Influence of the local orientational order on the anisotropy of the hydromechanical behavior of the clay matrix of argilites
A numerical approach

Required abilities: numerical homogenization, programming.
Knowledge of poroelasticity or nonlinear homogenization would be appreciated.

The Multiscale group of the Laboratoire Navier (UMR 8205, CNRS, ENPC, IFSTTAR, navier.enpc.fr) is seeking a post-doctoral fellow to work on a project which aims at the multiscale simulation of hydromechanical couplings in the clay matrix of argilite.

The French agency ANDRA is responsible for the research on the disposal of high level radioactive waste. It has selected deep underground storage as a viable solution. Located 200m under ground level, in a layer of callovo-oxfordian argillaceous rocks, the Bure site is a scale-one experimental site where the long-term reliability of nuclear waste storage is currently investigated. The life-span of storage sites is required to be over one million years. Although the permeability of argilite is very low, variations of its water content during this very long period of time should not be ruled out. It is therefore of the utmost importance to be able to capture the complex relationships between water content and macroscropic poroelastic properties. In order to do so, two length-scales will be considered in this work.

At the smallest length scale, a model of the poromechanical behavior of the clay particles will be developed within a thermodynamic framework which was recently proposed by Brochard, Vandamme and Pellenq (2012). This theory is a rigorous extension of poromechanics to microporous materials, which can take into account non-linear couplings between the inter-layer spacing and the poroelastic coefficients of the clay particles. Molecular simulations (based on a code developed locally) will be carried out in order to calibrate this model.

The core of the project will consist in upscaling this poromechanical behavior up to the scale of the clay matrix. In order to do so, numerical homogenization of an assemblage of flat particles will be carried out using an FFT-based method (Moulinec and Suquet, 1998; Brisard and Dormieux, 2010, 2012). The microstructures on which the homogenization will be performed will be generated numerically with in-house tools, based on simple building blocks (e.g. ellipsoids). This computation will allow the determination of the macroscopic non-linear poroelastic properties of the clay matrix. In particular, the influence of the local orientational order of the particles will be studied in detail. The resulting homogenized model of the clay matrix will be confronted to experimental results.

This work is co-funded by CNRS, ANDRA, IRSN, EDF and BRGM through the program NEEDS milieux poreux, which aims at improving our knowledge of porous geomaterials through multidisciplinary projects. The post-doctoral fellow will therefore be part of a larger, trans-laboratory network of researchers. He will be supervised by Dr. S. Brisard and Dr. M. Vandamme, both from Laboratoire Navier. The fellow will be hired for 1 year through CNRS and will start as soon as possible in 2013. He will be working at Ecole des Ponts ParisTech (Paris, France).

Informal inquiries and applications (including cover letter and CV) should be sent to Dr. Sébastien Brisard (sebastien.brisard@ifsttar.fr)

References

Brochard, Vandamme and Pellenq (2012), J. Mech. Phys. Sol. 60, 606-622
Brisard and Dormieux (2010), Comp. Mat. Sci 49(3), 663-671
Brisard and Dormieux (2012), Comp. Meth. App. Mech. Eng. 217-220, 197-212
Moulinec and Suquet (1998), Comp. Meth. App. Mech. Eng. 157(1-2), 69-94

6 et 8 avenue Blaise Pascal – Cité Descartes – Champs-sur-Marne-F-77455 MARNE-LA-VALLÉE CEDEX 2
☎: +33 (0) 1 64 15 37 51 – 🖷 : +33 (0) 1 64 15 37 48 – 🖃 : sebastien.brisard@ifsttar.fr – http://navier.enpc.fr/