

Ultramafic mantle assemblages from Sytykansкая kimberlite pipe (Yakutia)

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Upper Devonian (344 Ma old) Sytykansкая pipe (Davis et al., 1980) is situated in the Daldyn-Alakit region of the Yakutian Diamondiferous Province among Lower Paleozoic sedimentary deposits. The pipe is filled in with four or five varieties of eruptive kimberlite breccia. The widespread postmagmatic processes resulted in considerable alteration of the primary xenolith material.

A collection of xenoliths of mantle ultramafic rocks (260 specimens) and diamonds with inclusions (300 crystals) was under study. Among the xenoliths, granular varieties of garnet and garnet-spinel peridotites play a leading role, amounting about 70%; sheared peridotites are quite rare. Xenoliths of ilmenite-garnet peridotites with signs of metasomatism and shearing are sufficiently widespread (~15%). The diamonds from the Sytykansкая Pipe are genetically related chiefly to the ultramafic paragenesis.

Olivine from the peridotite xenoliths is represented by magnesian varieties ($mg = 88.7-92.2$). An admixture of Cr_2O_3 reaches up to 0.09wt.%, CaO ranges from 0.01 to 0.35 wt.%. Compositionally, the olivines from diamonds are similar to the varieties described earlier (Meyer, 1987). These are forsterites (mg varies from 88.9 to 94.0) with an insignificant admixture of CaO (0.02 wt.% on the average) and with a persistent admixture of Cr_2O_3 (0.01-0.08 wt.%).

Enstatites, included in diamonds, are also similar to the majority of inclusions ($Al_2O_3 - 0.21-0.43$; $Cr_2O_3 - 0.20-0.34$ wt.%); in peridotites they are completely altered.

Clinopyroxenes of xenoliths are typical chrome diopsides. Their mg ranges between 87.8-95.0. Chrome diopsides from diamonds have mg from 89.4 to 93.9. The grains of cubcalcic relatively high-temperature clinopyroxenes (100Ca/(Ca+Mg) ratios equal 37.6 and 40.2) are characterized by the lower mg (89.7 and 89.4 respectively). The peridotite clinopyroxenes are significantly enriched in sodium (0.73-6.38 wt.% Na_2O , averaging 3.00 wt.%) and Cr (0.48-6.00 wt.% Cr_2O_3 , averaging 2.70 wt.%). A persistent admixture of K_2O in the clinopyroxenes from xenoliths and from diamonds does not exceed 0.07 wt.% and reaches 0.27 wt.%, respectively.

In the composition of **Cr-spinels** from the ultramafic xenoliths the maximum variations are observed in Cr_2O_3 and Al_2O_3 relations at a low permanent TiO_2 admixture. An increase in TiO_2 (up to 3.91 wt.%) along with elevated Fe^{3+} leads to increasing of ulvöspinel and magnetite proportion. The diamond related Cr-spinels are compositionally similar to worldwide diamond inclusions (Meyer, 1987).

Picroilmenites from peridotite xenoliths contain MgO from 7.29 to 15.8, Al_2O_3 - from 0.06 up to 0.99, and Cr_2O_3 from 0.38 to 7.10 wt.%. On the whole, the ilmenites from the Sytykansкая pipe xenoliths are somewhat richer in Cr as compared with a number of other bodies in the Daldyn-Alakit region.

The absolute majority of the studied peridotite xenoliths contains **garnets** with the Ca-content, typical of lherzolite paragenesis (Sobolev et. al, 1973). In general, the content of Cr_2O_3 in garnets from granular peridotites ranges from 0.33 to 12.3 wt.%. mg of garnets varies within 73.8-89.9. It decreases down to 72.0 for the ilmenite-bearing peridotites. The average content of TiO_2 is 0.27 wt.% with variations from 0.01 to 2.07 wt.% (in the ilmenite-containing xenoliths the average is 0.56 wt.% with variations from 0.10 to 1.35 wt.%). For peridotite garnets a stable isomorphous Na_2O admixture (up to 0.17 wt.%, averaging 0.06 wt.%) is determined (Sobolev, Lavrent'ev, 1971) which

is directly correlated with the contents of Ca, Ti and Fe. Signs of metasomatism and heterogeneities in the composition of the mineral phases caused by solid-state reactions in the course of thermodynamic evolution of the mantle substrate are observed in a considerable (about 15%) number of peridotite xenoliths from Sytykanskaya pipe. The heterogeneities recognized there are as follows: a) zoning of large (up to 8 mm) grains of garnet in the ilmenite-garnet peridotite xenoliths with traces of melting and deformations, with Ca and Cr depletion and *mg* decrease along with the increase of the Ti-content towards the rim; b) zoning of garnets in the sheared garnet lherzolite xenoliths, with the grain periphery enriched in Ca, Ti, Fe, Na, and some incompatible elements (Zr, Y, Ga) and depleted in Cr and Sr; c) significant variations in grain compositions of the same mineral, e.g. garnet, homogeneous inside a grain, in separate sites of the xenolith, up to the change of paragenesis in one specimen (Fig.).

