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Metasomatism of UHP garnet peridotites by crustal-derived fluids in subduction zone setting reflected by solid inclusions and chemical zoning in garnet

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Garnet peridotites occur in spatial association with eclogites and diamond-bearing gneisses in an ultrahigh-pressure (UHP) complex within the Saxothuringian basement of the northern Bohemian Massif, European Variscan belt. The crustal and mantle rocks have a common subduction history as reflected by similar peak P-T conditions (c. 5 GPa and in excess of 1100°C) and petrological data. This rock assemblage thus provides unique material to study subduction-zone processes including fluid-mediated material transfer.
Garnets from peridotites contain primary multiphase solid solutions (MSI) concentrated at their $\approx$ 200-300 μm thick rim. These MSI are polygonal, equant to elongated, reaching up to 40 μm in size, and they are dominated by carbonates (dolomite±magnesite), amphibole and Ba-rich mica (Ba-rich phlogopite to kinoshitalite). Minor phases involve graphite, spinel, thorianite, apatite and pentlandite. Garnets from lherzolite show large chemically homogeneous core and approximately 100-500 μm wide rim with retrograde zoning features, i.e. Fe increase and Mg as well as XMg decrease. Trace element zoning patterns are distinct from those of major elements. Apart from Mn and Ti (+Nb), which continuously increase from garnet core to rim, other trace elements show rather flat zoning profiles in the core and marked changes in concentrations at the MSI-bearing rim. These involve increase in Th, U, Y+REE (and Mn) and drop in Zr, Hf, Nb, Ta and Ti. In contrast to major elements (Fe, Mg) with high diffusivities in garnet, which are prone to reequilibration upon cooling, the less diffusive trace elements can preserve the growth patterns. We suggest that trace element concentration profiles at the MSI-bearing garnet rims reflect change in composition of the growth environment characterized by high Th, U, and REE, as also reflected by presence of thorianite (Th, U) and REE-bearing Cl-apatite within the MSI. Enrichment in LILE (Ba, K, Sr: kinoshitalite, carbonates, amphibole, apatite) and volatiles (H_2O, CO_2, Cl > F) in the MSI provide additional evidence for fluid-mediated element transport from subducting crustal slab into the overlying mantle wedge. Our findings are compatible with evidence for cryptic metasomatism with respect to Th, U and LREE documented by bulk rock chemical data (Medaris et al., 2015). At given context, the elements could be mobilized by supercritical liquids produced by dehydration melting of the associated UHP-UHT metasediments which are efficient carriers of all trace elements in question. Major element bulk composition of the MSI in a lherzolite sample, however, is not uniform: although the XMg, MgO/FeO, MgO/SiO_2 and $SiO_2/Al2O_3$ ratios are similar, CaO contents are variable: this is also reflected in different proportions of carbonates. Rehomogenization experiments on the MSI will allow constraining the nature of the transport media (fluids/melts/supercritical fluids) as well as element sources.

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Medaris, G., Ackerman, L., Jelínek, E. et al. (2015) Depletion, cryptic metasomatism, and modal mesatomatism (refertilization) of Variscan lithospheric mantle: Evidence from major elements, trace elements, and Sr-Nd-Os isotopes in a Saxothuringian garnet peridotite. Lithos 226: 81-97.