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Trace element geochemistry of garnet peridotites and chlorite harzburgites from Cima di Gagnone (Central Alps, Switzerland)

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Dehydration of oceanic serpentinites is rarely documented in nature because few rocks are exhumed from beyond the antigorite breakdown. The garnet (grt) lherzolites and chlorite (chl) harzburgites from Cima di Gagnone are unique in the Alps and are since long considered as serpentinized oceanic mantle subducted to 2.5 GPa-800°C (1). Here we present the trace element survey of Gagnone grt lherzolites and chl harzburgites to test an origin from serpentinites and to characterize the fluids they released at breakdown of major hydrous phases.

The grt peridotites are foliated and contain olivine (ol), ortho- and clino-pyroxene (opx, cpx), Ca-amphibole (amph). Poikiloblastic grt overgrows former foliation(s) and partially equilibrates with the above minerals; olivine + ilmenite replace former Ti-clinohumite. The chl harzburgites display foliated and massive textures. Massive rocks have randomly oriented ol and opx, minor chl, Ti-clinohumite and locally carbonate. Foliated harzburgites have dominant olivine; opx and chl parallel the foliation and display equilibrium textures. Chl harzburgites may also derive from retrogressed grt peridotites; in this case post-kynematic chl overgrows grt. In the field, chl harzburgites are associated with eclogites and HP metarodingites, which form stretched dikes of previous MORB materials. This indicates a common eclogite-facies equilibration of mafic and ultramafic material, potentially of former oceanic origin.

Cpx from grt lherzolites shows LREE-depletion (LaN/SmN 0.42) and highly variable M- to HREE spectra, from flat (SmN/LuN 1.3) to HREE depleted (SmN/LuN 119). The flat patterns resemble those of cpx from ophiolitic Alpine-Apennine spinel-lherzolites: they can represent mantle precursors prior to subduction equilibration with grt, reflected by the HREE depletion. Amph both occurs along the grt foliation and after cpx. It shows LREE depletion (like cpx) and heterogeneous HREE contents always > 1 chondrite, implying disequilibrium with grt. Amph may thus be a re-equilibrated eclogitic phase, or a retrograde phase that mimics cpx. Boron concentrations in ol and opx from the Gagnone grt lherzolites and chl harzburgites are intermediate between pristine mantle compositions and those of the Betic harzburgites. In the latter rocks, B enrichment was inherited from precursor serpentinites. Arsenic represents another element of interest in these rocks. Enrichment in As characterizes all rock-forming minerals of grt lherzolites and chl harzburgites; the highest concentrations pertain to amphibole. Arsenic is characteristic of subduction-zone and of HP mantle wedge serpentinites (2,3). The above evidence point to a serpentinite component in the protoliths of the Gagnone lherzolites and harzburgites and in the source of inclusions they host. Hence, we confirm that the Gagnone grt peridotites and chl harzburgites may originate from increasingly serpentinized mantle subducted beyond antigorite stability.

(1) Evans B.W., Trommsdorff V. 1978, EPSL 40, 333-348; (2) Hattori K, Guillot S. 2003, Geology 31, 525-528; (3) Deschamps F. et al. 2009, Chem Geol, doi: 10.1016/j.chemgeo.2009.10.002