



## Characteristics of acoustic emissions from shearing of granular media

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Deformation and abrupt formation of small failure cracks on hillslopes often precede sudden release of shallow landslides. The associated frictional sliding, breakage of cementing agents and rupture of embedded biological fibers or liquid bonds between grain contacts are associated with measurable acoustic emissions (AE). The aim of this study was to characterize small scale shear induced failure events (as models of precursors prior to a landslide) by capturing elastic body waves emitted from such events. We conducted a series of experiments with a specially-designed shear frame to measure and characterize high frequency (kHz range) acoustic emissions under different conditions using piezoelectric sensors. Tests were performed at different shear rates ranging from 0.01mm/sec to 2mm/sec with different dry and wet granular materials. In addition to acoustic emissions the setup allows to measure forces and deformations in both horizontal and vertical directions. Results provide means to define characteristic AE signature for different failure events. We observed an increase in AE activity during dilation of granular samples. In wet material AE signals were attributed to the snap-off of liquid bridges between single grains. Acoustic emissions clearly provide an experimental tool for exploring micro-mechanical processes in dry and wet material. Moreover, high sampling rates found in most AE systems coupled with waveguides to overcome signal attenuation offer a promise for field applications as an early warning method for observing the progressive development of slip planes prior to the onset of a landslide.