

Characterization of the mechanical and petrophysical properties of the Barrois limestone formation

BARROIS research project¹ context and objectives

BARROIS¹ intends to answer to Energy and Environment challenges in the context of the CIGEO² project, a deep geological disposal facility for radioactive waste, that is currently under discussion to be built in France. CIGEO may serve for disposal of highly radioactive long-lived waste produced by France's current fleet of nuclear facilities, until they are dismantled, as well as from reprocessing of spent fuel from nuclear power plants.

In this context, BARROIS gathers a multidisciplinary team that aims to better constrain the geological characteristics of all the lithological units constituting the Barrois Limestone formation, overlying the possible clayey host layer for radioactive wastes, and ultimately to better understand the associated hydrological system, in particular because of its karst nature. The petrophysical properties (porosity and permeability) and their spatial variability as well as the organization and extension of the fracturing of the limestone formation largely govern the possible circulations of fluids. Recent studies showed that the gelifraction/cryoclasty processes have mainly affected the first thirty meters of the formation, thus developing a complex network of fractures which evolves over time. Understanding and identifying the fracturing processes as well as the related parameters constitute an essential scientific issue for the further development of the geological, structural and hydrological model of the Barrois limestones in the Meuse / Haute-Marne sector.

The Barrois Limestone formation (Upper Kimmeridgian - Lower Tithonian) consists of a succession of six (6) carbonate lithological units, with metric to pluri-decamic thicknesses and variable amounts of clays and silt. These limestones constitute the surface formation present on the Meuse / Haute-Marne site with a thickness of up to 140 m. Given the thickness of the formation, its great regional extension and its fractured and karstified character, it represents a multi-layered aquifer and an important water resource system.

The three main objectives of the BARROIS project are:

- the study of the fracturing (nature, distribution / density, orientation, dimension, filling, etc.) and the mechanical characteristics of the various limestones;
- the characterization of the matrix properties as well as the diagenetic processes associated with the different lithological units;
- the interpretation of the spatial distribution of the structural heterogeneities as a function of the sedimentological, the diagenetic, the petrophysical and the mechanical parameters in order to provide, for a later study, the essential input data for the robust determination of the horizontal and vertical flows in the hydrographic network.

Partners

Academic partners:

E2S-UPPA - LFCR/G2MP team

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Paris-Saclay Univ. - GEOPS/RBR team

Pr. David Grégoire (porous media and rock mechanics)

Pr. Jean-Paul Callot (structural geology)

Dr. Nicolas Beaudoin (diagenesis and structural geology of carbonate)

Dr. Benjamin Brigaud (sedimentology and diagenesis)

Dr. Thomas Blaise (sedimentology and diagenesis)

Private partners:

CVA group

Cambridge Carbonates

Company for consulting and services in petroleum geosciences

Company for expertise in carbonate and evaporite systems

Master candidate objectives

Within the BARROIS project, the master candidate will be in charge of the rock material characterization in term of petrophysical and mechanical properties (~100 samples). In Anglet, he will carry out mercury intrusion porosimetry tests to identify the porosity and the pore size distribution, gas permeability tests to measure the transport properties and ultrasonic pulse velocity tests to measure elastic properties. In addition, and in collaboration with Heriot-Watt University, he will perform triaxial and Brazilian tests to characterize the elastic and the fracture properties of some selected samples. The sampling and the plug preparation will be performed independently. The master will have the opportunity to travel and exchange with all the other partners and particularly with another master student hosted at Paris-Saclay university and in charge of the sedimentology and diagenesis characterization. For instance, an intermediate meeting will be organized in June within the CIGEO site and the underground research lab will be visited by the students in the presence of all the partners.

Laboratories

Main location

G2MP research team (4 months), LFCR lab (UMR5150 UPPA CNRS Total), Anglet, France.

Secondary location

CRG research team (2 days per months), LFCR lab (UMR5150 UPPA CNRS Total), Pau, France.

Tertiary location

Heriot-Watt University (1 month residency), Edinbourg, UK.

Grant

560 € / month.

Duration

From February 1st to June 30th, 2022 (5 months).

Candidate's profile

MSc student (M2) in geomechanics, rock mechanics or civil engineering with a strong interest in performing experimental work in a multidisciplinary team. Proficiency in English is mandatory for both oral and writing communication.

Contact and supervision

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Dr. Nicolas Beaudoin – nicolas.beaudoin@univ-pau.fr

¹ BARROIS project: Spatio-temporal analysis of the diagenesis and fracturing of the Barrois limestone formation

² The Industrial Centre for Geological Disposal (<https://international.andra.fr/solutions-long-lived-waste/cigeo>)