

Abstract Title: Understanding Caprock Integrity During Underground Hydrogen Storage (UHS) in Subsurface Rocks

Understanding caprock integrity is pivotal to the safe and efficient deployment of subsurface hydrogen storage as a crucial element of the renewable energy landscape. This research contributes valuable insights to the broader goal of achieving sustainable energy solutions while minimizing environmental risks associated with subsurface operations. The successful storage of hydrogen in subsurface geological formations depends largely on the integrity of the caprocks that overlays the reservoir rocks. These caprocks are impermeable rocks that serves as barriers, preventing the leakage of stored hydrogen gases to the surface. This abstract provides an overview of the research that will be conducted to comprehensively understand caprock integrity within the context of underground hydrogen storage.

The study employs a multidisciplinary approach, combining petrophysics, geochemistry, and geomechanics principles to assess the factors influencing caprock seal efficiency during UHS. Shale from different formations (Marcellus, Wolfcamp, Manos and Eagleford) were obtained for this analysis, which was followed by injection-depletion cycles of hydrogen into these rocks at approximately 1000psi at different time steps (0, 30, 45, and 90 days) in a pressure reactor. At each time step, hydrogen was depleted from the pressure reactor, and the changes in the rock strength and permeability was recorded. In order to have a deep understanding of changes in rock strength and permeability, pore size distribution, change in mineralogical and elemental composition, and changes in gas composition will also be carried out.

In order to recommend the results for commercial use, the laboratory generated results would be scaled-up using advanced numerical simulation tools, such as the computer modelling group compositional and unconventional reservoir simulator (CMG GEM), in order to model caprock behavior over extended storage periods and under different operational scenarios. These simulations will help predict potential caprock failure mechanisms, such as fracturing or gas migration pathways, allowing for preemptive risk mitigation strategies.