

EXPERIMENTAL NUCLEATION AND GROWTH OF DIAMOND FROM CARBONATE-GRAPHITE SYSTEMS.

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More than 40 high-P,T experiments show that nucleation and growth of diamond occurs from mixtures of graphite and carbonate at pressures greater than 9 GPa. In the presence of carbonate, diamond nucleation temperatures and pressures are consistently reduced by ~200°C and ~3 GPa, respectively, from conditions at which graphite spontaneously converts to diamond in the absence of a catalyst. A 9 GPa threshold for diamond nucleation was observed for the graphite-magnesite system. Above 9 GPa, the minimum temperature for nucleation of diamond from this system was reduced by over 250°C from the temperature, in excess of 1850°C, required at pressures below 9 GPa. No catalytic effect was observed for the system graphite-calcite under the same P-T conditions. Under nominally anhydrous run conditions (8-10 GPa, 1550-1800°C, duration 20 minutes) magnesite remained in the solid state whereas the K-Mg carbonate was completely molten. This led to different morphologies and sizes of synthesized diamond: the diamond produced by solid-state reaction was typically 1-3 µm with poor crystal form, whereas the diamond synthesised from graphite and K-Mg carbonate was 10-20 µm grain size with cubo octahedral, or twinned form. Carbon isotope studies of the experimental starting materials and products clearly identify graphite as the only contributor of carbon to the synthesized diamond. The apparent strong catalytic action of solid magnesite is not fully understood at present. The synthesis temperatures are the lowest known (~1550°C) for experimental diamond nucleation using non-metallic catalysts. The P-T conditions for diamond synthesis within this system (8-10 GPa, 1550-1800°C) overlap with those proposed for upper mantle geotherms (Fig.1). The synthesis results for the graphite-carbonate system are believed to be relevant to nucleation and growth of some natural diamonds. Microdiamonds grown from graphite-carbonate mixtures may perhaps account for the "seed diamonds" seen in the growth centres of some natural diamonds by cathodoluminescence studies (Bulanova, 1995). The seeds have been overgrown by later diamond zones under lower P-T conditions. The carbonate responsible for seed diamond formation could be derived either from the primary asthenospheric mantle (magnesite or magnesiocarbonatite melt) or the subducted lithosphere where, in some bulk compositions, carbonate may persist to high pressures (Yaxley & Green, 1994).

Methods: All experiments were conducted in a 1000 ton multianvil press at UCL using cast MgO octahedra and 8 mm TEL tungsten carbide anvils fully calibrated for P and T (Taniguchi *et al.*, in prep.) All experiments were conducted dry for 20 min duration. The same graphite cell and capsule arrangement was used for each experiment and products were analysed by X-ray, optical, SEM and EPMA methods.

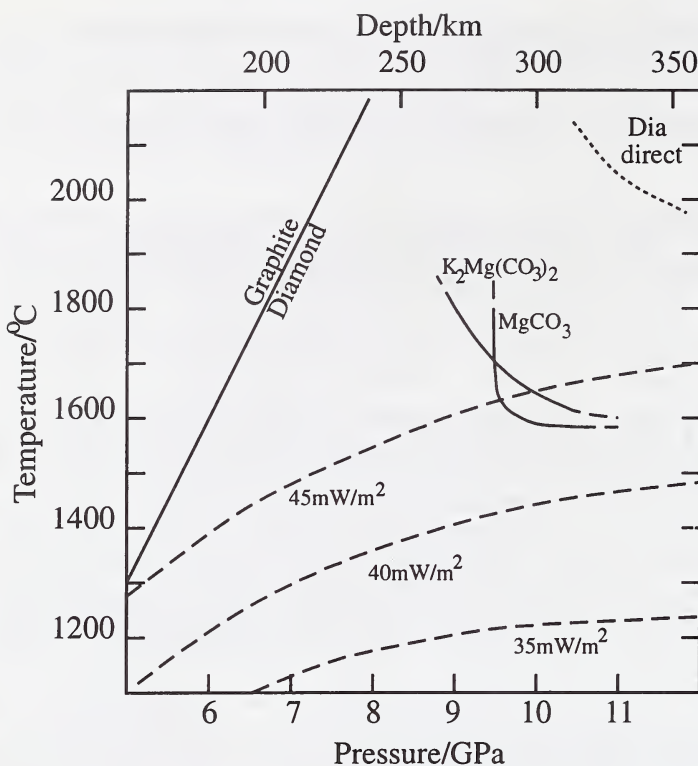


Figure 1: Diamond nucleation and growth region for graphite-carbonate systems. The region of direct transformation of graphite to diamond (Dia direct) and geotherms calculated for heat flows of 35, 40 and 45 mW/m² are also plotted.

References

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