alkaline, mafic to ultramafic igneous rocks, which typically occur as dyke swarms. Lamprophyres often contain mineral assemblages that were formed during the early stages of magmatic evolution, making it notoriously difficult to date their intrusive event (Rock, 1990).

The Fennoscandian Shield is composed of Archaean continental blocks in the northeast and the accretionary arc complexes of the Svecofennian Orogen (1.93-1.76 Ga) in the southwest. The magmatic end of the Svecofennian Orogen is represented by several low-volume bimodal shoshonitic granitoid intrusions as well as shoshonitic lamprophyres and carbonatites.

For this study, samples of shoshonitic lamprophyres intruded into both the Archeaen and Protoerozoic domains of the Fennoscandian Shield were examined. By analysing different isotope systems (e.g. U-Pb; Rb-Sr; Sm-Nd) as well as utilising the high spatial resolution capabilities of secondary ionisation mass spectrometry (SIMS), we aim to acquire geochronological data from the lamprophyres as well as the crust in which they have intruded.

Zircon grains were separated for SIMS analysis from three samples from the Lake Syväri region of eastern Finland and five samples from the western Lake Ladoga region of Russian Karelia. Zircon rims consistently yield ages between 1.78-1.77 Ga. These parallel the results of Eklund & Shebanov (2005) for the Åva ring intrusion in southwest Finland, and are similarly interpreted as the age of the lamprophyre intrusons. Cores yield a variable array of ages, which correspond to several well-established crustal formation events within the Fennoscandian Shield.

Preliminary Sm-Nd isochron ages from two Lake Ladoga samples are 1.67 Ga, while a Rb-Sr isochron from a Lake Syväri sample was 1.68 Ga. These are in agreement with K-Ar ages given by Haudenschild (1988) from the country rocks in eastern Finland, reflecting cooling and thus exhumation rates. ε_{Nd}(1800) was found to be near zero for all three samples, indicative of shield scale mantle metasomatism at aproximately 1.9 Ga. Partial melting of this subductively enriched mantle wedge generated the lamprophyric magma.

Our results show that by utilising several isotope systems coupled with high spatial resolution techniques, age data from diverse crustal forming events may be obtained from lamprophyres.

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Ferric iron in clinopyroxene from the garnet peridotite facies: Systematics and partitioning behaviour

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Ferric iron is an important minor element in the Earth's mantle. Its presence in individual minerals is influenced not only by crystal chemistry and bulk rock coposition, but also by the prevailing oxygen fugacity, which is known to vary laterally as well as with depth (e.g. Woodland & Koch 2003). Aside from garnet, pyroxene can be a significant carrier of Fe^{3+} in the garnet peridotite facies of the upper mantle. Fe^{3+} contents of clinopyroxene (cpx) measured by Mössbauer spectroscopy are reported for 32 garnet peridotite xenoliths from South Africa and Lesotho. Together with literature data, this enlarged data set allows a more robust analysis of the systematics of Fe^{3+} incorporation in cpx and partitioning behaviour of Fe^{3+} between cpx and garnet than that previously attempted (Canil & O'Neill 1995).

Measured Fe^{3+}/Fe_{tot} in cpx ranges from 0.10-0.38 and exhibits a general decrease with increasing equilibration temperature (the Fe^{3+}-insensitive BKN two-px thermometer). Such an anti-correlation is not found for Fe^{3+} cpfu in cpx. The reason for this is that the Fe^{2+} content of cpx also changes with temperature in the presence of garnet (i.e. Ellis & Green 1979). Fe^{3+} contents correlate with Na, underlining the importance of the aegerine component in these cpxs. Such a relationship is not observed in spinel peridotites (Woodland *et al*. 2006; Canil & O'Neill 1995), indicating a change in substitution mechanism for Fe^{3+} in cpx going from the spinel to the garnet peridotite facies.

Partitioning of Fe^{3+} between cpx and garnet is T-dependent. This has the effect of transferring Fe^{3+} into garnet with increasing T along a geotherm, which can influence how the fO_2 will vary with depth.

References

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