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Paragenesis of Diamond and Minerals of Peridotites and Carbonatites in the Mantle Magma Chambers Based on Experiments Data

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It is considered that role of carbonate melts is important in processes of mantle metasomatism; according to other representations, it is also assumed that they could be formed at partial melting of carbonated peridotite. Dissolving of peridotite minerals and carbon in carbonate melts are responsible for formation of completely miscible carbonate-silicate-carbon magmas parental for diamonds. It can be expected that such carbonate magmas are capable to assimilate an form parental magama "chambers" within the hosting mantle peridotite. While natural cooling of the chambers dissolved in carbonate melts components of the peridotite crystallize forming minerals similar to these of the host mantle peridotite. The recrystallized peridotite minerals are fragmentarily included hermetically within growing diamonds and occur as syngenetic inclusions in them.

Therefore experimental modeling of origin of the upper mantle carbonate-silicate diamond-forming melts, their consolidations in the magmatic chambers and evolutions at conditions of equilibrium and fractional crystallization are especially significant for understanding of processes of deep magmatic petrology and genetic mineralogy, including genesis of diamond.

In the study at 6 GPa model approximations of mineral phases, significant in compositions of probable metasomatic agents, the upper mantle peridotites, and also syngenetic inclusions in diamonds were used: starting mixtures were model peridotite with composition $Ol_{48}Opx_{16}Cpx_{16}Grt_{20}$, close to model compositions of the primitive mantle and real mantle xenolithes, as well as multicomponent carbonate $(CaCO_3)_{20}(Na_2CO_3)_{20}(FeCO_3)_{20}(Na_2CO_3)_{20}(K_2CO_3)_{20}$ modeling carbonatite inclusions in natural diamonds. Spectral pure graphite was used as a source of carbon in the system. Pressure and temperature were reached using apparatus of toroidal type “anvil-with-hole”. Electron microprobe and SEM researches were carried out on the polished surfaces with carbon covering at IEM RAS.

Phase relations of end-member binary systems carbonatite-carbon, peridotite-carbon and complex peridotite-carbonatite were studied at 6 GPa and 1100 - 1750°C. Carbonatite-carbon and peridotite-carbonatite systems are characterized by euthectic type of melting and are responsible for the formation of diamond and paragenetic minerals. We also carried out test experiments proving diamond-forming effectiveness of carbonate-carbon melts oversaturated with dissolved carbon. A solubility curve on the diagram carbonatite-carbon controls the conditions of nucleation and crystallization of diamond. At the same time it is conjugated with phase fields of formation of associations of paragenetic carbonate minerals.

The system peridotite – carbon is notable for demonstration that carbon is insoluble in peridotite phases (olivine, orthopyroxene, clynopyroxene, garnet and melts) in solid and liquid state. A source of components providing syngenesis of diamond and peridotite minerals of peridotite paragenesis in melts of a base ternary system peridotite-carbonatite-diamond. Experimentally proved thermodynamic and kinetic points and boundaries (concentration barrier of diamond nucleation, diamond solubility in peridotite-carbonatite melts, fields of metastable and labile oversaturation) are plotted on a projection of liquidus surface of the system.

The experimental diagrams characterize physico-chemical conditions of syngenesis of diamond and paragenetic peridotitic and carbonatitic minerals.

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