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Extreme heterogeneity in North Lanzo peridotite: insights on mantle processes in the sub-continental lithosphere

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The North Lanzo peridotite body (Western Alps, NW Italy) represents a sector of sub-continental lithospheric mantle that was exhumed and exposed at the sea-floor of the Jurassic Ligurian Tethys.

Structural and compositional features indicate the extreme heterogeneity of these mantle rocks. The field mutual relationships between the different rock types indicate that the oldest mantle protoliths mostly consist of Sp harzburgites preserving structural relics (Opx+Sp clusters) of pristine mantle garnet(Gnt). They are diffusely veined by Sp pyroxenite bands and pods which show widespread structural relics of pre-existing Gnt. Peridotites and pyroxenites were equilibrated at Sp-peridotite facies conditions. Widespread subsolidus structures (i.e. Plg+Opx exsolutions in Cpx, Ol+Plg reaction rims between Px's and Sp) indicate that pristine Sp peridotites were exhumed to Plg-facies conditions. Peridotites and pyroxenites locally underwent significant structural-compositional modifications suggesting reactive melt-rock interaction (pyroxene dissolution and olivine precipitation) by silica undersaturated melts. On a decametric-hectometric scale, they were strongly enriched of magmatic Plg and mm-size gabbroic pods, indicating melt impregnation. All these rocks types are locally replaced by channels and pods of Plg-free Sp peridotites in places enriched of interstitial magmatic Cpx, suggesting reactive depletion/enrichment by melt-rock interaction.

The strong compositional heterogeneity of the Lanzo mantle is well documented by the Cpx trace element composition: (1) Cpx of the mantle protoliths show LREE and HREE fractionated patterns documenting variable Gnt- and Sp-facies melting processes; (2) Cpx of Sp pyroxenites show negatively fractionated LREE patterns, suggesting equilibration with MORB melts, and very high HREE (and Sc) contents that are reminiscent of a precursor Gnt-bearing assemblage; (3) Cpx of Plg-enriched peridotites and pyroxenites show relatively low (La/Yb)N values at increasing YbN, and significant EuN negative anomaly, confirming percolation/impregnation of MORB melts; (4) Cpx of replacive peridotites show very high (La/Yb)N values documenting interaction with, and crystallization from, strongly LREE enriched - HREE depleted melts with alkaline affinity.

Isotope data indicate different signatures for the various rock types: (1) DMM for Cpx in peridotite protoliths (143Nd/144Nd = 0.513479-0.513347) that also possess Proterozoic Nd model ages; (2) MORB for Cpx in Plg-enriched peridotites (143Nd/144Nd = 0.513399-0.513108), and (3) OIB for Cpx in late replacive peridotite channels (143Nd/144Nd = 0.512962-0.512706).

Available data concur to support that the peridotite protoliths were accreted to the sub-continental lithospheric mantle during Proterozoic times after Gnt-Sp-facies partial melting. They were intruded by asthenospheric melts at P in the range 2.5-1.5 GPa, giving rise to Gnt pyroxenite veins, and were subsequently equilibrated at Sp-facies conditions. They were later exhumed to Plg-facies conditions and were in places percolated by MORB-type melts, which modified the trace element compositions and, partially, the DMM isotope signature of the pristine peridotites. They locally underwent focused percolation of OIB-like alkaline melts which modified the trace element budget and erased the DMM and MORB isotopic signatures of the pre-existing Sp and Plg peridotites.

New data for the North Lanzo peridotites allow us to track the evolution of a sector of sub-continental mantle since its early (Proterozoic?) deep-seated partial melting and accretion to the lithosphere of the Europe-Adria system. This mantle sector was exhumed during continental extension and rifting in the Ligurian Tethys domain and underwent interaction with different MORB and OIB primary melts formed by decompression melting of heterogeneous mantle sources.