Nanometer-Sized Sulfide Inclusions in Yakutian Diamonds: the Role of Sulfides in Diamond Nucleation

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Sulfide inclusions are common among the mineral inclusions in diamonds. They include pyrrhotite, pentlandite, chalcopyrite and Cu-Fe-Ni-monosulfide solid solutions (Mss) and provide unique information on the distribution of chalcophile elements in the mantle. Sulfides as well as the other inclusions in diamonds (DIs) are derived from the two principal rock types occurring in the deep lithosphere, peridotite and eclogite. Nucleation of eclogitic diamonds occurred on a matrix of graphite+iron+wustite, in an environment dominated by forsteritic olivine and Fe-Ni sulfide. Nucleation of eclogitic diamonds occurred in an environment dominated by Fe-sulfide and omphacite (K,Na,Al,Si-melt).

Using FIB/TEM techniques such as electron diffraction, AEM including line scan and elemental mapping, EELS and HREM, we investigated nanometer-sized sulfide-graphite and sulfide-olivine intergrowths; sulfide-silicate-sphen (in aragonite DIs), sulfide-apatite (in coesite - quartz DIs) and sulfide–phlogopite-dolomite–ilmenite-magnetite–apatite–fluid multiphase inclusions in the central zones of Yakutian diamonds. Oriented intergrowths of graphite and sulfide, all of which are homogenous in their chemistry (Fe/Ni ratio is constant) were identified in a diamond containing fluid bubbles. These mineral are accompanied by pyrrhotite or by Mss. All of them are reflecting the diamond habit and coexist with multiple omphacite – microinclusions. As confirmed by recent experimental results sulfides might serve as a possible redox agent. Sulfides inside aragonite DIs as in the case of sulfide-apatite and sulfide-olivine assemblages have heterogeneous composition by distribution of Fe, Ni, Cu –phases in volume. The sulfides consisting of multiphase inclusions and sulfide-olivine intergrowths were trapped together with carbonatitic melts and peridotitic minerals. The common occurrence of sulfide, silicic and carbonatite melts add another branch to the diamond forming fluid system and widens the range of trace elements that may be transported by such fluids. The sulfides assemblages in different central DIs provide evidence for deep fluid processes during diamond nucleation history and they would have significant implication for the interpretation of the chemical and geochronological record of diamond inclusions.

References

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