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Mono- and polymineralic inclusions within garnet megacrysts from the Grib kimberlite, Arkhangelsk province, Russia: evidence for kimberlite melt evolution

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Kimberlite is a composite rock made up of juvenile magmatic materials, mantle and crustal xenoliths and xenocrysts, and megacrysts of garnet, clinopyroxene, phlogopite, olivine and ilmenite. Garnet megacryst often contains polymineralic inclusions which are interpreted as trapped early kimberlite melt that was modified by interaction with host mineral during kimberlite ascent (Bussweiler et al., 2016). Therefore, the one of the way to trace evolution of kimberlite melt is to study monomineralic and polymineralic inclusions within megacrysts.
We present preliminary petrographic and geochemical data on polymineralic and monomineralic inclusions and host megacryst from the Grib kimberlite, Arkhangelsk province.
The garnet megacrysts occur as rounded or angular grains up to 3 cm in size. The garnets are almandine-pyrope solid solutions with 68-77 mol.% pyrope. Based on Cr and Ti contents, they are subdivided into three groups: high-Cr ($Cr2O_3$ = 4.30-5.30 wt.%; TiO_2 = 0.87-1.12 wt.%), moderate-Cr ($Cr2O_3$ = 2.67-3.52 wt.%; TiO_2 = 0.69-1.11 wt.%), and low-Cr ($Cr2O_3$ = 2.12-2.50 wt.%; TiO_2 = 0.45 – 0.87 wt.%). Megacrysts from the Grib kimberlite were likely formed by metasomatic interaction between kimberlite melt at different stages of its evolution and surrounding lithospheric mantle (Kargin et al., 2017).
It was found that the distinguished groups of garnet megacrysts contain definite types of monomineralic (single grain) and polymineralic inclusions. The low-Cr megacrysts contain angular polymineralic inclusions consisting of phlogopite, Cr-spinel, barite, celestine, and monomineralic inclusions of olivine (replaced by serpentine) and ilmenite. The high-Cr garnet contains > 500 μm polymineralic (clinopyroxene, ilmenite, serpentine, calcite, and perovskite) elongate inclusion surrounded by amphibole-phlogopite reaction rim. The moderate-Cr megacrysts contain polymineralic inclusions made up of clinopyroxene, serpentine and calcite also surrounded by amphibole-phlogopite reaction rim and clinopyroxene monomineralic inclusions.
Clinopyroxene within inclusions yields equilibrium T around 1100° and P around 45 kbar (Nimis, Taylor, 2000) and it is intermediate in composition (Mg# = 0.89-0.91, $Cr2O_3$ = 1.04-1.54 wt.%) between those of sheared peridotite xenolith and high-Cr megacryst (Kargin et al., 2017).
The appearance of amphibole and phlogopite as reaction phases at the contact between inclusion and garnet indicates extensive interaction of the latters. Composition of inclusions is controlled by host garnet and, correspondingly, marks the different stages of kimberlite melt evolution.
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