
 <p>energy environment solutions</p>	<p>Joint PhD position at University Pau &amp; Pays Adour (France) and Northwestern University (USA)</p> <p><b>Phase transitions and confined crystallization in inelastic geomaterials</b> <b>(Newpores project)</b></p>	 <p>NORTHWESTERN UNIVERSITY</p>
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### NewPores research project presentation

NewPores is an international hub dedicated to the mechanics and physics of porous materials, which intends to answer to new Energy and Environment challenges. This is a joint effort of the group on Geomechanics and Porous Materials (G2MP) of the Laboratoire des Fluides Complexes et leurs Réservoirs at E2S UPPA (France), the Centre for Sustainable Engineering of Geological and Infrastructure Materials (SEGIM) at Northwestern University (USA), the University of Vigo (Spain), the Technical University of Madrid (Spain) and University of Liège (Belgium).

### Phase transitions and confined crystallization in inelastic geomaterials

Geomaterials are porous, discrete and heterogeneous media exposed to environmental interactions. These materials host multiple fluids with which they establish physico-chemical feedbacks. During the last decades, major shifts in climate and the continued exploration of remote environments encouraged the study of phase transitions within the pores of soils and rocks, which include salt crystallization, mineral precipitation, freeze/thaw dynamics, and methane hydrate dissociation, among others. Phase transitions are a key source of weathering, as they cause unprecedented alterations in the strength and deformation properties of natural deposits. Major challenges for the future generations are especially in the context of arctic regions, which are warming faster than everywhere else on Earth. In particular, scarcity of data and lack of scientifically sound predictive models make it very challenging to predict future scenarios. This opens the possibility of unprecedented risks for natural settings, as well as opportunities for rethinking the management and design of modern infrastructure.

This project is rooted in this context and aims to deepen our understanding of the multi-scale, multi-physical behavior of fluid-infiltrated porous geomaterials subjected to alternating cycles of freezing and melting. The project aims to address low-temperature processes starting from the micro-scale, where pore-size effects control the dynamics of liquid–solid transitions and the pressure jump across phases. We aim to upscale these processes at the level of porous continua, where the existence of coexisting phases affects the stresses acting on the solid matrix, as well as the very own constitution of the matrix. Finally, we aim to tackle the mechanics of failure in materials undergoing phase transitions, thus rethinking the methods currently used to assess natural risks and infrastructure deterioration for systems subjected to temperature-induced phase transitions. Research in this area can lead to numerous benefits, including the increase of the durability of materials subjected to frost action, with consequent major reductions in maintenance and repair costs, as well as the prevention of natural hazards and loss of lives in permafrost regions, i.e. some of those most heavily impacted by projected climate changes.

### Partners

- *E2S Newpores project* (an international hub for the mechanics and physics of porous materials)
- *Centre for Sustainable Engineering of Geological and Infrastructure Materials (SEGIM)* at Northwestern University, USA.
- *Geomechanics and Porous Materials* research group (G2MP, LFCR UMR5150) at E2S UPPA, France.

### PhD candidate objectives

The overarching objective of this PhD research is to formulate and validate a computational multiscale and multiphysics model for the simulation of geomaterials under cycles of freezing and thawing. The modeling approach will be pursued within the framework of the Lattice Discrete Particle Model (LDPM) with multiphysical constitutive equations formulated in the context of damage-plasticity. The formulated model will be calibrated and validated on the basis of experimental data gathered from the literature and from tests performed during this project.



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### Candidate's profile

The candidate should hold a MSc-degree in civil, geotechnical or mechanical engineering, physics, materials science or a similar field. Previous experience with the modelling or the characterization of multi-physics couplings appearing in porous media is an asset. The candidate should have a strong interest in performing computational modelling and programming in a multi-disciplinary team. Proficiency in English is mandatory for both oral and writing communication.

### Job details

The envisioned starting date is October 1<sup>st</sup>, 2021 and the project duration is 4 years with 2 years residency requirement at both places.

The candidate is expected to earn a Ph.D. from both institutions at the end of the project.

The position will follow the local University standard (salary, social security coverage) during the 2 years residency at each institution and the evaluation procedure will be performed in parallel by the two institutions.

The candidate will be supervised by:

- Pr. David Grégoire (E2S UPPA/LFCR/G2MP)
- Pr. Gilles Pijaudier-Cabot (E2S UPPA/LFCR/G2MP)
- Pr. Gianluca Cusatis (Northwestern University)
- Pr. Giuseppe Buscarnera (Northwestern University)

### Additional information for enrollment at E2S-UPPA

For 2-years, the successful candidate will be hosted at ISA BTP Civil Engineering School by E2S-UPPA on the Basque Coast campus in Anglet, France (<https://goo.gl/maps/AHm3uNy8juiqJXfg7>). He/She will be fully integrated in the G2MP research group at LFCR lab (UMR5150). The position includes full social security coverage and a gross salary of approx. 1878 € per month. This salary encompasses 32h of teaching hours at E2S UPPA/ISA BTP per year. Candidates will be ranked in a first phase based on their submitted application. In a second phase, an interview will be organized with the selected candidates (possibly via Skype).

Applications should include a cover letter, CV, passport/ID copy, transcripts of diplomas and lists of courses attended (with grades obtained), recommendation letters, and names and contact details of at least two references.

Applications should be submitted **before 01/05/2021** at [www.davidgregoire.fr/opening-positions](http://www.davidgregoire.fr/opening-positions)

The interview will take place during the second half of May.

Final answer will be provided by the end of May.

Contact : david.gregoire[at]univ-pau.fr

### Additional information for enrollment at Northwestern University

For 2-years, the successful will be enrolled within the Mechanics, Materials and Structures (MMS) program at Northwestern University in Evanston, USA (<https://goo.gl/maps/WLJGRscW2vYccVL9>). He/She will be fully integrated in the SEGIM center. The position includes student health insurance, full tuition coverage and a stipend of approx. \$33,504 per year. Northwestern's policy is to accept students through a competitive selection process upon reception of an official application (**admission deadline: 15/12/2020**). For information on the application process, perspective students are encouraged to contact Ms. Melissa Koelling, Academic Coordinator (mkoelling[at]northwestern.edu).

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