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Deformation analysis for understanding landslide-induced brittle fractures at the Super-Sauze landslide

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Applying passive seismic analysis techniques realized by Nanoseismic Monitoring to creeping or slow-moving, soft-rock landslides in the Alps, we observed fracture processes ($M_L < 0$) of slope material, also called slide-quakes. Their time-frequency signature is similar to impulsive signals from local earthquakes, and indicates brittle fracturing of slope material. Slidequakes are weak signals with poor signal-to-noise ratio (SNR); thus neither precise depths nor moment tensor solutions could be derived. Another type of non-impulsive, very weak signals that are recorded are called tremors. These signals are visible on too few single stations and thus cannot be located, but the source can be attributed to the immediate vicinity of the seismometers. Seismic analysis tools alone do not help to understand the occurrence and the possible generation mechanisms of these seismic signals.

For several years, seismic strain-rate tensors derived from earthquake observations and crustal geodetic strain-rate were combined to provide insights into the deformation process of tectonically active zones. This showed that the axes of the seismic and the geodetic strain rate tensors have similar orientation and are of similar style.

We applied a deformation analysis of the temporal and spatial heterogeneous displacement fields of the Super-Sauze landslide (Southern French Alps) that were derived from multi-temporal aerial photographs, DGPS and TLS measurements. The geodetic strain rate at the surface and the shear rates in the direction of movement were determined. The strain rate fields exhibit heterogeneous patterns, reflecting the temporally and spatially variable extension and compression of subareas. In regions with a temporal strain drop a preferred occurrence of slidequakes can be expected. The areas with increased shear rates, however are presumed to be the source of tremor signals, which are infact most often encountered in the boundary regions between hard rock and slope material.

We will discuss how far the observations of crustal deformation can be transferred to the significantly smaller scale of soft-rock landslides at the example of the Super-Sauze landslide. Furthermore we will show what application possibilities and limits the strain analysis related to slidequakes provides and how they can contribute to the understanding of their occurrence and the possible generation mechanisms.