EVALUATION OF THE HYDROGEN STORAGE POTENTIAL OF POROUS-MEDIA DEPLETED HYDROCARBON RESERVOIRS OF ITALY

Hydrogen has emerged as a primary factor to addressing both the climate and energy crises, owing to its clean combustion and storability. Among storage alternatives, Underground Hydrogen Storage (UHS) offers significant advantages, including large capacities, enhanced safety, and lower levelized costs of stored gas. However, given Italy's extensive oil and gas infrastructure and the geological diversity of its hydrocarbon reservoirs, a dedicated workflow is essential to optimize site-selection procedures. In this context, this thesis establishes a robust workflow for selecting UHS sites, contributing to the assessment of hydrogen storage potential within Italy's porous, depleted, and nearly depleted hydrocarbon reservoirs. To achieve this goal, two primary stages were developed: a preliminary screening phase and a site-specific characterization phase. In the screening stage, a wide range of candidate sites was evaluated using a custom method designed to rank them from multiple perspectives and identify the most promising options for hydrogen storage. Key parameters influencing the site ranking were highlighted, and potential scores were calculated for less well-characterized sites. Building on this, a comprehensive experimental approach was applied to evaluate the geochemical reactivity and potential structural changes induced by hydrogen exposure in a sandstone from an Italian reservoir. This included a preliminary characterization of Torrente Baganza turbiditic sandstones, followed by a series of static batch tests and a flow-through experiment conducted at varying pressures, temperatures, and durations to simulate conditions potentially occurring in UHS sites over both short and long timescales. The samples underwent post-exposure petrographic, structural, and geochemical re-characterization. Overall, this study introduces the first systematic workflow for the ranking and characterization of potential UHS sites in Italy, marking a fundamental step toward evaluating the country's hydrogen storage potential in porous hydrocarbon reservoirs. Additionally, the research highlights the benefits of active collaboration between academia and industry, offering valuable insights into sandstone reactivity to hydrogen and identifying effective experimental approaches for similar assessments.