TRACE ELEMENT CHEMISTRY OF HIGH PRESSURE MINERALS IN PROGRADE GARNET LHERZOLITES OF THE CENTRAL ALPS

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ABSTRACT

In the Cima Lunga - Adula Unit of the Central Alps, garnet peridotites outcrop in over ten localities: the most prominent occurrences are at Alpe Arami, Cima di Gagnone, and Monte Duria. At Cima di Gagnone, metamorphosed mantle rocks are associated with metacarbonates, in part meta-ophicarbonate rocks; eclogites-amphibolites of MORB affinity, and the ultramafics are crosscut by rodingitized MORB dikes. Peridotites at Monte Duria and Alpe Arami are accompanied by leucocratic migmatitic gneisses, by thin calc-slicate layers, eclogites and mafic boudins, in part mildly rodingitized. Based on field occurrence, these peridotite bodies have been interpreted as fragments of lithospheric mantle which was exhumed and at Gagnone denuded in a ocean-continent transition realm, during Jurassic rifting. During the oceanic stage the lherzolites were serpentinized to variable degrees and concomitantly the mafic dykes rodingitized. With the gradual closure of the Tethyan ocean basins, from Cretaceous to Eocene, the ultramafic-mafic suites including ophicarbonate rocks were subducted and after continental collision, from the Oligocene onward, exhumed. The prograde evolution during subduction is testified by the devolpment of a series of mineral assemblages that overgrew each other.

At Cima di Gagnone garnet is poikiloblastic and overgrew folded, pre-existing mineral assemblages with enstatite, diopside, forsterite and pargasite to magnesio-hornblende. Moreover, at Cima di Gagnone garnet overgrew pseudomorphs of olivine plus ilmenite after titanian clinohumite. A second textural type of garnet peridotite dominates at Alpe Arami. It contains an older porphyroblastic generation of olivine, an a younger one that is porphyroclastic due to late movements along the Southern Steep Belt of the Central Alps. In this texture garnet porphyroblasts are rounded and contain only occasionally inclusions among which brown spinel has been observed. At Monte Duria both textural types of garnet peridotite occur in close association with folded strings of spinel overgrown by poikiloblastic garnet.

Recent thermobarometric estimates have indicated P-T conditions at about 32 kbar and 800°C for the recrystallization of the garnet-bearing assemblage in all the peridotites (Nimis et al., this volume).

Trace element mineral chemistry data have been performed by the ion microprobe operating at CSCC of Pavia (Italy), on garnet peridotites from the three localities. In the Alpe Arami and Monte Duria peridotites, investigations have been focussed on, i) porphyroblastic garnet and clinopyroxene in textural equilibrium within the peak metamorphic garnet + clinopyroxene + olivine assemblage, ii) retrograde amphibole developed as coronas around garnet. In the Cima di Gagnone peridotites, we analysed: i) poikiloblastic garnet, ii) clinopyroxene and amphibole which are either included in garnet or in textural equilibrium within the garnet-bearing assemblage.

Alpe Arami and Monte Duria garnets display fractionated REE patterns (Ce_N/Yb_N = 0.0004-0.012), high HREE (10-30 x C1), Sc (80-120 ppm), Zr (20-40 ppm), and very low Sr (<1 ppm) abundances. Coexisting clinopyroxenes exhibit almost flat L- to M-REE patterns at 10-20 x C1, strong HREE fractionation (in the range 0.2-2 x C1), low Zr (10-15 ppm), Sc (15-30 ppm) and high Sr (100-150 ppm) contents. These compositional features indicate that complete geochemical equilibrium has been attained between minerals of the garnet-bearing assemblage. Amphibole The REE and Sr compositions of retrograde amphibole are consistent with crystallization by interaction between clinopyroxene, garnet and an hydrous fluid not enriched in incompatible elements like LREE and Sr.

Cima di Gagnone garnets show fractionated REE patterns (Ce_N/Yb_N = 0.003-0.018) and relatively high HREE contents (8-35 x C1). Clinopyroxene and amphibole display heterogeneous compositions, depending on their textural occurrence. Clinopyroxene and amphibole crystallized in equilibrium with garnet exhibit, as expected, very low HREE absolute concentrations (at about 0.8-2 x C1) and strong LREE/HREE fractionation. Clinopyroxene, moreover, also displays low Sc (< 25 ppm), Y (1-3 ppm) and high V (400-600 ppm), Sr (about 200 ppm) concentrations, indicative of trace element partitioning with coexisting garnet. By contrast, clinopyroxene and amphiboles included in poikiloblastic garnet show rather flat REE spectra at 5-10 x C1, clearly indicating chemical disequilibrium with garnet. In addition, clinopyroxenes have higher Sc, Y and lower V, Sr contents. The compositions of these clinopyroxenes record an equilibration within a garnet-free assemblage, and are closely similar to typical trace element compositions of mantle clinopyroxene in spinel-bearing assemblages.

Trace element mineral chemistry in the Cima di Gagnone peridotites provide evidence that: i) garnet crystallized in presence of an amphibole+clinopyroxene assemblage, and ii) the geochemical equilibrium during garnet growth was only attained in local microtextural sites, thus preserving records of a previous garnet-free, clinopyroxene+amphibole-bearing assemblage.

REFERENCES

Nimis P., Trommsdorff V. and Russo U., 1999. Revised thermobarometry of grt-peridotites from Cima Lunga-Adula nappe complex, Central Alps. This volume.