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Coarse-grained cubic diamond overgrowth on fine-grained diamond in the Kokchetav UHP garnet-clinopyroxene rock

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Using multilayered 2D laser Raman mappings, an overgrowth of coarse-grained (max. 200 μm across) cubic diamond on a fine-grained diamond (ca. 10 μm) was confirmed in diamond-bearing garnet-clinopyroxene rock from the Kokchetav Massif. Garnet-clinopyroxene rock is one of the diamond-bearing rock types which were first reported as metamorphic diamonds by Sobolev and Shatsky (1990), whereas diamond-free garnet-clinopyroxene rock with coesite exsolution in titanite was reported later by Sakamaki and Ogasawara (2014). The occurrence of extraordinary coarse grains (cubic and "ball-shaped") as "microdiamond" in this rock has been well known to UHP metamorphic petrologists (e.g., Dobrzhinetskaya, 2012; Schertl and Sobolev, 2013). Recently, we found 4 grains of fine-grained diamond having different morphology (rounded-shaped with smooth surface) in the same rock sample, and these two types suggest that diamonds in garnet-clinopyroxene rock formed at two different stages and environments.

Diamonds in garnet-clinopyroxene rock were analyzed by laser Raman spectroscopy using Ar^{+} laser (514.5 nm) and solid-state laser (487.9 nm). All diamonds showed a Raman peak at ca. 1332 cm^{-1}. The peak positions and the values of the FWHM (full widths at half maximum) of the Raman bands are followings: (1) cubic: 1330.8-1332.0 cm^{-1}, 4.29-5.34 cm^{-1}, and (2) fine-grained: 1332.1-1335.2 cm^{-1}, 4.75-5.43 cm^{-1}. 2D Raman mappings at different focal depths were conducted to examine the internal structure of cubic diamond. Very clear internal zonation (core domain and rim domain) of peak positions and FWHMs of diamond Raman band were recognized in the three grains; the peak positions slightly decrease from the center (1331.8-1331.9 cm^{-1}) to the outside (1331.1-1331.6 cm^{-1}) and the values of FWHM decrease from the center (4.73-5.13 cm^{-1}) to the outside (4.21-4.81 cm^{-1}). Fine-grained diamond recently found showed similar peak positions and FWHMs with the core domain of the cubic grains. Diamonds in dolomite marble and in garnet-biotite gneiss did not show such internal structure. Such heterogeneity of peak positions and FWHMs cannot be explained by the residual pressure of homogeneous diamond grain itself according to the results of Raman spectroscopy of Kimberlite diamonds. The zonation pattern like the core domain and the rim domain shows heterogeneous characters in coarse-grained cubic diamond and strongly suggests the overgrowth of cubic diamond on fine-grained one as a seed crystal. We concluded that in diamond-bearing garnet-clinopyroxene rock the diamonds crystallized at two different stages and the cubic diamond at the 2^{nd} stage was probably crystallized from aqueous fluid.

References

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