



Melting relations in peridotite-carbonate and eclogite-carbonate melts at 7.0–8.5 GPa: application to diamond genesis

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We simulated crystallization of diamonds in melts with variable compositions of model peridotite [60 wt% olivine (Ol), 16 wt% orthopyroxene (Opx), 12 wt% clinopyroxene (Cpx), 12 wt% garnet (Grt)] and eclogite [50 wt% Grt, 50 wt% Cpx], with carbonate of dolomite composition ($\text{CaCO}_3 \cdot \text{MgCO}_3$), K_2CO_3 , and multi-component K-Na-Ca-Mg-Fe-carbonatites. Carbonate-silicate melts in all experiments performed at PT-conditions of diamond stability are completely soluble. Concentration barriers of nucleation (CBN) were estimated at a pressure of 8.5 GPa for variable concentrations of silicate and carbonate components in parental melts: 25, 30, and 30 wt.% of peridotite components and 35, 45, and 35 wt.% of eclogite components, for $\text{CaCO}_3 \cdot \text{MgCO}_3$, K_2CO_3 , and model carbonatite, respectively. At higher silicate concentrations in carbonate-silicate melts, diamond grows only on seed being accompanied by thermodynamically unstable graphite phase.

The appearance of peridotite minerals syngenetic to diamond in the studied diamond-forming melts was established in special run series at $P = 7.0$ GPa and $T = 1200\text{--}1800^\circ$ for the composition of peridotite30–carbonate70 (wt.%). Ol is a liquidus phase in the system with ($\text{CaCO}_3 \cdot \text{MgCO}_3$); at $T < 1700^\circ$, an association of Cpx + Ol + carbonate-silicate melt (L) is stable; at 1600° , Grt is added. The prevalence of Cpx over other silicates was established for this system; none of the runs demonstrated the presence of Opx. It is assumed that in CaCO_3 -rich systems Opx enters into reaction like $2\text{MgSiO}_3 + \text{CaCO}_3 \rightarrow \text{CaMgSi}_2\text{O}_6 + \text{MgCO}_3$ and practically is not presented as a proper phase. In the system of peridotite–alkali carbonate (K_2CO_3) the following assemblages are established: Opx(Ol) + L (1800°C); Opx + X phase + L (1500°C); Opx + Ol + carbonate + L (1300°C), Opx + Ol + wadeite + carbonate (1200°). Crystallization of melts with model multi-component (K-Na-Ca-Mg-Fe) carbonatite proceeds with the following change of mineral parageneses as the temperature decreases: Ol + L \rightarrow Ol + Cpx (Grt) + L \rightarrow Ol + Cpx (Grt) + carbonate. In principle, the appearance of Opx is possible in this system, but only if initial peridotite is enriched in this component, and alkali carbonate (K_2CO_3) essentially prevails over CaCO_3 among carbonate phases. In the eclogite–carbonate system, for the composition of [Grt50Cpx50]35Carb65 (wt%), Grt and Cpx were obtained as liquidus phases depending on the starting composition. Melt crystallization proceeds by the following scheme with a temperature decrease: L – Cpx+L (Grt+L) – Grt+Cpx+L (Grt+Carb+L) – Grt+Cpx+Carb+L – Grt+CPx+Carb.

The results obtained correspond to the carbonatite (carbonate-silicate) model of diamond genesis and point on the theoretical possibility of crystallization of peridotitic and eclogitic silicate minerals syngenetic to diamond in silicate–carbonate melts under PT-conditions of diamond stability. The definite set of mineral inclusions in diamond is determined by the chemistry of carbonate-silicate systems including carbonate composition.

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