ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

ed560.stepup@u-paris.fr

Titre du sujet : Discrete element modeling of earthquake cycle in an oblique context: From instantaneous to cumulated deformation

Directeur: KLINGER Yann, DR CNRS, klinger@ipgp.fr
Co-encadrant : SCHOLTES Luc, MdC UCA, luc.scholtes@uca.fr
Equipe d'accueil : **IPGP- Equipe de Tectonique et mecanique de la lithosphere – UMR7154**

Financement : **Contrat doctoral avec ou sans mission d'enseignement**

Développement du sujet : (Maximum 2 pages)

Up to now, continental earthquakes remain one of the most deadly and costly natural hazards, as shown once more during the doublet of earthquakes in Turkey, in 2023. If today earthquake prediction seems still out of reach, a better understanding of parameters controlling the unraveling of an earthquake rupture, how earthquakes succeed in a fault system, or how fault geometry evolves through earthquake cycles, is a priority to try to better mitigate catastrophic earthquakes.

This project targets more specifically oblique continental fault systems. The core target is to understand the mutual dependencies between the fault geometry and the earthquake rupture by studying the evolution of a fault system during successive earthquake cycles. In order to model the growth of a fault system in continental crust, we propose to use a numerical sand box type of experiment, based on discrete element modeling (DEM). Unlike other modeling approaches based on continuum mechanics, the main advantage of the DEM methodology is that there is no need to prescribe any fault geometry a-priori as the fault system emerges naturally during the modeling process. Once the experiment set up, and generating earthquakes in an evolving fault system, we will look at the effect of the heterogeneities of the crust (by perturbating slightly the local properties of the model) or at the impact of inherited geological structures on the evolution of the fault system and associated earthquakes. We will also look how deformation is distributed on and around the main fault zone to build scaling laws that could later be used in fault displacement hazard assessment studies.

This work is funded in the framework of the Sigma-3 program about seismic hazard and ground motion led in part by the French electrical company EDF. This work will also be strongly related to the ERC project BE_FACT that aims at producing synthetic earthquake series in various tectonic context to understand the relation between the geometry of faults and earthquake ruptures. Hence, this work is part of a group effort to build earthquake cycle models relating long and short terms earthquake activity.

The applicant should have taste for numerical modeling and mechanics of solid applied to the earth sciences, and more specifically to issues related to earthquakes and fault evolution. In term of expertise, a good command of numerical methods and mechanics, as well as knowledge in Python are needed. The main modeling tool will make use of the open source tool Yade DEM.

The work will be located at IPGP, in the group of tectonics, and will be supervised by Y. Klinger and L. Scholtes who is based in Clermond Ferrand. Strong interactions with the collaborators of the Sigma-3 program and the BE_FACT group are expected.