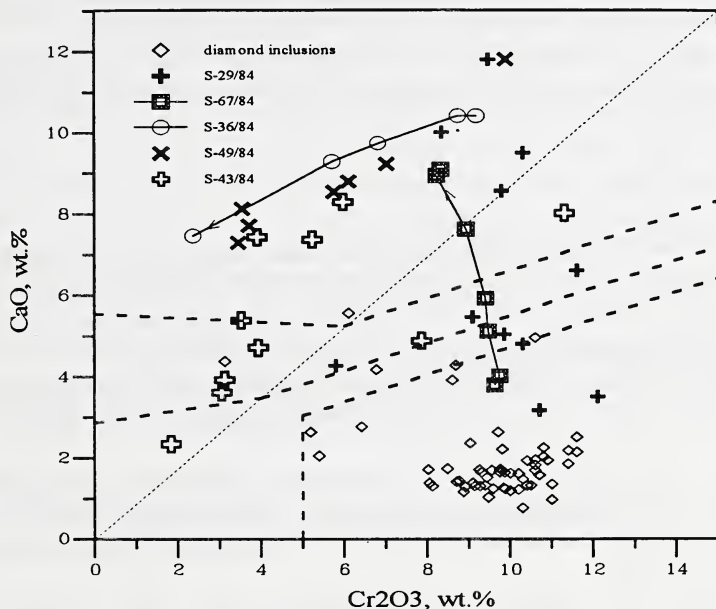


Fig. Cr₂O₃ vs CaO diagram for chrome pyropes from Sytykanskaya pipe. Diamonds - diamond inclusions; unequilibrated and zoned pyrope grains from xenoliths of granular (samples S-29/84, S-67/84, S-43/84) and ilmenite-bearing peridotites (samples S-36/84, S-49/84) with signs of shearing are shown by other symbols. The core-rim direction is marked by arrows.

A typical feature of the garnets of dunite-harzburgite paragenesis from the Sytykanskaya pipe diamonds is their rather stable very low content of Ca (CaO is 1.78 wt.% on the average) and significant variations in Cr content (Cr₂O₃ is 5.19-11.6 wt.%), which resembles Finsch pipe diamond inclusions (Gurney et al., 1979). The chrome pyropes from diamonds contain very low sodium: 0.01-0.05 wt.% Na₂O. Two available inclusions of lherzolitic garnets are characterized by elevated TiO₂ content (0.90 and 1.11 wt.%) and lower *mg* (84.6 and 82.6 respectively) as compared to the depleted harzburgite dunite compositions. In chemistry, these grains are similar to the garnet from diamondiferous sheared ilmenite-garnet lherzolite (Pokhilenko et al., 1976), interpreted as a fragment of weakly depleted «hot» mantle.

The results of the investigation of diamond inclusions show that the parental rocks for the absolute majority of diamonds of Sytykanskaya pipe are extremely depleted harzburgite-dunites. Comparative analysis of rock-forming mineral compositions evidences for significant inhomogeneities (see Fig.) possibly related to the instability of PT-parameters and environmental chemistry due to metasomatism processes. The mantle shearing leading to the rock deformation and recrystallization was favourable for depth high-temperature metasomatism, assisting penetration of fluids. This is confirmed by the signs of significant plastic deformations, shearing and partial melting in the rocks, containing nonequilibrium mineral assemblages. The most probable mechanism of the formation of these assemblages seems to be a mechanical mixing of the matter from separate interlayers in local zones of mantle fracturing. The formation of contaminated rocks, «polymict peridotites» according to Lawless et al. (1979) or the "mantle melanites" (Laz'ko, Serenko, 1991) is a result of shearing stresses along with a mixing of partially melted peridotite substrate. Combined with shearing and partial melting of matter, the processes of mantle metasomatism seemed to immediately precede the formation of kimberlite melts and transportation of nonequilibrium assemblages to the Earth's surface, where they remained in the metastable state. Thus, Sytykanskaya pipe is characterized by a high-grade primary differentiation, vertical heterogeneity of the Upper Mantle and high intensity of the mantle metasomatic processes.

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