

Cristallisation-induced damage in heterogeneous porous media in the context of the erosion of the French Basque coast and the damage of its protection buildings

Doctoral school	Doctoral School of Exact Sciences and their Applications (↪web-ED211).
University	University Pau and Pays Adour (↪web-UPPA).
Laboratory	Laboratory for the thermodynamics of complex fluids and geological reservoirs UMR5150 UPPA/CNRS/TOTAL (↪web-LFCR).
Research team	Geomechanics and Porous Media (↪web-G2MP).
PhD supervisors	David Grégoire

Context

The Ezponda project intends to answer to E2S-Energy and Environment challenges by predicting the evolution of the impact and the velocity of coastal erosion under current climate changes and forthcoming sea level rises. In particular, the Ezponda project aims at studying and hierarchizing the different key parameters (haloclasty, rain, storms), which drives coastal erosion and coastal protection building damage.

Haloclasty is a natural rock failure process driven by salt crystallisation and salt weathering. It is particularly at sight on coastal areas because it is a key parameter for their natural erosion, which is a crucial social-economic challenge for local authorities in charge of coast management.

Crystallization-induced damage contributes majorly to the degradation or weathering of natural rocks, natural building stones, construction materials and cultural heritage. When saline fluids are present in the pore space of the material, salt crystals might precipitate upon changes in temperature or humidity conditions, leading to salt precipitation on the surface, efflorescence, or to salt crystals precipitating in the pores, subflorescence. The confined crystal growth within the pores might lead to a buildup of crystallization-induced stresses, which can eventually induce fractures in the porous medium. The fracturing results from the interplay of saline flow, salt precipitation reactions and crystallization-induced stresses and it is thus essential to understand the coupling between those phenomena in order to develop models for advising local authorities in charge of coast management.

Objectives & methodology

The Ezponda project aims at studying and hierarchizing the different key parameters (haloclasty, rain, storms), which drives coastal erosion and coastal protection building damage. Within this Ezponda project, the G2MP team is in charge of the development of a robust and physically meaningful numerical simulation tool capable to predict cristallisation-induced damage in natural rock and coastal protection building. This study encompasses numerical and experimental aspects and will be based on experimental-numerical dialog. The team will consist on 2 Full Professors, 1 CNRS researcher, 1 postdoc and the PhD student. The postdoc will be hired after the PhD student in order to complete the PhD student competences and they will both work on the two aspects. Therefore PhD candidates with numerical backgrounds may apply as well as candidates with experimental ones.

Numerical modelling

First, mesoscale simulation will be developed to predict cristallisation-induced damage in the porous medium and the corresponding changes in its global mechanical properties. Then, the latter effects will be upscaled in order to predict at the scale of a geological structure or a protection building the damage induced by haloclasty and characterise its influence on the global coastal erosion phenomenon.

Experimental validation

At each step the numerical model will be validated by experimental comparison. First a dedicated site on the French Basque Coast will be instrumented in order to characterize its environmental conditions. Then, an experimental database will be built allowing the validation of haloclasty simulation tools based on the simultaneous use of both neutron and X-ray tomography to monitor at the same time the transport of fluid, the salt crystallization and the induced damage. Experimental tests will be performed at Anglet and at the ILL Institute in Grenoble, which is a unique instrument for neutron imaging. A special focus on the influence of initial heterogeneities will be studied, as natural cracks are preferential salt weathering paths.

Candidate's profile

The candidate should hold a master degree in mechanics or physics related to porous media. Candidates who are finalizing their master's program and will obtain their master degree in the summer of 2019 are also eligible and are strongly encouraged to apply. Previous experience with numerical simulation, modelling (thermodynamics, poromechanics, ...) or experimental study related to cristallisation-induced damage in porous media is an asset. The candidate should have a strong interest in the experimental-numerical dialog. Proficiency in English is mandatory.

Job details

The successful candidate will be hosted by the Geomechanics and Porous Media team of the Laboratoire des Fluides Complexes et leurs Réservoirs (LFCR, UMR5150, UPPA-CNRS-Total SA) at the University of Pau & Pays Adour (UPPA) in Anglet, France. The project will be directed by Prof. David Grégoire (Professeur des Universités) and co-supervised by Pr. Gilles Pijaudier-Cabot (Professeur des Universités) and Dr. Hannelore Derluyn (Chercheur CNRS). The envisioned starting date is 1 October 2019, and the maximum duration is 3 years. The position includes full social security coverage and a gross salary of 1768 € per month.

Evaluation procedure

Candidates are 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: cover letter, CV, passeport/ID copy, transcripts of diplomas and the lists of courses attended (with grades obtained), recommendation letters, and names and contact details of (at least two) references.

Applications should be submitted before 01/05/2019 by email (david.gregoire[at]univ-pau.fr) with an external link for downloading the application material (wetransfer or other).

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

Final answer will be provided by the end of May.

Contact

For application or further information about this position, please contact Pr. David Grégoire (david.gregoire[at]univ-pau.fr).