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GARNETS OF KIMBERLITE PIPE NYURBINS'KA (WESTERN YAKUTIA)

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Basing on complex investigations of garnets from concentrate of pipe Nyurbins'ka kimberlites and properties of diamonds quality the dependence of diamond raw material from abyssal paragenic associations has been revealed. It has been shown that analysis of garnet compositions allows determining prevailing abyssal parageneses in the selection and by this makes it possible to judge about geologic-economic potential of the deposit.

Key words: kimberlite, diamond, garnet, abyssal paragenesis, deposit, Yakutia.

Garnet is one of the most informative diamond indicator minerals, for it is xenogenic in kimberlites, and it got into them during disintegration of mantle xenoliths of ultrabasic and basic compositions. This thesis is well proved in a number of fundamental works [1–5] where it is shown that xenoliths of various garnet-bearing rocks are the sources of garnets occurring as crystals and fragments in kimberlites. Consequently, revelation of prevailing abyssal paragenesis of garnets allows judging about the structure of upper mantle and potential diamondiferousness of kimberlite bodies.

A representative selection of garnets from concentrate of Nyurbins'ka pipe key exploration wells has been studied by methods of optical spectroscopy and microroentgenospectral analysis. Investigation results of optical-spectroscopic and colorimetric parameters of garnets in combination with electronic-probe determinations of composition made it possible to reveal a broad spectrum of abyssal paragenesis occurring in this deposit and to perform correlation with the level of rocks' diamondiferousness. Converting of chemical analyses of pyropes into crystallochemical formulas were performed on specialized software products on standard electronic computer. Segregation of iron into ferrous and ferric forms was performed on calculation basis of mineral crystallochemical formulas reasoning from stoichiometry on oxygen method.

The content of garnets in kimberlites of the pipe varies in broad ranges from 140 to 900 g/t. They occur as grains of angular irregular shape, often with conchoidal fracture, with broad spectrum of colour spectrum. Orange, reddish-orange, purple and lilac colours prevail, violet, red, and pink garnets occur less frequently. Most of the grains lack in crystallographic faceting, relics of kelyphitic rim are frequently encountered, but grains with primarily magmatic surface are also not rare.

The basis of revelation of paragenic garnet associations is constituted by modified chromatic circuit (Fig. 1) and electronic-probe study, which allowed making availability

of paragenic types in the selection more precise. It follows from the results that garnets of ultrabasic paragenesis are most distributed in the pipe, represented by websterites, garnet lherzolites, magnesia-ferriferous pyroxenites and peridotites that constitute 67 % of total selection. The rest constitute garnets of eclogitic paragenesis where the leading positions are occupied by diamondiferous and potentially diamondiferous magnesia-ferriferous eclogites, disthen eclogites and grospydites are stated in smaller degree. Individual garnets from bimineral magnesia and corundum eclogites are recorded.

