

NEW GENETIC TYPE OF DIAMOND DEPOSITS: GEOLOGICAL PECULIARITIES AND ORIGIN

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Kumdykolskoye diamond deposit of the new genetic type was found in 1980 by geologists of the Kokchetav expedition in the Kokchetav crystalline massif of North Kazakhstan. It contains the great amount of diamonds and enormous explored reserves. It's discovery means that it was found the third type of nature diamond deposits because only kimberlitic and impactitic types were known before it.

Three groups of geologists have different viewpoints on genesis of new diamond type. Group one advocates the mantle origin of diamonds. A second idea is that the diamonds were formed in the Earth crust under the ultrahigh pressure of regional metamorphism. A third (our) theory, that is based on geological data (structure of the deposit, petrology of the diamond-bearing rocks and composition of rock-forming minerals, also the diamond peculiarities) is that diamonds were crystallized "in situ" under moderate P-T conditions.

I, The Kumdykolskoye deposit has following peculiarities:

1. Diamonds are localized in the primordial stratified formation of garnet-biotite gneisses, schists and calciphyres with lenses of eclogites and amphibolites. Main part of ores (93.3%) are composed by gneiss and quartz rocks with high SiO_2 (from 60 to 75%); garnet-pyroxene ore, including altered eclogites occupies 4% and carbonate ore - 2.7% of ores volume. The occurrences of diamonds within stratified rocks of mainly acid composition and their absence within nonaltered eclogites and rare ultramaphites don't confirm the diamond origination in Earth's mantle.

2. The deposit is connected with tectonic zone, the rocks of which had been milonitized, broken down and transformed as a result of metamorphic processes. Rock-forming minerals (mainly garnet and pyroxene) are characterized by wide range of their compositions. The garnets are represented by pyrope-grossular-almandines, pyrope-grossulars, grossulars and grossular-almandines, pyroxenes - by diopsides and salites. It was traced the changing of chemical compositions from nondiamond-bearing rocks to ore. As a rule, gneiss were enriched by Ca. In this process, new Ca-bearing minerals are formed, but garnets and pyroxenes within gneiss enriched by Ca too. The same process took place in eclogites, which were transformed to garnet-pyroxene ore. Garnets composition changed from pyrope-almandine to almandine-grossular (Fig.1). The extraction of gas phase from the rocks of deposit revealed enrichment by CO_2 , CH_4 and others hydrocarbons.

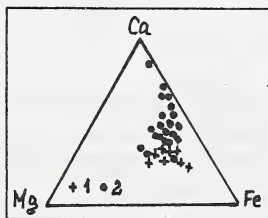


Fig.1. The change of garnets from eclogites to diamondiferous garnet- pyroxene rocks. Garnets: 1 - from eclogites, 2 - from garnet-pyroxene rocks.

3. In difference of kimberlites, the mineral-satellites of diamonds are absent in the new type of deposits. Diamonds are within rock-forming minerals - garnet, pyroxene, amphibole, micas, quartz and many others. The compositions of minerals containing diamond inclusions and of minerals from the ore-free rocks haven't essential distinctions. For example, the garnets from diamondiferous rocks with diamond inclusions and the same minerals from diamond-free rocks aren't differed by chemical composition. But there are variations within groups of rocks (Table 1).

	1	2	3	4	5	6
SiO ₂	38.32	40.32	38.03	38.83	39.25	38.02
TiO ₂	0.17	0.22	0.05	0.14	0.00	0.00
Al ₂ O ₃	20.88	22.21	21.39	21.71	21.21	20.94
Cr ₂ O ₃	0.02	0.04	0.00	0.00	0.52	0.01
FeO	25.99	13.68	26.33	17.67	20.98	22.14
MnO	2.55	1.07	2.01	0.69	1.47	2.47
CaO	7.14	15.33	4.25	12.06	4.36	10.54
MgO	5.02	7.70	6.91	7.04	9.75	3.95
Total	100.09	100.57	98.97	98.14	97.60	98.62

Table 1. Compositions of garnets from gneiss: 1,2-with diamond inclusions, 3,4-from nondiamondiferous rocks within ore zone, 5,6-the same, outside ore zone.

4. The diamonds of metamorphic type are typomorphic. The differences have shown in the table 2.

	Kimberlitic type	Impactitic type	Metamorphic type
Size	0.1mm-1000mm	0.2-5.0mm(average-0.5-2.0mm)	0.001-1.3mm(average 0.02-0.05mm)
Colour	Glass, colourless, rare colours	Grey-black, yellow	Yellowish-green
Habit	Octahedral, rare cubes, dodecahedrons et al.	Polycrystals of table form	Cubes, imperfect (rosette like, spheroidal, table) crystals with zoned-sectoral structure
Isotopic composition a)diamond b)graphite	-1 - -11‰ the same	-12.0 - -17.0‰ the same	-11.6 - -17.0‰ -16.0 - -22.4‰
Mechanism of crystallization	Face (grane)	Just transition graphite-diamond	Nonface fibrous

Table 2. The properties of diamonds from different genetic types

5. The diamonds of different ores are different (Table 3.)

Ore type	Typomorphic diamonds
Garnet-biotite-quartz-feldspatite rocks over gneissis	Yellowish-green cubic crystals, often skeletal ones, 20-50µm - average size
Biotite-quartz rocks	Yellowish-green and colourless octahedron the same size
Pyroxene-flogopite-carbonate rocks	Yellow, grey, white imperfect (rozette-like, spheroidal) crystals, 1-10µm size
Garnet-pyroxene rocks and eclogites	Grey cubic crystals, 100-1000µm size

Table 3.

6. Diamonds from different types of rocks differ by isotopic composition: diamonds from pyroxene-flogopite-carbonaceous rocks contain more ^{13}C then those from apogneissis rocks.

II. There are a few nonindustrial diamond manifestations in the Kokchetav massif besides the deposit. Some of them are localized in altered rocks as a deposit and are represented by the bodies within tectonic zones, the others - by very small ones of a garnet-pyroxene skarns, confined to the margin of granitic massif near the deep fault zone. The reliability of these finds is confirmed by diamond presence in thin sections. Two finds of diamond have taken place within recrystallized eclogites, but this were not confirmed by thin sections. Common feature of these occurrences is localization in altered rocks near the deep fault zone.

III. Not so far ago, Barchy ore area was found in the distance 15 km from the Kumdykolskoye deposit. Its geological position is like the deposit. A lot of ore zones were found in this new area. There are some difference between Barchy area and the deposit. Diamondiferous rocks of Barchy area often are more compound. As a rule, gneissis contain the disten and tourmaline and thier garnets are more ferriferous, than in the deposit. The most of diamonds have perfect and transparent forms; atelene skeleton forms are occured rarely.

IV. The geological data on the deposit and nonindustrial manifestations give the evidence of the diamond crystallization from gas fase in tectonic zones under moderate P-T conditions. Principal possibility of such process is confirmed by theoretal (Rudenko et al., 1993) and experimental (Fedoseev and Derjaguin, 1983) investigations.

Rudenko, A.P., Kulakova, I.I., Skvortsova, V.L. (1993) Chemical Diamond Sinthesis.

Aspects of General Theory. Uspehi Chimii, 62-2, 99-117 (in Russian).

Fedoseev, D.V and Derjaguin, B.V. (1983) Origin and growth of diamond at the high and low pressures. In Super-hard materials, p.16-22. Kiev. (in Russian).