Characteristics of a microdiamond discovered from the orogenic garnet-peridotite in the Bohemian Massif

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In the Moldanubian zone of the Bohemian Massif, lenticular garnet-bearing peridotites occur within the Gfohl granulite which suffered ultrahigh-temperature metamorphism (˜1000 C). Medaris et al. (1998) postulated that some garnet-bearing peridotites were derived from the asthenospheric mantle and acted as a heat source for ultrahigh-temperature metamorphism of country granulite. However previous pressure-temperature estimates for these garnet-bearing peridotites are generally below the stability field of diamond, which contradicts the asthenospheric origin for these peridotites. This study reports on the first finding of a diamond from the garnet-bearing peridotite in the granulite of the Bohemian Massif. We study on the characteristics of this diamond by use of spectroscopic techniques and the synchrotron micro-XRF spectroscopy.

A diamond grain, with 0.1 mm in diameter, was incidentally collected from one garnet-bearing peridotite sample during the course of extractions of thorianite and monazite grains (Naemura et al., 2008). We also confirmed the existences of graphite grains in the peridotite sample. Graphite and the diamond have been identified by use of Raman spectroscopy. Although there are dark inclusions in the diamond, we cannot identify them by Raman spectroscopy. Further analysis by use of FT-IR spectroscopy detected H2O-related absorptions (1650, 3000-3400 cm-1) from the diamond, suggesting that the diamond grain contains some fluid phases and/or hydrous minerals. FT-IR analysis also suggests that the diamond grain contains ˜300 ppm nitrogen that distributes as a dispersed atom in the lattice of diamond (so called Type Ib diamond). The extremely low aggregation state of nitrogen in this diamond suggests that diamond did not experience annealing at high-temperature conditions (˜1000 C).

To determine the chemical compositions of inclusions in the diamond, we performed the micro-beam X-ray fluorescence analysis in KEK-PF BL-4A, Japan. The obtained results revealed that Fe, Ni, Cu and Zn distribute heterogeneously throughout the diamond grain. Particularly, the presence of a significant amount of zinc in the diamond strongly suggests that this diamond grain is not contamination of synthetic diamond grain, because zinc is never used as catalysts through the synthetic processes in general. Other minor elements, such as K, Cl, and Ca, have been also identified. We further analyzed the valence states of Fe, Ni, Cu and Zn on the basis of the K-edge XANES spectra. The obtained results suggest that Fe and Ni mostly occur as metals, while Cu and Zn occur as divalent ions. Particularly the latter chalcophile elements probably occur as sulfide inclusions.

The similar diamond grain, that shows an extremely low aggregation state of nitrogen and contains Fe-Ni metals, is reported from the Donqiao ophiolite in the Tibet (Nixon, 1995), and it has been quite difficult to distinguish such a diamond from the artificial synthetic ones. This study suggests that the existences of chalcophile elements (Cu, Zn) offer new criteria to distinguish the natural diamonds from the artificial ones. If the newly found diamond is natural origin, the host garnet peridotite should once reside in the diamond-stability field which cannot be identified by the previous thermobarometric studies (Naemura, 2008). The extremely low aggregation state of nitrogen suggests that the diamond should not stay in the mantle for a long time. Instead, the diamond crystallized shortly before and/or during the exhumation of the peridotite from the diamond-stability field.