



Fluid-induced oxidation at the slab-mantle interface: insights from UHP garnet peridotites

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At subduction zones the volatile transfer from slab to mantle is accomplished by fluid phases released by dehydration, partial melting and/or decarbonation reactions in the slab lithologies. The mechanism of slab-to-mantle volatile transfer is strongly related to the fluid speciation, which in turn is a function of oxygen fugacity, in a system buffered by equilibria involving redox-sensitive elements. Although much is known about the oxidation state of the upper mantle, the redox processes taking place in the portion of mantle wedge on top of the subducting slab is poorly investigated and the oxidising power of fluids is still unknown.

Information on fluid/melt related processes occurring at sub-arc depth can be gained by the study of orogenic UHP metasomatised ultramafic rocks associated with deeply subducted crust. A relevant case study is represented by garnet orthopyroxenites and peridotites coming from the Dabie-Sulu belt (China). Orthopyroxenites (Maowu Ultramafic Complex) are hosted by garnet-coesite gneisses and locally crop out associated with phlogopite-rich layers. They contain an association of orthopyroxene + garnet ± clinopyroxene ± olivine, which form at the expenses of a previous garnet peridotite. Garnet includes core clusters of primary polyphase inclusions corresponding to a solute-rich aqueous fluid enriched in LILE and LREE. Textural and geochemical data demonstrate that these orthopyroxenites represent metasomatic layers produced after the reaction of mantle peridotites with a Si-saturated fluid phase sourced by the associated crustal rocks at UHP conditions. The trace element pattern of this fluid shows a peculiar LILE signature which is recorded by subduction garnet peridotites from Zhimafang. These samples show two UHP mineral assemblages. The older one is made of porphyroclastic garnet, coarse exsolved clinopyroxene and coarse phlogopite flakes. The younger paragenesis consists of fine-grained olivine + clinopyroxene + orthopyroxene + phlogopite ± magnesite equilibrated with neoblastic garnet.

We have evaluated the oxidation degree of subduction garnet orthopyroxenites and peridotites by measuring the Fe³⁺ distribution of the major phases combining Flank Method electron probe microanalyses and Electron Energy Loss Spectroscopy (EELS). The results indicate that pyrope-rich metasomatic garnets present a chemical zoning, with the complementary decrease in Al₂O₃ (~26 to ~21 wt%), relative to the increase of Fe₂O₃ (~0.8 to ~2.5 wt%). Diopsidic clinopyroxenes contain relatively high Fe³⁺/ΣFe ratios (0.48-0.51) and Na contents (0.13-0.17 a.p.f.u.). The enrichment of Fe³⁺ in Ca-clinopyroxene requires the incorporation of a NaFe₃Si₂O₆ component. The coupled Na-Fe³⁺ enrichment in clinopyroxene likely suggests a corresponding enrichment in the whole rock and could be favoured by the influx of alkali-rich metasomatic fluid phases. In order to investigate the role of deep fluids in the redox processes of the suprasubduction mantle we also measured the Fe³⁺ concentration of the microprecipitates in polyphase inclusions using EELS on a TEM. Preliminary data indicate that the solute content of UHP slab fluids may contain high Fe³⁺ concentrations. If net bulk rock oxidation can be demonstrated, silicate- and/or alkali-rich C-bearing fluids could be regarded as potential carriers of Fe³⁺ and alkali, able to "oxidise" the suprasubduction mantle.