

Diamond formation from magnesite in the presence of C-H-O fluid under high pressure and temperature

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Diamond formation in the Earth's mantle is believed to be a metasomatic process by fluid/melt with peridotitic and/or eclogitic rocks [1]. The ubiquitous occurrence of fluid inclusions in diamonds and the result of recent experimental studies [2] suggest that the presence of C-H-O fluid plays an important role in diamond forming reaction. The composition of C-H-O fluid depends largely on the surrounding oxygen fugacity. Taking into an account the oxygen fugacity values estimated from diamond-bearing xenoliths, the most major components of such fluids at the depth of 150-200 km are likely H₂O and CH₄ [1]. In the deeper mantle, the relative proportion of CH₄ is expected to increase with depth [3]. In the present work, we studied the diamond formation through the reaction between magnesite and reduced C-H-O fluid at high pressure and temperature.

In-situ XRD observation showed that magnesite, MgCO₃ decomposes into periclase, MgO, brucite, Mg(OH)₂ and diamond in the presence of CH₄-rich fluid at pressures above 18 GPa and at ~2000K. Brucite is likely a metastable kinetic product. The formation of nanocrystalline diamond was also observed in the samples recovered from the experiments. Although diamond was produced by the decomposition reaction of stearic acid through the equation described above, the reduction of magnesite by CH₄-rich fluid must also have resulted in diamond formation. Inclusion studies of super-deep diamonds reported that the most dominant mineral phase found in such diamonds is periclase (~60%). However, this is not consistent with the result of high-pressure experimental studies using pyrolitic composition, where Mg-perovskite is the most dominant. Our result implies that some of the periclase inclusions solely found in those diamonds might have formed as a result of the reaction of Mg-rich carbonate with reduced C-H-O fluid. This means that the information obtained from diamond inclusion does not necessarily reflect the bulk composition of the lower mantle.

[1] Shirey *et al.* (2013) *Rev. Miner. Geochem.* **75**, 355-421. [2] Sokol *et al.* (2009) *Lithos* **112S**, 690-700. [3] Frost & McCammon (2008) *Annu. Rev. Earth Planet. Sci.* **26**, 389-420.