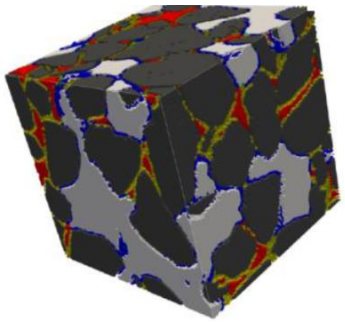
PhD position at Ecole des Ponts ParisTech
October 2024 – September 2027

Multi-scale hydro-chemo-mechanical behaviour of swelling clay-sulfate rocks

Clay-sulfate rocks are rocks that contain clay minerals and anhydrite. They swell in the presence of water because of two physical processes that increase volume: some clay minerals (e.g., montmorillonite) adsorb water (i.e., physical swelling), and anhydrite reacts with water to form gypsum (i.e., chemical swelling). If the volume increase is hindered, high swelling pressures can occur, in the order of several MPa. Consequently, construction projects in clay-sulfate rock today are still prone to imponderable risks: in tunneling, where the swelling can cause uplift of the tunnel floor, and in the context of geothermal energy, for which geothermal drillings can trigger swelling ground with uplift rates exceeding 1 cm/month, causing dramatic damages in neighboring cities.

The PhD project is part of a French-German multi-year research project (ProSwell) between Ecole des Ponts ParisTech (France) and TU Bergakademie Freiberg (Germany). The overarching goal of the multi-year research is to generate experimental results that quantitatively characterize the hydro-chemo-mechanical coupled swelling behavior of clay-sulfate rocks and translate those results into constitutive equations usable in numerical simulations at the geological structure scale.

The Ph.D. project aims to understand the physical origins for the macroscopic swelling and permeability variations observed in flow-through swelling experiments. To do so, we aim at: (1) characterizing the microstructure and its evolution in swelling experiments through direct pore-scale imaging by X-ray microtomography and scanning electron microscopy; (2) imaging water flow, profile, and state during small-scale flow-through experiments by a combination of nuclear magnetic resonance/magnetic resonance imaging.



Tomography image of a geomaterial (false color)

The candidate, who must have obtained a M.Sc. degree (or equivalent, such as an engineering degree) by the beginning of the Ph.D., must have a background in geology, rock mechanics, or soil mechanics and a strong taste for experiments.

- *Net salary: > 1700€/month*
- *Location of work: Laboratoire Navier, Champs-sur-Marne (just outside Paris, France)*
- *Duration: 36 months, from October 2024 to September 2027*
- *Contact and application: Anh Minh TANG (anh-minh.tang@enpc.fr) and Matthieu VANDAMME (matthieu.vandamme@enpc.fr).*
- *Applications:* ***by 15 March 2024****.*

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