

Discovery of H₂O 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 C-O₂ 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