# Apprenticeship offer IFPEN

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*The teams in the Digital Physics of Porous Media and Experimental Physics of Fluids and Porous Media departments of the Earth Sciences and Environmental Technologies division offer an apprenticeship at the Rueil-Malmaison site.*

## Apprenticeship topic

**Experimental/numerical coupling for modelling carbonate dissolution.**

## Job description

### Context

The injection and storage of anthropogenic $CO_2$ in deep saline aquifers is one of the solutions being considered to reduce its accumulation in the atmosphere and thus limit the cause of climate change. The success of large-scale storage projects depends on the multi-scale characterisation of these geological formations, an understanding of $CO_2$ and brine flows, and knowledge of fluid/rock interactions.

Among the physical and chemical processes inherent in the injection of $CO_2$ at depth, its solubilisation in the aquifer has two consequences: (1) the acidification of the brine in contact with the $CO_2$ and (2) an increase in the brine density as a result of the $CO_2$ solubilisation. At the reservoir scale, the acidification and brine density rise mainly occur at the interface between the stratigraphically trapped $CO_2$ plume and the aquifer above which it accumulates. This results in the destabilisation of the upper layers of the aquifer by gravity, with heavier, acidified brine being carried downwards and 'fresh' water rising towards the caprock. This density-driven flow is a critical mechanism in $CO_2$ storage but also impacts the geological formations it flows through. In the case of carbonate rocks, the circulation of acidified brine leads to their gradual dissolution according to complex dissolution patterns specific to the flow conditions and the chemical and petrophysical properties of the rock. Finally, the dissolution alters the initial properties of the geological formation, as well as its flow and storage properties.

Understanding dissolution mechanisms and predicting dissolution patterns are essential for determining the viability and sustainability of a $CO_2$ storage project.

### Missions

The proposed apprenticeship aims to numerically model dissolution phenomena at a laboratory scale on a carbonate rock sample. It requires understanding the physical and chemical properties that control this dissolution to extract the relevant properties for creating a static model representative of the porous medium. 3D tomographic images and experimental data on the dissolution of carbonate rocks will have been acquired beforehand, under different injection conditions and with different carbonate rock types, to carry out the experimental/numerical coupling.

The first step will be to build a static model representative of the rock sample. Image processing approaches will be needed to estimate/characterise various properties (porosity map, permeability, facies, etc.) from the tomography images and to upscale them to the numerical model's dimensions. A second step will be to optimise parameters that are difficult to measure (reactive surface areas, reaction kinetic constants, etc.) using reactive transport modelling. Finally, the last stage may involve analysing the evolution of the above properties during dissolution and adapting the numerical model/laws accordingly.

You will work closely with a team of engineers, technicians and students. You will be familiar with experimental data acquisition and numerical modelling techniques.

**Techniques applied during the apprenticeship**

- Image processing / Analysis
- Static and dynamic numerical modelling
- Computer programming

## Requested profile and skills

- Apprentice engineer for the IFP School's Petroleum Geosciences programme (PGS) or the IFP School's Petroleum Engineering & Project Development programme (PEPD)
- Proficiency in computer programming
- Advanced knowledge of numerical modelling (static and dynamic)
- Knowledge of fluid mechanics, geochemistry and petrophysics
- Autonomy and good interpersonal skills

## Contacts

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