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Fluid/melt inclusions in alluvial Northeast Siberian diamonds: new approach on diamond formation.

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The origin of alluvial Northeast Siberian diamonds is still a subject of controversy. Fluid/melt inclusions in diamonds are the deepest available samples of mantle fluids and provide the unique information on the medium in which diamonds have grown. These inclusions carry high-density fluids (HDFs), the compositional variability is in the range of hydrous-silicic, carbonatitic (high-Mg and low-Mg) and saline end-members. Previous studies of the bulk composition and internal morphology of microinclusions in alluvial Northeast Siberian diamonds suggested that they contain fluids, but distribution and structure of their constitutional phases could not be determined.

We investigated two populations of diamonds from Northeast Siberian Platform placers (Ebelyakh area) using TEM, FTIR, EPMA methods: (I) rounded single-crystals (dodecahedrons, octahedrons and irregular stones with a black central zone rich in microinclusions. Some of them frequently exhibit growth twinning; (II) rounded dark crystals, related to variety V according to the classification by Orlov (1977). This group of stones has their own typical features: dark color due to abundant black microinclusions and high dislocation density; mosaic-block internal structure; very light carbon isotopic composition; the high degree of nitrogen aggregation and nearly total absence of mineral inclusions.

Diamonds of the first population are characterized by two types of fluid/melt nanoinclusions:1) multi-phase high-Mg assemblages, which include solid phases (magnesite, dolomite, clinohumite, Fe-spinel, graphite) and fluid bubbles; 2) oriented sulfide melt nanoinclusions in association with halides (KCl, NaCl), high-Si mica and fluid bubbles. All of them ranging between 5 and 200 nm in diameter are reflecting the diamond habit. Sulfides are homogeneous in composition. The Ni/(Ni+Fe) ratio of the inclusions is 0.037 ± 0.04. Still closed fluid bubbles were identified in TEM studies as changing absorption contrast due to density fluctuations caused by the electron beam. Bubbles contain high K, Cl, O concentrations. All of this diamonds are strongly deformed which is documented by high dislocation density. Many dislocations are found around nanoinclusions.

Population II diamonds carry low-Mg carbonatitic HDFs, rich in Ba and Sr. Fluid/melt nanoinclusions consist of several phases: Ba-Sr-carbonates, Ca,Fe-carbonates, K,Ba-phosphates (individual phases not identified), graphite, fluid bubbles and few Ti-silicate phases (not identified). Separatly NaCl, KCl nanoinclusions have been identified. Fluids are rich in H2O, CO2 and CH4.

These preliminary results proved that the diamonds from Northeast Siberian Platform placers are characterized by compositional variability of the parental medium and suggest at least three different sources. The composition of high-Mg is closer to that of near-solidus melts of saturated carbonate peridotites. Thus, it should be possible to produce the Mg-rich HDF either by incipient melting or by cooling and crystallization of a proto-kimberlitic melt at depth (Klein-BenDavid et.al., 2009). Carbonatitic, hydrous-silicic melts and brine and melts were found before. The sulfide melts can coexist with them as well and add another branch to the diamond forming fluid system, thus enlarging the range of trace elements that may be transported by such fluids.

The source rock for the carbonatitic HDFs detected in diamonds variety V, in the view of the first reported data and previous ones as well (Ragozin et al., 2002), can be carbonate- eclogite. The extreme enrichment of these HDFs in incompatible elements can be attributable to the interaction of saline fluids, which bring Ba, Sr, K, Cl, with carbonate-bearing source rock.