

## Master 2 research project

**Title:** « Chemical alteration and mineralogical composition of fault zones in shale rocks »

**Goals:** The hydrogeological and mechanical properties of faults affecting consolidated clay-rocks are poorly known and highly dependent on their mineralogical composition. This is a highly topical issue as clay-rich faults are possible pathways for fluid migration in low permeable caprocks, and in other settings, they are responsible for important coseismic displacements (e.g. 50 m for the Tohoku earthquake). Their properties depend on their reactivation mode which may lead to the loss of caprock containment, causing industrial losses and earthquakes. Preliminary analyzes performed on cores from Tournemire Underground Research Laboratory (URL), run by the French Institute for Radiological Protection and Nuclear Safety (IRSN), has highlighted the existence of chemical and mineralogical variations within a clay-rich fault at various scales. However, the exact relationship between the different deformation structures and the chemical alterations still remains unclear. A key point in this project will be to identify, in an apparently homogenous formation, the compositional variations related to (1) fluid flow, (2) mechanical deformation and (3) lithological variations.

Furthermore, the student will have to answer the following questions:

- Is the fault core enriched with clay minerals and how does this influence the fault's petrophysical properties (porosity, permeability, friction coefficient, etc.)?
- Is the rock's chemical composition altered around mineral veins?
- Do the polished fault planes have a different mineral composition than the rock's matrix?
- What are the processes that control the chemical mobility of elements in the fault zone and at what scale do they occur?

The student will conduct a systematic and methodological sampling throughout the fault zone, describe the structures and establish a typology. Thin sections will be made from these samples and studied by various methods : imaging by optical microscopy and scanning electron microscopy (SEM), elemental chemical cartography by XRF and SEM-EDS. The mineralogical composition will be specified by XRD. These results will be compared with those obtained from boreholes drilled throughout the URL at different stratigraphic levels so as to take into account lithological variability. These results will then be placed in a wider bibliographic context and an emphasis will be placed on the links between petrophysical properties and fault dynamics.

The internship will take place in the premises of the IRSN in Fontenay-aux-Roses (SW Paris), and will require some field work at the Tournemire URL and a couple of meetings at the University of Aix-Marseille.

**Methods:** Field work, XCT-scan, thin sections, optical microscopy, microscopy XRF, SEM et SEM-EDS, ICP-OES, ICP-MS, XRD and micro XRD.

**Supervisors:** Pierre Dick ([pierre.dick@irsn.fr](mailto:pierre.dick@irsn.fr)), Pierre Henry ([henry@cerege.fr](mailto:henry@cerege.fr)), Alexandre Dauzères ([alexandre.dauzere@irsn.fr](mailto:alexandre.dauzere@irsn.fr))