Mineralogical study of microdiamonds in Higo- and Nishisonogi metamorphic rocks

*Hiroaki Ohfuji[1], Kosuke Fukuba[1], Tadao Nishiyama[2]

1. Geodynamics Research Center, Ehime University, 2. Department of Earth and Environmental Sciences, School of Science, Graduate School of Science and Technology, Kumamoto University

Non-kimberlitic diamonds have been reported mostly from orogenic belts produced by continental collision such as in ultra-high pressure metamorphic rocks (e.g. Kokchetav, Kazakhstan) and in ophiolites (e.g. Tibet and Polar Urals, Russia). Recently, microdiamonds have been identified in Higo- and Nishisonogi metamorphic rocks in Kyusyu, Japan by micro-Raman spectroscopy (Nishiyama et al., 2015, 2017 JpGU). In the former rock micro(nano?)-diamonds were found in fluid inclusions (negative crystals) in chromite crystals constituting chromitite found in a serpentinite block, while in the latter rock they occur in a matrix of metapelite contained in a serpentinite mélange. In the both cases, a peak centered at 1330-1332cm^{-1}, which is characteristic to diamond, was clearly observed in the Raman spectra collected from the surface of thin-sections which were carefully prepared by mechanical polishing using only carborundum (SiC) and alumina abrasives so that the samples are not contaminated by any extrinsic diamond sources. In this study, we conducted the direct electron microscopic observation of those diamond and diamond-like carbon grains contained in the two metamorphic rocks.

We carefully prepared cross-sections from sample blocks by ion-milling using a JEOL cross-section polisher (CP) to avoid any potential contaminations during the sectioning process. The ion-polished surface was then coated with osmium and observed by FE-SEM equipped with EDS. Thin cross-sections foils were cut out from some target areas containing microdiamond grains by focused ion beam (FIB) for TEM observation. In the samples from the Higo metamorphic belt, diamond-like carbon grains were found exclusively inside negative crystals in chromite and show a spindle shape of < 1 micrometer. TEM analysis of the grains revealed that they consist of randomly aggregated nanocrystalline graphite of tens to hundreds of nanometers and show no signs of the presence of diamond phases according to the selected-area electron diffraction and high-resolution imaging. These poorly crystalline graphite grains may be a pseudomorph after diamond produced by the retrogressive phase transition during ascending of the host rock.

On the other hand, in the metapelite from Nishisonogi (Nagasaki) metamorphic belt, diamond grains occur mostly in pore spaces (cavities) in the phengite matrix. The metapelite samples also contain graphite crystals with tubular shapes in the matrix and pyrite grains, but diamond was not found near those graphite crystals. TEM observation showed that individual diamond crystals are ~0.5 micrometer in size and show angular shapes. Electron diffraction pattern collected from each crystal show single-crystal patterns which are reasonably explained by diamond reciprocal patterns. We are further examining the mineralogical and crystallographic features of these diamond and diamond-like grains to understand their formation process.

Keywords: Diamond, Higo metamorphic rock, Nishisonogi metamorphic rock

