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Geophysical characterisation of landslide deposits using active and passive seismics

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Geophysical prospection methods facilitate near surface investigations, especially in complex or remote environments where direct exploration, such as drilling or trenching, are unfeasible or too expensive. Multiple techniques can be used for a vast number of survey targets in different study areas. However, on very large and heterogeneous sites, such as in our case on large unstable or failed slopes, some of these methods have limitations in terms of investigation depth and lateral resolution, or their application is limited due to the the characteristics of subsurface (e.g., very high or low water content, particular material properties).
Seismic geophysical techniques make use of seismic energy, either artificially activated (e.g., by hammer blows or explosions) or passively induced (e.g. ambient noise). By combining both, we are able to partly overcome limitations: active seismic refraction - analysed as 2D P-wave tomography (SRT) and as 1D MASW (Multi Channel Analysis of Surface Waves) – together with passive methods, i.e. small-aperture seismic array and single station HVNR (Horizontal-to-Vertical Noise Ratio) measurements. In contrast to P-wave velocity prospections, surface and shear wave velocity measurements are able to reveal lateral contrasts that are independent of the soils water content and thus useful to define the mechanical properties of complex slope deformations. Ambient noise array methods, in addition, may allow for very deep sounding.
Discussed study sites primarily inlcude old large landslide bodies of unknown origin in seismically active areas. By applying the presented seismic techniques within a landslide area, as well as in its surroundings, we try to define the landslide structure in size and volume, as well as the general slope development. Measurements in the surrounding areas (i.e. supposedly intact areas) thereby serve as reference data representing in-situ material in its assumed pre-failure conditions. In order to better illustrate the presented study-cases, results are implemented into 3D geomodels.