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Distinct magmatic mantle and oceanic hydration histories of subducted ultramafic rocks from the central European Alps

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Bodies of chlorite-harzburgite, chromite-peridotite, garnet-peridotite, and spinel-peridotite occur scattered across the central European Alps. Meta-rodingites document oceanic hydration metasomatism, suggesting a former Piemonte-Ligurian ocean origin. Here we test to which extent these metaperidotite bodies, metamorphosed to T ≥ ~700 °C and P > ~0.7 GPa, preserve a geochemical memory of their magmatic history and oceanic hydration metasomatism, in order to constrain their genesis in the light of opening and closing of the Piemonte-Ligurian ocean.

Extended bulk rock major to trace element systematics are employed, since any magmatic mineral relics were erased during metamorphism. Rocks encompass lherzolites, harzburgites, and rarely dunites. PM-normalised trace element distribution diagrams record metasomatism upon oceanic hydration via absolute enrichments in the fluid-mobile elements (FME) B, W, As, Sb, and ±Li, and variable enrichments relative to elements of similar magmatic compatibility are apparent for U, Cs, Li, Bi, ±Sn, ±Sr, ±Ba, and ±Rb.

Plotting MgO/SiO_2 vs. $Al2O_3/SiO_2$, samples cluster below the residual peridotite trend after melt extraction. We find that bulk rock Mg# record pristine magmatic signatures, and lowered MgO/SiO_2 thus indicate variable silica addition upon oceanic hydration. A few samples plot above this trend and contain high olivine modes combined with bulk rock Mg# < 89. Such replacive dunites display high FeO_{tot} along with the highest MgO/SiO_2 of the data set, indicative of prominent melt-rock reaction in the thermal boundary layer. However, fertile peridotites are abundant, and rare residual dunites (Mg# >92.5) suggest >30% of melt extraction. Such variable extents of melt depletion and magmatic refertilisation are reflected by variable chondrite-normalised REE patterns, from slightly to strongly LREE depleted to U-shaped. Linear trends are displayed for MgO vs. Sc, V, and HREE, for Y vs. Ni, Sc, Yb, and between REE element pairs, reflecting magmatic compatibility trends.

Magmatic and hydration signatures resemble geochemical characteristics of lithospheric peridotites exposed on the ocean floor. We thus interpret these metaperidotites to represent lithospheric remnants of the hyper-extended continental margin of Europe, belonging to the Alpine - Apennine ophiolite belt. Despite near-complete metamorphic dehydration, metaperidotites retain distinct FME enrichments, available for re-fertilising convecting mantle domains.