Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04591, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04591
EGU General Assembly 2008

Fluidized carbonate-silicate-carbon melts as growth medium for mantle-derived diamond by experimental criteria

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A common chemical composition of parent medium for mantle-derived diamond is certainly known from mineralogical analysis of syngenetic inclusions therein. The composition can be substantially expressed in terms of multicomponent heterogeneous system of mantle oxides, silicates, carbonates, phosphates, sulfides, chlorides of Mg, Fe, Ni, Ca, K, Na, Al, Cr, some other elements and C-O-H-N fluid components. But, there is not mineralogical evidence for diamond-forming efficiency of any one of these materials or their mixtures at the solid, liquid or fluidized state. Because of this, the chemical composition and phase state of growth medium for most of mantle-derived diamond is highly conjectural. Routine experimental criterion of diamond nucleation («HPHT spontaneous synthesis») provides to determine unequivocally the diamond-forming efficiency of any relevant material. The criterion points to the fact that not a solitary one but a wide diversity of the materials is effrective for diamond nucleation at HPHT experiments. Dissimilar carbonate, sulfide, silicate, chloride, C-O-H phases and their mixtures are among these, and because of this the chemical character of growth medium for most of natural diamond remains a mystery again. A novel experimental criterion of syngenesis of diamond and growth inclusions (which embraces the diamond nucleation one) is proposed and used in this work. The criterion is based on a necessary physicochemical condition for the growth medium to form both diamond and syngenetic inclusions therein. A great body of recent HPHT experimental physicochemical evidence, if based on the syngenesis criterion and fit to mineralogical data, substantiates the model of fluidized carbonate-silicate-carbon melt

(if oversaturated with carbon) as growth medium for most of mantle-derived diamond (Litvin, 2007). The growth medium is molten and composed of major completely miscible carbonate and silicate constituents as well as minor components both soluble (oxides, phosphates, chlorides, C-O-H-N fluids, etc.) and completely immiscible insoluble (sulfides, native metals, etc.). The chemical and phase composition of the molten medium is largely variable in respect of the ratio for carbonate/silicate and carbonate/silicate/soluble components. Fluidization of the growth medium seems to be at an under saturation level and largely variable as well, but the probability of regular existence of high fluid content in the host carbonate-silicate melt and especially formation of the own fluid phase is low. It was recently found that a concentration barrier of diamond nucleation within the changeable carbonate-silicate growth melt fits to the carbonatite composition (less than 40 wt. % peridotite or eclogite constituent) demonstrating an inhibitory role of silicate components for diamond nucleation. Influence of the dissolved C-O-H fluid components onto diamond nucleation and growth in carbonate-silicate (carbonatite) melts is worked out. Immiscible sulfide melt if oversaturated with carbon can serve as the independent growth medium of a secondary consideration for formation of limited mass of diamond with distinctive properties. Support: INTAS grant 05-1000008-7927 «Diamond and graphite in carbonate magmas», Program P9 of the Russian Ac. Sci. «Study of materials at extreme conditions».

Reference.

Litvin Yu.A (2007). High-pressure mineralogy of diamond genesis. *in* Ohtani, E., ed., Advances in High-Pressure Mineralogy: Geophysical Society of America Special Paper 421: 83-103.