EXPERIMENTAL STUDY OF THE FORMATION OF ROUNDED DIAMOND CRYSTALS

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At present, most of the scientists do not question the formation of rounded natural diamonds of octahedroid, dodecahedroid and tetrahexahedroid type in the process of post-growth evolution of the flat-faced crystals. Yet, the problem of the nature of such process and the composition of the medium, influencing diamond, remains open to discussion. This leads to the appearance of a new term, "resorption", for describing a non-specific process which has, subsequent to diamond growth diminished the size of the diamond, whether it be by oxidation, graphitization or some other mechanism [1]. In previous works [2-4] we had shown that in the process of dissolution in aqueous silicate melts, the dissolution forms, morphologically similar to the natural semi-rounded diamond crystals, developed. However, in such experiments synthetic diamond crystals were used, and dissolution was followed only up to 15-20% loss of their initial mass. In the present work, the experimental results of deep dissolution of the main habit types of natural diamond in the model carbonate and silicate systems are presented.

The experiments were held on the high-pressure apparatus of the "split-sphere" type at the pressure 5.0-5.5 GPa in the temperature range 1350-1450°C, in accordance with the previously published technology [5]. In the experiments, the carbonates Na_2CO_3, $CaCO_3$, $MgCO_3$ and silicate $CaMgSi_2O_6$ were used. The purity of the reagents was not less than 99.9 wt %. Carbonate or silicate powder (120-130 mg), distilled water (20 wt %) and diamond crystals were put into platinum ampoules, which then were hermetized by arch-welding. For the purpose of dissolution, natural octahedrons, pseudo-dodecahedrons and cubes 0.5-1.0 mm in size from the "Udachnaya" and "Ajkhal" kimberlite pipes, along with cubooctahedral synthetic diamond crystals, were used. In each experiment the number of crystals was 10, with their bulk mass of 3.5 up to 5.5 mg. Dissolution of the crystals was stated according to the changes of their weight, decrease of their geometrical size and changes of macro- and micromorphology. In the experimental series with their duration from 1 to 40 hrs, the evolution of crystals' forms, up to their complete dissolution, was followed. There were not found any essential morphological differences for the forms of diamond dissolution in the carbonate or water-silicate systems. Dissolution of the crystals in all the studied systems proceeded according to one scheme.

At the initial stage of diamond dissolution the negatively oriented trigons and ditrigonal layers of dissolution form on the {111} faces, while on the {100} faces, tetragonal pits occur. At crystal edges, the rounded surfaces with the sheaf-like or hackle striation, drop-like hills and facial juncture, develop. In the course of dissolution, the rounded surfaces expand and, finally, totally destroy the initial crystal faces. The initial faces of octahedral crystals disappear completely after dissolution of more than 20 wt %, at the same time, the crystal still maintains its octahedral habit and can be characterized as octahedroid. The initial faces of natural cubes disappear after dissolution of more than 50 wt %, and the crystal attains the characteristic form of tetrahexahedroid. Dissolution of pseudo-dodecahedrons manifests itself in gradual rounding of the {110} pseudo-faces. On crystals of all the types, ditrigonal layers around the [111] apexes and facial junctures are present. In the process of further dissolution, the crystals become more and more rounded and lose their initial shape completely, taking the spherical form, typical for the so-called natural diamonds of the Ural type.

Thus, the obtained results represent the first experimental proof of the formation of dodecahedroids, octahedroids and tetrahexahedroids of natural diamond in the process of dissolution of the flat-faced crystals. Considering the previously obtained results on diamond dissolution in anhydrous silicate [2] and carbonate [6] melts, the conclusion can be made, that it is the presence of water in the reaction medium that has the particular importance for the formation of natural diamond rounded crystals. Kimberlite and lamproite magmas, transporting diamond from the upper mantle, are the most probable water-containing carbonate-silicate media reactional relative to natural diamond.

1. Otter M.L., Gurney J.J. Mineral inclusions in diamonds from the Sloan diatremes, Colorado-Wyoming State Line kimberlite district, North America // Kimberlites and Related Rocks (ed. J. Ross), Geological Society of Australia, Spec. Publ. 1986.N 14. V.2. Blackwell, Oxford. P.1042-1053.
2. Chepurov A.I., Pal'yanov Yu.N., Khokhriakov A.F., Sonin V.M., Sobolev N.V.. On the forms of dissolution of diamond crystals in the silicate melts at high pressure // Dokl. AN SSSR. 1985. V.285. № 1. P.212-216.
3. Khokhriakov A.F., Pal'yanov Yu.N. Morphology of diamond crystals, dissolved in the aqueous silicate melts // Mineral. Zhurnal. 1990. V.12. № 1. P.14-23.
4. Pal`yanov Yu.N., Khokhriakov A.F., Borzdov Yu.M., Sokol A.G. On the Role of Water in Growth and Dissolutions of Diamond // Proceeding of 8 Int. Symp. on Water-Rock Interaction

(WRI-8) Vladivostok, Russia, 1995, Balkema, Roterdam. Eds I.Haraka and O.Chudaev. P.95-98.

5. Pal'yanov Yu.N., Khokhriakov A.F., Borzdov Yu.M., Sokol A.G, Gusev V.A., Rylov G.M., Sobolev N.V. Growth conditions and real structure of synthetic diamond crystals // Russian Geology and Geophysics. 1997. V.38. № 5. P.920-945.
6. Khokhriakov A.F., Bajev D.A., Pal'yanov Yu.N. Forms of growth and dissolution of diamond crystals in $CaCO_3$-C system // IV International conf. "Crystals: growth, real structure, application" Alexandrov. 1999. V.1. P.337-341.