Title

Multi-scale experimental characterization of HM damage in claystones

Thesis subject

This PhD thesis is a part of a large ANR (National Agency for Research) research program 2018-2021 called *HydroGeoDam* (*Toward a better assessment of hydraulically induced damage in geo-engineering applications*). Predicting occurrence of hydraulically induced damage in geological systems constitutes a major challenge in subsurface engineering (e.g., geo-resources completion, underground storage management, building and maintenance of tunnels, dams, mines). These highly coupled Hydro-Mechanical (HM) processes which originate at different length scales, from the crack scale (centimeter) to the fracture or fault scale (meter or decimeter), constitute prominent issues in geo-engineering that are not yet fully understood. The overall goal of this project is thus to improve our understanding of the HM processes taking place in the subsurface for a better assessment of the associated risks and to propose non-intrusive methods to help assess these processes. If the phenomena involved in hydraulically induced damage processes are reasonably well understood at the laboratory scale, considerable difficulties remain in the interpretation of in-situ behaviours, where several features come into play (e.g., geological structures, material and stress heterogeneity, anisotropy), and in the numerical modelling of such phenomena at a large scale to improve our predictive capabilities.

In order to better understand damage mechanisms and to take into account the more general problem of upscaling (from the laboratory scale to the in-situ scale), the PhD student will have to characterize experimentally at laboratory (on samples of different sizes, from the millimetric scale to the metric scale) the cracking/fracturing mechanisms induced by HM coupling in rocks. Non-intrusive experimental techniques will be used during the thesis for the monitoring of damage, namely acoustic emissions monitoring, X-ray 3D nano computed-tomography, electrokinetics/self-potential, resistivity, induced polarization. Emphasis will be put on the analysis of the evolution of mechanical properties, porosity, permeability and cracking (initiation, propagation, localization) at the different scales. The cracking mechanisms will be investigated in terms of fluid flow rate, water saturation, fluid viscosity, stress conditions and fluid chemistry.

Different experimental techniques (compression cells, damage monitoring) will be employed depending on the scale of interest: micro-compression uniaxial tests under environmental scanning electron microscope (micrometric/millimetric scale), micro-compression flow-through triaxial tests under X-ray 3D tomography (centimetric scale), macro-compression flow-through triaxial tests (decimetric scale), macro-compression flow-through true triaxial tests (metric scale). All the laboratory multi-scale poro-mechanical tests will be performed under temperature, pore fluid pressure and stresses representative of in-situ conditions. Impact of structural anisotropy will be investigated through the use of two representative claystones (including Tournemire shale) with different degrees of anisotropy. In addition, experiments under partially saturated conditions will be conducted in order to study the effect of desiccation and self-sealing processes.

This work will be carried out inside the **GeoRessources** laboratory (« Hydrogeomechanics multi-scale » team, UMR 7359 - GeoRessources UL).

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Required scientific skills

Solid basis in continuum mechanics, rock mechanics, poromechanics, transfers in porous media, petrophysics. Knowledge of geomaterials will be appreciated. The taste and interest for laboratory experimentations are mandatory. Motivation and initiative, ability to work as part of a team.

Duration

3 years: from October 2019 to October 2022

Net salary (scholarship)

1500 € per month

Application deadline

May 31th 2019

Required application documents

- Cover letter
- Curriculum vitae
- Copies of certificates of any academic degrees and marks reports during their master studies
- Recommendation Letter

Eligibility

- Citizens of all nationalities are eligible to apply
- Candidates must hold a Master's or equivalent degree
- Applicants whose first language is not French must have communication skills in written and spoken English

Contacts

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Location

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