



## PhD Research Position (Nancy, France)

### Hydromechanical behaviour of a compacted clay cover layer in the very long term

In the context of nuclear waste storage at shallow depth, it is necessary to study the hydro-mechanical parameters of the host in situ clay and of the cover layer made of compacted clay. The key issue is to ensure the sustainability of the hydro-mechanical properties of these materials in the very long term. Indeed, it is likely that they will be subjected to various environmental stresses and climate variations under different mechanical conditions in the very long term. Their hydro-mechanical properties (hydraulic conductivity, swelling pressure, etc.) could be progressively modified, thus altering the performance of the repository. It is therefore essential to quantify the impact of these stresses on the hydro-mechanical properties of these materials, including compressibility, creep and transfer characteristics.

The main objective of this thesis is therefore to quantify the impact of external modifications (water content, chemical, mechanical) on the hydro-mechanical behavior of a clay in the very long-term.. This project is divided in two main phases. Firstly, from an experimental point of view, we will focus on the analysis of the impact of cyclic water and thermal variations on compressibility, creep, hydraulic conductivity and cracking of the compacted clay. Chemical alteration of the host clay induced by a modification of the pore fluid chemistry will be also considered. Secondly, these results will be employed to model the long term behaviour of the repository to assess the impact of the alteration of soil properties.

PhD works will be of experimental and numerical nature, relying on state-of-the art laboratory equipment and strong numerical modelling resources.

Candidates should own a Master Degree in Civil, Geotechnical or Mechanical engineering, and have a strong interest in Mechanics of Geomaterials.

Knowledge of the French language is not mandatory. The thesis can be written in English.

This research is fully funded by ANDRA, the French National Radioactive Waste Management Agency ([www.andra.fr](http://www.andra.fr)).

#### Conditions

*Starting date* : September 2014 for a duration of three years

*Gross Salary/ Studentship* ≈ 2000 € per month

*Institution* : LEMTA ([http://lemta.univ-lorraine.fr/comp\\_thmc\\_sols.html](http://lemta.univ-lorraine.fr/comp_thmc_sols.html))

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#### How to apply ?

Send by e-mail before April, 15<sup>th</sup> 2014 a CV (2 pages max), if available a copy of the Master thesis (pdf file, internet link) and the name of one referee to both correspondents:

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### List of references

- Ajdari M., Habibagahi G., Masrouri F. - 2013 - The role of suction and degree of saturation on the hydro-mechanical response of a dual porosity silt-bentonite mixture. *Applied Clay Science* 83-84, pp. 83-90.
- Blanck G., Cuisinier O., Masrouri F. - 2013 - Soil treatment with organic non-traditional additives for the improvement of earthworks. *Acta Geotechnica*, pp. 1-12.
- Cuisinier O., Javadi A.A., Ahangar-Asr A., Masrouri F. - 2013 - Identification of coupling parameters between shear strength behaviour of compacted soils and chemical's effects with an evolutionary-based data mining technique. *Computers and Geotechnics* 48, pp. 107-116.
- Cuisinier, O. & Masrouri, F. 2005. Influence of complex hydromechanical loadings on the behaviour of a compacted expansive soil. *Canadian Geotechnical Journal*, vol. 42, n°3, 731-741.
- Cuisinier, O. & Masrouri, F. 2005. Hydromechanical behaviour of a compacted swelling soil over a wide suction range. *Engineering Geology*, vol. 81, n°3, 204-212.
- Cuisinier, O., Masrouri, F. (2004) Testing the hydromechanical behaviour of a compacted swelling soil. *Geotechnical Testing J.* 27, 598-606.
- Jahangir E., Deck O., Masrouri F. - 2013 - An analytical model of soil-structure interaction with swelling soils during droughts. *Computers and Geotechnics* 54, pp. 16-32.
- Le Runigo, B., Cuisinier, O., Cui, Y.-J., Deneele, D. & Ferber, V. 2009. Impact of the initial state on fabric and permeability of a lime treated silt under long term leaching. *Canadian Geotechnical Journal*, 46, 1243-1257.
- Nowamooz, H., Mrad, M., Abdallah, A. & Masrouri, F. 2009a. Experimental and numerical studies of the hydromechanical behaviour of a natural unsaturated swelling soil, *Can. Geotech. J.*, 46(4): 393-410.
- Nowamooz, H. & Masrouri, F. 2009b. Density-dependent hydromechanical behaviour of a compacted expansive soil *International Journal of Engineering Geology* 106 (3-4), pp. 105-115.