PhD student (F/M) for ERC project on Dynamic salt precipitation experiments in rock (https://bit.ly/3gZ4KCT)

Thesis description

Climate change leads to increasing weathering cycles on landscapes and the built environment. Promotion of alternative energy sources such as geothermal energy and underground storage of CO_2 intensifies cyclic perturbations of the underground environment. Both lead to precipitation-dissolution cycles of salts, natural constituents of brines present inside porous rock. When precipitation occurs inside the pores, stresses build up which eventually crack the material. This might be a positive outcome, e.g., increasing the production rate of a geothermal reservoir, or on the contrary, be the cause of severe deterioration of natural building stones and coastal erosion, or lead to leakage of CO_2.

What is the actual trigger for the dynamic response of a rock when precipitation occurs, and can we ultimately control this trigger? The EU-funded ERC project "Precipitation Triggered Rock Dynamics: the missing mesoscopic link" (PRD-Trigger) advocates that the answer lies at the mesoscale, i.e. the scale of the pore network, where precipitation-dissolution reactions, geometry changes and flow and transport properties changes meet. These reactions and changes are strongly coupled, but their respective importance for the resulting rock dynamics is unclear. As a PhD-student on this project, you will work on an experimental work package performing 4D X-ray micro-tomographic experiments providing new insights in the correlations between transport-precipitation-deformation processes inside rock.

Your first task will consist in designing test protocols that result in a damaging dynamic response of the rock to salt precipitation. We will start working with two model salts, sodium sulphate and sodium chloride. Sodium sulphate and sodium chloride are the two most abundant salts found in building materials upon salt weathering damage. Sodium sulphate can be considered as a "model" salt for hydration reactions, whereas sodium chloride can be regarded as a "model" salt for coastal conditions or reservoir brines. In a second task, visualizations will be made in 4D (3D and time) of the most damaging protocols identified in task 1 by means of dynamic X-ray imaging. In the final task, the main objective is to identify key correlations between morphological identifiers of the pore space, fluid and salt distributions, and precipitation damage, based on quantitative image processing of the datasets acquired in task 2. An optimized analysis workflow will need to be set up in this task to merge analysis methods that currently exist separately for morphological recognition, phase segmentation and digital volume correlation.

Work context

You will work within the framework of the ERC project PRD-Trigger, led by Dr. Hannelore Derluyn (CNRS Associate Scientist). The PRD-Trigger team will consist of you, Dr. Derluyn, a technical engineer and two postdocs, and is affiliated with the French National Centre for Scientific Research (CNRS). The team will be hosted at the Laboratory of Complex Fluids and their Reservoirs (LFCR UMR 5150, *lfc.univ-pau.fr*) and the Pau Centre for X-ray Imaging (DMEX UMS 3360, *imagingcenter.univ-pau.fr*) at the University of Pau & Pays Adour (UPPA) in France, on its campus in Pau. Prof. L. Mercury of the Earth Sciences Institute of Orléans (University of Orléans) will be an external advisor of your PhD project. You will be registered as a PhD student at the Doctoral School of Exact and Applied Sciences ED 211 SEA, an ISO 9001 certified school.

UPPA is a laureate of the French Science Innovation Excellence Initiative I-SITE (one of only 8 universities in France, *e2s-uppa.eu*). The LFCR consists of about 110 members (60 non-permanent, 40 permanent staff and 10 support staff) and its research focuses on the behavior of fluids and reservoirs, and the coupling between them, from nano to reservoir scale. The multi-disciplinary character of the laboratory is reflected by the research groups of which it consists, working on: (1) geomechanics and porous media, (2) characterization of geological reservoirs, (3) interfaces and dispersed systems and (4) thermophysical properties. The PRD-Trigger project inscribes into the transversal research axes of the laboratory spanning the different research groups, focusing on multi-scale numerical approaches and experimental imaging techniques. DMEX is a service unit, ISO 9001 certified since 2017, whose mission is to provide services related to X-ray imaging and material characterization, both to academic and industrial (TOTAL, TEREGA, STORENGY, SAFT,…) partners.

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 this summer are also eligible and are strongly encouraged to apply. Previous experience with the characterization of porous media and tomographic imaging is an asset, but not mandatory. The candidate should have a strong interest in performing experimental work in a multi-disciplinary team. Proficiency in English is mandatory.

Complementary information

Interviews will be held end of June online or if possible at the laboratory in person. Preferable starting date is between September and October 1st 2020. The position is for a duration of 3 years, with a monthly gross salary of 2135 €.

More information on the ERC-project and Dr. Derluyn can be found on:
in English:
https://www.youtube.com/watch?v=d4RimsgjwzA
https://cordis.europa.eu/project/id/850853
in French:
https://insis.cnrs.fr/fr/personne/hannelore-derluyn
https://recherche.univ-pau.fr/_resources/Documents/Emergences/Emergences2019.pdf

More information on moving to Pau, the gateway to the mountain range of the Pyrenees, can be obtained on the website of UPPA's International Welcome Desk:
https://ri.univ-pau.fr/en/international-welcome-desk.html
and on the city's website: https://www.pau.fr//accueil

How to apply

In a first step, it is mandatory to apply via the CNRS portal: https://bit.ly/3gZ4KCT by **June 25th 2020**, after which a preselection will be made. Please do not apply by email directly.
Contact: Dr. Hannelore Derluyn (hannelore.derluyn@univ-pau.fr)