Subject offered for a contract starting in September 2014

SUBJECT TITTLE: Experimental study of acoustic emissions from granular flows

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Host lab/ Team : **IPGP- Seismology group – UMR7154**

Financing: Doctoral contract with or without assignment

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The seismic signal generated by rockfalls, landslides or avalanches provides a unique tool to detect, characterize and monitor gravitational flow activity, with strong implication in terms of natural hazards. Indeed, as natural flows travel down the slope, they apply stresses on top of the Earth surface, generating seismic waves in a wide frequency band, associated to the different physical processes involved. As an example, by coupling seismic and video recording of rockfalls on Réunion Island, *Hibert et al.* [2014] showed the existence of high frequencies generated by impacts of blocs and of low frequencies, associated with granular flows. However, the complexity of natural flows where several effects such as erosion, presence of fluid, complex topography, etc. are mixed up, makes it difficult to distinct between the processes involved and therefore to quantify their relative contribution.

The objective of this PhD is to address this problem by developing laboratory experiments dedicated to the measurement of acoustic waves generated by granular flows. Indeed, the new granular flow experiments that we have carried out in collaboration with Institut Langevin and IPGS show that piezoelectric transducers and accelerometers with an acquisition rate of several M*Hz*, placed on the underlying elastic substrate below an avalanche, record a measurable signal, making it possible to monitor the propagation of seismic waves in the basement during the flow [*Farin et al.*, 2013b] (Figure 1). These waves carry the signature of the source (size, volume, velocity, grain roughness, behavior of the flow, etc.). Using a combination of optical and acoustic methods, we will measure the seismic signal generated by granular flows on different substrates at the laboratory scale. These substrate will be made of plates and blocs of different sizes and characteristics. We will first study the seismic signals associated with the impact and rolling of beads of different properties before investigating the collapse of granular columns over horizontal and sloping substrates. The full waveforms will be recorded continuously using a 64 channels acoustic monitoring system and the source flow itself will be simultaneously imaged by a fast camera (1000 frames/s), synchronized with the acoustic monitoring system. In particular, we will

try to identify the seismic wave phases, the characteristics and patterns of the full waveform, the energy partition, and how they depend on the flow properties that can be easily tuned experimentally.

Ultimately, these experiments will guide the recognition of seismic waves generated by selected natural landslides. In particular, we will analyze the impacts of rocks instrumented in Tahiti (collaboration BRGM) and recurrent rockfalls on the Piton de la Fournaise volcano, Réunion Island. These researches will be a basis for future development of operational methods for monitoring gravitational hazards in collaboration with the volcanic and seismic Observatories in la Réunion (OVPF) and Antilles (OVSM).

This PhD, funded by Europe, is part of a large European project ERC SLIDEQUAKES, involving a team of 6 young researchers in complementary domains (geophysics, physics, mechanics and mathematics). This research will be performed in the seismology team of IPGP among reasearchers interested in modelling and monitoring of environmental sources (gravitational flows, volcanoes, oceans, hurricans, glaciers, quarries, etc.). For more information on the research group: http://www.ipgp.fr/~mangeney/Research.html

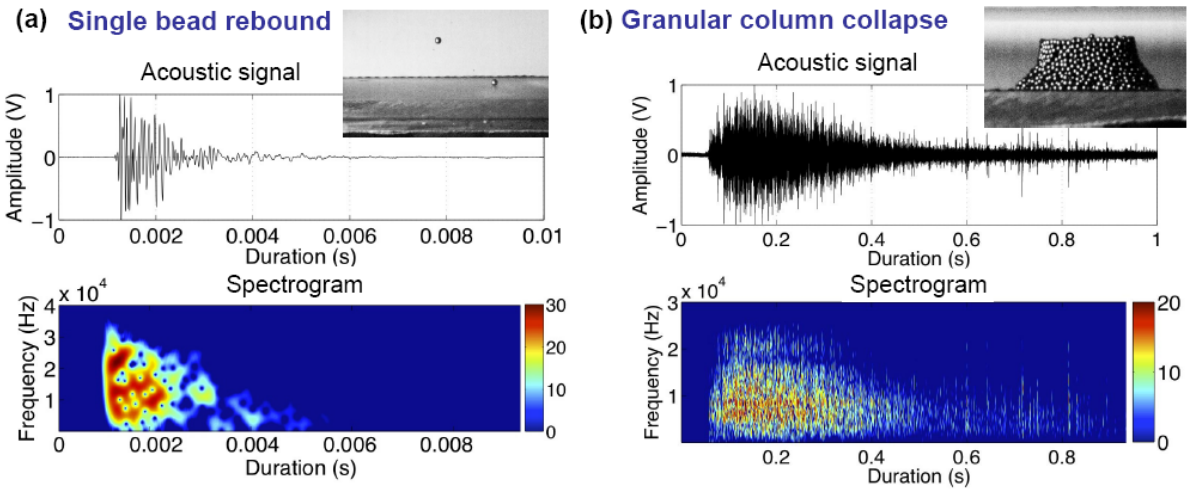

Figure 1: Record of the normalized acoustic signal and associated spectrogram of (a) a single bead impacting a plexiglas substrate, (b) the collapse of a granular column made of the same beads [*Farin et al.*, 2013].

Farin, M., Mangeney, A., Toussaint, R., and De Rosny, J., 2013. Characterization of granular collapse onto hard substrates by acoustic emissions, EGU2013-5926, Vienne.

Hibert, C., Mangeney, A., Grandjean, G., Baillard, C., Rivet, D., Shapiro, N., Satriano, C., Maggi, A., Patrice Boissier, P., Ferrazzini, V., and Crawford, W., 2014. Automated identification, location and volume estimation of rockfalls at Piton de la Fournaise volcano, J. Geophys. Res., submitted.