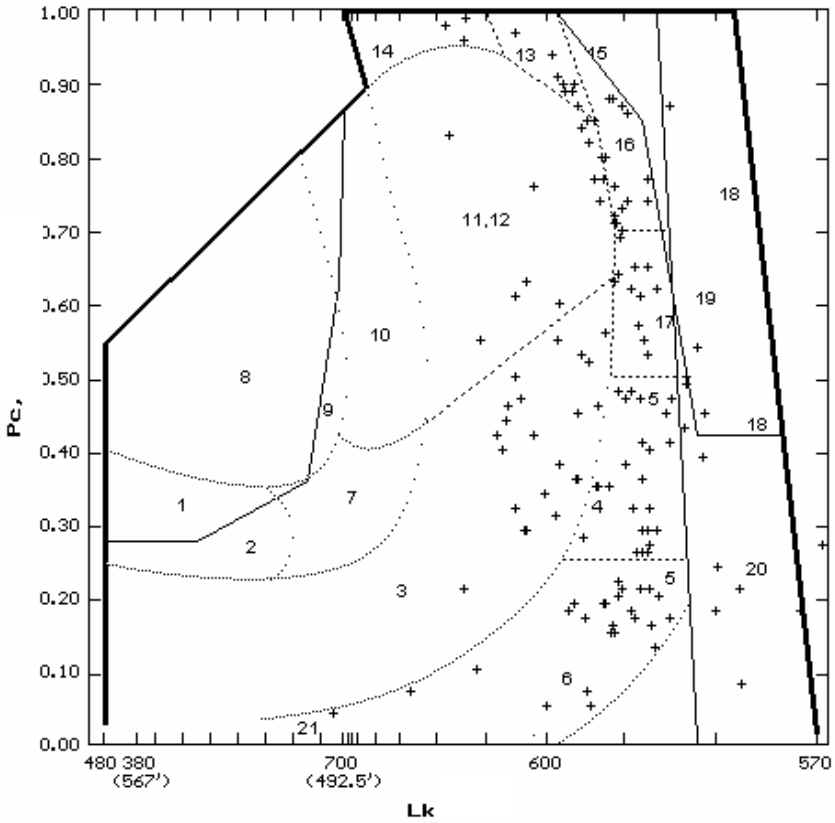

Fig. 1. Modified chromatic circuit of garnets from abyssal mineral associations in kimberlites of pipe Nyurbins'ka [6] from:

1 – potentially diamondiferous harzburgites; *2* – harzburgites; *3* – uniformly granular garnet lherzolites; *4* – websterites; *5* – websterites with reduced content of orthopyroxene (< 5 %); *6* – bimineral magnesia eclogites; *7* – chromite-garnet ultrabasites (harzburgites, dunites, lherzolites, vehrlites); *8* – potentially diamondiferous dunites; *9* – dunites; *10* – vehrlites; *11*, *12* – broken down porphyric and porphyraceous lherzolites and magnesia-ferriferous pyroxenites; *13* – ilmenite peridotites; *14* – nodules of garnet; *15* – diamondiferous and potentially diamondiferous magnesia-ferriferous eclogites; *16* – magnesia-ferriferous eclogites; *17* – micaceous magnesia-ferriferous eclogites; *18* – diamondiferous and potentially diamondiferous disthen eclogites and grospydites; *19* – diamondiferous corundum eclogite; *20* – disthen eclogites and grospydites; *21* – corundum eclogite.

These data are confirmed by revealed cluster groups, which unified positive correlating parameters of garnet compositions belonging to one abyssal paragenesis. This is also confirmed by composition of hard inclusions in diamonds proper, where according to [7] 1/3 part of the studied inclusions belongs to eclogitic genesis.

Garnets of diamondiferous magnesia-ferriferous eclogites are characterized by low content of Cr_2O_3 (0,1 mas. %), moderate CaO (6,44 mas. %) and MgO (8,78 mas. %), by high content of Fe (23,61 mas. %) and, in comparison with other paragenesises, by the least content of TiO_2 (0,07 mas. %) and SiO_2 (39,16 mas. %). 6 % of eclogite paragenesis selection fall at garnets from disthen eclogites and grospydites. Such garnets are characterized by high content of Cr_2O_3 (7,45 mas. %) and MgO (17,77 mas. %), average FeO (8,41 mas. %) and CaO (6,7 mas. %) and, in comparison with other eclogitic types, by somewhat increased TiO_2 to 0,1 mas. %.

As it was already noted garnets of ultrabasic paragenesis compose approximately 2/3 of the studied selection. The following composition variations are common for them, mas. %: Cr_2O_3 (4,56–6,23), CaO (4,16–6,50), MgO (19,19–20,48), FeO (7,75–8,21), TiO_2 (0,13–0,27) and SiO_2 (41,22–41,61). It should be noted that 6 % of ultrabasic paragenesis pyropes satisfy diamondiferousness' criteria conditions according to N.V. Sobolev [1]. Such garnets (Fig. 2) are characterized by high content of Cr_2O_3 (8,94 mas. %), moderate – MgO (20,48 mas. %) and SiO_2 (41,22 mas. %), decreased – CaO (4,16 mas. %) and FeO (7,53 mas. %).

