Composition and origin of kelyphitic rims around garnets in fresh sheared lherzolite from the Udachnaya-East kimberlite pipe, the Siberian Craton

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A zoned reaction rim (kelyphite) around garnet of xenolith of fresh sheared lherzolite from the Udachnaya-East kimberlite pipe, Russia, has been investigated. The aim of the study is a detailed characterization of bulk major and trace element compositions of the kelyphite zones, kelyphite-forming minerals and theirs relationships with each other and with rock-forming minerals of the lherzolite.

There are three points of possible origin of the kelyphite: 1) a solid-solid reaction (between garnets and rock-forming minerals) during transporting to the surface and modifying by a kimberlite melt (introduction of Na, K, Ca and H$_2$O into the kelyphite) after reaction, 2) a reaction between garnets and a kimberlite melt, 3) mantle metasomatism.

Scanning electron microscopy coupled with energy dispersive spectrometry was used for phase determination and chemical analyses. Chemical composition of large grains (>6 μm) was also examined with wave-length-dispersive spectrometry on electron probe micro-analyzer. Raman spectroscopy was used for phase verification. Bulk trace element composition of reaction rim was studied by laser ablation-inductively coupled plasma-mass spectrometry.

Garnet forms rounded grains up to 4 mm in size, which are surrounded by the kelyphitic rim. The kelyphite has a concentric structure forming three distinct textural and chemical zones, which are extremely fine-grained aggregates of Cr- and Al-rich orthopyroxene, spinel with a wide range of Cr#, Cr and Al-rich clinopyroxene, amphibole, phlogopite, sodalite and olivine. Veinlets, which traverse the reaction rim and the garnet, are composed of the kelyphite-like mineral aggregate.

The kelyphite formation took place after the lherzolite was entrapped by the kimberlite magma during ascent and emplacement. Orthopyroxene, clinopyroxene and spinel were primarily formed (hereafter the first association). Known limits of pressure-temperature stability of sodalite, phlogopite and amphibole suggest their low-pressure crystallization in the kelyphite (hereafter the second association). The kimberlite melt participated in the formation of both the first mineral association and the second mineral association of the kelyphite. Olivine is believed to be result from a reaction between the kimberlite melt and the kelyphite after forming of the first association but before forming of the second association. On the basis of bulk chemical composition for each zone of the kelyphite and chemical composition of the precursor garnet, a
material transfer into the kelyphite during the formation was quantitatively evaluated. Introduction of Mg, Fe, Ti and Ca in the kelyphite occurred before formation of the second mineral association and introduction of Na, K, Ca, Cl, F and H₂O due to formation of the second mineral association. Therefore, we can expect that the kimberlite melt was a diffusion agent during formation of the first mineral association (the garnet and rock-forming minerals are considered as reactants) and was a reactant during formation of the second mineral association. This study was supported by the Russian Science Foundation (grant No 18-77-10062).

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