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Hydrous fluid as the growth media of natural polycrystalline diamond, carbonado: Implication from IR spectra and microtextural observations

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Abstract

Carbonado, a variety of natural polycrystalline diamond whose origin remains unknown, differs notably in the properties from common diamonds of mantle origin. In this study, infrared spectroscopic and microscopic analyses were conducted on carbonado from the Central African Republic. Stepwise heating followed by infrared spectroscopic measurements indicated that liquid H_2O is enclosed within diamond single crystals in carbonado. Transmission electron microscope observation revealed a negative crystal that is interpreted as a primary fluid inclusion in a diamond single crystal. Observations by field-emission scanning electron microscope and electron backscatter diffraction analysis show an absence of lattice preferred orientation of diamond crystals, {111} growth steps along grain boundaries, and the crystal-size distribution of diamond similar to those of crystals formed in liquid media. In addition, the redox conditions of carbonado formation is inferred to be ~3 log units below the quartz-magnetite-fayalite buffer, which is the prevailing condition in cratonic upper mantle. These lines of evidence suggest that the carbonado crystallized in C-O-H fluid, supporting the hypothesis of a mantle-depth origin of carbonado.

Keywords: Carbonado, diamond, fluid inclusion, IR spectroscopy, TEM, crystal-size distribution