TL intensity changes of fine-grained quartz gouge during frictional sliding:an attempt to detect frictional heating

Akiko Yoshimoto[1], Shozo HIRAGA[2], Kazuo Mizoguchi[3], Akito Tsutsumi[4], Toshihiko Shimamoto[5]

[1] NUE, [2] Dept. Earth Sci., Nara Univ. Education, [3] Earth and Planetary Sci., Kyoto Univ, [4] Kyoto Univ., [5] Dept. of Geol. & Mineral., Graduate School of Science, Kyoto Univ.

TL intensities of intrafault materials decrease by stress or frictional heating at the time of fault movement. The details of the zeroing mechanism of TL signals at the time of fault activity are not clear, and so it is necessary to investigate each elementary process conceivable. Hiraga et al.,(2002) investigated the change of TL intensities for quartz with various degree of shear, based on shear experiments concerning the elementary processes attributable to stress. TL intensities increase once, then revert back to decrease with increasing stress. They interpreted it as follows: the increase of TL intensities with increasing stress is due to the so-called radiation damage increment induced by generation of detached electrons at the time of new surface formation caused by shear fracture. We study experimentally to clarify the conditions of complete zeroing by the effect of stress. To avoid an effect of the increase of TL intensities, we used the fine grains of 1-8 um for starting samples.

In the present work, we used the quartz samples that were separated from St. Peter Sand and made fine into 1-8 um. The shear experiments were performed using the high-temperature biaxial testing machine installed at Kyoto University. Fine-grained quartz of 500 mg were placed between 3 blocks of gabbro as 4*5cm^2-area shear in the biaxial machine. Experimental conditions are as follows: a slip rate of 56 um/s, the total displacement of 2 cm, and normal stress of 4.9, 9.8, 19.6, 29.4, 39.2, 49.0 MPa. The coefficient of friction calculated from ultimate frictional strength and residual frictional strength is 0.62 and 0.54, respectively. TL intensities of the starting sample and the sheared sample were measured using the Daybreak 1150 TL/OSL machine. And we assessed the total surface area of the sample grains from measurements of grain size distribution. As a result of TL measurements, it was found that TL intensities decrease with increasing frictional work per unit area. When the sample is suffered the frictional work of 5.2*10^5J/m^2, it's TL intensities fall into 60 percent level of starting sample. From the results of measurements, we found the correlation of TL intensities and the frictional work per unit area(R^2=0.98). Extrapolating the above results, we evaluate a frictional work of 1.2*10^6J/m^2 necessary to complete zeroing.

In the present work, the slip rate was 56 um/s with due regard to avoid the effect of frictional heating. And, the effect of increase in TL intensities due to fracturing was controlled by experiments with fine-grained samples. We could find the conditions of complete zeroing in TL intensity of fine-grained samples by shear stress. Now a frictional heating is expected if an experiment is performed under conditions of slip rate and the total displacement supposed during actual fault activity. If we could detect the frictional heating and clarify the conditions of complete zeroing, using TL method which is sensitive to heat, we think that the possibility of fault dating will increase.