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Precursory Acoustic Emissions from Bench-Scale Landslides

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Rapid and shallow hydrologically-triggered landslides may result from initiation of local slip failures and deformations that eventually coalesce to global failure along a shear surface. These local small failure processes reflect complex interactions of shear, tensile, and compression forces resulting from dynamic formation of force chains, collapse of grain cementing, load redistribution by root failure, and pore-water pressure due to water infiltration. We study how local failures and deformations may be used as precursory warning signals to landslides by monitoring acoustic emissions and imaging formation of tension-cracks during small bench-scale landslides of sand using an inclined sand box. Sands of various sizes and water contents failed as slope-angle was increased or during simulated rain infiltration. Acoustic emission (AE) sensors placed either directly in the sand or on metallic waveguides recorded the high-frequency pressure waves produced by granular friction and rolling. A high-speed camera synchronized to the AE system captured the initial formation of tension cracks in the upper portion of the slide. A laser profiler measured the initial and final states of the slope to estimate the position of the slip surface and the volume of the slide. Precursory acoustic signals were analyzed using statistics of acoustic emissions to determine criteria for incipient failure. Results from these experiments could potentially provide the basis for monitoring activities in support of an early warning system.