



Multistage metasomatism in lithospheric mantle beneath V. Grib pipe (Arkhangelsk diamondiferous province, Russia): evidence from REE patterns in garnet xenocrysts.

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150 garnet xenocrysts from V. Grib kimberlite pipe were analyzed for major and trace elements compositions. 70 % of garnet belong to lherzolite field; 14 % – megacrysts and pyroxenites; 11 % – eclogites; 4 % – harzburgite; 1 % (1– wehrlite defined by Sobolev (1973).

Harzburgite garnets: sinusoidal REE patterns $S_{mn}/E_{rn} > 5$ (5.2 – 19.8). low Y (0.5 – 3.9 ppm), Zr (1.1 – 44.6 ppm), Ti (54 – 1322 ppm). Wehrlite garnet: close to sinusoidal REE patterns, $S_{mn}/E_{rn} = 1.8$. Megacrysts and pyroxenites garnets: normal REE patterns $S_{mn}/E_{rn} < 1$ (0.2 – 0.6), high TiO_2 (0.9 – 1.3 wt %).

Lherzolite garnets 70 % show four groups of REE patterns similar to peridotite xenoliths (Shchukina et al., 2013, 2015). 1-st contains MREE at 1 level, $S_{mn}/E_{rn} = 0.03$, $La/Y_{bn} = 0.002$. increasing La -Yb range, low Y, Zr, Ti indicating residual nature. 2-nd: MREE at 2 – 13 chondrite units, S_{mn}/E_{rn} (0.16 – 0.98), $La/Y_{bn} = 0.001 – 0.040$ and flat pattern from MREE to HREE. 3-rd -MREE at 5 – 14 chondrite units, $S_{mn}/E_{rn} > 1$ (1.05 – 4.81) $La/Y_{bn} = 0.010–0.051$ increasing an hump at MREE decreasing to HREE. 4-th: sinusoidal REE, S_{mn}/E_{rn} 4.2 – 27.2. and harzburgite Y, Zr, Ti . Average Cr_2O_3 content increases from 2-nd to the 3-rd group (3.3 to 5.7 wt%) and 4th (7.9 wt %). Average Y/Zr decreases from 2-nd (0.6) to 3rd (0.2) and 4th group (0.08). REE and Y, Zr, Ti indicate the metasomatic origin of garnets of 2, 3. 4 groups. Modeling of TREF for equilibrated melts and fractional crystallization 2nd group close to Turyino field basalts and 3-rd - to Izmozero field picrites of Arkhangelsk diamondiferous province (ADP).

Basing on geochemical data of garnet xenocrysts and garnets and clinopyroxenes in peridotites (Shchukina et al., 2013, 2015) we suppose at least 3 stage of high-temperature metasomatic enrichment. 1st stage – is enrichment of residual garnets (found only in peridotite garnets) in LREE by the influence of carbonatite melt close to the Mela field carbonatites of ADP. REE patterns in clinopyroxenes from these peridotite samples and the geochemical modeling results show that clinopyroxenes are also in equilibrium with carbonatite melt. Formation of garnet with the sinusoidal REE pattern could also occurs during carbonatite stage of mantle metasomatism. The 2- nd stage – is formation of garnets of group 3 from the melt of composition close to Izmozero field picrites. Garnets of group 3 are of lherzolite paragenesis on the content of CaO and Cr_2O_3 , but their REE patterns are close to sinusoidal patterns. The final stage of mantle metasomatism is the formation of garnets of group 2 exposed to the melt of composition close to Turyino field basalts. Garnets of group 2 have low Cr_2O_3 that indicate the significant amounts of basaltic component in the resulting melt composition or direct crystallization from the melt in case of most low-chromium garnets and megacrysts garnets. Modeling results show that the formation of the garnets of group 2 in peridotites associated with crystallization of the clinopyroxenes. At this stage of mantle metasomatism garnets have typical major and trace element lherzolite composition.