CLARIFICATION OF SHOCK-INDUCED EFFECT ON CATHODOLUMINESCENCE OF ALKALI FELDSPAR. M. Kayama[1], H. Nishido[1], T. Sekine[2], T. Nakazato[1], A. Gucsik[3,4] and K. Ninagawa[5], [1]Research Institute of Natural Sciences, Okayama University of Science, 1-1 Ridaicho, Kita-ku, Okayama 700-0005, Japan (E-mail: kayama@rins.ous.ac.jp); [2]Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, Kagami-yama 1-3-1, Higashi-Hiroshima, Hiroshima 739-8526, Japan; [3]Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University, Aoba 6-3, Aramaki, Aoba-ku, Sendai, 980-8578, Japan; [4]Konkoly Observatory of the Hungarian Academy of Sciences, H-1121, Budapest, Konkoly Thege Miklós út 15-17., Hungary; [5]Department of Applied Physics, Okayama University of Science, 1-1 Ridaicho, Kita-ku, Okayama 700-0005, Japan;

Introduction: Materials subjected to shockwaves display characteristic and irreversible structural changes on both macroscopic and microscopic scales, depending on the applied shock strength. The shock pressure at the time of impacting, therefore, is the most important parameter that needs to clarify the collisional history of asteroid and meteorite impacts. Shock metamorphic process caused by hypervelocity meteorite impacts, however, has not been fully understood yet. Cathodoluminescence (CL) spectroscopy and microscopy provide useful information on the existence and distribution of defects and trace elements in materials with high spatial resolution. This technique is expected to be applied to clarify shock pressure effect on the minerals in meteorites and impactites. In this study, CL analysis of experimentally shocked alkali feldspar has been conducted to evaluate shock-induced effect on CL of feldspar.

Samples and methods: Single crystals of sanidine ($Or_{87}Ab_{13}An_0$) from Eifel, Germany, and microcline ($Or_{63}Ab_{37}An_0$) from Marumori, Japan were selected as starting material for shock recovery experiments. The shock pressure was induced on sanidine at 10.0, 20.0, 31.7 and 40.1 GPa using a propellant gun. CL images and spectra were obtained by an SEM-CL system.

Results and discussion: Color CL images of unshocked (Sa00) and experimentally shocked sanidine at 10 GPa (Sa10) indicate a red–violet emission. Sanidine at 20 GPa (Sa20) displays a blue emission with vein-shaped textures and a red–violet luminescent background. A blue emission is also distinguished in the color CL images of shocked samples at 31.7 GPa (Sa30) and 40.1 GPa (Sa40). Color CL images of unshocked (Mi00) and shocked microcline at 10.0, 20.0, 31.7 and 40.1 GPa (Mi10, Mi20, Mi30 and Mi40, respectively) exhibit blue CL emissions, where the intensity increases with an increase in shock pressure. Raman spectra of unshocked and shocked sanidine as well as microcline at 10 GPa consist of pronounced peaks at 180, 290, 485 and 510 cm^{-1}, which are assigned to T–O–T stretching vibration. Shocked sanidine and microcline above 20 GPa present rather weak peaks at 510 and 600 cm^{-1}. Shock metamorphism breaks a linkage of the T–O–T bond in the framework structure of sanidine, resulting in the transition of sanidine and microcline into diaplectic glass. Blue CL areas in shocked sanidine are identified to diaplectic glass, but red-violet areas to diaplectic or unshocked sanidine.

CL spectra of Sa00 and Mi00 show a blue emission band at 420 nm and a red-IR one at 730 nm. Shocked sanidine and microcline above 20 GPa have UV-blue CL emissions at 380 and 330 nm of which intensities increase with an increase in shock pressure. Spectral deconvolution of CL spectra from shocked sanidine and microcline provides Gaussian components at 2.948, 3.261 and 3.881 eV. The components at 3.261 and 3.881 eV are recognized in diaplectic glass, but not in diaplectic or unshocked sanidine and microcline. It indicates that these components are characteristic of CL signals derived from diaplectic glass. Shock metamorphism destroys a linkage of T–O–T bond in the framework structure of sanidine and microcline, but resulting in formation of shock-induced defect center related to the components at 3.261 and 3.881 eV. Their component intensities increase with an increase in shock pressure, where the increasing rates are different between sanidine and microcline. It is noteworthy that the intensity depends on not only shock pressure, but also phase composition and structural order-disorder which are closely related to transition shock pressure from feldspar into diaplectic glass. The component at 2.948 eV was detected in both diaplectic feldspar and glass, suggesting that the shock-induced defect center is almost independent of the breaking of the linkage of the T–O–T bond caused by shock metamorphism. The intensity correlates linearly with peak shock pressure induced on sanidine and microcline, with little dependence on composition or structure. The correlation can provide quantitative values of the shock pressures experienced on the feldspar at the time of impacting, which can estimate shock pressures of meteorites and impact crater impactite with higher precision than conventional method. This shock barometry should be extensively used in the clarification of meteoritic or planetesimal collision history and the interpretation of the ejection process on Mars and Moon.