Subject offered for a contract starting october 2016

SUBJECT TITTLE: "IMAGING LABORATORY EARTHQUAKE SOURCE COMPLEXITY"

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Host lab/ Team :
ENS- Laboratoire de Géologie de l'ENS- UMR 8538

Financing: ERC grant REALISM (Reproducing Earthquakes in the Laboratory: Imaging, Speed and Mineralogy)

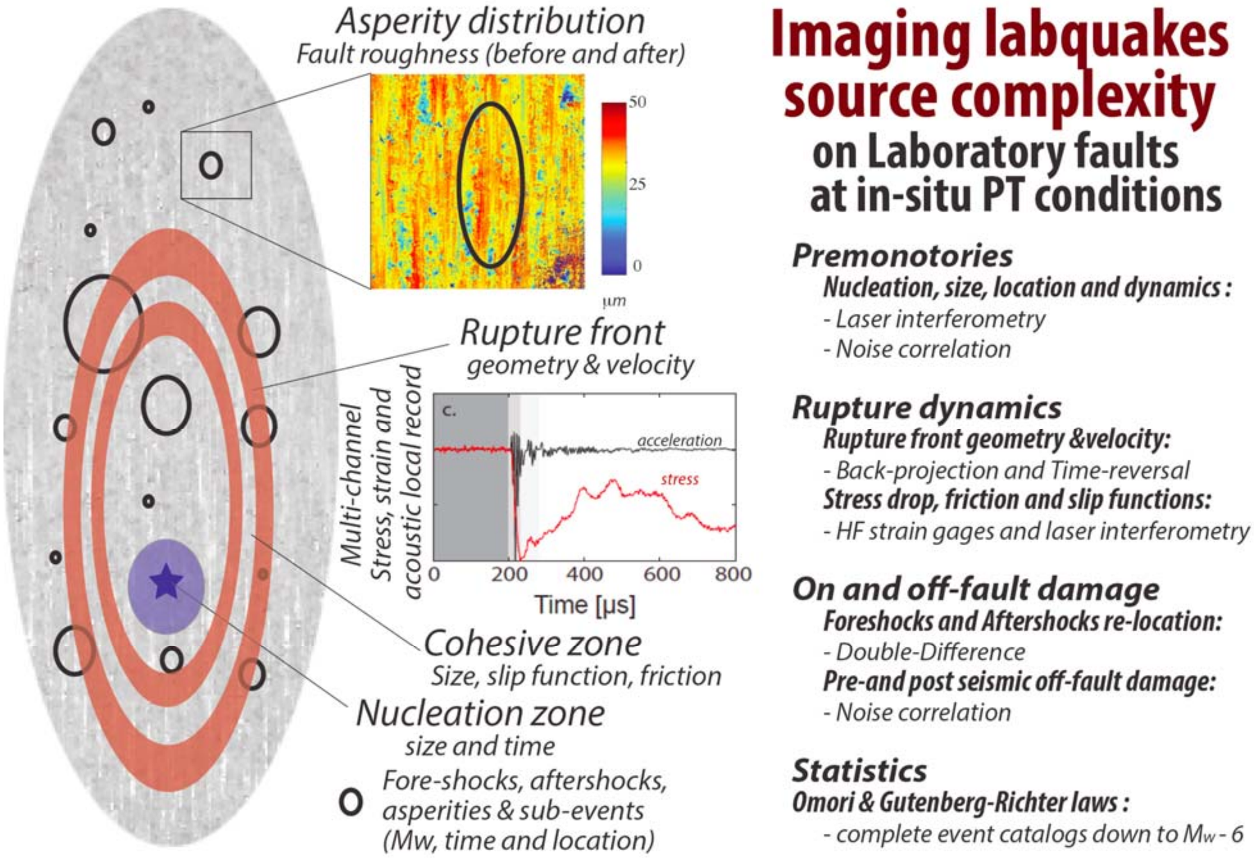
For more information go to http://ed560.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

On one hand, recent seismological observations have highlighted increasing foreshock activity preceding the failure of large earthquakes, as observed both prior the 2011 Tohoku-Oki M_w 9.0 and the 2014 Iquique M_w 8.1 earthquakes. However, foreshocks are not systematic and the reason why they occur remains poorly understood. On the other hand, the inversion of seismic data for the distribution of slip on the fault has become a standard procedure in large earthquake analysis. These inversions are prone to non-uniqueness owing to limitations in availability and frequency bandwidth of seismic data. In addition, uncertainties in the location and shape of the fault plane as well as in the seismic velocities of the surrounding rocks hamper successful characterization of earthquake kinematics. Furthermore, as a purely kinematic description of the earthquake source, slip-distribution models provide no direct evidence about the forces involved during the rupture process or about the frictional properties of the fault. Inversion of seismic data for dynamic quantities, i.e., dynamic source inversions, are highly nonlinear since, for example, small changes in the initial stress distribution may strongly change the rupture process, and exhibit significant trade-offs between the various parameters.

Observations of faulting events in the laboratory with prescribed faults provide a unique approach to dynamic source inversion that overcomes many of these obstacles and thus -for the first time- enables to test contrasting end member cases, the asperity model vs. the barrier model.

The objectives of this PhD project are to:

1- Observe the premonitory processes leading to dynamic failure;
2- Track the rupture front, its local rupture and sliding velocities along propagation and obtain the local slip functions and the frictional properties of the fault;
3- Obtain complete fore-shock, co-seismic sub-events and aftershock catalogs at different PT and loading conditions.
4- Provide benchmarks to better constrain traditional inversion schemes.



Synoptic view of PhD project. We plan to image laboratory earthquakes source complexity, at in-situ PT conditions, by combining new measurements (acoustic, stress, strains, accelerations displacement and elastic wave velocities), on large rock samples, and state-of-the-art modern seismology inversion techniques.

- *Methodology:* Observations of faulting events in the laboratory with prescribed faults provide a unique approach to dynamic source inversion that overcomes many obstacles encountered in the field and thus -for the first time- enables to test contrasting end member cases, the asperity model vs. the barrier model. Our rationale is to reproduce laboratory earthquakes on samples from typical seismogenic zone lithologies such as granites and peridotites, with controlled varying surface roughness. During propagation, record the full acoustic wavefield, accelerations, velocities, stress and strains in the near field using a high frequency multi-station array and invert this data implementing modern seismological techniques, such as the double-difference earthquake location, back-projection and time reversal.

This PhD. project is fully funded via an ERC consolidator grant starting Oct. 1st 2016. In total, three PhD students, two post-doctorates and one research engineer will also be hired over the course of the project. The candidate is expected to work and collaborate within a team.

Knowledge and Skills (not essentially required, but desirable)

- Familiarity with rock physics rock mechanics technology and methods
- Ability to communicate effectively, both orally and in writing, with a wide range of people
- Familiarity with data processing and signal analysis using Matlab/Python
- Commitment to high quality scientific research.
- Motivation to carry out and publish scientific research and to develop a scientific career.
- Ability to work collaboratively as part of a team.

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