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Petrochemical types of kimberlites and their diamond-bearing capacity

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Kimberlite rocks of Yakutian province (belong to 1 group of kimberlites after Smith, 1983) are characterized by wide variations of rock-forming oxides [Ilupin et al., 1986; Milashev, 1965; Kharkiv et al., 1991]. A number of factors could be discussed to explain the variety of chemical compositions of rocks. The first factor, explaining the regional differences in the kimberlite composition with primarily different composition of source kimberlite melt-fluid, is conventionally called «primary». All other factors are connected with the secondary redistribution of chemical components of kimberlites. Irrespective of intensity of secondary factors, the primary composition of kimberlites varies broadly, which is noticeable in kimberlites of some provinces, kimberlites fields, pipe clusters and individual pipes. The petrochemical types are classified based on the contents of such oxides as FeO, TiO2 and K2O, being relatively inert in the secondary processes. In the Yakutian Province we have distinguished 5 petrochemical types of kimberlites (Kostrovitsky et al, 2007); with principal ones – high-Mg, magnesium-ferruginous (Mg-Fe) and ferruginous-titaniferous, their composition: < 6; 6-9; 8-15 % FeOtotal and < 1; 1-2.5; 1.5-5.0 % TiO2).

Some petrochemical and mineralogical criteria of diamond-bearing capacity of kimberlites were identified some time before. The essence of petrochemical criterion consists of the inverse correlation dependence between the contents FeOtotal, TiO2 in kimberlite rocks and their diamond-bearing capacity (Milashev, 1965; Krivonos, 1998). The mineralogical criteria of diamond-bearing capacity infer presence of direct dependence of the rate of capacity on the content in kimberlites of low-Ca, high-Cr garnet and chrome spinellids with Cr2O3 > 62% and TiO2 < 0.5%, of dunite-harzburgite paragenesis (Sobolev, 1974; Meyer, 1968).

The acquired results are applied to evaluate «efficiency» of criteria of diamond-bearing capacity exemplified by the deposits of Yakutian Province.

The high-Mg kimberlites of the Njurba, Botuoba, International and Aikhal pipes are known as mostly diamondiferous. Kimberlites of these fields are marked by absence or minor abundance of minerals of low-Cr megacryst association – picroilmenite and orange-red garnet, and on the other hand, increased content of chrome spinellids and garnets, referred to as dunite-harzburgite paragenesis. Whereas most of the other deposits of Yakutia (pipes Mir, Udachnaya-Vostochnaya, Udachnaya-Zapadnaya, Yubileinaya, Komsomolskaya, Zarnitsa and Sytykan) are referred to the Mg-Fe petrochemical type distinguished by fairly raised content of TiO2 and FeOtotal and high content of minerals of low-Cr megacryst association. The minerals of dunite-harzburgite paragenesis in kimberlites of Mg-Fe type occur as varying amounts, but in general they are less numerous than in high-Mg type of kimberlites. The enumerated deposits have different rates of diamond-bearing capacity, but none of them reaches the rate of capacity common for the Mg-type deposits.

The kimberlites with higher content of TiO2 and FeOtotal, referred to the Fe-Ti petrochemical type, do not produce commercial diamond fields within the Yakutian Province. The kimberlites of this type practically do not contain garnet and spinellids of dunite-harzburgite paragenesis. Therefore, comparison of kimberlite deposits of different petrochemical types points out that the petrochemical criterion of diamond capacity is as if «workable». But on the other hand, there are pipes composed of kimberlites of high-Mg and Mg-Fe petrochemical types with a poor capacity or devoid diamonds, which essentially conceal supposed dependence of parameter of diamond-bearing capacity on the chemical composition of rocks. Thus, the negative correlation between the contents FeOtotal, TiO2 in kimberlite rocks and their diamond capacity manifests itself as a tendency in general for kimberlite rocks. Different petrochemical types of kimberlites, varying in the rate of diamond capacity, are indistinguishable in the content of incompatible elements or differ slightly (Kostrovitsky et al, 2007). There is no correlation relationship between the microelement composition (from some incoherent elements) and diamond-bearing capacity of kimberlites.

The efficiency of applying petrochemical and mineralogical criteria of diamond-bearing capacity is explained considering the genesis of kimberlite rock formation. It is assumed that the asthenosphere kimberlite-forming fluid-melt displayed capacity of fluid brecciation of rocks of lithosphere mantle. The composition of kimberlites and their diamond-bearing capacity also depend on the fact, which rocks of the mantle are largely brecciated and captured by the fluid melt. While kimberlite pipes Aikhal and International were formed, these were basically the rocks of high-Mg dunite-harzburgite diamondiferous paragenesis, which experienced brecciation. This predetermined both the petrochemical type of kimberlites and diamond-bearing capacity of these pipes.

Thus, we suppose, that kimberlites, traditionally referred to group I, are not similar. Within this group it is feasible to recognize petrochemical types differing in mineralogical composition and the rate of potential diamond-bearing capacity.

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