Title: Arrangement of clay particles in porous media: comparison between experimentations and simulations.

IC2MP Institute, University of Poitiers, France

Keywords: structure, simulation, experiments, X-ray tomography, porosity, particle orientation

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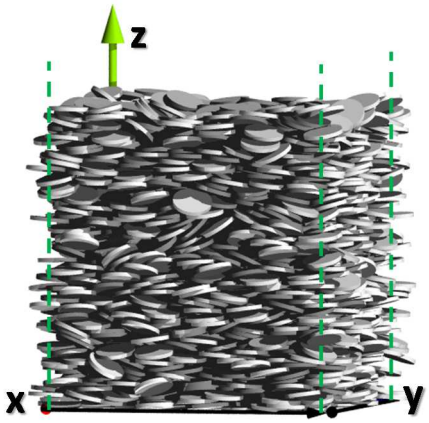
Clay minerals most often display strongly anisometric particle shapes. On larger spatial scales, the presence of these clay particles and their mutual arrangement in porous media are thus most often associated with the development of anisotropy in interparticle pore networks. Such preferential particle orientation has a considerable impact on the directional dependence of hydraulic permeability, which results in the preferential transfer of fluids and solutes. Understanding the anisotropic features of clay porous media and their effect on the migration of water and solutes is thus of prime importance for many natural processes involving the transfer of water and solutes on the macroscopic scale.

Objective 1: The student will perform simulations of porous media made of discs, in order to represent different arrangements of clay particles, on the computation cluster of IC2MP (Fig. on the right). He/she will investigate the role played by the anisotropy in particle orientation on key geometrical parameters of the porous media (porosity, anisotropy in pore network, distribution function of particle orientation, etc…).



Objective 2: The student will perform experiments by making porous media made of discs of similar dimensions and by analysis the properties of the porous media using X-ray micro-tomography available at IC2MP. Experimental results will be compared to simulated data regarding the properties of the obtained porous media. Additional experiments performed on porous media made of natural clay particles will also be performed in order to assess the validity of the relations derived from discs to natural systems.

All the information and the confrontation between experimental and numerical data will be used to shed new light on the role of clay minerals on the anisotropic features of particle orientation in natural media.

Duration of the stage: 5 months (February-March to June-July 2016).

Expected skills: numerical modelling, a bit (not mandatory) of fortran programming, porous media properties.

Articles in relation with the project:

- Ferrage, E.; Hubert, F.; Tertre, E.; Delville, A. ; Michot, L.J. ; Levitz, P. Modeling the arrangement of particles in natural swelling-clay porous media using three-dimensional packing of elliptic disks. Physical Review E. 2015. 91, 062210.
- Hubert, F.; Bihannic, I.; Prêt, D.; Tertre, E.; Nauleau, B.; Pelletier, M.; Demé, B.; Ferrage, E. Investigating the anisotropic features of particle orientation in synthetic swelling clay porous media. Clays and Clay Minerals. 2013. 61, p. 397-415.
- Reinholdt, M. X.; Hubert, F.; Faurel, M.; Tertre, E.; Razafitianamaharavo, A.; Francius, G.; Prêt, D.; Petit, S.; Béré, E.; Pelletier, M.; Ferrage, E. Morphological properties of vermiculite particles in size-selected fractions obtained by sonication. Applied Clay Science. 2013. 77-78, p. 18–32.