TRACE ELEMENT TRANSFER IN THE MANTLE WEDGE: EVIDENCE FROM POLYPHASE INCLUSIONS IN GARNET-PYROXENITES (DABIE-SHAN, CHINA)

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Ultra-high pressure (UHP) rocks are unique natural observatories on fluid-related metasomatism at subduction zones. We investigated garnet-pyroxenites from the Maowu ultramafic complex (China) that experienced UHP metamorphism. The pyroxenites are characterised by a peak assemblage of millimeter-sized orthopyroxene (opx_2), inclusion-rich garnet, and minor clinopyroxene, associated with discontinuous layers of titanian-clinohumite. Rounded blebs of relic olivine and orthopyroxene (opx_1) are included in poikiloblastic opx_2. Orthopyroxene has high Mg# (93 - 94) and garnet is pyrope-rich (70 – 73 %), indicative of ultramafic rocks. Low CaO (0.03 - 0.09 wt%) and Al_2O_3 (< 0.1 wt%) in orthopyroxene coexisting with clinopyroxene and garnet are in agreement with previously determined peak conditions of 750 °C and 40 – 50 kbar (LIOU & ZHANG, 1998). Relic olivine included in opx_2 with high Ni content (1729 – 5658 ppm) suggests olivine dissolution and orthopyroxene precipitation during percolation of siliceous agents at UHP conditions. Laser Ablation ICP-MS analyses show that opx_2 is enriched in LREE with respect to opx_1. The garnet REE pattern also shows a relative enrichment in LREE. This indicates that garnet and opx_2 growth was induced by the influx of a SiO_2 and Al_2O_3 rich melt characterised by high LREE content. Polyphase primary inclusions occurring at the core of garnet display negative crystal shapes and constant volume proportions of infilling magnetite (10 - 20 vol%), chlorite, amphibole, spinel and apatite. Separated inclusion-rich garnets were run in a piston cylinder experiment at 900 °C and 35 kbar. After the run, the primary inclusions were all homogeneised and contained porous SiO_2-rich quench indicating that garnet originally trapped solute-rich aqueous fluids. The trace element patterns of the quench material are generally enriched in LILE and LREE with respect to the host garnet. They also show positive spikes of Cs, Ba, and Pb relative to Rb and K and high U/Th ratios. The observed features indicate that the studied samples were harzburgites that reacted with a hydrous silicate melt derived from a crustal source at UHP conditions, to form orthopyroxene + garnet + residual fluid. The signature of this fluid is very similar to what is regarded as the "subduction component" in arc lavas. This study provides for the first time direct insights on crust-to-mantle wedge transfer of trace element at sub-arc depths.

Reference

LIOU, J.G. & ZHANG, R.Y (1998): Petrogenesis of ultrahigh-P garnet bearing ultramafic body from Maowu, the Dabie Mountains, Central China. The Island Arc, 7, 115-134.