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Origin of the mantle rocks with green garnets (isotope and trace element study of the mantle xenoliths from Newlands dyke, South Africa and Nyurbinskaya pipe, Yakutia)

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Green garnets occur in concentrates of diamondiferous kimberlite bodies in Yakutia (Udachnaya, Mir, etc.), South Africa (Newlands, Bellsbank), Venezuela (Guaniamo sills), and Canada (Mud Lake field). Mantle xenoliths of rocks containing such garnets are very rare.

We found peridotite xenoliths with green garnet *in situ* in kimberlites of the Newlands dike. Xenoliths are irregular in form, 4.5*1.9 cm, 1.5*0.8 cm, and 1.0*0.5 cm in size, and have similar modal compositions: gar(70)+ol(28)+sp(2), gar(9)+ol(90)+sp(1) and gar(50)+ol(30)+sp(20). Rock texture is medium-crystalline, while structure is massive. We also identified a garnet macrocryst of 0.5*0.4 cm in size with a pale green kelyphytic rim.

Garnet composition in the studied samples is quite constant and is characterized by the high Cr_2O_3 content (10.94-11.99%) and CaO content (19.52-24.94%) at the reduced contents of TiO_2 (0.24-0.52%). The chrome spinel is high Cr_2O_3 (55%) content and the low TiO_2 (0.5-0.6%) content. Olivine is high-Mg (Fo_{95}), but elevated CaO content (0.09%).

Isotopic composition of oxygen in garnet (δ^{18}O = 4.05-4.25 pm) and olivine (δ^{18}O = 4.91 pm) differs drastically from the mantle values.

Rb-Sr and Sm-Nd isotopic composition show the relatively "young" model age of the sample relative to the depleted mantle (1.78 billion years), the age of formation of this rocks is also relatively "young" – probable mezoproterozoic.

In kimberlites and placers of the Nyurbinskaya pipe (Nakyn field, Yakutia) there are 4 green garnet grains of 0.5-2.0 mm in size, including one intergrowth gar+sp. Most garnets are characterized by the higher CaO (18.06-22.87%) and TiO_2 (1.46, 1.65, 1.75%) contents not noted before for similar garnets.

Studied green garnets have the similar "sine wave" type of REE distribution for low-Ti garnets and a "raised" type of REE distribution with enrichment in medium and light REE for high-Ti garnet.

All green garnets are characterized by an increased content of light REE and Sc. High-Ti garnets are characterized by an increased content of light and middle REE, as well as titanium, and a particularly sharply increased content of Zr (!).

Paragenesis ol+sp is formed at 805^{o}and 23.4 kbar, and paragenesis ol+gar is formed at 1080^{o}and 23.8 kbar. The rocks are characterized by nonequilibrium paragenesis ol+sp+gar and formation at moderate depths (80-90 km) under conditions of high heat flow (52-55 mW/m^2).

Judging from modal composition of studied xenoliths (absence of clinopyroxene), variations in chemical compositions and trace element compositions, relatively "young" model age and non-mantle isotopy of oxygen in garnets, these rocks are not “wehrlites” and likely represent metasomatic rocks such as uvarovite-chromite veins or schlierens at the moderate depths of upper mantle – it is similar to uvarovite-chromite veins of the metasomatic or a hydrothermal origin in the crustal serpentinites.