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Inclusions of chlorides in natural diamonds from Siberia

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In recent years, microinclusions of Cl-bearing high density fluids that contained silicic, carbonatitic and saline components in variable proportions have been revealed in octahedral diamonds with cloudy central or intermediate growth zones, in diamonds with fibrous coat and in fibrous cubic diamonds from many kimberlite deposits (Tomlinson et al., 2006; Klein-BenDavid et al., 2007 and references therein). Experimental works have shown that chloride-bearing system is a favorable medium for diamond growth (Palyanov et al., 2007). In course of study of microinclusions in diamonds from Siberia unusual chloride microinclusions with specific morphologies have been found by us in a rounded dark-grey dodecahedron from the placer deposits with unknown source in northern Yakutia and in a dark-grey coarse-grained polycrystalline aggregate of diamond from the kimberlites of western Yakutia. The rounded dodecahedron represented V variety according to the diamond classification by Y.L.Orlov consisted of a quite perfect core and fibrous coat with abundant black microinclusions. Its rounded shape was formed during post growth dissolution. The polycrystalline diamond aggregate contained numerous black microinclusions of magnetite and some other Fe-phase as was reported previously (Titkov et al., 2003).
The microinclusions were studied using a JEOL JSM-5300 scanning electron microscope equipped with an Oxford LINK ISIS energy-dispersive spectrometer with an analytical range from Be to U. In preparation for analysis, each sample was crushed after being wrapped in a special paper to avoid contamination. Analysis was performed on rough surfaces of fragments that were fairly flat and oriented nearly perpendicular to the electron beam. These samples were carbon coated.
Study of rounded dodecahedron fragments revealed irregular cavity, about 30 [U+F06D]m across. Its main volume was occupied by a large inclusion of variable composition with an average of 20.6 wt% Na, 15.5 wt% K, 0.6 wt% S, 0.6 wt% Si, 23,2 wt% Cl, 39.5 wt% O. The majority of oxygen may be due to the presence of water. The empty space of the cavity was filled with specific dendrites made up of K, Na, Cl, and O in variable proportions.
In polycrystalline aggregate of diamond, empty cavity, about 70 [U+F06D]m across, was found. Its walls were covered by elongated crystals of chlorides. They consisted of Na, K, Cl, and minor O, with Na sharply predominating over K. It appears that this inclusion contained a large amount of water and volatile components which were possibly lost.
Cl-bearing fluids revealed in natural diamonds in the previous studies contained both K, Cl, water and variable amounts of Na, divalent ions (Ca, Mg, Fe, Ba), carbonate and silica. While it was suggested that pure Cl-brines may occurred in deep-seated diamond-forming system (Tomlinson et al., 2006; Klein-BenDavid et al., 2007). Our results indicate that evolution of diamond-forming systems actually may give birth to practically pure alkaline-chloride brines. These brines were trapped by growing diamonds as inclusions. Upon cooling, K-Na-chlorides crystallized from the brines. Water and volatile components of the system appeared to be removed under decrepitation of the inclusions.

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