CIVIL AND ENVIRONMENTAL ENGINEERING

MUR DM 117/Stellantis - Chemo-Mechanical effects of CO2 sequestration on aquifer rocks

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Context of the research activity	Over the coming century, Carbon Capture and Storage (CCS) in deep sedimentary formations (i.e. saline aquifers and exhausted hydrocarbon reservoirs) might contribute to over 20% of CO2 emission reduction. One of the major challenges for storage is the CO2-induced alteration of rock properties. To date, this has mainly been tackled from a transport-chemical perspective. The triggered geochemical reactions can induce formation porosity and permeability changes. Mechanical effects, i.e. collapse and changes in strength, are also anticipated. This research aims at their identification and quantitative evaluation at the laboratory scale. Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23001990004
Objectives	Mechanical effects related to CO2 geological sequestration are driven by the chemical interaction between the pore fluid and the rock minerals. Preliminary evidence showed that the flow of CO2-saturated water leads to pore structure collapse in carbonate rocks, whereas salt precipitation and an increase in stiffness occurred in sandstones. The environmental success of the Carbon Capture and Sequestration depends on the chemo-mechanical interaction with the host rock, in terms of reactions, changes in the pore fluid composition and triggered mechanical behaviour. Pore structure collapse might lead to undesired settlements at the ground surface, while salt precipitation might lead to pore clogging and make the injection of CO2 more difficult. Given the time scale of the CO2 life in the underground and the complex geochemo-mechanical processes involved, the safe engineering of CCS requires an advancement of existing experimental data and modelling tools, to be implemented in coupled chemo-hydro-mechanical FE codes.

	The proposed PhD project focuses on the chemo-mechanical interaction in the host rocks. It aims to contribute to engineering knowledge by quantifying these effects to check their relevance in the practice and allowing their forecasts in planned operations. It will develop as follows: - Providing an updated overview of the scientific state of the art; - Providing experimental data on the impact on CO2-rich water/low pH water and/or supercritical CO2 interacting under in situ stress conditions with reservoir/aquifer rocks. Two materials might be studied, one carbonate dominated, the other quartzitic, - Checking the reliability of existing mechanical constitutive models for the type of degradation/enhancement phenomena described in the literature and obtained from experimental data; - Contributing to the coupling between the transport-reaction models and their mechanical counterparts.

Skills and competencies for the development of the activity	Knowledge of soil and rock mechanics is required. Knowledge of constitutive modelling and transport phenomena in porous media is also appreciated.