ESTIMATION OF SHOCK PRESSURE ON QUARTZ AND ALKALI FELDSPAR FROM RIES CRATER USING CATHODOLUMINESCENCE SPECTROSCOPY

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Introduction: Cathodoluminescence (CL) spectroscopy provides important information on the existence and distribution of defects and trace elements in materials which is related to shock metamorphism. A few CL studies on minerals in shocked rock samples from impact crater, however, have been reported as far. In this study, CL of quartz and alkali feldspar from Ries Crater have been measured to estimate shock pressure on the minerals.

Samples and Methods: Quartz and alkali feldspar ($Or_{84-91}Ab_{9-15}An_{0-1}$) in the boring core samples in suevite-amphibolite layer in the depth of 601−602 m from the surface in the Ries Crater were used for CL measurements. CL spectroscopy was obtained in the range from 300 to 800 nm using a scanning electron microscopy-cathodoluminescence system (SEM-CL) system.

Result and Discussion CL spectra of quartz exhibit emission bands at 390 nm in blue region and 650 nm in red region. Blue CL emission is related to Ti^{4+} or $[AlO_4/M^+]^0$ (M^+: H^+, Li^+, Na^+ and K^+) defect center. An emission band at 650 nm is attributed to oxygen vacancy center. CL images of quartz at room temperature show a homogeneous distribution of the intensities, whereas those at −130 °C indicate thin dark lines superimposed on more brightly luminescent background. These thin line features are corresponding to multiple PDFs by impact-shocked metamorphism observed under an optical microscope. Interference shock wave with high pressure might cause structural destruction with parallel array along wave front, resulting in non-luminescence in the PDFs. Shock pressure on this quartz might be deduced at 15-20 GPa by judging from existence of multiple PDFs. These facts indicate that CL imaging at low temperature can be used to detect PDFs in shocked quartz.

The euhedral alkali feldspar has CL emissions at around 430 nm in blue region and 720 nm in red-IR region. The blue and red-IR CL emissions are attributed to $Al{-}O^-{-}Al$ defect and Fe^{3+} impurity center, respectively. CL spectra of isotropic alkali feldspar under optical microscope consist of an emission band at around 380 nm, which have been reported in CL spectra of diaplectic glass changed from alkali feldspar by shock experiment. The deconvolution of CL spectra obtained from this alkali feldspar and the experimentally shocked alkali feldspar provides three Gaussian components at 2.95, 3.26 and 3.88 eV. A plot of the integral intensity of experimentally shocked alkali feldspar at 2.95 eV against the shock pressure quantitatively enables an evaluation of shock pressure induced on the isotropic alkali feldspar in suevite-amphibolite layer from Ries crater. Estimated shock pressure for the isotropic alkali feldspar is 15.9 ± 0.7 GPa.