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コクチェタフ産マイクロダイヤモンド中の炭素包有物の発見―超高圧変成作用起源のダイヤモンド形成に伴う sp2 結合炭素の介在
Diamond formation through intermediate sp2 carbon from fluid in dolomite marble during the Kokchetav UHP metamorphism

三浦 将 [1*] ; 小笠原 義秀 [1]
MIURA, Sho[1*] ; OGASAWARA, Yoshihide[1]

[1] 早稲田大学地球科学教室
[1]Department of Earth Sciences, Waseda University

Graphitic carbon inclusions were discovered inside microdiamond grains in dolomite marble from the Kokchetav Massif. The discovered inclusions are sp^2 carbon species and are probably relics of an intermediate metastable phase for diamond formation from H_2O-rich fluid during UHP metamorphism; on our previous studies on diamond and graphite, these carbon species are not metamorphic graphite relics, not graphite changed from diamond, and not graphite crystallized from H_2O-rich fluid at later stage.

We examined over 5,000 diamond grains in 40 thin sections of dolomite marbles under a transmission optical microscope. Five sp^2 carbon inclusions have been discovered in five diamond grains. These host diamond grains are 4-15 μm in diameter. These graphitic carbon inclusions are black under a microscope and their sizes are 1-5 μm across.

The microdiamond in dolomite marble has been classified into S-type, T-type, and R-type grains on the basis of the morphologies [1], Raman spectra [1], cathodoluminescence spectra [2], and carbon isotopic compositions [3]. R-type and the core of S-type formed at 1^{st} stage, and T-type and the rim of S-type crystallized at 2^{nd} stage from H_2O-rich fluid. All sp^2 carbon inclusions were found only in the rim of S-type (one grain) and T-type (four grains).

Using multilayered 2D Raman mappings at different focal depths with solid-state laser (487.9 nm), Ar^+ laser (514.5 nm), and He-Ne laser (632.8 nm), the Raman spectra of the examined graphitic carbon inclusions show a peak at ca. 1580 cm^{-1} (assigned to G-band caused by sp^2 bond of carbon), and these sp^2 carbon inclusions are completely included inside the host diamond grains. The G-bands of peak position with FWHM for the sp^2 carbon inclusions are as follows: (the rim of S-type) 1572.0 cm^{-1} with 17.8 cm^{-1}, 1581.3 cm^{-1} with 17.7 cm^{-1}, and 1576.5 cm^{-1} with 16.5 cm^{-1}; (T-type) 1574.9-1584.0 cm^{-1} with 18.0-28.3 cm^{-1}, 1580.3-1587.1 cm^{-1} with 17.3-41.9 cm^{-1}, and 1581.5-1584.2 cm^{-1} with 17.7-31.0 cm^{-1}. The relative peak intensities of G-band to the host diamond band (ca. 1332 cm^{-1}) are less than 10 %, and the strongest G-band peaks were detected at the center of the host diamond grains. The spectra of the inclusions often show disordered graphite bands; D1-band (ca. 1360 cm^{-1}) and D2-band (ca. 1620 cm^{-1}), but these bands are usually weak rather than G-band.

The discovered sp^2 carbon inclusions were formed at the 2^{nd} stage of the diamond formation, and could be relics of an intermediate metastable phase precipitated from H_2O-rich fluid and followed by the transformation to diamond. This interpretation is consistent with the previous studies of diamond synthesis using C-O-H fluid at diamond stability fields (e.g. [4]).

References

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Keywords: microdiamond, sp2 carbon inclusion, diamond formation, intermediate metastable phase, H2O-rich fluid, Kokchetav UHP metamorphism