

Cathodoluminescence study of silica minerals in eucrites

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Eucrites belonging to HED meteorites correspond to the material in the crust of a large asteroid possibly equivalent of 4 Vesta. These meteorites contain various silica polymorphs. Quartz in eucrite has been identified by a new method of color CL imaging. In this study, we have conducted to clarify the origin of the silica minerals, especially the genesis of quartz in eucrite.

Seven eucrite (NWA 1466, NWA 5356, NWA 7188, Juvinas and Agoult) were selected for CL measurements. CL color images were obtained using the Luminoscope (ELM-3) with electron beams generated by an excitation voltage of 10 kV and a beam current of 0.5 mA. CL spectra were obtained employing a system of CL-SEM, which comprises a SEM (JEOL: JSM-5400) combined with an integral grating monochromator (Oxford: Mono CL2) over the wide wavelength range of 300 nm to 800 nm. The system was operated at 15 kV with 2 nA incident beam current in a scanning mode. All CL spectra were corrected for the total instrumental response.

CL color imaging at high magnification can identify the quartz in Juvinas as a red-brown to maroon color, which occurs in the fissures and /or rim of tridymite with blue-gray CL. A spot analysis by Raman spectroscopy confirms the silica polymorphs, whereas CL imaging can easily picture a two-dimensional view of these minerals. CL spectrum of the quartz shows two emission bands at 380-390 nm in a blue region and 640-650 nm in a red region. Spectral deconvolution analysis using a Gaussian curve reveals that the emission components at 3.3 eV and 2.8 eV in a blue region are assigned to defect centers related to Al-O Bridge and Ti impurity, respectively, also the component at 1.9 eV to a non-bridging oxygen hole center (NBOHC). Low emission component derived from Ti center indicates a quartz crystallization at a relatively low temperature. NBOHC has the emission center related to the OH in the lattice such as a $O_3\text{Si-O-H}$ precursor. These results imply that the quartz in Juvinas occurred as a secondary mineral altered from the tridymite under hydrothermal condition.