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Analysis of the dynamics of supervised single-block rockfalls from intra-block accelerometers, seismology and remote sensing.

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Understanding the dynamics of rockfalls is critical to mitigate the associated hazards but is rendered very difficult by the nature of these natural disasters that makes them hard to observe directly. Recent advances in seismology allow determining the dynamics of the largest gravitational processes on Earth from the very low-frequency seismic waves they generate. However, the majority of processes that occur worldwide are too small to generate low-frequency seismic waves but will generate high-frequency seismic signals. Unfortunately we cannot yet use these high-frequency seismic records to infer dynamics parameters of gravitational processes as the source of these waves is not well understood.

To better understand the physics involved in the generation of high-frequency seismic waves, we study the link between the dynamics of single blocks and the features of the seismic signal generated. To do so, a single-block rockfalls controlled launch experiment has been carried out in the Riou-Bourdoux gully test site (South East French Alps) and blocks of weights in the range 50 to 150 kg have been launched. In such study the dynamics of the block is usually inferred from the reconstruction of the 3D trajectory from fixed camera and UAV records. In this study, in addition to trajectories reconstruction from direct observations, we deployed accelerometers/gyroscopes embedded in some of the launched blocks. This allows directly quantifying dynamic properties such as the acceleration, the velocity and the angular direction of the block before, after and at the impact with the ground. A dense seismic network (including 19 3-component sensors and 27 1-component sensors) was deployed close to the propagation track. This dense network helps to reconstruct the full wavefield and to study effects of the propagation path (dispersion, attenuation) on the high-frequency seismic waves generated by each impact. This set of new observations leads to a better grasp of the fundamental relationships between physical parameters of the block propagation and the seismic signals properties, and open the way to the use of seismic monitoring for rockfall dynamics quantification in other contexts.