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Fluid/mineral interaction in mantle wedge garnet peridotites

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We present two case studies of metasomatised garnet peridotite from the Sulu (Zhimafang) and of garnet orthopyroxenite from the Dabie Shan (Maowu) ultrahigh-pressure terranes (Eastern China). The mantle derived peridotite from Zhimafang shows two ultrahigh-pressure (UHP) mineral assemblages. The older one is made of porphyroclastic garnet rich in inclusions (Grt1), coarse exsolved clinopyroxene (Cpx1) and coarse phlogopite flakes (Phl1). The younger paragenesis consists of fine-grained olivine + clinopyroxene (Cpx2) + orthopyroxene ± magnesite ± Phl2 equilibrated with neoblastic garnet (Grt2). The inclusions inside porphyroclastic Grt1 are polyphase secondary inclusions related to microfractures cutting the garnet core. They display irregular shapes and contain microcrystals of calcic-amphibole, chlorite, phlogopite and rare talc, associated with pyrite and/or spinel. The low Al2O3 content (<0.2 wt.%) in orthopyroxene coexisting with garnets and clinopyroxenes indicates equilibration at P=4.0–6.0 GPa and T=700–1000 °C. The trace element composition of Cpx1 and Phl1 combined with previous petrologic and isotopic data suggests that the Zhimafang garnet peridotite experienced metasomatism by a melt with alkaline character at high-temperature conditions (T=1000 °C and P>5.0 GPa). The microtextural identification of pseudosecondary inclusions in the porphyroclastic garnet core and their geochemical characterisation indicate that an incompatible element- and silicate-rich fluid subsequently metasomatised the garnet peridotite and equilibrated with the newly formed Cpx2 probably during Triassic UHP metamorphism.
Ultramafic metasomatic layers at Maowu Ultramafic Complex (Dabie Shan) consist of layered websterite and orthopyroxenite which preserve an old olivine + orthopyroxene (Opx1) + garnet (Grt1) ± Ti-clinohumite paragenesis, overgrown by poikilitic Opx2. Grt2 is associated with Opx2 + phlogopite along the foliation, together with fine-grained idiomorphic clinopyroxene. Grt2 cores contain disseminated primary polyphase inclusions. The textural and geochemical analyses of the primary polyphase inclusions indicate that they derive from a homogeneous fluid characterised by high LILE concentrations with spikes in Cs, Ba, Pb and high U/Th. These inclusions are interpreted as remnants of the LILE- and LREE-enriched residual fluid produced when a crust derived Si-rich metasomatic agent reacted with a previous harzburgite to form garnet orthopyroxenite. The in situ trace element analyses of the major phases garnet, clinopyroxene and phlogopite that formed at the same time as the polyphase inclusions at Maowu, permit the determination of empirical mineral/fluid partitioning at pressures relevant for element recycling in subduction zones. Our estimated D(Cpx/fluid) suggests that all LILE are highly incompatible, Th and U are moderately incompatible, Pb is close to unity and Sr is moderately compatible. Phlogopite preferentially incorporates Rb and K with respect to Ba and Cs, and Th with respect to U. The similarity between the residual Maowu fluid with the secondary inclusions in the UHP wedge-type garnet peridotite from Sulu, indicates that the fluids produced from reactions at the slab–mantle interface may be effective metasomatic agents in the mantle wedge. Such reactions may produce phlogopite, which plays an important role in controlling the LILE characteristics of the slab-derived fluid in subduction zones.