



The evolution of focalised melt migration through the mantle lithosphere: Geochemical evidence from dunite-hosted clinopyroxenes in Lanzo South and External Ligurides ophiolitic peridotites

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Ophiolitic mantle sequences outcropping in the Western Alps - Northern Apennine chain are characterised by the localised transformation of plagioclase peridotites into granular spinel harzburgites and dunites. These spinel peridotites often preserve relics of the foliation of the host plagioclase peridotites and of the spinel pyroxenite banding, as well as “enclaves” characterised by plagioclase-bearing mineral assemblage. Such features evidence the “replacive” origin of these lithologies, namely their generation through focused and reactive porous-flow migration through the lithospheric mantle of pyroxenes-undersaturated melts originated by partial melting of plumbing asthenospheric sources. At Mt. Musinè (Southern Lanzo Body, Western Alps), “replacive” peridotites mainly outcrop as: i) elongated, meter-wide bands, within the tectonite-mylonite shear zones, concordant with the main foliation of the country rock; ii) huge, decametre-wide, discordant dunite masses, crosscutting both the peridotite foliation and the concordant spinel harzburgite and dunite bands. Interstitial and megacrystic clinopyroxenes from spinel harzburgite and dunite bands and bodies from Lanzo South body are characterised by a significant geochemical heterogeneity, which can be interpreted as the result of different stages of melt evolution during channelled migration. On the basis of the geochemical composition of the clinopyroxenes, the “replacive” spinel peridotites at Mt. Musinè have been separated in three different Groups. The Group A is defined by some concordant spinel harzburgites, in which clinopyroxene shows a “depleted” trace element composition. In particular, they have contents in moderately incompatible trace element (e.g. HREE, Y, Ti and V) significantly lower

with respect to those of the clinopyroxenes from the host plagioclase peridotites (e.g. $Yb_N = 7.1-1.9$) and of the clinopyroxenes in equilibrium with MORB. The LREE content is low (e.g. $La_N = 1.2-0.4$), but they are less depleted and fractionated than that expected according to the HREE concentration level and partial melting modelling. As a whole, the field, petrographic and petrologic features of these harzburgites suggests that these spinel harzburgites record the early stages of opening of the “replacive” conduits, which is proposed to have been characterised by melt-assisted near-fractional melting of the ambient plagioclase-peridotite. Group B clinopyroxene composition is shown by most of the “replacive” spinel harzburgites and dunites. It is characterised by trace element compositions typically found in clinopyroxene crystallised from N-MORB to slightly LILE-enriched MORB. Such a geochemical signature is shared by both discordant and concordant bodies. All the petrochemical features indicate that these “replacive” bodies could have efficiently acted as melt feeder of ocean-floor magmatism. Group C composition is defined by small interstitial Cpx from metre-wide concordant dunite bands that have patterns characterised by HREE and Y contents like those of Group 2 clinopyroxenes, but with strong enrichment in highly incompatible elements, such as LREE, Nb, Ta, Zr, Hf, Sr, Th and U. Relatively high concentrations are also shown by moderately incompatible elements, such as Ti, Sc and V. The REE patterns are concave-upward with an abrupt change of slope at Sm or Gd. The geochemical modelling indicates that such composition can reflect the development of transient geochemical features during the consumption of very small aliquots of MORB by fractional crystallisation. Thus, the enrichment in highly incompatible element documented by clinopyroxene from Group C dunites likely record the last “breath” of the dunite conduits. Completely different trace element compositions are exhibited by clinopyroxenes from the “replacive” spinel peridotites substituting plagioclase peridotites in Mt. Nero massif (External Ligurides). Although the trace element compositions of the clinopyroxene show some relevant differences from sample to sample, they are ubiquitously characterised by L-MREE-enriched convex-upward patterns with maximum at Sm-Eu, as typically found in clinopyroxenes segregated from melts with transitional to alkaline affinity produced by partial melting of garnet-facies sources. In the clinopyroxenes from the REE-richest “replacive” peridotites, La_N is $\sim 6.5 \times C1$, Sm_N is 19-23 $\times C1$ and Yb_N is 7-10 $\times C1$. Interestingly, the clinopyroxenes from the host plagioclase peridotites (produced by pervasive porous flow melt migration) possess similar LREE content, being, conversely, typically characterised by larger concentration in HREE ($Yb_N = 15-20 \times C1$), as expected for melts produced or equilibrated under spinel-facies mantle conditions. Ongoing geochemical modelling is devoted to assess the petrochemical and geodynamic relationships occurring between the two distinct stages (i.e. pervasive and channeled) of porous flow melt migration experienced by this part of the External Ligurides.