Direct dating of faults by luminescence and ESR: Case studies from Japan and Switzerland

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Luminescence and electron spin resonance (ESR) signals from quartz and feldspar have ultralow closure temperatures, and therefore these dating methods have a significant potential in elucidating neotectonic activities and erosion histories (King et al., 2016). Direct dating of fault gouge using luminescence and ESR has been proposed and tested as a possible method to estimate the last movement of faults (e.g. Ikeya et al., 1982). However, when apparent luminescence and ESR ages were compared with a known age of the last large earthquake, in most cases the ages are overestimated, because the signals used for dating have not been fully reset at the last earthquake.

In this study, we show our results of direct dating of fault gouges from the Simplon Fault, Switzerland, and the Atotsugawa Fault, Japan using luminescence and ESR. The Simplon Fault is a major, late orogenic, normal fault in the Alps, and the Atotsugawa Fault is a very active dextral strike slip fault, in central Japan.

The natural feldspar infrared stimulated luminescence (IRSL) signals from the Simplon Fault were indistinguishable from saturation, whereas the natural quartz ESR signal (Al centre) was not in saturation, yielding a preliminary equivalent dose value of ~1500 Gy. Our results suggest that by combining luminescence and ESR dating with different saturation limits, it is possible to narrow down the age range of the last seismic activity on the fault.

The apparent quartz optically stimulated luminescence (OSL) ages from four gouge samples from the Atotsugawa Fault yielded a mean age of 38 ±6 ka, which is about two order of magnitude older than the age of the last large earthquake, occurred in 1858 (~ 170 a). We measured the thermal decay of the OSL signal in the laboratory and converted the mean apparent age to a mean apparent temperature (T_{app}), 54 ±1 ˚C. We propose that T_{app} could be used as a new metric to evaluate the activity of faults.

Keywords: fault gouge, direct dating, optically stimulated luminescence, electron spin resonance

