Silicic acid removal as magnesium silicate and uptake of boron from synthetic geothermal water for the effective utilization of geothermal energy

YOHEI KAWABATA[1]*, KOTARO YONEZU[1], KOICHIRO WATANABE[1], AKIRA IMAI[1] AND TAKUSHI YOKOYAMA[2]

[1]Department of Earth Resources Engineering, Faculty of Engineering, Kyushu University, Fukuoka 819-0395, Japan (*correspondence: kawabata-yohei@mine.kyushu-u.ac.jp, yone@mine.kyushu-u.ac.jp)
[2]Department of Chemistry, Faculty of Sciences, Kyushu University, Fukuoka 812-0053, Japan

Geothermal energy is one of characteristic natural enargies in Japan. However, 'silica scale' and hazardous elements such as boron and arsenic included in geothermal water constitute barriers to promote geothermal power generation and utilize geothermal water. Therefore, in order to solve both silica scale and hazardous elements problems in geothermal water, silicic acid removal as magnesium siilicate and uptake of boron from synthetic geothermal water was investigated. The model experiment was conducted at ambient temperature. After magnesium was added into synthetic geothermal water (in the absence or presence of boron as 40 ppm) to have Mg/Si (moral ratio) = 1.4, 2.1, 3.5 and 4.0, pH of the solution was adjusted at 11 or 12. Sample solutions were collected after desired time and then filtrated by using 0.45μm membrane filter. Crystallinity and mineral composition of substances were analyzed by X-ray diffraction (XRD). The concentrations of silicon, magnesium and boron were determined by inductivity coupled plasma atomic emission spectrometry (ICP-AES). As increasing in Mg/Si ratio, almost all silicic acid was successfully removed from the solution at pH 11 and 12 after 24 hours (initial concentration of Si = 400 ppm). The precipitates mainly consisted of amorphous magnesium silicates. In the presence of 40 ppm boron in the synthetic geothermal solution, boron was also completely removed from the solution immediately under the condition of 2.1 or 3.5 of Mg/Si ratios at pH11. The removed boron is possibly forming amorphous magnesium borate or incorporated into the structure of magnesium silicate due to such as substitution of silicon during the formation of magnesium silicate because no boron was adhered on the surface of magnesium silicate through bonding with free hydroxyl groups. In future studies, the structure of boron incorporated by magnesium silicate should be investigated to reveal such a hypothesis.

Quantitative evaluation of shock pressure by cathodoluminescence analysis of alkali feldspar

M. KAYAMA[1]*, H. NISHIDO[1], T. SEKINE[2], T. NAKAZATO[1] AND K. NINAGAWA[3]

[1]Research Institute of Natural Sciences, Okayama University of Science, Japan (*correspondence: kayama@rins.ous.ac.jp)
[2]National Institute for Materials Science, Japan
[3]Department of Applied Physics, Okayama University of Science, Japan

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 could be applied 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 characterize their emission mechanisms related to shock metamorphism.

Single crystal of sanidine from Eifel, Germany was selected as a starting material for shock recovery experiments at 10 to 40 GPa by a propellant gun. CL spectra were obtained by SEM-CL system, which is comprised of SEM (JEOL: JSM-5410) combined with a grating monochromator (OXFORD: Mono CL2).

CL spectrum of unshocked sanidine has an emission band at 430 nm in UV-blue region. Shocked sanidine above 20 GPa has UV-blue CL emissions at 380 and 330 nm of which intensities increase with an increase in shock pressure. The shocked samples above 30 GPa have emission bands at around 380 and 330 nm. The deconvolution of these CL spectra in UV-blue region can successfully separate the emission bands into four Gaussian components at 2.82, 2.95, 3.26 and 3.88 eV in energy units. The integral intensities of these components closely relate to shock pressure on the sanidine, suggesting CL emissions derived from shock-induced defect centers. The component intensity at 2.95 eV can be employed for the calibration to estimate shock pressure. Furthermore, this component is detected in other shocked alkali feldspar such as microcline with different structural order. Therefore, CL spectral deconvolution method allows us a new indicator for an evaluation of shock pressure in a wide range below 40 GPa for the micron-size alkali feldspar in meteorites and impactites.