Patterns of endogenous seismicity at active clay-rich landslides

Naomi Vouillamoz (1), Sabrina Rothmund (1), Manfred Joswig (1) & Birgit Jochum (2)

Abstract

Landslides developed in clay-rich formations are characterised by unpredictable reactivation. In recent years, seismic monitoring of active landslides detected a variety of – generally weak – seismic signals which are inferred to be triggered by the unstable slope. Evaluating landslide seismicity and characterising its occurrence in space and time enable thus to monitor and map dynamics of the landslide in near real-time. Passive seismic monitoring appears therefore as a good approach to complement surveillance of active landslides. If precursor events are detected, it can further help for future slope failure prediction. However, extreme scattering of the waveforms in the heterogeneous material composing the slopes combined to the inherent difficulty of operating seismic networks with optimal geometry in rugged terrains severely challenge standard approaches to event location and consequently impedes source processes interpretation.

In this study, we investigate continuous seismic data of the well-instrumented Super-Sauze landslide (southeastern France) and compare observations with newly acquired seismic data at the Pechgraben landslide (Upper Austria). We apply the nanoseismic monitoring methodology to detect and evaluate seismicity patterns (Sick et al., 2012; Vouillamoz et al., 2016). Despite varying displacement rates (mm/d–cm/d) and hydrological conditions, comparable signals that range from impulsive earthquake-like signals to minute-long tremor sequences are detected at both landslides. In addition to beam forming methods (Joswig, 2008), we use waveform attenuation patterns to evaluate the signal source location. Source sizing is then benchmarked with calibration shots carried out at the two landslides. First results indicate that endogenous seismicity rates correlate positively with higher displacement rates. Signals seem to be preferentially originated at shearing boundaries of the slides, which in turn suggests creeping processes as main source of seismic energy release.

References

Joswig, M. (2008): Nanoseismic monitoring fills the gap between microseismic networks and passive seismic. – First break, **26**, 117–124, Oxford.

Sick, B., Walter, M. & Joswig, M. (2012): Visual Event Screening of Continuous Seismic Data by Supersonograms. – Pure and Applied Geophysics, **171**/3, 549–559, Basel. DOI: *https://dx.doi.org/10.1007/s00024-012-0618-x*

Vouillamoz, N., Wust-Bloch, G.H., Abednego, M. & Mosar, J. (2016): Optimizing Event Detection and Location in Low-Seismicity Zones: Case Study from Western Switzerland. – Bulletin of the Seismological Society of America, **106**/5, 2023–2036, Washington, D.C. DOI: *https://dx.doi.org/10.1785/0120160029*

(1) Universität Stuttgart, Institut für Geophysik, Azenbergstraße 16, 70174 Stuttgart, Deutschland.
naomi.vouillamoz@geopys.uni-stuttgart.de

(2) Geologische Bundesanstalt, Neulinggasse 38, 1030 Wien.