Morphological change and dissolution rate of diamond in kimberlitic and lamproitic melts

Yusuke Kozai[1]; Makoto Arima[2]

[1] Geological Institute, Yokohama Natl. Univ.; [2] Geolo. Instit. Yokohama Natl. Univ.

Natural diamonds hosted by kimberlite or lamproite display variety of morphological forms and surface textures reflecting mantle source conditions during and following the growth of a diamond and also resulting from dissolution throughout the host magma emplacement. To evaluate the morphological change and dissolution dependence of diamond crystal in kimberlite and lamproite melts, a series of diamond dissolution experiments were carried out in the graphite stability field at 1300-1500 C and 1 GPa under the WI, MW, and HM oxygen partial pressures. Dissolution agents are an aphanitic kimberlite from Wesslton mine, South Africa and a phlogopite lamproite, Mount North, West Kimberley, Australia.

Negatively oriented trigons were formed on the octahedral {111} face. As degree of diamond dissolution increases, trigon changed from smaller shallow type to larger deep type. Trigon and hexagon are limited to octahedral {111} faces. Elongate hillocks formed on rounded tetrahexahedroidal face with minor amount of irregular shaped etch pits. With proceeding dissolution, diamond morphology changed gradually from sharp octahedron with flat {111} faces through combinations of octahedron and tetrahexahedroidal form to spherical tetrahexahedroid with rounded faces and edges.

Diamond dissolution rate in kimberlitic solvent at 1300 C is 0.12 mm/hr under HM buffer, 0.0034 mm/hr under MW buffer and 0.0017 mm/hr under WI buffer. The dissolution rate at 1420 C in the kimberlite solvent is 0.014 mm/hr under the WI buffer. In the lamproite solvent, the dissolution rate is 0.0024 mm/hr at 1420 C under the WI buffer. Under WI buffer condition, the dissolution rate in kimberlitic melt are 0.010 mm/hr at 1400 C, 0.014 mm/hr at 1420 C and 0.059 mm/hr at 1500 C. Diamond dissolution rate in Mount North phlogopite lamproite is 0.0024 mm/hr at 1420 C. Diamond dissolution depends of temperature and its activation energy of 410kJ/mol is obtained for diamond dissolution in kimberlitic melt at 1300 C and 1 GPa under WI buffer condition. The data indicate that diamond dissolves in the silicate melts as carbonate by an oxidizing reaction. The present experimental results clearly demonstrate that diamond dissolves in kimberlite or lamproite melts in the graphite stability field. The degree of dissolution strongly depends on temperature, oxidation state, and the compositional dependence of CO2 solubility in the melts.