FIB-TEM study of the diamond-graphite boundary in K-bearing tourmaline (Kokchetav massif, Northern Kazakhstan)

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Ultrahigh pressure (UHP) terrains are the unique geological objects for the reconstruction of the carbon cycle in the lithosphere. Diamond and graphite coexist in all diamond bearing UHP terrains (e.g., Schertl and Sobolev, 2013). Graphite coating around metamorphic diamonds in UHP metamorphic rocks has been attributed to the partial replacement of diamond within the graphite stability field (Zhang et al., 1997; Ogasawara et al., 2000; Zhu and Ogasawara, 2002). Here we present the results of FIB-TEM study of the diamond-graphite interface. The focused ion beam technique (FIB) is an ideal tool for transmission electron microscopy (TEM) sample preparation and it allows studying the relationship between minerals on a submicron scale. Diamond-graphite intergrowth, occurring as inclusions in K-bearing tourmaline, was selected for this study. This tourmaline cannot be named maruyamaite (Lussier et al., 2016) due to low K_2O contents (up to 1.8 wt.%).

The diamond + graphite inclusion was located about 5 microns below the thin section surface. Graphite was detected in the contact only with one {111} diamond face, whereas all other diamond surfaces do not show any evidence of an existence of graphite. The grain boundary between diamond and graphite is very sharp. The dissolution features were detected neither on diamond nor on graphite crystals. Graphite has well-ordered structure. The lack of disordered graphite along diamond-graphite interface indicates clearly that the origin of the well-ordered graphite is not related to partial graphitization of diamond. Electronic diffraction patterns of the graphite and diamond crystals testify for their epitaxial growth. Thus, there are two possible explanations for presence of the diamond-graphite intergrowth in UHP metamorphic rocks: (i) metastable graphite crystallization in the diamond stability field implies an UHP origin of K-bearing tourmaline or (ii) if graphite crystallization occurred in its own stability field, subsequently K-bearing tourmaline is not UHP mineral indicator.

This study was supported by Russian Science Foundation grant 15-17-30012.

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Keywords: diamond, graphite, K-tourmaline, ultrahigh pressure metamorphic rocks, Kokchetav massif

