SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

DM 351 PA - Characterization of shale cap-rock formations for gas storage activities

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Context of the research activity	Energy transition is a process toward decarbonization of the energy sources and mitigation of greenhouse gases emissions responsible for climate change. Gas storage in deep geological formations is considered as one of the most significant and viable options for CO2 sequestration but it has also been given increasing consideration for large-scale storage of chemical energy (H2). For these reasons underground gas storage has been included among the fundamental topics to be investigated in the project “Infrastructure for Energy Transition and Circular Economy @ EuroNanoLab” (iENTRANCE@ENL) supported by MUR through the PNRR funds. Underground gas storages require a multi-disciplinary study approach to define their capacity, injectivity and safety. Safety comprises the hydraulic and the mechanical sealing efficiency of the cap-rock, typically a low-permeability clayey formation, which must be able to guarantee long-term confinement of gases in the underlying reservoir. The research topic is the setup and execution of dedicated laboratory analyses, which are fundamental to characterize the properties of the cap-rock according to different conditions, corresponding to as many storage scenarios. Potentially, the design and/or setup of the equipment are included. An important target is also the definition of best practices to test caprocks for hydrogen and CO2 storage. These technical guidelines could serve as a reference to regulatory bodies and public authorities to assess whether safety issues have been properly assessed and/or to recommend optimal testing procedures.
	Scholarship funded in the frame of MD 351/2022 Public Administration CUP: E12B22000890005 Main seat to carry out the research: Politecnico di Torino – DIATI Internship at the IIT (Istituto Italiano di Tecnologia) - Center for Sustainable Future Technologies (Torino) Supervisor: Francesca Verga francesca.verga@polito.it

Objectives	The focus of the PhD project is the laboratory determination of the key petrophysical and fluid-rock interaction parameters (porosity, permeability and threshold capillary pressure) of the cap-rock together with its mechanical characteristics (strain and strength). These properties represent fundamental data to assess the storage safety and also a necessary input to the analytical methods and numerical models applied to simulate the system response to fluid injection. The main goal of the research is setting and/or optimizing laboratory techniques for the evaluation of the abovementioned caprock parameters. Furthermore, empirical correlations between different types of parameters can be potentially defined. Although some testing techniques are routinely adopted for geotechnical analyses they have to be optimized to investigate deep formations - which are subject to high pressure and high temperature conditions. Other tests, such as those focusing on the determination of the threshold pressure, still lack a widely adopted approach; consequently, the optimization of the testing equipment and techniques must be addressed. Useful suggestions might be taken from the review of the available technical literature, however direct lab experience will allow the candidate to define new, effective procedures to be shared with the scientific community and regulatory bodies and public authorities. In fact, existing guidelines are very general and limited to pointing out the need for guaranteeing safety conditions but do not address the technical problems. Eventually, the data obtained by laboratory analyses on a number of samples cored from real caprocks will be used to setup a reference dataset to be used in the case of damage or absence of samples from other potential storages. This data set too will serve as a reference for further applications

Skills and competencies for the development of the activity	Strong background in petroleum engineering. Specific knowledge on laboratory testing equipment and methodologies for rock petrophysical and mechanical characterization and reservoir simulation. A MSc degree in Petroleum Engineering / Petroleum and Mining Engineering will be preferentially considered.