PhD position at University of Pau & Pays Adour

Combined neutRon and x-raY imaging for the characterization of in Situ crysTallisation-induced crAcking in the context of cuLtural heritage preservation (CRYSTAL project)

Tomographies RX et neutron pour la caractérisation in situ de l'endommagement induit par cristallisation de sels dans le contexte de la préservation de sites culturels patrimoniaux

CRYSTAL research project

Crystallization-induced damage contributes majorly to the degradation or weathering of natural building stones, construction materials and our 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 the building and stone conservation industry. Moreover, it can be expected that with climate change, salt weathering will become even more important: cycles of wetting and drying will become extremer and larger risks for floods (rising damp) and wind-driven rain on buildings will arise.

The CRYSTAL project is motivated by the interest of the local authorities and restoration companies in salt weathering of historic monuments and will start with the characterisation of two buildings affected by salt action. The first one, the Villa Belza in Biarritz at the Basque Coast, is exposed to marine conditions, whereas the second one, the city hall of Pau, is subjected to an urban context. The composition of the salt mixtures in the stones and mortars will be analysed on site and in the lab, benefitting from an interregional collaboration with the IBeA laboratory at the University of the Basque Country. In addition, the transport properties, mechanical and poromechanical properties of the stones and mortars will be determined on virgin and weathered samples originating from the sites. This will allow defining critical weathering conditions for selecting suitable combinations of stone/mortar and salt to reproduce realistic damage patterns in the lab while focusing on the fundamental coupling factors between transport, crystallization, deformation and fracturing. These couplings will be studied at the pore scale level by visualizing the process dynamics in 3D using simultaneous X-ray and neutron tomography. The project builds on previous work where neutron imaging proved to be a well-suited technique for saline transport visualization in rock samples, and X-ray tomography was employed to analyse salt precipitation and crystallization-induced fracturing in the same samples post mortem. Ideally, X-ray and neutron images should be acquired simultaneously, to elucidate on the direct coupling between saline transport, salt precipitation, and salt damage. This would be novel to the field of crystallization in porous media, and becomes possible through a collaboration between the host laboratory, the 3SR laboratory and the ILL at Grenoble and TOTAL.

Within the CRYSTAL project, the PhD candidate will be in charge of the materials' characterization, the development of a dedicated experimental setup compatible with the X-ray μCT scanner at the Pau Centre for X-ray imaging and the D50 beamline at the ILL, and the image processing, analysis and interpretation of the acquired datasets. As such, an indispensable dataset for future validation of salt damage models at the pore scale level will be obtained.

Candidate's profile

The candidate should hold a master degree in civil or mechanical engineering, physics, materials science, geosciences or a similar field. Candidates who are finalizing their master's program and will obtain their master degree in the summer of 2017 are also eligible and are strongly encouraged to apply. Previous experience with the characterization of porous media, the development of custom-made experimental set-ups or tomographic imaging is an asset. The candidate should have a strong interest in performing experimental work in a multi-disciplinary team. 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 Pau, France. The project will be directed by Prof. David Grégoire (Maître de Conférences, HDR) and co-directed by Dr. Hannelore Derluyn (Chargée de recherche CNRS). The envisioned starting date is 1 October 2017, and the maximum duration is 3 years. The position includes full social security coverage and a gross salary of 1685 € 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 a cover letter, CV, 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 01/05/2017** by email. The interview will take place during the second half of May. For application or further information about this position, please contact Dr. Hannelore Derluyn (hannelore.derluyn@univ-pau.fr).