Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SMP43-09 Room:303 Time:May 24 11:15-11:30

Trace-element analyses of clinopyroxene megacryst in garnet lherzolites from the Bohemian Massif

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High-pressure and ultrahigh-pressure metamorphic rocks in the continetal collision zone contain a number of garnet-bearing ultramafic rocks within the metamorphic rocks of upper crustal compositions. Two different hypotheses has been proposed to incorporate the peridotites in the crustal metamorphic rocks: (1)a high-temperature mantle wedge peridotite was dropped into the subducting crust, and (2)the dry mantle peridotite was entrained in the low-P-T crustal rocks and was transformed to serpentinite/chlorite peridotites that are transformed into garnet peridotite by the subsequent subduction.

To reconcile this controversy, we study garnet peridotites from the two localities in the Bohemian massif (Variscan orogeny), Lom pod Libidem (LPL) and Plesovice quarry (PQ). In both localities, garnet peridotites are enclosed in the high-pressure acidic granulite. The previous researches demonstrated that these garnet peridotite have equilibrated at 1020 C/2.5 GPa and 940 C/2.9 GPa during the UHP metamorphism. The subsequent exhumation partially transformed garnet peridotite into spinel peridotite at 770C/1.5 GPa.

We find clinopyroxene megacrysts, with size up to 3 cm, surrounded by the fine-grained matrix of garnet peridotite assemblages which are variably retrogressed to spinel peridotite ones. The clinopyroxene megacryst contains numerous amphibole inclusion (bleb/lamella) along with phlogopite, olivine, orthopyroxene, apatite,ferrit chromite, and rare huttonite.

The 3 cm-size clinopyroxene from the LPL locality are strongly zoned. Chemical mapping demonstrated it consists of three zones: (1)the core poor in Al2O3 (˜1.0 wt. %) and Na2O (0.8 wt. %), (2)the mantle contains highern Al2O3 (˜2.0 wt. %) and Na2O (1.2 wt.%) and (3) the rim with higher Al2O3 (˜3.0 wt. %) and lower Na2O (0.8 wt.%). The CaO content slightly decreases from the core to the mantle (from 22.0 to 20.5). The trace element analyses of clinopyroxene showed positive anomalies of Pb, Sr, LREE and negative HFSE anamalies, suggesting an involvement of fluid. Rare earth element concentration is very low in the core with moderate LREE/HREE slop with (Yb/Gd)N=9+-5 normalized by CI chondrite. Such an Al-Na-REE poor clinopyroxene are typically observed in the chlorite-bearing peridotite. The mantle REE pattern have a steeper slope of LREE/HREE with (Yb/Gd)N=17+-4 suggesting a coexistence with garnet. The REE contents at the rim become higher in concentration with a slope of (Yb/Gd)N=7+-2, reflecting a re-equilibration in the spinel-lherzolite facies.

The clinopyroxene megacryst at the PQ locality show a similar zoning with the core and the rim. (1)The core is poor in Al2O3, Cr2O3 and Na2O (2.0, 0.5 and 1.2 wt.% respectively), and (2)the rim is rich in them (3.6, 0.8 and 1.9 wt.% respectively). The CaO content decreases from the core toward the rim (from 22 to 20 wt. %).The trace element analyses for the megacryst rim showed enrichment in Pb, Sr. LREE and depletion in HFSE. The rim contain high concentration of REE with a steep LREE/HREE {(Yb/Gd)N˜20+-6}, suggesting a coexistence with garnet. The coexistence of clinopyroxene rim with garnet suggest a week retrogression that is consistent with the week kelyphitization of garnet.

Based on the above information, we propose a following thermal history for the Bohemian garnet peridotites. Both the LPL and PQ peridotites were stable at chlorite-stability field at the initial thermal history. The alumina-poor composition in clinopyroxene suggests the rocks were originally chlorite-bearing peridotites at T<700C (or very low-T spinel peridotite), and the increse of Al, Na and the decrease of Ca toward the rim suggests a heating during the subduction history, which finally transformed chlorite peridotite into garnet peridotites. Both peridotite were partially transformed to spinel peridotite, but the retrogression is more severe in LPL peridotite while PQ peridotite preserve the garnet-peridotite even at the rim of clinopyroxene.

Keywords: orogenic peridotite, continental collision, Bohemian massif, subduction, clinopyroxene megacryst