A consideration on volume change, stree generation and mineral transfer associated with the kelyphitization of garnet

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Garnet may be kelyphitized according to the following reaction when a garnet peridotite is decompressed into the spinel-lherzolite facies field.

Garnet + olivine = Opx + Cpx + spinel (1)

Kelyphite is a fine-grained mineral aggregates typically composed of Opx, Cpx and spinel. It occurs as coronas surrounding garnet grains. These three phases have topotaxial crystallographic relationships (Obata et al., 2008 JPGU Meeting) and their lineation structure is oriented nearly perpendicular to the grain boundaries of the adjacent garnet (the law of normality). Reaction (1) involves a large volume increase and how this volume-increase is accommodated in solid rocks is considered.

The kelyphitization advances inward replacing garnet (Fig. 1). Concomitantly, coarse Opx rim is developed replacing adjacent olivine grains. Kelyphitization occurs only at the reaction front (i.e., garnet grain surfaces) and the produced kelyphite does not see further reaction inside and works only as a medium of material transfers across the zone. Considering the spatial relationship and mechanical strength of the minerals, the metasomatic reaction at the reaction front cannot involve any significant volume increase. Therefore volume increase of the reaction (1) should occur outside the kelyphite shell. It is plausible that the reaction front sees an excess stress because the potential volume increase at the reaction front is suppressed by the external kelyphite shell. The law of normality may be ascribed to this hypothetical excess stress along the reaction front. Assuming the constancy of the volume of the kelyphitization front, I formulate the kelyphitization reaction in the MgO-Al2O3-SiO2 model system and estimated the material transfer across the kelyphite zone.