CATHODOLUMINESCENCE SPECTROSCOPY FOR QUANTITATIVE ESTIMATION OF SHOCK PRESSURE ON ALKALI FELDSPAR IN MARTIAN METEORITES

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Introduction: Shock pressure induced on meteorites and impactites has been estimated to elucidate a meteorite ejection process based on refractive indices of plagioclase-maskelynite, which has been not available for weakly shocked materials below 15 GPa and micro-size samples. Cathodoluminescence (CL) spectroscopy provides useful information on the existence and distribution of defects and trace elements in micro-size minerals. This technique can be expected to clarify shock pressure effect on the feldspar in meteorites and impactites. In this study, CL spectral analysis of experimentally shocked sanidine has been conducted to deduce shock pressure on alkali feldspar in Martian meteorites.

Samples and Methods: Single crystal of sanidine ($Or_{87}Ab_{13}$) from Eifel, Germany was selected as a starting material for shock recovery experiments at 10 to 40 GPa by a propellant gun. Diaplectic feldspar and glass in shergotty of Dhofar 019 ($Or_{49}Ab_{42}An_9$), Shergotty ($Or_{71}Ab_{22}An_7$), Zagami ($Or_{67}Ab_{26}An_7$) and NWA 2975 ($Or_{69}Ab_{28}An_3$), in nakhlite of Yamato 000749 ($Or_{70}Ab_{27}An_3$) were analyzed by CL spectroscopy. CL spectra were obtained by a scanning electron microscopy-cathodoluminescence system (SEM-CL), which is comprised of SEM (JEOL: JSM-5410) combined with a grating monochromator (OXFORD: Mono CL2).

Result and Discussion: Color CL images of unshocked and experimentally shocked sanidine at 10.0 GPa show a red-violet emission similar to alkali feldspar in nakhlite of Yamato 000749, whereas that of sanidine at 20.0 GPa consists of blue CL with vein-shaped texture on red-violet luminescent background. Shocked sanidine at 31.7 and 40.1 GPa and alkali feldspar in shergottite of Dhofar 019, Shergotty, Zagami, and NWA 2975, however, exhibit a blue emission in color CL images. CL spectrum of unshocked sanidine has emission bands at 420 nm and at 730 nm. Shocked sanidine above 31.7 GPa have CL emissions at 330 and 380 nm. Similar UV-blue emissions were found in alkali feldspar in the Martian meteorites. The deconvolution of CL spectra obtained from unshocked and experimentally shocked sanidine, and alkali feldspar in the Martian meteorites can successfully separate the emission bands in UV-blue region into four Gaussian components at 2.82, 2.95, 3.26 and 3.88 eV. Integral intensities of the component at 2.95 eV assigned to shock-induced defect center positively correlate with shock pressure induced on the sanidine, resulting in estimated shock pressures at 7.4 GPa for Yamato 000749, at 26.1 GPa for Dhofar 019, at 31.3 GPa for Shergotty, at 25.5 GPa for Zagami, at 34.4 GPa for NWA 2975. The present CL spectral deconvolution method may allow us to estimate shock pressures to as weak as 5 GPa quantitatively for micron-size alkali feldspar.