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Testing direct dating of Alpine faults by luminescence and ESR

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For a better understanding of the recent exhumation history of the Alps and the distribution of palaeo- and recent earthquakes within the orogen, it is important to elucidate the Quaternary activity of major faults. In this study, we test the applicability of luminescence and electron spin resonance (ESR) dating, which have ultralow closure temperatures, to directly date fault gouge of the Simplon Fault. A dark grey to black, fine-grained fault gouge was sampled near Visp, Switzerland, from an outcrop that exposes rocks that formed at ductile/brittle conditions. Quartz and feldspar grains were extracted from the sample; quartz grains were used for ESR dating, whereas feldspar grains were used for infrared stimulated luminescence (IRSL) dating.

The IRSL measurements reveal that the natural post-IR IRSL signal, stimulated at 225°C ($pIRIR_{225}$) was in saturation. The $pIRIR_{225}$ signal had an extremely low saturation dose, with a characteristic saturation dose (D_0) of ~90 Gy. The natural IRSL signal at 50°C (IR_{50}) is about 80 % of the laboratory saturation, so that this signal is presumably in the field saturation. The IR_{50} also showed a small D_0 of ~250 Gy. Although these D_0 values are unexpectedly small, the IRSL signals can be used to calculate the minimum age of the last seismic movement of the fault.

Both natural and laboratory-irradiated ESR spectra did not contain detectable Ti centre. Therefore, only the Al centre was used for ESR dating. The natural Al centre from the fault was not in saturation, with a preliminary equivalent dose value of ~1500 Gy. Since the last seismogenic movement most likely only partially reset the Al centre, the ESR age can be regarded as the maximum age of the last event. We show that by combining luminescence and ESR dating, it is possible to narrow down the age range of the last seismic activity on the fault.