CHARACTERIZATION OF RADIATION EFFECTS IN ALBITE BY CATHODOLUMINESCENCE. M. Kayama[1], H. Nishido[1], S. Toyoda[2], K. Komuro[3] and K. Ninagawa[2], [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 Applied Physics, Okayama University of Science, 1-1 Ridaicho, Kita-ku, Okayama 700-0005, Japan.; [3]Earth Evolution Sciences, University of Tsukuba, Ten-nodai, Ibaraki, 305-8571, Japan;

Introduction: Cathodoluminescence (CL) microscopy and spectroscopy provide useful information about the existence and distribution of lattice defects and trace elements in materials with high-spatial resolution of a few micron meters. The CL spectral features are closely related to radiation dose of alpha- or gamma-particles, suggesting geoscientific applications for geodosimeter using CL of minerals such as quartz and zircon. No CL investigations on radiation effects in feldspar which is a most important rock-forming mineral on earth's crust have been conducted to date, although the visible halos caused by alpha-particle can be easily found in the feldspar directly attached to radioactive minerals. In this study, He^+ ion implantation at 4 MeV, corresponding to the energy of alpha-particle from ^{238}U, has been conducted to characterize radiation effect of alpha-particle by CL in albite.

Samples and methods: Single crystals of albite from Minas Gerais, Brazil, from Itoigawa Japan, and from Tanogami, Japan were used in the present study. He^+ ion implantation (dose density: 2.18×10^{-6} to 6.33×10^{-4} C/cm^2) on the samples was performed using a 3M-tandem ion accelerator at 4 MeV corresponding to the energy of alpha-particles from ^{238}U. A scanning electron microscopy-cathodoluminescence (SEM-CL) was used to obtain CL spectra of these albite samples. Operating conditions were set at 15 kV (accelerating voltage) and 1.0 nA (beam current).

Results and discussion: CL images of He^+ ion implanted albite from Minas Gerais, Brazil, from Itoigawa Japan, and from Tanogami Japan show a bright luminescent band of ~14 μm width from the implanted surface, which is identified as a CL halo. The width of the halo is consistent with the theoretical range of He^+ ion implantation at 4 MeV. CL line analysis revealed that an increase in the CL intensity along depth direction substantially corresponds to the Bragg's curve, indicating an energy loss process of specific ionization along the track of a changed particle.

CL spectra of unimplanted albite from Minas Gerais, Brazil, from Itoigawa Japan, and from Tanogami Japan have emission peaks at 350, 400, 570 and 740 nm which are assigned to Ce^{3+} impurity, Ti^{4+} impurity or Al-O$^-$-Al center defect, Mn^{2+} impurity and Fe^{3+} impurity centers, respectively. Similar emission peaks were recognized in CL spectra of the implanted albite. The intensities of all of these CL emissions decrease with an increase in radiation dose of He^+ implantation. Raman spectroscopy on these albite indicates that Raman peak at 505 cm^{-1} shows a decrease in the intensity and an increase in the full width at half maximum (FWHM) with increasing the He^+ dose. These observations suggest that He^+ implantation breaks a linkage of T-O-T bonds in the framework of albite, resulting in a reduction of CL emissions due to impurity centers.

CL spectra of all implanted albite have a red emission at 700 nm, of which the intensities increase with an increase in the radiation dose. Deconvolution of CL spectra from the unimplanted and implanted albite can successfully provides six Gaussian components at 3.05, 2.82, 2.10, 1.86, 1.67, and 1.56 eV, where the component at 1.86 eV is observed only in the implanted albite samples. Integral intensity of the component at 1.86 eV linearly correlates with the radiation dose. These results suggest that the component at 1.86 eV is assigned to radiation-induced defect center formed by He^+ ion implantation. The component intensity at 1.861 eV correlates with the radiation dose as a function of radiation sensitivity, but does not depend on the density and distribution of other emission centers, degree of Si-Al ordering, the presence of microstructures or texture, nor the provenance, i.e., Minas Gerais, Brazil, from Itoigawa Japan or Tanogami Japan.

CL microscopy, therefore, was found to be useful to visualize radiation halo, and CL spectral deconvolution can quantitatively evaluate radiation dose of alpha particles from natural radionuclides on albite, which could be a geodosimeter.