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Compositional variations of a diamond-forming medium: data from microinclusions in cloudy diamonds from the Internatsionalnaya and Mir kimberlite pipes and coated diamonds from the Sytykanskaya pipe (Yakutia)

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Since diamonds are of considerable fundamental and applied interest, studies of natural and experimental diamond-forming systems remain actual at present. Studies of mineral inclusions in natural diamonds allow considering diamond formation in deep zones of continental lithosphere at 900-1300˚ and more than 5 GPa in eclogitic and peridotitic suits (Sobolev, 1974; Meyer, 1987). Though, multiple petrographic evidences suggest a metasomatic diamond origin with a participation of a high-density fluid or a melt with high volatiles content (e.g. Shatsky et. al., 2005). Thus the most debatable question is concerned with a chemical composition of diamond growth medium, its reference to kimberlitic and lamproitic magmas, and to a mantle metasomatism as well. Clues can be found in polyphase microinclusions, preserved in fibrous diamonds of cubic habit (so-called “cuboids”), coated diamonds, and in cores of octahedral cloudy diamonds. Current studies significantly increase a database of direct analyses of mantle fluid composition in diamonds, but for Siberian kimberlite mines these data are still strongly constrained (e.g. Zedgenizov et al., 2004, 2007, 2009; Skuzovatov et. al., 2011). Here we report the compositional features of diamond-forming HDF for series of natural diamonds from Internatsionalnaya, Sytykanskaya and Mir pipes.

Microinclusions in studied diamonds show wide range of major components content. For most of the Internatsionalnaya pipe cloudy diamonds a carbonatitic type of HDF with rather uniform composition within an individual sample and a whole selection of diamonds is revealed. Here microinclusions are characterized by a low SiO_2 (up to 26 weight %) and the highest CaO, MgO and FeO content. Additionally a continuous trend from carbonatitic to chloride-carbonate compositions was found. Cloudy diamonds from the Mir pipe, being visually similar to those from the Internatsionalnaya kimberlite, have microinclusions with more specific compositional features. Most of them belong to a carbonate-rich type of HDF with a SiO_2content of up to 23 weight %; some samples show a slight enrichment in alkalis (K_2O+Na_2O) or SiO_2 content, marking potential trends towards chloride-carbonate and carbonate-silicic HDF’s respectively. Furthermore, for few samples from the same mine low Ca and silicate-rich compositions are distinguished. At last, two samples from the Mir pipe have microinclusions of both carbonatitic and silicate-rich types. The most significant compositional variations are observed for fibrous coats of the Sytykanskaya pipe coated diamonds. Microinclusions in these diamonds refer to a compositional trend from carbonate-silicic to silicate-rich HDF’s and are similar with diamondiferous kimberlites of Yakutia by a trace element distribution pattern.

It has been established that the bulk composition of microinclusions in diamonds from different deposits of the world varies continuously from water–saline to carbonate and from carbonate to water–silicate end-members (Navon et al., 1988; Schrauder and Navon, 1994; Izraeli et al., 2001 etc.). Our data suggest that formation of fibrous diamonds is possible from the different types of HDF and is not controlled by its major component composition. Moreover, co-existing of several types of HDF’s is possible during diamond formation.