HP melting of eclogites and metasomatism of garnet peridotites in the Monte Duria area (Central Alps, N Italy): a proxy for the mafic crust-to-mantle mass transfer at subduction zones

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In the Monte Duria area (Adula-Cima Lunga unit, Central Alps, N Italy) Grt-peridotites occur in direct contact with migmatised orthogneiss (Mt. Duria) and eclogites (Borgo). Both mafic and ultramafic rocks share a common HP peak at 2.8 GPa and 750 °C and post-peak static equilibration at 1.2 GPa and 850 °C (Tumiati et al., 2018).

Grt-peridotites show abundant amphibole, dolomite, phlogopite and orthopyroxene after olivine, suggesting that they experienced metasomatism by crust-derived agents enriched in SiO₂, K₂O, CO₂ and H₂O. Peridotites also display LREE fractionation (La/Nd = 2.4) related to LREE-rich amphibole and clinopyroxene grown in equilibrium with garnet, indicating that metasomatism occurred at HP conditions. At Borgo, retrogressed Grt-peridotites show low strain domains characterised by garnet compositional layering, cut by a subsequent low-pressure chlorite foliation, in direct contact with migmatised eclogites. Kfs+Pl+Qz+Cpx interstitial pocket aggregates and Cpx+Kfs thin films around symplectites after omphacite parallel to the Zo+Omp+Grt foliation in the eclogites suggest that they underwent partial melting at HP.

The contact between garnet peridotites and associated eclogites is marked by a tremolitite layer. Tremolitites also occur as variably stretched layers within the peridotite lens, showing a boudinage parallel to the garnet layering of peridotites, indicating that the tremolitite boudins formed when peridotites were in the garnet stability field. Tremolitites also show Phl+Tc+Chl+Tr pseudomorphs after garnet, both crystallized in a static regime postdating the boudins formation, suggesting that they derive from a Grt-bearing precursor. Tremolitites have Mg#>0.90 and Al₂O₃=2.75 wt.% pointing to ultramafic compositions but also show enrichments in SiO₂, CaO, and LREE suggesting that they formed after the reaction between the eclogite-derived melt and the garnet peridotite at HP. To test this hypothesis, we calculated a log aH₂O-X pseudosection at fixed P=3GPa and T=750°C to model the chemical interaction between the garnet peridotite and the eclogite-derived melt. Our results show that the interaction produces a Opx+Cpx+Grt assemblage + Amp+Phl, depending on the water activity in the melt, suggesting that tremolitites likely derive from a previous Grt-websterite with amphibole and phlogopite. Both peridotites and tremolitites also
show a selective enrichment in LILE recorded by amphiboles in the spinel stability field, indicating that a fluid-assisted metasomatic event occurred at LP conditions, leading to the formation of a Chl-foliation post-dating the garnet layering in peridotites, and the retrogression of Grt-websterites in tremolitites.

The Monte Duria area is a unique case study where we can observe eclogite-derived melt interacting with peridotite at HP and relatively HT, and could thus represents a proxy for the crust-to mantle mass transfer at great depths in subduction zones.