PhD position

Title : **Effect of Microstructural factors on deformation and fluid transport in partially saturated low permeability materials**

Starting date : 2019-2020

Research Institute : GeM

Teams : MS and MEO

Location : Ecole Centrale de Nantes (France), University of Rome TorVergata (Italy)

To apply : online application on the website of « Université Bretagne Loire »
https://theses.u-bretagneloire.fr/spi/proposition-de-sujet-de-these-hors-cde

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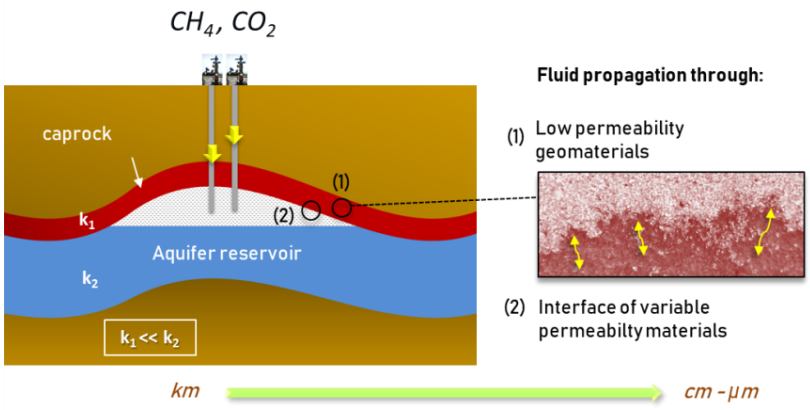
Topic

Storage of energy into underground aquifer reservoirs is one of the current solutions to solve irregularities between energy production and needs. For short or long term storages, the interface between the reservoir material and the caprock is a potential area for critical hydromechanical behavior due to different materials and fluid properties (see the figure below). Studies of outcrops have shown that a variety of types of interfaces may arise in nature, depending on the depositional setting. In particular, a gradual transition from sand-rich facies in the aquifer to mud-rich facies in the caprock can occur.



The thesis deals with the investigation of the mecanisms of fluid percolation and strain localization through the diffuse interface between high and low permeability geomaterials, as in the above case which mentioned the interface between an acquifer reservoir rock and a sealing tight caprock.

The analysis will focus on the quantitative characterization of the interactions between the microstructure, the fluid propagation and the localized strains, eventually implying fracture, of partially saturated materials which form the diffuse interface.

At the laboratory scale (0.5µm-cm), analogous materials of high and low permeability soils will be used to study their response to combined hydraulic (drainage and imbibition) and mechanical biaxial loadings. The evolution of microstructure and fluids will be followed by digital cameras on the sample cell surface of a new transparent biaxial apparatus adapted to unsaturated soils.
Full-field measurements of displacements, strains, fluid distributions and microstructure changes will be quantified by digital image correlation and mark tracking.
The challenge of this experimental activity is multi-fold from the preparation of analogous of low permeability geomaterials to the injection experiments which will involve the development of a new methodology to compare quantitatively strains, fluid distribution and microstructure in complex geomaterials.

Quantitative relationships among fluid interfaces, solid diffuse interfaces and deformation of layered geomaterials are strongly expected. The results will therefore improve the understanding of the response of large scale geomaterials interfaces during fluid injection.

Key words : low permeability materials, digital image correlation, unsaturated soils, microstructure, deformation, fluid

Skills

- Strong competences in fluid mechanics, soil mechanics, engineering geology and programming ; knowledge in digital image correlation will be appreciated.
- Ability to be independent and to work in a group
- Ability to assist with the supervision of master students, produce reports and presentations for project meetings and publications

Additional information

The thesis will be co-driven by Ecole Centrale de Nantes and by the University of Rome TorVergata. Main experimental activities are based at ECN but the PhD candidate will spend several months in Rome to complete the mechanical characterization of the unsaturated soils used in the study.

The study is developped within the framework of the ANR project STOWENG underground STOrage of reneWable ENergies in low permeability Geomaterials.