An investigation of coseismic OSL / TL time zeroing of quartz gouge based on high-velocity friction experiments

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The OSL (optically stimulated luminescence) and TL (thermoluminescence) dating methods are mainly used to characterize an age of sedimentary rocks based on trapping of electron by natural radiation exposure. Recently, Ganzawa et al. (2013) suggest its applicability on direct age measurement of fault using fault zone material. The idea behind to the OSL/TL dating for a determination of paleo-earthquake event is the accumulated natural radiation damage becomes to zero (time zeroing) by the frictional heating and/or grinding. However, the relationship between fault motion and annihilation of the luminescence signals has not been fully understood. Understanding this relationship leads to expand measurable age range of active fault. In this study, we conduct low- to high-velocity friction experiments using quartz gouge under various experimental conditions (e.g., normal stress, displacement, moisture content) to establish an empirical relationship and physical and geological conditions of coseismic OSL time zeroing.

In the friction experiments, we used quartz grains of <150 μm separated from Tsushigawa granite (taken from the east wall of the Nojima fault Ogura trench site) as an analogue gouge. We conducted two series of experiments; (1) various slip rate experiments to see dependence of OSL/TL signal resetting on slip rate, (2) various displacement experiments to see dependence of OSL/TL signal resetting on displacement. In order to consider the effect of crushing, we separated the recovered sample into two grain sizes of <75 μm and 75-150 μm.

Our results of the OSL measurements are (1) <75 μm fraction of sheared gouge have high fast component ratio than the pre-sheared grains, (2) the fast component ratio of <75 μm fraction increases with increasing slip rate from 200 μm/s to 0.13 m, (3) OSL signal becomes to zero (time zeroing) in the experiment sheared under 0.65 m/s. The increase of the fast component ratio found in relatively low slip-rate experiments may be caused by the addition of the ionized electrons, that emitted from newly formed fracture surface during comminution, in electron center. The time zeroing observed in high-velocity friction experiment is attributable to rapid frictional heating up to 600 ℃ by temperature measurement. Based on the calculation of frictional energy we added to the experiment sheared under 0.65 m/s, we estimated the zeroing depth in natural conditions of earthquake (1.6 m in displacement) to 117 m.

Keywords: Asano fault, luminescence, high-velocity friction experiment, time-zeroing