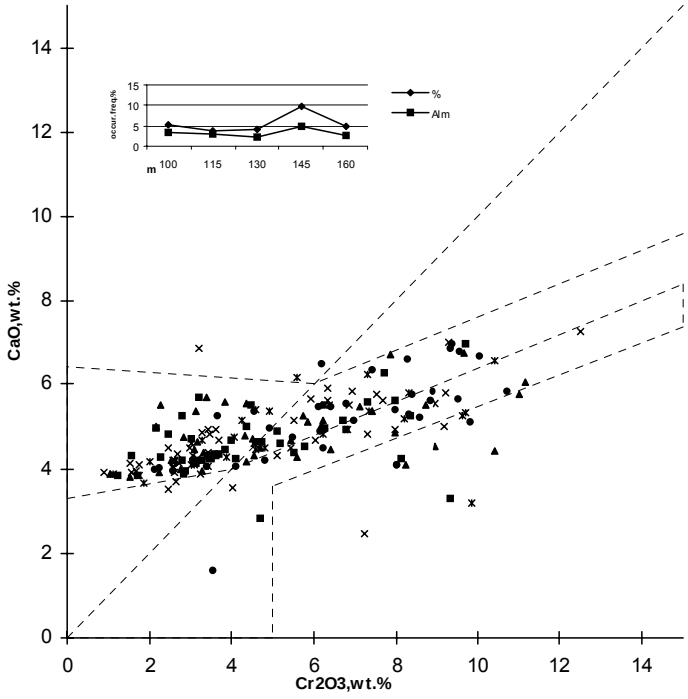

Fig. 2. Composition of pipe Nyurbins'ka garnets, n = 199 (fields according to [1]). Insertion – distribution of ultrabasic garnets of diamond association and useful component along the section.

Fig. 3 and 4 illustrate garnet compositions of revealed genetic groups in different co-ordinates. In the given three-dimensional diagram of co-ordinates areas Mg–Ca–Fe (see fig. 3) of compositions may be overlapped to some extent.

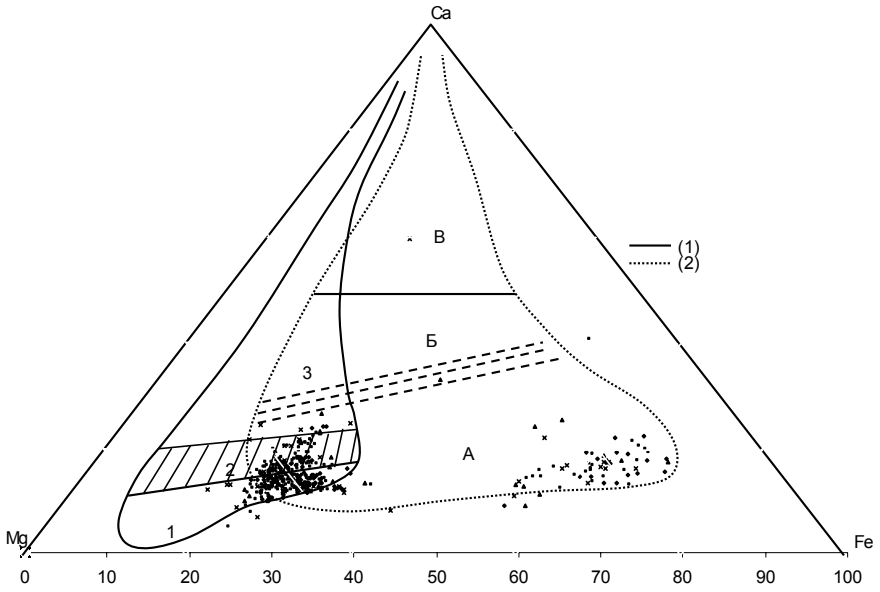

Fig. 3. Diagram of garnet compositions of ultrabasic (*1*) and eclogitic (*2*) paragenesises from kimberlites of Nyurbins'ka pipe in co-ordinates Mg–Ca–Fe. Revealed fields (according to [7]): *1* – of harzburgite-dunites; *2* – lherzolites; *3* – vehrlites; A – bimineral eclogites, Б – disthen eclogites, B – grospydites (n = 432).

In particular part of garnets from magnesia eclogites falls on the field of lherzolite paragenesis. However, on diagram in co-ordinates of calculated parameters Cat (100×Ca/Ca+Mg)–Chr (100×Cr/Cr+Al)–Fe (100×Fe^{2+}/Fe^{2+}+Mg) (see fig. 4) figurative points of eclogitic paragenesis' garnet compositions are localized into a separate field. As it follows from the figure two branches of ultrabasic paragenesis pyrope compositions' distribution are distinguished, separating harzburgite-dunite, lherzolite and vehrlite diversities. Due to high content of chromic component, garnets of diamond association also form a separate trend on this diagram. These diagrams allow detailed description of garnet compositions in the selection and may be used in considering potential diamondiferousness of rocks.

One can trace direct correlation of content in a sample of diamond association garnets, both of basic and ultrabasic paragenesises (see fig. 2), with the level of rocks' diamondiferousness. Carried out investigation of garnet compositions and their co-ordination with morphological and physical properties of diamonds testify about essential dependence of diamond raw material quality on abyssal paragenic associations. Thus, with the increase of eclogitic paragenesis garnets in a sample the content of variety I cubic habit diamonds and crystals of variety IV according to [8] increases.

