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Estimation of depth origin of inclusions in diamonds using three-dimensional Raman mapping measurement.

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Most natural diamonds trap the surrounding minerals or fluids as inclusions during its formation in the Earth's interior. The depth information of inclusions is very important for considering mineral distribution in the Earth and formation condition of diamonds. The depth origins of diamonds are commonly estimated by chemical composition of inclusions or chemical equilibria between coexisting mineral inclusions. Recently, several studies reported the source conditions of diamonds estimated from residual stress in inclusion and around the inclusions. This method has prospects of universally applicable to estimate the depth origin independently from chemical composition of inclusions.

In the process of ascent to the Earth's surface, the inclusion and the host diamond experience the volume variation in response to reduction of pressures and temperatures. As a result, volume of most inclusions become larger than that of host diamond, then the inclusions are under compression and diamond around inclusions become stressed. Residual pressure of diamond can be measure using micro-Raman spectroscopy, as the diamond Raman peak shifts to higher wavenumber when positive pressure is applied. In this study, pressure and temperature of the diamond source region was estimated by three-dimensional micro Raman mapping measurement.

The studied sample is from Internationalnaya pipe (Russia) and contains olivine and chromites as inclusions. The sample surface was polished to optical grade. Raman spectra of diamond were measured using a confocal laser microscope equipped automatic X-Y-Z stage. As the peak position of Raman spectra oscillate synchronizing with room temperature variation and it makes noise on measured result, neon atomic lines were inserted directly into the spectrometer together with the Raman spectrum and used for wavenumber calibration.

As results of Raman mapping measurements, deformation around inclusions was three-dimensionally visualized and the difference of the maximum residual pressure around olivine and chromite was revealed. Using measured maximum residual pressures, the compressibility and thermal expansion of diamond and inclusions, source temperature and pressure were calculated. The value was in the stability field of diamond, but the calculated temperature was significantly low compared with the mantle geotherm. In our presentation, further details about the discrepancy will be discussed.