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Experimental study on diamond dissolution in kimberlitic and lamproitic melts at 1300–1420 °C and 1 GPa with controlled oxygen partial pressure

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ABSTRACT

To evaluate the dissolution processes of diamond crystals in kimberlitic and lamproitic magmas, a series of diamond dissolution experiments were carried out in the graphite stability field at 1300–1420 °C and 1 GPa under the WI, MW, and HM buffers. Dissolution agents used include an aphanitic kimberlite from Wesselton Mine, South Africa, and a lamproite from Mount North, West Kimberley, Australia. With increasing run duration, diamond morphology changed from a sharp octahedron through combinations of octahedron and tetrahexahedroidal forms to spherical tetrahexahedroid having rounded faces. Negatively oriented trigons were formed on the octahedral {111} face. As the degree of diamond dissolution increased, the trigons changed from smaller shallow types to larger deep types. The dissolution rate in the kimberlitic solvent at 1300 °C was 0.12 mm/h under the HM buffer, 0.0034 mm/h under the MW buffer, and 0.0017 mm/h under the WI buffer, whereas that at 1420 °C was 0.014 mm/h under the WI buffer. In the lamproitic solvent, the dissolution rate was 0.0024 mm/h at 1420 °C under the WI buffer. The data indicate that diamond dissolves in silicate melts as carbonate ions through an oxidizing reaction. The degree of dissolution strongly depends on temperature, oxidation state, and the compositional dependence of CO_2 solubility in the melts.