Characterization of blocks impacts and fluidofracture processes from acoustic emissions: energy partitioning, laboratory experiments using optics and accelerometry

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Rockfalls, debris flows and rock avalanches represent a major natural hazard for the population in mountainous, volcanic and coastal areas but their direct observation on the field is very dangerous. Recent studies showed that gravitational instabilities can be detected and characterized (volume, duration,...) thanks to the seismic signal they generate. In an avalanche, individual block bouncing and rolling on the ground are expected to generated signals of higher frequencies than the main flow spreading. The identification of the time/frequency signature of individual blocks in the recorded signal remains however difficult.

Similarly, microseismic events during reservoir exploitation, or reservoir stimulation during the injection of fluids, are one of the main sources of information on processes at play during hydrofracture, but their interpretation is non trivial.

Laboratory experiments were conducted to investigate the acoustic signature of diverse simple sources corresponding to grains falling over thin plates of plexiglas and glass and over rock blocks.
We also investigate the acoustic signature of hydrofracture by recording both the acoustic emissions and the deformation and the detailed geometry of the formed channels during controlled fluidofracture in the laboratory. These channels exhibita geometry depending on the pressure applied, and the pressure rate change [Niebling et al. 2012a, 2012b]

In the case of emissions during rock falls or avalanches, the elastic energy emitted by a single bouncing bead into the support was first quantitatively estimated and compared to the potential energy of fall and to the potential energy change during the shock.
We obtained simple scaling laws relating the impactor characteristics (size, height of fall, material,...) to the elastic energy and spectral content. Next, we consider the collapse of granular columns made of steel spherical beads onto hard substrates. Initially, these columns were held by a magnetic field allowing to suppress suddenly the cohesion between the beads, and thus to minimize friction effects that would arise from side walls. We varied systematically the column volume, the column aspect ratio (height over length) and the grain size. This is shown to affect the signal envelope and frequency content. In the experiments, accelerometers (1 Hz to 56 kHz) were used to record the signals in a wide frequency range. The experiments were also monitored optically using fast cameras. Eventually, we looked at what types of features in the signal are affected by individual impacts, rolling of beads or by the large scale geometry of the avalanche.

We will also discuss the evolution of the spectrum of the microseismicity during fluid injection, and its possible origins. The situation of mode I and mode II injection [Aochi et al. 2014] are discussed.

References:

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