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# Material transfer in the kelyphitization of garnet -- a description in the oxygen-fixed reference frame

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Kelyphitization of garnet is a metasomatic process that accompanies material transfer across the reaction zone between reactants, garnet and olivine in the garnet peridotite case. Any description of material transfer requires the selection of a reference frame or a spatial coordinate system. Here we propose on the basis of crystallographic observation using electron back-scattered diffraction (EBSD) (Obata et al, 2009, JpGU, I130-001) and a crystal-chemical consideration that the oxygen -fixed reference frame (abbreviated as OFRF hereafter) provides the best description of the kelyphitization process.

We analyzed the material transfer based on an OFRF by using data from three previously studied garnet peridotites taken from literature (one from the Czech Bohemian and two from the Alpine Ultental, N. Italy) and from a newly analyzed sample of a garnet peridotite from the Norwegian Caledonides. The bulk composition of kelyphite of the Norwegian sample was obtained using electron microprobe analyses (WDS) of the constituent minerals in combination with mineral modes obtained from 2D-image analyses of SEM-BSE images. The kelyphite is typically an extremely fine-grained, fibrous material consisting of Cpx, Opx and spinel +/-amphibole and is surrounded by a narrow rim of coarse-grained granular Opx +/- Cpx (abbrev. COR) adjacent to primary olivine crystals. In addition, several larger nodular (discrete) grains of Cr-Al spinel (typically less than 100 micron size) resides at the kelyphite/COR interface. The fine-grained kelyphite part consists of two domains ? a lamellar intergrowth of Cpx and spinel and a lamellar intergrowth of Opx and spinel. The lamellae are typically submicron in size. Although lamellae size are smaller than the X-ray exiting volume by electron beam, it was possible to obtain each constituent mineral accurately assuming the mineral stoichiometry and using mixing calculations.

Analyses of mass balance using OFRF revealed some common features among the four samples as follows: There is a significant mass flow of Mg from the olivine side towards the garnet side and are counter flows of Si and Al in the opposite direction. In more details, the flux of Si is reduced in various extent among the four samples and that of Al increases slightly at the interface between the kelyphite and the COR. This tendency is the greatest for the Norwegian sample, in which nodular spinel is the most conspicuous at or near the interface. We speculate that such discontinuities in the material fluxes may be due to a growth of chromium spinel in the expense of pyroxenes at the kelyphite/COR interface. Incorporating this hypothetical reaction to the mass balance calculations above we obtain a better result of mass balancing and could evaluate quantitatively the contribution of this hypothetical reaction by means of a least square analysis. For correct interpretation of the observed pattern of material flow and, in particular, the origin of the nodular spinel at the kelyphite/COR interface, a gradient of non-hydrostatic stress that is developed in the reaction zone due to the volume change reactions in the solid state (Obata and Shimizu, 2009, JpGU, K133-005) must probably be considered.

Keywords: kelyphite, garnet peridotite, material transfer, metasomatic reaction