Underground gas (H₂, CO₂) Storage: Engineering-based solutions contributing towards a net-zero carbon society

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Abstract

The UK is poised to embrace net zero carbon emission technologies to meet its Paris accord targets, including offshore gas storage associated with hydrogen fuel economy (UHS) and long-planned Carbon Capture Utilization and Storage (CCUS) schemes. During gas injection into geological reservoirs, different dissolution and precipitation processes can occur simultaneously, due to pressure and temperature gradients and chemical disequilibria. Consequently, local rock heterogeneities develop, potentially affecting both the injectivity and mechanical integrity of the storage site. In the NOC Rock Physics Laboratory (NOC-RPLab), we conduct experiments which replicate reservoir conditions during human gas (CO₂ and H₂) injection/extraction activities in target CCUS and UHS reservoirs. Our goal is to generate data that can help ensuring safe and sustainable operations: (i) by understanding how they could compromise the stability of the geological system and affect the ecosystems above (e.g., leakages, shallow aquifer contamination, tremors), and (ii) by exploring more efficient carbon clean strategies, such as CO₂ enhanced geothermal recovery or CO₂-buffering H₂ storage. The integration of our experimental data into seismic forward modelling is essential to assess the detectability and interpretation of all these changes using remote geophysical methods.

Biosketch

Dr Falcon-Suarez is an experimental geoscientist with wide-ranging experience in hydrogeomechanical, geophysical and geochemical techniques and proven skills in water-engineering. He uses these skills to expand the Ocean BioGeosciences group in the UK National Oceanography Centre (OBG-NOC) research expertise into climate change mitigation and cleaner energy strategies, including CO₂/H₂-seawater-rock interactions underground during CO₂ and H₂ storage, reservoirs characterization/monitoring during production/injection activities and seafloor minerals and energy resources quantification. He leads and develop an interdisciplinary research strategy that includes designing multisensory experimental setups, generating comprehensive datasets and coding novel software for data interpretation, to generate cutting-edge outcomes for multiple projects funded by EPSRC, NERC, EU and Research Council of Norway (https://noc.ac.uk/n/Ismael+Himar+Falcon+Suarez)