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Effect of the surface roughness on the seismic signal generated by a single rock impact: insight from laboratory experiments

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The seismic signal generated by rockfalls, landslides or avalanches is a unique tool to detect, characterize and monitor gravitational flow activity, with strong implication in terms of natural hazard monitoring. Indeed, as natural flows travel down the slope, they apply stresses on the ground, generating seismic waves in a wide frequency band. Our ultimate objective is to relate the granular flow properties to the generated signals that result from the different physical processes involved. We investigate here the more simple process: the impact of a single bead on a rough surface.
Farin et al. [2015] have already shown theoretically and experimentally the existence of a link between the properties of an impacting bead (mass and velocity) on smooth surfaces, and the emitted signal (radiated elastic energy and mean frequency). This demonstrates that the single impactor properties can be deduced from the form of the emitted signal. We extend this work here by investigating the impact of single beads and gravels on rough and erodible surfaces.
Experimentally, we drop glass and steel beads of diameters from 2 mm to 10 mm on a PMMA plate. The roughness of this last is obtained by gluing 3mm-diameter glass beads on one of its face. Free beads have been also added to get erodible beds. We track the dropped impactor motion, times between impacts and the generated acoustic waves using two fast cameras and 8 accelerometers. Cameras are used in addition to estimate the impactor rotation. We investigate the energy balance during the impact process, especially how the energy restitution varies as a function of the energy lost through acoustic waves. From these experiments, we clearly observe that even if more dissipative processes are involved (friction, grain reorganization, etc.), the single bead scaling laws obtained on smooth surfaces remain valid. A main result of this work is to quantify the fluctuations of the characteristic quantities such as the bounce angle, the seismic energy and frequency induced by the plate roughness.