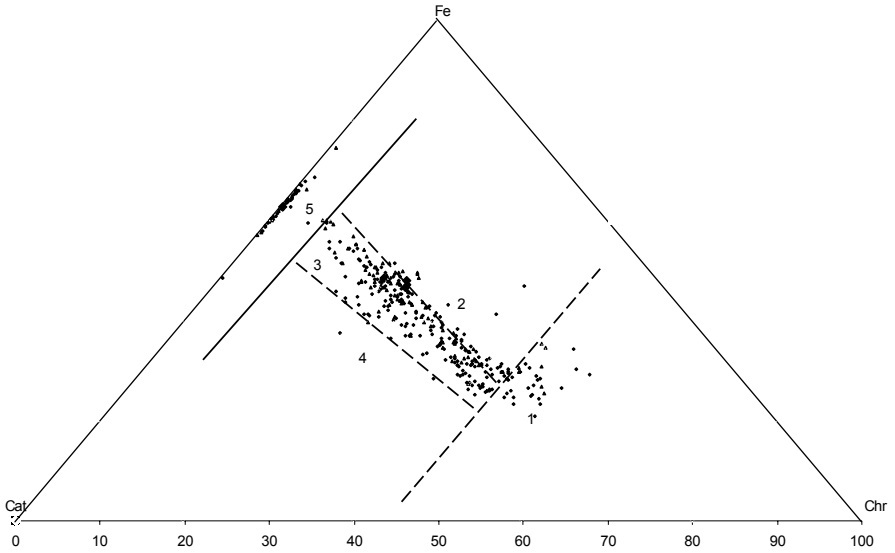

Fig. 4. Diagram of garnet compositions of various genetic groups from kimberlites of Nyurbins'ka pipe in co-ordinates calcic–ferriferous–chromic properties (n = 432). Revealed areas of garnets from: *1* – diamondiferous dunites and harzburgites; *2* – harzburgite-dunites; *3* – lherzolites; *4* – vehrlites; *5* – eclogites.

One can note direct correlation of lherzolite paragenesis garnets with the quantity of variety I octahedral habit crystals. Increase of the quantity of variety VIII diamonds is fixed in the samples with increased content of ilmenite peridotite garnets. The content of crystals of Brazil type "rounded" shape is inversely as the content of rocks' potential diamondiferousness. Diamonds with yellow and yellow-green colouring correlate well with the garnets of eclogitic paragenesis, and crystals with grey colouring – with the content of websterite garnets. Definite relationship of crystal photoluminescence with abyssal paragenesis is observed. The content of diamonds with yellow-green luminescence increases with increase of garnets from porphyraceous lherzolites and magnesia-ferriferous pyroxenites. The quantity of diamonds with zonal luminescence directly correlates with the content of garnets from potentially diamondiferous magnesia-ferriferous eclogites. Inverse dependence is fixed in diamonds of IR-spectra of absorption in system B1 and B2 with availability of eclogitic paragenesis garnets in the sample.

Carried out investigations allow supposing that prevailing part of cubic habit diamonds in kimberlites of pipe Nyurbins'ka was formed on account of eclogitic paragenesis disintegration. Yellow and yellow-green colouring, heterogeneous distribution of photoluminescence, absence of defects in system B2, and higher integrity are characteristic of such crystals. Diamonds of other morphological types with characteristic of them properties positively correlate with the content ultrabasic paragenesis garnets in the selection. Thus, analysis of garnet compositions and diamond properties make it possible to reveal dependence of diamond raw material quality on abyssal paragenesises and by this show the possibility of using indicator minerals during assessment of geologic-economic potential of a deposit.

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ГРАНАТИ З КІМБЕРЛІТОВОЇ ТРУБКИ НЮРБІНСЬКА (ЗАХІДНА ЯКУТІЯ)

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На підставі комплексних досліджень гранатів із концентратів кімберлітів трубки Нюрбінська та властивостей алмазів доведено залежність якості алмазної сировини від глибинних парагенетичних асоціацій. З'ясовано, що аналіз складу гранатів дає змогу визначати глибинний парагенезис у вибірці, а це, відповідно, допомагає оцінити геолого-економічний потенціал родовища.

Ключові слова: кімберліт, алмаз, гранат, глибинний парагенезис, родовище, Якутія.

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