Thermoluminescence sensitivity of rock-forming minerals of deformation and fracturing

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Thermoluminescence (TL) of mineral is originated by a lattice defects and impurities in crystal, which indicates TL behavior has potential possibilities for indicator of lattice structural defects of mineral and impurities contained in the crystal, based on the principle of TL. In this study, artificial deformation of rock was performed, and then measurement of TL from quartz was carried out to reveal sensitivity of TL for stress deformation.

All rock samples used in this study are Iidate granite, collected from Fukushima Prefecture. The samples ware cut out as cylinders, 36mm in diameter and 72mm in length. They were applying fixed uniaxial compression stress 3days-1week. After grinding the compressed sample, quartz grains were separated by handpicking, and then chemical treatment is conducted. The grains were then crushed again and the 74-250 micrometer quartz fraction was obtained by sieving. Since the initial paleodose preserves in the samples, it was annealing to remove this before irradiating about 480Gy of gamma ray originated in Co60. The temperature of the sample is from room temperature to 400 degrees C., heating rate was 40 degrees C. per minutes.

Main luminescence peaks of the sample were observed at 735nm and 460nm. TL intensity of 735nm peak was not changed by stress condition, however, the short wavelength peak (460nm) has changed. Intensity of the short TL peak decreased with increasing compressive stress. Intensity of TL also affected by duration of stress, for example, TL emission was declined by elapsed time. We can find dependence of TL intensity for compressive stress; however, relationship between compressive stress and TL intensity is not simple. We have to verify the relation under several stress conditions.

TL is as already stated a phenomenon which happens by the electron trap center originating in a lattice defect, and impurities in crystal. Total emission of luminescence is in proportion to the quantity of the accumulated radiation energy. In this study, all samples were irradiated same quantity of gamma ray. So it is thought that change of TL intensity was influenced by the change of the density of electron trap center. Our result shows that TL intensity decreases with increasing pressure. This suggests that distortion by compression decreased the electron trap centers.

Preliminary results indicates TL behavior after artificial irradiation show some sensitivity for stress, so that TL phenomena of quartz have potential possibilities for a crustal stress sensor.