Discovery of H_2O inclusions in Kokchetav metamorphic diamond; diamond crystallization during metasomatism in UHP conditions

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Metamorphic diamond was first reported from the Kumdy-Kol area of the Kokchetav Massif (Sobolev & Shatsky, 1990). Kokchetav diamond occurs in dolomite marbles, gneisses, and garnet-clinopyroxene rock with various features of morphology and occurrence. The coarsest crystal (> 100 μm across) of metamorphic diamond occurs in garnet-clinopyroxene rock, compared to diamond in dolomite marble and gneisses (average size: 10 μm across after Schertl & Sobolev, 2013). We report H2O inclusions and carbonate inclusions in coarse-grained cubic diamond in this rock.
The garnet-clinopyroxene rock collected at the Kumdy-Kol area is composed of garnet layers and clinopyroxene layers with minor amounts of rutile. Due to the simple main constituents, this rock looks like low-P skarn. Diamond occurs as inclusions in garnet and clinopyroxene, and interstitial phases in their boundary. Recently, the same rock type but diamond-free one was described; this diamond-free garnet-clinopyroxene rock contains supersilicic titanite as evidence of UHP conditions (Sakamaki & Ogasawara, 2014).
Cubic diamond grains (approximately 100 μm across) chemically separated from the rock was examined by micro-Fourier transform Infrared spectroscopy (micro-FTIR) spectroscopy in transmission mode. IR spectra of diamond were obtained by using a KBr pellet as an IR transparent window in N2 gas atmosphere. Obtained transmission IR spectra show CO32- bands at 1455 cm-1 (weak), clear CH bands at 3107 cm-1 (strong), broad H2O bands at 3428 cm-1 (strong), and sharp OH bands at 3555 cm-1 (strong) were identified. These bands are caused by carbonate inclusions, H2O fluid inclusions, hydrogen in diamond matrices, and a hydrous silicate mineral, respectively. These IR absorption bands are similar to those from garnet-clinopyroxenite from the same area in De Corte et al. (1998). Strong IR absorption bands by C-N bonds at 1282 cm-1 (A center, very strong), 1180 cm-1 (B center, very weak), and 1133 cm-1 (C center, weak) are also detected.
High concentrations of water as structural OH and submicron-sized H2O fluid inclusions in garnet and clinopyroxene coexisting with diamond were detected; 0 (dry) to OH: 1727 ppm and H2O: 1592 ppm in garnet and total water (OH+H2O): 721 to 4515 ppm in clinopyroxene. Water (OH and H2O) distribution in the host rock is very heterogeneous grain by grain.
The skarn-like constituents, H2O fluid inclusions in diamond, host garnet and clinopyroxene, and high OH contents in host garnet and clinopyroxene indicate that the diamond and its host rock formed under H2O-rich fluid environments such as metasomatism at UHP conditions. The heterogeneous water distribution in the host rock results from a spatial and temporal heterogeneities of H2O fluid conditions during UHP metasomatism.

Keywords: Kokchetav Massif, Diamond, H2O fluid inclusion, micro-FTIR

