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Characterization of Unstable Rock Slopes Through Passive Seismic Measurements

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Catastrophic rock slope failures have high social impact, causing significant damage to infrastructure and many casualties throughout the world each year. Both detection and characterization of rock instabilities are therefore of key importance. Analysing unstable rock slopes by means of ambient vibrations might be a new alternative to the already existing methods as for example geotechnical displacement measurements. A systematic measurement campaign has been initiated recently in Switzerland in order to study the seismic response of potential rockslides concerning a broad class of slope failure mechanisms and material conditions. First results are presented in this contribution.
Small aperture seismic arrays were deployed at sites of interest for a short period of time (several hours) in order to record ambient vibrations. During each measurement a reference station was installed on a stable part close to the instability. The total number of stations used varies from 16 down to 2, depending on the site scope and resource availability. Instable rock slopes show a highly directional ground motion which is significantly amplified with respect to stable areas. These effects are strongest at certain frequencies which are identified as eigenfrequencies of the unstable rock mass. The eigenfrequencies and predominant directions have been estimated by frequency dependent polarization analysis. Site-to-reference spectral ratios have been calculated as well in order to estimate the relative amplification of ground motion at unstable parts. The retrieved results were compared with independent in-situ observations and other available data. The directions of maximum amplification are in most cases perpendicular to open cracks mapped on the surface and in good agreement with the deformation directions obtained by geodetic measurements. The interpretation of the observed wave field is done through numerical modelling of seismic wave propagation in fractured media with complex topography. For example, a potential relation between eigenfrequencies and unstable rock mass volume is investigated.