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Mapping of residual pressure around an inclusion in sapphire by fluorescence spectroscopy

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Residual pressure distributes around a mineral inclusion taken in a mantle-derived mineral represented by diamonds (e.g. Nasdala et al., 2003). It can provide useful information about the depth in the origin of the diamond by determining the residual pressure around a mineral inclusion in a diamond with spectrophotometric technique (e.g. Kagi et al., 2009). Differential stress between an inclusion and host mineral such as a diamond arises from differences in thermal expansion and compressibility between a mineral inclusion and host mineral. Corundum is the second hardest mineral and substantial residual pressure around an inclusion can be expected as well as diamond.

In general, corundum (Al_2O_3) includes a small amount of Cr^{3+} in the structure and fluorescence spectra attribute to Cr^{3+} ions can be obtained. Fluorescence spectra of corundum consist of R1 line at 694.3 nm and R2 line at 692.9 nm. The peak shift of the R1 line is affected by the differential stress, but the R2 line is not (Chai and Brown, 1996). So, we can estimate residual pressure from the peak position of the R2 line.

In this study, we used sapphire samples a kind of corundum. Around a mineral inclusion in sapphire, we measured fluorescence spectra using a three-dimensional fluorescence mapping system every 5 micrometers or 10 micrometers and determined residual pressure of each measurement point from the peak shift of the R2 line using a pressure calibration curve (Mao et al. 1986). We studied two kinds of sapphire samples; one is from Kings plains creek, Australia, and the other is from Kanchanaburi, Thailand. Albite, zircon and rutile were contained as mineral inclusion around 100 micrometer in size, and some of the inclusions have a radial crack. The maximum residual pressures around the zircon in the sample from Australia and albite in that from Thailand were determined to be 0.60GPa and 0.25 GPa, respectively. In the presentation, we will discuss the uptake process of the inclusion and the growth history of the sapphire from the pressure distribution around the inclusion.

Keywords: inclusion, sapphire, residual pressure, fluorescence spectroscopy