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Surface structure of micro-diamond from ultrahigh-pressure felsic granulite, Bohemian Massif: AFM study of growth and resorption phenomena

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Morphology, associated phases and retrogression phenomena of in-situ microdiamonds formed at extreme pressures in ultrahigh-pressure metamorphic terranes represent excellent tools to study character of diamond-forming media at great depths. Well-preserved microdiamonds discovered recently along with coesite in ultrahigh-pressure granulites of the north Bohemian crystalline basement, European Variscan belt (Kotková et al., 2011), provide unique material for such investigations. The diamonds are enclosed in major granulite phases, i.e. garnet both in felsic and intermediate lithologies and in kyanite in the felsic sample, as well as in zircon. Transmitted and reflected light microscopy of the felsic granulite sample, with peak mineral assemblage garnet, kyanite, feldspar and quartz, revealed presence of numerous, 5-20 μm-sized, perfectly preserved diamond crystals enclosed in kyanite grains. In contrast, diamonds within garnet are rare, can reach up to 30 μm in size, and graphite rims as well as polycrystalline graphite aggregates possibly representing complete diamond retrogression are common.
We applied atomic force microscopy to study in-situ crystal morphology and surface microtopographic features, representing clues to the conditions and mechanisms of crystal formation as well as diamond resorption and retrogression. Both diamond enclosed in garnet and in kyanite of the felsic granulite occur exclusively as single crystals. The crystals have octahedral crystal shapes with straight but rounded edges and rounded corners. Concentric triangular terraces delimiting a flat triangular table on crystal scale and small micron-sized negatively oriented downward-pointing trigons developed on the octahedron crystal faces. Higher magnification reveals presence of discontinuous elongate hillocks oriented parallel to the octahedron face edge with positively oriented trigons. We suggest that the large-scale triangular terraces represent growth features. In contrast, the rounding of crystal edges and corners and development of negative trigons reflect diamond resorption. According to experimental works, such features are attributed to high temperature resorption, i.e. oxidation above $\sim$ 950°C due to interaction with CO_2 and/or H_2O-bearing fluids (or fluid-bearing melts). Our results are consistent with presence of supercritical C-O-H fluid in the rocks in subduction zones documented from other ultrahigh-pressure metamorphic terranes, the resorption morphology corresponding rather to the interaction with water-rich than CO_2-rich fluids.
Kotková J., O′Brien P., Ziemann M. (2011): Diamond and coesite discovered in Saxony-type granulite: Solution to the Variscan garnet peridotite enigma. Geology, 39, 7, 667-670.