Carbon-rich fluids and formation of microdiamonds in nature

JINGSUI YANG[1], DONGYANG LIAN[2], PAUL T. ROBINSON[1], AND WEIWEI WU[3]

[1] CARMA, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, 100037, China
[2] School of Earth Sciences and Engineering, Nanjing University, Nanjing, 210023, China
[3] College of Marine Science and Technology, China University of Geosciences, Wuhan, 430074, China

We have confirmed the existence of microdiamonds in ophiolitic mantle peridotites and podiform chromitites. Occurrences of ultrahigh-pressure and super-reduced minerals in chromite and peridotite, collectively confirm extremely high pressures (10 GPa to ≥ 22 GPa) and super-reducing conditions in their environment of formation in the mantle. New Infrared (IR) spectra data reveal that these diamonds contain fluid inclusions, e.g., water, carbonates, hydrocarbons, and solid CO_2. The high IR peak position of solid CO_2 inclusions is caused by intense internal pressure, providing evidence that the fluid inclusions were trapped during diamond growth [1]. Crystallization of diamond from a C-rich fluid is consistent with the observed inclusions. These prove that the diamonds formed in carbon-rich fluids which differ significantly from most gem-diamonds in kimberlites. Many types of microdiamonds (less than 1 mm), in addition to macrodiamonds, occur within kimberlite and lamproite, including some fibrous and cuboid diamonds. Coated cuboid diamonds typically contain abundant hydrocarbons and water, which suggest they may have grown from carbon-rich fluids and/or volatile-rich melts. Microdiamonds have also been reported from volcanic basalts and diabase dikes in oceanic basins and cratons. The features and carbon isotopes of these microdiamonds suggest that they most likely grew from carbon-rich fluids in deeply subducted slabs. Carbon-bearing fluids and melts may have formed in the mantle transition zone, in the lower mantle, or even near the core-mantle boundary. Fluids or melts may rise through the lower mantle, possibly as deep plumes and reach the MTZ under both oceanic and continental crust. Because ophiolites represent widely distributed blocks of ancient oceanic lithosphere on land, they represent a major output of recycled subduction materials, and provide one of the most important means of studying deep mantle circulation and deep Earth dynamics.

[1] Moe et al., 2017. Lithosphere.10(1): 133-141.