Carbonate melt in oceanic mantle: evidence from kerguelen mantle xenoliths

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Numerous peridotite xenoliths occur in alkaline and highly alkaline dykes from Kerguelen archipelago (South Indian Ocean). In some harzburgites and dunites, bulk-rock and mineral trace element compositions evidence a metasomatic event with "carbonatitic" signature as described in continental (*p.e.*Yaxley et al., 1991, Ionov, 1998) or in oceanic settings (Hauri et al., 1993). Moreover, in two amphibole-bearing dunites, we find carbonates in small pockets (100-300µm) as mosaic aggregates of fine (10-50µm) grains. These rocks show equigranular microstructures and are clinopyroxene-and/or amphibole-rich, orthopyroxene- and apatite-free. Clinopyroxene has spongy appearance and it is Cr_2O_3- and Na_2O-rich (respectively: 1 wt% and 1.56 wt%). Mg-bearing calcite (MgO: <1.4 wt%) is associated with fine grains of spinel, sulfides and Fe-periclase concentrated to the pocket boundary. Stable isotopic compositions of carbonates are in the mantle and carbonatite range ($\delta^{13}C$=-6.7 to –8.6 ‰ PDB) but they present a relatively high $\delta^{18}O$ (17.5 to 22‰ SMOW) close to carbonic signature in oceanic basalt. Trace element patterns in calcite from amphibole-bearing dunites are characterized by low alkali and high Sr, Ba contents, but appear unusual in their high LREE contents (150 to 900 ppm). Their shapes are relatively similar to hypothetical carbonatitic liquids estimated from compositions of coexisting metasomatic clinopyroxenes. However, the calculated liquids have systematically higher HFSE contents in comparison with carbonates (Kd not applicable?). Crystallization of this unusual assemblage, microstructural features and chemical composition of carbonates suggest that they are near quenched carbonate melt rather than crystal cumulates from primary carbonate-rich melts (Ionov, 1998 ; Lee et al., 2000, Ionov & Harmer, *in press*) and furthermore, some trace element contents (*p.e.* medium REE) differ from those of common carbonatites.

We conclude that these carbonates reflect the final stage of diffentiation from highly alkaline silicate melt resulting of infiltration, reaction and crystallization processes in the upper mantle.

Melt-host rock interaction and zircon growth during high grade metamorphism

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Understanding zircon formation during metamorphic events is fundamentally important for the interpretation of U-Pb geochronological data. Linking growth mechanisms to zircon chemistry and textural evidence will lead to improved understanding of the timeframes of metamor-phic events and subsequently to more precise geological models relying on these data. Electron- and ion-micro-probe *in-situ* analyses have been used in this study to identify and characterize zircon grown during specific stages of high grade metamorphism in UHT granulites from Rogaland, southern Norway.

In migmatitic granulites, contact zones between leucosomes (former melts) and their host rock are found to contain abundant zircon. Many of these zones are melano-cratic, but not restitic. Instead, interaction of passing or crystallising melt and host rock is interpreted to have produced these biotite-, opaque- and zircon-rich selvages. Most of the zircons contain older cores overgrown by texturally and chemically distinct rims. The mechanism concentrating pre-metamorphic zircon along the veins is not yet understood.

Standard XRF whole rock data for one of these contact zones shows 20-50 times higher Y compared to other, granitic samples. This enrichment is reflected in overgrowths on inherited zircon which have high Y, P and HREE contents and are intergrown with xenotime. This may be interpreted to result from the dissolution of minerals containing these elements in the reaction zone between melt and host rock or an enrichment in a fluid phase active during melt crystallization.

In-situ analysis of trace elements in metamorphic garnet overgrowing zircon show coupled strong zoning in Y and Zr contents (c. 20 times), decreasing from core to rim. This is correlated with decreasing REE contents from core to rim and decreasing HREE enrichment (rims have flat HREE patterns). Zoning may reflect fractionation during garnet growth, but this has to be tested by high-resolution element profiles.

An important place of occurrence for metamorphic zircon has thus been identified, which can aid sample selection for dating in high grade gneiss complexes. The distinction of magmatic and metamorphic zircon in high grade rocks requires more than shape and Th/U. Many metamorphic zircons have high Y and low Hf, but Th/U indistinguishable from inherited magmatic populations.