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ORIGIN OF ULTRA-DEEP DIAMONDS: CHEMICAL INTERACTION OF Ca-CARBONATE AND THE EARTH'S LOWER MANTLE MINERALS

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The main goal of the work is experimental study of physicochemical conditions of origin of ultra-deep diamonds in the substance of the Earth's lower mantle (LM) based on the experimental criterium of syngenesis of diamond and primary inclusions of LM mineral. Magnesiowustite (Mg,Fe)O, Mg-Fe perovskite (Mg,Fe)(Si,Al)O_3 and Ca-perovskite $CaSiO_3$ mainly present the LM substance and are frequently disclosed as primary inclusions in ultra-deep diamonds together with Ca-, (Ca, Mg, Fe)-, Na-Ca-carbonates. For the upper mantle conditions, the mantle-carbonatite conception of diamond genesis was developed based on the effects of congruent melting of carbonates and complete liquid miscibility of carbonate-silicate melts. Melting of Ca-carbonate and $CaCO_3$ - (Mg,Fe)O, $CaCO_3$ - (Mg,Fe)(Si,Al)O_3 systems, stability of the melts and their decomposition were studied in static high pressure experiments at pressures of 16 to 55 GPa and temperatures of 1600 to 3900 K using diamond anvil cell technique with laser heating. It was determined that melting of Ca-carbonate is congruent at the PT-conditions of the lower mantle and characterized by an expanded field of liquid Ca-carbonate phase. We observed formation of graphite (below 16 GPa) and diamond (between 16 and 43 GPa) on decomposition of the $CaCO_3$ melt at temperatures above 3400 K. At temperatures below 3400 K congruent melting of calcium carbonate was confirmed. Also it was shown that $CaCO_3$ - (Mg,Fe)O - (Mg,Fe)(Si,Al)O_3 system is capable to form diamonds together with Ca-carbonate, magnesiowustite and perovskite as syngenesis minerals at PT-conditions of the lower mantle. We observed formation diamond (between 40 and 55 GPa) on decomposition of the $CaCO_3$ from $CaCO_3$ - (Mg,Fe)(Si,Al)O_3 melt at temperatures above 2000 K. The experimental data on phase relations at the melting and decomposition of $CaCO_3$ and $CaCO_3$-(Mg,Fe)O-(Mg,Fe)(Si,Al)O_3 system as well as diamond crystallization are applied to the problem of formation of natural ultra-deep diamond in carbonate-containing growth media of the Earth's lower mantle.
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